12-18-2015

Stochastic Goal Programming and a Metaheuristic for Scheduling of Operating Rooms

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A Thesis
Submitted to the Faculty of Graduate Studies
through the Department of Industrial and Manufacturing Systems Engineering
in Partial Fulfillment of the Requirements for
the Degree of Master of Applied Science
at the University of Windsor

Windsor, Ontario, Canada

2015

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ABSTRACT

Health care systems in Canada provide benefits to patients but have issues with costs and wait lists. Long wait lists negatively affect patients' welfares. This in turn can increase costs because conditions can develop into more complicated ones over time. Operating rooms in a hospital are responsible for a significant portion of both costs and benefits; therefore, finding ways to use them more efficiently can reduce both the waste of tax dollars and the lengths of wait lists and can improve patients' welfares. In this research, a stochastic weighted goal programming model is proposed to perform elective surgery scheduling under uncertainty of both surgical durations and patient lengths of stay. The model generates a Master Surgical Schedule that schedules surgical teams in operating room blocks in a way that minimizes four objectives, which are the deviations between the targeted number of surgeries and the actual number of surgeries performed, the deviations between the targeted number of hours for surgeries and the actual number of hours used for surgeries, the maximum expected number of patients in the recovery ward over the course of the planning horizon, and the difference between the maximum and minimum expected numbers of patients in the recovery ward over the course of the planning horizon. In addition, the impact of cancellations on the schedule is taken into account. A simulated annealing metaheuristic is developed to find near-optimal solutions. Discrete event simulation is used for validation and to demonstrate the system of operating rooms and recovery ward beds to relevant stakeholders in the health care sector.

ACKNOWLEDGEMENTS

I would like to acknowledge my co-advisors, Dr. Ahmed Azab and Dr. Mohammed Fazle Baki, for allowing me to work on this research. Furthermore, I would like to thank them for their guidance and suggestions. I would also like to acknowledge my committee members, Dr. Maher El-Masri and Dr. Reza Lashkari, for providing invaluable constructive criticism.

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CPU	Central Processing Unit
DSS	Decision Support System
MSS	Master Surgery Schedule or Master Surgical Schedule
OR	Operating Room
ORUU	Operating Room Underutilization
OT	Operating Theatre
PACU	Post-Anesthesia Care Unit
SA	Simulated Annealing
VBA	Visual Basic for Applications

CHAPTER 1: INTRODUCTION

In Chapter 1, background information relevant to the problem is provided. The specific engineering problem being considered and its importance are then explained.

1.1 Health Care and Insurance in Canada

Developed countries typically have some form of universal public health coverage. Canada is no exception to this. Health care and health insurance in Canada are complicated to some extent by jurisdictional issues. Although the federal government provides some transfer funding for health care and has some powers because of the Canada Health Act and other laws, health care and health insurance are primarily provincial and territorial issues; therefore, there is no single Canadian health care system (Deber, 2003, pp. 20-21). In each province and territory, people who meet residency and other eligibility requirements can register for public health insurance, which covers many common medical issues (Deber, 2003, p. 20). Some procedures are not covered by provincial health care plans; thus, some patients may have to rely on private sources, such as private insurance provided by employers, to pay for treatments (Deber, 2003, p. 22).

Although universal public health coverage is available, some Canadians still choose to travel abroad for medical treatment. This suggests that some Canadians may not have confidence in their public health care systems. Determining why these people choose to leave can provide some insights into how health care systems can be improved from the perspective of patients and potential patients. According to Snyder et al. (2011), Canadians engage in medical tourism primarily because of wait lists (pp. e142-e143). Reducing the time that patients have to wait for surgeries therefore is an important goal to achieve.

From the perspective of taxpayers, provincial and territorial governments, and the federal government, the main issue with Canadian style health care is and will continue to be funding. If all of the provincial and territorial budgets in Canada were combined, then

approximately 38% of the money would be spent on health care (Canadian Institute for Health Information, 2015c, p. 18). There are three main factors that will continue to increase the cost of health care in Canada: an increasing population, an aging population, and a desire for cutting-edge procedures. Canada currently has one of the highest population growth rates in the developed world (Statistics Canada, 2014, p. 14). Clearly, the increased number of people will strain the health care system; therefore, provincial and territorial governments will have to devote more funding to health care. The median age of Canadians in 2014 was nearly 10 years higher than in 1984; furthermore, the over-65 and over-85 age cohorts in Canada have population growth rates that are significantly higher than the 15-64 cohort (Statistics Canada, 2014, pp. 56-59). The aging population will strain health care systems; consequently, funding will have to be increased. Finally, according to Snyder et al. (2011), the secondary reason that Canadians engage in medical tourism is because other countries have procedures that are not available in Canada (p. e143). If provincial and territorial governments want their residents to retain confidence in their health care systems, then they will have to fund more of these procedures in order to prevent Canadians from travelling to other countries to procure health care.

Industrial Engineering methodologies can be used to help fix some of these issues. The following section explains the concepts used in this proposed thesis.

1.2 Industrial Engineering Methodologies

In this section, relevant Industrial Engineering methodologies are explained.

1.2.1 Goal Programming and Stochastic Programming

Goal programming is a form of mathematical programming that makes it possible to consider multiple objectives. A goal is set for each objective, and the deviation between each objective and its goal are minimized. There are three common types of goal programming: weighted, lexicographic, and min-max (Tamiz et al., 1998, p. 570). In weighted goal programming, each objective is multiplied by a weight assigned to it, and the overall objective function, which is the Archimedian sum of all these, is minimized (Tamiz et al., 1998, p.

570). In lexicographic goal programming, the objectives are assigned priorities; next, they are ranked by priority from highest to lowest; subsequently, the first objective is minimized by itself, and a constraint is set after the optimization to prevent the next optimization from obtaining a worse result; finally, this procedure is repeated for all of the objectives (Tamiz et al., 1998, p. 570). In min-max goal programming, the maximum difference between any goal and its objective is minimized (Tamiz et al., 1998, p. 570).

Stochastic programs have two or more stages. In a two-stage problem, first stage decisions are made under uncertainty of second stage parameters (Kall & Wallace, 1994, p. 9). In the second stage, there are a finite or infinite number of scenarios that contain realizations of second stage parameters (Shapiro et al., 2009, p. 30). If there are a finite number of scenarios, then the overall objective function is the sum of the first stage costs and the expected value of the objective functions from the second stage (Shapiro et al., 2009, p. 4).

1.2.2 Optimization Methods

There are two main types of optimization methods: exact and approximate. An exact optimization method will find the best feasible solution whereas an approximate method will just find a feasible solution (Talbi, 2009, p.18).

There are different types of exact optimization methods. Branch and bound, branch and cut, and branch and price are commonly used exact optimization methods that use tree structures to enumerate solutions until the optimal solution is found (Talbi, 2009, p. 19). Other examples of exact methods are dynamic programming, constraint programming, and iterative deepening algorithms. (Talbi, 2009, p.19).

Approximate optimization methods are divided into two classes: approximation algorithms and heuristic algorithms. An approximation algorithm is specific to a problem being solved and is designed to find a solution with a certain level of optimality within a certain amount of time; a heuristic algorithm finds a near-optimal solution but does not have any guarantees with respect to the level of optimality or the amount of time required to find the solution

(Talbi, 2009, pp. 21-23).

Heuristic algorithms are also divided into two classes: specific heuristics and metaheuristics. A specific heuristic can only solve a specific problem whereas a metaheuristic contains a higher level heuristic that controls one or more lower level heuristics (Talbi, 2009, p. 21).

The appropriate optimization method depends on the problem being considered. If the problem is small, then an exact method, such as branch and bound, usually will be appropriate. However, large problems often can not be solved using exact methods. This is referred to as intractability (Gigerenzer, 2008, p. 21). Approximate methods should be used for large problems. Approximation algorithms and specific heuristics are problem specific and typically obtain solutions that are far from optimal; for these reasons, they are not particularly useful (Talbi, 2009, pp. 21-23). Metaheuristics are not problem specific and can find near-optimal solutions reasonably quickly; accordingly, they are useful for solving large problems (Talbi, 2009, p. 23).

1.2.3 Simulated Annealing

Simulated annealing (SA) is a metaheuristic proposed by Kirkpatrick et al. (1983) and Černỳ (1985) that is inspired by the actual process of annealing. At the start of the metaheuristic, a random initial solution is generated (Nahar et al., 1986, p. 294). The outer loop of the metaheuristic starts at some initial "‘temperature" (Nahar et al., 1986, p. 294). A new neighbouring solution is then found (Nahar et al., 1986, p. 294). If the new solution is feasible and better than the current solution, then it is accepted (Nahar et al., 1986, p. 294). If it is feasible and worse, then it may or may not be accepted (Kirkpatrick et al., 1983, pp. 672-673). A condition developed by Metropolis et al. (1953), which uses a random number, is used to decide whether the worse solution should be accepted; this aspect of the metaheuristic prevents it from getting stuck in local optima (Kirkpatrick et al., 1983, pp. 672-673). More new neighbouring solutions are found at that temperature until the inner loop length is reached; subsequently, the temperature in the outer loop is lowered; next, this

process repeats until the final temperature is reached (Nahar et al., 1986, p. 294). SA is a stochastic metaheuristic; ergo, running it over the same problem multiple times will obtain different results (Kirkpatrick et al., 1983, p. 674).

In an SA metaheuristic, there are four parameters: initial temperature. final temperature, cooling rate, and inner loop length. These parameters are important because they control the metaheuristic. However, they do not have any physical meanings outside of the context of the metaheuristic itself. The initial temperature needs to be high enough so that nearly 100% of solutions are accepted (Kirkpatrick et al., 1983, p. 675). This allows the metaheuristic to diversify. The lower temperature needs to be low enough to ensure that only improved solutions will be accepted near the end of a run of the metaheuristic. This allows the metaheuristic to intensify towards a good solution. The inner loop length controls the number of iterations at each temperature, and the cooling rate controls the number of temperature levels at which solutions are considered. Both of these parameters therefore impact the run time of the metaheuristic.

1.3 Scheduling Elective Surgeries Under Uncertainty

In this section, the engineering problem being considered and the purpose of this research are explained.

In a hospital that has an Operating Theatre (OT), there are different types of patients who require different types of surgeries. The flow of a particular patient in the hospital depends on the type of surgery the patient requires. A surgical team, which consists of one or more surgeons, nurses, and other medical professionals, can use an operating room (OR) in the OT to perform a surgery on a patient. The surgical teams and the patients need to be scheduled into the ORs.

1.3.1 Types of Hospitals

Different jurisdictions can classify hospitals into various categories. In Ontario, Regulation 964, which is associated with the Public Hospitals Act, classifies hospitals into 22 alphabetic groups (2001). The most relevant hospital classifications are groups A, B, and C, which correspond to general teaching hospitals, general hospitals with more than 100 beds, and general hospitals with fewer than 100 beds, respectively (2001).

It should be noted that in addition to ORs in general hospitals, there are trauma centers that specialize in emergent surgeries. Ontario currently has nine trauma centers for adult patients (Gomez et al., 2014, p. E177).

1.3.2 Types of Surgical Patients

There are three main cases of surgical patients: emergent, urgent, and elective. Emergent surgical patients need to be treated immediately or may suffer serious health problems or death (Christensen & Kockrow, 2014, p. 18). Urgent surgical patients also will suffer if they are not treated, but they are able to wait for some period of time (Christensen & Kockrow, 2014, p. 18). Elective surgical patients can wait significant periods of time without suffering significantly; consequently, these patients can decide when they wish to be operated on. (Christensen & Kockrow, 2014, p. 18). Elective surgical patients can be further split into two different groups. An elective inpatient needs to stay in a bed in the hospital after being treated (Christensen & Kockrow, 2014, p. 18). An elective outpatient does not need to stay in a bed and can be discharged from the hospital shortly after the surgery (Christensen & Kockrow, 2014, p. 18). All types of elective surgical patients clearly are different than emergent and urgent ones, but the distinction between emergent and urgent surgical patients is less clear. Dexter and O'Neill (2001) consider an emergent case to be one where a surgical patient needs to be treated by a surgical team that is already in the hospital whereas an urgent case is one where the patient can wait for a surgical team to arrive from outside the hospital (p. 664).

1.3.3 Elective Patient Flows

Different types of elective patients will flow through different parts of the hospital. Figure 1, which is adapted and modified from Ballard and Kuhl (2006), is a process diagram that shows these paths. Note that an elective inpatient requires a full examination before an operation; an elective outpatient does not require the examination (Ballard & Kuhl, 2006, p. 435). Also, note that an elective outpatient leaves shortly after being operated on and thus does not recover in the ward (Ballard & Kuhl, 2006, p. 435). In addition to these intra-hospital patient flows, inter-hospital patient flows can occur. In some cases, patients, especially the ones needing elective procedures, may be transferred between hospitals for a variety of reasons (Robinson et al., 2009).

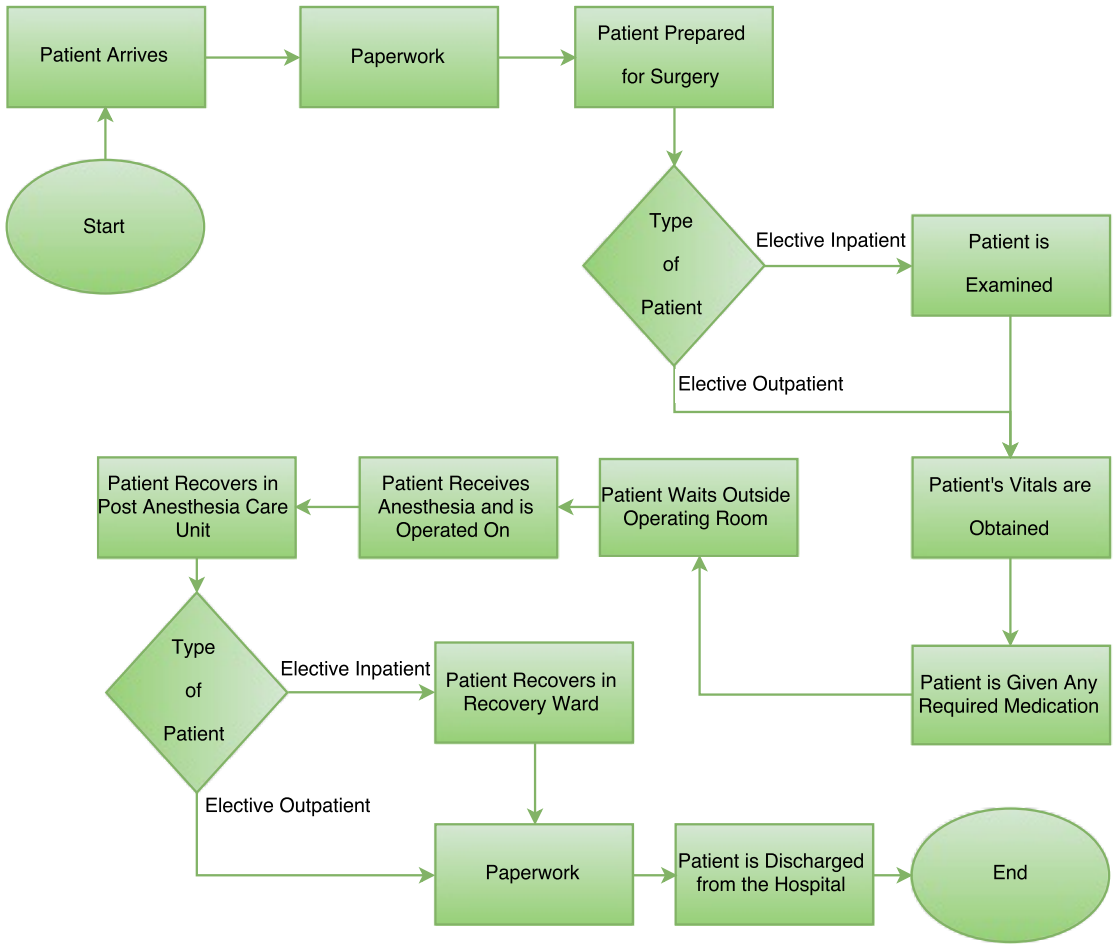

Figure 1: Process Diagram of Elective Patient Flows [Adapted and Modified from Ballard and Kuhl (2006, p.434)]

1.3.4 Uncertainties

A hospital can collect data to determine how long it takes to perform surgeries or how long patients stay in the recovery ward. It is also possible to use other means to obtain relevant data. For example, it is possible to estimate surgical durations in Ontario by using billing data from anesthesiologists (Redelmeier et al., 2008). However, these data values are averages. The actual length of an individual surgery may be longer or shorter than the average. Similarly, it is not known in advance exactly how long a given patient will recover in the ward. These uncertainties in surgical durations and patient lengths of stay need to be accounted for when scheduling is performed.

1.3.5 Operating Room Scheduling

OR scheduling has multiple decisions that need to be made over different time frames. In tactical scheduling, surgical teams have to be scheduled within a planning horizon, which might be a week or a month. There are three main ways to do this: block scheduling, open scheduling, and modified block scheduling (Fei et al., 2010, p. 222). In block scheduling, each OR is divided into time blocks for the duration of the planning horizon (Chaabane et al., 2008, p. 173). Surgical teams are assigned to blocks by following some criteria (Chaabane et al., 2008, p. 173). The schedule generated by following this process is the Master Surgical Schedule (MSS), which can be re-used cyclically (Tànfani & Testi, 2010, p. 106). In open scheduling, surgical teams are not guaranteed specific time blocks (Chaabane et al., 2008, pp. 172-173). Instead, a surgical team requests to use a particular OR on a certain day (Chaabane et al., 2008, pp. 172-173). Scheduling assignments are performed based on the order in which the requests were received (Chaabane et al., 2008, pp. 172-173). Modified block scheduling uses aspects of both block scheduling and open scheduling (Chaabane et al., 2008, p. 173).

1.3.6 Importance of Viewing a Hospital as a System

The research is primarily concerned with the scheduling of ORs. However, it is important to view a hospital as a system. Pam Bush, who has over 20 years of experience managing various units in hospitals, is now the Clinical Director Stakeholder Engagement, Informa-

tion Services, and also is a Perioperative Coach at The Ottawa Hospital, stresses this by explaining that "operating rooms have always been the focus of attention, due to their resource intensity. However, many perioperative leaders do not appreciate that one inefficient perioperative unit will negatively impact the others because of interdependencies. For example if the [Post-Anesthesia Care Unit (PACU)] does not have clinically based discharge criteria, patients will block PACU beds, bringing the ORs to a standstill. Likewise an operating room schedule that does not evenly distribute resource requirements across the week, will cause chaos in the surgical day care unit, the ORs and PACU" (Ontario Ministry of Health and Long-Term Care, 2010, p. 33).

1.3.7 Engineering Problem and Purpose of Research

The purpose of this research is to investigate the problem of designing a system of ORs and recovery ward beds in a way that optimally allocates blocks to surgical teams. This involves generating an MSS for elective inpatients that optimizes utilization of both the ORs and the beds in the recovery ward under uncertainties of both surgical durations in the ORs and patient lengths of stay in the recovery ward. Only elective surgeries are considered. Emergent and urgent patients are ignored. The ORs are optimized by minimizing both deviations from targets set by the hospital during strategic scheduling and OR underutilization. The recovery ward is optimized by minimizing both the maximum expected number of patients in the recovery ward and the difference between the maximum and minimum expected number of patients in the recovery ward. The solution to this problem can help maximize the welfares of patients and alleviate some of the aforementioned issues, such as long wait lists and high costs, that are negatively affecting health care systems in Canada.

1.3.8 Related Engineering Problems

This research focuses on a system of ORs and beds. However, the problem being considered here could easily be modified into other engineering problems that consider the designs of other systems in hospitals, such as diagnostic imaging departments.

1.3.9 Importance of Research

Computers are now ubiquitous. However, health care sectors in developed countries, especially Canada, have not fully adopted computers and related information technologies. In Canada, fewer than 20% of primary care physicians and 30% of secondary care physicians regularly use electronic health records to exchange information with other doctors (Protti, 2015, p. 422). Many hospitals in Canada and other countries still use manual techniques to schedule surgeries (Blake et al., 2002; Roland et al., 2010). The schedules used by these hospitals therefore may not be utilizing the ORs and the recovery ward beds in an efficient manner. Using the ORs and the recovery ward beds inefficiently leads to higher costs and longer wait lists.

Long wait lists are a problem both because they negatively affect patients' welfares and because the health of a given patient might deteriorate while waiting for a surgery. This can also lead to higher costs because relatively simple conditions can quickly develop into major conditions. For example, in Ontario in fiscal year 2012-2013, surgery for esophagitis had an estimated average direct cost to a hospital of $3913; a major intervention to the esophagus, which could be necessary if esophagitis is not treated quickly enough, had an estimated average cost to a hospital of $42796 (Canadian Institute for Health Information, 2015d). Note that both cost values are averages across all age groups. This is just one example, but it shows how simple conditions that could have been treated for not much money can develop into major conditions that are more expensive. In Canada, hospitals are expected to spend nearly $65 billion in 2015 (Canadian Institute for Health Information, 2015b). Clearly, there is a significant opportunity to reduce costs and potentially save millions of dollars by implementing this research.

Another factor to consider is that manual scheduling techniques are time consuming. For example, the manager of an operating theatre at a hospital in Belgium had to devote an entire work day every week to manually generate feasible advance and allocation schedules

(Roland et al., 2010, p. 219). Health care professionals have more important things to do; for this reason, the amount of time they spend on developing schedules should be minimized. This research can resolve this issue.

This research therefore is not some unnecessary luxury. Maximizing patients' welfares should be a priority for all hospitals. Hospitals need to adopt this research in order to reduce the length of wait lists, prevent the health of patients from getting even worse, and reduce costs.

1.4 Thesis Organization

In this thesis, there are seven chapters, which are organized as follows.

In this chapter, an overview of both health care and insurance in Canada is included. Also, this chapter has an overview of relevant Industrial Engineering methodologies. Finally, the specific engineering problem being considered is explained.

In chapter 2, a review of literature relevant to OR scheduling problems is provided.

In chapter 3, a stochastic weighted goal programming model is proposed for creating an optimal Master Surgical Schedule under uncertainty of both surgical durations and patient lengths of stay.

In chapter 4, a simulated annealing metaheuristic is developed and used to quickly obtain near-optimal solutions.

In chapter 5, a discrete event simulation model is created and used to demonstrate and validate the design of the system of ORs and recovery ward beds.

In chapter 6, a numerical example is provided.

Finally, chapter 7 contains conclusions and a discussion about future research.

CHAPTER 2: LITERATURE REVIEW

In chapter 2, a review of literature on operating room (OR) scheduling is provided.

2.1 Overview

According to Testi et al. (2007), OR scheduling can be divided into three hierarchical phases: strategic, tactical, and operational. In the strategic phase, long term decisions regarding case mix are made. These decisions involve the allocation of OR time and capacity to different surgical specialties. In a hospital in Ontario, strategic decisions need to account for the needs of patients, the needs of surgeons who perform surgeries at the hospital, priorities in the community, and other priorities developed by strategic decision makers (Ontario Ministry of Health and Long-Term Care, 2010, p. 8). In the tactical phase, a Master Surgical Schedule (MSS) is developed. The MSS is used to assign the different surgical specialties to time blocks in the OR schedule. Typically, the MSS will have a planning horizon of a few weeks or months and can be used on a cycle until new strategic decisions are made (Tànfani & Testi, 2010, p. 106). Alternatives to block scheduling include modified block scheduling and open scheduling. In the operational phase, the overall Surgical Scheduling Problem is split into two sub-problems: advance scheduling and allocation scheduling. In advance scheduling, which is done before the day of surgery, actual surgeries are assigned into blocks in the MSS. In allocation scheduling, which is performed on the actual day of surgery, the sequence of events needed to perform each procedure are determined and scheduled into the corresponding block.

Abdelrasol et al. (2013) propose a framework that also uses a three phase approach for OR scheduling. In the first stage, a stochastic dynamic programming model is used to make the strategic case mix decisions. In the second stage, modified block scheduling is used to both allocate elective surgery cases to ORs and to route emergency patients. In addition, simulation is used for sequencing. In the third stage, a system dynamics model is used to

improve the overall efficiency.

There are a variety of approaches available for scheduling ORs at strategic, tactical, and operational phases. Before reviewing these approaches, it is important to reiterate that the three phases proposed by Testi et al. (2007) are hierarchical. Some articles in the literature only consider scheduling at one phase whereas others try to integrate one or more phases. In addition, it should be noted that these phases do not have standard definitions in the literature; thus, an article on tactical scheduling might not use the same definition of the word tactical as Testi et al. (2007).

2.2 Literature Relevant to OR Scheduling Problems

This section contains a literature review of OR scheduling approaches. For other literature reviews on OR scheduling, see Cardoen et al. (2010), Guerriero and Guido (2011), and May et al. (2011).

2.2.1 Job Shop and Flow Shop Approaches

Two common manufacturing systems are job shops and flow shops. Both systems consist of multiple machines, which are also referred to as stages, that are used to complete jobs (Johnson, 1954). In a job shop, different jobs require the use of different machines in different orders; in a flow shop, all jobs use the same machines in the same order (Sule, 2008, p. 10). There are two main types of flow shops: classical and hybrid. In a classical flow shop, there is only one machine in each stage (Allaoui & Artiba, 2004, p. 433). In a hybrid flow shop, at least one stage contains multiple machines; if a stage has more than one machine, then they operate in parallel (Linn & Zhang, 1999, p. 57). Job shops and flow shops can both be affected by blocking; this is the situation where a finished job must stay in a machine because there is no storage space available outside of the machine (Sule, 2008, p. 13). Scheduling techniques for both manufacturing systems often minimize the makespan, which is the total amount of time it takes to finish all jobs (Sule, 2008, p. 10). All of the approaches in this subsection involve the application of manufacturing scheduling techniques to OR scheduling problems.

Pham and Klinkert (2008) apply two mixed integer programs of multi-mode blocking job shops to the elective surgery case scheduling problem. The first model schedules elective surgeries, and the second inserts three types of add-on surgeries: emergency surgeries, urgent surgeries, and additional elective surgeries. This online job shop scheduling approach can be used for both allocation and external resource, but not advance, scheduling of inpatients and outpatients in both public and private hospitals. The authors provide a numerical example of a daily schedule for two days but do not use actual data to validate their model.

Guinet and Chaabane (2003) propose a linear program for advance scheduling and a two-stage hybrid flow shop model for allocation scheduling. The first stage of the flow shop accounts for the surgical duration in the OR plus time spent cleaning after the procedure, and the second stage accounts for time spent in the recovery area. In Chaabane et al. (2008), this model is compared to a different model under both block and open scheduling. Jebali et al. (2006) consider a similar problem as Guinet and Chaabane (2003) and Marques et al. (2012) and develop a deterministic mixed integer linear program for advance and allocation scheduling that is solved using a two stage method. In the first stage, surgeries are assigned to an OR in a way that minimizes three things: surgery lead time, OR overutilization, and OR underutilization (ORUU). In the second stage, which is similar to the flow shop model in Guinet and Chaabane (2003), the operations that must be performed are planned in a way that minimizes overtime.

Fei et al. (2010) develop two models for advance and allocation scheduling within an open scheduling system. The first model is an integer linear program of a set partitioning model that assigns surgery dates over a one week period. The second model is a two-stage hybrid flow shop model that creates daily schedules. The OR is the first stage of the flow shop, and the recovery room is the second stage. A novelty of this model is that recovery time can be split between the OR and the recovery room.

A more complicated flow shop model is proposed by Augusto et al. (2010). They use a four-

stage hybrid flow shop model with blocking to investigate elective allocation scheduling within an open scheduling system. The resources considered are OR beds, transporters, and recovery beds. A novelty of this model is that patients can recover in OR beds if recovery beds are unavailable. However, resource costs are not taken into account. They suggest testing the robustness of the model against uncertainties in surgery durations and patient recovery times.

Xiang et al. (2013) develop a mathematical model of a flexible job shop that minimizes the makespans of the surgeries. All variables, aside from times, are 0-1. Unlike the models in Fei et al. (2010) and Augusto et al. (2010), their model does not consider surgeons as being interchangeable because each surgeon has different skills and abilities. In Xiang et al. (2015), this model is extended to make nurses non-interchangeable.

2.2.2 Markov Chain, Markov Decision Process, Newsvendor Model, and Queueing Theory Approaches

Many articles in this category use variants of the newsvendor model; this is a classic model for inventory management that involves the tradeoff between procuring too many copies of a perishable object (e.g. newspapers), which results in overage costs, and buying too few, which results in underage (i.e. stockout) costs (Porteus, 2002, p. 7-17). In OR scheduling problems, the newsvendor model is relevant because capacity, which is perishable, needs to be allocated. Olivares et al. (2008) consider the problem of allocating capacity to specific elective surgery cases in a cardiac department. They apply a structural estimation approach to a newsvendor model to evaluate the balance between allocating too much time for a case versus not allocating enough time. Zonderland et al. (2010) also propose a newsvendor model for the capacity allocation aspect of strategic scheduling. This model minimizes cancellations of elective surgeries because of preemptions caused by semi-urgent surgeries while also minimizing the time scheduled for semi-urgent surgeries. This minimizes ORUU. Their model has three components: a queueing model that determines how much

capacity is needed to perform all semi-urgent surgeries, another queueing model that evaluates elective surgery cancellations versus ORUU, and a Markov Decision Process solved using policy iteration. Choi and Wilhelm (2014b) also consider capacity allocation but instead develop a non-linear stochastic model to maximize excess revenue by minimizing three expected costs: costs associated with failing to provide service to patients, costs associated with OR overutilization, and costs associated with ORUU. This base model is then developed into four models. Two of these models are based on the newsvendor model, and the other two linearize the base model into stochastic integer programs. Choi and Wilhelm (2014a) instead consider scheduling at the tactical level by formulating two mathematical models for creating block surgical schedules for an intermediate time period. The first is a newsvendor model that determines the block duration, and the second is a sequential newsvendor model, which is novel, that determines the block sequence. They also enhance their models to account for patients who fail to show up. Instead of overbooking, they accomplish this by considering patient no-shows, who follow a discrete probability distribution, and then recalculating the optimal block duration.

Tancrez et al. (2009) establish a method for both strategic and tactical scheduling that uses a Markov Chain approach to investigate the impact of stochastic operating times and disruptions caused by emergency surgeries. Their model minimizes overtime and has two types of ORs: dedicated rooms for emergencies and versatile rooms that can handle both elective and emergency patients. They use a simulation package to validate their model. Tancrez et al. (2013) improve this model by including the recovery ward. A case study of a hospital in Belgium is also included.

Gerchak et al. (1996) propose using an infinite horizon Markov Decision Process and a dynamic stochastic programming model to create an advance schedule that maximizes the number of elective surgeries that can be performed while still being able to service emergency patients. Both elective and emergency surgeries have uncertain demands. Their

model finds the optimal policy that maximizes the expected profit. Although this model is primarily for Canadian hospitals that do not use OR block schedules, it could be applied to hospitals in other countries.

Astaraky and Patrick (2015) use an infinite horizon Markov Decision Process and an approximate dynamic programming model, which uses simulation and approximate policy iteration, for the advance scheduling of elective and emergency surgeries with the objective of minimizing three things: surgery lead time, OR overtime, and ward congestion. Unlike Gerchak et al. (1996), they create the advance schedule a variable number of days in advance. Parizi and Ghate (2015) extend the model in Astaraky and Patrick (2015) by including overbooking, cancellations and no-shows.

2.2.3 Mathematical Programming Approaches

Denton et al. (2007) develop a two-stage stochastic mixed integer model, which considers uncertainties in surgery durations, that simultaneously sequences and schedules elective surgeries on a daily basis. The model works under both block and open scheduling. In the case study, they use real world data from a non-profit hospital in the United States.

Generation of a Master Surgical Schedule (MSS) is a problem considered by many authors. Blake et al. (2002) propose an integer linear programming model for creating an MSS that minimizes both the underutilization of allocated hours and the differences between weekly schedules. They present a case study that uses data from a hospital in Toronto. Santibáñez et al. (2007) extend the models in Blake et al. (2002) and Blake and Donald (2002) by considering the Master Surgical Schedule Problem in the context of a group of hospitals in British Columbia. Their mixed integer linear program is flexible in a manner that objectives can be turned into constraints; thus, the model can be used to design different cyclic MSS that influence a variety of performance measures across the entire group of hospitals. Testi and Tànfani (2009) also consider the tactical Master Surgical Schedule Problem but also include the operational Surgical Case Assignment Problem. They develop an integer linear

program that minimizes costs associated with patients' welfares. They use data from the Department of General Surgery at an Italian hospital to verify their model.

Multiple authors consider the problem of optimizing and balancing bed utilization. Beliën and Demeulemeester (2007) propose a non-linear program, which is linearized into a mixed integer linear program, for creating a cyclic MSS that minimizes the total expected bed shortage in the ward. The number of patients in an OR block and lengths of stay are both stochastic. This model is incorporated into a decision support system in Beliën et al. (2009). Yahia et al. (2014) propose a mixed integer linear program for creating an MSS that levels both bed occupancy and nurse workloads. The approach for creating the MSS is similar to Testi et al. (2007) and Mannino et al. (2012). Surgery duration and lengths of stay are both deterministic. Surgeons' preferences are considered in a novel way. The model is solved using Lingo, which results in a small optimality gap. A case study using data from a non-profit hospital in Egypt is used to demonstrate the model. van Oostrum et al. (2008) develop a two-phase stochastic mixed integer linear program to create a cyclic MSS for elective procedures that are performed frequently. Less frequent elective procedures and all emergencies are ignored. Surgery durations are stochastic. They propose extending their model by including the uncertainty of the demand for beds.

A similar problem is considered by Li et al. (2015). They develop a deterministic mixed integer goal programming model for tactical elective surgery scheduling. The model optimizes the utilization of the ORs and the recovery ward. It also considers the impact of cancellations at different levels on the schedule. They propose modifying the model to account for uncertainties in surgery durations and patient lengths of stay.

Capacity scheduling has been investigated by many authors. Adan and Vissers (2002) develop an integer linear program for strategic and tactical capacity scheduling that satisfies patient throughput targets while also minimizing the deviation between actual and targeted resource utilization values. The resources that are included in the model are beds, operating

theater capacity, nursing capacity, and intensive care beds. Vissers et al. (2005) investigate a similar problem but consider different resources (operating theater time, medium care beds, intensive care beds, and intensive care nurses), focus on tactical scheduling, and apply their model to a cardiothoracic department, which is more likely to have emergency patients than the orthopedics department used in Adan and Vissers (2002). The mixed-integer linear program in Vissers et al. (2005) creates a cyclic MSS for elective surgeries, which are classified into different categories, and reserves space for emergencies. Each patient category has different average resource requirements. In Adan et al. (2009), this model is extended by using stochastic lengths of stay in both medium and intensive care units. However, emergencies are ignored; hence, the MSS only takes elective surgeries into account. In Adan et al. (2011), this model is extended to include emergency patients, a weighted goal programming approach, and operational scheduling. Also, this model incorporates cancellations by scanning through the categories of patients. However, they suggest developing a better approach for dealing with cancellations. Dellaert et al. (2015) also extend the tactical scheduling model in Adan et al. (2009) by determining mathematical relationships of probability distributions for both waiting times and the utilization of resources. The probability distributions can then be used to see how a given MSS will affect both waiting times and resource utilization. In addition, they develop novel strategies to improve both of these performance measures. They, unlike Adan et al. (2011), ignore emergencies.

Other authors use probability distributions to solve OR scheduling problems. Vanberkel et al. (2011a) develop a model that uses binomial distributions to represent patient discharges. Next, these discharge values are used to calculate bed utilization. Finally, pair-wise swaps in the MSS are made to improve the schedule. Vanberkel et al. (2011b) use the same approach but include mathematical relationships of probability distributions associated with the number of patients in the ward, patient admissions, patient discharges, and the number

of patients who have been recovering in the ward for a certain number of days.

Jebali and Diabat (2015) propose a two-stage stochastic mixed integer program with recourse for advance scheduling. Their model considers elective patients, but not emergency patients, and accounts for uncertainties in surgery durations and lengths of stay in both the intensive care unit and the ward. They use the data from Adan et al. (2011) for their case study.

Marques et al. (2012) investigate the Elective Case Scheduling Problem at a hospital in Lisbon and develop an integer linear program for both advance and allocation scheduling that maximizes OR utilization. The model considers elective patients at four different priority levels and ambulatory patients. Also, outpatients and maternity patients are ignored because the hospital in the case study does not provide those services. Their model is solved in two stages. In the first stage, elective surgeries are planned. In the second phase, scheduling for the ambulatory patients, who have a dedicated OR, is performed. In Marques et al. (2014), the same model is extended to maximize both OR utilization and patient throughput.

Agnetis et al. (2014) develop two integer programs for the decomposition of tactical and operational elective surgery scheduling. The first models the process of creating a weekly MSS as a minimum cost flow problem. The second models advance scheduling as a multiple knapsack problem. These problems are solved sequentially. San Giuseppe Hospital in Italy is used as a case study. Agnetis et al. (2012) use the same hospital to study the impact of using a weekly MSS, which is created using an integer linear program, that changes over a one year period.

Conforti et al. (2010) propose a deterministic mixed integer program for both tactical and operational scheduling of elective surgeries under a block scheduling system. Their model has four objectives: maximization of OR utilization for all ORs, maximization of the num-

ber of procedures performed on high priority patients, maximization of the satisfaction of preferences of each surgical specialty, and minimization of the underutilization of each surgical specialty. Also, they use preliminary data from an Italian hospital to perform a small case study.

Aringhieri, Landa, Soriano, et al. (2015) develop a 0-1 linear program for block scheduling and advance scheduling over a one week planning horizon. Unlike the approaches used by Agnetis et al. (2014) and Conforti et al. (2010), the scheduling phases in this model are performed simultaneously instead of sequentially. They calculate the complexity of the OR scheduling problem being considered. This model only considers elective patients because there are dedicated resources for emergencies. Patients can use care beds on the weekend. A case study with scenarios generated from real world data is included.

Aringhieri, Landa, and Tànfani (2015) propose a 0-1 linear program for advance scheduling of elective surgeries over some given planning horizon and within a given MSS. Their model levels ward bed utilization by maximizing the quantity of ward beds being used at the lowest possible bed utilization level. This also maximizes OR utilization.

Determining how to allocate resources to different types of surgeries is considered by a few authors. Kuo et al. (2003) propose a linear program for the strategic case mix problem that maximizes revenues for surgeons at Duke University Medical Center. The authors assume that beds downstream to the ORs are always available. Hans et al. (2008) consider a similar problem at tactical and operational phases.

Sier et al. (1997) develop a non-linear mixed integer program for daily elective and emergency surgery scheduling that minimizes conflicts while prioritizing younger children over older children and adults, higher priority cases over lower priority ones, and longer operations over shorter ones.

2.2.4 Simulation Approaches

The problem of scheduling patient admissions is considered by Granja et al. (2014) in the context of a radiology department in Portugal. They develop a simulation model of the process that patients go through and use it to find bottlenecks. They also use the simulation model to determine how a different configuration would affect the efficiency of the process. Their model does not consider the impact of scheduling patients in different orders and does not provide any information related to costs and benefits.

Zhang et al. (2009) propose a mixed integer programming model with a finite horizon for tactical scheduling. Their model, which can prioritize emergency patients over elective patients and can constrain the usage of OR resources, determines the master surgical schedule that minimizes the length of stay for patients. However, their model ignores uncertainties associated with surgery durations and patient arrivals. In addition to the mixed integer programming model, they use a simulation model to find both the average length of stay for patients and OR utilization.

Ivaldi et al. (2003) use a discrete event simulation model to manage a wait list. The model considers both elective and emergent surgeries; a constraint reserves beds for emergent cases. A case study, which uses data collected over a two year period from a hospital in San Genoa, Italy, is included. The simulation model can be used to investigate the impact of increasing the amount of time available for surgeries on the length of the wait list.

Banditori et al. (2013) develop a mixed integer linear program for creating an MSS for elective surgeries that considers due dates and has a waiting list that can be managed. Emergency patients are ignored because they do not use the same resources as elective patients. They use a simulation model to evaluate the ability of the MSS to handle variations in both patient lengths of stay and surgery durations. Cappanera et al. (2014) expand this model by proposing a multi-objective mixed integer program that maximizes patient throughput and resource leveling while still being able to adapt to uncertainties associated

with patient lengths of stay and surgery durations. The resources that are considered and leveled are surgeons, ORs, and ward beds. Also, an additional leveling criterion not considered by Banditori et al. (2013) is included. They again use a simulation model to see how the model responds to the uncertainties.

Ferrand et al. (2014) use a simulation model to investigate different methods of handling elective emergent surgeries. In general hospitals, there are two different approaches for dealing with emergent surgeries. In the first approach, an OR is reserved for emergent surgeries. In the second approach, emergent and urgent surgeries can be scheduled into any of the ORs. These two approaches can be described as the focused approach and the flexible approach, respectively. It is also possible to use a combination of both approaches. It is unclear which approach is better. According to Ferrand et al. (2014), a partially flexible approach reduces wait times for both elective and emergent surgeries. Heng and Wright (2013) develop a mathematical model and show that having a dedicated OR for emergent surgeries in a children's hospital in Toronto decreases wait times for low priority emergent surgeries, decreases cancellations of elective surgeries, and decreases the total overtime associated with elective surgeries. However, Wullink et al. (2007) use a mathematical model to compare the two approaches and find that the flexible approach reduces wait times for emergent surgeries, reduces overtime, and increases OR utilization.

