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Quality Nurse Scheduling

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Advisors:

Dr. Frances Grodzinsky, Dr. Samah Senbel, and Dr. Mary Dietmann

Hypothesis

If nurses can input their personal preferences, then the schedule can be based on fairness, which will result in increased nurse satisfaction and create a more productive work environment in hospitals.

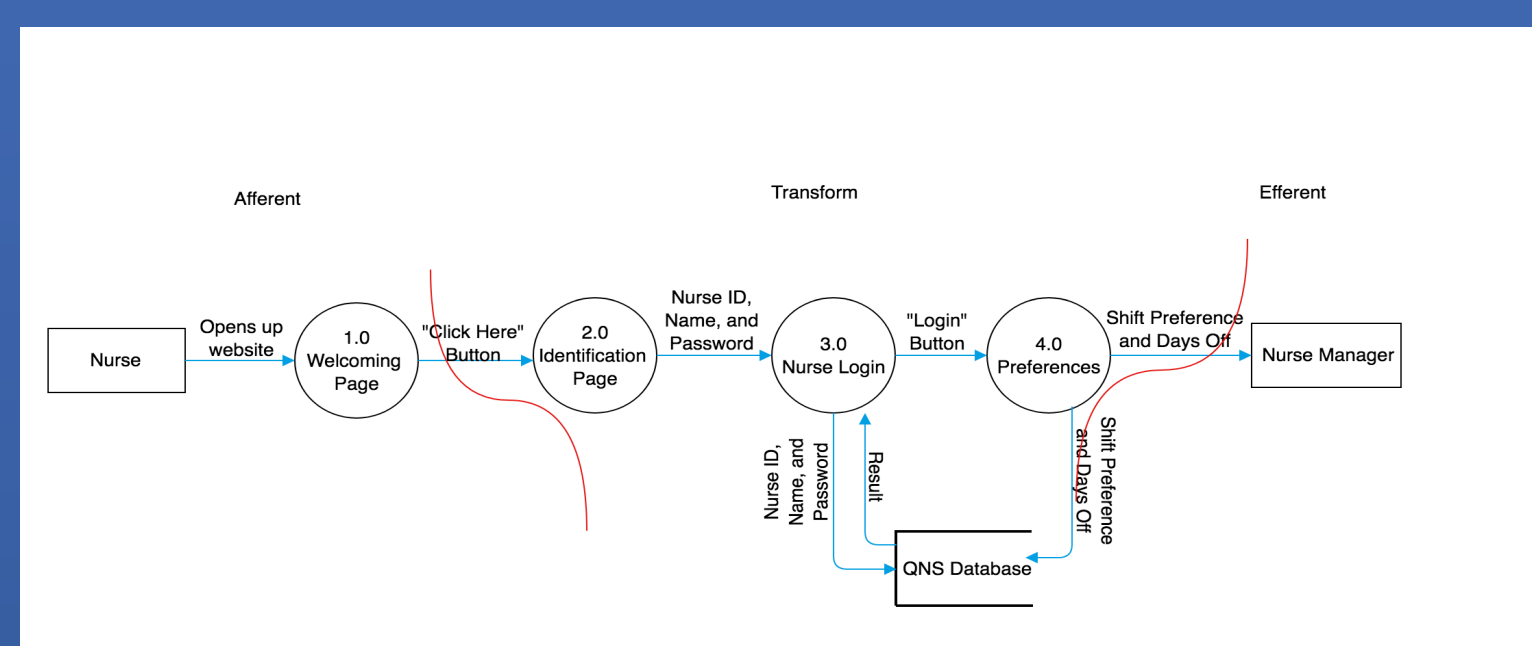
Proposal

Our goal is to create a website that will schedule nursing shifts fairly while also taking into account personal preferences of the nurses. We will conduct interviews with nursing professionals in order to understand the constraints of the environment and develop a product that satisfies the users. There are certain hard constraints that we must first consider; these are hospital rules such as minimum time between shifts and staffing requirements. We will then factor in soft constraints, such as fairness regarding distribution of day and night shifts. This will help create an environment wherein nurses feel they are respected and treated fairly. Our website will also allow nurses to input their preferences such as time off requests and whether they would prefer morning or evening shifts.

