Stevens Institute of Technology
Howe School of Technology Management
Syllabus

BIA 650

Optimization and Process Analytics

Fall 2017	Thursday 3:00-05:30 PM
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	Course Room/Web Address: McLean Hall 218A/ http://www.stevens.edu/canvas

Overview

This course covers basic concepts in optimization and heuristic search. It provides an introduction to process management and process mining. The emphasis is on the application of mathematical optimization models rather than the underlying mathematics of their algorithms.

While the skills developed in this course can be applied to a very broad range of business problems, the practice examples and student exercises will focus on the following areas: marketing, logistics and supply chain optimization, capital budgeting, asset management, portfolio analysis. Most of the student exercises will involve the use of Microsoft Excel's "Solver" add-on package for mathematical optimization.

Prerequisites: Admission requirements for the BI&A program.

Course Objectives

This course develops students' ability to analyze a real-world problem and develop a mathematical formulation that is amenable to solution using techniques of operations research such as linear and integer programming, genetic algorithms and simulation. The ability to translate practical problems into representations that are amenable to analysis requires critical thinking and imagination and is an essential skill for analysts wishing to develop creative solutions in practice. While the emphasis is on modeling rather than mathematical algorithms, the analytical techniques learned in this course are essential building blocks for risk analysis, social network analysis and machine learning techniques such as neural networks. A final module of the course covers the analysis of workflow logs and introduces students to process data mining. This course is therefore an essential foundation for the study of other subject areas in the BI&A curriculum.

Additional learning objectives include the development of:

Written and Oral Communications Skills: the individual project proposal will be used to assess written skills and the final presentations will be video-taped and used to assess presentation skills.

Ethical Understanding: all students will take part in an ethics quiz and ethical issues will be discussed in lecture 5.

Team Skills: The final project for the course will involve student teams; an online survey instrument will be used to measure individual contributions to team performance.

Course Outcomes

After taking this course, students will be able to:

- Develop and solve optimization models in a number of domains such as supply chain modeling, marketing, production, asset management, capital budgeting and financial portfolio analysis.
- Develop simulation models and design simulation experiments.
- Perform process mining on workflow logs.
- Understand the optimization and search techniques underlying machine learning techniques such as neural networks and social network analysis.

Pedagogy

The course will employ lectures, class discussion, in-class individual assignments, individual homeworks and a team project. In the team project, students will analyze a real industrial problem, formulate a model, collect data, solve the problem using one or more of the techniques discussed in class, and interpret the solution for management.

Recommended Free Online Review Resources

Linear Algebra:
EDX: https://www.edx.org/course/linear-algebra-foundations-frontiers-utaustinx-ut-5-03x
Calculus:
Coursera: https://www.coursera.org/courses?query=calculus%20one&languages=en

Online tutorials on oral presentations are available at:
Part 1 - http://vimeo.com/54537755
Part 2 - http://vimeo.com/54537939

Readings

Required Textbook

Winston, Wayne L. and S. Christian Albright, "Practical Management Science." Pacific Grove, CA: Duxbury, 2012 (4th edition). (W&A) ISBN: 978-1-111-53131-7

Supplementary Textbooks

Vasant Dhar and Roger Stein (1997). *Seven methods for transforming corporate data into business intelligence*. Upper Saddle River: Prentice Hall.

Kelton, W. David, et al. (2006). *Simulation with Arena,* McGraw-Hill Professional (5th edition).

Weske, Mathias (2007), Business Process Management: Concepts Languages and Architectures. Berlin: Springer-Verlag.

Articles

Chidanand Apte, Bing Liu, Edwin P.D. Pednault, Padhraic Smyth (2006) Business Applications of Data Mining.

Kim, Y.G. (1995) "Process Modeling for BPR: Event-Process Chain Approach." Proceedings, 16th International Conference on Information Systems (ICIS). December 10-13. pp. 109-122.

van der Aalst, Wil, Ton Weijters, and Laura Maruster (2004). Workflow Mining: Discovering Process: Models from Event Logs. *IEEE Transactions on Knowledge and Data Engineering*, 16 (9).

