IE 492 PROJECT TOPICS / Spring 2018

1. Title: Stock Optimization (Advisor: Prof. Dr. Necati Aras)

Different methods are currently being used to calculate the optimum stock levels (imported, local and oversea flows) that need to be found in Oyak Renault factories. Reviewing these methods, if necessary, eliminating their deficiencies and developing suggestions that can improve stock levels.

2. Title: Electronic Kanban (Advisor: Prof. Dr. Necati Aras & Prof. Dr. Ümit Bilge)

Oyak Renault, it is required to improve the process of feeding some of consumed parts from warehouse to production line. It is an Electronic Kanban project that will be applied between the warehouse and the production line to increase the efficiency of the feeding process and to manage the line stock in optimum level. Automatic stock replenishment method with electronic kanban; The operator who feeds the parts to production line can follow up line inventories from his screen and feeds the parts that drop below a certain stock level at the defined economic party sizes. On the screen which feeding operator follow up; reference parameters, lot sizes, and minimum and maximum level of line stocks must be identifiable on references basis.

3. Title: Flow Management by RFID (Advisor: Prof. Dr. Necati Aras & Prof. Dr. Ümit Bilge)

Oyak Renault AILN (Alliance International Logistic Network) division supplies parts from many suppliers and carries out shipping activities for the production of Renault's plants in several countries. This activity generally involves the administrative reception of parts, grouping or repacking of parts and sending processes. In the current situation, information on the availability of parts, traceability, and how much parts are tracked in the process after the administrative reception is not instantly available. It is aimed to be able to access these data instantly by RFID method.

4. Title: Capacity assessment for a shared multi-product conveyor system under different product combination scenarios (Advisor: Prof. Dr. Necati Aras & Prof. Dr. Ümit Bilge)

Description: In a BabyCare plant, two multi-product production lines share a single palletizing workstation. Both lines feed their output to a shared conveyor. This conveyor that links the two production lines to the palletizing station also acts as a work-in-progress inventory. Depending on various factors including product-dependent production rates of these lines, interruptions on the lines and/or palletizer, the load on the conveyor may fluctuate significantly. Certain product mixes may lead to blockage on the conveyor, which in turn leads to inefficiencies for the production line couple as a whole.

In this project, the team is expected to work with the problem owner (i.e. a FMCG company) in order to analyze the current situation, and conduct an analysis with different product combination in order to identify the combinations and conditions for which the current production system is likely to experience capacity problems. As a follow up, the team will experiment with alternatives in order to assess whether the identified problems can be alleviated with interventions deemed to be feasible and applicable by the problem owner.

5. Title: Designing an auto-adaptive inventory replenishment system (Advisor: Doç. Dr. Gönenç Yücel)

Description: In a periodic-review inventory replenishment system, two key questions are when to order (at which level of inventory) and how much to order (order up to which level). A periodic-review replenishment policy requires these two parameters (s,S) be specified for each stock keeping unit (SKU). These parameters should be estimated based on the demand pattern of the corresponding SKU. However, in a volatile business environment a certain parameter set can be outdated very frequently. In that respect, there is a need for an auto-adaptive replenishment system, which can monitor the demand pattern of the SKU and update ("correct") its key parameters accordingly on continuous basis.

In this project, the team is expected to work with the problem owner (i.e. a sanitary ware producer) in order to design and evaluate such a system on the real demand data of a set of SKUs. The performance of the proposed auto-adaptive system will be compared with the static case where a predetermined parameter set is kept constant throughout the analysis time window.

6. Title: Design of a Robust and Diversified Asset Allocation System (Advisor: Prof. Dr. Refik Güllü) 3-4 Students

Asset allocation, or portfolio optimization is an important component of financial decision-making. It is perhaps the most fundamental decision problem for corporations, financial institutions, mutual funds, and even individual investors. A classical approach used in asset allocation is to come up with a portfolio where a financial institution aims to minimize the portfolio risk and at the same time tries to achieve an average desired return. Although this approach is fairly easy to apply, it has serious shortcomings. Due to these shortcomings, financial planners show hesitancy in applying this approach. The portfolios formed by using this approach tend to be too concentrated, that is, the method allocates funds on a few number of assets, and the resulting portfolio may change significantly as the estimates of input parameters slightly differ. In this project, we would like to come up with the design of a system where given the input parameters, a robust and well-diversified portfolio can be obtained. We would like to test the validity of our design on real data. Of course, besides generating a diversified and robust portfolio, the system should also yield a well performing portfolio with respect to common benchmarks.

7. Title: A Pricing and Allocation System Design under Price Dependent Random Demand (Advisor: Prof. Dr. Refik Güllü) 3-4 Students

In this project, we aim to design a system where a single product is to be procured and sent to retail stores for meeting customer demand. The customer demand is random and it depends on the sales price, and the location of the retailer. The system that we design should take into account the demand forecasts at the retailers and decide on: how much to procure, how to price the product, and how much of the procured quantity to allocate to each of the retailers.