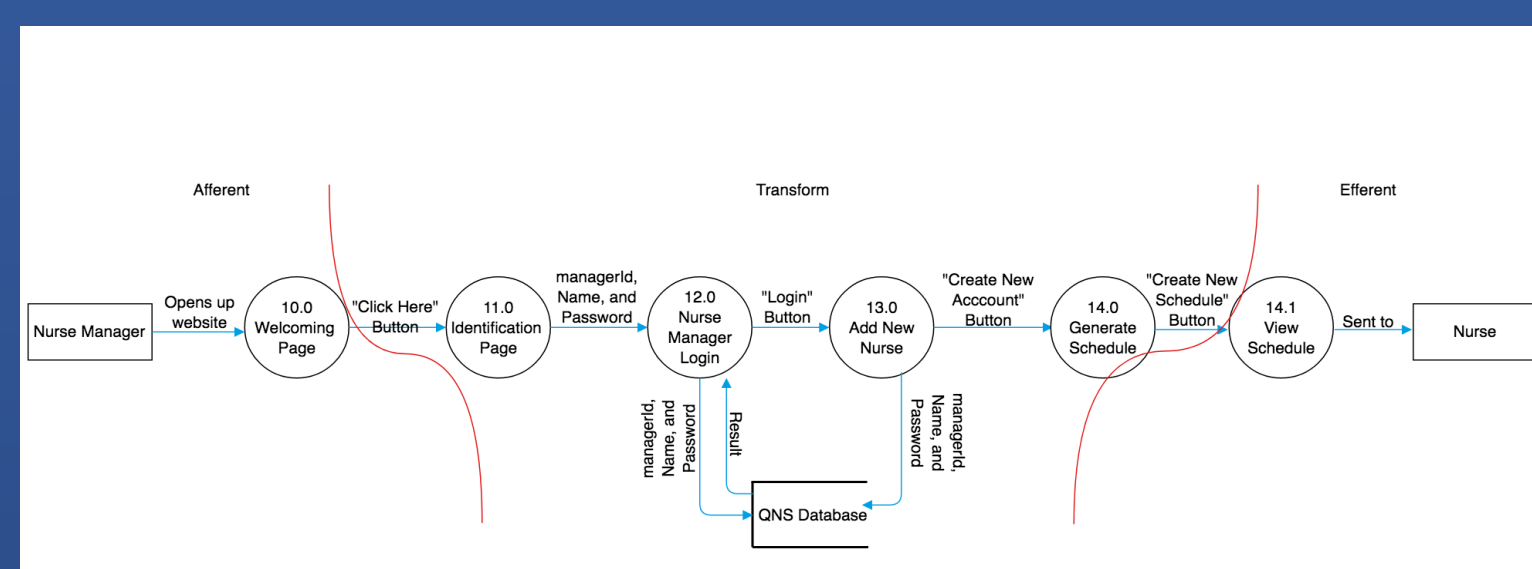
The nurse manager executes the function to create the schedule, and the scheduling mechanism will create thousands of possibilities and then select the optimal schedule. The finalized schedule will be saved to a text file, which the nurse manager can then edit and send out to the nursing staff. The nurse manager will also be able to create an account for new nurses.

We have chosen to code our website in HTML because it is the standard markup language for creating web pages. We will be using Java because it is currently one of the most popular programming languages in use, especially for client-server web applications. Furthermore, Java is portable and designed to have as few implementation dependencies as possible. Java is also compatible with Apache Derby, an open source relational database. Apache Derby is implemented entirely in Java and supports the client-server mode that this project will require. We will thoroughly test our program to ensure that it accomplishes our original goal of creating a fair schedule that also considers personal preferences of the nurses. We will allow nursing faculty at Sacred Heart University to test our program and provide feedback.

Nurse Data Flow Diagram



Nurse Manager Data Flow Diagram



Abstract

The nurse-scheduling problem has fascinated mathematicians, computer scientists, and nursing professionals alike for years. The aim of this project is to create a website that will schedule nursing shifts in a fair and humane way. The website will allow nurse managers to create a schedule that considers the wants and needs of all staff members. The website will be easily modifiable with an understandable user-interface. The scheduling mechanism used will factor in personal preferences such as time off and shift requests. The schedule will also ensure that nurses do not work consecutive shifts and that there is a fair distribution of shifts amongst all nurses. Furthermore, the scheduling program will eliminate personal bias or favoritism when creating the schedule. This will decrease conflict amongst nurses because the schedule is created with total objectivity. Our research in this field has shown us that there does not currently exist a website or application that values the humanity of nurses by taking into account fairness and personal preferences.



