to improve health care performance and reduce patient waiting times, it is important to consider interactions between resource capacity, service time and appointment scheduling rules. The main objective of our work is to set up a patient appointment scheduling algorithm for an imaging center to increase the number of patients seen per day, while we minimize the waiting times and optimize the material and human resources. The good quality of service will be maintained. The project uses machine learning techniques to estimate the time required to complete each type of examination and possibly to classify patients. Using predictive models, we develop an online stochastic model to determine the day and the best possible time slots for each appointment. At the end of our project, we will be able to assign to each patient the best appointment time, having the most positive impact on the increase of the number of patients during the day.

■ HE-26

Thursday, 16:45-18:15 - 302A

OR in agriculture 2

Stream: OR in agriculture
Invited session
Chair: *Marina Segura*

1 - Market imperfections and income concentration: Global and regional perspectives on Brazilian agricultural production performance

Geraldo Souza, Eliane Gomes, Eliseu Alves

We measure performance for the Brazilian agriculture by means of free disposal hull (FDH) measures of technical efficiency. Measurements are conditional on contextual variables that may be responsible for market imperfection variables. The production frontier is generated by a product probability measure. Production observations are aggregated by county and analyzed by region. The efficiency measure is output oriented and assumes variable returns to scale. Output is rural gross income and inputs are land expenses, labor expenses and expenses on other technological inputs. The covariates for production are credit, technical assistance, social, environmental, and demographic indicators and income concentration, measured by the Gini index. Overall Brazilian rural production performance responds favorably to credit, income concentration and environment score and unfavorably to technical assistance, at the 95% level. Results differ by region. Agricultural public policies envisaging inclusion of small farmers into the main stream of production should be regionally oriented.

2 - Information quality value under a real option planning approach: The case of wine grape harvesting

Elbio Avanzini, Alejandro Mac Cawley, Jorge Vera, Sergio Maturana

Planning in the agriculture is subject to a significant level of uncertainty due to the climatic and biological factors involved in the production. In this work we study, using a real option approach, how climatic information quality or certainty affects the harvesting decisions in wine grape production system. The proposed model, as the grape producer, has to determine a harvesting plan (lots to harvest, labor and machine) at the start of the vintage. This harvesting plan is then confronted with climatic conditions, such as rain, which affects it by not allowing harvest during that period. In order to take account for the probability of rain in a given moment, we model the its probability using binomial lattice model and plan using a real option approach. The climatic information quality or certainty is modeled as the difference between the "real" probabilities and the "projected" ones during the planning phase. The effect is measured as the differences in the value of the plan under the different circumstances (high or low uncertainty). The contribution of this work is to develop a methodology that will allow the decision maker to determine the value and effect that information certainty has on the quality of the planning, under a real option planning approach.

3 - Agriculture of the Brazilian savannah: Technical efficiency, productivities and future perspectives

Eliane Gomes, Geraldo Souza, Eliseu Alves

Based on information collected in the Brazilian Agricultural Census of 2006 we present the production characteristics of the Brazilian Savannah agriculture. We compute robust non parametric measures of technical efficiency, product oriented, based on DEA models. The analysis is carried out both at county level and for income groups of farmers. Projections on the county DEA efficient production frontier are used for the assessment of labor, land and technological elasticities. Technology dominates, followed by land and labor. Contextual variables affecting efficiency are investigated by means of fractional regression models and bootstrap. These contextual variables are constructs defined by indicators of the rural county value added, health and sanitation, education and environment. Additionally, annual projections up to 2040 are shown for the major agricultural products prevailing in the region, with the use of ARIMA and State Space models. The one-step-ahead forecasts generated by these models are the base for the calculation of productivity confidence limits. The products of interest are cotton, rice, beef, coffee in grain, sugar-cane, sugar, bean, milk, cassava, corn, soybean, sorghum and wheat.

■ HE-27

Thursday, 16:45-18:15 - 302B

Advances in mine planning 1

Stream: OR in mining
Invited session
Chair: *Michel Gamache*

1 - A two-stage stochastic model for open pit mine planning under geological uncertainty

Eduardo Moreno, Xavier Emery, Marcos Goycoolea, Nelson Morales, Gonzalo Nelis

In open pit mining operations, planners must periodically prepare an strategic mine plan. This is a production schedule for the remaining life of the mine based on the information of a block models. Block models usually include a single estimation of the geological characteristics of the rock, particularly ore grades. However, most of block-models are constructed by averaging conditional simulations of the mine, based on the information from drill-holes. In this work, we present a two-stage stochastic model for this problem, that consider the different simulations of an ore body. In a first stage, the scheduling decision is taken, assigning an extraction period of each region of the mine. In a second stage, when the true ore grade is revealed, the model decides how to treat each individual block. Our proposed integer programming model can be reformulated as a large-scale precedence constrained knapsack problem, that can be (near-optimally) solved using decomposition techniques. This allow to solve real instances of the problem in a few hours. We apply this model to a copper mine in Chile. We compare the resulting NPV from the deterministic solution (expected value solution), the best-possible plan for each scenario (wait-and-see solution), and our proposed model. Computational experiment shows that, in these data, the proposed two-stage stochastic model captures a 70% of the gap in between the wait-and-see and the deterministic solution, obtaining more robust mine plans.

2 - Investigating a new hyper-heuristic method for mine production scheduling under uncertainty

Amina Lamghari, Roussos Dimitrakopoulos

A hyper-heuristic refers to a search method or a learning mechanism for selecting or generating heuristics to solve computational search problems. Operating at a level of abstraction above that of a meta-heuristic, it can be seen as an algorithm that tries to find an appropriate solution method at a given decision point rather than a solution. In this talk, a new hyper-heuristic that combines elements from reinforcement learning and tabu search is presented. It is applied to solve a complex real-world scheduling problem, namely the stochastic open-pit mine