2.2.5 Heuristics and Metaheuristics Approaches

A variety of approaches using heuristics and/or metaheuristics exist in the literature. Some of these approaches focus on tactical scheduling. Blake and Donald (2002) consider the same hospital as Blake et al. (2002) but develop a post-solution heuristic to find better solutions. van Oostrum et al. (2008) use a column generation heuristic to solve their model that generates cyclic MSS. Beliën and Demeulemeester (2007) develop a repetitive mixed integer program heuristic, a quadratic mixed integer program heuristic, and a simulated annealing metaheuristic to solve their model. Li et al. (2015) extend the work of Beliën and

Demeulemeester (2007) but only use a commercial solver to solve the model. They suggest developing a metaheuristic that can be used to solve larger scheduling problems. Adan et al. (2011) and Yahia et al. (2014) also suggest developing heuristics and/or metaheuristics to solve their models. Aringhieri, Landa, Soriano, et al. (2015) include a novel two-level tabu search metaheuristic that simultaneously performs both block scheduling and advance scheduling. Conforti et al. (2010) also consider both tactical and operational scheduling and use a genetic algorithm.

Many of the approaches using heuristics and/or metaheuristics involve operational scheduling problems. Sier et al. (1997) use a simulated annealing metaheuristic to solve their model. Van Houdenhoven et al. (2007) compare various approaches, including some that use heuristics, for scheduling surgical cases. Pham and Klinkert (2008), like Li et al. (2015), suggest developing a metaheuristic in order to make it possible to solve large scheduling problems. They specifically recommend a tabu search metaheuristic. Guinet and Chaabane (2003) use a Hungarian primal-dual heuristic to solve their models that perform advance and allocation scheduling. Fei et al. (2010) use a heuristic based on column generation to solve their advance scheduling model. Furthermore, the two models for advance scheduling and allocation scheduling are also solved using a hybrid genetic algorithm. Augusto et al. (2010) and Parizi and Ghate (2015) both use Lagrangian relaxation heuristics to solve their models. Riise and Burke (2011) apply a local search heuristic to an operational scheduling model. Vijayakumar et al. (2013) develop a first fit decreasing heuristic to solve their mixed integer dual bin-packing model; surgical cases are assigned priorities and are then assigned by order of priority. Silva et al. (2015) extend Pham and Klinkert (2008), Riise and Burke (2011), and Vijayakumar et al. (2013) by considering specialized human resources who can perform multiple surgeries at the same time; a relax-and-fix heuristic and a linear programming based heuristic are used to solve the model. Xiang et al. (2013) and Xiang et al. (2015) use a modified ant colony optimiza-

tion metaheuristic to solve their operational scheduling models. They also show that their metaheuristic outperforms a different scheduling model that uses discrete event simulation. Denton et al. (2007) use several heuristics to solve their mathematical programming model that schedules elective surgeries on a daily basis. Aringhieri, Landa, and Tànfani (2015) develop reduced and adaptive variable neighborhood search metaheuristics to solve their advanced scheduling model. Marques et al. (2012) use a genetic algorithm to solve large instances of their model for advanced and allocation scheduling.

2.3 Contributions of This Research

The literature review shows important trends in research related to OR scheduling. Many articles consider uncertainties in surgical durations and/or uncertainties in patient lengths of stay. Authors of other articles suggest extending their models to account for these uncertainties. Some articles use simulation approaches to test, demonstrate, and validate models. Many articles contain heuristics and/or metaheuristics. Simulated annealing, genetic algorithm, tabu search, and ant colony optimization seem to be the most common types of metaheuristics used. Furthermore, some authors suggest developing metaheuristics in order to solve larger problem instances.

The aim of this research is to extend the deterministic mixed integer goal programming model from Li et al. (2015), which optimizes both ORs and recovery ward utilization, by doing the following:

1. Consider uncertain surgical durations in the ORs
2. Consider uncertain patient lengths of stay in the recovery ward
3. Develop a simulation model to demonstrate and validate the mathematical model
4. Develop a metaheuristic to get a near-optimal solution in a reasonable amount of time

CHAPTER 3: MATHEMATICAL MODEL

In this chapter, a stochastic weighted goal programming model is proposed for creating an optimal Master Surgical Schedule (MSS) that maximizes the utilization of operating rooms (OR) and balances the utilization of beds in the recovery ward under uncertainty of both surgical durations and patient lengths of stay. The MSS is only for elective surgeries.

The model is designed to be as general as possible and is not tailored to any specific hospital. However, different hospitals can vary in size and in structure. Some aspects of the model thus might be more relevant at certain hospitals. For example, a given orthopedic surgical team at a large hospital in Toronto may only perform knee surgeries whereas a given orthopedic surgical team at a smaller hospital in Windsor may perform many different types of surgery. Therefore, the concept of using patient mix clusters is relevant at the hospital in Windsor but may not be as relevant at the hospital in Toronto. Also, the large hospital in Toronto has more ORs, more surgical teams, more surgical specialties, and more recovery ward beds.

3.1 Assumptions

In this model, a number of assumptions are made to simplify the problem.

1. Various strategic decisions are made by hospital administrators in advance of any tactical scheduling. These strategic decisions affect the number of patients a surgical team will operate on in a planning horizon, the number of blocks assigned to surgical teams in a planning horizon, the number of blocks assigned to surgical specialties in a planning horizon, and the maximum patient lengths of stay. Note that strategic decisions can change over time.

2. Elective patients for all surgical specialties are selected from wait lists that always have available supplies of patients who require surgeries.

3. Emergent and urgent patients are not operated on in these ORs.

4. Patients and all surgical team members always arrive on time.

5. A selected patient is operated on by a surgical team from the appropriate surgical specialty. The duration of a surgery is not known with certainty in advance. The patient is then transferred to a bed in the ward to recover.

6. Patients may pass through the Post-Anesthesia Care Unit (PACU) in between the ORs and the recovery ward. However, this unit is ignored because different surgical specialties may have different requirements and policies regarding how patients should be recover from anesthesia.

7. Surgeries can only be scheduled on weekdays because all ORs are closed on Saturdays and Sundays.

8. The recovery ward is always open and always has a surplus of beds.

9. The amount of time that a given patient stays in the recovery ward is not known with certainty in advance.

10. Scheduled surgeries can be cancelled. All cancellations are made after the schedule is generated.

3.2 Model Components

In this section, the parameters, variables, constraints, and objective functions used in the model are explained.

3.2.1 Indices

The following parameters are used to index other parameters.

i	$i = 1, 2, ..., m$ indexes the surgical teams.
j	$j = 1, 2, ..., n$ indexes the operating rooms.
k	$k = 1, 2, ..., T$ indexes the days of the planning horizon.

l $l = 0, 1, 2, ..., h_i$ indexes the days of the patient lengths of stay in the recovery ward.

e $e = 1, 2, ..., E_i$ indexes the types of surgery associated with each surgical team i.

r $r = 1, 2, ..., R$ indexes the surgical specialties.

3.2.2 Deterministic Parameters

In the strategic scheduling phase, the following parameters are set over the planning horizon for each surgical team i.

N_i Each surgical team i should perform surgeries on N_i patients.

L_i Each surgical team i should perform surgeries in at least L_i blocks.

H_i Each surgical team i should perform surgeries in at most H_i blocks.

h_i Each surgical team i should perform surgeries on patients in assigned blocks. After surgeries are completed, patients can recover in beds. The maximum patient length of stay in the recovery ward for patients operated on by surgical team i should not exceed h_i days.

In the strategic scheduling phase, the following parameters are set over the planning horizon for each surgical specialty r.

S_r Each surgical team i is assigned to one of R surgical specialties. The set of surgical teams in each surgical specialty is S_r.

B_r Each surgical specialty r is assigned B_r blocks.

The following parameters are also used.

n The Operating Theatre contains n ORs.

m There are m surgical teams.

T The planning horizon has T days.

R Each surgical team i is assigned to one of R surgical specialties.

E_i Each surgical team i performs E_i types of surgery. Each type of surgery is a cluster. This represents the patient mix.

v Each block in an OR is v hours long.

O_{ie} Each cluster e of each surgical team i requires an overhead time multiplier O_{ie} to account for the time needed to set up before the procedure and to clean up after the procedure.

f_{ie} Each cluster e of each surgical team i represents a number of procedures that is a fraction f_{ie} of the total number of procedures associated with all clusters in surgical team i.

Π_{ij} An OR j may or may not be available for a surgical team i. If the OR j is available for surgical team i, then $\Pi_{ij} = 0$. If the OR j is not available for surgical team i, then $\Pi_{ij} = 1$.

Ω_{ik} A day k in the planning horizon may or may not be available for a surgical team i. If the day k is available for surgical team i, then $\Omega_{ik} = 0$. If the day k is not available for surgical team i, then $\Omega ik = 1$.

3.2.3 Stochastic Parameters

The following stochastic parameters are used.

NS There are NS scenarios. Each scenario has realizations of surgical durations and patient lengths of stay.

ω $\omega = 1, 2, ...NS$ indexes the scenarios.

D_{ie}^{ω} and $\tilde{D}_{ie}$ In scenario ω, if a surgery associated with cluster e of surgical team i is performed, then the surgical duration will be D_{ie}^{ω}, where D_{ie}^{ω} is a realization of the stochastic parameter $\tilde{D}_{ie}$ in scenario ω.

p_{il}^{ω} and $\tilde{p}_{il}$ In scenario ω, if a surgery is performed by surgical team i, then the patient will stay in the recovery ward for l days with probability p_{il}^{ω}, where p_{il}^{ω} is a realization of the stochastic parameter $\tilde{p}_{il}$ in scenario ω.

A_i^{ω} In scenario ω, a surgery associated with cluster e that is performed by surgical team i has a duration of D_{ie}^{ω}. This duration accounts for the time it takes to perform the surgery but does not account for the time it takes to set up for the surgery and the time it takes to clean the OR after the surgery. In scenario ω, the total expected surgical duration A_i^{ω} across all clusters e for surgical team i is the sum of the products of the surgical durations D_{ie}^{ω}, the time multipliers O_{ie} for setting up before the surgery and cleaning after the surgery, and the relative fractions f_{ie} at which surgeries are performed. A_i^{ω} for a given surgical team i and for a given scenario ω equals $\sum_{i=1}^{m} \sum_{e=1}^{E_i} D_{ie}^{\omega} O_{ie} f_{ie}$.

n_i^{ω} The length of a block is v hours. This limits how many surgeries can be performed by a surgical team in a block. In scenario ω, each surgical team i can perform surgeries on an expected maximum of $n_i^{\omega} = \left\lfloor \frac{v}{A_i^{\omega}} \right\rfloor$ patients in a block.

Φ_{il}^{ω} In scenario ω, if surgical team i uses a block today, then the recovery ward is expected to have a cumulative total of Φ_{il}^{ω} patients operated on by surgical team i in l days. Patient counts are performed every day at 18:00. If a patient leaves the hospital before that time, then that patient is not counted on that day. Therefore, this parameter counts how many

nights each patient from surgical team i stays in the recovery ward. If a maximum length of stay h_i is longer than the length T of the planning horizon, then the recovery ward will have patients operated on by surgical team i from multiple planning horizons. Φ_{il}^{ω} in a given scenario ω equals $\sum_{\tau=0}^{\lfloor h_i/T \rfloor} \sum_{l'=l+T\tau+1}^{h_i} n_i^{\omega} p_{il'}^{\omega}$.

3.2.4 Deterministic Variables

x_{ijk} is a 0-1 decision variable that represents the scheduling decisions.

$$x_{ijk} = \begin{cases} 1 & \text{if a decision is made to assign OR } j \text{ to surgical team } i \text{ on day } k, \\ 0 & \text{if OR } j \text{ is not assigned to surgical team } i \text{ on day } k. \end{cases}$$

3.2.5 Deviation Variables

These deviation variables are used in the goal constraints and are minimized.

$d_{1i}^{\omega-}$ In scenario ω, $d_{1i}^{\omega-}$ is the deviation between the target number of surgeries N_i and the actual number of surgeries performed by surgical team i, where the actual number of surgeries is less than N_i.

$d_{1i}^{\omega+}$ In scenario ω, $d_{1i}^{\omega+}$ is the deviation between the target number of surgeries N_i and the actual number of surgeries performed by surgical team i, where the actual number of surgeries is greater than N_i.

$d_{2ijk}^{\omega-}$ In scenario ω, $d_{2ijk}^{\omega-}$ is the deviation between the total number of hours available for surgical team i in OR j on day k and the actual number of hours used by surgical team i in OR j on day k, where the actual number of hours used is less than the total number of hours available.

3.2.6 Stochastic Variables

These stochastic variables account for the utilization of the recovery ward, which is downstream to the ORs.

I_k^ω — On day k of the planning horizon in scenario ω, the recovery ward is expected to have I_k^ω patients.

I_{max}^ω — Over the course of all days k in the planning horizon in scenario ω, the recovery ward is expected to have a maximum of I_{max}^ω patients.

I_{min}^ω — Over the course of all days k in the planning horizon in scenario ω, the recovery ward is expected to have a minimum of I_{min}^ω patients.

3.2.7 Constraints

The following constraints are used.

Constraint 1

A surgical team i may prefer not to be scheduled in OR j. If $\Pi_{ij} = 1$, then the surgical team i cannot be assigned to OR j. If $\Pi_{ij} = 0$, then the surgical team i can be assigned to OR j. Therefore, the product of Π_{ij} and x_{ijk} must sum to 0 for all days k.

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\Pi_{ij}x_{ijk} = 0 \quad \forall k = 1,2,...,T \tag{1}$$

Constraint 2

A surgical team i may prefer not to be scheduled on day k. If $\Omega_{ik} = 1$, then the surgical team i cannot be assigned to day k. If $\Omega_{ik} = 0$, then the surgical team i can be assigned to day k. Therefore, the product of Ω_{ik} and x_{ijk} must sum to 0 for all OR j.

$$\sum_{i=1}^{m}\sum_{k=1}^{T}\Omega_{ik}x_{ijk} = 0 \quad \forall j = 1,2,...,n \tag{2}$$

Constraint 3

Each block can be assigned to at most one surgical team i. This constraint prevents multiple surgical teams from being assigned to the same OR j on the same day k.

$$\sum_{i=1}^{m} x_{ijk} \leq 1 \quad \forall j = 1,2,...,n \quad \forall k = 1,2,...,T \tag{3}$$

Constraint 4
A surgical team i can be allocated at most one block per day. This constraint prevents a surgical team from being assigned to multiple ORs on the same day k.

$$\sum_{j=1}^{n} x_{ijk} \leq 1 \quad \forall i = 1,2,...,m \quad \forall k = 1,2,...,T \tag{4}$$

Constraint 5
In the strategic phase of scheduling, each surgical team i is allocated between L_i and H_i blocks to be used over the planning horizon.

$$L_i \leq \sum_{j=1}^{n} \sum_{k=1}^{T} x_{ijk} \leq H_i \quad \forall i = 1,2,...,m \tag{5}$$

Constraint 6
In the strategic phase of scheduling, each surgical specialty r is allocated B_r blocks to be used over the planning horizon.

$$B_r = \sum_{i \in S_r} \sum_{j=1}^{n} \sum_{k=1}^{T} x_{ijk} \quad \forall r = 1,2,...,R \tag{6}$$

Constraint 7
In the strategic phase of scheduling, each surgical team i is assigned a target number of surgeries N_i to be performed over the planning horizon.

$$n_i^{\omega} \sum_{j=1}^{n} \sum_{k=1}^{T} x_{ijk} + d_{1i}^{\omega-} - d_{1i}^{\omega+} = N_i \quad \forall i = 1,2,...,m \quad \forall \omega = 1,2,...,NS \tag{7}$$

Constraint 8
All ORs j should be in use at all times.

$$(A_i^{\omega} n_i^{\omega} - v) x_{ijk} + d_{2ijk}^{\omega-} = 0 \quad \forall i = 1,2,...,m \quad \forall j = 1,2,...,n \quad \forall k = 1,2,...,T \quad \forall \omega = 1,2,...,NS \tag{8}$$

Constraint 9
The Master Surgical Schedule is cyclical, so the recovery ward on day k at 18:00 in scenario ω is expected to have some patients from the current planning horizon and some from the previous horizon.

$$I_k^\omega = \sum_{i=1}^{m}\sum_{l=1}^{k}\sum_{j=1}^{n}\Phi_{i(k-l)}^\omega x_{ijl} + \sum_{i=1}^{m}\sum_{l=k+1}^{T}\sum_{j=1}^{n}\Phi_{i(k+T-l)}^\omega x_{ijl} \quad \forall k = 1,2,...,T \quad \forall \omega = 1,2,...,NS \tag{9}$$

Constraint 10
All I_k^ω must be between I_{min}^ω and I_{max}^ω.

$$I_{min}^\omega \leq I_k^\omega \leq I_{max}^\omega \quad \forall k = 1,2,...,T \quad \forall \omega = 1,2,...,NS \tag{10}$$

Constraint 11
x_{ijk} is a 0-1 variable.

$$x_{ijk} \in \{0,1\} \quad \forall i = 1,2,...,m \quad \forall j = 1,2,...,n \quad \forall k = 1,2,...,T \tag{11}$$

Constraints 12-18
All variables must be non-negative.

$$x_{ijk} \geq 0 \quad \forall i = 1,2,...,m \quad \forall j = 1,2,...,n \quad \forall k = 1,2,...,T \tag{12}$$

$$d_{1i}^{\omega-} \geq 0 \quad \forall i = 1,2,...,m \quad \forall \omega = 1,2,...,NS \tag{13}$$

$$d_{1i}^{\omega+} \geq 0 \quad \forall i = 1,2,...,m \quad \forall \omega = 1,2,...,NS \tag{14}$$

$$d_{2ijk}^{\omega-} \geq 0 \quad \forall i = 1,2,...,m \quad \forall j = 1,2,...,n \quad \forall k = 1,2,...,T \quad \forall \omega = 1,2,...,NS \tag{15}$$

$$I_k^{\omega} \geq 0 \quad \forall k = 1,2,...,T \quad \forall \omega = 1,2,...,NS \tag{16}$$

$$I_{max}^{\omega} \geq 0 \quad \forall \omega = 1,2,...,NS \tag{17}$$

$$I_{min}^{\omega} \geq 0 \quad \forall \omega = 1,2,...,NS \tag{18}$$

3.2.8 Scenarios, Realizations, Goals, and Objective Functions

In the model, there are two stages. In the first stage, the scheduling decisions x_{ijk} are made under uncertainty of both surgical durations and patient lengths of stay. In the second stage, there are NS scenarios. In each scenario ω, there is a realization D_{ie}^{ω} of the surgical duration parameter $\tilde{D}_{ie}$ and a realization p_{il}^{ω} of the length of stay probability parameter $\tilde{p}_{il}$.

The weighted goal programming model uses four goals in all scenarios. The four goals and their importance are as follows.

Goal 1 is the sum of deviations between the targeted number of surgeries and the actual number of surgeries performed. Minimizing goal 1 ensures that strategic targets are met.

Goal 1: $g_1^{\omega} = \sum_{i=1}^{m} d_{1i}^{\omega-}$

Goal 2 is the sum of the deviations between the targeted number of hours for surgeries and the actual number of hours used for surgeries. Minimizing goal 2 ensures that the ORs are used as much as possible.

Goal 2: $g_2^{\omega} = \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{T} d_{2ijk}^{\omega-}$

Goal 3 is the maximum expected number of patients in the recovery ward over the course of the planning horizon. Minimizing goal 3 ensures that the number of recovery ward beds required is as low as possible.

Goal 3: $g_3^{\omega} = I_{max}^{\omega}$

Goal 4 is the difference between the maximum and minimum expected numbers of patients in the recovery ward over the course of the planning horizon. Minimizing goal 4 ensures that the bed utilization in the ward is balanced.

Goal 4: $g_4^{\omega} = I_{max}^{\omega} - I_{min}^{\omega}$

Each scenario is a deterministic problem. In each scenario, each goal g is multiplied by a factor w_g. The overall objective function, which is minimized, is the expected value of all the weighted goals associated with the scenarios.

Minimize $E_{\omega=1,2,\ldots,NS}[w_1 \sum_{i=1}^{m} d_{1i}^{\omega-} + w_2 \sum_{i=1}^{m} \sum_{j=1}^{n} \sum_{k=1}^{T} d_{2ijk}^{\omega-} + w_3 I_{max}^{\omega} + w_4 (I_{max}^{\omega} - I_{min}^{\omega})]$

3.3 Cancellations

Cancellations happen after all other decisions have been made. For every scheduling assignment (i.e. $x_{ijk} = 1$) a value c_{ijk} is generated from some given distribution. If a given c_{ijk} value fails to meet some condition (e.g. it is too far from the mean of the distribution from which the c_{ijk} values were generated), then the assignment is cancelled.

CHAPTER 4: METAHEURISTIC

In this chapter, a simulated annealing metaheuristic is developed and applied to the model from chapter 3.

4.1 Motivation, Purpose, and Importance

The mathematical model is a mixed integer program that generates a Master Surgical Schedule (MSS). There are a variety of commercial solvers available that can solve this kind of problem. These programs typically use a branch and bound search to find an exact solution to the problem. This search technique uses a tree structure and can be exponential in terms of complexity (Jeroslow, 1974). Different hospitals may have different numbers of surgical teams, operating rooms (ORs), and/or planning horizon lengths. All of these affect the size of the problem, which can range from thousands to hundreds of thousands of variables and constraints. If the problem is moderately sized, then a commercial solver can be used to generate an MSS. However, if the problem is large, then the commercial solver may take too long and/or utilize too much memory.

A way of finding a near-optimal schedule is to use a metaheuristic; note that near-optimal does not mean exact. In this chapter, a simulated annealing metaheuristic is developed because it is necessary for solving large scheduling instances.

4.2 Simulated Annealing Metaheuristic for Operating Room Scheduling

There are four main components in the metaheuristic: initialization, initial schedule generation, an inner loop, and an outer loop. The components of the metaheuristic are explained in detail in the following subsections.

4.2.1 Initialization and Physical Meanings of the Parameters

In the initialization component, values for the parameters in metaheuristic are set. The parameters are the initial temperature, the final temperature, the cooling rate, and the maximum number of accepted solutions per inner loop. Note that the parameters have no physical meanings outside of the context of the metaheuristic itself. These values can af-

fect both the speed of the metaheuristic and the quality of the schedule obtained; hence, the values of the parameters should be determined through experimentation. Furthermore, the energy function, which is the same as the objective function in the mathematical model, is defined. Figure 2 is a flowchart of both the initialization and initial schedule generation components; this flowchart connects to Figure 3.

4.2.2 Initial Schedule Generation

An initial schedule that can be improved is needed as a starting point. The schedule needs to be feasible because an infeasible schedule cannot be implemented. The number of blocks available in the schedule first needs to be calculated. The schedule is then generated by looping through the surgical teams, the operating rooms (ORs), and the days in the planning horizon and making assignments until no more blocks are available. After each assignment is made, the partially completed schedule is run through a feasibility function, which contains the constraints, to ensure that the assignment does not violate any of the constraints. If a constraint is violated, then the assignment is rejected.

The order in which the assignments are made is important for two reasons. The first reason is that constraint 5 in the model from chapter 3 has a lower bound and an upper bound for each surgical team i. Before the metaheuristic can make assignments to any surgical team, it first satisfies all of the lower bounds associated with constraint 5. The second reason that the assignment order matters is because some blocks are available to more surgical teams than others. A small example can be used to demonstrate this. Consider the process of developing a schedule for an operating theater that has five surgical teams and five ORs. There are various constraints that need to be satisfied; thus, some assignments cannot be made. Table 1 shows the initial state of the schedule before any assignments are made. If an OR contains a letter x, then it is unavailable to that surgical team.

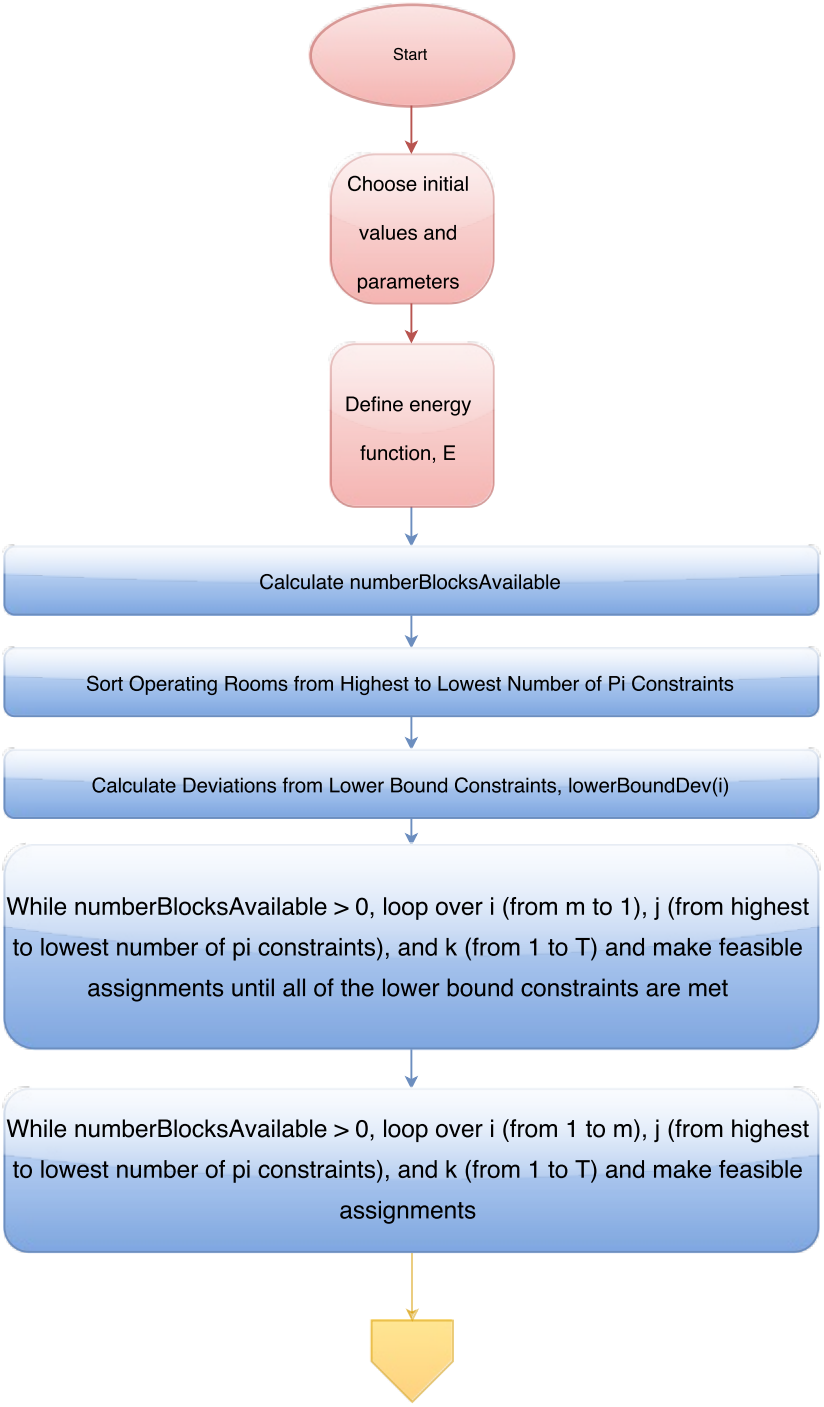

Figure 2: Simulated Annealing - Initialization and Initial Schedule Generation

		j				
		1	2	3	4	5
i	1			x		
	2					x
	3		x			x
	4					x
	5			x		x

Table 1: Simulated Annealing - Loop Order Example - Empty Schedule

Potential assignments are made into the schedule by looping over surgical teams *i* and ORs *j* and then running the schedule through a feasibility function. First, try assigning surgical team 1 to OR 1.

		j				
		1	2	3	4	5
i	1	1		x		
	2					x
	3		x			x
	4					x
	5			x		x

Table 2: Simulated Annealing - Loop Order Example - Partial Schedule 1

The schedule is run through a feasibility function and does not violate any constraints; as a result, this assignment is accepted. Now try assigning surgical team 2 to OR 2.

		j				
		1	2	3	4	5
i	1	1		x		
	2		1			x
	3		x			x
	4					x
	5			x		x

Table 3: Simulated Annealing - Loop Order Example - Partial Schedule 2

Again, it passes the feasibility test; thus, the assignment is accepted. If this process is repeated for surgical teams 3 and 4, then this feasible partial schedule is obtained.

		j				
		1	2	3	4	5
i	1	1		x		
	2		1			x
	3		x	1		x
	4				1	x
	5			x		x

Table 4: Simulated Annealing - Loop Order Example - Partial Schedule 3

OR 5 is only available to surgical team 1. However, surgical 1 is already is assigned to OR 1. Therefore, an assignment for OR 5 cannot be made; consequently, a full schedule cannot be generated. This is why the looping order matters. If the number of x constraints is taken into account before the looping process, then the following feasible schedule can be obtained.

		j				
		1	2	3	4	5
i	1			x		1
	2		1			x
	3		x	1		x
	4				1	x
	5	1		x		x

Table 5: Simulated Annealing - Loop Order Example - Full Feasible Schedule

In the actual model, constraint 1, which prevents the assignment of certain surgical teams i to certain OR j, is the equivalent of the x constraints in the small example. The SA metaheuristic therefore calculates the number of Π_{ij} constraints per OR and then loops over j from the highest to lowest number of Π_{ij} constraints. This allows a full schedule to be generated.

4.2.3 Inner Loop

In the inner loop, random values of i, j, k, j_2, and k_2 are chosen. If $i = 30$, then $i_2 = 1$. Otherwise, $i_2 = i + 1$. If $x_{ijk} = x_{i_2 j_2 k_2}$, then new values of i, j, k, i_2, j_2, and k_2 are chosen. Otherwise, the values of x_{ijk} and $x_{i_2 j_2 k_2}$ are swapped. The new schedule is run through the

feasibility function to ensure that it does not violate any constraints and thus is feasible. If it is infeasible, then the inner loop starts over. If it is feasible, then the new energy of the schedule is calculated. If the new energy is less than the current energy, then the new schedule and new energy are accepted as the current schedule and current energy, respectively. If the new energy is greater than or equal to the current energy, then a random real number *RN* is generated from the uniform distribution $U(0,1)$. If $e^{-\frac{\text{New Energy}-\text{Current Energy}}{\text{Current Temperature}}} > RN$, then the new schedule and new energy are accepted as the current schedule and current energy, respectively, even though this schedule is worse. Otherwise, the schedule is rejected. The acceptance of some, but not all, worse solutions allows the metaheuristic to escape from local optima. The inner loop repeats until the maximum number of solutions per inner loop *L* has been reached. Figure 3 is a flow chart that shows the inner and outer loops.

4.2.4 Outer Loop

In the outer loop, the temperature starts at an initial value T_i. The temperature is decreased by multiplying the current temperature by the cooling rate α that was set during initialization. After the temperature is decreased, the metaheuristic returns to the inner loop. This process repeats until the current temperature is less than the final temperature T_f.

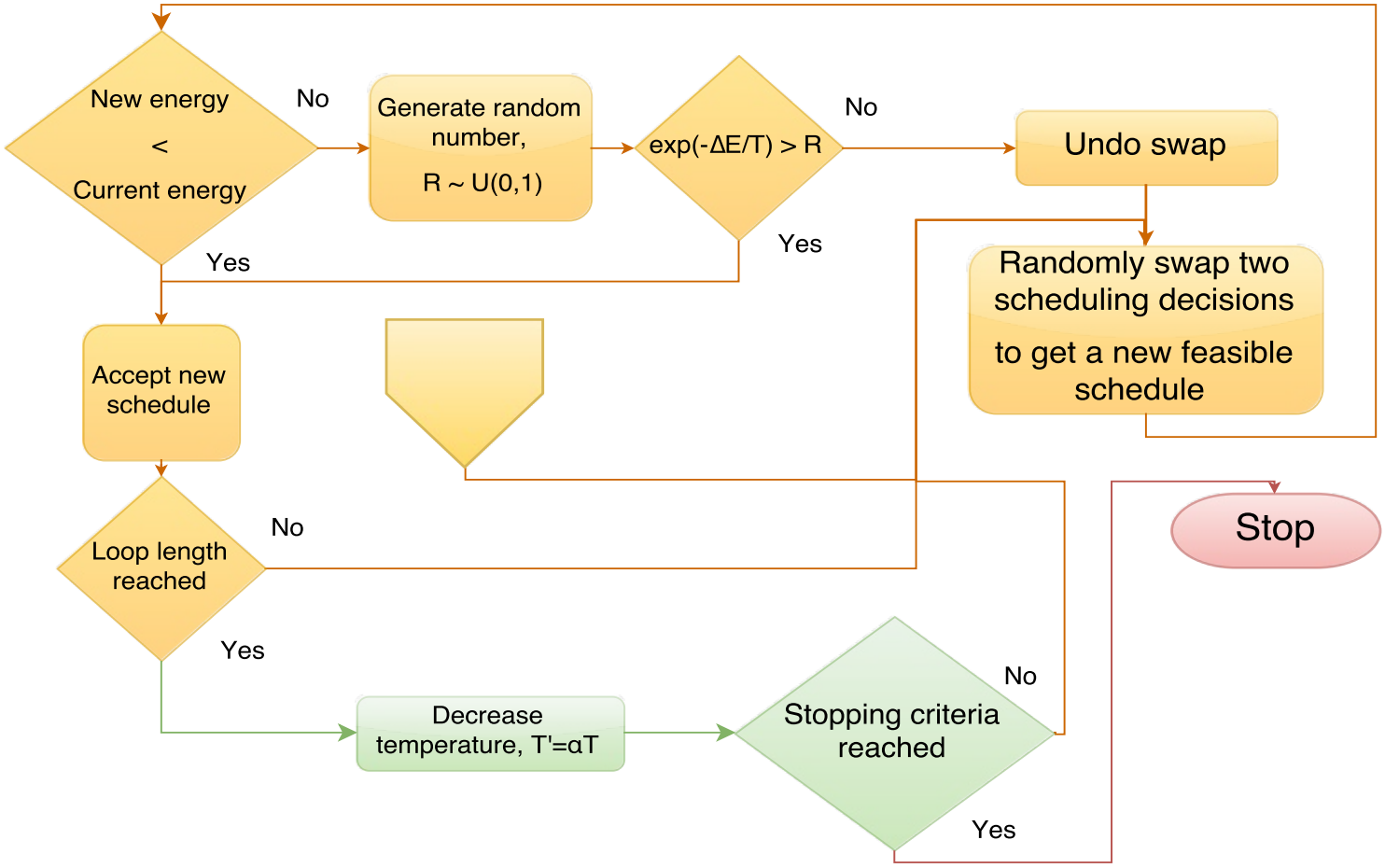

Figure 3: Simulated Annealing - Loops

CHAPTER 5: DISCRETE EVENT SIMULATION

In this chapter, a discrete event simulation model is developed.

5.1 Motivation, Purpose, and Importance

The mathematical model in chapter 3 and the simulated annealing (SA) metaheuristic in chapter 4 are useful for people who have a background in operations research. However, they may not make sense to others. Discrete event simulation models can be understood by nearly anyone. Therefore, the main purpose of the discrete event simulation model is to demonstrate the impact that schedules have on the operating rooms (ORs) and the recovery ward beds. Schedules are not generated using the discrete event simulation model. The schedules can be generated using either the mathematical model or the simulated annealing (SA) metaheuristic. In addition, the schedules can be generated manually.

The discrete event simulation model is necessary because it can be used to show that the schedules generated by the mathematical model and the SA metaheuristic use the system of ORs and recovery ward beds more efficiently than manually generated schedules. This can be done by generating a schedule using a manual technique, generating a second schedule using the mathematical model, and generating a third schedule using the SA metaheuristic. Each schedule can then be simulated. The discrete event simulation model produces results for utilizations of both the ORs and the recovery ward beds. These results can be used to compare the performance of the three schedule generation techniques. This is an important part of convincing relevant stakeholders in the health care sector that this research can lead to actual improvements.

Furthermore, the mathematical model has a variety of assumptions that may not be completely realistic. The discrete event simulation model can be used to change some of the less realistic assumptions.

5.2 Discrete Event Simulation in ProModel

ProModel is a commercial discrete event simulation package. A model in ProModel has four primary aspects: locations, entities, arrivals, and processes. In addition to these primary aspects, there are a variety of other aspects that can be included in models. Relevant aspects are explained in the following subsections. Furthermore, a screenshot of the model used in the numerical example is provided.

5.2.1 Locations, Entities, and Entity Flow

Patients are the only entities that flow through the system. Patients are selected from wait lists. A patient who enters the system is placed in the Arrival Buffer and then proceeds to the Arrival Area. Next, the patient is placed in the Surgery Buffer. Subsequently, the patient is moved to the appropriate OR. After the surgery is complete, the patient is moved to the Recovery Buffer. The patient then is moved again to the Initial Recovery Area, which represents the Post-Anesthesia Care Unit. The patient is then transported to the Recovery Ward Buffer. The next location for the patient is the Recovery Ward. Finally, the patient eventually is discharged from the hospital and enters a Discharge Buffer before being removed from the system.

All buffers in the system have infinite capacities and only exist to avoid blockages during patient flows.

5.2.2 Arrivals

If surgical team i is scheduled on day k, then a batch of patients corresponding to that surgical team arrives on that day. For each batch, a random scenario value is generated. Each batch is then split into the appropriate number of patients for that scenario. All patients arrive before the block actually starts because they need to check in and be prepared for surgery. This means that some patients might have to wait for a few hours, but that is not a problem because a comfortable waiting area is available for patients who are scheduled to be operated on later in the day.

5.2.3 Processing

The simulation model has a process that corresponds to each physical non-buffer location; accordingly, there are four processes: Arrival, Surgery, Initial Recovery, and Recovery.

At the Arrival Process, the patients check in and fill out any necessary forms. Each patient is then prepared for surgery. This process always finishes before the ORs open at the start of the day.

At the Surgery Process, each patient is operated on by the appropriate surgical team in the appropriate OR. The duration of each surgery is not known in advance.

At the Initial Recovery Process, the patients recover until they are well enough to be transported to beds in the actual recovery ward.

At the Recovery Process, patients recover in beds until they are ready to be discharged. The length of stay for each patient is not known in advance.

5.2.4 Attributes

Each patient is assigned attributes that keep track of which scenario the patient falls under, which surgical team that patient belongs to, which OR the patient is assigned to, and which day the patient is operated on by the surgical team.

5.2.5 Resources and Scheduling

There are two resources that are used in the simulation: surgical teams and ORs. Surgical teams are needed during the Surgery Process. The schedule for surgical teams can be generated using either the mathematical model in chapter 3 or the simulated annealing metaheuristic in chapter 4; the schedule can also be generated manually. Each OR location is assigned a corresponding resource.

5.2.6 Screenshot of the Discrete Event Simulation Model

Figure 4 is a screenshot of the model. The desk is the Arrivals Area. In the numerical example in chapter 6, it is assumed that the hospital has nine ORs; thus, the nine surgical tables are the ORs. The stretchers are the Initial Recovery Area. The beds are the Recovery Ward. The boxes are buffers, and the targets show where the entities are placed. The arrows

are the routes for the patients.

Figure 4: Simulation - Screenshot of Model

CHAPTER 6: NUMERICAL EXAMPLE

In this chapter, a numerical example is provided.

6.1 Data

In the strategic phase of scheduling, multiple decisions are made. In this case, the hospital is hypothetical and does not exist yet; therefore, reasonable values are chosen to demonstrate how the model functions. It would be trivial to use different values to see how the performance would change. All random data generation, except for random numbers associated with cancellations, is performed in MATLAB with a Mersenne Twist random number generator using a seed value of 5. This is important because it ensures consistency, which makes it possible to compare results. Cancellations occur after optimization is completed; thus, consistency is not important for those values.

The hospital will have thirty surgical teams ($m = 30$, $i = 1,2,...,30$) and nine operating rooms (ORs) ($n = 9$, $j = 1,2,...,9$). Each block within the twenty-eight day planning horizon ($T = 28$, $k = 1,2,...,28$) will be eight hours long ($v = 8$). Each surgical team will have no more than eight clusters ($E = 8$, $e = 1,2,...,8$). There will be six surgical specialties ($R = 6$, $r = 1,2,...,6$): General, Gynecology, Plastic, Ear-Nose-Throat, Orthopedic, and Urology. Each surgical specialty will be assigned six blocks for every surgical team within the specialty. Table 6 shows how the surgical teams and blocks will be assigned to surgical specialties.