Analysis Of Research

The research conducted in the preliminary stage of developing Quality Nurse Scheduling revealed that there is a substantial amount of research in the field of computer science to find a solution to the nurse-scheduling problem. This problem has no one solution and therefore a variety of approaches have been utilized. Approaches have included Soft Computing techniques such as Particle Swarm optimization and Genetic algorithms. Mathematical modeling such as the Bayesian optimization technique has also been utilized in an attempt to find a solution to a problem that cannot be solved by exact methods.

To gain further insight into the wants and needs of nurse managers, we conducted interviews with two experienced nurses: Dr. Mary Dietmann and Margaret Jones, RN. Dietmann and Jones gave us a better understanding of the constraints of the problem we were dealing with. Through the interviews conducted with both professionals, we solidified our list of hard constraints. These hard constraints are always adhered to. Nurses cannot work back-to-back shifts, there must be 3 nurses working on each shift, and shifts must be equally distributed among nurses. The soft constraints we finalized with their input were shift preference and two day off requests for the month. These soft constraints are adhered to whenever possible.

Our research showed us that there was not currently a scheduling program that was simple and straightforward from the user side while still performing thousands of computations on the back end to produce an optimal schedule. Our goal is to create a program that makes nurses feel that their preferences are considered and respected when the monthly schedule is made. Furthermore, we want to save the nurse manager a considerable amount of time by having a program create the schedule for him or her. This research helped shape our decision making during the design process of QNS.