8. Title: Minimum Spanning Tree Problem with Conflicts (Advisor: Prof. Dr. İ. K. Altınel)

A variant of the ordinary minimum spnanning tree problem, the Minimum Spanning Tree Problem with Conflict Constraints (MSTC) will be considered in this project. A conflict constraint states that a certain pair of edges cannot be contained simultaneously in a feasible solution. It is convenient to represent these conflict constraints in terms of the so-called conflict graph whose vertices

correspond to the edges of the original graph, and whose edges represent conflict relations. Then, every stable set of the conflict graph is a conflict-free subset of edges. Hence, MSTC becomes the determination of a stable set of the conflict graph whose elements represent a connected acyclic and spanning subgraph of the original graph with minimum total weight. The goal of this project is to formulate MSTC, and develop and implement solution procedures. **(3-4 students)**

9. Title: A machine learning algorithm in the presence of a delayed response (Advisors: Doç. Dr. H. Yaşarcan & Yrd. Doç. Dr. M.G. Baydoğan)

There are many machine learning algorithms that can successfully map complex relationships between input and output variables! However, in the presence of delayed response, we presume that they may fail to map the relationships successfully. Especially in the presence of feedback loops, they may completely fail! The team is required to identify cases that will fail the existing algorithms and suggest improvements to them so as to capture at least mild dynamic complexity present in the data. **(2-3 students).**

10. Title: Modeling the dynamics of points won in individual sports (billiards and tennis) (Advisors: Prof. Dr. Yaman Barlas, co-advisor: Doç. Dr. H. yaşarcan)

There is significant work in literature analyzing and modeling how points are won or lost in individual sports, and ultimately trying to estimate the probability of a particular player winning a match. In building such models, a standard question is: given the quality of a player, is it possible to talk about a constant probability of winning a given point? If we could define such constant probabilities, then the match could be modeled more or less as a Markov process: the match would progress from state to state with some given probabilities, independent of the dynamics of past points. Most models in literature do make such an assumption, that successive points are independent (and identically distributed) random events. However, most sports commentators talk about which player has 'momentum' in any stage of the match, who is 'on a roll' etc. Commentators obviously believe that the historical dynamics of points do matter in determining the future performance, that successive points are not independent random outcomes, that winning or losing points are strongly auto-correlated in complicated ways.

In this project, data from billiards and tennis will be collected and analyzed first. Next, the dynamics of winning/losing points will be represented by building a stochastic dynamic model with memory, inertia and feedback. This means in effect modeling the dynamics of high and low morale episodes of both players, as they are influenced both by their own recent performances and the performance of their rival. The resulting model can then be used to generate the dynamics of points with a realistic (autocorrelated) structure and it can be potentially used to predict which player is likely to win the match under what conditions. **(3 students).**

11. Title: Interactive dynamic 'diving simulator' to train novice scuba divers

(Advisor: Prof. Dr. Yaman Barlas, co-advisor: Doç. Dr. G. Yücel)

In scuba diving, the body is subject to several forces, some of which being non-linear and delayed. Thus, smooth scuba diving and stabilization is not trivial, which can be risky for the diver. The most essential factor in this process is the force exerted by the jacket (buoyancy compensator), so the diver regulates buoyancy by deflating air from or inflating air into the

jacket. The basic forces and feedbacks involved in this process were already modeled in a M.S. thesis by Evrim Dalkıran (2006) and a simple interactive simulator was built. The purpose of this new project is to extend this prior work in two directions: i- to include and model other realistic factors and forces, such as the hand and fin movements of the diver, position and other diver characteristics, ii- to create a more realistic and richer scuba diving game, by using more advanced software, preferably with extensive web-based and animation features. Firstly the original model will be improved, then the interactive game will be built using this improved model, and finally the game will be thoroughly tested by players. The ultimate purpose is to develop a 'diving' simulator to help diving schools/clubs in training novice divers. The project will involve substantial amount of system dynamics simulation and general computer programming. **(3 students).**

12. Title: Productivity and Safety Improvement of a Work System
(Advisor: Prof. Dr. Mahmut Ekşioğlu) (2 to 4 students)

Description: Application of ergonomics and other industrial engineering principles at the workplace enhances productivity, quality, and safety and health. This project involves application of these principles in the evaluation and redesign of a selected work system. Project consists of three main parts: (1) data gathering for identification of productivity, safety and health issues, (2) solving the identified issues, and (3) cost-benefit analysis.
Requirement: A basic course in ergonomics