Whitley, D. (1994). A Genetic Algorithm Tutorial. *Statistics and Computing* 4, 65–85.

IEEE Task Force on Process Mining (2011). "Process Mining Manifesto." http://fluxicon.com/blog/2011/08/help-the-ieee-task-force-write-the-process-mining-manifesto/

Simulation Models (Course Notes).

Process Mining (Course Notes).
ProM - process mining toolkit.
Fluxicon: http://www.fluxicon.com/academic/

Grading and Homework Assignments

INDIVIDUAL HOMEWORKS (30%):
To help reinforce the material covered in the lectures, a homework exercise will be assigned each week, which will involve formulating and solving a small but practically-relevant homework problem from the textbook. Oral presentations of homeworks are part of the course.

Homework Submission. All home works must be submitted through the BIA 650 course web site. Please be careful to identify all details of the homework very carefully.
The file name should include "HWK week #", your last name, the textbook chapter and number of the question (s) and the date of submission in that order (e.g., "HWK #2 Ch3 Qs 4, 6 and 8, March 23 2013". Each worksheet in the file should have a clear heading and a named tab. Please avoid .pdf submissions to the extent possible.

Presentation of Homeworks. The Excel textbook (W&A) assignments will be graded on their clarity as well as numerical accuracy. Each homework is worth 2 points: 1 point for the Excel numerical solution and 1 point for the management explanation of the problem and its solution. Each homework should have a cover age with identification information.

Homework Portfolio. A neatly formatted portfolio of all the work submitted through the semester is due on the last day of class (worth 2 points.)

All assignments are due as noted below. In fairness to others, late work will be penalized 10% per week overdue.

MIDTERM EXAMINATION (25%):
This take-home examination will take place shortly after the mid-point of the course. Its purpose is to consolidate the learning on optimization techniques. It will involve the formulation and solution of a number of small but typical problems from business practice.

INDIVIDUAL PROJECT PROPOSAL (15%):
An individual project involving the framing of a data analysis problem, the development of appropriate research questions and the identification of relevant data sources will be due in the latter half of the semester. This proposal could be tied to the team project (see below.)

TEAM PROJECT REPORT & PRESENTATION (20%):
The class practical will involve solving a real industry problem presented in the form of a case study. Alternatively, the team can take a real industry problem collect data and develop a recommended solution. One of the deliverables for this exercise is a team oral presentation, which should last thirty (30) minutes and will be worth 5% of your final grade.

CLASS PARTICIPATION (10%)
To enhance the learning experience, all students are expected to participate in class discussion and the in-class team exercises. Attendance in class sessions is an important component of this grade.

Ethical Conduct

The following statement is printed in the Stevens Graduate Catalog and applies to all students taking Stevens courses, on and off campus.

"Cheating during in-class tests or take-home examinations or homework is, of course, illegal and immoral. A Graduate Academic Evaluation Board exists to investigate academic improprieties, conduct hearings, and determine any necessary actions. The term 'academic impropriety' is meant to include, but is not limited to, cheating on homework, during in-class or take home examinations and plagiarism."

Consequences of academic impropriety are severe, ranging from receiving an "F" in a course, to a warning from the Dean of the Graduate School, which becomes a part of the permanent student record, to expulsion.

Reference: *The Graduate Student Handbook, Academic Year 2003-2004 Stevens Institute of Technology, page 10.*

Consistent with the above statements, all homework exercises, tests and exams that are designated as individual assignments MUST contain the following signed statement before they can be accepted for grading. _____

I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination. I further pledge that I have not copied any material from a book, article, the Internet or any other source except where I have expressly cited the source.

Signature _____ Date: _____

Please note that assignments in this class may be submitted to www.turnitin.com, a web-based anti-plagiarism system, for an evaluation of their originality.

Course/Teacher Evaluation

Continuous improvement can only occur with feedback based on comprehensive and appropriate surveys. Your feedback is an important contributor to decisions to modify course content/pedagogy which is why we strive for 100% class participation in the survey.