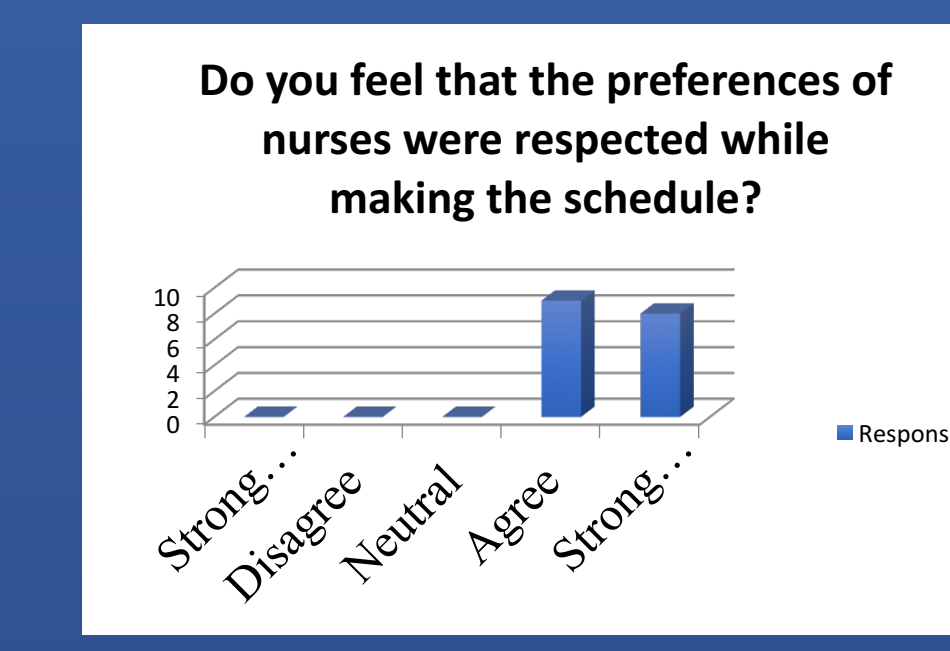
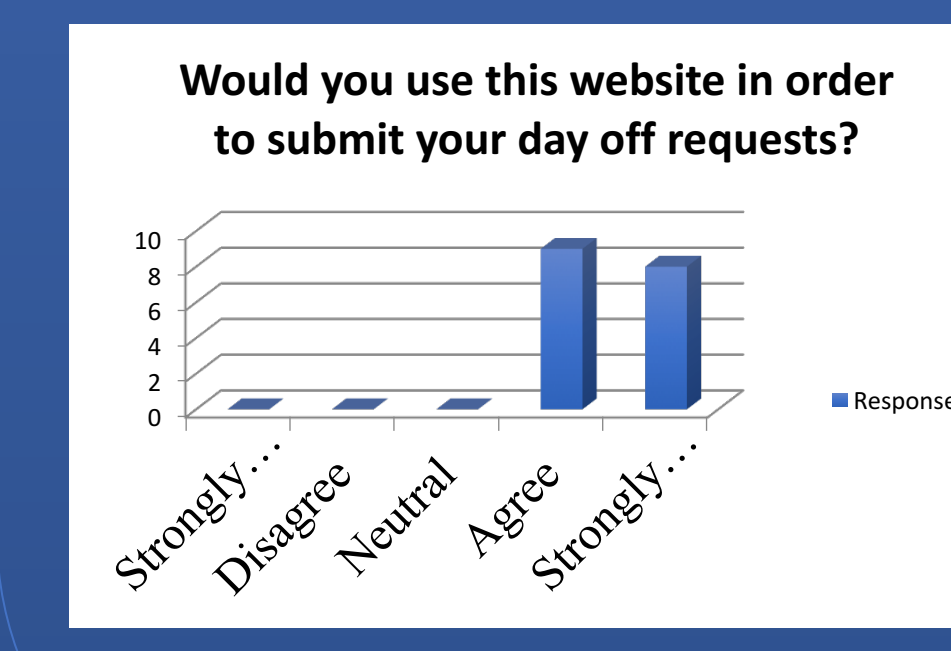
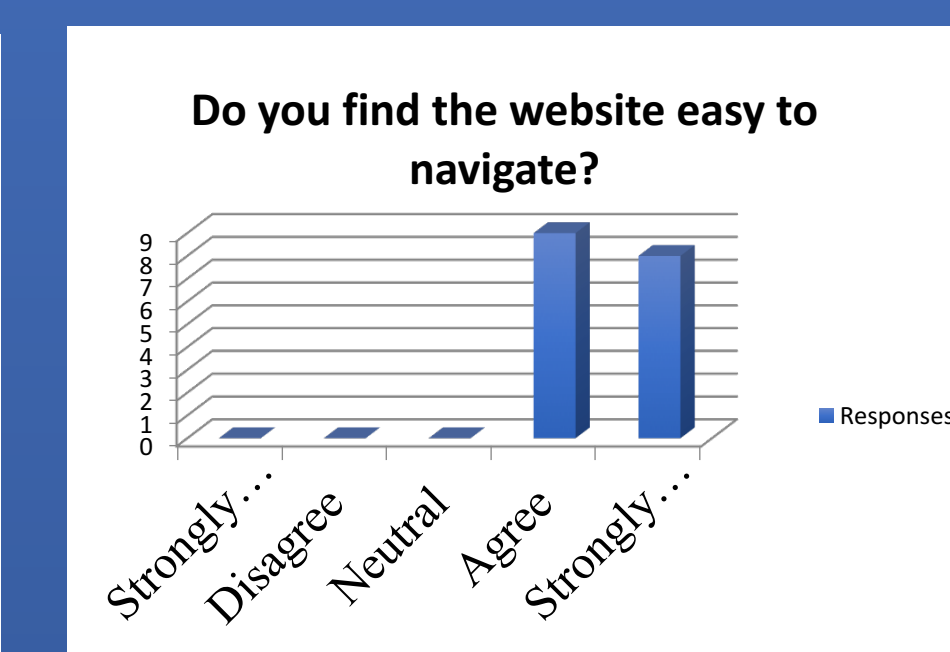
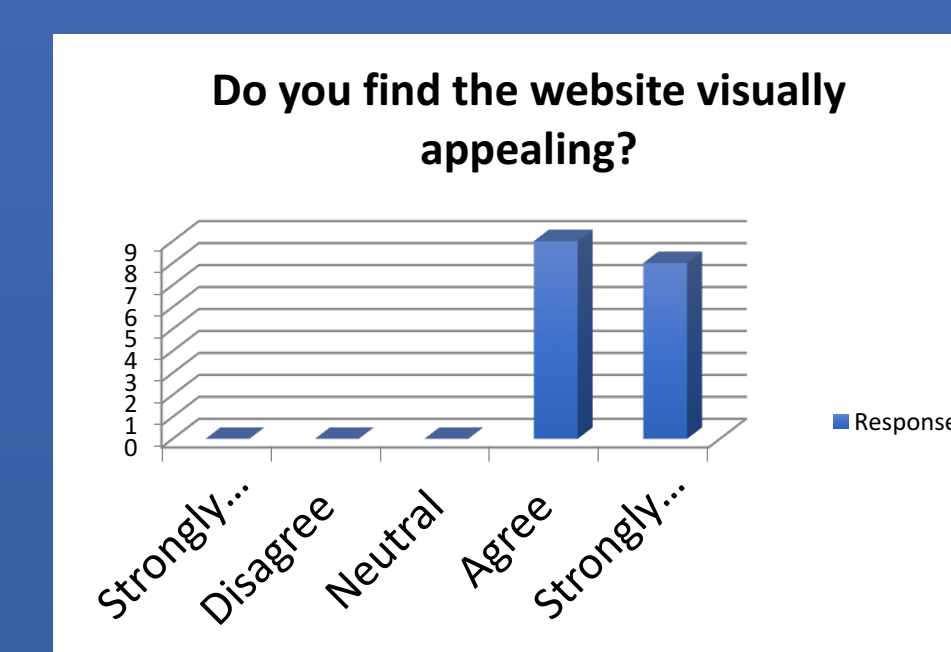
ANALYSIS OF NURSE PREFERENCES TESTING