Surgical Specialty r	**Surgical Teams** i	**Number of Blocks** B_r
General	1-6	36
Gynecology	7-11	30
Plastic	12-14	18
Ear-Nose-Throat	15-16	12
Orthopedic	17-22	36
Urology	23-30	48

Table 6: Assignment of Surgical Teams and Blocks to Surgical Specialties

Note that the assignments in Table 6 are for the entire 28 day planning horizon. All ORs are closed on Saturdays and Sundays, and there are no holidays or other days off in this numerical example; therefore, the 28 day planning horizon has 20 weekdays available. There are 9 operating rooms; thus, the schedule has (9 $\frac{\text{blocks}}{\text{day}}$) (20 days) = 180 blocks available. Each block is 8 hours long. Therefore, there are (9 ORs)(8 $\frac{\text{hours}}{\text{OR}}$) = 72 hours per day available for surgeries that are divided across 6 surgical specialties. Thus, each surgical specialty is assigned an average of $\frac{72}{6}$ = 12 hours per surgical specialty per day; this corresponds to an average of $\frac{12}{8}$ = 1.5 blocks per surgical specialty per day.

Targets are set for each surgical team. Over the course of the planning horizon, each surgical team should perform surgeries in between L_i and H_i blocks. Values for L_i are generated by sampling integers from the uniform distribution $U(1,5)$, and values for H_i are generated by sampling integers from the uniform distribution $U(6,20)$. Also, each surgical team should operate on N_i patients. Values for N_i are generated by sampling integers from the uniform distribution $U(20,35)$.

For each surgical team, a maximum patient length of stay h_i is generated by sampling integers from the uniform distribution $U(0,5)$. Also, for each surgical team, length of stay probabilities for each length of stay in 0,1,...,h_i are generated by sampling terms from a normal distribution with certain parameters, summing those values, and then dividing each generated term by the sum. This ensures that the length of stay probabilities for a given surgical team will always sum to one. It should be noted that generating terms from a normal distribution and then dividing by their sum does not necessarily result in terms that are normally distributed. A different array of length of stay probabilities is obtained for each scenario by using different pairs of parameters in the normal distribution.

Van Houdenhoven et al. (2007) provide real-world data from a teaching hospital in the Netherlands for surgical durations D_{ie} in hours and the relative frequencies f_{ie} at which these surgeries are performed. Table 7 shows these values for all six surgical specialties.

Surgical Specialty r	**Parameter**	**Cluster** e **of surgical team** i							
		1	2	3	4	5	6	7	8
General	D_{ie} (hr)	2.50	1.12	1.67	2.25	2.85	3.55	4.37	5.85
	f_{ie} (%)	8	4	12	19	20	3	25	9
Gynecology	D_{ie} (hr)	1.33	0.87	1.22	1.63	2.08	2.60	3.55	N/A
	f_{ie} (%)	2	14	19	25	32	2	6	0
Plastic	D_{ie} (hr)	1.98	1.05	1.37	1.87	2.32	3.12	7.20	N/A
	f_{ie} (%)	5	4	17	21	22	11	10	0
Ear-Nose-Throat	D_{ie} (hr)	1.70	0.67	1.08	1.70	2.12	3.03	4.23	9.15
	f_{ie} (%)	4	33	19	12	14	8	5	6
Orthopedic	D_{ie} (hr)	1.78	1.02	1.38	1.82	2.67	3.32	4.85	N/A
	f_{ie} (%)	9	10	18	21	21	16	5	0
Urology	D_{ie} (hr)	2.02	0.98	1.23	1.70	2.53	3.83	6.42	N/A
	f_{ie} (%)	3	5	30	15	17	21	8	0

Table 7: Surgical Duration and Frequency Values [Adapted from Van Houdenhoven et al. (2007)]

An array of surgical durations is generated for each scenario. For each cluster e of surgical team i, the mean surgical duration across all scenarios is the real-world surgical duration value from Table 7. The f_{ie} values from Van Houdenhoven et al. (2007) are not modified. The values for overhead time factors O_{ie} are generated by sampling real numbers from the uniform distribution $U(1.01, 1.5)$.

Each array of patient lengths of stay is a realization of $\tilde{p}_{il}$. Similarly, each array of surgical durations is a realization of $\tilde{D}_{ie}$. It is assumed that each realization is equally likely. A stochastic scenario tree is generated by making combinations of realizations of patient lengths of stay and surgical durations. This results in a two-stage scenario tree with sixteen equally likely scenarios. Any number of scenarios could be used, but sixteen is chosen to limit the amount of computational time required to create the scenario tree.

The objective function for the deterministic problem in each scenario ω has four goals that are multiplied by weights to obtain a weighted objective function. The overall objective function for the stochastic weighted goal program is the expected value of the objective functions from all sixteen scenarios. Different sets of weights can be used for the goals.

However, according to Li et al. (2015), the weighted goal programming model for this kind of problem produces similar schedules regardless of which weights are used. Therefore, all of the goals in the objective function are multiplied by a weight of 1.

The scheduling decisions x_{ijk} are made in the first stage under uncertainty and are scenario-independent. All other variables are determined in the second stage and are scenario-dependent.

Cancellations are made after optimization is complete. For each scheduling decision x_{ijk}, a value c_{ijk} is generated by sampling a real number from the normal distribution $N(50, 2)$. If a c_{ijk} value falls outside two standard deviations from the mean, then the surgery is cancelled and the surgical decision x_{ijk} is changed from 1 to 0. After cancellations are made, all other variables are recalculated to determine the impact of cancellations.

6.2 Mathematical Model

The 64 bit version of the commercial solver Xpress 7.7 is used to implement the stochastic weighted goal programming model from chapter 3. The model is run on a laptop with an Intel Core i5-3210 2.50 GHz Central Processing Unit (CPU) and 12.0 GB of memory. The Xpress code and the data file are included in the appendices. Note that some of the names of parameters, variables, and constraint in the code may not align directly with the names in the mathematical model in chapter 3.

The results from Xpress can be analyzed numerically and graphically to see how well the schedule generated by the model achieves these goals. In this section, numerical results from the stochastic weighted goal programming model are presented. Also, graphs are created to show how the recovery ward is utilized. Optimality gap values are included. Finally, a Master Surgery Schedule generated by the mathematical model is shown.

6.2.1 Numerical Results

Table 8 shows the expected values and standard deviations of expected values for the recovery ward utilization variables. It also shows the percentage of time that the ORs are underutilized before and after cancellations.

The utilization percentage for an OR is the total amount of time used for setting up for surgeries, performing surgeries, and cleaning up after surgeries divided by the total amount of time that the OR both is available and has the necessary staff available to perform surgeries and related tasks (Dexter et al., 1999, p. 7). The OR underutilization (ORUU) percentage is the utilization percentage subtracted from 100%. In this case, the ORUU percentage is calculated as the expected value across all scenarios of $\frac{100*\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{T} d_{2ijk}^{\omega-}}{\text{Number of blocks available}*(vT)}$.

Cancellations need to be accounted for. Assume a surgery has a duration of five hours and is scheduled in an eight hour long block. The underutilization and underutilization percentages therefore are three hours and 37.5%. If the block were cancelled, then the ORUU and ORUU percentages would be zero hours and 0% because an unused block cannot underutilize the OR. Therefore, the ORUU percentage actually decreases after cancellations.

	$\mathbf{E}_{\boldsymbol{\omega}}(\mathbf{I}_{\mathbf{max}}^{\boldsymbol{\omega}})$	$\mathbf{E}_{\boldsymbol{\omega}}(\mathbf{I}_{\mathbf{max}}^{\boldsymbol{\omega}} - \mathbf{I}_{\mathbf{min}}^{\boldsymbol{\omega}})$	$\mathbf{StdDev}(\mathbf{E}_{\boldsymbol{\omega}}(\mathbf{I}_{\mathbf{k}}^{\boldsymbol{\omega}}))$	$\mathbf{E}_{\boldsymbol{\omega}}(\mathbf{ORUU}^{\boldsymbol{\omega}})(\%)$
Before Cancellations	24.86	19.17	6.33	18.82
After Cancellations	24.46	19.59	6.08	17.78

Table 8: Mathematical Model - Underutilization of Operating Rooms and Utilization of Recovery Ward Beds

The results in Table 8 show that the variation in the expected number of patients in the recovery ward is small. This means that the recovery ward is being used efficiently. For all ORs across Canada, the OR utilization percentage during working days is estimated to be 70%; only 12% of Canadian ORs are utilized more than 80% of the time during working days (Canadian Institute for Health Information, 2015a). The results in Table 8 also show that the ORUU percentage is under 20% before and after cancellations; therefore, this is reasonable compared to the utilization of actual ORs in Canada. ORs are expensive to operate; hence, it is crucial to keep the ORUU percentage as low as possible.

6.2.2 Recovery Ward Utilization Graphs

Utilization of the recovery ward beds can be analyzed graphically. However, the graphs need to be generated from the results associated with the mathematical model. The procedure for creating graphs from the Xpress results is as follows. Xpress returns values for all sixteen scenarios. Figure 5 shows the expected number of patients in the recovery ward before cancellations are made for all of the scenarios.

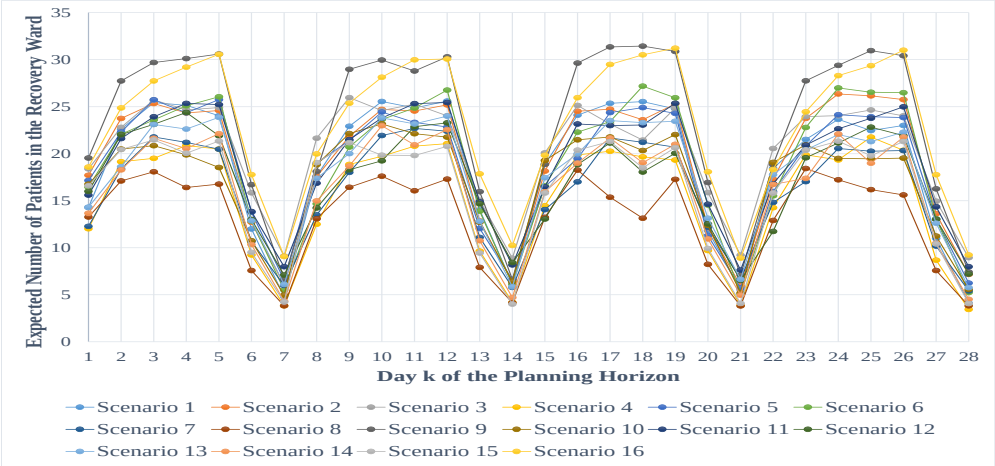

Figure 5: Mathematical Model - Expected Number of Patients in the Recovery Ward Over Planning Horizon - Before Cancellations, All Scenarios

The overall objective function uses the expected value of all the weighted goals associated with the scenarios. Figure 6 shows the expected value of the number of patients in the recovery ward before cancellations are made.

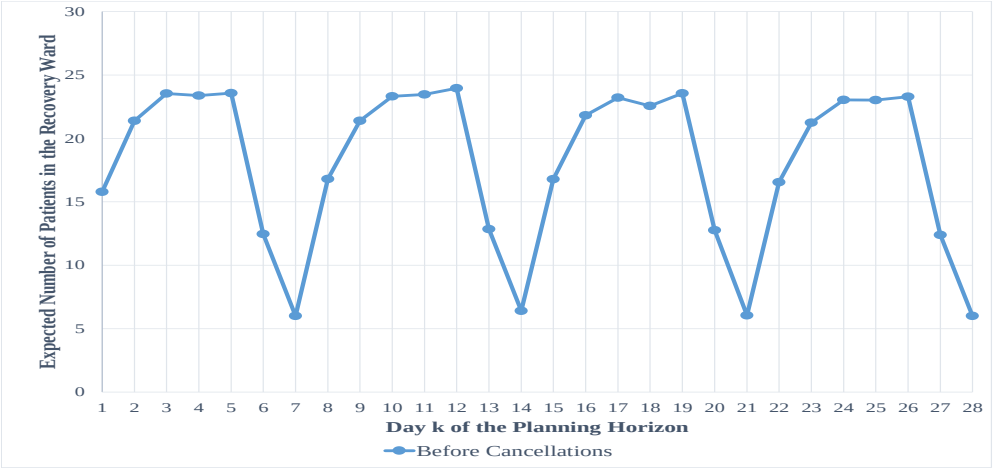

Figure 6: Mathematical Model - Expected Number of Patients in the Recovery Ward Over Planning Horizon - Before Cancellations

Figure 7 shows the expected number of patients in the recovery ward after cancellations are made.

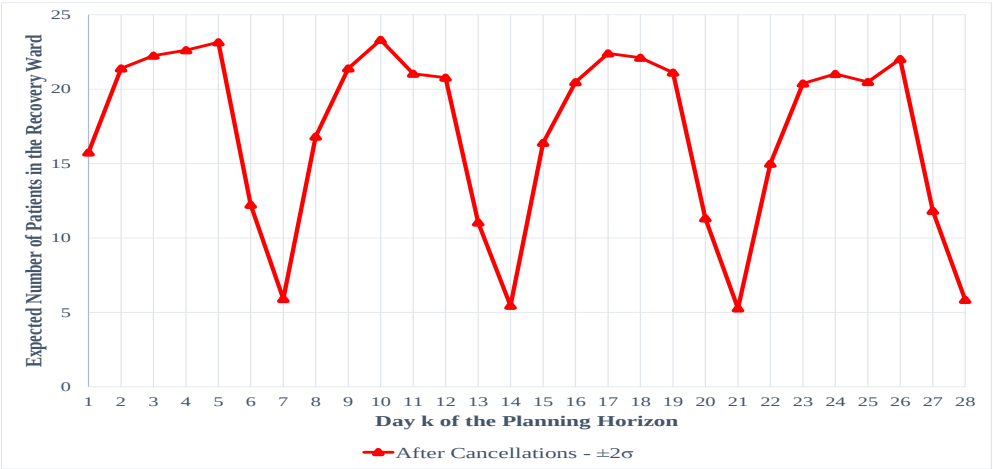

Figure 7: Mathematical Model - Expected Number of Patients in the Recovery Ward Over Planning Horizon - After Cancellations

Figure 8 combines Figure 6 and Figure 7.

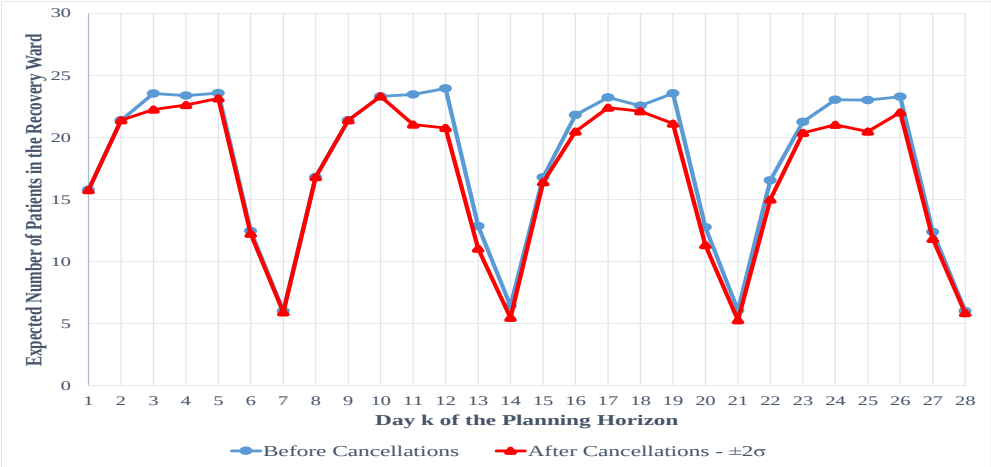

Figure 8: Mathematical Model - Expected Number of Patients in the Recovery Ward Over Planning Horizon - Before and After Cancellations

Figure 8 shows that the expected number of patients in the recovery ward is reasonably flat during weekdays. This means that the recovery ward bed utilization is balanced even though the scheduling decisions were made under uncertainty of both surgical durations and patient lengths of stay. Therefore, the recovery ward is being used efficiently, which is the purpose of the last two goals in the stochastic weighted goal programming model. After cancellations are made, the bed utilization is still reasonably balanced.

6.2.3 Variables and Constraints

The mathematical model has 129960 variables and 123979 constraints.

6.2.4 Optimality Gaps

For mixed integer programs, Xpress solves the linear relaxation of the problem, uses heuristics to find initial integer feasible solutions, and then uses a branch-and-bound search technique to find integer feasible solutions; thus, there are optimality gaps (FICO, 2014, pp. 20-26). A maximum search time of 3600 seconds is used. Table 9 shows the number of integer feasible solutions found, the times at which the first and last integer feasible solutions are found, and the relative optimality gaps.

Initial Relative Optimality Gap (%)	**Number of Integer Feasible Solutions Found**	**Final Solution Time (s)**	**Final Relative Optimality Gap (%)**
0.55	11	714	0.42

Table 9: Mathematical Model - Optimality Gaps

A Master Surgical Schedule (MSS) is generated in about 12 minutes. An MSS can be re-used on a cycle until the strategic decisions change (Tànfani & Testi, 2010, p. 106). Therefore, this amount of time is acceptable.

6.2.5 Example Master Surgical Schedule

Tables 10, 11, 12, and 13 show the MSS generated by the mathematical model; thus, these tables are displaying the x_{ijk} variables that equal 1. Each block in the schedule starts at 0800 and ends at 1600.

		Day						
		1	**2**	**3**	**4**	**5**	**6**	**7**
Operating Room	**1**	Surgical Team 15	Surgical Team 28	Surgical Team 2	Surgical Team 26	Surgical Team 14	OR Closed	OR Closed
	2	Surgical Team 5	Surgical Team 30	Surgical Team 4	Surgical Team 5	Surgical Team 1	OR Closed	OR Closed
	3	Surgical Team 17	Surgical Team 18	Surgical Team 14	Surgical Team 23	Surgical Team 12	OR Closed	OR Closed
	4	Surgical Team 26	Surgical Team 17	Surgical Team 21	Surgical Team 1	Surgical Team 15	OR Closed	OR Closed
	5	Surgical Team 8	Surgical Team 14	Surgical Team 24	Surgical Team 7	Surgical Team 18	OR Closed	OR Closed
	6	Surgical Team 28	Surgical Team 10	Surgical Team 11	Surgical Team 6	Surgical Team 9	OR Closed	OR Closed
	7	Surgical Team 10	Surgical Team 16	Surgical Team 25	Surgical Team 19	Surgical Team 6	OR Closed	OR Closed
	8	Surgical Team 12	Surgical Team 21	Surgical Team 13	Surgical Team 12	Surgical Team 25	OR Closed	OR Closed
	9	Surgical Team 21	Surgical Team 22	Surgical Team 19	Surgical Team 29	Surgical Team 26	OR Closed	OR Closed

Table 10: Mathematical Model - Example Master Surgical Schedule - Week 1

		Day						
		8	**9**	**10**	**11**	**12**	**13**	**14**
Operating Room	**1**	Surgical Team 9	Surgical Team 10	Surgical Team 30	Surgical Team 25	Surgical Team 23	OR Closed	OR Closed
	2	Surgical Team 5	Surgical Team 30	Surgical Team 4	Surgical Team 5	Surgical Team 3	OR Closed	OR Closed
	3	Surgical Team 7	Surgical Team 21	Surgical Team 11	Surgical Team 7	Surgical Team 15	OR Closed	OR Closed
	4	Surgical Team 25	Surgical Team 16	Surgical Team 21	Surgical Team 29	Surgical Team 12	OR Closed	OR Closed
	5	Surgical Team 17	Surgical Team 17	Surgical Team 23	Surgical Team 1	Surgical Team 18	OR Closed	OR Closed
	6	Surgical Team 10	Surgical Team 14	Surgical Team 2	Surgical Team 26	Surgical Team 9	OR Closed	OR Closed
	7	Surgical Team 15	Surgical Team 4	Surgical Team 5	Surgical Team 19	Surgical Team 14	OR Closed	OR Closed
	8	Surgical Team 8	Surgical Team 19	Surgical Team 25	Surgical Team 12	Surgical Team 26	OR Closed	OR Closed
	9	Surgical Team 21	Surgical Team 28	Surgical Team 24	Surgical Team 23	Surgical Team 1	OR Closed	OR Closed

Table 11: Mathematical Model - Example Master Surgical Schedule - Week 2

		Day						
		15	**16**	**17**	**18**	**19**	**20**	**21**
Operating Room	**1**	Surgical Team 7	Surgical Team 21	Surgical Team 5	Surgical Team 28	Surgical Team 14	OR Closed	OR Closed
	2	Surgical Team 5	Surgical Team 30	Surgical Team 2	Surgical Team 1	Surgical Team 1	OR Closed	OR Closed
	3	Surgical Team 28	Surgical Team 16	Surgical Team 18	Surgical Team 19	Surgical Team 9	OR Closed	OR Closed
	4	Surgical Team 11	Surgical Team 26	Surgical Team 7	Surgical Team 15	Surgical Team 18	OR Closed	OR Closed
	5	Surgical Team 15	Surgical Team 28	Surgical Team 21	Surgical Team 6	Surgical Team 26	OR Closed	OR Closed
	6	Surgical Team 9	Surgical Team 14	Surgical Team 1	Surgical Team 5	Surgical Team 16	OR Closed	OR Closed
	7	Surgical Team 10	Surgical Team 10	Surgical Team 28	Surgical Team 2	Surgical Team 27	OR Closed	OR Closed
	8	Surgical Team 17	Surgical Team 17	Surgical Team 11	Surgical Team 20	Surgical Team 12	OR Closed	OR Closed
	9	Surgical Team 25	Surgical Team 19	Surgical Team 4	Surgical Team 29	Surgical Team 25	OR Closed	OR Closed

Table 12: Mathematical Model - Example Master Surgical Schedule - Week 3

		Day						
		22	**23**	**24**	**25**	**26**	**27**	**28**
Operating Room	**1**	Surgical Team 17	Surgical Team 17	Surgical Team 21	Surgical Team 5	Surgical Team 14	OR Closed	OR Closed
	2	Surgical Team 5	Surgical Team 30	Surgical Team 30	Surgical Team 1	Surgical Team 1	OR Closed	OR Closed
	3	Surgical Team 10	Surgical Team 26	Surgical Team 2	Surgical Team 3	Surgical Team 26	OR Closed	OR Closed
	4	Surgical Team 11	Surgical Team 21	Surgical Team 6	Surgical Team 26	Surgical Team 9	OR Closed	OR Closed
	5	Surgical Team 25	Surgical Team 12	Surgical Team 25	Surgical Team 20	Surgical Team 6	OR Closed	OR Closed
	6	Surgical Team 15	Surgical Team 10	Surgical Team 11	Surgical Team 7	Surgical Team 12	OR Closed	OR Closed
	7	Surgical Team 7	Surgical Team 4	Surgical Team 17	Surgical Team 19	Surgical Team 18	OR Closed	OR Closed
	8	Surgical Team 9	Surgical Team 19	Surgical Team 28	Surgical Team 12	Surgical Team 15	OR Closed	OR Closed
	9	Surgical Team 28	Surgical Team 28	Surgical Team 24	Surgical Team 23	Surgical Team 25	OR Closed	OR Closed

Table 13: Mathematical Model - Example Master Surgical Schedule - Week 4

6.3 Simulated Annealing

The SA metaheuristic is implemented in MATLAB R2014b and is run on the same laptop. The MATLAB code and the data files are included in the appendices.

There are four parameters in the metaheuristic for which values need to be chosen: cooling rate (α), initial temperature (T_i), final temperature (T_f), and the number of solutions accepted per inner loop (L). The metaheuristic is first run over a variety of parameter com-

binations to see which ones provide reasonable results in a reasonable amount of time. Design of Experiments is then used to determine whether the values of parameters have a significant impact on the energy values.

6.3.1 Preliminary Numerical Results

Different combinations of parameters can be used in the metaheuristic. Choices for parameter values are completely arbitrary. Each combination is run ten times. Table 14 shows preliminary results. The first four columns are the parameter values. The next three columns are the best, average, and worst solutions obtained for each combination of parameter values; the values of these solutions come from the energy function, which is the same as the objective function in the mathematical model. The energy function is being minimized, so lower values are better. The final column shows the standard deviation of the ten runs for each combination of parameter values.

				Solutions From Ten Runs of Each Combination			
Cooling Rate	T_i	T_f	**L**	**Best**	**Average**	**Worst**	**Standard Deviation**
0.85	1e5	1	1	762.469	767.647	772.653	3.477
0.85	1e4	1	1	762.919	767.417	774.706	3.466
0.85	2e3	1	1	763.044	766.568	773.687	3.357
0.85	1e3	1	1	762.635	766.754	771.918	3.082
0.90	1e5	1	1	759.876	767.081	770.935	3.650
0.90	1e4	1	1	761.382	766.225	772.804	3.627
0.90	2e3	1	1	761.938	767.077	771.344	3.390
0.90	1e3	1	1	759.267	765.849	775.609	4.263
0.95	1e5	1	1	757.998	761.784	765.989	2.824
0.95	1e4	1	1	758.960	763.847	767.517	3.164
0.95	2e3	1	1	758.927	765.254	771.522	4.292
0.95	1e3	1	1	761.024	767.305	770.889	3.059
0.85	1e5	1	2	760.405	766.184	770.489	3.526
0.85	1e4	1	2	760.172	766.568	769.561	2.933
0.85	2e3	1	3	761.448	766.912	773.436	3.785
0.85	1e3	1	3	759.223	767.037	771.838	3.968
0.85	1e5	1	10	754.656	759.982	764.272	3.111
0.85	1e8	1e-3	1	747.394	749.704	753.372	1.687
0.85	1e5	1e-2	1	754.975	760.493	764.446	2.863

Table 14: Simulated Annealing - Preliminary Numerical Results

Some insights can be gained from these preliminary numerical results. Average results are approximately the same regardless of which parameters are used. The exception to this is when an extremely low final temperature is used. Results for the best solutions behave differently. In general, using higher cooling rates takes longer but usually results in lower best solutions. Similarly, a lower final temperature typically will obtain a lower best result. Finally, using a higher number of solutions per inner loop also obtains lower results for the best values but requires more time.

6.3.2 Design of Experiments

In the designed experiment, each parameter is a factor. Each factor is assigned a high value (1) and a low value (-1). The choice of values is arbitrary but is based on the preliminary numerical results. Values that produce reasonable results in a reasonable amount of time are used. For the cooling rate α, high and low values of 0.95 and 0.85, respectively, are used. Note that the high cooling rate value actually causes slower cooling than the low value. For the initial temperature T_i, high and low values of 100 000 000 and 1 000, respectively, are used. For the final temperature T_f, values of 1 and 0.1, respectively, are used. For the number of solutions per inner loop L, high and low values of 3 and 1, respectively are used. Table 15 summarizes the values of the factors.

	Factor			
Level	**Cooling Rate**	**Initial Temperature**	**Final Temperature**	**Solutions Per Inner Loop**
High (1)	0.95	100 000 000	1	3
Low (-1)	0.85	1 000	0.1	1

Table 15: Simulated Annealing - Factor Values

A randomized 2^4 full factorial design without replication and without repeats is used for the experiment. This is justifiable because the standard deviation values in Table 14 are low. Table 16 shows the order in which the runs are conducted and the results from the experiment.

Order		Factor				
Standard	**Run**	**Cooling Rate**	**Initial Temperature**	**Final Temperature**	**L**	**Energy Value**
4	1	1	1	-1	-1	752.9992
6	2	1	-1	1	-1	767.797
13	3	-1	-1	1	1	768.3791
9	4	-1	-1	-1	1	753.7186
3	5	-1	1	-1	-1	765.0815
2	6	1	-1	-1	-1	752.8883
16	7	1	1	1	1	758.8771
5	8	-1	-1	1	-1	768.9311
11	9	-1	1	-1	1	754.053
8	10	1	1	1	-1	770.9658
15	11	-1	1	1	1	766.4768
12	12	1	1	-1	1	749.1089
14	13	1	-1	1	1	763.3421
1	14	-1	-1	-1	-1	762.2911
7	15	-1	1	1	-1	766.9889
10	16	1	-1	-1	1	749.443

Table 16: Simulated Annealing - 2^4 Factorial Designed Experiment

Figure 9 is a normal effects plot generated by Minitab 16.0. It shows that the final temperature (Factor C, T_f) has a large positive effect on the energy value (i.e. objective function value). In other words, as the final temperature increases, the energy value also increases. The cooling rate (Factor A, α), the number of solutions per inner loop (Factor D, L), and the interaction between cooling rate, final temperature, and solutions per inner loop (Interaction ACD) have small negative effects on the energy value. If a factor with a negative effect (e.g. final temperature) is increased, then the response (i.e. energy value) decreases. The initial temperature (Factor B, T_i) and all other factor interactions do not have significant effects on the energy value.

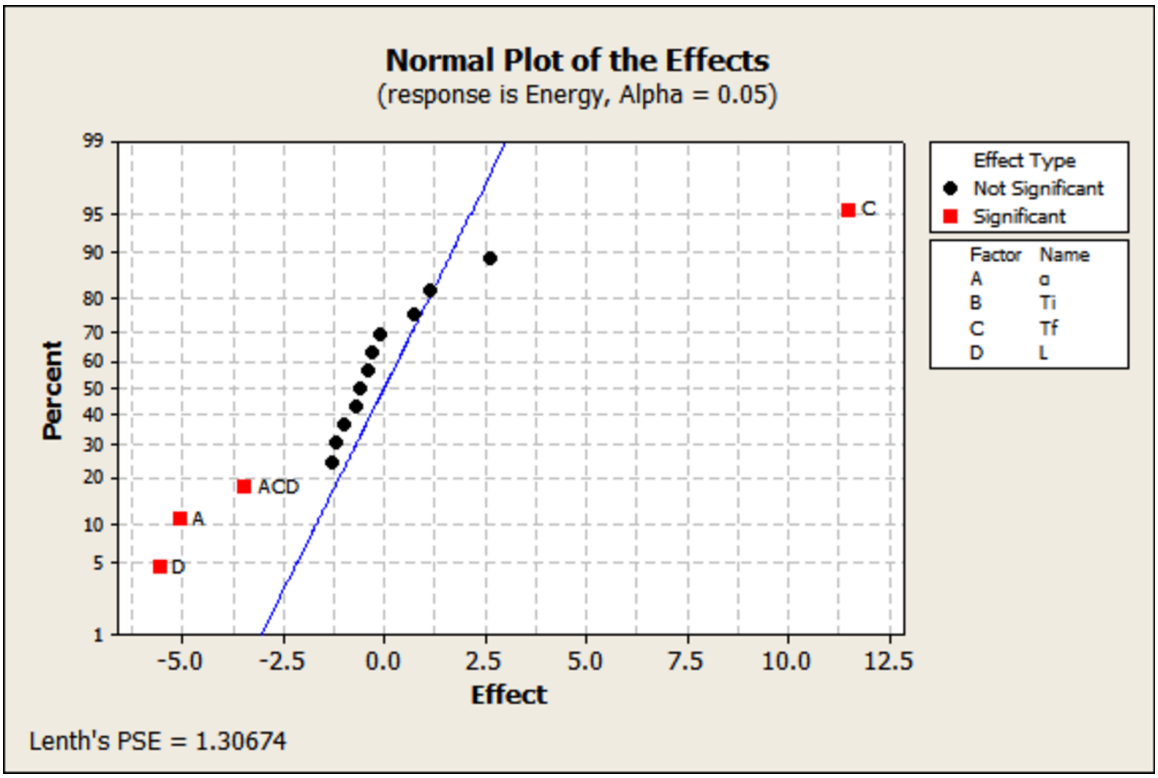

Figure 9: Simulated Annealing - Normal Effects Plot

The results of the preliminary experiment and the designed experiment are used to suggest values for the parameters. The initial temperature does not have a significant effect on the energy value; therefore, T_i should be set to 1 000 in order to reduce the amount of computational time required to find a schedule. α, T_f, and L should be set to 0.95, 0.1, and 3, respectively.

6.4 Discrete Event Simulation

999 replications of a 28 day planning horizon are performed in ProModel. February of 2010 is used because it has 28 days and starts on Monday February 1. However, any 28 day period could be used.

The Master Surgical Schedule (MSS) generated by either the mathematical model or the metaheuristic can be used to schedule surgical teams. In this case, the MSS from the mathematical model (see Tables 10, 11, 12, and 13) is used. Each day at 0600 an entity called PatientBatch for each surgical team scheduled to that day arrives at the Arrival buffer. Each

PatientBatch is assigned attributes to keep track of the associated surgical team, OR, and day of surgery. Also, each PatientBatch is randomly assigned a scenario value by selecting an integer from 1 to 16. In different scenarios, a given surgical team can operate on a different number of patients because the surgical durations are different. Each PatientBatch entity is split into the appropriate number of Patient entities for the assigned scenario. All attributes are then transferred to the Patient entities. This procedure ensures that each surgical teams receives an appropriate number of patients in the correct OR on the correct day. All PatientBatch entities exit the system after the Patient entities are generated.

OR resources and surgical team resources are both scheduled on weekdays from 0800 to 1600. All patients arrive and are available for their surgeries before 0800.

All buffers have infinite capacities. The Arrival Area has one unit with an infinite capacity. Each OR, Initial Recovery Area, and Recovery Ward has a capacity of one patient. There are nine ORs, twenty-five Initial Recovery Area units, and sixty Recovery Ward units.

Some of the locations, such as the Arrival Area and the Initial Recovery Area, and the processes that occur at those locations are not relevant to the problem being considered but are added to the simulation to enhance its realism. It it assumed that the Arrival Process follows the normal distribution $N(60,3)$ minutes and that the Initial Recovery Process follows the normal distribution $N(75,5)$ minutes.

Process times in the ORs and in the Recovery Ward do matter. The simulation uses the same surgical duration values and length of stay probabilities as the mathematical model and the simulated annealing metaheuristic. The OR process times follow the weighted surgical duration parameter A_i^{ω}. These values are exported from MATLAB and are loaded into the simulation. Similarly, the probability distributions for patient lengths of stay, which are also generated in MATLAB, are loaded into the simulation. The Recovery Ward process time for a patient is randomly selected from the appropriate probability distribution. The

patient then stays in the Recovery Ward for the selected number of days.

Buffers, except for the final one where patients are discharged, do not have any processing times. The processing time for discharges follows the normal distribution $N(30, 1)$ minutes.

Any cancellations are made after the MSS is generated; therefore, cancellations are not included in the simulation.

6.4.1 Simulation Results

For the 28 day planning horizon, the number of patients operated on has a mean of 399.16 patients and a standard deviation of 5.69 patients. The time that a patient spends in the system has a mean of 2210.43 minutes and a standard deviation of 111.56 minutes. The breakdown of the average time is 27.31 minutes in waiting (standard deviation = 0.38 minutes), 2036.33 minutes in operation (standard deviation = 111.72 minutes), and 146.78 minutes in blocking (standard deviation = 2.36 minutes). The blocking happens because all patients arrive at 0600 and then wait for their surgeries after being processed at the Arrival Area. All other blocking is eliminated by the buffers.

Table 17 shows utilization values for the ORs. The ORs are open for 8 hours per day for 20 days in the planning horizon; thus, the scheduled time per OR in the planning horizon is $(8\ \frac{\text{hours}}{\text{day}})$ (20 days) = 160 hours. The work time is the number of minutes that an OR is used for over the course of the planning horizon. The OR underutilization (ORUU) values can be obtained by subtracting each % utilization value from 100%. Note that the these values are similar to the ones associated with the mathematical model in Table 8.

	Scheduled Time Per OR (hr)	Work Time (min)		Time Per Usage (min)		% Utilization	
Operating Room	**Mean**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
1	160	7459.02	229.39	173.58	4.50	77.70	2.39
2	160	7614.15	354.39	216.35	4.59	79.31	3.69
3	160	7835.56	214.24	161.64	4.16	81.62	2.23
4	160	7932.92	224.05	164.83	4.15	82.63	2.33
5	160	7721.60	224.32	174.54	4.62	80.43	2.24
6	160	7969.55	235.15	156.66	3.72	83.02	2.45
7	160	7740.83	257.22	168.10	4.29	80.63	2.68
8	160	7816.90	211.48	164.43	4.40	81.43	2.20
9	160	7589.75	223.77	183.91	4.72	79.06	2.33

Table 17: Simulation - Utilization of Operating Rooms

Figure 10 is a graph of the expected utilization of recovery ward beds. This graph can be compared to the equivalent graph from the mathematical programming model in Figure 6. Note that there is no warm-up period in the simulation. In other words, there are no spillover patients from January 2010 because the simulation started on February 1, 2010. The recovery ward beds are being used efficiently in the simulation.

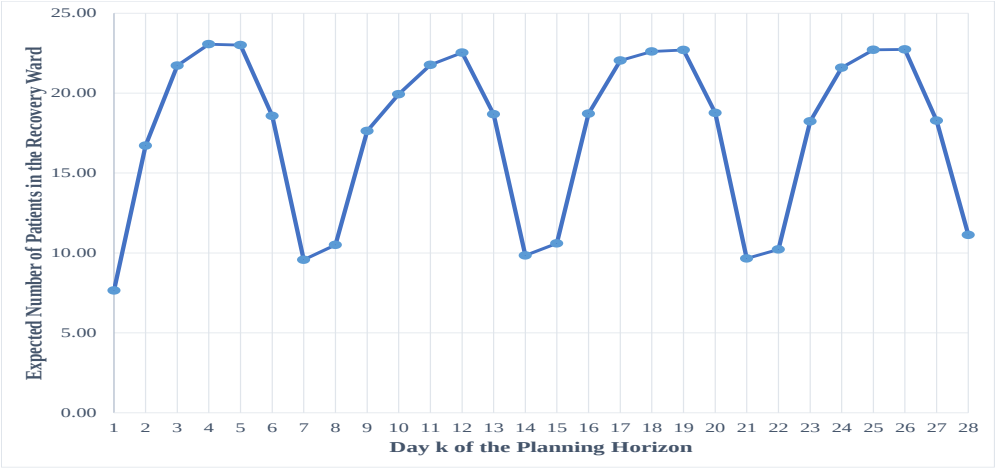

Figure 10: Simulation - Expected Recovery Ward Utilization

CHAPTER 7: CONCLUSIONS AND FUTURE RESEARCH

In this chapter, conclusions and ideas for future research are presented.

7.1 Conclusions

In this research, the problem of designing a system of operating rooms (ORs) and recovery ward beds by allocating OR blocks to surgical teams in an optimal manner is considered. Viewing a hospital as a system is important because problems in one area of a hospital can affect other areas. A stochastic weighted goal programming model is proposed to schedule elective surgeries under uncertainty of both surgical durations and patient lengths of stay. The model generates a Master Surgical Schedule (MSS) that allocates blocks to surgical teams in a way that optimizes the utilization of both the ORs and the recovery ward beds. Four goals are used in the model: the deviations between the targeted number of surgeries and the actual number of surgeries performed, the deviations between the targeted number of hours for surgeries and the actual number of hours used for surgeries, the maximum expected number of patients in the recovery ward over the course of the planning horizon, and the difference between the maximum and minimum expected numbers of patients in the recovery ward over the course of the planning horizon. Using a stochastic weighted goal programming model to generate an MSS that optimizes both the ORs and the recovery ward beds while accounting for both the uncertainties in surgical durations and patient lengths of stay is an innovation that is present in this research.

Xpress, which is a commercial mathematical programming package, is used to solve the model. The numerical example shows that the implementation of the mathematical model in Xpress generates an MSS with an optimality gap of 0.42%; the branch and bound search runs for 3600 seconds. The expected OR utilization is approximately 80%. The maximum expected number of patients in the recovery ward is minimized, and the expected number of patients in the recovery ward is balanced over the course of the planning horizon. Fur-

thermore, the results from the model are still sensible after cancellations are made. It is concluded that stochastic weighted goal programming is a reasonable way of scheduling surgical teams into ORs while accounting for uncertainties in surgical durations and patient lengths of stay. It should be noted that large scheduling instances likely will have issues with tractability.

The issues with time and memory can be managed by using a metaheuristic. Therefore, a simulated annealing (SA) metaheuristic is developed. In the numerical example, the SA metaheuristic uses less memory than the Xpress implementation of the mathematical model and requires less time; however, the schedules generated by the metaheuristic are near-optimal. Design of Experiments is used to investigate the impact of parameter values in the metaheuristic on the quality of the solutions obtained. It is found that the final temperature parameter has a large positive effect on the energy value, which is the objective function value and thus represents the quality of a schedule. The cooling rate, the inner loop length, and the interaction between the cooling rate, the final temperature, and the inner loop length all have negative effects on the energy value.

A discrete event simulation is developed for the purposes of demonstrating and validating the system of ORs and recovery ward beds. The discrete event simulation model can use an MSS generated by either the mathematical model or the SA metaheuristic. It is shown that the discrete simulation model has similar results as the mathematical model; it should also have similar results as the metaheuristic, but this is not shown in this research. The discrete event simulation model is an important part of demonstrating the value of this research to relevant stakeholders in the health care sector.

The most important conclusion is that both the Xpress implementation of the mathematical model and the SA metaheuristic make it possible for a computer to generate MSS that are near-optimal. Therefore, this research optimizes the system of ORs and recovery ward beds in a hospital; this can reduce costs, make wait lists shorter, and positively affect the

welfares of patients. Furthermore, it can save time for schedulers in the health care sector; however, it must be developed properly in order to be adopted in the health care sector.

7.2 Future Research

There are many ways in which this research could be extended.

