Sloan School of Management – Massachusetts Institute of Technology

General Information
15.060: Data, Models, and Decisions

MBA Program
Fall 2015

Professors David Gamarnik, Juan-Carlos Ferrer, and Juan Pablo Vielma

Description

Many managerial decisions—regardless of their functional orientation—are increasingly based on analysis using *quantitative* models from the discipline of management science. Management science tools, techniques and concepts (e.g., data, models, and software programs) have dramatically changed the way businesses operate in manufacturing, service operations, marketing, transportation, and finance. This subject is designed to introduce first-year Sloan students to the fundamental techniques of using data to make informed management decisions. In particular, we will focus on various ways of modeling, or thinking structurally about, decision problems in order to enhance decision-making skills.

Rather than survey all of the techniques of management science, we stress those fundamental concepts that we believe are most important for the practical analysis of management decisions. Consequently, we focus on evaluating uncertainty explicitly, understanding the dynamic nature of decision-making, using historical data and limited information effectively, simulating complex systems, and optimally allocating resources. The implementation of these tools has been facilitated considerably by the development of spreadsheet-based software packages, and so we will make liberal use of spreadsheet models.

It is impossible to teach you all there is to know about management science techniques in only one semester; rather, our goal is to enable you to become intelligent users of management science techniques. In that vein, emphasis will be placed on how, what and why certain techniques and tools are useful, and what their ramifications would be when used in practice, all in concert with the overarching goal for you to become excellent managers. This will necessitate some mechanical manipulations of formulas and data, but it is not our goal for you to become adept handlers of mathematical equations and computer software.

To give you a perspective on how management science is used in practice, much of the material will be presented in the context of practical business situations from a variety of settings. We hope that this illustrative material will help you in selecting future subjects.

Grading

Your course grade will be based on a final exam, a quiz, case write-ups, homework assignments, and class participation, as follows:

1.	Final Exam (3-hour exam, Monday, December 14, 9am-12noon, Tentative)	40%
2.	Case Write-ups and Homework Assignments	30%
3.	Quiz (1.5-hour test held in class on Wednesday October 28)	20%
4.	Class Participation	10%

By definition, class participation will be subjectively evaluated (see below).

Much of your education will take place outside the classroom, as you study, review, and apply the topics to which you are introduced in class.

Case Write-Ups: Case write-ups should consist of a memo that is no more than two pages of text, single-sided. The memo should be void of calculations and written in a managerial style; the memo should clearly articulate your recommendations and proposals. Up to six pages of supporting documents (charts, figures, calculations, etc.) may be appended to the memo. We recommend that no more than 8 hours be devoted to any case write-up. There will be two types of case write-ups (team assignments as well as individual case write-ups). For team assignments, you should work as a team and submit one case write-up per team. Individual case write-ups on the other hand should represent only the work of a single student. You may discuss the case with other students in your team, the teaching assistants, or the professors of the course, but the memo and the analysis should represent only your own work.

Homework Assignments: Homework assignments are designed to help you learn the mechanics of the methods discussed in class and to give you an opportunity to apply these concepts in a straightforward manner. Because mastery of the basic mechanics is necessary for effective and discerning usage of the concepts, we require that you do the homework assignments individually.

In addition to their value as learning exercises, doing a careful and thorough job on the homework assignments is the best preparation for the final examination of the course.

There are three types of assignments: **Read, Prepare** and **Hand In.**

Read: When the assignment is to **Read** some material, this reading is an important introduction to the topics to be discussed in class. We will proceed on the assumption that you have done the reading before class and have understood much (but not necessarily all) of it. When the assignment is to **Read** a problem, that problem will often be used in class to introduce new concepts. You should be familiar with the problem, but you will not be expected to have fully analyzed it before the discussion in class.

Prepare: Fully analyze the problem. Be ready to discuss it in class, with model equations formulated, the numbers computed, etc. We will cold-call on people, so please be ready.

Hand In: The same as Prepare, but you must turn in your analysis. All written assignments must be handed in at the beginning of class on the day they are due, and so you will probably want to make a copy of your assignment for reference during class. All written assignments will be graded and returned to you.

Team Work

There are three types of assignments: (i) team cases (these should be done as a team and you only need to hand in one write-up per team), (ii) individual homeworks and (iii) individual case write-ups (the latter two need to be done individually). Nevertheless, even for (ii) and (iii), you may find it useful to discuss broad conceptual issues and general solution procedures with others. If this is the case, then we enthusiastically recommend that you do so. The objective here is to learn. In our opinion (and personal experiences), the material of this class is best learned through individual practice and exposure to a variety of application contexts. The syllabus specifies clearly which of the assignments are team cases.

On the first type of assignment (team case) we want you to work as a team. On the two other types of assignments we only allow "Type 1 collaboration". This means that collaboration is allowed, but the final product must be individual. You are allowed to discuss the assignment with other team members and work through the problems together. What you turn in, however, must be your own product, written in your own handwriting, or in a computer file of which you are the sole author. Copying another's work or electronic file is not acceptable.