This testing was conducted by running the scheduling program with complete input from all 20 nurses saved in the database. The purpose of this testing was to see how well the scheduling adheres to the soft constraints of shift preference and day off requests. The program does exceptionally well at adhering to day off requests and also adheres to the shift preference constraint moderately well.

This distinction between importance of day off requests and shift preferences was done purposefully. Through the interviews we conducted with nurse managers and our research, we concluded that day off requests are more important to nurses than shift preferences, therefore we assigned a higher penalty value to day off requests not being met than to shift preference not being met. Through this testing we can see that the soft constraints of the system are being adhered to and therefore the scheduling within itself is a success.

USABILITY TESTING ANALYSIS

Quality Nurse Scheduling tested well with users surveyed. 16 out of 17 users felt that the website was visually appealing and all users surveyed agreed that the website was easy to navigate. Users also agreed that they felt their preferences were taken into consideration during scheduling and that they would use this website in order to submit their day off and shift preference requests. The most frequent response to the question "What do you like most about the website?" was that it was simple, straightforward, and easy to navigate. This was a major goal of this project from the beginning of the design phase. The most frequent response to the question "What future enhancements would you like to see added?" was sending the final schedule to the nursing staff via email. Sending the finalized schedule via email is included on our future enhancement list. We also learned from our users that they would like to be able to input vacation days on the preferences page which we added to our future enhancements list.



OBSERVATIONS AND CONCLUSIONS

Obstacles Experienced During Project:

- Sacred Heart University was unable to host our website because it is coded in Java. This resulted in us having to find an outside party to host our site and a significant amount of time being dedicated to creating a grant proposal in order to pay for the cost of the hosting services.
- Host Gator (the hosting site we selected) was difficult to contact and not very helpful to us. They refused to host our server and would only host the client. This resulted in Emily's computer acting as the server, which created another issue regarding IP addressing.
- Emily's computer acting as a server posed an issue because the IP address of her computer was constantly changing and therefore needed to be updated in the client code. This obstacle was overcome by learning how to assign one IP address and reserve that IP address for Emily's machine on the Sacred Heart University network.
- Our original research told us that we needed to use a Java Applet in order to have a Java application running a web browser. Weeks of effort and time was wasted on trying to code a Java Applet when in reality the new updated way to run a Java application in a web browser was through a Java Web Start.
- We originally planned on using MySQL as our database but struggled with integrating it into our system. A substantial amount of time was lost attempting to integrate this database. We later changed our database to Apache Derby because it is built-in with Java and our needs are not very complex regarding our database.

Future Enhancements:

- The main future enhancement that we would like to have made a reality is the final schedule being sent out to the entire staff via email. This was a common request during our conducted surveys.
- Nurses being able to submit anonymous peer reviews. Nurses would evaluate the other nurses that they have worked with over the course of the previous month. These reviews would be available only to the nurse manager and would be valuable information for her.
- Schedule would also factor in work experience of nurses.
- Nurses being able to swap shifts with each other via the website.

What We Learned:

- **Technical Skills:** We learned Java, Java Web Start, and Apache Derby. None of us knew Java when beginning this project, but felt it was important to become proficient in this language because it is so popular.
- **Professional Skills:** We learned when to ask for help. There were times in this project when we faced substantial obstacles and needed to consult with our advisors and other computer science faculty. We became very comfortable with approaching anyone who we felt could help us, and learned that there is no shame in asking for help when you need it.
- **Time Management:** We learned that everything is going to take longer than you thought it would, especially coding and testing. Furthermore, we learned to expect the unexpected when it comes to coding. A module that you thought would be quick and easy can create hundreds of bugs throughout the program.
- **Personality:** We learned how rewarding it is to see a project of this scope through from start to finish. Regardless of all the challenges we faced we produced a final project that accomplishes everything we originally planned.