BA571E - Mathematical Programming

Fall 2016

Instructor:

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Time/Location:

Time: TBA

Course Overview:

This graduate level course introduces mathematical programming techniques and their applications to problems in business research, mainly for operations and supply chain management. The course also covers some techniques that can be used for other fields such as quantitative finance, marketing, economics, etc. Techniques that will be discussed include linear programming (and integer programming), nonlinear programming, quadratic programming, and dynamic programming. We will also study how to apply these techniques to various problems arising in business practices. Examples of such applications are including, but not limited to, inventory and supply chain management, derivatives pricing, portfolio optimization, and dynamic pricing (or revenue management). The students are expected to read and understand relevant research papers in each one's fields of interest with mathematical programming and eventually to contribute to research in such fields.

Prerequisites:

Undergraduate level calculus, analysis, and linear algebra courses

Reference Materials:

It is recommended to read the following reference books, especially, the book by Bertsimas & Tsitsiklis. Some of the reference materials are available online for free.

- Introduction to linear optimization by D. Bertsimas and J. N. Tsitsiklis
- Optimization methods in Finance by G. Cornuejols and R. Tutuncu
- Applied mathematical programming by Bradley, Hax, and Magnanti (available online at http://web.mit.edu/15.053/www/)
- Introduction to mathematical programming by W. L. Winston
- Game theory in supply chain analysis by G. P. Cachon and S. Netessine (available online at http://opim.wharton.upenn.edu/~cachon/pdf/cachon_netessine_gt.pdf)

Homeworks

Homeworks are assigned usually from one of the reading materials above almost every other week. Homework is due *one* week from the date it is assigned and should be handled before the class begins on the due date. Late submission is generally *not* accepted.

Exam

There will be one midterm exam in this course that covers all core optimization techniques. Since the coverage is wide, the exam may be held *later* than the usual midterm period (possibly on mid-November). Students who have a concern on this late exam schedule should consult with the instructor before finalizing course registration

Paper Presentation

Depending on the class size, there will be a team or individual paper presentation. Papers will be selected to introduce various applications of mathematical programming in business practices and academic research. Paper selection should be approved by the instructor before finalized. Thus, schedule your paper section accordingly and make sure you are prepared in a timely manner. Each team or individual is asked to prepare a presentation to deliver main idea and techniques in the paper to the class. Discussion and Q&A will be followed by the presentation. After presentation, the students can revise the presentation material and submit it by the end of the course.

Discussion

All students are *required* to read other teams' papers and participate in the discussion. Those who actively participate would have some *extra credits*.

Evaluation

- Homework (10%)
- Midterm (40%)
- Presentation (40%)
- Attendance & participation in paper presentation (10%)

Software:

Excel solver and Matlab are useful to solve some homework problems.

Make-up class

There will be no class in Nov. 14 and 16. A make-up class will be arranged accordingly. Alternatively, there might be some extend classes to two and half hours.

Course contents (Tentative):

Part I: Core mathematical programming techniques

1. Introduction to math programming model
    - Modeling optimization problems
    - Examples of math programming

2. Linear Optimization
    - Optimality condition
    - Simplex method
    - Duality
    - Sensitivity analysis

3. Nonlinear Programming
    - Univariate optimization
    - Unconstrained optimization
    - Constrained optimization

4. Quadratic programming
    - Optimality conditions
    - Mean-variance utility and efficient frontier

5. Integer programming
    - Modeling with integer programming
    - Ex. Uncapacitated fixed charge location problem
    - Solutions and its limitations
    - Nonlinear integer programming
    - Ex. Location model with risk pooling (LMRP) with column generation(Ch 8 of fundamentals of SC)
    - Uncapacitated fixed charge location problem (UFLP)

[Exam]

Part II: Advanced Topics

6. Network Programming
    - Max flow problem
    - Ex. Shortfall minimization (in ch 9 of fundamentals of SC)

7. Dynamic Programming
    - Modeling recursive equation
    - Applications of DP to:
        - Revenue management (Dynamic pricing)
        - American Call Options pricing
    - **Lot sizing problem as an applications of DP?**

8. Stochastic programming and basic stochastic modeling (if time permitted)

[Final Presentation]

Academic Integrity

All examinations and written homework assignments are subject to the usual standards of academic honesty. You are permitted to work together for homework assignment, but each student is required to write up the solution individually. You are also required to acknowledge any book or person you have consulted.