Overview. Direct continuation of the core MGT 409 class. In this elective we will study new formulations of the tools surveyed in 409, thereby greatly extending the range of business problems that can be solved using existing methods. New analytic tools (seductively named Monte Carlo methods) for simulating future, uncertain events will also be introduced. These methods fall under the discipline of Management Science, the science of decision making. The subject can be highly mathematical and in the past you would need to hire a mathlete with steady bathing habits to implement these tools. Nowadays the spreadsheet environment allows you to abstract away from the technical complexity so you can focus on problem formulation and managerial insight.

After a brief refresher on linear optimization, we will examine the immensely useful Data Envelopment Analysis (DEA) technique, a linear program model that can be used to identify efficient branches of businesses and provide guidelines for improving inefficient ones. A mini case study on how one of our alums applied DEA to transform an international nonprofit health organization will be presented.

We will then study two important extensions of traditional linear programming: network LP and integer LP. The former is important to distribution and location logistics (how do Amazon.com robots decide on the order in which it retrieves requested items from a warehouse the size of, well, the Amazon?), and the latter underpins all modern timetable scheduling from airport flight schedules to staffing at hospitals.

Of course, most business problems are not linear. The second part of this course is devoted to non-linear optimization methods that will be used to examine problems in revenue management (how do travel websites price a flight ticket only, hotel stay only and a flight-and-hotel package?) and portfolio optimization.
The last part of the course introduces the Monte Carlo method for simulating uncertain events. Rather than battle with complicated equations for average values and standard deviations of random outcomes like future returns, simulations provide a very intuitive approach for estimating any summary statistic you could possibly want. Application areas covered include finance (retirement planning and ETF simulation), data-driven inventory planning, and simulating Net Present Values for projects with uncertain risks and rewards.

**Textbook.** Practical Management Science (PMS), revised 3rd edition. By Winston and Albright, South-Western College Pub. 2008. A copy of the text will be placed on reserve in the Center for Science and Social Science Information (CSSSI). If you want to purchase it, look for copies of the book without the CD (we will not be using it) – used copies go for a song on Amazon.com, and you can split the cost amongst your homework team (see below).

**Software.** Microsoft Excel with the built-in Solver Add-In; @RISK Add-In (part of the Windows-based Palisade DecisionSuite software). Please see the SOM IT office if you do not already have Palisade DecisionSuite from the MGT409 Spreadsheet Modeling core course. For the cool kids using Macs, you will have to log onto the SOM remote Windows desktop environment to use @RISK during the second half of the course – instructions will be provided on classesv2.

**Prerequisites.** Few beyond core knowledge. For MAM and non-SOM students, a basic familiarity with the Excel environment is advised. Select materials from the core MGT409 for a quick and simple introduction to linear programming can be found at yale.box.com/MGT809.

All students are expected to bring their laptops to class.

**TAs.** TBA.

**Attendance, homework and exams.** Yes, yes and unlikely. Students are expected to attend all classes and complete assignments. There will be two sets of homework questions and you may work in groups of up to three on these assignments. Midterms and finals are highly unlikely, but
the instructor reserves the right to threaten to have one. Final grade will be based on attendance, participation, enthusiasm, and homework grades. There will also be a third optional homework on the Monte Carlo simulation part of the course for extra credit.

**Syllabus.**

Part I: Networks. Minimum cost network flows and shortest path problems. PMS Sections 5.1-5.5. Network cycles (foreign exchange arbitrage) and Tours (UPS delivery optimization) as minimum cost network flows. Project scheduling with the Critical Path Method.


Part II: Nonlinear programming. Pricing optimization models. PMS chapter 7. Portfolio optimization and fixed income management II. Evolutionary methods. PMS chapter 8.

Part III: Monte Carlo simulations: Introducing the @RISK Excel Add-In package. PMS chapters 11-12. Simulation of stock price evolution with applications to retirement planning and analyzing leveraged ETFs. Estimating inventory demand and data-driven inventory planning without formulas. Predicting Net Present Values of projects in the presence of uncertain risks and rewards.