The mathematical model, the simulated annealing metaheuristic, and the discrete event simulation model can be incorporated into a Decision Support System (DSS) software package that allows the scheduler to generate MSS without having to understand the underlying mathematics and optimization techniques. Different hospitals may have different needs; thus, the DSS could be customized. The DSS would be based in Microsoft Excel and would contain Visual Basic for Applications (VBA) code to analyze the size of the scheduling problem. Extremely small problems could be solved directly in Excel by using the built in solver package. The overhead would be low. Unfortunately, the Excel solver package can only manage 200 decision variables; ergo, most problems would have to be solved using a commercial solver (Fylstra et al., 1998, p. 32). Some problems may be too large to solve in a commercial solver; hence, these could be solved using the simulated annealing metaheuristic. The Excel file would contain more VBA code to display the schedule to the scheduler. Also, the schedule would be sent to the simulation model to show how the schedule would function in the operating theatre. The simulation model would also generate data regarding the utilization of ORs and recovery ward beds. The schedule in Excel could be interactive. The scheduler would have the option of making swaps in the schedule. The simulation model could then be run again to show the impacts of the swaps. Eventually the scheduler would accept an MSS that would be implemented.

More real world data could be obtained by collaborating with relevant agencies and organizations, such as the Local Health Integration Networks in Ontario, the Community Care Access Centre, and the Institute for Clinical Evaluative Sciences. Also, data from the Ontario Health Insurance Plan and equivalent plans from other provinces could be collected

and used. Furthermore, it would be useful to interact with OR managers in order to consider any special needs or wants that they might have and to ensure that the research is accurately representing real operating theatres. Furthermore, this research should be tested in the real world in using a clinical approach. This could be accomplished by finding a hospital that is willing to implement the approach in this research over a long time period. In the first planning horizon, the hospital could continue to use its existing approach for OR scheduling. The hospital would also use the approach in this research to generate a Master Surgical Schedule (MSS). Performance measures, such as costs, wait list lengths, and measures of patients' welfares, would need to be established in order to allow for comparisons between this approach and the existing approach. Fixler and Wright (2013) propose a scorecard based approach for evaluating the efficiency of ORs. In subsequent planning horizons, the hospital would stop using the existing approach and would exclusively use the approach in this research. At the end of each planning horizon, the performance measures would be used to compare the result of the current planning horizon to results from previous ones. Many factors would need to be controlled for to ensure that changes are due to the scheduling approach.

This research considers the scheduling of surgical teams into ORs, which is a tactical problem. The mathematical model could be extended to make strategic decisions and to schedule surgical cases.

The mathematical model has a number of limitations. In addition, it has assumptions that might not be completely realistic. Different hospitals might be structured differently, and a given hospital can vary significantly on a day to day basis. The model does not consider any of these differences or variances. One assumption is that beds are always available in the recovery ward. In actual hospitals, recovery wards do not have infinite capacities (Beliën et al., 2006, p. 346). A lack of beds would cause cancellations in the proposed operational scheduling model. It is also assumed that all surgical teams within a given surgical specialty

are equally competent. For each surgical team, the relationship between the competence of that surgical team and the length of stays for patients operated on by that surgical team should be derived and incorporated into the mathematical model. Furthermore, it is assumed that all patients operated on by a given surgical team are interchangeable. However, different patients may have certain characteristics that affect surgical durations and/or patient lengths of stay. For example, if the same surgical team performs the same procedure on an 85 year old patient and a 25 year old patient, then the 85 year old patient probably will have a longer length of stay. These variations between patient types should be considered in the mathematical model. Also, some hospitals schedule children before adults; thus, the proposed operational scheduling model should do this (Meskens et al., 2013, p. 651). In addition, emergent surgeries, urgent surgeries, and patient transfers should be considered by the proposed operational case scheduling model. Furthermore, the impact of these on the tactical scheduling should be considered.

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APPENDIX 1 - MATHEMATICAL MODEL - XPRESS CODE (SWGPM.MOS)

```
model "Weighted Goal Programming Model"

        !Load modules
        uses "mmsp", "random"

        !Location of data file
        parameters
                DataFile = 'Data/DataFile.dat'
        end-parameters

        declarations
        !Declare a random seed value
        randSeed: integer

        !Declare index sets
        i, j, k, l, e, r: range

        !Declare the upper bounds of the index sets
        m, n, T, h, E, R: integer

        !Declare other parameters
        v: real

        L, H, N: array(i) of integer

        B, B1, F2: array(r) of integer

        D1, D2, D3, D4, D5, D6, D7, D8: array(i,e) of real
        D9, D10, D11, D12, D13, D14, D15, D16: array(i,e) of real

        p1, p2, p3, p4, p5, p6, p7, p8: array(i,l) of real
        p9, p10, p11, p12, p13, p14, p15, p16: array(i,l) of real

        O, f: array(i,e) of real

        pi: array(i,j) of integer

        OMEGA: array(i,k) of integer

        !Declare 0-1 decision variables
        x: array(i,j,k) of spvar

```

```
!Declare continuous decision variables
I: array(k) of spvar

I_max, I_min: spvar

!Declare deviation variables
d1minus, d1plus: array(i) of spvar

d2n: array(i,j,k) of spvar

!Define number of scenarios
numScenarios: integer

!Declare stochastic parameters
D: array(i,e) of sprand

p: array(i,l) of sprand

!Declare random expressions
maxni: array(i) of sprandexp

A: array(i) of sprandexp

PHI: array(i,l) of sprandexp

!Declare stages in scenario tree
Stages = "First","Second"
end-declarations

initializations from DataFile
        randSeed numScenarios m n T h E R
end-initializations

!Set the random seed
setmtrandseed(randSeed)

!Define all index sets
i := 1..m
j := 1..n
k := 1..T
l := 0..28 !Note that l starts at 0
e := 1..E
r := 1..R

!Finalize the index sets
```

```
88          finalize(i)
89          finalize(j)
90          finalize(k)
91          finalize(l)
92          finalize(e)
93          finalize(r)
94
95          !Forward declarations of procedures
96          forward procedure assembleData
97          forward procedure calculateCancellations
98          forward procedure createBinaryDecisionVariables
99          forward procedure createContinuousVariables
100         forward procedure createDeviationVariables
101         forward procedure displayResults
102         forward procedure generateScenarioTree
103         forward procedure weightedGoalProgramming
104
105
106         !Call the procedures to create the decision variables
107         createBinaryDecisionVariables
108         createContinuousVariables
109         createDeviationVariables
110
111         !Read values from the data file
112         initializations from DataFile
113                 v pi OMEGA
114         end-initializations
115
116
117         (!*****************************************************************************
118
119         Named Constraints, Parameters, and Calculations
120
121         *****************************************************************************!)
122         declarations
123                 constraint1: array(k) of splinctr
124                 constraint2: array(j) of splinctr
125                 constraint3: array(j,k) of splinctr
126                 constraint4: array(i,k) of splinctr
127                 constraint5: array(i) of splinctr
128                 constraint6: array(i) of splinctr
129                 constraint7: array(r) of splinctr
130                 constraint8: array(i) of splinctr
131                 constraint9: array(i,j,k) of splinctr
132                 constraint10: array(k) of splinctr
```

```
        constraint11: array(k) of splinctr
        constraint12: array(k) of splinctr
end-declarations

assembleData

!Generate the scenario tree
generateScenarioTree

forall(icount in i) A(icount) := sum(ecount in e)
(D(icount,ecount)*O(icount,ecount)*f(icount,ecount))

forall(icount in i) maxni(icount) := floor(v/A(icount))

forall(icount in i, lcount in l) PHI(icount,lcount) :=
sum(tau in 0..floor(h/T), lcount2 in lcount+tau*T+1..h)maxni(icount)*p(icount,lcount2)

!Constraints
forall(kcount in k) constraint1(kcount) :=
sum(icount in i, jcount in j) pi(icount,jcount) * x(icount,jcount,kcount) = 0

forall(jcount in j) constraint2(jcount)  :=
sum(icount in i, kcount in k) OMEGA(icount,kcount) * x(icount,jcount,kcount) = 0

forall(jcount in j, kcount in k) constraint3(jcount,kcount) :=
sum(icount in i) x(icount,jcount,kcount) <= 1

forall(icount in i, kcount in k) constraint4(icount,kcount) :=
sum(jcount in j) x(icount,jcount,kcount) <= 1

forall(icount in i) do
        constraint5(icount) := sum(jcount in j, kcount in k) x(icount,jcount,kcount) >= L(icount)
        constraint6(icount) := sum(jcount in j, kcount in k) x(icount,jcount,kcount) <= H(icount)
end-do

forall(rcount in r) constraint7(rcount) :=
sum(icount in B1(rcount)..F2(rcount), jcount in j, kcount in k)
x(icount,jcount,kcount) = B(rcount)

forall(icount in i) constraint8(icount) :=
maxni(icount)*(sum(jcount in j, kcount in k)
(x(icount,jcount,kcount))) + d1minus(icount) - d1plus(icount) = N(icount)

forall(icount in i, jcount in j, kcount in k) constraint9(icount,jcount,kcount) :=
(A(icount)*maxni(icount) - v)*(x(icount,jcount,kcount)) + d2n(icount,jcount,kcount) = 0
```

```
178
179         forall(kcount in k) constraint10(kcount) := I(kcount) =
180         sum(icount in i, jcount in j, lcount2 in 1..kcount) PHI(icount,kcount-lcount2)*x(icount,jcount,lcount2) +
181         sum(icount in i, jcount in j, lcount2 in kcount..T) PHI(icount,kcount+T-lcount2)*x(icount,jcount,lcount2)
182
183         forall(kcount in k) constraint11(kcount):= I(kcount) <= I_max
184
185         forall(kcount in k) constraint12(kcount):= I(kcount) >= I_min
186
187         (!*************************************************************************
188
189         Main part of program
190         *************************************************************************!)
191         weightedGoalProgramming
192
193         (!*************************************************************************
194
195         Weighted goal programming procedure
196
197         *************************************************************************!)
198         procedure weightedGoalProgramming
199
200                 declarations
201                         objective: splinctr
202                 end-declarations
203
204                 !Objective function
205                 objective :=  sum(icount in i)(d1minus(icount)) +
206                 sum(icount in i, jcount in j, kcount in k) (d2n(icount,jcount,kcount)) +
207                 I_max +
208                 (I_max - I_min)
209
210                 setparam("XPRS_MAXTIME", -3600)
211                 minimize(objective)
212                 displayResults
213         end-procedure
214
215         (!*************************************************************************
216
217         Procedure for displaying the results
218
219         *************************************************************************!)
220         procedure displayResults
221
222                 writeln("**********Objective value before cancellations **********")
```

```
writeln(getparam("xprs_mipobjval"))

writeln("**********xijk values before cancellations **********")
forall(icount in i, jcount in j, kcount in k | getsol(x(icount,jcount,kcount)) = 1)
writeln("x(",icount,",",jcount,",",kcount,") = ", getsol(x(icount,jcount,kcount)))

forall(s in 1..numScenarios) do
        writeln("********** Sum of d1minus(i) values before cancellations, Scenario", s, "**********")
        writeln(sum(icount in i)(getsolinscen(d1minus(icount),s)))
end-do

forall(s in 1..numScenarios) do
        writeln("********** Sum of d2n(i,j,k) values before cancellations, Scenario", s, "**********")
        writeln("Underutilized time,",(sum(icount in i, jcount in j, kcount in k)
        getsolinscen(d2n(icount,jcount,kcount),s)))
end-do

forall(s in 1..numScenarios) do
        writeln("********** Percent underutilization values before cancellations, Scenario", s, "**********")
        writeln("Percent unutilized OR time,",100*(sum(icount in i, jcount in j, kcount in k)
        getsolinscen(d2n(icount,jcount,kcount),s))/(v*n*(T-8)))
end-do

forall(s in 1..numScenarios) do
        writeln("********** I(k) values before cancellations, Scenario", s, "**********")
        forall(kcount in k) writeln(getsolinscen(I(kcount),s))
end-do

calculateCancellations

forall(s in 1..numScenarios) do
        writeln("********** Sum of d2n(i,j,k) values after cancellations, Scenario ", s, "**********")
        writeln("Underutilized time",
        (sum(icount in i, jcount in j, kcount in k | speval(x(icount,jcount,kcount),s) = 1)
        (v - speval(A(icount),s)*speval(maxni(icount),s))))
end-do

forall(s in 1..numScenarios) do
        writeln("********** Sum of d2n(i,j,k) values after cancellations, Scenario", s,  "**********")
        writeln("Percent unutilized OR time,",
                100*(sum(icount in i, jcount in j, kcount in k | speval(x(icount,jcount,kcount),s) = 1)
                (v - speval(A(icount),s)*speval(maxni(icount),s)))/(v*n*(T-8)))
end-do

forall(s in 1..numScenarios) do
```

```
                writeln("********** I(k) values after Cancellations, Scenario", s, "**********")
                forall(kcount in k) writeln(speval(
                sum(icount in i, jcount in j, lcount2 in 1..kcount)
                PHI(icount,kcount-lcount2)*x(icount,jcount,lcount2) +
                sum(icount in i, jcount in j, lcount2 in kcount+1..T)
                PHI(icount,kcount+T-lcount2)*x(icount,jcount,lcount2),s))
        end-do
end-procedure

(!*****************************************************************************

Variable creation procedures

*****************************************************************************!)
!Create the binary decision variables
procedure createBinaryDecisionVariables
        forall(icount in i, jcount in j, kcount in k) do
                create(x(icount,jcount,kcount))
                x(icount,jcount,kcount) is_binary
        end-do
end-procedure

!Create the continuous decision variables
procedure createContinuousVariables
        forall(kcount in k) create(I(kcount))
end-procedure

!Create the deviation variables
procedure createDeviationVariables
        forall(icount in i) do
                create(d1plus(icount))
                create(d1minus(icount))
        end-do

        forall(icount in i, jcount in j, kcount in k) create(d2n(icount,jcount,kcount))
end-procedure

(!*****************************************************************************

Scenario Tree Generation

*****************************************************************************!)
procedure generateScenarioTree
        declarations
                Probabilities : array (1..numScenarios) of real
```

```
313     end-declarations
314
315     Probabilities::[1/numScenarios,1/numScenarios,1/numScenarios, 1/numScenarios,
316             1/numScenarios,1/numScenarios,1/numScenarios, 1/numScenarios,1/numScenarios,
317             1/numScenarios,1/numScenarios,1/numScenarios,1/numScenarios,1/numScenarios,
318             1/numScenarios,1/numScenarios]
319
320     spsetstages(Stages)
321
322     forall(kcount in k) spsetstage(constraint1(kcount), "First")
323     forall(jcount in j) spsetstage(constraint2(jcount), "First")
324     forall(jcount in j, kcount in k) spsetstage(constraint3(jcount, kcount), "First")
325     forall(icount in i, kcount in k) spsetstage(constraint4(icount,kcount), "First")
326     forall(icount in i) spsetstage(constraint5(icount), "First")
327     forall(icount in i) spsetstage(constraint6(icount), "First")
328     forall(rcount in r) spsetstage(constraint7(rcount), "First")
329     forall(icount in i) spsetstage(constraint8(icount), "Second")
330     forall(icount in i, jcount in j, kcount in k) spsetstage(constraint9(icount,jcount,kcount), "Second")
331     forall(kcount in k) spsetstage(constraint10(kcount), "Second")
332     forall(kcount in k) spsetstage(constraint11(kcount), "Second")
333     forall(kcount in k) spsetstage(constraint12(kcount), "Second")
334
335     forall(icount in i, jcount in j, kcount in k) spsetstage(x(icount,jcount,kcount), "First")
336     forall(icount in i, ecount in e) spsetstage(D(icount, ecount), "Second")
337     forall(icount in i, lcount in l) spsetstage(p(icount,lcount), "Second")
338     forall(kcount in k) spsetstage(I(kcount), "Second")
339     spsetstage(I_max, "Second")
340     spsetstage(I_min, "Second")
341     forall(icount in i) spsetstage(d1minus(icount), "Second")
342     forall(icount in i) spsetstage(d1plus(icount), "Second")
343     forall(icount in i, jcount in j, kcount in k) spsetstage(d2n(icount,jcount,kcount), "Second")
344
345     !Create the tree
346     spcreatetree(numScenarios)
347
348     !Assign realizations of p(i,l) and D(i,e)
349
350     forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 1, D1(icount,ecount))
351     forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 1, p1(icount,lcount))
352
353     forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 2, D2(icount,ecount))
354     forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 2, p2(icount,lcount))
355
356     forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 3, D3(icount,ecount))
357     forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 3, p3(icount,lcount))
```

```
forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 4, D4(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 4, p4(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 5, D5(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 5, p5(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 6, D6(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 6, p6(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 7, D7(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 7, p7(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 8, D8(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 8, p8(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 9, D9(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 9, p9(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 10, D10(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 10, p10(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 11, D11(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 11, p11(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 12, D12(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 12, p12(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 13, D13(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 13, p13(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 14, D14(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 14, p14(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 15, D15(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 15, p15(icount,lcount))

forall(icount in i, ecount in e) spsetrandatnode(D(icount,ecount), 16, D16(icount,ecount))
forall(icount in i, lcount in l) spsetrandatnode(p(icount,lcount), 16, p16(icount,lcount))

!Assign probabilities to branches
spsetprobcond(2,Probabilities)

!Generate the tree
spgentree
```

```
403         end-procedure
404
405         (!*****************************************************************************
406
407         Assemble Data
408
409         *****************************************************************************!)
410         procedure assembleData
411                         initializations from DataFile
412                                 L H N O
413                                 D1 D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13 D14 D15 D16
414                                 p1 p2 p3 p4 p5 p6 p7 p8 p9 p10 p11 p12 p13 p14 p15 p16
415                                 f as "f1"
416                                 B1 as "B11"
417                                 F2 as "F21"
418                                 B as "B1"
419                         end-initializations
420         end-procedure
421
422         (!*****************************************************************************
423
424         Cancellations
425
426         *****************************************************************************!)
427         procedure calculateCancellations
428
429                         declarations
430                         c: array(i,j,k) of real
431                         mean: real
432                         stdev: real
433                 end-declarations
434
435                 initializations from DataFile
436                         mean stdev
437                 end-initializations
438
439                 !Generate a value of cijk for all xijk by selecting from a normal distribution.
440                 forall(icount in i, jcount in j, kcount in k) c(icount,jcount,kcount) := normal(mean,stdev)
441
442                 !If the value of cijk falls outside of the bounds, then xijk will be fixed to 0.
443                 forall(icount in i, jcount in j, kcount in k | c(icount,jcount,kcount) <= (mean - 2*stdev) or
444                 c(icount,jcount,kcount) >= (mean+2*stdev)) spfix(x(icount,jcount,kcount),0)
445
446                 !Display cancellations
447                 writeln("********** Cancellations **********")
```

```
                forall(icount in i, jcount in j, kcount in k | c(icount,jcount,kcount) <=
                (mean - 2*stdev) or c(icount,jcount,kcount) >= (mean+2*stdev))
                writeln("x(",icount,",",jcount,",",kcount,"):",c(icount,jcount,kcount)," = 0")
        end-procedure

end-model
```

APPENDIX 2 - MATHEMATICAL MODEL - XPRESS DATA FILE (~DATA/DATAFILE.DAT)

```
!Random seed value
randSeed: 5

!Number of scenarios
numScenarios: 16

!Upper bounds for index sets
m: 30
n: 9
T: 28
h: 28
v: 8
R: 6
E: 8

N:[20 21 33 23 24 30 28 26 26 34 25 35 25 21 30 22 27 21 26 31 32 31 32 22 29 29 24 30 30 35]
L:[1 5 1 5 2 5 3 2 2 4 3 5 1 1 2 4 3 2 2 2 3 1 5 3 2 5 1 4 3 4]
H:[9 14 12 16 10 8 17 18 10 18 7 9 12 16 16 18 13 12 20 8 13 20 11 7 10 10 17 10 11 6]

B11:[1 7 12 15 17 23]
F21:[6 11 14 16 22 30]
B1:[36 30 18 12 36 48]

pi:[0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 1
    0 1 0 0 0 0 0 0 0 0
    0 1 0 0 0 0 0 0 0 0
```

```
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     0 1 0 0 0 0 0 0 0
     1 1 1 0 1 1 0 0 0
     0 0 0 1 0 0 1 1 1]

omega:[1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
       0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
       0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
       0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
       0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
       1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
       0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
       0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
       0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
       0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
       0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
       0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
       0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
       1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
       0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
       0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
       0 0 0 1 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 1 1
       0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
       0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
       0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
       0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
       0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
       1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
       0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
       0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
       0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
       0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
       0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
       1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1]

D1: [2.3173 0.7446 2.2956 2.8759 3.8257 3.2070 3.7625 8.0210
 3.4796 0.8833 2.2587 2.2586 2.6717 4.0321 4.7326 5.9723
```

```
 1.7038 1.3210 1.1107 1.8261 1.7691 2.5791 5.4525 3.8960
 4.1565 1.3954 1.6853 2.7277 2.3129 2.5092 5.8354 6.2566
 2.4947 0.6581 1.0788 1.4872 1.7912 3.9252 4.4539 4.3219
 2.5375 1.1567 1.6341 2.1475 2.6922 2.9506 4.7939 3.3971
 1.5174 0.4754 1.3031 1.4026 2.5217 3.6492 4.4615 0
 1.2310 1.1292 0.6299 2.2318 1.4573 2.4759 3.9117 0
 0.8574 1.0559 0.8278 2.0638 1.7825 2.5556 3.7492 0
 0.8463 0.9741 1.1390 0.9440 2.8403 2.8394 4.0146 0
 0.8672 1.3024 1.1323 0.7568 1.6091 2.7147 3.7169 0
 2.6737 0.6448 1.5334 1.5747 1.3902 3.6321 6.2399 0
 1.9178 1.0408 1.1499 2.1099 1.7620 4.3342 7.6834 0
 1.2966 1.1982 1.6916 1.8868 1.9815 3.0361 7.6597 0
 1.6916 0.5361 0.9663 1.6393 2.2734 2.3995 3.2762 8.6857
 1.4712 0.8104 1.0314 2.3654 1.5598 3.3235 3.4926 5.8404
 1.8449 0.9602 2.0882 2.5831 1.7495 4.1742 3.3657 0
 1.3964 1.1592 1.5681 1.9055 3.6620 3.7478 3.9180 0
 2.0268 1.0119 0.8461 2.5511 3.7432 5.2705 3.5831 0
 1.9759 0.3947 2.0725 1.7499 2.9620 2.3582 3.7911 0
 1.7972 0.8097 1.1811 1.0520 4.1368 3.2656 3.4545 0
 1.6677 0.6867 0.9302 1.7455 2.1655 2.7414 3.9156 0
 1.7541 0.9010 1.1636 2.0174 3.5691 2.8988 5.4100 0
 1.4383 1.1282 1.4630 1.9644 2.5182 3.4189 6.6003 0
 1.6318 1.0152 1.3424 2.0822 2.1652 3.5522 7.3678 0
 1.1347 1.5308 1.0838 1.9629 2.7909 3.6708 6.7298 0
 1.0705 0.9953 0.9358 2.6200 2.5914 3.5918 5.0396 0
 2.8894 1.0933 1.3803 1.9310 3.2616 3.0142 8.5488 0
 2.2151 1.2180 0.8661 1.8301 0.9485 3.7859 7.8162 0
 0.9405 1.2198 1.3990 2.1633 2.9292 3.4481 5.7142 0]

D2: [2.3036 1.0673 1.4400 2.7063 2.1923 4.5825 3.5551 6.2214
 2.1117 0.9154 1.2136 1.4661 2.5226 3.0288 5.4398 3.3969
 2.9125 0.9735 0.8892 2.4945 2.5439 4.7532 3.8917 3.3326
 2.0772 1.2095 2.0898 3.4496 2.3321 3.6615 3.5372 4.8369
 1.6445 1.0228 2.5461 1.7821 3.3118 4.6515 3.3698 6.3941
 2.5113 0.8949 2.2198 2.5457 3.6127 4.6390 6.6048 6.6878
 1.3535 0.7639 1.1724 1.7634 2.9433 1.8130 3.1236 0
 1.3847 0.6795 0.7920 1.7311 1.9119 2.4012 3.1595 0
 1.7088 0.8004 1.1955 1.5136 2.6419 1.9401 4.5591 0
 1.5710 0.9156 0.9679 1.9230 2.3736 1.9169 3.2888 0
 0.7568 0.8977 1.1320 2.0730 2.6005 2.1824 3.5604 0
 1.7395 1.0564 1.1685 1.4064 2.3437 4.1202 6.6140 0
 2.0257 0.5071 1.9561 1.4228 2.6995 2.3076 2.7818 0
 2.3079 0.8988 1.3777 1.8509 2.6080 2.4694 7.8432 0
 2.1393 0.3315 0.8069 2.0306 2.0453 4.0885 3.3051 8.0558
 1.5874 0.4372 1.0808 1.3357 2.3399 3.1571 3.6869 5.6817
```

```
 2.0382 1.1705 1.5369 2.0402 3.5958 3.3524 6.3725 0
 2.4231 1.0817 1.6741 1.5415 2.7121 4.1181 5.4140 0
 1.2886 1.2449 0.9425 2.3725 2.6202 4.0764 4.6467 0
 1.4581 0.9904 2.0387 1.5078 2.3536 2.8613 4.5906 0
 1.5699 0.9453 1.2873 1.8477 2.9571 2.8700 1.2443 0
 1.8051 1.3515 1.6648 2.3718 2.2989 2.6811 4.9976 0
 3.2565 0.9559 1.6818 1.7207 3.0374 5.2443 4.9949 0
 2.1398 1.1068 1.6293 2.0355 2.5127 5.0388 6.3106 0
 2.8266 1.5678 1.3863 1.4690 2.6479 2.3836 6.6692 0
 2.4931 0.7811 1.3980 1.5232 2.6727 3.9482 8.3583 0
 2.0390 0.9004 1.3184 1.2721 2.9331 3.8359 4.7773 0
 1.7940 1.0451 1.1781 1.5397 3.2623 5.1773 5.1520 0
 1.7083 0.9473 0.7977 1.5527 2.9319 3.5988 6.9051 0
 2.3703 0.9601 1.1916 1.5259 2.0545 3.1997 3.3752 0]

D3: [3.0081 1.3156 1.3275 3.0569 3.3628 4.3715 4.1266 4.3920
 2.5170 0.9346 1.6501 2.5059 3.2834 3.2008 5.7869 3.0810
 2.4210 1.5181 1.9738 2.4342 2.9332 4.9547 5.6921 6.1123
 4.0752 0.8926 1.1118 2.2508 2.5911 3.9923 3.3730 8.0185
 2.9958 1.0621 1.5283 2.2004 2.5831 4.4686 4.0606 4.2970
 1.7744 0.7573 1.4003 2.6234 2.1151 3.8966 2.2859 5.1654
 1.6966 1.0833 0.9157 1.4250 2.0627 2.4939 4.5432 0
 1.1638 0.7943 1.3105 1.6362 3.2289 3.5430 4.8002 0
 0.7630 0.7791 1.4088 2.3003 2.0696 1.5938 4.0495 0
 1.1920 0.7136 1.2887 1.2597 2.3661 2.5048 3.9534 0
 1.5215 0.7831 1.4880 0.9749 2.1511 3.3879 2.5010 0
 2.8887 0.8997 0.9906 1.5862 1.6761 2.9059 7.2340 0
 2.4221 1.3654 1.0871 1.3076 1.5496 2.7278 7.2900 0
 2.0397 1.0828 1.0261 1.6659 2.4257 2.7394 7.6117 0
 2.1151 0.7424 0.8435 1.7386 2.6374 3.6154 4.9380 8.5380
 1.6947 0.2523 0.9236 1.0843 2.4493 3.2440 3.7755 11.9197
 1.2962 0.9793 1.6178 1.2148 2.0818 3.2666 3.4984 0
 1.7398 0.5926 1.3410 2.2117 2.2223 3.6956 4.5390 0
 2.2190 0.7593 1.7888 1.5568 1.8265 2.8189 5.6011 0
 2.2529 1.0231 1.7759 2.1280 2.2137 3.5716 6.5526 0
 2.0500 1.1779 1.4761 1.7295 3.0441 3.2371 6.4869 0
 2.2572 1.3157 1.7053 2.0401 2.4892 3.0216 4.7826 0
 1.5424 1.0555 0.2866 1.2755 2.5657 3.0809 5.3454 0
 2.5329 0.2653 1.6098 1.7658 2.2840 4.3854 7.1894 0
 1.7452 0.7825 0.7911 1.4915 2.5349 2.8504 5.9098 0
 2.8616 1.3858 1.3784 1.8332 2.7865 3.8427 6.2737 0
 2.6341 1.2674 1.2656 1.2811 1.6889 4.4513 2.0232 0
 1.6186 1.1872 0.4574 1.8657 3.4409 3.0967 6.2763 0
 2.7221 1.0186 1.7727 1.3711 2.1707 3.5404 5.3838 0
 2.0720 1.4093 0.9339 1.9654 1.9577 3.3833 9.8419 0]
```

```
D4: [2.6261 0.7973 1.5039 2.1333 2.1267 3.2601 4.3550 2.6987
 2.6990 0.9439 1.7641 2.3241 2.4378 4.9148 5.1610 6.5007
 2.6721 0.7684 2.0406 1.7402 3.9554 3.3150 4.2893 7.4307
 2.7214 0.8455 1.2378 2.2558 2.9251 2.7494 2.5978 2.4169
 2.2181 0.8572 1.5432 2.5450 2.9035 2.2022 3.7114 5.9892
 2.5534 1.5176 1.8581 2.1892 2.2798 3.6650 2.4203 3.9796
 0.9870 0.9232 1.5098 1.6141 2.1393 1.8938 3.8644 0
 1.5319 0.8938 1.4532 2.3308 1.8737 2.7757 2.3949 0
 1.3395 0.9104 1.3290 1.2006 2.8971 1.1159 3.4773 0
 1.0424 0.5905 1.4788 1.4325 2.7318 2.6629 3.0825 0
 1.3558 1.1202 1.4835 2.2713 2.1034 0.6202 2.4925 0
 1.5362 1.1084 1.8944 1.8795 3.0494 3.3172 8.3618 0
 1.9569 0.9435 1.4524 2.3220 1.3730 2.1707 8.2483 0
 1.9267 1.3518 1.1451 2.1355 2.9953 3.8768 8.9984 0
 1.4644 0.6692 1.3343 1.6544 2.3949 3.1250 3.5180 16.1407
 0.9262 0.8439 0.9580 2.0292 2.4085 4.4661 4.2976 10.6269
 1.3824 0.8325 1.2415 1.9103 2.5255 4.5602 5.4097 0
 2.5245 0.9352 1.2396 1.9288 2.0770 3.6246 5.3946 0
 1.2865 1.2205 1.3650 1.7027 2.8233 3.6846 5.1707 0
 1.5775 1.1722 1.2937 1.8694 2.4980 4.3594 4.2248 0
 1.9571 0.9182 0.9742 1.0841 1.8747 4.1448 4.1669 0
 1.6044 0.5175 1.1805 0.9098 3.6299 3.8417 4.8939 0
 1.8009 1.5319 1.1600 1.9057 2.7185 3.7608 6.8070 0
 1.2431 0.7080 0.6758 2.0164 1.6114 5.8964 6.3605 0
 1.9707 0.8062 1.1986 2.6022 3.2581 3.8418 8.4042 0
 2.0803 1.1741 0.9831 1.7012 3.6501 3.1552 5.6400 0
 2.0254 0.6043 1.9123 1.1904 2.4289 2.5041 7.3081 0
 1.8215 0.8433 1.2558 1.6864 1.5512 4.0074 6.6171 0
 1.4516 1.2974 0.9357 0.9689 4.1820 2.3738 5.6593 0
 1.9258 1.0685 0.8714 1.8383 2.7087 4.2752 5.7589 0]

D5: [1.8086 1.4044 1.3023 1.3424 4.5007 2.0959 4.4558 6.2837
 2.5949 1.0789 1.2776 2.0811 3.8034 2.9238 3.2701 5.2408
 2.1100 1.0225 1.3633 2.3885 4.2814 4.5938 5.3726 7.3294
 1.1330 1.3181 2.0143 3.2584 2.3333 3.9020 4.8510 5.2287
 1.6640 1.7755 1.7072 2.6904 2.9407 4.4588 3.3019 6.0410
 2.3293 0.7121 1.3882 1.2075 2.3132 4.6200 5.3698 4.6051
 1.4615 1.1073 1.2544 1.4482 2.3279 2.6653 3.5876 0
 1.1988 1.0835 1.3115 1.5624 2.6988 3.2463 4.4870 0
 1.3316 0.8587 1.3004 1.6599 1.7730 3.1521 3.7601 0
 1.7389 0.7852 0.8024 0.9841 1.6735 2.4489 5.8680 0
 1.8081 0.9267 1.2255 1.6925 2.7003 1.3061 3.1500 0
 2.4932 0.8059 1.3483 1.9601 1.8508 2.7592 9.1338 0
 1.8248 1.3021 0.9781 1.8164 2.1005 2.7234 5.7237 0
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 1.7383 0.2987 1.1036 1.2656 2.8150 4.2200 5.4480 9.9459
 1.6104 0.7966 0.9286 1.3831 2.4129 2.0015 5.4253 11.5019
 0.9968 0.8761 1.4489 1.9854 2.3103 3.4647 6.1439 0
 2.0341 1.1073 1.0108 2.3392 3.1501 3.0730 5.7624 0
 2.0939 1.1988 1.3334 1.7757 2.7348 3.5499 5.3518 0
 1.7085 1.2998 1.4862 1.7722 2.5040 1.3391 7.1248 0
 2.2774 0.5917 1.0536 2.2255 1.9649 3.0453 4.2913 0
 2.1551 1.1530 1.5095 1.7841 2.2934 2.5764 6.4521 0
 2.0250 0.8743 1.5875 1.9035 2.3161 3.5643 6.8492 0
 1.0578 0.9684 1.2955 0.9750 2.1510 2.5035 9.6689 0
 1.5534 0.8256 0.6682 2.7064 1.3538 4.1150 7.4634 0
 2.0396 1.4144 1.2384 1.0083 2.2946 5.8054 5.5282 0
 2.1339 1.3187 1.0450 2.0537 2.4396 5.1147 9.3216 0
 1.5213 1.1281 1.5422 1.9097 3.6273 3.8194 4.8078 0
 2.5229 0.8692 1.2392 1.5102 1.7828 3.7981 5.7316 0
 1.6614 0.9307 1.6761 1.8663 2.9133 4.5037 9.7266 0]

D6: [2.4299 1.3688 1.9204 2.6874 3.2631 3.1091 3.9126 6.4664
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 2.5426 1.0242 2.1839 2.3938 3.6502 3.3186 2.2127 5.5873
 2.8154 0.8618 1.8996 1.2509 2.9272 4.2377 4.4465 7.3801
 2.4283 1.1214 0.8419 2.0247 2.6692 3.3892 6.1868 5.8346
 2.8659 0.9941 1.3475 2.9419 3.3148 2.9559 2.2844 4.6927
 2.0404 0.5901 1.1087 1.9302 2.0010 2.1157 2.9950 0
 1.4480 1.2100 1.0498 1.9106 1.1082 2.6265 4.6232 0
 1.6007 0.8858 1.8748 1.1614 2.3708 3.7003 3.7768 0
 2.0103 0.9934 0.7718 1.6419 2.2157 2.3520 2.4100 0
 1.6270 0.9299 1.1609 2.4933 1.8094 1.9619 3.4945 0
 2.6452 0.7400 1.3488 1.8822 3.6234 2.1872 5.6692 0
 1.9617 0.8436 1.1810 1.7784 3.0710 2.6904 8.2344 0
 2.5072 1.1770 1.0618 1.6576 1.6876 3.9167 8.0061 0
 1.5947 0.7025 1.2178 1.8617 1.8960 2.7056 3.9361 9.9441
 1.6688 0.7606 0.9725 2.1994 2.3756 4.2608 5.8444 13.9264
 2.4757 1.4894 0.8595 1.7496 2.8334 3.0258 5.0001 0
 1.5585 1.5521 1.7235 1.7660 3.0463 4.1603 4.4995 0
 1.6182 0.7818 0.9887 2.2240 1.5914 2.8350 6.1909 0
 1.9417 0.7562 1.4395 1.3039 3.0246 3.8399 5.2749 0
 1.9108 1.1849 1.5985 1.7226 1.7748 3.8930 6.4771 0
 1.9581 1.3041 1.4210 2.6586 1.7581 2.9820 6.4612 0
 1.6177 1.0442 1.3343 1.4458 2.1609 5.0621 5.5496 0
 2.0993 1.0822 1.3502 1.1317 2.7675 4.4323 6.1223 0
 1.9961 1.2258 1.2393 1.2109 2.7812 5.2329 7.1361 0
 1.3463 0.7252 1.3549 2.5452 1.5239 4.3220 4.2427 0
 1.5343 0.9422 0.9618 2.6242 2.2142 4.8750 4.1469 0
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 2.3591 0.9054 1.2160 1.7949 2.8352 4.3729 4.7232 0
 2.5610 0.5884 0.7491 2.2030 1.8600 3.4842 4.9155 0]

D7: [2.8900 1.2882 1.5227 1.3855 2.2993 3.9151 5.1432 6.0263
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 1.7367 1.6773 1.9651 3.0410 2.6759 1.7380 3.9418 5.7926
 1.5021 1.1606 1.3672 2.3470 3.4270 4.0530 4.0533 5.9007
 2.6004 1.2109 2.2900 2.3624 3.5122 4.5272 3.3822 7.4683
 1.7529 0.9831 1.7197 2.1429 3.0962 3.6293 5.8869 4.1834
 0.8703 0.8699 1.5801 1.7259 1.7686 3.4421 3.3638 0
 1.3198 0.7844 1.4443 2.0456 2.7162 2.4003 2.8390 0
 1.7594 0.8489 1.0799 1.8884 1.7608 2.8442 2.9900 0
 1.5544 0.9136 1.8198 1.7424 2.4168 2.8146 3.2972 0
 2.0215 1.1514 0.3631 1.9989 1.6506 3.2958 4.4267 0
 2.6093 1.2037 1.4052 1.5271 3.3483 3.8881 7.4408 0
 2.0843 1.1369 1.3065 2.4484 2.7527 3.2516 5.7509 0
 2.5913 1.1594 1.4696 1.9086 2.6454 2.2334 6.7907 0
 1.5673 0.6332 1.0770 0.8750 1.9304 1.9899 4.4970 8.2841
 1.5346 0.4548 0.8862 1.2942 2.5491 4.9715 4.0243 6.8074
 2.4668 0.8873 1.6175 1.8902 3.1160 4.3050 4.0828 0
 2.3434 1.1386 1.5905 1.7440 1.8813 3.8181 5.7380 0
 1.7432 0.8051 1.4178 2.0310 3.3170 3.0906 4.2194 0
 2.7387 1.1069 1.2877 1.9128 3.3491 4.0695 5.8159 0
 1.7522 1.0551 1.5071 2.8684 3.6315 3.1924 3.2522 0
 1.4538 1.0532 1.3487 1.5925 2.9509 5.5482 4.7454 0
 1.7976 0.7397 0.8486 2.0174 2.7619 3.8258 8.2783 0
 2.4468 0.7556 1.0654 1.5335 2.8036 3.7785 7.6586 0
 1.3420 0.7041 0.6183 1.2045 1.8897 4.0889 3.8036 0
 2.7456 0.6810 0.9706 2.1665 2.3855 4.7507 4.1974 0
 1.8398 1.0039 1.0701 1.0805 3.2297 4.5652 6.3719 0
 1.3704 0.7580 0.9002 1.9472 3.1314 2.6829 6.6296 0
 2.5037 0.9502 1.9102 2.1614 2.5420 2.6650 5.3493 0
 2.6631 1.4186 1.7121 1.4488 1.9422 5.3740 6.1727 0]

D8:[2.7982 1.1182 1.8836 1.6022 3.2312 3.8135 4.2530 5.5964
 1.9626 1.0796 2.5403 2.4314 2.6682 4.4716 4.2855 7.6165
 2.6632 1.2788 1.8123 2.0244 3.8795 3.1594 3.3376 3.5462
 2.0686 1.8747 1.7143 1.1771 3.4463 3.5109 5.2523 5.4075
 2.7014 1.4494 1.0722 2.3700 4.0829 2.4591 2.5806 4.5716
 2.1557 1.4027 1.8212 3.5077 2.6545 4.3630 3.0783 5.6706
 1.2790 0.5435 0.9490 1.5776 1.5758 3.1117 3.6115 0
 1.4797 1.0680 1.6599 1.7914 3.1436 1.9666 3.4109 0
 1.6819 0.8201 1.2341 1.9627 1.9514 1.6581 3.9871 0
 1.1112 0.9619 1.1540 1.6735 1.6898 2.2055 3.1405 0
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 1.2845 0.6119 1.4537 1.9919 1.9998 2.4161 4.0214 0
 1.3288 1.5123 1.6204 1.7229 2.7450 3.7344 6.3281 0
 2.0897 0.7301 1.6009 2.4340 2.7221 4.7561 7.2469 0
 1.6092 0.7380 1.9943 2.2564 2.0125 1.9573 6.5648 0
 1.8935 0.9715 1.1042 2.5128 1.8895 2.6709 3.1938 8.5543
 2.0071 0.6202 1.2383 1.8125 2.6621 2.4018 2.6716 8.0201
 2.2165 1.1175 1.2394 1.1405 2.2403 2.0191 4.0415 0
 0.9457 1.1771 1.5855 1.8926 2.5680 3.3709 3.0404 0
 1.5673 1.1943 1.5627 2.3029 2.6409 2.9781 5.4348 0
 1.4689 0.9381 0.9698 1.8057 3.0961 4.0390 2.5039 0
 1.4581 1.1838 1.6354 1.6776 2.0165 3.0579 3.0679 0
 2.3199 1.2955 1.6425 2.4536 2.3617 3.8651 3.1285 0
 2.3330 1.0559 1.2433 1.7776 1.8138 3.2431 7.1776 0
 2.0044 1.1488 1.1817 2.5047 1.8005 4.4849 5.7934 0
 2.8183 1.3606 1.8453 1.3980 2.2696 3.6706 5.6502 0
 1.0493 1.0512 1.2840 1.2936 0.4916 3.3615 5.3150 0
 1.9435 0.9175 1.0129 1.6801 1.5914 4.9867 4.5512 0
 1.8754 0.9866 0.9477 1.1849 2.3546 3.9142 3.9931 0
 2.1377 0.9703 1.4140 2.0452 2.3798 6.0492 9.0372 0
 2.1638 0.7689 1.0799 1.9415 3.0215 4.1971 3.8235 0]

D9:[3.0932 1.5746 1.2194 2.2979 1.9066 4.2361 4.2960 5.8473
 2.9781 1.3878 1.6572 1.7274 2.7987 2.9939 5.0778 6.7837
 2.9919 0.9192 1.6276 2.3124 2.7455 5.6039 4.4453 5.3724
 2.8962 1.0297 1.6443 1.9954 1.7445 3.1754 4.1301 5.9746
 2.4731 1.2426 1.3724 2.3699 3.2532 3.0256 3.7975 5.2230
 2.5568 1.3285 0.5619 1.9553 1.4372 4.0838 3.2946 7.6567
 1.2329 0.7950 1.3675 2.2341 1.8226 1.3954 2.5659 0
 0.8028 1.2246 0.3404 1.0581 1.3949 2.0840 3.9393 0
 1.5654 0.8189 1.3933 1.0690 2.1066 3.8945 3.4164 0
 1.1484 0.8409 1.7410 2.1695 0.9871 3.3713 2.6741 0
 1.0502 0.8803 1.4173 1.9061 2.2799 3.9242 3.5457 0
 1.3525 1.4262 0.8004 2.1305 1.9760 2.4828 7.0427 0
 2.0775 1.0187 1.0022 1.7340 2.3397 2.4060 6.8788 0
 2.2274 1.1371 0.9167 1.8036 1.6452 3.5110 4.7420 0
 1.8517 0.6217 1.0875 0.4384 2.5228 2.7315 5.0218 15.0672
 1.9585 0.7100 1.3998 1.7556 1.8512 2.4617 4.7827 8.2022
 2.0639 0.6583 1.7088 1.1323 2.3393 2.8517 3.4498 0
 2.3766 1.0033 1.8209 1.7061 2.9924 3.5402 5.2940 0
 1.8017 0.5602 1.6641 0.8550 3.9424 2.7137 3.9761 0
 2.2015 1.3038 0.8903 1.3738 1.6440 3.5297 4.9764 0
 1.9869 1.1225 1.6170 1.8258 2.5633 3.3895 4.1276 0
 1.7425 0.8314 1.0281 1.0827 1.6385 2.9230 3.7049 0
 1.3926 1.0296 1.7621 2.1419 2.7463 3.9560 6.5638 0
 2.0980 1.5127 1.5976 1.5899 3.5240 3.3100 5.9706 0
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 2.4238 1.0019 1.2954 2.0779 2.6311 3.7967 6.6943 0
 2.2436 0.7992 1.3334 2.0474 2.3398 4.3856 8.0057 0
 2.2828 0.9306 1.2921 2.4650 2.1853 3.5525 7.1232 0
 2.5243 0.7208 1.3592 1.7471 0.5051 2.1903 4.0445 0
 1.3758 0.6917 1.4881 1.8902 2.7786 4.0818 5.2156 0
 1.8919 0.6749 1.2971 1.8907 2.7726 2.2438 8.0264 0]

D10:[2.1614 1.3316 2.1129 2.2241 1.5196 3.4615 4.9322 8.5426
 2.6261 0.9832 1.6366 2.5209 3.5371 3.6571 5.0451 6.2282
 2.4442 1.3551 2.4817 1.9268 1.7290 2.2479 3.9935 5.0123
 1.9264 0.7342 1.9233 1.7108 3.3873 3.9204 3.6783 6.7964
 3.0089 1.0484 2.1533 1.5140 3.4780 3.6684 4.4925 6.3764
 3.0656 1.0397 1.9915 2.1957 3.8988 4.9173 3.0587 6.9954
 1.2598 0.8761 1.2774 1.7303 1.2425 3.0051 3.9090 0
 1.0681 0.2707 1.5576 1.2591 2.7559 2.9191 3.2014 0
 1.0309 0.6373 1.1690 1.7818 2.4335 2.9652 2.3974 0
 0.9483 0.9047 1.0829 1.5075 1.5411 3.4604 2.0168 0
 1.0575 1.1740 1.2037 2.0996 1.8299 2.7040 3.0112 0
 1.1316 1.3815 1.2379 1.8950 2.2311 3.3044 11.0390 0
 2.4469 0.8333 1.3357 2.1868 3.1171 3.9896 7.8874 0
 2.2406 0.5583 1.9200 1.6463 1.5058 4.3146 6.4323 0
 1.7152 0.4428 0.7138 1.5925 2.0071 3.0050 3.6480 9.8775
 2.0831 0.6766 1.1186 1.8480 1.0964 2.3959 5.9962 7.6382
 2.8808 0.9429 1.0903 2.8579 3.4538 3.8000 5.7781 0
 1.0259 0.6789 0.8302 1.4149 2.5649 3.3898 5.6582 0
 2.3740 1.1539 1.6328 1.8054 3.3402 2.4523 4.8546 0
 1.1964 0.9455 1.0133 2.1700 1.7903 2.4158 3.7121 0
 2.0972 1.2522 1.1198 1.3112 2.1577 3.1467 5.8404 0
 1.5051 0.9931 1.1127 2.2389 2.8170 3.5348 4.7531 0
 1.7803 0.9876 1.1580 1.7862 2.2286 3.7170 5.3586 0
 2.0084 0.8685 1.1488 1.6546 3.9480 1.9942 6.5511 0
 1.7750 0.7829 1.6648 2.2025 3.1762 2.9637 6.1419 0
 2.4607 0.9967 1.2112 1.3985 2.4083 5.2271 4.5261 0
 2.5145 0.6723 1.3010 2.1555 2.9871 0.4838 9.1944 0
 1.9573 1.1346 1.0253 2.0410 4.1563 4.2015 6.3799 0
 2.3424 0.7339 1.3208 2.0285 2.3807 3.6826 5.3793 0
 2.2454 0.7236 1.0031 1.6379 2.4319 5.2158 6.7049 0]

D11:[2.3851 1.2033 2.5894 1.6495 3.5378 4.0536 6.1495 6.7710
 2.5929 1.1014 1.3524 3.1833 2.2057 2.9233 3.1481 6.1986
 3.0676 1.0964 1.4446 1.8859 3.9198 3.0007 3.5727 6.9085
 2.4550 0.6875 1.0278 2.1424 3.4823 4.9825 2.6861 5.3070
 0.8710 1.4640 2.0465 2.8529 2.3303 2.5730 4.2755 6.6741
 3.2478 1.4305 2.1471 2.3306 2.6225 1.8970 5.7167 5.6957
 1.2279 0.9547 1.4008 1.5450 1.9080 1.7420 2.8820 0
```