13. Title: Preference learning with click-stream data
(Advisor: Yrd. Doç. Dr. M.G. Baydoğan)

Understanding online searching and shopping behaviors has become an important issue for researchers. Surveys are often used to understand consumer behaviors. On the other hand, a detailed information of online user activities are recorded as the click-stream data which is a significant source to understand the consuming behavior. The detailed paths of products viewed but not purchased provided by click-stream data reveal more about consumer search and consideration sets. Analysis based on click-stream data provide retailers a great advantage especially if the customer demographics and previous purchase information is not available. The research topics in click-stream data analysis can be centralized around three main subjects: online browsing behavior, online advertising methods, and predicting online purchases. We will be interested in online purchasing processes. Customers make decisions among a set of alternatives including no-purchase option. This type of problems are called discrete-choice problems. In this sense, clickstream data offers a rich information about the revealed preferences of the consumers. Considering the fact that online purchasing behavior is heterogeneous and the choice set is very large, modeling the customer preferences is very challenging. Moreover, there are some additional valuable information such as customer comments, product ratings in addition to the product attributes. This research aims at learning the preference function of the customers such that the ranking of the products in a category is the one that maximize the likelihood of a conversion (i.e. the customer buys the product). Considering the large volume and velocity of the data, learning the preference function of a customer (or a segment of customers) is a challenging task. This project will investigate the use of learning to rank approaches (typically used for information retrieval purposes, i.e ranking documents by computing their relevance to search term) to model consumer behavior using click-stream data. **(3 students)**

14. Title: Sports Forecasting: Use of Alternative Information Sources for Predicting Turkish Soccer Games Outcomes
(Advisor: Yrd. Doç. Dr. M.G. Baydoğan)

Sports forecasting is important for sports fans, team managers, sponsors, the media and the growing number of punters who bet on online platforms. Widespread demand for professional advice regarding the results of sporting events is met by a variety of expert forecasts, usually in the form of recommendations from tipsters. In addition, betting odds offer a type of predictor and source of expert advice regarding sports outcomes. Whereas fixed odds reflect the (expert) predictions of bookmakers, the odds in pari-mutuel betting markets indicate the combined expectations of all punters, which implies an aggregated expert prediction.

Expert forecasts of sport outcomes often come from so-called 'tipsters', whose predictions appear in sports journals or daily newspapers. Tipsters are usually independent experts who do not apply a formal model but rather derive their predictions from their experience or intuition. They generally provide forecasts for only a specific selection of games, often related to betting. No immediate financial consequences result from the predictions of tipsters. Empirical evidence regarding the forecast accuracy of tipsters shows that their ability is limited.

This project is about the use of available information from different sources (such as weather data, betting odds from different betting companies, team status and etc.) to predict the outcome of the soccer games for Turkish Super League games. **(3 students).**

15. Title: Demand Planning for a Global B2B Manufacturer
(Advisor: Prof. Dr. Taner Bilgiç)

A large multi-national company active in manufacturing and distributing a wide range of rotating equipment and related technologies to OEM and aftermarket customers around the world is reconsidering its demand planning process. The demand is mostly "derived" by the manufacturing and sales of their OEM customers active in all kinds of industries. The objective of this project is to understand the key drivers of the demand for the company's products by channel and to propose a data-driven forecasting and analysis tool for a subset of its products**.** **(3 students)**

16. Title: Analyzing the Effect of Logistic Operations for an Online Marketplace
(Advisors: Yrd. Doç. Dr. M.G. Baydoğan, Prof. Dr. Taner Bilgiç, Prof. Dr. Refik Güllü)

Using a detailed transaction data from a major global online marketplace, the objective of this project is to understand the competitive dynamics at work on the supply side. There are hundreds of sellers of thousands of products to millions of customers on such marketplaces. The logistics operations to fulfill a customer order are also quite complex and has consequences on the speed of delivery, service scores from customers and sales in the future. You will concentrate on a single category of products and develop hypotheses to test with the available transaction data. You need solid (big) data analysis skills (using R and data.table is strongly recommended) along with creative process analysis and statistics. **(3 students)**

17. Title: Energy-economy modeling
(Advisors: Prof. Dr. Gürkan Kumbaroğlu & Prof. Dr. İlhan Or)

This study elaborates on the integration of an energy technology assessment model with a macroeconomic growth model providing for substitution between capital, labor, and energy inputs within a single-sector nonlinear production function. The production function shall be part of a MACRO module to represent the interactions between consumption, investment and energy costs within a single economic sector with perfect foresight. This macroeconomic submodel is to be combined with an energy submodel which includes a highly detailed technological description of energy flows with time-varying technical and economic parameters for Turkey. **(2 students)**
Prerequisite: double major or minor in economics

18. Title: Natural gas demand forecasting
(Advisors: Prof. Dr. İlhan Or & Prof. Dr. Gürkan Kumbaroğlu)

This study deals with the long-term forecasting of natural gas demand in Turkey through bottom-up modeling. First, historical data on gas consumption shall be compiled at sub-sectoral level together with data on demand triggering factors (such as pipeline infrastructure, substitute energy carriers, sectorial gas penetration rates, sectorial value added and physical production values, gas prices and other possibly related parameters). Second, data validation analyses shall be carried out while constructing the LEAP (Long-range Energy Alternatives Planning) model to project gas demand at sectoral level. Various complementary statistical analyses will have to be employed on historical data to forecast necessary input data. **(3 students)**