All course teacher evaluations are conducted on-line. You will receive an e-mail one week prior to the end of the course informing you that the survey site (https://www.stevens.edu/assess) is open along with instructions for accessing the site. Login using your Campus (email) username and password. This is the same username and password you use for access to Canvas. Simply click on the course that you wish to evaluate and enter the information. All responses are strictly anonymous. We especially encourage you to clarify your position on any of the questions and give explicit feedbacks on your overall evaluations in the section at the end of the formal survey which allows for written comments. We ask that you submit your survey prior to end of the examination period.

COURSE SCHEDULE

Note: Homework exercises are due the week after they are listed below. (Individual project and midterm are due on the day noted.)

1. Introduction to Modeling	**Thu, Aug 31**
Overview: processes, Big Data, Models. Productivity and efficiency. Classification of models. Sensitivity analysis. The seven-step modeling process. Stakeholder Analysis. Spreadsheet modeling. Excel's pivot function.	
Readings: W&A Text: Chapters 1 & 2	
2. Introduction to Linear Programming	**Thu, Sept 7**
Introduction to Linear Programming (LP). Graphical representation. Basic assumptions. The simplex algorithm. Infeasibility and unboundedness. Production problem example.	
Readings: W&A Text: Chapter 3	
3. The Simplex Technique;	**Thu, Sept 14**
Simplex Algorithm; Simple inventory optimization problem. Ethics discussion.	
Readings: Lecture Slides	
4. Linear Programming Models	**Thu, Sept 21**
Production scheduling. Bond portfolio optimization. Extracting additional meaning from LP models: shadow prices, sensitivity analysis. Data Envelopment Analysis. Case studies.	
Readings: W&A Text: Chapter 4	
5. Network Models	**Thu, Sept 28**
The classic transportation model. Supply chain modeling. Graph theory – the shortest path model.	
Readings: W&A Text: Chapter 5	
6. Integer Programming	**Thu, Oct 5**
Approaches to optimization with integer variables. The branch and bound approach. Either-or constraints. Examples: capital budgeting, spatial analysis: location models	
Readings: W&A Text: Chapter 6.	
7. Case Studies in Optimization and Data Analytics	**Thu, Oct 12**
Applications in different functional areas of business.	
Readings: W&A Text Ch. 6	
8. Nonlinear Optimization	**Thu, Oct 19**
Convex and concave functions; assumptions for nonlinear optimization in Solver. Sales force assignment. Balancing risk and return - portfolio optimization.	
Readings: W&A Text: Chapter 7.	

9. Genetic Algorithms	**Thu, Oct 26**
Conditions under which standard optimization techniques fail. The evolutionary approach.	
Readings: W&A Text: Ch. 8; Dhar and Stein: Ch. 6	
10. Multi-objective Function Decision Making	**Thu, Nov 2**
Goal programming; pareto optimality and trade-off curves; the Analytic Hierarchy Process (AHP)	
Readings: W&A Text: 4E Ch.16 (online) = 3E Ch 9 (Book)	
Individual Research Proposal due today	
11. Process Mapping/ Design:	**Thu, Nov 9**
Formal graphical representations of process flow. EPC, Petri nets. Introduction to Business Process Notation (BPMN). Team in-class exercise: Flow charting a process.	
Readings: Slides and Lecture	
12. Uncertainty: Simulation Modeling	**Thu, Nov 16**
Readings: Course Notes: W&A Chapter 11	
13. Introduction to Process Mining	**Thu, Nov 30**
Concept and content of workflow logs; discovering the underlying process; discovering exceptions. Process Mining (Course Notes). ProM - process mining toolkit. Fluxicon: http://www.fluxicon.com/academic/	
Readings: Course Notes: Process Mining, The "Process Mining Manifesto."	
14. Student Presentations of Term Projects - I	**Thu, Dec 7**
Each team presents their term project: written report plus oral presentation	