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 1.6419 0.9823 1.0049 1.4971 2.2290 1.7486 3.3167 0
 1.0858 0.8130 1.5731 0.9922 1.5258 3.1538 4.4344 0
 1.8024 1.1303 1.4621 1.5199 1.8123 2.4469 4.1481 0
 1.3131 0.7061 1.1367 0.9862 2.0971 3.5733 2.6992 0
 1.9071 0.6415 0.7861 2.2562 2.3762 3.2531 7.2713 0
 1.6928 1.1783 1.1606 2.1388 3.0906 4.2414 7.4008 0
 2.0851 1.5346 1.6194 1.8775 2.0058 2.5321 8.6327 0
 2.1725 0.6840 1.1777 1.9366 1.8726 2.3254 4.6789 8.1352
 0.9702 0.6915 0.9193 1.4147 2.1743 2.5079 4.1536 7.5546
 1.2745 1.2026 1.3058 2.1110 1.8324 3.1839 5.7012 0
 1.7272 1.0021 1.5133 0.7695 2.5928 3.2486 5.2462 0
 1.3701 1.1047 1.4964 1.5034 1.0645 4.3035 7.8735 0
 1.5597 1.3771 1.3152 1.8687 2.6418 3.5723 5.2384 0
 2.2707 0.5899 1.2416 1.9550 3.6246 3.5244 5.7459 0
 1.5527 1.3668 1.5826 1.5663 2.6311 3.8744 6.4212 0
 1.4956 0.7754 0.9861 1.5461 1.5332 3.5853 8.1750 0
 1.8464 1.0210 1.1982 1.9712 2.4413 2.8002 5.2331 0
 1.2613 0.8422 1.2026 1.2848 3.9188 3.8399 7.4841 0
 2.0258 0.7715 1.2378 1.7201 2.7384 5.5954 6.3249 0
 1.8735 1.1143 1.5806 1.5342 3.1843 3.2230 5.1825 0
 2.1282 0.9512 1.5208 1.3514 3.3545 3.9804 5.9235 0
 1.3875 1.1969 1.0095 2.1161 2.2407 2.5643 8.6256 0
 1.9643 1.1836 0.9162 1.6942 2.3203 3.8959 6.7805 0]

D12:[2.4752 0.8889 1.3653 2.3507 2.5801 3.1986 4.7725 5.6514
 1.9504 0.7835 2.4283 2.5174 3.7133 2.2330 3.8893 7.2974
 2.3328 1.0972 1.3840 1.4186 1.6895 4.0423 4.6618 6.7106
 1.9101 1.0559 2.4037 2.3243 3.0502 3.5196 5.6283 4.9429
 3.8338 0.6980 1.5551 1.9170 1.4921 2.4858 6.0978 6.1774
 1.7480 1.0954 1.3209 1.6855 2.9333 3.4414 4.6544 6.7492
 0.9157 0.8446 0.8492 1.4091 1.9353 2.4158 4.2322 0
 1.3667 0.7051 1.3941 1.9478 1.1085 2.4639 2.2255 0
 1.1509 0.7984 0.8674 1.1208 2.1537 3.2006 2.7299 0
 1.1441 0.8447 0.8712 1.7866 2.8291 1.9232 3.4581 0
 1.0150 0.4789 1.5361 1.7460 2.3936 2.2873 4.3333 0
 2.0589 1.2677 2.0901 2.1564 2.5263 2.1712 6.2271 0
 1.1294 1.3887 1.7311 1.5892 2.6339 2.6333 6.9755 0
 1.1722 0.8608 1.2567 1.0113 2.5048 4.5040 8.7667 0
 1.2147 0.8471 1.2848 1.9266 1.5457 1.6207 5.7656 4.4617
 1.6939 0.7198 1.0232 1.1912 1.5062 3.4746 3.0580 8.7985
 1.6373 1.2250 0.7464 1.3005 2.4727 3.4269 3.7827 0
 1.2971 1.2405 1.1035 1.5989 2.7426 4.2647 2.7715 0
 2.1675 0.9887 1.7094 1.1018 2.3810 3.2877 5.4139 0
 2.1946 0.7589 1.2604 2.6691 3.1060 2.2592 4.7618 0
 1.2083 1.2700 1.3577 2.1831 2.1768 3.9353 5.3825 0
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 1.2363 0.5842 1.6299 1.1499 3.6835 3.5068 3.7511 0
 2.4615 1.0633 1.5083 1.3617 1.5633 4.7347 6.7480 0
 2.1338 0.7572 1.0591 1.5877 2.9797 4.2697 3.6885 0
 2.4119 0.8297 1.2898 0.9619 2.0725 4.8892 6.7860 0
 1.8058 0.8897 1.1775 2.0987 2.3917 3.2372 9.4374 0
 1.9594 0.8423 1.2167 1.5049 2.6312 4.0489 9.3311 0
 1.9519 1.3586 2.0221 1.1775 1.6545 2.8536 9.6237 0
 2.0812 1.1897 0.8666 1.4927 2.9863 3.9917 7.0292 0
 1.5439 1.4139 1.6117 0.9345 3.7265 1.7125 8.7979 0]

D13:[2.9524 0.6186 1.8623 2.2425 2.6355 3.6238 5.7230 5.4766
 2.8549 0.9897 0.6461 2.2780 2.8103 4.2065 4.7696 6.8732
 2.2058 0.9596 1.9649 3.0709 2.5072 3.1030 6.2607 6.7735
 2.4454 1.0938 1.2220 2.3759 2.3313 5.1214 4.4051 3.8574
 1.8292 1.1256 1.5278 1.9994 3.1658 4.3792 3.8218 5.0341
 2.3878 1.1709 1.5176 2.6214 2.8635 3.2036 6.5723 6.9837
 0.8140 1.0824 1.2556 2.2702 2.9602 3.4888 4.6497 0
 0.8073 0.6356 1.3324 1.5728 2.3321 2.4047 3.7267 0
 1.0160 0.8165 1.1138 1.7285 1.3841 1.9764 3.7633 0
 1.2725 0.7958 1.3366 1.4659 2.8730 3.0425 3.3860 0
 1.2189 0.8566 0.5064 1.7555 2.0748 4.0393 3.8764 0
 3.2070 0.9758 0.9467 1.8264 2.7696 2.7433 8.0783 0
 2.1578 1.2371 1.6965 1.5350 2.8252 3.2972 9.3830 0
 2.5672 1.4170 0.9333 2.9959 3.2276 1.4578 7.0533 0
 1.4083 0.7445 1.1160 1.7802 1.8093 3.8734 5.3948 9.0792
 1.6106 0.7062 1.0141 1.7117 2.0968 3.3874 3.8319 10.8240
 1.6255 0.8313 1.8443 1.8073 3.4383 2.3765 5.2709 0
 1.8704 0.7061 1.4425 1.7598 1.8087 3.0224 4.2968 0
 3.0087 0.9884 0.9362 2.3963 3.3815 4.0943 3.6433 0
 1.0820 0.9014 1.4184 2.2550 2.4545 4.5591 6.8556 0
 1.6849 1.1858 1.3100 2.3332 2.6831 3.3330 6.1804 0
 2.2420 0.8475 1.1343 1.8123 2.4002 3.0629 4.9347 0
 2.4315 0.6305 1.7529 1.9352 2.2781 4.2954 4.8991 0
 2.1386 1.1270 1.5645 1.5264 2.2661 2.9553 6.3171 0
 1.7462 0.9895 1.0059 0.7831 2.4292 3.4675 6.7183 0
 1.6624 0.7980 1.0760 1.5751 2.1343 2.7857 7.0820 0
 2.8613 0.7031 1.5218 1.5123 1.5987 3.9781 6.7863 0
 2.8192 0.9417 0.8783 1.9320 2.4710 3.6127 7.0400 0
 1.5532 0.4465 1.0649 1.0974 2.5033 3.7620 7.7031 0
 2.0406 0.7625 1.3473 1.8860 2.6713 4.4820 4.9543 0]

D14:[2.5592 1.0596 1.2835 1.7881 2.3981 1.6146 5.4188 5.3929
 3.1674 1.3899 1.6198 2.3517 2.2173 6.0826 4.2841 3.9562
 3.1527 1.1108 1.0829 2.4774 3.4694 3.3189 5.0647 6.2825
 2.1918 1.5489 1.9056 2.1041 3.5226 3.2573 6.3415 6.0122
```

```
 3.9763 0.5894 2.1682 2.1147 2.7093 3.1181 3.4302 6.7334
 3.1411 1.3038 1.5892 1.4898 2.3846 1.7839 4.4895 5.9404
 1.7298 0.9518 1.4163 1.3024 2.1772 2.9500 3.1001 0
 1.6545 0.9985 1.4155 1.2788 2.5729 3.2465 3.1568 0
 1.0106 0.8978 0.9684 2.2098 1.2964 3.4784 4.2757 0
 1.8832 0.8152 1.3538 2.2018 1.1347 3.1205 3.9967 0
 1.7475 0.7772 1.2960 0.4120 1.5370 1.7388 4.4279 0
 1.6459 1.1237 1.5527 1.9337 2.3043 3.5609 5.1227 0
 2.5458 1.0469 1.1700 1.3149 1.4933 1.7001 7.0195 0
 1.5744 0.8517 1.4043 1.6504 1.6615 3.7129 8.0088 0
 1.7457 0.8905 1.3474 1.4249 1.8214 4.0219 4.0130 8.5712
 2.2006 0.7425 1.0673 1.5344 2.2188 2.1664 4.4806 11.3547
 1.4180 1.0319 0.9230 1.6913 2.3288 3.1291 5.0238 0
 1.8066 1.1458 1.0590 2.5912 2.5509 2.4757 6.2181 0
 1.2581 0.7073 1.2771 0.8319 2.3392 3.0401 5.1176 0
 1.8387 1.0114 1.3134 1.5435 3.2682 3.7967 3.2244 0
 1.9797 0.8883 1.2129 1.5232 2.6633 2.7827 6.1011 0
 2.1770 1.0969 1.6355 1.7544 3.7296 3.3352 4.8393 0
 2.0096 1.0221 1.4475 1.0007 3.0648 3.3307 5.7920 0
 2.7409 1.2731 0.4682 2.0317 2.5610 4.0318 5.6442 0
 2.5222 1.2901 1.4896 1.8896 2.5444 3.1921 6.6085 0
 2.5011 0.9353 1.4292 1.5788 3.4834 3.9594 5.0728 0
 1.5319 1.2851 0.5580 1.3513 3.3841 4.3639 5.6777 0
 1.3877 1.0566 1.5804 0.9862 1.4501 4.0211 8.2475 0
 2.4195 1.2268 1.0904 1.8110 2.6342 4.6351 8.0823 0
 2.3255 0.8483 0.9908 1.7229 3.6993 2.9053 6.2074 0]

D15:[2.3864 1.2860 1.3685 2.9866 2.8718 4.9646 2.0811 4.5223
 2.9475 0.7836 1.7433 2.1226 2.6597 2.9488 5.4724 3.2492
 1.8133 0.9127 1.6266 2.2810 2.1043 2.5594 3.6627 7.5478
 2.1757 1.1165 1.6434 2.2775 2.8550 2.3098 5.1770 8.0361
 2.1968 1.2729 2.0841 2.4957 2.3887 3.2961 6.8851 5.3921
 2.1531 1.2512 2.1032 2.2414 3.9556 2.9719 5.2505 8.1017
 1.3026 0.8370 1.3062 1.0652 1.5836 2.8880 3.0148 0
 1.5799 0.5809 1.2157 0.6833 1.8614 2.8965 3.5288 0
 1.7736 1.3346 1.1681 1.8489 2.2160 1.5439 3.3717 0
 1.3182 0.7170 0.9877 2.1579 1.5789 1.4697 3.5568 0
 1.0368 0.7565 1.8785 1.6631 2.1879 3.2334 4.8760 0
 1.2238 1.3197 1.7047 2.2855 1.7479 3.3356 6.9313 0
 0.8747 0.9916 1.6389 1.7346 1.8286 3.0571 7.7365 0
 1.7013 0.7407 1.3150 1.2607 2.3491 2.9347 5.7175 0
 1.2526 1.0098 1.1668 2.1822 2.6152 3.3799 3.0163 3.9889
 1.9483 0.8073 1.1855 2.6235 2.2804 1.6737 4.0391 11.4377
 1.2979 1.0552 1.2327 2.3629 3.8262 3.3815 6.5508 0
 1.7799 0.8842 1.3477 2.0552 3.8453 2.9068 3.5471 0
```

```
 1.9273 1.2156 1.1994 2.3363 2.8874 3.1500 3.1139 0
 1.9376 1.4771 1.0823 1.6667 2.7872 3.3230 4.4170 0
 1.4467 0.9564 1.5190 1.5214 2.3868 3.6321 3.6697 0
 1.6907 1.0139 1.1744 1.7932 2.5523 2.7207 5.1261 0
 2.3019 1.2339 0.9327 1.8781 3.2231 5.0997 8.9742 0
 2.3287 0.7595 1.8470 1.5586 2.0414 4.9009 7.0513 0
 2.0542 0.8108 1.6663 1.6021 2.1845 4.3306 3.3280 0
 2.4412 1.1026 0.7735 1.6205 3.0994 0.7031 9.6848 0
 2.3602 1.2484 1.2902 1.8858 2.5668 4.5453 7.0609 0
 2.0394 1.0614 1.0205 1.8240 2.3278 5.2675 8.4489 0
 1.3139 0.9885 1.3702 2.1793 2.1010 3.8579 4.3087 0
 1.6066 1.0606 1.2950 0.6575 1.8683 5.4491 4.9040 0]

D16:[1.8054 0.8530 1.7227 2.6706 3.3487 3.2924 2.9831 5.6902
 1.6811 1.6850 1.7056 1.9779 2.3011 3.7843 1.4747 5.6721
 3.2297 0.8853 1.7688 2.2844 1.7465 4.5122 4.0683 5.9655
 3.4500 1.0954 1.8298 2.3523 2.9318 1.8976 3.9270 7.2275
 3.0637 1.3215 1.2048 3.2743 2.9880 4.1720 6.0722 7.0719
 3.2193 0.8814 2.0998 2.1744 3.4261 3.7818 4.1588 7.0954
 1.5916 1.2219 0.8538 1.6368 2.3103 2.5300 2.8958 0
 1.6013 0.8796 1.6082 1.5432 0.8866 2.4011 4.0784 0
 1.6046 0.8442 1.0165 1.5783 2.9168 2.8269 2.0622 0
 0.6964 1.0235 1.2625 1.6698 2.2162 3.0206 4.5082 0
 1.5986 0.5671 1.1063 1.2587 2.2556 2.2145 2.6669 0
 1.2385 0.6928 1.4918 1.8972 1.1619 2.5242 6.4659 0
 2.4720 1.2358 1.4729 2.0471 1.7613 3.6334 8.9590 0
 1.7565 1.3010 1.4538 2.4309 2.4495 2.8354 5.1975 0
 1.6354 0.5944 0.9324 2.3406 1.8442 2.7075 4.0293 9.0705
 2.2343 0.6900 1.5328 1.6170 1.9389 2.5861 4.1198 6.2654
 1.5645 1.0600 1.5792 1.3428 2.5759 2.8024 4.1283 0
 1.6308 0.9152 1.2299 1.8953 2.3030 0.6637 6.2621 0
 0.7291 1.3845 1.9195 1.7734 2.0864 1.7745 3.4085 0
 1.3474 0.8635 1.4226 1.5235 3.0268 3.2263 4.5355 0
 1.0330 1.1884 1.9887 2.2597 3.0641 2.6701 8.1113 0
 1.1123 0.9091 1.3801 2.1663 3.3202 2.9046 4.6926 0
 2.3197 0.7792 0.8266 1.4864 2.8991 1.8812 5.7971 0
 2.0629 1.1978 0.5259 1.3530 2.2696 3.0792 6.5601 0
 2.2412 0.8450 0.9762 2.2334 2.6229 5.0649 6.5546 0
 1.4287 0.6434 1.7502 1.1266 3.2888 2.5299 6.3011 0
 1.7161 0.9343 1.3978 0.9888 2.8255 3.1598 8.8239 0
 2.4786 0.6230 1.3343 2.2890 1.8498 5.3604 7.6331 0
 2.2263 1.0297 1.3180 1.3503 3.0823 4.5206 5.7706 0
 2.3439 0.6485 1.6057 1.8238 1.6027 3.5102 7.0162 0]

O:[1.207 1.336 1.192 1.048 1.049 1.342 1.432 1.206
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1.453 1.303 1.034 1.092 1.368 1.222 1.0931.475
1.313 1.199 1.174 1.086 1.193 1.238 1.264 1.343
1.485 1.030 1.204 1.423 1.132 1.295 1.089 1.193
1.178 1.061 1.162 1.322 1.199 1.300 1.307 1.467
1.117 1.423 1.411 1.336 1.180 1.422 1.403 1.291
1.490 1.023 1.075 1.396 1.497 1.244 1.247 1.431
1.199 1.171 1.213 1.214 1.367 1.268 1.348 1.368
1.061 1.127 1.177 1.472 1.169 1.340 1.339 1.343
1.324 1.099 1.467 1.402 1.466 1.270 1.225 1.276
1.140 1.290 1.079 1.115 1.064 1.348 1.049 1.049
1.491 1.178 1.493 1.278 1.476 1.362 1.482 1.351
1.177 1.378 1.339 1.088 1.486 1.289 1.203 1.359
1.087 1.460 1.184 1.174 1.368 1.096 1.054 1.064
1.026 1.417 1.346 1.320 1.233 1.064 1.099 1.420
1.108 1.157 1.224 1.377 1.454 1.068 1.057 1.497
1.397 1.486 1.053 1.306 1.177 1.392 1.329 1.025
1.376 1.420 1.373 1.367 1.018 1.479 1.030 1.091
1.332 1.187 1.438 1.169 1.051 1.445 1.418 1.467
1.471 1.341 1.394 1.306 1.199 1.061 1.389 1.298
1.390 1.183 1.217 1.324 1.266 1.369 1.208 1.093
1.156 1.195 1.128 1.077 1.155 1.106 1.307 1.272
1.207 1.491 1.400 1.429 1.330 1.147 1.087 1.247
1.385 1.103 1.025 1.465 1.434 1.498 1.312 1.495
1.380 1.211 1.305 1.477 1.390 1.348 1.066 1.026
1.343 1.433 1.354 1.218 1.032 1.145 1.223 1.134
1.487 1.126 1.366 1.364 1.201 1.079 1.058 1.282
1.118 1.451 1.175 1.259 1.160 1.362 1.265 1.359
1.175 1.238 1.273 1.317 1.133 1.372 1.292 1.471]


f1:[0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
    0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
    0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
    0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
    0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
    0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
    0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
    0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
    0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
    0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
    0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
    0.05 0.14 0.17 0.21 0.22 0.11 0.1  0.0
    0.05 0.14 0.17 0.21 0.22 0.11 0.1  0.0
    0.05 0.14 0.17 0.21 0.22 0.11 0.1  0.0
```

```
     0.04 0.33 0.19 0.12 0.14 0.08 0.05 0.06
     0.04 0.33 0.19 0.12 0.14 0.08 0.05 0.06
     0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
     0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
     0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
     0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
     0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
     0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
     0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0]

p1:[0.331051746 0.333185348 0.335762906 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.167641468 0.166902703 0.162785635 0.165680763 0.169982581 0.167006849 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.314014218 0.337276495 0.348709286 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.248006347 0.256774441 0.243448534 0.251770678 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.246079724 0.246469413 0.25370076 0.253750103 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.339644776 0.327238725 0.333116498 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.252279398 0.251230373 0.252213814 0.244276415 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.52564529 0.47435471 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.254224517 0.253193125 0.246591309 0.245991048 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.2008332 0.197964282 0.201980749 0.20228349 0.196938279 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.343321511 0.327307921 0.329370568 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.330939794 0.344793963 0.324266244 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.505165817 0.494834183 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.198445662 0.194261619 0.203421057 0.205041633 0.198830028 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.161591757 0.173031248 0.163021898 0.168143446 0.166034591 0.168177058 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.246931455 0.246205588 0.246416302 0.260446655 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.251070845 0.243766303 0.247857667 0.257305185 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.332380527 0.336599721 0.331019752 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250893142 0.240107236 0.250919758 0.258079865 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.197782394 0.192459026 0.202550966 0.199938023 0.207269592 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.251109982 0.256351157 0.24696982 0.245569041 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.164925606 0.165668592 0.168710763 0.168909948 0.163513845 0.168271246 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.163209621 0.173929073 0.165054203 0.15582686 0.174485444 0.167494798 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.496619346 0.503380654 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.257199689 0.24414869 0.251767112 0.24688451 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.254932788 0.250098984 0.244313095 0.250655134 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.492114108 0.507885892 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

0.160227674 0.167315346 0.16680414 0.174178931 0.166116658 0.165357251 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.517514004 0.482485996 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

p2:[1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.169360501 0.166542893 0.166612339 0.160784897 0.169872769 0.166826602 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.200220577 0.207506045 0.196187818 0.202019853 0.194065708 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.333228863 0.337964761 0.328806376 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.254824756 0.247175307 0.249786656 0.248213281 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.493771845 0.506228155 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.500835048 0.499164952 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.498994111 0.501005889 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.328053466 0.341221198 0.330725336 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166334529 0.168832878 0.166500446 0.164156204 0.169858647 0.164317297 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.249966215 0.250690592 0.24593332 0.253409873 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.199076146 0.199842935 0.199901661 0.197725027 0.203454232 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.200623131 0.199447167 0.197997893 0.197734393 0.204197416 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.167041868 0.164531234 0.165692905 0.170940692 0.161346058 0.170447243 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.507292522 0.492707478 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.167806379 0.165677522 0.163688744 0.168092724 0.167706379 0.167028252 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.500818357 0.499181643 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.198451744 0.205396622 0.202023389 0.195814369 0.198313877 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.197475739 0.200465385 0.197184893 0.203989641 0.200884343 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.509764398 0.490235602 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250418315 0.252665406 0.24658242 0.250333859 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.33599105 0.33285304 0.33115591 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.337765423 0.327664893 0.334569684 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.251680357 0.246307916 0.252132082 0.249879645 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166771954 0.16483816 0.16860181 0.165667894 0.168415023 0.165705158 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250624255 0.246004252 0.251704605 0.251666888 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.252579753 0.248204905 0.254258724 0.244956618 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.329752203 0.328212984 0.342034813 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

p3:[0.200361596 0.199473474 0.201642685 0.200222462 0.198299783 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.167124586 0.165585173 0.166572363 0.167954635 0.167582514 0.165180729 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.496401109 0.503598891 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.201182021 0.199475862 0.199169367 0.200202871 0.199969879 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.168288845 0.165015513 0.166290786 0.168295146 0.167549279 0.164560431 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166049599 0.169779211 0.16665148 0.16697883 0.165225947 0.165314933 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.246824009 0.250249989 0.250376131 0.252549872 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.498188198 0.501811802 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

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0.201207629 0.197084493 0.198042761 0.202895714 0.200769403 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.165729435 0.166578766 0.166553455 0.165641096 0.167609237 0.167888012 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.202021156 0.197945709 0.196489036 0.204046156 0.199497943 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.165916587 0.168865685 0.164584941 0.165638131 0.167355407 0.167639249 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.331311262 0.333545687 0.335143051 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.2477105 0.250095003 0.252505488 0.249689008 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.252529653 0.251635617 0.248555947 0.247278784 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.203367681 0.199858636 0.197550958 0.198792684 0.200430042 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.500669205 0.499330795 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166166141 0.167801585 0.166486451 0.167587422 0.166867907 0.165090493 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.169172335 0.163248643 0.169325609 0.165894305 0.166414592 0.165944516 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.332320966 0.33440546 0.333273574 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

p4:[1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.246434193 0.248838703 0.252222527 0.252504576 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.329905753 0.333742775 0.336351472 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.16551686 0.166663953 0.167758834 0.16621758 0.166657954 0.167184818 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.501858919 0.498141081 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.24989414 0.249127717 0.250483444 0.250494699 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.200999659 0.200751188 0.198035602 0.201062016 0.199151536 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.165610514 0.167304756 0.166904987 0.166716351 0.165137669 0.168325723 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.337439711 0.333857839 0.328702449 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.200507478 0.201325038 0.198893531 0.198536421 0.200737532 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.167922468 0.168586055 0.166003037 0.163836708 0.167261393 0.16639034 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.252376114 0.249328287 0.25028891 0.248006688 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

p5:[0.194996967 0.202646026 0.205780482 0.201452347 0.195124179 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.507330789 0.492669211 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.243088815 0.245085075 0.254911135 0.256914976 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.167649071 0.162499135 0.164257907 0.168331133 0.16686782 0.170394935 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.3288952 0.336987193 0.334117607 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.500323071 0.499676929 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.205161787 0.191685506 0.202761546 0.196195312 0.204195848 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.169445464 0.171293288 0.164437449 0.164239609 0.168108672 0.162475519 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.509044858 0.490955142 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.319347286 0.346342535 0.334310179 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.49381418 0.50618582 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.331573746 0.339537829 0.328888426 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.163383938 0.169222059 0.164044396 0.169867835 0.164610428 0.168871345 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.198978843 0.195265521 0.202444242 0.202598106 0.200713288 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.338905752 0.32993553 0.331158718 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

p6:[0.32892209 0.334818748 0.336259162 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.168495379 0.164410276 0.163042337 0.167515559 0.167521767 0.169014681 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.197655917 0.198442382 0.198953426 0.203617256 0.20133102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250034116 0.245187639 0.249280286 0.255497959 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.330902359 0.337961482 0.331136159 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.16819545 0.169208419 0.166216139 0.162472637 0.166893538 0.167013816 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.16254549 0.169318284 0.167156079 0.167901534 0.169086275 0.163992338 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.256143763 0.243750039 0.249474635 0.250631563 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.256318099 0.248639888 0.248136731 0.246905283 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.164521948 0.168350972 0.1678033 0.165124292 0.166494003 0.167705485 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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p7:[0.499327608 0.500672392 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.16516619 0.165350068 0.166896537 0.167927706 0.166382656 0.168276843 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.164073999 0.16973408 0.163834489 0.167760562 0.169725349 0.164871522 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.248172643 0.250068919 0.252813137 0.248945302 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.198909185 0.201141814 0.199699996 0.200495511 0.199753494 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.166267734 0.165488974 0.165709493 0.167587489 0.167466888 0.167479421 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.168503598 0.168880539 0.165732098 0.166369867 0.164331372 0.166182526 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.500779853 0.499220147 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.503781882 0.496218118 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.497319793 0.502680207 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.332003386 0.332472764 0.33552385 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.330302957 0.331031922 0.338665121 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

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0.337050567 0.330984483 0.33196495 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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0.198057216 0.203655988 0.194744255 0.202503228 0.201039313 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.200643156 0.198270608 0.201311712 0.198946032 0.200828492 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.497515901 0.502484099 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.256674301 0.248923224 0.253904112 0.240498363 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.1684854 0.165730899 0.16597798 0.171306793 0.160349275 0.168149653 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250282554 0.249109936 0.250448072 0.250159437 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.251073643 0.25311412 0.253712882 0.242099354 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.202416589 0.193709422 0.202677602 0.199464112 0.201732274 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.338383991 0.336848841 0.324767168 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.254611879 0.244881367 0.246109053 0.254397702 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.489803023 0.510196977 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.203792513 0.199128564 0.201037423 0.198822 0.197219499 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.494394807 0.505605193 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.495490572 0.504509428 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.202938647 0.200682938 0.199141662 0.200117723 0.197119029 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.495182656 0.504817344 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.198449846 0.196722676 0.202247956 0.202296517 0.200283005 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.170876231 0.16774614 0.163910468 0.163892245 0.166953667 0.166621249 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166822989 0.166000243 0.166331479 0.167269885 0.165343326 0.168232078 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.496243965 0.503756035 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.170251974 0.170143616 0.166126283 0.161839897 0.165613463 0.166024767 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.199340713 0.198037819 0.198985807 0.199298832 0.204336829 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

```
p15:[1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.330169478 0.337429495 0.332401027 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250815428 0.243119814 0.25053429 0.255530468 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166608576 0.16671677 0.165772843 0.164826112 0.167183457 0.168892242 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.249827742 0.249370499 0.24780607 0.252995689 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.248257312 0.249416648 0.251416492 0.250909549 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.198889615 0.200378789 0.199351657 0.197839255 0.203540685 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.167566654 0.165982929 0.166319929 0.166845661 0.166928491 0.166356336 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.203926244 0.198818359 0.197732496 0.200241981 0.19928092 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.249577754 0.253806175 0.249195121 0.24742095 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.248856393 0.253609368 0.246637464 0.250896775 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.249718232 0.249439971 0.251332005 0.249509792 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.332548091 0.33225744 0.335194469 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.493360985 0.506639015 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.503224683 0.496775317 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.200104849 0.202260935 0.197868801 0.199599438 0.200165976 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.198556578 0.198525836 0.198747409 0.202235565 0.201934612 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.496853169 0.503146831 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.25120054 0.248445094 0.247332837 0.253021529 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.203563138 0.200304444 0.19864188 0.197407296 0.200083243 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.253384091 0.248439812 0.250575344 0.247600753 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.496123852 0.503876148 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250158437 0.251732134 0.249329872 0.248779558 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.197675581 0.202278062 0.200001522 0.199475247 0.200569588 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.331772651 0.329499294 0.338728055 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

p16:[0.165936324 0.166106386 0.165877405 0.166156718 0.168930266 0.166992902 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.330756619 0.330704012 0.338539368 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.251139265 0.253561383 0.248113465 0.247185887 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.332922071 0.334531862 0.332546067 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166461995 0.167476113 0.168098644 0.164943906 0.16523195 0.167787392 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.168295555 0.166423517 0.166562873 0.167132528 0.165236838 0.166348689 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.253359364 0.250019669 0.250713679 0.245907287 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.200314127 0.200895267 0.198187588 0.201684374 0.198918643 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.332562691 0.332370455 0.335066854 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.334260563 0.333416996 0.332322441 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.504734864 0.495265136 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

```
0.25249248 0.25080242 0.24732566 0.24937944 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.249800431 0.250641216 0.248510902 0.251047451 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.250862565 0.251738641 0.247585534 0.249813259 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.201161914 0.199344363 0.201277468 0.199528498 0.198687758 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.166214788 0.165495791 0.167520543 0.165038398 0.1694064 0.16632408 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.19930128 0.200078201 0.19965316 0.20091713 0.200050228 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.331418792 0.332909451 0.335671757 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.331183035 0.333288228 0.335528737 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.198109846 0.197130928 0.204154461 0.200922565 0.1996822 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.167001486 0.164842474 0.165431667 0.167118214 0.168723228 0.166882932 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.333762569 0.336688147 0.329549284 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.334037903 0.335231438 0.330730659 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.332210343 0.331082501 0.336707157 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.168040212 0.168457169 0.165315907 0.16689399 0.165106749 0.166185973 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.496971089 0.503028911 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0.335494543 0.332888904 0.331616553 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

!Cancellation values: Mean, standard deviation, sigma level
mean: 50
stdev: 2
sigma: 2
```

APPENDIX 3 - SIMULATED ANNEALING METAHEURISTIC - MATLAB CODE

MAIN SIMULATED ANNEALING CODE (SIMULATEDANNEALING.M)

```
1
2  %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
3  %Set random seed
4  rng(5); %5
5  %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
6
7  %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
8  %Data for model
9  fileID = fopen('Data/parameters.txt');
10 formatSpec = '%*s m = %d n = %d T = %d l = %d h = %d v = %d R = %d E = %d numberScenarios = %d %*s';
11 parameters = cell2mat(textscan(fileID,formatSpec,...
12     'Delimiter', '\ n', ...
13     'CollectOutput', true));
14 fclose(fileID);
15
16 m = parameters(1);
17 n = parameters(2);
18 T = parameters(3);
19 l = parameters(4);
20 h = parameters(5);
21 v = double(parameters(6));
22 R = parameters(7);
23 E = parameters(8);
24 numberScenarios = parameters(9);
25
26 omegaFilename = 'Data/omega.txt';
27 omegaDelimiterIn = ' ';
28 omegaHeaderLinesIn = 0;
29 omega = importdata(omegaFilename,omegaDelimiterIn,omegaHeaderLinesIn);
30
31 piFilename = 'Data/pi.txt';
32 piDelimiterIn = ' ';
33 piHeaderLinesIn = 0;
34 pi = importdata(piFilename,piDelimiterIn,piHeaderLinesIn);
35
36 DmeanFilename = 'Data/D.txt';
37 fFilename = 'Data/f.txt';
38 DmeanfDelimeterIn = ' ';
39 DmeanfHeaderLinesIn = 0;
40 Dmean = importdata(DmeanFilename,DmeanfDelimeterIn,DmeanfHeaderLinesIn);
```

```
f = importdata(fFilename,DmeanfDelimeterIn,DmeanfHeaderLinesIn);

D = zeros(m,E,numberScenarios);

D = generateSurgicalDurations(Dmean,0.25,m,E,numberScenarios);

%Probabilities
p = zeros(m,l,numberScenarios);

for scenario = 1:4:16
    p(:,:,scenario) = generateLengthOfStayProbabilities(0.2,0.005,m,l);
end

for scenario = 2:4:16
    p(:,:,scenario) = generateLengthOfStayProbabilities(0.3,0.005,m,l);
end

for scenario = 3:4:16
    p(:,:,scenario) = generateLengthOfStayProbabilities(0.5,0.005,m,l);
end

for scenario = 4:4:16
    p(:,:,scenario) = generateLengthOfStayProbabilities(0.6,0.005,m,l);
end

%Block constraint
B1 = [ 1 7  12 15 17 23];
F2 = [ 6 11 14 16 22 30];
B =  [36 30 18 12 36 48];

%Generate overhead time factors
O = zeros(m,E);

for i = 1:m
    for e = 1:E
        O(i,e) = unifrnd(1.01,1.5);
    end
end

%Cancellation values
meanCancellations = 50;
stdDevCancellations = 2;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%Targets
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
L = randi([1,5],m,1);
H = randi([6,20],m,1);
N = randi([20,35],m,1);

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%Calculations and Initial Schedule Generation
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
A = zeros(m,scenario);
maxNumberPatients = zeros(m,scenario);
PHI = zeros(m,l,scenario);
for scenario = 1:numberScenarios

    for i = 1:m
        A(:,scenario) = sum(times(times(D(:,:,scenario),O),f),2);
        maxNumberPatients(i,scenario) = floor(v/A(i,scenario));

        for lCount = 1:l
            PHI(i,lCount,scenario) = maxNumberPatients(i,scenario)*sum(p(i,lCount+1:l,scenario),2);
        end
    end
end

numberBlocksTotal = n*(T-8)
numberBlocksAvailable = numberBlocksTotal;

%Create an empty schedule
x = zeros(m,n,T);
lowerBoundDev = zeros(m);
upperBoundDev = zeros(m);
isInitialScheduleFeasible = 0;
numberAssignments = 0;

%Sort from highest to lowest number of pi constraints
piSum = sum(pi,1);
[piSumA,piSumB] = sort(piSum, 'descend');

%Generate the initial schedule
while isInitialScheduleFeasible == 0
    while numberBlocksAvailable > 0
        while (sum(sum(sum(x,2),3) >= L)) < m

            for i = 1:m
                lowerBoundDev(i) = L(i) - sum(sum(x(i,:,:),2),3);
            end
```

```
        for i = m:-1:1
            for k = 1:T
                for j = piSumB
                    if(numberBlocksAvailable > 0 && lowerBoundDev(i) > 0)
                        if(numberBlocksAvailable > 0  && x(i,j,k) == 0)
                            x(i,j,k) = 1;
                            if(isFeasible(x, 'partialSchedule', m, n, T, l, h, v, R, E, ...
                                    numberScenarios, pi, omega, L, H, B, B1, F2, ...
                                    maxNumberPatients, N, A, PHI) == 1)
                                numberBlocksAvailable = numberBlocksAvailable - 1;
                                numberAssignments = numberAssignments + 1;
                                lowerBoundDev(i) = lowerBoundDev(i) - 1;
                            else
                                x(i,j,k) = 0;
                            end
                        end
                    end
                end
            end
        end
    end

    while (sum(sum(sum(x,2),3) > H)) == 0 && numberBlocksAvailable > 0

        for i = 1:m
            upperBoundDev(i) = H(i) - sum(sum(x(i,:,:),2),3);
        end

        for i = 1:m
            for k = 1:T
                for j = piSumB
                    if(numberBlocksAvailable > 0 && upperBoundDev(i) > 0)
                        if(numberBlocksAvailable > 0  && x(i,j,k) == 0)
                            x(i,j,k) = 1;
                            if(isFeasible(x, 'partialSchedule', m, n, T, l, h, v, R, E, ...
                                    numberScenarios, pi, omega, L, H, B, B1, F2, ...
                                    maxNumberPatients, N, A, PHI) == 1)
                                numberBlocksAvailable = numberBlocksAvailable - 1;
                                numberAssignments = numberAssignments + 1;
                                upperBoundDev(i) = upperBoundDev(i) - 1;
                            else
                                x(i,j,k) = 0;
                            end
                        end
```

```
                        end
                    end
                end
            end
        end
    end

    if(isFeasible(x, 'partialSchedule', m, n, T, l, h, v, R, E, ...
            numberScenarios, pi, omega, L, H, B, B1, F2, ...
            maxNumberPatients, N, A, PHI) == 1)
        isInitialScheduleFeasible = 1;
    else
        isInitialScheduleFeasible = 0;
    end
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%Inner and Outer Loops
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
xInitial = x;

rng();

%Parameters
coolingRate = 0.95;
initialTemperature = 1000;
finalTemperature = 0.1;
maximumSolutionsAccepted = 3;

[energy, d1MinusSum, d2nSum, I, IMax, IRange] = ...
    energyFunction(x, m, n, T, l, h, v, R, E, ...
    numberScenarios, pi, omega, L, H, B, B1, F2, ...
    maxNumberPatients, N, A, PHI);
initialEnergy = energy;

currentEnergy = initialEnergy;
currentTemperature = initialTemperature;

NA = 0;
NATotal = 0;

while currentTemperature > finalTemperature
    [energy, d1MinusSum, d2nSum, I, IMax, IRange] = ...
        energyFunction(x, m, n, T, l, h, v, R, E, ...
        numberScenarios, pi, omega, L, H, B, B1, F2, ...
```

```
        maxNumberPatients, N, A, PHI);
    currentEnergy = energy;

    NATotal = NATotal + NA;
    NA = 0;

    while NA < maximumSolutionsAccepted
        i = randi([1,m]);
        j = randi([1,n]);
        k = randi([1,T]);

        if(i == 30)
            i2 = 1;
        else
            i2 = i + 1;
        end

        j2 = randi([1,n]);
        k2 = randi([1,T]);

        if(x(i,j,k) == 0 && x(i2,j2,k2) == 1)
            status = 1;
            x(i,j,k) = 1;
            x(i2,j2,k2) = 0;

        elseif(x(i,j,k) == 1 && x(i2,j2,k2) == 0)
            status = 2;
            x(i,j,k) = 0;
            x(i2,j2,k2) = 1;
        end

        if(x(i,j,k) ~= x(i2,j2,k2))
            if(isFeasible(x, 'fullSchedule', m, n, T, l, h, v, R, E,...
                    numberScenarios, pi, omega, L, H, B, B1, F2, ...
                    maxNumberPatients, N, A, PHI) == 1)

                [energy, d1MinusSum, d2nSum, I, IMax, IRange] = ...
                    energyFunction(x, m, n, T, l, h, v, R, E, ...
                    numberScenarios, pi, omega, L, H, B, B1, F2, ...
                    maxNumberPatients, N, A, PHI);
                newEnergy = energy;

                %See if the new schedule
                %is better or not
                if(newEnergy < currentEnergy)
```

```
                    NA = NA + 1;
                    %Accept new solution and swap values
                    currentEnergy = newEnergy;

                elseif(newEnergy >= currentEnergy)
                    %Metropolis Criterion
                    if exp(-(newEnergy - currentEnergy)/ currentTemperature) > unifrnd(0,1)
                        %Accept new solution and swap values
                        NA = NA + 1;
                        currentEnergy = newEnergy;
                    else
                        %Reject new solution and don't swap values
                        if(status == 1)
                            x(i,j,k) = 0;
                            x(i2,j2,k2) = 1;
                        elseif(status == 2)
                            x(i,j,k) = 1;
                            x(i2,j2,k2) = 0;
                        end
                    end
                end
            else
                %Reject due to infeasibility
                if(status == 1)
                    x(i,j,k) = 0;
                    x(i2,j2,k2) = 1;
                elseif(status == 2)
                    x(i,j,k) = 1;
                    x(i2,j2,k2) = 0;
                end
            end
        else
        end

    end
    currentTemperature = currentTemperature * coolingRate;
end

%Display results before cancellations
isFeasible(x, 'fullSchedule', m, n, T, l, h, v, R, E, ...
    numberScenarios, pi, omega, L, H, B, B1, F2, ...
    maxNumberPatients, N, A, PHI);
[energy, d1MinusSum, d2nSum, I, IMax, IRange] = ...
    energyFunction(x, m, n, T, l, h, v, R, E, ...
    numberScenarios, pi, omega, L, H, B, B1, F2, ...
```

```
    maxNumberPatients, N, A, PHI);

%Cancellations
xBeforeCancellations = x;

c = zeros(m,n,T);
for i = 1:m
    for j = 1:n
        for k = 1:T
            if(x(i,j,k) == 1)
                c(i,j,k) = normrnd(meanCancellations, stdDevCancellations);

                if((c(i,j,k) <= (meanCancellations - 2*stdDevCancellations) || ...
                        (c(i,j,k) >= (meanCancellations + 2*stdDevCancellations))));
                    x(i,j,k) = 0;
                end
            end
        end
    end
end

%Display results after cancellations
xAfterCancellations = x;
isFeasible(xAfterCancellations, 'fullSchedule', m, n, T, l, h, v, R, E, ...
    numberScenarios, pi, omega, L, H, B, B1, F2, ...
    maxNumberPatients, N, A, PHI);
[energyAfterCancellations, d1MinusSumAfterCancellations, ...
    d2nSumAfterCancellations, IAfterCancellations, ...
    IMaxAfterCancellations, IRangeAfterCancellations] = ...
    energyFunction(xAfterCancellations, m, n, T, l, h, v, R, E, ...
    numberScenarios, pi, omega, L, H, B, B1, F2, ...
    maxNumberPatients, N, A, PHI);
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

FUNCTION TO CHECK FOR FEASIBILITY (ISFEASIBLE.M)

```
function [feasibility] = isFeasible(x, scheduleType, m, n, T, l, h, v, R, E, ...
    numberScenarios, pi, omega, L, H, B, B1, F2, ...
    maxNumberPatients, N, A, PHI)

infeasibilityCounter = 0;


if(strcmp(scheduleType, 'partialSchedule') == 1)
    %Constraints 1 and 2
    for k = 1:T
        for j = 1:n
            for i = 1:m

                if(x(i,j,k) == 1 && pi(i,j) == 1)
                    infeasibilityCounter = infeasibilityCounter + 1;
                end

                if(x(i,j,k) == 1 && omega(i,k) == 1)
                    infeasibilityCounter = infeasibilityCounter + 1;
                end
            end
        end
    end

    %Constraint 3
    constraint3 = sum(x(1:m,:,:),1);
    for j = 1:n
        for k = 1:T
            if(constraint3(:,j,k) > 1)
                infeasibilityCounter = infeasibilityCounter + 1;
            end
        end
    end

    %Constraint 4
    constraint4 =  sum(x(:,1:n,:),2);
    for i = 1:m
        for k = 1:T
            if(constraint4(i,:,k) > 1)
                infeasibilityCounter = infeasibilityCounter + 1;
            end
        end
    end
```

```
44
45      %Constraint 5
46      constraint5 = sum(sum(x,2),3);
47      for i = 1:m
48          if(constraint5(i) > H(i))
49              infeasibilityCounter = infeasibilityCounter + 1;
50          end
51      end
52
53      %Constraint 6
54      for r = 1:R
55          if(sum(sum(sum(x(B1(r):F2(r),:,:),1),3),2) > B(r))
56              infeasibilityCounter = infeasibilityCounter + 1;
57          end
58      end
59
60  elseif(strcmp(scheduleType, 'fullSchedule') == 1)
61      %Constraints 1 and 2
62      for k = 1:T
63          for j = 1:n
64              for i = 1:m
65
66                  if(x(i,j,k) == 1 && pi(i,j) == 1)
67                      infeasibilityCounter = infeasibilityCounter + 1;
68                  end
69
70                  if(x(i,j,k) == 1 && omega(i,k) == 1)
71                      infeasibilityCounter = infeasibilityCounter + 1;
72                  end
73              end
74          end
75      end
76
77      %Constraint 3
78      constraint3 = sum(x(1:m,:,:),1);
79      for j = 1:n
80          for k = 1:T
81              if(constraint3(:,j,k) > 1)
82                  infeasibilityCounter = infeasibilityCounter + 1;
83              end
84          end
85      end
86
87      %Constraint 4
88      constraint4 =  sum(x(:,1:n,:),2);
```

```
    for i = 1:m
        for k = 1:T
            if(constraint4(i,:,k) > 1)
                infeasibilityCounter = infeasibilityCounter + 1;
            end
        end
    end

    %Constraint 5
    constraint5a = sum(sum(x,2),3);
    for i = 1:m
        if(constraint5a(i) > H(i))
            infeasibilityCounter = infeasibilityCounter + 1;
        end
    end

    constraint5b = sum(sum(x,2),3);
    for i = 1:m
        if(constraint5b(i) < L(i))
            infeasibilityCounter = infeasibilityCounter + 1;
        end
    end

    %Constraint 6
    for r = 1:R
        if(sum(sum(sum(x(B1(r):F2(r),:,:),1),3),2) ~= B(r))
            infeasibilityCounter = infeasibilityCounter + 1;
        end
    end

else
    infeasibilityCounter = 1;
end

%Return the feasibility of the schedule
if(infeasibilityCounter == 0)
    feasibility = 1;
else
    feasibility = 0;
end
end
```

FUNCTION TO CALCULATE ENERGY (ENERGYFUNCTION.M)

```
function [energy, d1MinusSum, d2nSum, I, IMax, IRange] = ...
    energyFunction(x, m, n, T, l, h, v,...
    R, E, numberScenarios, pi, omega, L, H, B, B1, F2, ...
    maxNumberPatients, N, A, PHI)

%Constraint 7
d1Plus = zeros(m,numberScenarios);
d1Minus = zeros(m,numberScenarios);
for scenario = 1:numberScenarios
    for i = 1:m
        if(maxNumberPatients(i,scenario)*sum(sum(sum(x(i,:,:),2),3)) > N(i))
            d1Plus(i,scenario) = maxNumberPatients(i,scenario)*sum(sum(sum(x(i,:,:),2),3)) - N(i);
        elseif(maxNumberPatients(i,scenario)*sum(sum(sum(x(i,:,:),2),3)) < N(i))
            d1Minus(i,scenario) = N(i) - maxNumberPatients(i,scenario)*sum(sum(sum(x(i,:,:),2),3));
        end
    end
end

d1MinusSum = zeros(numberScenarios,1);
for scenario = 1:numberScenarios
    d1MinusSum(scenario) = sum(sum(d1Minus(:,scenario),1));
end

%Constraint 8
d2n = zeros(m,n,T,numberScenarios);
for scenario = 1:numberScenarios
    for i = 1:m
        for j = 1:n
            for k = 1:T
                if(x(i,j,k) == 0)
                    d2n(i,j,k,scenario) = 0;
                elseif(x(i,j,k) == 1 && v > A(i,scenario)*maxNumberPatients(i,scenario))
                    d2n(i,j,k,scenario) = v - A(i,scenario)*maxNumberPatients(i,scenario);
                end
            end
        end
    end
end

d2nSum = zeros(numberScenarios,1);
for scenario = 1:numberScenarios
    d2nSum(scenario) = sum(sum(sum(d2n(:,:,:,scenario),1),2),3);
end
```

```
44
45 %Constraint 9
46 partialI1 = zeros(T,numberScenarios);
47 partialI2 = zeros(T,numberScenarios);
48 for scenario = 1:numberScenarios
49     for i = 1:m
50         for j = 1:n
51             for k = 1:T
52                 for lCount = 1:k
53                     partialI1(k,scenario) = partialI1(k,scenario) + x(i,j,lCount)*PHI(i,k-lCount+1,scenario);
54                 end
55
56                 for lCount = k+1:T
57                     partialI2(k,scenario) = partialI2(k,scenario) + x(i,j,lCount)*PHI(i,k-lCount+1+T,scenario);
58                 end
59
60             end
61         end
62     end
63 end
64 I = zeros(T, numberScenarios);
65 for scenario = 1:numberScenarios
66     for k = 1:T
67         I(k,scenario) = partialI1(k,scenario) + partialI2(k,scenario);
68     end
69 end
70
71 %IMax, IMin, IRange
72 Isort = zeros(T, numberScenarios);
73 IMax = zeros(numberScenarios,1);
74 IMin = zeros(numberScenarios,1);
75 IRange = zeros(numberScenarios,1);
76
77 for scenario = 1:numberScenarios
78     Isort(:,scenario) = sort(I(:,scenario));
79     IMax(scenario) = Isort(T,scenario);
80     IMin(scenario) = Isort(1,scenario);
81     IRange(scenario) = IMax(scenario) - IMin(scenario);
82 end
83
84 subProblemObjectiveFunction = zeros(numberScenarios,1);
85 for scenario = 1:numberScenarios
86     subProblemObjectiveFunction(scenario) = d1MinusSum(scenario) + ...
87         d2nSum(scenario) + ...
88         IMax(scenario) + ...
```

```
89          (IMax(scenario) - IMin(scenario));
90  end
91
92  energy = sum(subProblemObjectiveFunction(:))/double(numberScenarios);
93
94  end
```

FUNCTION TO GENERATE LENGTH OF STAY PROBABILITIES (GENERATELENGTHOFSTAYPROBABILITIES.M)

```
function [p] = generateLengthOfStayProbabilities(pGenMean, pGenStdDev,m,l)

pGen = zeros(m,l);
pGen2 = zeros(m);
pGen3 = zeros(m,l);
hGen = randi([1,6],m,1);

for i = 1:m
    for lCount = 1:hGen(i)
        pGen(i,lCount) = normrnd(pGenMean, pGenStdDev);
    end

    pGen2(i) = sum(pGen(i,:),2);

    for lCount = 1:hGen(i)
        pGen3(i,:) = pGen(i,:) / pGen2(i);
    end
    p = pGen3;
end
end
```

FUNCTION TO GENERATE SURGICAL DURATIONS (GENERATESURGICALDURATIONS.M)

```
function [D] = generateSurgicalDurations(Dmean,DGenStdDev,m,E,numberScenarios)

DGen = zeros(m,E,numberScenarios);
DGen2 = zeros(m,E);
DGen3 = zeros(m,E,numberScenarios);

DGen = normrnd(1,DGenStdDev,[m,E,numberScenarios]);

for i = 1:m
    for e = 1:E
        for scenario = 1:numberScenarios
            DGen2(i,e) = DGen2(i,e) + DGen(i,e,scenario);
        end
    end
end

for scenario = 1:numberScenarios
    for e = 1:E
        for i = 1:m
            DGen3(i,e,scenario) = (DGen(i,e,scenario) / DGen2(i,e));
        end
    end
end

for scenario = 1:numberScenarios
    for e = 1:E
        for i = 1:m
            DGen4(i,e,scenario) = Dmean(i,e)*double(numberScenarios)*DGen3(i,e,scenario);
        end
    end
end

D = DGen4;
end

```

APPENDIX 4 - MATLAB DATA FILES

DATA FILE WITH REAL WORLD SURGICAL DURATIONS (~ DATA/D.TXT)

```
2.50 1.12 1.67 2.25 2.85 3.55 4.37 5.85
2.50 1.12 1.67 2.25 2.85 3.55 4.37 5.85
2.50 1.12 1.67 2.25 2.85 3.55 4.37 5.85
2.50 1.12 1.67 2.25 2.85 3.55 4.37 5.85
2.50 1.12 1.67 2.25 2.85 3.55 4.37 5.85
2.50 1.12 1.67 2.25 2.85 3.55 4.37 5.85
1.33 0.87 1.22 1.63 2.08 2.60 3.55 0
1.33 0.87 1.22 1.63 2.08 2.60 3.55 0
1.33 0.87 1.22 1.63 2.08 2.60 3.55 0
1.33 0.87 1.22 1.63 2.08 2.60 3.55 0
1.33 0.87 1.22 1.63 2.08 2.60 3.55 0
1.98 1.05 1.37 1.87 2.32 3.12 7.2  0
1.98 1.05 1.37 1.87 2.32 3.12 7.2  0
1.98 1.05 1.37 1.87 2.32 3.12 7.2  0
1.70 0.67 1.08 1.70 2.12 3.03 4.23 9.15
1.70 0.67 1.08 1.70 2.12 3.03 4.23 9.15
1.78 1.02 1.38 1.82 2.67 3.32 4.85 0
1.78 1.02 1.38 1.82 2.67 3.32 4.85 0
1.78 1.02 1.38 1.82 2.67 3.32 4.85 0
1.78 1.02 1.38 1.82 2.67 3.32 4.85 0
1.78 1.02 1.38 1.82 2.67 3.32 4.85 0
1.78 1.02 1.38 1.82 2.67 3.32 4.85 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
2.02 0.98 1.23 1.70 2.53 3.83 6.42 0
```

DATA FILE WITH REAL WORLD SURGICAL FREQUENCIES (~ DATA/F.TXT)

```
0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
```

```
0.08 0.04 0.12 0.19 0.2 0.03 0.25 0.09
0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
0.02 0.14 0.19 0.25 0.32 0.02 0.06 0.0
0.05 0.14 0.17 0.21 0.22 0.11 0.1  0.0
0.05 0.14 0.17 0.21 0.22 0.11 0.1  0.0
0.05 0.14 0.17 0.21 0.22 0.11 0.1  0.0
0.04 0.33 0.19 0.12 0.14 0.08 0.05 0.06
0.04 0.33 0.19 0.12 0.14 0.08 0.05 0.06
0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
0.09 0.1 0.18 0.21 0.21 0.16 0.05  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
0.03 0.05 0.3 0.15 0.17 0.21 0.08  0.0
```


DATA FILE WITH OMEGA CONSTRAINTS (~ DATA/OMEGA.TXT)T

```
1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
```

```
0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
0 0 0 1 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 1 1 0 0 0 1 1 1 1
0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1 0 1 0 0 0 1 1
0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1 0 0 0 1 0 1 1
0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1
0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 0 0 1 1
1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1 1 0 0 0 0 1 1
```

DATA FILE WITH PARAMETERS (~ DATA/PARAMETERS.TXT)

```
begin
m = 30
n = 9
T = 28
l = 29
h = 28
v = 8
R = 6
E = 8
numberScenarios = 16
end
```

DATA FILE WITH PI CONSTRAINTS (~ DATA/PI.TXT)

```
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 1
0 1 0 0 0 0 0 0 1
0 1 0 0 0 0 0 0 1
0 1 0 0 0 0 0 0 1
```

10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 5 - DISCRETE EVENT SIMULATION - PROMODEL CODE

```
1  ********************************************************************************
2  *                                                                              *
3  *                        Formatted Listing of Model:                           *
4  *                                                                              *
5  *                                                                              *
6  ********************************************************************************
7
8    Time Units:                       Hours
9    Distance Units:                   Meters
10
11
12 ********************************************************************************
13 *                                Locations                                     *
14 ********************************************************************************
15
16   Name               Cap Units Stats       Rules            Cost
17   ------------------ --- ----- ----------- ---------------- ------------
18   ArrivalBuffer      inf 1     Time Series Oldest, ,
19   Arrival            inf 1     Time Series Oldest, , First
20   PreSurgeryBuffer   inf 1     Time Series Oldest, ,
21   OperatingRoom1     1   1     Time Series Oldest, ,
22   OperatingRoom2     1   1     Time Series Oldest, ,
23   OperatingRoom3     1   1     Time Series Oldest, ,
24   OperatingRoom4     1   1     Time Series Oldest, ,
25   OperatingRoom5     1   1     Time Series Oldest, ,
26   OperatingRoom6     1   1     Time Series Oldest, ,
27   OperatingRoom7     1   1     Time Series Oldest, ,
28   OperatingRoom8     1   1     Time Series Oldest, ,
29   OperatingRoom9     1   1     Time Series Oldest, ,
30   PreRecoveryBuffer  inf 1     Time Series Oldest, ,
31   Recovery           1   25    Time Series Oldest, , Fewest
32   Recovery.1         1   1     Time Series Oldest, ,
33   Recovery.2         1   1     Time Series Oldest, ,
34   Recovery.3         1   1     Time Series Oldest, ,
35   Recovery.4         1   1     Time Series Oldest, ,
36   Recovery.5         1   1     Time Series Oldest, ,
37   Recovery.6         1   1     Time Series Oldest, ,
38   Recovery.7         1   1     Time Series Oldest, ,
39   Recovery.8         1   1     Time Series Oldest, ,
40   Recovery.9         1   1     Time Series Oldest, ,
41   Recovery.10        1   1     Time Series Oldest, ,
42   Recovery.11        1   1     Time Series Oldest, ,
43   Recovery.12        1   1     Time Series Oldest, ,
44   Recovery.13        1   1     Time Series Oldest, ,
45   Recovery.14        1   1     Time Series Oldest, ,
46   Recovery.15        1   1     Time Series Oldest, ,
47   Recovery.16        1   1     Time Series Oldest, ,
48   Recovery.17        1   1     Time Series Oldest, ,
49   Recovery.18        1   1     Time Series Oldest, ,
50   Recovery.19        1   1     Time Series Oldest, ,
51   Recovery.20        1   1     Time Series Oldest, ,
52   Recovery.21        1   1     Time Series Oldest, ,
53   Recovery.22        1   1     Time Series Oldest, ,
54   Recovery.23        1   1     Time Series Oldest, ,
55   Recovery.24        1   1     Time Series Oldest, ,
56   Recovery.25        1   1     Time Series Oldest, ,
57   RecoveryWardBuffer inf 1     Time Series Oldest, ,
```

```
RecoveryWard       1   60    Time Series Oldest, , Fewest
RecoveryWard.1     1   1     Time Series Oldest, ,
RecoveryWard.2     1   1     Time Series Oldest, ,
RecoveryWard.3     1   1     Time Series Oldest, ,
RecoveryWard.4     1   1     Time Series Oldest, ,
RecoveryWard.5     1   1     Time Series Oldest, ,
RecoveryWard.6     1   1     Time Series Oldest, ,
RecoveryWard.7     1   1     Time Series Oldest, ,
RecoveryWard.8     1   1     Time Series Oldest, ,
RecoveryWard.9     1   1     Time Series Oldest, ,
RecoveryWard.10    1   1     Time Series Oldest, ,
RecoveryWard.11    1   1     Time Series Oldest, ,
RecoveryWard.12    1   1     Time Series Oldest, ,
RecoveryWard.13    1   1     Time Series Oldest, ,
RecoveryWard.14    1   1     Time Series Oldest, ,
RecoveryWard.15    1   1     Time Series Oldest, ,
RecoveryWard.16    1   1     Time Series Oldest, ,
RecoveryWard.17    1   1     Time Series Oldest, ,
RecoveryWard.18    1   1     Time Series Oldest, ,
RecoveryWard.19    1   1     Time Series Oldest, ,
RecoveryWard.20    1   1     Time Series Oldest, ,
RecoveryWard.21    1   1     Time Series Oldest, ,
RecoveryWard.22    1   1     Time Series Oldest, ,
RecoveryWard.23    1   1     Time Series Oldest, ,
RecoveryWard.24    1   1     Time Series Oldest, ,
RecoveryWard.25    1   1     Time Series Oldest, ,
RecoveryWard.26    1   1     Time Series Oldest, ,
RecoveryWard.27    1   1     Time Series Oldest, ,
RecoveryWard.28    1   1     Time Series Oldest, ,
RecoveryWard.29    1   1     Time Series Oldest, ,
RecoveryWard.30    1   1     Time Series Oldest, ,
RecoveryWard.31    1   1     Time Series Oldest, ,
RecoveryWard.32    1   1     Time Series Oldest, ,
RecoveryWard.33    1   1     Time Series Oldest, ,
RecoveryWard.34    1   1     Time Series Oldest, ,
RecoveryWard.35    1   1     Time Series Oldest, ,
RecoveryWard.36    1   1     Time Series Oldest, ,
RecoveryWard.37    1   1     Time Series Oldest, ,
RecoveryWard.38    1   1     Time Series Oldest, ,
RecoveryWard.39    1   1     Time Series Oldest, ,
RecoveryWard.40    1   1     Time Series Oldest, ,
RecoveryWard.41    1   1     Time Series Oldest, ,
RecoveryWard.42    1   1     Time Series Oldest, ,
RecoveryWard.43    1   1     Time Series Oldest, ,
RecoveryWard.44    1   1     Time Series Oldest, ,
RecoveryWard.45    1   1     Time Series Oldest, ,
RecoveryWard.46    1   1     Time Series Oldest, ,
RecoveryWard.47    1   1     Time Series Oldest, ,
RecoveryWard.48    1   1     Time Series Oldest, ,
RecoveryWard.49    1   1     Time Series Oldest, ,
RecoveryWard.50    1   1     Time Series Oldest, ,
RecoveryWard.51    1   1     Time Series Oldest, ,
RecoveryWard.52    1   1     Time Series Oldest, ,
RecoveryWard.53    1   1     Time Series Oldest, ,
RecoveryWard.54    1   1     Time Series Oldest, ,
RecoveryWard.55    1   1     Time Series Oldest, ,
RecoveryWard.56    1   1     Time Series Oldest, ,
RecoveryWard.57    1   1     Time Series Oldest, ,
RecoveryWard.58    1   1     Time Series Oldest, ,
RecoveryWard.59    1   1     Time Series Oldest, ,
RecoveryWard.60    1   1     Time Series Oldest, ,
```

```
  Discharge          inf 1     Time Series Oldest, ,


*****************************************************************************
*                                  Entities                                 *
*****************************************************************************

  Name         Speed (mpm)  Stats       Cost
  ------------ ------------ ----------- ------------
  PatientBatch 50           Time Series
  Patient      50           Time Series


*****************************************************************************
*                                 Resources                                 *
*****************************************************************************

                                 Res    Ent
  Name             Units Stats    Search Search Path       Motion        Cost
  ---------------- ----- -------- ------ ------ ---------- ------------- ------------
  Surgical_Team_1  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_2  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_3  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_4  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_5  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_6  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_7  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_8  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_9  1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_10 1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_11 1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_12 1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_13 1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm

  Surgical_Team_14 1     By Unit  None   Oldest            Empty: 50 mpm
                                                           Full: 50 mpm
```

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Surgical_Team_15 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_16 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_17 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_18 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_19 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_20 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_21 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_22 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_23 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_24 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_25 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_26 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_27 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_28 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_29 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

Surgical_Team_30 1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

OperatingRoom_1  1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

OperatingRoom_2  1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

OperatingRoom_3  1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm

OperatingRoom_4  1     By Unit  None   Oldest           Empty: 50 mpm
                                                        Full: 50 mpm
```

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 OperatingRoom_5  1     By Unit  None   Oldest            Empty: 50 mpm
                                                         Full: 50 mpm

 OperatingRoom_6  1     By Unit  None   Oldest            Empty: 50 mpm
                                                         Full: 50 mpm

 OperatingRoom_7  1     By Unit  None   Oldest            Empty: 50 mpm
                                                         Full: 50 mpm

 OperatingRoom_8  1     By Unit  None   Oldest            Empty: 50 mpm
                                                         Full: 50 mpm

 OperatingRoom_9  1     By Unit  None   Oldest            Empty: 50 mpm
                                                         Full: 50 mpm


************************************************************************
*                          Processing                                  *
************************************************************************

                                      Process                                Routing

 Entity       Location           Operation            Blk  Output       Destination        Rule                            Move Logic
 ------------ ------------------ ------------------   ---- ------------ ------------------ ------------------------------  ------------
 PatientBatch ArrivalBuffer      Split maximumNumberOfPatients[PatientBatch_SurgicalTeam, PatientBatch_Scenario] As Patient
                                                      1    PatientBatch EXIT               FIRST 1
 Patient      ArrivalBuffer      Patient_SurgicalTeam = PatientBatch_SurgicalTeam
                                 Patient_OperatingRoom = PatientBatch_OperatingRoom
                                 Patient_DayofSurgery = PatientBatch_DayofSurgery
                                 Patient_Scenario = PatientBatch_Scenario
                                                      1    Patient      Arrival            FIRST 1
 Patient      Arrival            Wait N(60,3) min
                                 Graphic 2            1    Patient      PreSurgeryBuffer   FIRST 1
 Patient      PreSurgeryBuffer                        1    Patient      OperatingRoom1     IF Patient_OperatingRoom = 1, 1
                                                           Patient      OperatingRoom2     IF Patient_OperatingRoom = 2
                                                           Patient      OperatingRoom3     IF Patient_OperatingRoom = 3
                                                           Patient      OperatingRoom4     IF Patient_OperatingRoom = 4
                                                           Patient      OperatingRoom5     IF Patient_OperatingRoom = 5
                                                           Patient      OperatingRoom6     IF Patient_OperatingRoom = 6
                                                           Patient      OperatingRoom7     IF Patient_OperatingRoom = 7
                                                           Patient      OperatingRoom8     IF Patient_OperatingRoom = 8
                                                           Patient      OperatingRoom9     IF Patient_OperatingRoom = 9
 Patient      OperatingRoom1     If Patient_SurgicalTeam = 1 Then
                                 Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_1 For A[1,Patient_Scenario] hr

                                 Else If Patient_SurgicalTeam = 2 Then
                                 Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_1 For A[2,Patient_Scenario] hr

                                 Else If Patient_SurgicalTeam = 3 Then
                                 Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_1 For A[3,Patient_Scenario] hr

                                 Else If Patient_SurgicalTeam = 4 Then
                                 Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_1 For A[4,Patient_Scenario] hr

                                 Else If Patient_SurgicalTeam = 5 Then
                                 Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_1 For A[5,Patient_Scenario] hr

                                 Else If Patient_SurgicalTeam = 6 Then
                                 Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_1 For A[6,Patient_Scenario] hr

                                 Else If Patient_SurgicalTeam = 7 Then
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Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_1 For A[7,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 8 Then
Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_1 For A[8,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 9 Then
Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_1 For A[9,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 10 Then
Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_1 For A[10,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 11 Then
Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_1 For A[11,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 12 Then
Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_1 For A[12,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 13 Then
Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_1 For A[13,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 14 Then
Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_1 For A[14,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 15 Then
Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_1 For A[15,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 16 Then
Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_1 For A[16,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 17 Then
Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_1 For A[17,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 18 Then
Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_1 For A[18,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 19 Then
Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_1 For A[19,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 20 Then
Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_1 For A[20,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 21 Then
Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_1 For A[21,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 22 Then
Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_1 For A[22,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 23 Then
Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_1 For A[23,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 24 Then
Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_1 For A[24,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 25 Then
Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_1 For A[25,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 26 Then
Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_1 For A[26,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 27 Then
Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_1 For A[27,Patient_Scenario] hr
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                                Else If Patient_SurgicalTeam = 28 Then
                                Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_1 For A[28,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 29 Then
                                Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_1 For A[29,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 30 Then
                                Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_1 For A[30,Patient_Scenario] hr
                                                        1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom2     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_2 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_2 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_2 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_2 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_2 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_2 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_2 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
                                Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_2 For A[8,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 9 Then
                                Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_2 For A[9,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 10 Then
                                Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_2 For A[10,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 11 Then
                                Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_2 For A[11,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 12 Then
                                Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_2 For A[12,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 13 Then
                                Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_2 For A[13,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 14 Then
                                Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_2 For A[14,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 15 Then
                                Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_2 For A[15,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 16 Then
                                Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_2 For A[16,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 17 Then
                                Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_2 For A[17,Patient_Scenario] hr
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                                Else If Patient_SurgicalTeam = 18 Then
                                Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_2 For A[18,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 19 Then
                                Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_2 For A[19,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 20 Then
                                Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_2 For A[20,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 21 Then
                                Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_2 For A[21,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 22 Then
                                Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_2 For A[22,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 23 Then
                                Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_2 For A[23,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 24 Then
                                Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_2 For A[24,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 25 Then
                                Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_2 For A[25,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 26 Then
                                Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_2 For A[26,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 27 Then
                                Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_2 For A[27,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 28 Then
                                Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_2 For A[28,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 29 Then
                                Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_2 For A[29,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 30 Then
                                Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_2 For A[30,Patient_Scenario] hr
                                        1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom3     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_3 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_3 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_3 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_3 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_3 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_3 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_3 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
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Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_3 For A[8,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 9 Then
Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_3 For A[9,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 10 Then
Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_3 For A[10,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 11 Then
Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_3 For A[11,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 12 Then
Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_3 For A[12,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 13 Then
Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_3 For A[13,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 14 Then
Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_3 For A[14,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 15 Then
Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_3 For A[15,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 16 Then
Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_3 For A[16,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 17 Then
Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_3 For A[17,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 18 Then
Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_3 For A[18,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 19 Then
Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_3 For A[19,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 20 Then
Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_3 For A[20,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 21 Then
Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_3 For A[21,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 22 Then
Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_3 For A[22,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 23 Then
Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_3 For A[23,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 24 Then
Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_3 For A[24,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 25 Then
Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_3 For A[25,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 26 Then
Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_3 For A[26,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 27 Then
Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_3 For A[27,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 28 Then
Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_3 For A[28,Patient_Scenario] hr
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                                Else If Patient_SurgicalTeam = 29 Then
                                Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_3 For A[29,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 30 Then
                                Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_3 For A[30,Patient_Scenario] hr
                                                        1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom4     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_4 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_4 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_4 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_4 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_4 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_4 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_4 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
                                Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_4 For A[8,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 9 Then
                                Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_4 For A[9,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 10 Then
                                Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_4 For A[10,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 11 Then
                                Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_4 For A[11,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 12 Then
                                Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_4 For A[12,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 13 Then
                                Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_4 For A[13,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 14 Then
                                Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_4 For A[14,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 15 Then
                                Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_4 For A[15,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 16 Then
                                Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_4 For A[16,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 17 Then
                                Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_4 For A[17,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 18 Then
                                Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_4 For A[18,Patient_Scenario] hr
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                                Else If Patient_SurgicalTeam = 19 Then
                                Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_4 For A[19,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 20 Then
                                Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_4 For A[20,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 21 Then
                                Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_4 For A[21,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 22 Then
                                Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_4 For A[22,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 23 Then
                                Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_4 For A[23,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 24 Then
                                Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_4 For A[24,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 25 Then
                                Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_4 For A[25,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 26 Then
                                Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_4 For A[26,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 27 Then
                                Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_4 For A[27,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 28 Then
                                Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_4 For A[28,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 29 Then
                                Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_4 For A[29,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 30 Then
                                Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_4 For A[30,Patient_Scenario] hr
                                                    1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom5     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_5 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_5 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_5 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_5 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_5 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_5 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_5 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
                                Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_5 For A[8,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 9 Then
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Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_5 For A[9,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 10 Then
Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_5 For A[10,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 11 Then
Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_5 For A[11,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 12 Then
Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_5 For A[12,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 13 Then
Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_5 For A[13,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 14 Then
Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_5 For A[14,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 15 Then
Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_5 For A[15,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 16 Then
Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_5 For A[16,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 17 Then
Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_5 For A[17,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 18 Then
Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_5 For A[18,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 19 Then
Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_5 For A[19,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 20 Then
Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_5 For A[20,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 21 Then
Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_5 For A[21,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 22 Then
Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_5 For A[22,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 23 Then
Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_5 For A[23,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 24 Then
Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_5 For A[24,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 25 Then
Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_5 For A[25,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 26 Then
Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_5 For A[26,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 27 Then
Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_5 For A[27,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 28 Then
Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_5 For A[28,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 29 Then
Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_5 For A[29,Patient_Scenario] hr
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                                Else If Patient_SurgicalTeam = 30 Then
                                Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_5 For A[30,Patient_Scenario] hr
                                                        1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom6     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_6 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_6 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_6 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_6 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_6 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_6 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_6 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
                                Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_6 For A[8,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 9 Then
                                Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_6 For A[9,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 10 Then
                                Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_6 For A[10,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 11 Then
                                Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_6 For A[11,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 12 Then
                                Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_6 For A[12,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 13 Then
                                Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_6 For A[13,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 14 Then
                                Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_6 For A[14,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 15 Then
                                Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_6 For A[15,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 16 Then
                                Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_6 For A[16,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 17 Then
                                Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_6 For A[17,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 18 Then
                                Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_6 For A[18,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 19 Then
                                Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_6 For A[19,Patient_Scenario] hr
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                                Else If Patient_SurgicalTeam = 20 Then
                                Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_6 For A[20,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 21 Then
                                Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_6 For A[21,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 22 Then
                                Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_6 For A[22,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 23 Then
                                Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_6 For A[23,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 24 Then
                                Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_6 For A[24,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 25 Then
                                Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_6 For A[25,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 26 Then
                                Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_6 For A[26,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 27 Then
                                Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_6 For A[27,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 28 Then
                                Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_6 For A[28,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 29 Then
                                Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_6 For A[29,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 30 Then
                                Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_6 For A[30,Patient_Scenario] hr
                                                        1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom7     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_7 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_7 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_7 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_7 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_7 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_7 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_7 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
                                Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_7 For A[8,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 9 Then
                                Use 1 Surgical_Team_9 For A[9,Patient_Segario] hr And 1 OperatingRoom_7 For A[9,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 10 Then
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Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_7 For A[10,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 11 Then
Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_7 For A[11,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 12 Then
Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_7 For A[12,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 13 Then
Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_7 For A[13,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 14 Then
Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_7 For A[14,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 15 Then
Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_7 For A[15,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 16 Then
Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_7 For A[16,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 17 Then
Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_7 For A[17,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 18 Then
Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_7 For A[18,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 19 Then
Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_7 For A[19,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 20 Then
Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_7 For A[20,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 21 Then
Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_7 For A[21,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 22 Then
Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_7 For A[22,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 23 Then
Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_7 For A[23,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 24 Then
Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_7 For A[24,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 25 Then
Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_7 For A[25,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 26 Then
Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_7 For A[26,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 27 Then
Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_7 For A[27,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 28 Then
Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_7 For A[28,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 29 Then
Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_7 For A[29,Patient_Scenario] hr

Else If Patient_SurgicalTeam = 30 Then
Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_7 For A[30,Patient_Scenario] hr
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                                          1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom8     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_8 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_8 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_8 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_8 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_8 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_8 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_8 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
                                Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_8 For A[8,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 9 Then
                                Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_8 For A[9,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 10 Then
                                Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_8 For A[10,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 11 Then
                                Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_8 For A[11,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 12 Then
                                Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_8 For A[12,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 13 Then
                                Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_8 For A[13,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 14 Then
                                Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_8 For A[14,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 15 Then
                                Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_8 For A[15,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 16 Then
                                Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_8 For A[16,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 17 Then
                                Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_8 For A[17,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 18 Then
                                Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_8 For A[18,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 19 Then
                                Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_8 For A[19,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 20 Then
                                Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_8 For A[20,Patient_Scenario] hr
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                                Else If Patient_SurgicalTeam = 21 Then
                                Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_8 For A[21,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 22 Then
                                Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_8 For A[22,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 23 Then
                                Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_8 For A[23,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 24 Then
                                Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_8 For A[24,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 25 Then
                                Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_8 For A[25,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 26 Then
                                Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_8 For A[26,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 27 Then
                                Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_8 For A[27,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 28 Then
                                Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_8 For A[28,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 29 Then
                                Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_8 For A[29,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 30 Then
                                Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_8 For A[30,Patient_Scenario] hr
                                                        1    Patient      PreRecoveryBuffer  FIRST 1
Patient      OperatingRoom9     If Patient_SurgicalTeam = 1 Then
                                Use 1 Surgical_Team_1 For A[1,Patient_Scenario] hr And 1 OperatingRoom_9 For A[1,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 2 Then
                                Use 1 Surgical_Team_2 For A[2,Patient_Scenario] hr And 1 OperatingRoom_9 For A[2,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 3 Then
                                Use 1 Surgical_Team_3 For A[3,Patient_Scenario] hr And 1 OperatingRoom_9 For A[3,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 4 Then
                                Use 1 Surgical_Team_4 For A[4,Patient_Scenario] hr And 1 OperatingRoom_9 For A[4,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 5 Then
                                Use 1 Surgical_Team_5 For A[5,Patient_Scenario] hr And 1 OperatingRoom_9 For A[5,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 6 Then
                                Use 1 Surgical_Team_6 For A[6,Patient_Scenario] hr And 1 OperatingRoom_9 For A[6,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 7 Then
                                Use 1 Surgical_Team_7 For A[7,Patient_Scenario] hr And 1 OperatingRoom_9 For A[7,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 8 Then
                                Use 1 Surgical_Team_8 For A[8,Patient_Scenario] hr And 1 OperatingRoom_9 For A[8,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 9 Then
                                Use 1 Surgical_Team_9 For A[9,Patient_Scenario] hr And 1 OperatingRoom_9 For A[9,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 10 Then
                                Use 1 Surgical_Team_10 For A[10,Patient_Scenario] hr And 1 OperatingRoom_9 For A[10,Patient_Scenario] hr

                                Else If Patient_SurgicalTeam = 11 Then
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                              Use 1 Surgical_Team_11 For A[11,Patient_Scenario] hr And 1 OperatingRoom_9 For A[11,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 12 Then
                              Use 1 Surgical_Team_12 For A[12,Patient_Scenario] hr And 1 OperatingRoom_9 For A[12,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 13 Then
                              Use 1 Surgical_Team_13 For A[13,Patient_Scenario] hr And 1 OperatingRoom_9 For A[13,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 14 Then
                              Use 1 Surgical_Team_14 For A[14,Patient_Scenario] hr And 1 OperatingRoom_9 For A[14,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 15 Then
                              Use 1 Surgical_Team_15 For A[15,Patient_Scenario] hr And 1 OperatingRoom_9 For A[15,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 16 Then
                              Use 1 Surgical_Team_16 For A[16,Patient_Scenario] hr And 1 OperatingRoom_9 For A[16,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 17 Then
                              Use 1 Surgical_Team_17 For A[17,Patient_Scenario] hr And 1 OperatingRoom_9 For A[17,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 18 Then
                              Use 1 Surgical_Team_18 For A[18,Patient_Scenario] hr And 1 OperatingRoom_9 For A[18,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 19 Then
                              Use 1 Surgical_Team_19 For A[19,Patient_Scenario] hr And 1 OperatingRoom_9 For A[19,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 20 Then
                              Use 1 Surgical_Team_20 For A[20,Patient_Scenario] hr And 1 OperatingRoom_9 For A[20,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 21 Then
                              Use 1 Surgical_Team_21 For A[21,Patient_Scenario] hr And 1 OperatingRoom_9 For A[21,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 22 Then
                              Use 1 Surgical_Team_22 For A[22,Patient_Scenario] hr And 1 OperatingRoom_9 For A[22,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 23 Then
                              Use 1 Surgical_Team_23 For A[23,Patient_Scenario] hr And 1 OperatingRoom_9 For A[23,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 24 Then
                              Use 1 Surgical_Team_24 For A[24,Patient_Scenario] hr And 1 OperatingRoom_9 For A[24,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 25 Then
                              Use 1 Surgical_Team_25 For A[25,Patient_Scenario] hr And 1 OperatingRoom_9 For A[25,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 26 Then
                              Use 1 Surgical_Team_26 For A[26,Patient_Scenario] hr And 1 OperatingRoom_9 For A[26,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 27 Then
                              Use 1 Surgical_Team_27 For A[27,Patient_Scenario] hr And 1 OperatingRoom_9 For A[27,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 28 Then
                              Use 1 Surgical_Team_28 For A[28,Patient_Scenario] hr And 1 OperatingRoom_9 For A[28,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 29 Then
                              Use 1 Surgical_Team_29 For A[29,Patient_Scenario] hr And 1 OperatingRoom_9 For A[29,Patient_Scenario] hr

                              Else If Patient_SurgicalTeam = 30 Then
                              Use 1 Surgical_Team_30 For A[30,Patient_Scenario] hr And 1 OperatingRoom_9 For A[30,Patient_Scenario] hr
                                                     1    Patient      PreRecoveryBuffer  FIRST 1
Patient      PreRecoveryBuffer                         1    Patient      Recovery           FIRST 1
Patient      Recovery          Wait N(75,5) min        1    Patient      RecoveryWardBuffer FIRST 1
```

```
Patient      RecoveryWardBuffer                    1    Patient      RecoveryWard       FIRST 1
Patient      RecoveryWard       If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 1) Then
                                                          Wait sli1() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 2) Then
                                                          Wait sli2() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 3) Then
                                                          Wait sli3() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 4) Then
                                                          Wait sli4() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 5) Then
                                                          Wait sli5() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 6) Then
                                                          Wait sli6() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 7) Then
                                                          Wait sli7() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 8) Then
                                                          Wait sli8() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 9) Then
                                                          Wait sli9() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 10) Then
                                                          Wait sli10() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 11) Then
                                                          Wait sli11() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 12) Then
                                                          Wait sli12() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 13) Then
                                                          Wait sli13() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 14) Then
                                                          Wait sli14() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 15) Then
                                                          Wait sli15() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 16) Then
                                                          Wait sli16() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 17) Then
                                                          Wait sli17() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 18) Then
                                                          Wait sli18() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 19) Then
                                                          Wait sli19() day

                                If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 20) Then
                                                          Wait sli20() day
```

```
If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 21) Then
                                    Wait s1i21() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 22) Then
                                    Wait s1i22() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 23) Then
                                    Wait s1i23() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 24) Then
                                    Wait s1i24() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 25) Then
                                    Wait s1i25() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 26) Then
                                    Wait s1i26() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 27) Then
                                    Wait s1i27() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 28) Then
                                    Wait s1i28() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 29) Then
                                    Wait s1i29() day

If (Patient_Scenario = 1) And (Patient_SurgicalTeam = 30) Then
                                    Wait s1i30() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 1) Then
                                    Wait s2i1() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 2) Then
                                    Wait s2i2() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 3) Then
                                    Wait s2i3() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 4) Then
                                    Wait s2i4() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 5) Then
                                    Wait s2i5() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 6) Then
                                    Wait s2i6() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 7) Then
                                    Wait s2i7() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 8) Then
                                    Wait s2i8() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 9) Then
                                    Wait s2i9() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 10) Then
                                    Wait s2i10() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 11) Then
```

```
                                    Wait s2i11() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 12) Then
                                    Wait s2i12() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 13) Then
                                    Wait s2i13() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 14) Then
                                    Wait s2i14() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 15) Then
                                    Wait s2i15() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 16) Then
                                    Wait s2i16() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 17) Then
                                    Wait s2i17() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 18) Then
                                    Wait s2i18() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 19) Then
                                    Wait s2i19() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 20) Then
                                    Wait s2i20() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 21) Then
                                    Wait s2i21() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 22) Then
                                    Wait s2i22() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 23) Then
                                    Wait s2i23() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 24) Then
                                    Wait s2i24() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 25) Then
                                    Wait s2i25() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 26) Then
                                    Wait s2i26() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 27) Then
                                    Wait s2i27() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 28) Then
                                    Wait s2i28() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 29) Then
                                    Wait s2i29() day

If (Patient_Scenario = 2) And (Patient_SurgicalTeam = 30) Then
                                    Wait s2i30() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 1) Then
                                    Wait s3i1() day
```

```
If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 2) Then
                                    Wait s3i2() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 3) Then
                                    Wait s3i3() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 4) Then
                                    Wait s3i4() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 5) Then
                                    Wait s3i5() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 6) Then
                                    Wait s3i6() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 7) Then
                                    Wait s3i7() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 8) Then
                                    Wait s3i8() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 9) Then
                                    Wait s3i9() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 10) Then
                                    Wait s3i10() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 11) Then
                                    Wait s3i11() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 12) Then
                                    Wait s3i12() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 13) Then
                                    Wait s3i13() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 14) Then
                                    Wait s3i14() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 15) Then
                                    Wait s3i15() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 16) Then
                                    Wait s3i16() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 17) Then
                                    Wait s3i17() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 18) Then
                                    Wait s3i18() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 19) Then
                                    Wait s3i19() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 20) Then
                                    Wait s3i20() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 21) Then
                                    Wait s3i21() day
```

```
If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 22) Then
                                    Wait s3i22() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 23) Then
                                    Wait s3i23() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 24) Then
                                    Wait s3i24() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 25) Then
                                    Wait s3i25() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 26) Then
                                    Wait s3i26() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 27) Then
                                    Wait s3i27() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 28) Then
                                    Wait s3i28() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 29) Then
                                    Wait s3i29() day

If (Patient_Scenario = 3) And (Patient_SurgicalTeam = 30) Then
                                    Wait s3i30() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 1) Then
                                    Wait s4i1() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 2) Then
                                    Wait s4i2() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 3) Then
                                    Wait s4i3() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 4) Then
                                    Wait s4i4() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 5) Then
                                    Wait s4i5() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 6) Then
                                    Wait s4i6() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 7) Then
                                    Wait s4i7() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 8) Then
                                    Wait s4i8() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 9) Then
                                    Wait s4i9() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 10) Then
                                    Wait s4i10() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 11) Then
                                    Wait s4i11() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 12) Then
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```
                                    Wait s4i12() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 13) Then
                                    Wait s4i13() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 14) Then
                                    Wait s4i14() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 15) Then
                                    Wait s4i15() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 16) Then
                                    Wait s4i16() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 17) Then
                                    Wait s4i17() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 18) Then
                                    Wait s4i18() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 19) Then
                                    Wait s4i19() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 20) Then
                                    Wait s4i20() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 21) Then
                                    Wait s4i21() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 22) Then
                                    Wait s4i22() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 23) Then
                                    Wait s4i23() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 24) Then
                                    Wait s4i24() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 25) Then
                                    Wait s4i25() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 26) Then
                                    Wait s4i26() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 27) Then
                                    Wait s4i27() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 28) Then
                                    Wait s4i28() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 29) Then
                                    Wait s4i29() day

If (Patient_Scenario = 4) And (Patient_SurgicalTeam = 30) Then
                                    Wait s4i30() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 1) Then
                                    Wait s5i1() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 2) Then
                                    Wait s5i2() day
```

```
If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 3) Then
                                    Wait s5i3() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 4) Then
                                    Wait s5i4() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 5) Then
                                    Wait s5i5() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 6) Then
                                    Wait s5i6() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 7) Then
                                    Wait s5i7() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 8) Then
                                    Wait s5i8() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 9) Then
                                    Wait s5i9() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 10) Then
                                    Wait s5i10() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 11) Then
                                    Wait s5i11() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 12) Then
                                    Wait s5i12() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 13) Then
                                    Wait s5i13() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 14) Then
                                    Wait s5i14() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 15) Then
                                    Wait s5i15() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 16) Then
                                    Wait s5i16() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 17) Then
                                    Wait s5i17() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 18) Then
                                    Wait s5i18() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 19) Then
                                    Wait s5i19() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 20) Then
                                    Wait s5i20() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 21) Then
                                    Wait s5i21() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 22) Then
                                    Wait s5i22() day
```

```
If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 23) Then
                                    Wait s5i23() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 24) Then
                                    Wait s5i24() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 25) Then
                                    Wait s5i25() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 26) Then
                                    Wait s5i26() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 27) Then
                                    Wait s5i27() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 28) Then
                                    Wait s5i28() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 29) Then
                                    Wait s5i29() day

If (Patient_Scenario = 5) And (Patient_SurgicalTeam = 30) Then
                                    Wait s5i30() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 1) Then
                                    Wait s6i1() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 2) Then
                                    Wait s6i2() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 3) Then
                                    Wait s6i3() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 4) Then
                                    Wait s6i4() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 5) Then
                                    Wait s6i5() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 6) Then
                                    Wait s6i6() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 7) Then
                                    Wait s6i7() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 8) Then
                                    Wait s6i8() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 9) Then
                                    Wait s6i9() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 10) Then
                                    Wait s6i10() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 11) Then
                                    Wait s6i11() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 12) Then
                                    Wait s6i12() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 13) Then
```

```
                                    Wait s6i13() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 14) Then
                                    Wait s6i14() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 15) Then
                                    Wait s6i15() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 16) Then
                                    Wait s6i16() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 17) Then
                                    Wait s6i17() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 18) Then
                                    Wait s6i18() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 19) Then
                                    Wait s6i19() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 20) Then
                                    Wait s6i20() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 21) Then
                                    Wait s6i21() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 22) Then
                                    Wait s6i22() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 23) Then
                                    Wait s6i23() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 24) Then
                                    Wait s6i24() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 25) Then
                                    Wait s6i25() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 26) Then
                                    Wait s6i26() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 27) Then
                                    Wait s6i27() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 28) Then
                                    Wait s6i28() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 29) Then
                                    Wait s6i29() day

If (Patient_Scenario = 6) And (Patient_SurgicalTeam = 30) Then
                                    Wait s6i30() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 1) Then
                                    Wait s7i1() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 2) Then
                                    Wait s7i2() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 3) Then
                                    Wait s7i3() day
```

```
If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 4) Then
                                    Wait s7i4() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 5) Then
                                    Wait s7i5() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 6) Then
                                    Wait s7i6() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 7) Then
                                    Wait s7i7() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 8) Then
                                    Wait s7i8() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 9) Then
                                    Wait s7i9() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 10) Then
                                    Wait s7i10() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 11) Then
                                    Wait s7i11() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 12) Then
                                    Wait s7i12() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 13) Then
                                    Wait s7i13() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 14) Then
                                    Wait s7i14() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 15) Then
                                    Wait s7i15() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 16) Then
                                    Wait s7i16() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 17) Then
                                    Wait s7i17() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 18) Then
                                    Wait s7i18() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 19) Then
                                    Wait s7i19() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 20) Then
                                    Wait s7i20() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 21) Then
                                    Wait s7i21() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 22) Then
                                    Wait s7i22() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 23) Then
                                    Wait s7i23() day
```

```
If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 24) Then
                                    Wait s7i24() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 25) Then
                                    Wait s7i25() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 26) Then
                                    Wait s7i26() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 27) Then
                                    Wait s7i27() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 28) Then
                                    Wait s7i28() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 29) Then
                                    Wait s7i29() day

If (Patient_Scenario = 7) And (Patient_SurgicalTeam = 30) Then
                                    Wait s7i30() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 1) Then
                                    Wait s8i1() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 2) Then
                                    Wait s8i2() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 3) Then
                                    Wait s8i3() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 4) Then
                                    Wait s8i4() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 5) Then
                                    Wait s8i5() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 6) Then
                                    Wait s8i6() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 7) Then
                                    Wait s8i7() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 8) Then
                                    Wait s8i8() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 9) Then
                                    Wait s8i9() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 10) Then
                                    Wait s8i10() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 11) Then
                                    Wait s8i11() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 12) Then
                                    Wait s8i12() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 13) Then
                                    Wait s8i13() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 14) Then
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                                    Wait s8i14() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 15) Then
                                    Wait s8i15() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 16) Then
                                    Wait s8i16() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 17) Then
                                    Wait s8i17() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 18) Then
                                    Wait s8i18() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 19) Then
                                    Wait s8i19() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 20) Then
                                    Wait s8i20() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 21) Then
                                    Wait s8i21() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 22) Then
                                    Wait s8i22() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 23) Then
                                    Wait s8i23() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 24) Then
                                    Wait s8i24() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 25) Then
                                    Wait s8i25() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 26) Then
                                    Wait s8i26() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 27) Then
                                    Wait s8i27() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 28) Then
                                    Wait s8i28() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 29) Then
                                    Wait s8i29() day

If (Patient_Scenario = 8) And (Patient_SurgicalTeam = 30) Then
                                    Wait s8i30() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 1) Then
                                    Wait s9i1() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 2) Then
                                    Wait s9i2() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 3) Then
                                    Wait s9i3() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 4) Then
                                    Wait s9i4() day
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If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 5) Then
                                    Wait s9i5() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 6) Then
                                    Wait s9i6() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 7) Then
                                    Wait s9i7() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 8) Then
                                    Wait s9i8() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 9) Then
                                    Wait s9i9() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 10) Then
                                    Wait s9i10() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 11) Then
                                    Wait s9i11() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 12) Then
                                    Wait s9i12() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 13) Then
                                    Wait s9i13() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 14) Then
                                    Wait s9i14() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 15) Then
                                    Wait s9i15() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 16) Then
                                    Wait s9i16() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 17) Then
                                    Wait s9i17() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 18) Then
                                    Wait s9i18() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 19) Then
                                    Wait s9i19() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 20) Then
                                    Wait s9i20() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 21) Then
                                    Wait s9i21() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 22) Then
                                    Wait s9i22() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 23) Then
                                    Wait s9i23() day

If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 24) Then
                                    Wait s9i24() day
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                If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 25) Then
                                    Wait s9i25() day

                If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 26) Then
                                    Wait s9i26() day

                If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 27) Then
                                    Wait s9i27() day

                If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 28) Then
                                    Wait s9i28() day

                If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 29) Then
                                    Wait s9i29() day

                If (Patient_Scenario = 9) And (Patient_SurgicalTeam = 30) Then
                                    Wait s9i30() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 1) Then
                                    Wait s10i1() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 2) Then
                                    Wait s10i2() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 3) Then
                                    Wait s10i3() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 4) Then
                                    Wait s10i4() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 5) Then
                                    Wait s10i5() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 6) Then
                                    Wait s10i6() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 7) Then
                                    Wait s10i7() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 8) Then
                                    Wait s10i8() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 9) Then
                                    Wait s10i9() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 10) Then
                                    Wait s10i10() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 11) Then
                                    Wait s10i11() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 12) Then
                                    Wait s10i12() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 13) Then
                                    Wait s10i13() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 14) Then
                                    Wait s10i14() day

                If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 15) Then
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                                    Wait s10i15() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 16) Then
                                    Wait s10i16() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 17) Then
                                    Wait s10i17() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 18) Then
                                    Wait s10i18() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 19) Then
                                    Wait s10i19() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 20) Then
                                    Wait s10i20() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 21) Then
                                    Wait s10i21() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 22) Then
                                    Wait s10i22() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 23) Then
                                    Wait s10i23() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 24) Then
                                    Wait s10i24() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 25) Then
                                    Wait s10i25() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 26) Then
                                    Wait s10i26() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 27) Then
                                    Wait s10i27() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 28) Then
                                    Wait s10i28() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 29) Then
                                    Wait s10i29() day

If (Patient_Scenario = 10) And (Patient_SurgicalTeam = 30) Then
                                    Wait s10i30() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 1) Then
                                    Wait s11i1() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 2) Then
                                    Wait s11i2() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 3) Then
                                    Wait s11i3() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 4) Then
                                    Wait s11i4() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 5) Then
                                    Wait s11i5() day
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If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 6) Then
                                  Wait s11i6() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 7) Then
                                  Wait s11i7() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 8) Then
                                  Wait s11i8() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 9) Then
                                  Wait s11i9() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 10) Then
                                  Wait s11i10() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 11) Then
                                  Wait s11i11() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 12) Then
                                  Wait s11i12() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 13) Then
                                  Wait s11i13() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 14) Then
                                  Wait s11i14() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 15) Then
                                  Wait s11i15() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 16) Then
                                  Wait s11i16() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 17) Then
                                  Wait s11i17() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 18) Then
                                  Wait s11i18() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 19) Then
                                  Wait s11i19() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 20) Then
                                  Wait s11i20() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 21) Then
                                  Wait s11i21() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 22) Then
                                  Wait s11i22() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 23) Then
                                  Wait s11i23() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 24) Then
                                  Wait s11i24() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 25) Then
                                  Wait s11i25() day
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If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 26) Then
                                    Wait s11i26() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 27) Then
                                    Wait s11i27() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 28) Then
                                    Wait s11i28() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 29) Then
                                    Wait s11i29() day

If (Patient_Scenario = 11) And (Patient_SurgicalTeam = 30) Then
                                    Wait s11i30() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 1) Then
                                    Wait s12i1() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 2) Then
                                    Wait s12i2() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 3) Then
                                    Wait s12i3() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 4) Then
                                    Wait s12i4() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 5) Then
                                    Wait s12i5() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 6) Then
                                    Wait s12i6() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 7) Then
                                    Wait s12i7() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 8) Then
                                    Wait s12i8() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 9) Then
                                    Wait s12i9() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 10) Then
                                    Wait s12i10() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 11) Then
                                    Wait s12i11() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 12) Then
                                    Wait s12i12() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 13) Then
                                    Wait s12i13() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 14) Then
                                    Wait s12i14() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 15) Then
                                    Wait s12i15() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 16) Then
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                                    Wait s12i16() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 17) Then
                                    Wait s12i17() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 18) Then
                                    Wait s12i18() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 19) Then
                                    Wait s12i19() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 20) Then
                                    Wait s12i20() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 21) Then
                                    Wait s12i21() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 22) Then
                                    Wait s12i22() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 23) Then
                                    Wait s12i23() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 24) Then
                                    Wait s12i24() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 25) Then
                                    Wait s12i25() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 26) Then
                                    Wait s12i26() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 27) Then
                                    Wait s12i27() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 28) Then
                                    Wait s12i28() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 29) Then
                                    Wait s12i29() day

If (Patient_Scenario = 12) And (Patient_SurgicalTeam = 30) Then
                                    Wait s12i30() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 1) Then
                                    Wait s13i1() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 2) Then
                                    Wait s13i2() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 3) Then
                                    Wait s13i3() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 4) Then
                                    Wait s13i4() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 5) Then
                                    Wait s13i5() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 6) Then
                                    Wait s13i6() day
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If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 7) Then
                                    Wait s13i7() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 8) Then
                                    Wait s13i8() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 9) Then
                                    Wait s13i9() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 10) Then
                                    Wait s13i10() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 11) Then
                                    Wait s13i11() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 12) Then
                                    Wait s13i12() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 13) Then
                                    Wait s13i13() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 14) Then
                                    Wait s13i14() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 15) Then
                                    Wait s13i15() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 16) Then
                                    Wait s13i16() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 17) Then
                                    Wait s13i17() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 18) Then
                                    Wait s13i18() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 19) Then
                                    Wait s13i19() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 20) Then
                                    Wait s13i20() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 21) Then
                                    Wait s13i21() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 22) Then
                                    Wait s13i22() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 23) Then
                                    Wait s13i23() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 24) Then
                                    Wait s13i24() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 25) Then
                                    Wait s13i25() day

If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 26) Then
                                    Wait s13i26() day
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                    If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 27) Then
                                        Wait s13i27() day

                    If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 28) Then
                                        Wait s13i28() day

                    If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 29) Then
                                        Wait s13i29() day

                    If (Patient_Scenario = 13) And (Patient_SurgicalTeam = 30) Then
                                        Wait s13i30() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 1) Then
                                        Wait s14i1() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 2) Then
                                        Wait s14i2() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 3) Then
                                        Wait s14i3() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 4) Then
                                        Wait s14i4() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 5) Then
                                        Wait s14i5() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 6) Then
                                        Wait s14i6() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 7) Then
                                        Wait s14i7() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 8) Then
                                        Wait s14i8() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 9) Then
                                        Wait s14i9() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 10) Then
                                        Wait s14i10() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 11) Then
                                        Wait s14i11() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 12) Then
                                        Wait s14i12() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 13) Then
                                        Wait s14i13() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 14) Then
                                        Wait s14i14() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 15) Then
                                        Wait s14i15() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 16) Then
                                        Wait s14i16() day

                    If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 17) Then
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                                    Wait s14i17() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 18) Then
                                    Wait s14i18() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 19) Then
                                    Wait s14i19() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 20) Then
                                    Wait s14i20() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 21) Then
                                    Wait s14i21() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 22) Then
                                    Wait s14i22() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 23) Then
                                    Wait s14i23() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 24) Then
                                    Wait s14i24() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 25) Then
                                    Wait s14i25() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 26) Then
                                    Wait s14i26() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 27) Then
                                    Wait s14i27() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 28) Then
                                    Wait s14i28() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 29) Then
                                    Wait s14i29() day

If (Patient_Scenario = 14) And (Patient_SurgicalTeam = 30) Then
                                    Wait s14i30() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 1) Then
                                    Wait s15i1() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 2) Then
                                    Wait s15i2() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 3) Then
                                    Wait s15i3() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 4) Then
                                    Wait s15i4() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 5) Then
                                    Wait s15i5() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 6) Then
                                    Wait s15i6() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 7) Then
                                    Wait s15i7() day
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If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 8) Then
                                    Wait s15i8() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 9) Then
                                    Wait s15i9() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 10) Then
                                    Wait s15i10() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 11) Then
                                    Wait s15i11() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 12) Then
                                    Wait s15i12() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 13) Then
                                    Wait s15i13() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 14) Then
                                    Wait s15i14() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 15) Then
                                    Wait s15i15() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 16) Then
                                    Wait s15i16() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 17) Then
                                    Wait s15i17() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 18) Then
                                    Wait s15i18() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 19) Then
                                    Wait s15i19() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 20) Then
                                    Wait s15i20() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 21) Then
                                    Wait s15i21() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 22) Then
                                    Wait s15i22() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 23) Then
                                    Wait s15i23() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 24) Then
                                    Wait s15i24() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 25) Then
                                    Wait s15i25() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 26) Then
                                    Wait s15i26() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 27) Then
                                    Wait s15i27() day
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If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 28) Then
                                    Wait s15i28() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 29) Then
                                    Wait s15i29() day

If (Patient_Scenario = 15) And (Patient_SurgicalTeam = 30) Then
                                    Wait s15i30() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 1) Then
                                    Wait s16i1() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 2) Then
                                    Wait s16i2() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 3) Then
                                    Wait s16i3() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 4) Then
                                    Wait s16i4() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 5) Then
                                    Wait s16i5() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 6) Then
                                    Wait s16i6() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 7) Then
                                    Wait s16i7() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 8) Then
                                    Wait s16i8() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 9) Then
                                    Wait s16i9() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 10) Then
                                    Wait s16i10() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 11) Then
                                    Wait s16i11() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 12) Then
                                    Wait s16i12() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 13) Then
                                    Wait s16i13() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 14) Then
                                    Wait s16i14() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 15) Then
                                    Wait s16i15() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 16) Then
                                    Wait s16i16() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 17) Then
                                    Wait s16i17() day

If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 18) Then
```

```
                                                    Wait s16i18() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 19) Then
                                                    Wait s16i19() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 20) Then
                                                    Wait s16i20() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 21) Then
                                                    Wait s16i21() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 22) Then
                                                    Wait s16i22() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 23) Then
                                                    Wait s16i23() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 24) Then
                                                    Wait s16i24() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 25) Then
                                                    Wait s16i25() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 26) Then
                                                    Wait s16i26() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 27) Then
                                                    Wait s16i27() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 28) Then
                                                    Wait s16i28() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 29) Then
                                                    Wait s16i29() day

                                If (Patient_Scenario = 16) And (Patient_SurgicalTeam = 30) Then
                                                    Wait s16i30() day
                                            1    Patient      Discharge          FIRST 1                          Graphic 3
 Patient      Discharge          Wait N(30,1) min     1    Patient      EXIT               FIRST 1


*****************************************************************************
*                                 Arrivals                                  *
*****************************************************************************

  Entity       Location      Qty Each   First Time                  Occurrences Frequency  Logic
  ------------ ------------- ---------- -------------------------- ----------- ---------- ------------
  PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1           1          PatientBatch_SurgicalTeam = 15
                                                                                           PatientBatch_OperatingRoom = 1
                                                                                           PatientBatch_DayofSurgery = 1
                                                                                           PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1           1          PatientBatch_SurgicalTeam = 5
                                                                                           PatientBatch_OperatingRoom = 2
                                                                                           PatientBatch_DayofSurgery = 1
                                                                                           PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1           1          PatientBatch_SurgicalTeam = 17
                                                                                           PatientBatch_OperatingRoom = 3
                                                                                           PatientBatch_DayofSurgery = 1
                                                                                           PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1           1          PatientBatch_SurgicalTeam = 26
                                                                                           PatientBatch_OperatingRoom = 4
```

```
                                                                                PatientBatch_DayofSurgery = 1
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 8
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 1
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 28
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 1
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 10
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 1
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 12
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 1
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 01 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 21
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 1
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 28
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 30
                                                                                PatientBatch_OperatingRoom = 2
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 18
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 17
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 14
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 10
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 16
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 21
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 02 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 22
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 2
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 2
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 3
```

```
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_Scenario = 1 + rand(15)
                                                                                        PatientBatch_SurgicalTeam = 4
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 14
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 21
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 24
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 11
                                                                                        PatientBatch_OperatingRoom = 6
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 25
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 13
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 03 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 19
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 3
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 26
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 5
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 23
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 1
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 7
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 6
                                                                                        PatientBatch_OperatingRoom = 6
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 19
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
```

```
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 12
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 04 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 29
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 4
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 14
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 1
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 12
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 15
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 18
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 9
                                                                                        PatientBatch_OperatingRoom = 6
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 6
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 25
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 05 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 26
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 5
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 9
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 8
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 5
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 8
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 7
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 8
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 25
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 8
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 17
```

```
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 8
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 10
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 8
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 15
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 8
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 8
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 8
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 08 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 21
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 8
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer            Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 10
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 30
                                                                                PatientBatch_OperatingRoom = 2
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 21
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 16
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 17
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 14
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 4
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 19
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 09 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 28
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 9
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 30
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 4
                                                                                PatientBatch_OperatingRoom = 2
```

```
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 11
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 21
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 23
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 2
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 5
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 25
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 10 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 24
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 10
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 25
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 11
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 5
                                                                                PatientBatch_OperatingRoom = 2
                                                                                PatientBatch_DayofSurgery = 11
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 7
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 11
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 29
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 11
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 1
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 11
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 26
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 11
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 19
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 11
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 12
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 11
```

```
PatientBatch ArrivalBuffer 1          Thu, Feb 11 2010 @ 06:00 AM 1          1          PatientBatch_Scenario = 1 + rand(15)
                                                                                        PatientBatch_SurgicalTeam = 23
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 11
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 23
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 3
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 15
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 12
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 18
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 9
                                                                                        PatientBatch_OperatingRoom = 6
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 14
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 26
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 12 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 1
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 12
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 15 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 7
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 15
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 15 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 5
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 15
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 15 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 28
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 15
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 15 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 11
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 15
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 15 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 15
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 15
                                                                                        PatientBatch_Scenario = 1 + rand(15)
```

```
2925 PatientBatch ArrivalBuffer 1         Mon, Feb 15 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 9
2926                                                                                       PatientBatch_OperatingRoom = 6
2927                                                                                       PatientBatch_DayofSurgery = 15
2928                                                                                       PatientBatch_Scenario = 1 + rand(15)
2929 PatientBatch ArrivalBuffer 1         Mon, Feb 15 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 10
2930                                                                                       PatientBatch_OperatingRoom = 7
2931                                                                                       PatientBatch_DayofSurgery = 15
2932                                                                                       PatientBatch_Scenario = 1 + rand(15)
2933 PatientBatch ArrivalBuffer 1         Mon, Feb 15 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 17
2934                                                                                       PatientBatch_OperatingRoom = 8
2935                                                                                       PatientBatch_DayofSurgery = 15
2936                                                                                       PatientBatch_Scenario = 1 + rand(15)
2937 PatientBatch ArrivalBuffer 1         Mon, Feb 15 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 25
2938                                                                                       PatientBatch_OperatingRoom = 9
2939                                                                                       PatientBatch_DayofSurgery = 15
2940                                                                                       PatientBatch_Scenario = 1 + rand(15)
2941 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 21
2942                                                                                       PatientBatch_OperatingRoom = 1
2943                                                                                       PatientBatch_DayofSurgery = 16
2944                                                                                       PatientBatch_Scenario = 1 + rand(15)
2945 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 30
2946                                                                                       PatientBatch_OperatingRoom = 2
2947                                                                                       PatientBatch_DayofSurgery = 16
2948                                                                                       PatientBatch_Scenario = 1 + rand(15)
2949 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 16
2950                                                                                       PatientBatch_OperatingRoom = 3
2951                                                                                       PatientBatch_DayofSurgery = 16
2952                                                                                       PatientBatch_Scenario = 1 + rand(15)
2953 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 26
2954                                                                                       PatientBatch_OperatingRoom = 4
2955                                                                                       PatientBatch_DayofSurgery = 16
2956                                                                                       PatientBatch_Scenario = 1 + rand(15)
2957 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 28
2958                                                                                       PatientBatch_OperatingRoom = 5
2959                                                                                       PatientBatch_DayofSurgery = 16
2960                                                                                       PatientBatch_Scenario = 1 + rand(15)
2961 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 14
2962                                                                                       PatientBatch_OperatingRoom = 6
2963                                                                                       PatientBatch_DayofSurgery = 16
2964                                                                                       PatientBatch_Scenario = 1 + rand(15)
2965 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 10
2966                                                                                       PatientBatch_OperatingRoom = 7
2967                                                                                       PatientBatch_DayofSurgery = 16
2968                                                                                       PatientBatch_Scenario = 1 + rand(15)
2969 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 17
2970                                                                                       PatientBatch_OperatingRoom = 8
2971                                                                                       PatientBatch_DayofSurgery = 16
2972                                                                                       PatientBatch_Scenario = 1 + rand(15)
2973 PatientBatch ArrivalBuffer 1         Tue, Feb 16 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 19
2974                                                                                       PatientBatch_OperatingRoom = 9
2975                                                                                       PatientBatch_DayofSurgery = 16
2976                                                                                       PatientBatch_Scenario = 1 + rand(15)
2977 PatientBatch ArrivalBuffer 1         Wed, Feb 17 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 5
2978                                                                                       PatientBatch_OperatingRoom = 1
2979                                                                                       PatientBatch_DayofSurgery = 17
2980                                                                                       PatientBatch_Scenario = 1 + rand(15)
2981 PatientBatch ArrivalBuffer 1         Wed, Feb 17 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 2
2982                                                                                       PatientBatch_OperatingRoom = 2
2983                                                                                       PatientBatch_DayofSurgery = 17
2984                                                                                       PatientBatch_Scenario = 1 + rand(15)
2985 PatientBatch ArrivalBuffer 1         Wed, Feb 17 2010 @ 06:00 AM 1          1         PatientBatch_SurgicalTeam = 18
```

```
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 17
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 17 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 7
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 17
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 17 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 21
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 17
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 17 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 1
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 17
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 17 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 28
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 17
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 17 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 11
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 17
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 17 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 4
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 17
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam =  28
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 1
                                                                                PatientBatch_OperatingRoom = 2
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 19
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 15
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 6
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 5
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 2
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 20
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 18 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 29
                                                                                PatientBatch_OperatingRoom = 9
```

```
                                                                                PatientBatch_DayofSurgery = 18
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 14
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 1
                                                                                PatientBatch_OperatingRoom = 2
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 9
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 18
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 26
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 16
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 27
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 12
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 19 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 25
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 19
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 17
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 22
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 5
                                                                                PatientBatch_OperatingRoom = 2
                                                                                PatientBatch_DayofSurgery = 22
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 10
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 22
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 11
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 22
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 25
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 22
                                                                                PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1  PatientBatch_SurgicalTeam = 15
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 22
```

```
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1          PatientBatch_Scenario = 1 + rand(15)
                                                                                        PatientBatch_SurgicalTeam = 7
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 22
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 9
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 22
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Mon, Feb 22 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 29
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 22
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 17
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 30
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 26
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 21
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 12
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 10
                                                                                        PatientBatch_OperatingRoom = 6
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 4
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 19
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Tue, Feb 23 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 28
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 23
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 21
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 30
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 2
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
```

```
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 6
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 25
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 11
                                                                                        PatientBatch_OperatingRoom = 6
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 17
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 28
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Wed, Feb 24 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 24
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 24
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 5
                                                                                        PatientBatch_OperatingRoom = 1
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 1
                                                                                        PatientBatch_OperatingRoom = 2
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 3
                                                                                        PatientBatch_OperatingRoom = 3
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 26
                                                                                        PatientBatch_OperatingRoom = 4
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 20
                                                                                        PatientBatch_OperatingRoom = 5
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 7
                                                                                        PatientBatch_OperatingRoom = 6
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 19
                                                                                        PatientBatch_OperatingRoom = 7
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 12
                                                                                        PatientBatch_OperatingRoom = 8
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Thu, Feb 25 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 23
                                                                                        PatientBatch_OperatingRoom = 9
                                                                                        PatientBatch_DayofSurgery = 25
                                                                                        PatientBatch_Scenario = 1 + rand(15)
PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 14
```

```
                                                                                PatientBatch_OperatingRoom = 1
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 1
                                                                                PatientBatch_OperatingRoom = 2
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 26
                                                                                PatientBatch_OperatingRoom = 3
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 9
                                                                                PatientBatch_OperatingRoom = 4
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 6
                                                                                PatientBatch_OperatingRoom = 5
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 12
                                                                                PatientBatch_OperatingRoom = 6
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 18
                                                                                PatientBatch_OperatingRoom = 7
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 15
                                                                                PatientBatch_OperatingRoom = 8
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)
  PatientBatch ArrivalBuffer 1          Fri, Feb 26 2010 @ 06:00 AM 1          1          PatientBatch_SurgicalTeam = 25
                                                                                PatientBatch_OperatingRoom = 9
                                                                                PatientBatch_DayofSurgery = 26
                                                                                PatientBatch_Scenario = 1 + rand(15)


************************************************************************
*                          Shift Assignments                           *
************************************************************************

  Locations... Resources...     Calendar File... Priorities... Disable Logic...
  ------------ ---------------- --------------- ------------- ------- ------------------
               OperatingRoom_1  ORcalendar.pmcal 99,99,99,99   No
               OperatingRoom_2
               OperatingRoom_3
               OperatingRoom_4
               OperatingRoom_5
               OperatingRoom_6
               OperatingRoom_7
               OperatingRoom_8
               OperatingRoom_9
               Surgical_Team_1
               Surgical_Team_10
               Surgical_Team_11
               Surgical_Team_12
               Surgical_Team_13
               Surgical_Team_14
               Surgical_Team_15
               Surgical_Team_16
               Surgical_Team_17
```

```
               Surgical_Team_18
               Surgical_Team_19
               Surgical_Team_2
               Surgical_Team_20
               Surgical_Team_21
               Surgical_Team_22
               Surgical_Team_23
               Surgical_Team_24
               Surgical_Team_25
               Surgical_Team_26
               Surgical_Team_27
               Surgical_Team_28
               Surgical_Team_29
               Surgical_Team_3
               Surgical_Team_30
               Surgical_Team_4
               Surgical_Team_5
               Surgical_Team_6
               Surgical_Team_7
               Surgical_Team_8
               Surgical_Team_9


*****************************************************************************
*                                Attributes                                 *
*****************************************************************************

  ID                        Type         Classification
  ------------------------- ------------ --------------
  PatientBatch_Scenario     Integer      Entity
  Patient_Scenario          Integer      Entity
  PatientBatch_SurgicalTeam Integer      Entity
  Patient_SurgicalTeam      Integer      Entity
  PatientBatch_OperatingRoom Integer     Entity
  Patient_OperatingRoom     Integer      Entity
  PatientBatch_DayofSurgery Integer      Entity
  Patient_DayofSurgery      Integer      Entity


*****************************************************************************
*                                 Arrays                                    *
*****************************************************************************

  ID                      Dimensions   Type         Import File         Export File Disable        Persist
  ----------------------- ------------ ------------ ------------------- ----------- -------------- --------------------------------
  A                       30,16        Real         simulationdata.xlsx             None           No
  maximumNumberOfPatients 30,16        Integer      simulationdata.xlsx             None           No


*****************************************************************************
*                            User Distributions                             *
*****************************************************************************

  ID         Type         Cumulative   Percentage             Value
  ---------- ------------ ------------ ---------------------- ------------
  s1i1       Discrete     No           33.1051745879108       0day
                                       33.318534832404        1day
                                       33.5762905796852       2day
  s1i2       Discrete     No           16.7641467972294       0day
                                       16.6902703421826       1day
```

				16.2785635181429	2day
				16.5680763289729	3day
				16.9982580820921	4day
				16.7006849313802	5day
	s1i3	Discrete	No	31.4014218354058000	0day
				33.7276495147772	1day
				34.870928649817	2day
	s1i4	Discrete	No	24.8006347452137	0day
				25.6774441182768	1day
				24.3448533757185	2day
				25.177067760791	3day
	s1i5	Discrete	No	24.607972385488	0day
				24.6469413456395	1day
				25.3700760179004	2day
				25.3750102509721	3day
	s1i6	Discrete	No	33.9644776326125	0day
				32.7238725245386	1day
				33.311649842849	2day
	s1i7	Discrete	No	25.2279398295615	0day
				25.123037297746	1day
				25.2213813697123	2day
				24.4276415029802	3day
	s1i8	Discrete	No	52.564528993973	0day
				47.435471006027	1day
	s1i9	Discrete	No	25.42245173625	0day
				25.3193125437274	1day
				24.6591309302351	2day
				24.5991047897875	3day
	s1i10	Discrete	No	20.0833199908548	0day
				19.7964282434059	1day
				20.1980748883227	2day
				20.2283490137011	3day
				19.6938278637154	4day
	s1i11	Discrete	No	34.3321511152545	0day
				32.7307921024526	1day
				32.9370567822929	2day
	s1i12	Discrete	No	100	0day
	s1i13	Discrete	No	33.0939793631048	0day
				34.479396285432	1day
				32.4266243514632	2day
	s1i14	Discrete	No	50.5165817246744	0day
				49.4834182753256	1day
	s1i15	Discrete	No	19.8445662491549	0day
				19.4261618783574	1day
				20.3421057487247	2day
				20.5041633343608	3day
				19.8830027894021	4day
	s1i16	Discrete	No	16.1591757265093	0day
				17.3031248493839	1day
				16.3021898446645	2day
				16.8143446137032	3day
				16.6034591191249	4day
				16.8177058466141	5day
	s1i17	Discrete	No	24.6931455414591	0day
				24.6205587714937	1day
				24.6416301761388	2day
				26.0446655109084	3day
	s1i18	Discrete	No	25.1070844783193	0day
				24.3766303273594	1day
				24.7857666707122	2day
				25.730518523609	3day

s1i19	Discrete	No	33.2380527327141	0day
			33.6599720853014	1day
			33.1019751819844	2day
s1i20	Discrete	No	25.0893141782455	0day
			24.0107235637528	1day
			25.091975795319	2day
			25.8079864626827	3day
s1i21	Discrete	No	19.778239351934	0day
			19.2459025773186	1day
			20.255096589772	2day
			19.9938022657153	3day
			20.7269592152602	4day
s1i22	Discrete	No	25.1109982433898	0day
			25.6351157127634	1day
			24.6969819831012	2day
			24.5569040607456	3day
s1i23	Discrete	No	16.4925605511723	0day
			16.5668591913936	1day
			16.8710763079242	2day
			16.8909948227076	3day
			16.3513845011373	4day
			16.827124625665	5day
s1i24	Discrete	No	16.3209621145789	0day
			17.3929073444032	1day
			16.50542032646	2day
			15.5826859536725	3day
			17.4485444298455	4day
			16.74947983104	5day
s1i25	Discrete	No	49.6619346019887	0day
			50.3380653980113	1day
s1i26	Discrete	No	25.719968863813	0day
			24.4148690004872	1day
			25.1767111676629	2day
			24.6884509680369	3day
s1i27	Discrete	No	25.4932787694904	0day
			25.0098983592752	1day
			24.4313095110717	2day
			25.0655133601627	3day
s1i28	Discrete	No	49.2114108192687	0day
			50.7885891807313	1day
s1i29	Discrete	No	16.0227674405706	0day
			16.7315345779971	1day
			16.6804140310763	2day
			17.4178930712871	3day
			16.6116658049711	4day
			16.5357250740978	5day
s1i30	Discrete	No	51.7514004277033	0day
			48.2485995722967	1day
s2i1	Discrete	No	100	0day
s2i2	Discrete	No	16.9360501107808	0day
			16.6542892504429	1day
			16.6612338788615	2day
			16.078489663391	3day
			16.9872768956176	4day
			16.6826602009062	5day
s2i3	Discrete	No	20.0220577075669	0day
			20.750604524976	1day
			19.6187817634775	2day
			20.2019852502052	3day
			19.4065707537744	4day
s2i4	Discrete	No	33.3228862701776	0day

				33.7964761185095	1day
				32.880637611313	2day
	s2i5	Discrete	No	25.482475620314	0day
				24.7175306630821	1day
				24.9786656278845	2day
				24.8213280887194	3day
	s2i6	Discrete	No	100	0day
	s2i7	Discrete	No	49.3771844704967	0day
				50.6228155295033	1day
	s2i8	Discrete	No	50.0835047819671	0day
				49.9164952180329	1day
	s2i9	Discrete	No	49.8994111110809	0day
				50.1005888889191	1day
	s2i10	Discrete	No	32.8053466175867	0day
				34.1221198051951	1day
				33.0725335772182	2day
	s2i11	Discrete	No	16.6334528852338000000000%	0day
				16.8832877538840000000000%	1day
				16.6500445737656000000000%	2day
				16.4156203585730000000000%	3day
				16.9858646937263000000000%	4day
				16.4317297348173000000000%	5day
	s2i12	Discrete	No	24.9966215134944	0day
				25.0690591767834	1day
				24.5933319985242	2day
				25.3409873111979	3day
	s2i13	Discrete	No	19.9076145993101	0day
				19.9842934943149	1day
				19.9901660519269	2day
				19.7725026594794	3day
				20.3454231949687	4day
	s2i14	Discrete	No	20.0623131095582	0day
				19.944716674797	1day
				19.7997893251763	2day
				19.7734392677011	3day
				20.4197416227675	4day
	s2i15	Discrete	No	16.7041867840328	0day
				16.4531234188641	1day
				16.5692905495551	2day
				17.094069213444	3day
				16.1346057567711	4day
				17.044724277333	5day
	s2i16	Discrete	No	50.7292521649273	0day
				49.2707478350727000000000%	1day
	s2i17	Discrete	No	16.7806379394092	0day
				16.5677522047729	1day
				16.3688743579573	2day
				16.8092723900563	3day
				16.770637912499	4day
				16.7028251953051	5day
	s2i18	Discrete	No	50.0818357492525	0day
				49.9181642507475	1day
	s2i19	Discrete	No	19.845174362239	0day
				20.5396621780198	1day
				20.2023389321986	2day
				19.5814368692158	3day
				19.8313876583269	4day
	s2i20	Discrete	No	19.7475738514698	0day
				20.046538520653	1day
				19.7184893107365	2day
				20.398964065784	3day

				20.0884342513568	4day
	s2i21	Discrete	No	50.9764397830425	0day
				49.0235602169575	1day
	s2i22	Discrete	No	25.0418315115393	0day
				25.2665405650978	1day
				24.658242024079	2day
				25.0333858992838	3day
	s2i23	Discrete	No	33.5991050090216	0day
				33.2853039698596	1day
				33.1155910211189	2day
	s2i24	Discrete	No	33.7765422560726	0day
				32.7664893078052	1day
				33.4569684361222	2day
	s2i25	Discrete	No	25.1680357263732	0day
				24.6307915873609	1day
				25.2132082195884	2day
				24.9879644666775	3day
	s2i26	Discrete	No	16.6771954338683	0day
				16.4838160414925	1day
				16.8601810035471	2day
				16.5667894001283	3day
				16.8415023137189	4day
				16.5705158072449	5day
	s2i27	Discrete	No	100	0day
	s2i28	Discrete	No	25.0624255375633	0day
				24.6004251580916	1day
				25.170460520802	2day
				25.1666887835431	3day
	s2i29	Discrete	No	25.2579753309248	0day
				24.8204905001769	1day
				25.4258723657238	2day
				24.4956618031745	3day
	s2i30	Discrete	No	32.9752202667347	0day
				32.8212984138348	1day
				34.2034813194305	2day
	s3i1	Discrete	No	20.0361595791713	0day
				19.9473474143028	1day
				20.1642684598568	2day
				20.0222462132993	3day
				19.8299783333698	4day
	s3i2	Discrete	No	32.8769402883526	0day
				33.3796869673693	1day
				33.7433727442781	2day
	s3i3	Discrete	No	16.7124585838174	0day
				16.5585172798918	1day
				16.6572363054957	2day
				16.7954635214517	3day
				16.7582514148649	4day
				16.5180728944785	5day
	s3i4	Discrete	No	100	0day
	s3i5	Discrete	No	49.640110851808	0day
				50.359889148192	1day
	s3i6	Discrete	No	100	0day
	s3i7	Discrete	No	20.1182021215628	0day
				19.9475862132679	1day
				19.9169366645972	2day
				20.0202871159806	3day
				19.9969878845914	4day
	s3i8	Discrete	No	16.8288844738073	0day
				16.5015513058006	1day
				16.6290785879071	2day

				16.8295146014181	3day
				16.7549279162411	4day
				16.4560431148259	5day
	s3i9	Discrete	No	16.6049599138972	0day
				16.9779210702807	1day
				16.6651480356827	2day
				16.6978830129269	3day
				16.5225946957736	4day
				16.5314932714389	5day
	s3i10	Discrete	No	24.6824009117885	0day
				25.0249988630138	1day
				25.0376130621925	2day
				25.2549871630052	3day
	s3i11	Discrete	No	49.8188198335622	0day
				50.1811801664378	1day
	s3i12	Discrete	No	20.1207628986008	0day
				19.7084493051291	1day
				19.8042760530303	2day
				20.2895714358606	3day
				20.0769403073792	4day
	s3i13	Discrete	No	20.1765198382883	0day
				19.7451824704407	1day
				20.0307316916887	2day
				20.3007100795353	3day
				19.7468559200469	4day
	s3i14	Discrete	No	16.572943504001	0day
				16.6578765644444	1day
				16.6553454729556	2day
				16.5641095573691	3day
				16.7609236699893	4day
				16.7888012312405	5day
	s3i15	Discrete	No	20.2021155873719	0day
				19.7945708841236	1day
				19.648903638525	2day
				20.4046155771237	3day
				19.9497943128558	4day
	s3i16	Discrete	No	25.1853503584506	0day
				24.8700387738893	1day
				25.0389290201063	2day
				24.9056818475539	3day
	s3i17	Discrete	No	16.5916586898253	0day
				16.8865685126072	1day
				16.4584941219854	2day
				16.5638130664422	3day
				16.7355407279774	4day
				16.7639248811626	5day
	s3i18	Discrete	No	100	0day
	s3i19	Discrete	No	50.3270039040248	0day
				49.6729960959752	1day
	s3i20	Discrete	No	49.7645187453722	0day
				50.2354812546278	1day
	s3i21	Discrete	No	33.1311262058833	0day
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				33.5143051158893	2day
	s3i22	Discrete	No	24.7710500212556	0day
				25.0095003195112	1day
				25.2505488358609	2day
				24.9689008233723	3day
	s3i23	Discrete	No	100	0day
	s3i24	Discrete	No	25.2529652518391	0day
				25.1635617221058	1day

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				24.7278783669649	3day
	s3i25	Discrete	No	20.336768069417	0day
				19.9858635862269	1day
				19.7550957528429	2day
				19.8792683722656	3day
				20.0430042192476	4day
	s3i26	Discrete	No	50.0669204696941	0day
				49.9330795303059	1day
	s3i27	Discrete	No	16.6166141484961	0day
				16.7801585104305	1day
				16.6486450541957	2day
				16.7587422188617	3day
				16.68679072002	4day
				16.509049347994	5day
	s3i28	Discrete	No	100	0day
	s3i29	Discrete	No	16.9172335043898	0day
				16.3248642589308	1day
				16.9325609180201	2day
				16.5894305248259	3day
				16.6414591800625	4day
				16.5944516137708	5day
	s3i30	Discrete	No	33.232096602461	0day
				33.4405460234199	1day
				33.3273573741191	2day
	s4i1	Discrete	No	100	0day
	s4i2	Discrete	No	100	0day
	s4i3	Discrete	No	20.0428837359469	0day
				19.9536313640158	1day
				19.9873895104057	2day
				19.9210470003142	3day
				20.0950483893173	4day
	s4i4	Discrete	No	49.7207649682348	0day
				50.2792350317651	1day
	s4i5	Discrete	No	20.2082647296455	0day
				19.9421411328695	1day
				20.0906186591904	2day
				19.7152263897463	3day
				20.0437490885482	4day
	s4i6	Discrete	No	24.643419335589	0day
				24.8838703103428	1day
				25.2222527148112	2day
				25.250457639257	3day
	s4i7	Discrete	No	32.9905753218997	0day
				33.3742775243334	1day
				33.6351471537669	2day
	s4i8	Discrete	No	100	0day
	s4i9	Discrete	No	20.1587043604761	0day
				19.8048943581986	1day
				20.1434627185065	2day
				20.0073886411689	3day
				19.8855499216498	4day
	s4i10	Discrete	No	33.6067683922517	0day
				33.2669347884912	1day
				33.1262968192572	2day
	s4i11	Discrete	No	33.1253013614914	0day
				33.3882249970731	1day
				33.4864736414355	2day
	s4i12	Discrete	No	33.5405994492777000000000%	0day
				33.0713653291930000000%	1day
				33.3880640178030000000%	2day

s4i13	Discrete	No	16.5516860231895	0day
			16.6663953487243	1day
			16.7758834354989	2day
			16.6217580111856	3day
			16.6657953688108	4day
			16.718481812591	5day
s4i14	Discrete	No	50.1858919151164	0day
			49.8141080848837	1day
s4i15	Discrete	No	33.5676052983551	0day
			33.160778473837	1day
			33.2716162278079	2day
s4i16	Discrete	No	33.2090453664538	0day
			33.4992741762794	1day
			33.2916804572667	2day
s4i17	Discrete	No	100	0day
s4i18	Discrete	No	50.5875373921802	0day
			49.4124626078198	1day
s4i19	Discrete	No	49.602126266325	0day
			50.397873733675	1day
s4i20	Discrete	No	19.7438595015983	0day
			19.725460963345	1day
			20.103551899963	2day
			20.1805536544481	3day
			20.2465739806455	4day
s4i21	Discrete	No	24.9894140084953	0day
			24.9127717261418	1day
			25.0483443689541	2day
			25.0494698964088	3day
s4i22	Discrete	No	19.9372822314145	0day
			19.9735664228189	1day
			20.1810572580314	2day
			19.686228951015	3day
			20.2218651367202	4day
s4i23	Discrete	No	20.0999659258178	0day
			20.0751187717707	1day
			19.8035601509742	2day
			20.1062015757445	3day
			19.9151535756928	4day
s4i24	Discrete	No	16.5610514418245	0day
			16.7304755632546	1day
			16.6904987343275	2day
			16.6716351200764	3day
			16.5137668743403	4day
			16.8325722661767	5day
s4i25	Discrete	No	100	0day
s4i26	Discrete	No	33.743971124479	0day
			33.3857839295663	1day
			32.8702449459547	2day
s4i27	Discrete	No	19.8885587791393	0day
			20.03191201608	1day
			20.0743525129411	2day
			20.0924033456444	3day
			19.9127733461951	4day
s4i28	Discrete	No	20.0507478004898	0day
			20.1325038292319	1day
			19.8893530529226	2day
			19.8536421336653	3day
			20.0737531836904	4day
s4i29	Discrete	No	16.792246793386	0day
			16.8586055074479	1day
			16.6003036537884	2day

				16.3836707800523	3day
				16.7261392925533	4day
				16.6390339727721	5day
	s4i30	Discrete	No	25.2376114125706	0day
				24.9328287079091	1day
				25.0288910328122	2day
				24.8006688467081	3day
	s5i1	Discrete	No	19.499696666419	0day
				20.2646025935285	1day
				20.5780481568236	2day
				20.1452347229963	3day
				19.5124178602326	4day
	s5i2	Discrete	No	33.65214186688	0day
				33.4423780556473	1day
				32.9054800774726	2day
	s5i3	Discrete	No	50.7330788578074	0day
				49.2669211421926	1day
	s5i4	Discrete	No	24.3088814921641	0day
				24.508507474094	1day
				25.4911134632166	2day
				25.6914975705253	3day
	s5i5	Discrete	No	16.7649070984711	0day
				16.2499134571583	1day
				16.4257907272434	2day
				16.8331132871649	3day
				16.6867819536563	4day
				17.039493476306	5day
	s5i6	Discrete	No	32.8895200384461	0day
				33.6987193088206	1day
				33.4117606527333	2day
	s5i7	Discrete	No	25.380322708935	0day
				24.896800304805	1day
				24.7396701840422	2day
				24.9832068022178	3day
	s5i8	Discrete	No	16.3115372903951	0day
				17.0334270268998	1day
				17.0788920666944	2day
				16.9211261053029	3day
				16.6340933099056	4day
				16.0209242008022	5day
	s5i9	Discrete	No	50.0323071282285	0day
				49.9676928717715	1day
	s5i10	Discrete	No	16.5121258538309	0day
				17.4501339803553	1day
				16.1254255109936	2day
				17.4934842228819	3day
				16.2924958663738	4day
				16.1263345655646	5day
	s5i11	Discrete	No	50.2968495081418	0day
				49.7031504918582	1day
	s5i12	Discrete	No	20.5161786957748	0day
				19.1685505816273	1day
				20.2761546453089	2day
				19.6195312370033	3day
				20.4195848402857	4day
	s5i13	Discrete	No	16.944546391639	0day
				17.1293287890542	1day
				16.4437448921225	2day
				16.4239608754781	3day
				16.8108671925933	4day
				16.247551859113	5day

s5i14	Discrete	No	100	0day
s5i15	Discrete	No	20.2562400062132	0day
			19.736069099345	1day
			20.2795116554116	2day
			19.7571322444631	3day
			19.9710469945671	4day
s5i16	Discrete	No	50.5884364861227	0day
			49.4115635138773	1day
s5i17	Discrete	No	100	0day
s5i18	Discrete	No	25.1359876161658	0day
			24.777007024045	1day
			25.4370485557466	2day
			24.6499568040426	3day
s5i19	Discrete	No	19.9811955608679	0day
			19.9336559160283	1day
			19.1736223987736	2day
			20.552049333952	3day
			20.3594767903782	4day
s5i20	Discrete	No	50.9044857661329	0day
			49.0955142338671	1day
s5i21	Discrete	No	24.3427423511048	0day
			24.557391474553	1day
			25.6256186869865	2day
			25.4742474873556	3day
s5i22	Discrete	No	31.9347286274385	0day
			34.634253517163	1day
			33.4310178553984	2day
s5i23	Discrete	No	100	0day
s5i24	Discrete	No	49.3814179803124	0day
			50.6185820196876	1day
s5i25	Discrete	No	33.1573745562165	0day
			33.95378286126	1day
			32.8888425825226	2day
s5i26	Discrete	No	16.3383937806154	0day
			16.9222059317387	1day
			16.4044396238984	2day
			16.9867834512496	3day
			16.4610427580284	4day
			16.8871344544694	5day
s5i27	Discrete	No	19.8978843496838	0day
			19.5265520933295	1day
			20.2444241644561	2day
			20.2598105643059	3day
			20.0713288282249	4day
s5i28	Discrete	No	100	0day
s5i29	Discrete	No	100	0day
s5i30	Discrete	No	33.8905751960537	0day
			32.9935530009963	1day
			33.1158718029499	2day
s6i1	Discrete	No	32.8922089888054	0day
			33.481874764393	1day
			33.6259162468016	2day
s6i2	Discrete	No	49.1543066285828	0day
			50.8456933714172	1day
s6i3	Discrete	No	20.4437097886591	0day
			20.2988362897534	1day
			19.7339102806029	2day
			19.3105170470111	3day
			20.2130265939735	4day
s6i4	Discrete	No	16.8495379401498	0day
			16.4410276131959	1day

				16.3042336985395	2day
				16.7515559427288	3day
				16.7521767042182	4day
				16.9014681011677	5day
	s6i5	Discrete	No	19.7655916694986	0day
				19.8442381743964	1day
				19.8953425869867	2day
				20.36172557531	3day
				20.1331019938083	4day
	s6i6	Discrete	No	25.003411630044	0day
				24.5187639351471	1day
				24.9280285555883	2day
				25.5497958792206	3day
	s6i7	Discrete	No	100	0day
	s6i8	Discrete	No	33.469979565007	0day
				32.9529242777863	1day
				33.5770961572067	2day
	s6i9	Discrete	No	33.8905011897976	0day
				33.0008524584375	1day
				33.1086463517649	2day
	s6i10	Discrete	No	19.7077665374839	0day
				19.9223949608578	1day
				20.2778411705867	2day
				19.5443387321759	3day
				20.5476585988957	4day
	s6i11	Discrete	No	32.8292446812282	0day
				34.049937085929	1day
				33.1208182328428	2day
	s6i12	Discrete	No	33.919381808661	0day
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				33.1661923469593	2day
	s6i13	Discrete	No	100	0day
	s6i14	Discrete	No	100	0day
	s6i15	Discrete	No	50.1528649625935	0day
				49.8471350374065	1day
	s6i16	Discrete	No	33.3282946149912	0day
				33.498042676227	1day
				33.1736627087818	2day
	s6i17	Discrete	No	33.0902358642641	0day
				33.7961482145418	1day
				33.1136159211941	2day
	s6i18	Discrete	No	20.3982250587597	0day
				20.2780943610506	1day
				19.9586879275124	2day
				19.6377584988047	3day
				19.7272341538727	4day
	s6i19	Discrete	No	16.8195450490001	0day
				16.9208419429296	1day
				16.6216138695107	2day
				16.2472637210403	3day
				16.6893537849191	4day
				16.7013816326002	5day
	s6i20	Discrete	No	16.2545489700512	0day
				16.9318283720317	1day
				16.7156079356643	2day
				16.7901533990991	3day
				16.9086274878288	4day
				16.3992338353249	5day
	s6i21	Discrete	No	19.9926413145809	0day
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				20.0869930470806	2day

				20.4129374106407	3day
				20.2139604180081	4day
	s6i22	Discrete	No	20.1000634126205	0day
				20.2602630662804	1day
				20.235232128362	2day
				19.1849675094978	3day
				20.2194738832394	4day
	s6i23	Discrete	No	16.724176335182	0day
				16.569387639649	1day
				16.6438584057739	2day
				16.6469898590059	3day
				16.7771595248964	4day
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	s6i24	Discrete	No	25.6143762788842	0day
				24.3750038947827	1day
				24.947463495698	2day
				25.063156330635	3day
	s6i25	Discrete	No	25.6318099152757	0day
				24.863988770594	1day
				24.8136730549965	2day
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	s6i26	Discrete	No	24.7831137808997	0day
				24.8964358688789	1day
				25.2377998916735	2day
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	s6i27	Discrete	No	34.7224891991855	0day
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				32.9115740725644	2day
	s6i28	Discrete	No	19.2983172329394	0day
				20.4102635078504	1day
				20.3394009938673	2day
				19.9921910421104	3day
				19.9598272232325	4day
	s6i29	Discrete	No	16.4521947794454	0day
				16.8350971771807	1day
				16.7803299998716	2day
				16.5124292000241	3day
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				16.7705484978794	5day
	s6i30	Discrete	No	50.0783192999608	0day
				49.9216807000392	1day
	s7i1	Discrete	No	49.9327608197561	0day
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	s7i2	Discrete	No	20.3979990351597	0day
				20.0661949835623	1day
				19.9378365991274	2day
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				19.8457367865392	4day
	s7i3	Discrete	No	50.2127340081055	0day
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	s7i4	Discrete	No	25.259265986541	0day
				24.8437869693256	1day
				24.8720027454667	2day
				25.0249442986667	3day
	s7i5	Discrete	No	16.5166189734752	0day
				16.5350067755943	1day
				16.6896536561318	2day
				16.7927706316344	3day
				16.6382656455388	4day
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	s7i6	Discrete	No	16.4073998960352	0day

				16.9734079534502	1day
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	s7i7	Discrete	No	33.6894413985965	0day
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				33.1257476095755	2day
	s7i8	Discrete	No	24.8172642641467	0day
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				24.8945301776683	3day
	s7i9	Discrete	No	100	0day
	s7i10	Discrete	No	25.1183427969461	0day
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	s7i11	Discrete	No	16.8090490597037	0day
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				16.8203686630133	4day
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	s7i12	Discrete	No	19.9316675928154	0day
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				20.1176296382992	2day
				19.9945130522848	3day
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	s7i13	Discrete	No	25.0367082119973	0day
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	s7i14	Discrete	No	25.3361269455401	0day
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	s7i15	Discrete	No	49.9280636276675	0day
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	s7i16	Discrete	No	24.9266768250787	0day
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	s7i17	Discrete	No	49.7522454523404	0day
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	s7i18	Discrete	No	25.18315634341	0day
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	s7i19	Discrete	No	100	0day
	s7i20	Discrete	No	24.702507058359	0day
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	s7i21	Discrete	No	50.050392855491	0day
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	s7i22	Discrete	No	25.1120393690771	0day
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	s7i23	Discrete	No	19.8909185285775	0day
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	s7i24	Discrete	No	50.3759669646473	0day
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	s7i26	Discrete	No	100	0day
	s7i27	Discrete	No	16.6588661139001	0day
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				16.8825637331482	3day
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	s7i28	Discrete	No	49.3646444420002	0day
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	s7i29	Discrete	No	19.7186683164162	0day
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	s7i30	Discrete	No	24.9592475394239	0day
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	s8i1	Discrete	No	100	0day
	s8i2	Discrete	No	100	0day
	s8i3	Discrete	No	49.752022201815	0day
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	s8i4	Discrete	No	100	0day
	s8i5	Discrete	No	16.8503598270544	0day
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				16.6182526322768	5day
	s8i6	Discrete	No	100	0day
	s8i7	Discrete	No	100	0day
	s8i8	Discrete	No	100	0day
	s8i9	Discrete	No	33.5880732991412	0day
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	s8i10	Discrete	No	33.1650659035775	0day
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	s8i11	Discrete	No	19.8668269807034	0day
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s8i14	Discrete	No	25.1330995282951	0day
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s8i15	Discrete	No	100	0day
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s8i18	Discrete	No	16.9089790736503	0day
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s8i19	Discrete	No	33.2422487505029	0day
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s8i20	Discrete	No	50.077985328395	0day
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s8i21	Discrete	No	24.9217752734514	0day
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s8i22	Discrete	No	100	0day
s8i23	Discrete	No	49.5562661789265	0day
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s8i26	Discrete	No	49.7319793033579	0day
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s8i27	Discrete	No	33.333649486831	0day
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s8i28	Discrete	No	100	0day
s8i29	Discrete	No	33.2003385990707	0day
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s8i30	Discrete	No	33.030295737574	0day
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s9i1	Discrete	No	34.5134547630157	0day
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			33.1472334254258	2day
s9i2	Discrete	No	20.1989430465325	0day
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			19.8625921400662	2day
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			20.2547877265418	4day
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			16.2581087336021	2day
			16.7696699664572	3day
			16.9893501052914	4day
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s9i4	Discrete	No	33.7050567351202	0day
			33.0984483095487	1day
			33.1964949553312	2day
s9i5	Discrete	No	19.7027283835171	0day
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	s9i6	Discrete	No	24.7096003371658	0day
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				25.3098192100552	2day
				25.5879401309559	3day
	s9i7	Discrete	No	25.0991415209587	0day
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				24.4974646315633	2day
				25.4528954220312	3day
	s9i8	Discrete	No	50.0339108467507	0day
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	s9i9	Discrete	No	20.6229338390309	0day
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	s9i10	Discrete	No	20.3467042219887	0day
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	s9i11	Discrete	No	49.7495707141584	0day
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	s9i12	Discrete	No	33.6510150415852	0day
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	s9i13	Discrete	No	48.978229827026	0day
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	s9i14	Discrete	No	17.0401659609663	0day
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	s9i15	Discrete	No	25.5946243928773	0day
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	s9i16	Discrete	No	20.43418615172050	0day
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	s9i17	Discrete	No	33.7111582611122	0day
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	s9i18	Discrete	No	100	0day
	s9i19	Discrete	No	20.4037963450583	0day
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	s9i20	Discrete	No	19.7036050556562	0day
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	s9i21	Discrete	No	16.6717672645892	0day
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	s9i25	Discrete	No	100	0day
	s9i26	Discrete	No	25.4564205500269	0day
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	s9i27	Discrete	No	25.1093660806173	0day
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	s9i28	Discrete	No	24.9288550437679	0day
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				24.2039917700846	3day
	s9i29	Discrete	No	100	0day
	s9i30	Discrete	No	24.7332697952217	0day
				25.0027841587126	1day
				24.9801954829072	2day
				25.2837505631585	3day
	s10i1	Discrete	No	100	0day
	s10i2	Discrete	No	100	0day
	s10i3	Discrete	No	24.70930574889	0day
				24.7884085005745	1day
				24.7229596017177	2day
				25.7793261488179	3day
	s10i4	Discrete	No	32.1731500627775	0day
				33.4958518454227	1day
				34.3309980917997	2day
	s10i5	Discrete	No	25.9287049973675	0day
				24.1632761224835	1day
				24.3192481772446	2day
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	s10i6	Discrete	No	24.7902604133879	0day
				25.3789236765835	1day
				25.2421802441541	2day
				24.5886356658745	3day
	s10i7	Discrete	No	51.463825906826	0day
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	s10i8	Discrete	No	19.7478745328728	0day
				19.8322376265655	1day
				19.9622586646108	2day
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	s10i9	Discrete	No	19.4198322592465	0day
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				19.9970906527169	3day
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	s10i10	Discrete	No	19.9978011847643	0day
				19.6091185188266	1day
				20.521917953376	2day
				19.6347291874498	3day
				20.2364331555832	4day
	s10i11	Discrete	No	24.330615065856	0day
				25.3263487720109	1day
				25.1171721306419	2day
				25.2258640314912	3day
	s10i12	Discrete	No	19.8786509845785	0day
				19.5561316553695	1day
				20.7510669117093	2day
				20.0797558921188	3day
				19.734394556224	4day
	s10i13	Discrete	No	33.2259185202684	0day
				32.8491317336461	1day
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	s10i14	Discrete	No	25.4519118838936	0day
				25.5066925581314	1day
				24.7234217297129	2day
				24.3179738282621	3day
	s10i15	Discrete	No	19.7907116330839	0day
				19.7318270696075	1day
				19.8272944189517	2day
				20.3947546730297	3day
				20.2554122053272	4day
	s10i16	Discrete	No	16.5193024440254	0day
				16.9912943911429	1day
				16.8007367610242	2day
				16.7062346752512	3day
				16.419915355857	4day
				16.5625163726995	5day
	s10i17	Discrete	No	49.0052135156286	0day
				50.9947864843714	1day
	s10i18	Discrete	No	100	0day
	s10i19	Discrete	No	100	0day
	s10i20	Discrete	No	19.8798792355209	0day
				19.4089334832743	1day
				19.9454314244097	2day
				20.126489374343	3day
				20.639266482452	4day
	s10i21	Discrete	No	49.4442686555373	0day
				50.5557313444627	1day
	s10i22	Discrete	No	100	0day
	s10i23	Discrete	No	20.1765302162208	0day
				20.0724990992579	1day
				19.9612723052878	2day
				19.9715022704084	3day
				19.8181961088251	4day
	s10i24	Discrete	No	100	0day
	s10i25	Discrete	No	34.2251826723757	0day
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				33.978566565438	2day
	s10i26	Discrete	No	100	0day
	s10i27	Discrete	No	33.2939088075148	0day
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				33.4669269466442	2day
	s10i28	Discrete	No	24.7252911710428	0day

				25.2697981795845	1day
				25.031239604005	2day
				24.9736710453677	3day
	s10i29	Discrete	No	25.2657221336552	0day
				24.6998130889439	1day
				25.0451368202495	2day
				24.9893279571513	3day
	s10i30	Discrete	No	100	0day
	s11i1	Discrete	No	20.0169876779386	0day
				20.3899748923051	1day
				19.8791652262361	2day
				20.0286655794848	3day
				19.6852066240355	4day
	s11i2	Discrete	No	24.5848098822648	0day
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				25.0319654522713	2day
				25.2219209773304	3day
	s11i3	Discrete	No	25.1131996647443	0day
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				24.8734997763367	2day
				24.9307820225061	3day
	s11i4	Discrete	No	100	0day
	s11i5	Discrete	No	16.4030077170352	0day
				16.4421663559571	1day
				16.8626028591885	2day
				16.5981200437473	3day
				16.7840186996083	4day
				16.9100843244636	5day
	s11i6	Discrete	No	50.0547782784406	0day
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	s11i7	Discrete	No	50.1581075500211	0day
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	s11i8	Discrete	No	100	0day
	s11i9	Discrete	No	24.9985107258792	0day
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				24.9022031146945	2day
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	s11i10	Discrete	No	19.6070677672831	0day
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				20.2820699417966	2day
				20.0028680619268	3day
				20.054391204301	4day
	s11i11	Discrete	No	100	0day
	s11i12	Discrete	No	16.7928659184015	0day
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				16.4425368425659	2day
				16.8364341177655	3day
				16.5772208983446	4day
				16.6846735750845	5day
	s11i13	Discrete	No	19.9644846232274	0day
				19.8910296939151	1day
				20.0022208208087	2day
				19.911904730073	3day
				20.2303601319758	4day
	s11i14	Discrete	No	24.7531027019525	0day
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				25.3351338857131	2day
				24.5655457807387	3day
	s11i15	Discrete	No	25.1666414557872	0day
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	s11i16	Discrete	No	19.8282005262178	0day
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				20.28102165451710	2day
				19.8957161064174	3day
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	s11i17	Discrete	No	100	0day
	s11i18	Discrete	No	100	0day
	s11i19	Discrete	No	33.5848393450229	0day
				33.5799445121086	1day
				32.8352161428685	2day
	s11i20	Discrete	No	49.6527026029597	0day
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	s11i21	Discrete	No	25.0116693742031	0day
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	s11i22	Discrete	No	50.0713113550401	0day
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	s11i23	Discrete	No	33.3679749879232	0day
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	s11i24	Discrete	No	16.5217731201147	0day
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	s11i25	Discrete	No	19.8248400529943	0day
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				19.9628407984467	2day
				20.0824421510548	3day
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	s11i26	Discrete	No	16.7230897129474	0day
				16.7522514531548	1day
				16.5635399108351	2day
				16.5256619178553	3day
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	s11i27	Discrete	No	24.5712572243823	0day
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				25.008218374653	3day
	s11i28	Discrete	No	25.048490049451	0day
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				24.8430896422977	2day
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	s11i29	Discrete	No	50.4930275754955	0day
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	s11i30	Discrete	No	33.6709470732915	0day
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	s12i1	Discrete	No	16.6608480608833	0day
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	s12i2	Discrete	No	49.9503746749197	0day
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	s12i3	Discrete	No	100	0day

s12i4	Discrete	No	20.3401563222602	0day
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s12i5	Discrete	No	100	0day
s12i6	Discrete	No	50.1366686441137	0day
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s12i7	Discrete	No	50.2877245338588	0day
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s12i8	Discrete	No	16.6101476645924	0day
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			16.5454118693362	2day
			16.7860805256946	3day
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			16.599016410722	5day
s12i9	Discrete	No	100	0day
s12i10	Discrete	No	16.8917331137539	0day
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			16.671591699756	3day
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s12i11	Discrete	No	16.53560987060580	0day
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			16.9917193518245	2day
			16.5119661003428	3day
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			16.6502042529736	5day
s12i12	Discrete	No	20.0021740729324	0day
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			19.8663562428541	2day
			19.8751545046924	3day
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s12i13	Discrete	No	25.1363548718177	0day
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s12i15	Discrete	No	100	0day
s12i16	Discrete	No	100	0day
s12i17	Discrete	No	16.567420753222	0day
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			16.7102715458245	3day
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s12i18	Discrete	No	16.7454314629296	0day
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			16.5516927395349	2day
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s12i19	Discrete	No	49.8039436469171	0day
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s12i21	Discrete	No	49.8913073758424	0day
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	s12i25	Discrete	No	100	0day
	s12i26	Discrete	No	16.7597191636488	0day
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	s12i27	Discrete	No	25.0203942023604	0day
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	s12i28	Discrete	No	100	0day
	s12i29	Discrete	No	20.0662279624492	0day
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	s12i30	Discrete	No	25.0665333062598	0day
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	s13i1	Discrete	No	33.7843601787583	0day
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	s13i2	Discrete	No	19.2567244088338	0day
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	s13i3	Discrete	No	25.5636109607486	0day
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	s13i5	Discrete	No	34.4947068120996	0day
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	s13i7	Discrete	No	24.5682527637128	0day
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	s13i8	Discrete	No	17.3254359466664	0day
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	s13i10	Discrete	No	100	0day
	s13i11	Discrete	No	32.5160314226718	0day
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	s13i13	Discrete	No	33.2727136672847	0day
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	s13i14	Discrete	No	19.4101420852409	0day
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	s13i15	Discrete	No	33.3541383652236	0day
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	s13i16	Discrete	No	100	0day
	s13i17	Discrete	No	20.1599215374563	0day
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	s13i18	Discrete	No	20.3859643519045	0day
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	s13i19	Discrete	No	24.6284227217456	0day
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	s13i20	Discrete	No	49.8764517951451	0day
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	s13i21	Discrete	No	50.5103305891974	0day
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	s13i22	Discrete	No	24.3495915086827	0day
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	s13i23	Discrete	No	50.8778278514871	0day
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	s13i24	Discrete	No	33.3581051489168	0day
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	s13i25	Discrete	No	24.29078266515	0day
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	s13i26	Discrete	No	16.9853976339351	0day
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	s13i27	Discrete	No	16.6096072563402	0day

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				16.6089217116832	5day
	s13i28	Discrete	No	25.1701442450244	0day
				24.1112110728458	1day
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	s13i29	Discrete	No	25.4146466849593	0day
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	s13i30	Discrete	No	25.3657228523684	0day
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	s14i1	Discrete	No	25.1726763387861	0day
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	s14i2	Discrete	No	100	0day
	s14i3	Discrete	No	19.8057215884931	0day
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	s14i4	Discrete	No	20.0643156184251	0day
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	s14i5	Discrete	No	49.7515901296345	0day
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	s14i6	Discrete	No	25.6674300738416	0day
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	s14i7	Discrete	No	100	0day
	s14i8	Discrete	No	16.8485399729926	0day
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	s14i9	Discrete	No	25.0282554406215	0day
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				25.0159437405575	3day
	s14i10	Discrete	No	25.1073643476651	0day
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	s14i11	Discrete	No	20.2416589111749	0day
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	s14i12	Discrete	No	100	0day
	s14i13	Discrete	No	33.8383990832046	0day
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	s14i14	Discrete	No	25.461187857968	0day
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	s14i15	Discrete	No	48.9803023211696	0day
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	s14i16	Discrete	No	20.379251301678	0day
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				19.8821999951471	3day
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	s14i17	Discrete	No	49.4394806885865	0day
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	s14i18	Discrete	No	49.5490572474896	0day
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	s14i19	Discrete	No	100	0day
	s14i20	Discrete	No	100	0day
	s14i21	Discrete	No	20.2938646801459	0day
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	s14i22	Discrete	No	49.5182655863532	0day
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	s14i23	Discrete	No	19.8449845530882	0day
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				20.229651671664	3day
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	s14i24	Discrete	No	17.0876231068307	0day
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				16.3892245429159	3day
				16.6953667106787	4day
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	s14i25	Discrete	No	16.6822988768103	0day
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				16.7269885275274	3day
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				16.8232077656969	5day
	s14i26	Discrete	No	49.6243965216286	0day
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	s14i27	Discrete	No	17.0251974329217	0day
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				16.1839897032084	3day
				16.5613462604464	4day
				16.6024767427334	5day
	s14i28	Discrete	No	19.9340712773727	0day
				19.8037818615896	1day
				19.8985807072122	2day
				19.9298832145206	3day
				20.4336829393049	4day
	s14i29	Discrete	No	100	0day
	s14i30	Discrete	No	100	0day
	s15i1	Discrete	No	100	0day
	s15i2	Discrete	No	33.0169477612647	0day
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				33.240102745712	2day

s15i3	Discrete	No	25.0815428494156	0day
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			25.0534289684396	2day
			25.5530468294713	3day
s15i4	Discrete	No	16.6608576135675	0day
			16.6716770365951	1day
			16.5772843325797	2day
			16.4826111925709	3day
			16.7183456641195	4day
			16.8892241605674	5day
s15i5	Discrete	No	24.982774247796	0day
			24.9370498651636	1day
			24.7806070106176	2day
			25.2995688764228	3day
s15i6	Discrete	No	24.825731170875	0day
			24.9416647519405	1day
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	s15i24	Discrete	No	20.3563137589761	0day
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	s15i27	Discrete	No	25.0158436513236	0day
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	s15i28	Discrete	No	19.7675580760376	0day
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	s15i29	Discrete	No	33.1772651446532	0day
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	s15i30	Discrete	No	100	0day
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(null)	Shift	ORcalendar.pmcal	

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