Class Participation and Conduct

Your class participation will be evaluated subjectively, but will rely upon measures of punctuality, attendance, familiarity with the required readings, relevance and insight reflected in classroom questions, and commentary. Your class participation will be judged by what you add to the class environment, regardless of your technical background. Although several lectures will be didactic, we will rely heavily upon interactive discussion within the class. Students will be expected to be familiar with the readings, even though they might not understand all of the material in advance. In general, questions and comments are encouraged. Comments should be limited to the important aspects of earlier points made, and reflect knowledge of the readings.

We may call on you periodically to answer questions about either the homework or classroom developments. We will evaluate your classroom participation based on the extent to which you contribute to the learning environment. (Demonstration of mastery of advanced topics at inappropriate times does not help create a positive learning environment.) However, correcting the professor when he/she makes a mistake and asking what appear to be "dumb questions" about what is being covered both do help! In the case of so-called "dumb questions," very often half of the class will have the same questions in mind and are relieved to have them asked.

Consistent with Classroom Values@MITSloan, we have the following policies:

- Students are expected to arrive promptly on time and to stay for the entire class.
- Laptops and e-readers are not to be open in the classroom.

- Cell phones and PDAs are not to be used or permitted to ring in the classroom.
- Students are expected to attend all classes.
- Maintenance of a professional atmosphere by using respectful comments and respectful humor.
- Refraining from distracting or disrespectful activities (e.g., avoiding side conversations and games).
- Courtesy towards all participants in the classroom.
- Observance of the most conservative standards when one is unsure about which norms apply.

Please refer to the Values@MITSloan materials for more details. Violations of Values@MITSloan policies will be marked. Three or more violations will result in an automatic penalty of a letter grade.

We ask that you use your name card in every class.

Policy on Individual Work and Plagiarism

In the case of written homework assignments and cases (if they are not team assignments), your assignment and/or case write-up must represent your own individual work. Although you may discuss homework problems with other students, assignments must represent your own work. You are expected to adhere to the following standards:

- Do not copy all or part of another student's work (with or without "permission").
- Do not allow another student to copy your work.
- Do not ask another person to write all or part of an assignment for you.
- Do not work together with another student in order to answer a question, or solve a problem, or write a computer program jointly.
- Do not consult or submit work (in whole or in part) that has been completed by other students in this or previous years for the same or substantially the same assignment.
- Do not use print or internet materials directly related to a case/problem set unless explicitly authorized by the instructor.
- Do not use print or internet materials without explicit quotation and/or citation.
- Do not submit the same, or similar, piece of work for two or more subjects without the explicit approval of the two or more instructors involved.

During the quiz and the final examination, any student who either receives or knowingly gives assistance or information concerning the examination will be in violation of the policy on

individual work. The violation of the policy on individual work is a serious offense, and suitable consequences include grade reduction, an F grade, a transcript notation, delay of graduation, or expulsion from MIT Sloan.

Required Materials

Textbook: *Data, Models, and Decisions: The Fundamentals of Management Science* by Dimitris Bertsimas and Robert M. Freund, Dynamic Ideas LLC, 2004.

Optional Reading and Books on Reserve

Below we include some optional text resources. These should not be necessary except for redhots and/or the hopelessly confused.

- McClave, Benson, and Sincich, *A First Course in Business Statistics,* Prentice Hall, 1998.
- Hamburg and Young, *Statistical Analysis for Decision Making,* Dryden Press, Fort Worth, Texas, 1994.

Professors

	David Gamarnik	Juan-Carlos Ferrer	Juan Pablo Vielma
Office:	E62-563	E62-569	E62-561
Phone:	617 253-7779	617 225-6330	617-324-1204
Email:	gamarnik@mit.edu	jcferrer@mit.edu	jvielma@mit.edu

Course Homepage

The homepage for the course is accessible through the stellar class management system:

https://stellar.mit.edu/S/course/15/fa15/15.060/index.html

Teaching Assistants

Section	**TA**	**Email**	**Office hours (TBD)**
Section A	Michelle Ton	mton@mit.edu	Tuesday 4-5 PM
Section B	Vinit Sukhija	vsukhija@mit.edu	Tuesday 5-6 PM
Section C	Tim Wolfe	twolfe@mit.edu	Monday 3-4 PM
Section D	Colin Pawlowski	cpawlows@mit.edu	Tuesday 2-3 PM
Section E	Jerry Lai Kung	jkung@mit.edu	Monday 5-6 PM
Section F	Rim Hariss	rhariss@mit.edu	Thursday 3-4 PM

Lectures

Section	Professor	Lecture		
Section A	Gamarnik	MW	8:30-10:00	E62-262
Section B	Vielma	MW	8:30-10:00	E51-335
Section C	Ferrer	MW	8:30-10:00	E62-223
Section D	Gamarnik	MW	10:00-11:30	E62-262
Section E	Vielma	MW	10:00-11:30	E51-335
Section F	Ferrer	MW	10:00-11:30	E62-223

Recitations

Section	Recitations		
Section A	Thursday	4:00-5:00	E62-250
Section B	Wednesday	3:00-4:00	E62-223
Section C	Wednesday	3:00-4:00	E51-149
Section D	Wednesday	3:00-4:00	E62-233
Section E	Thursday	3:00-4:00	E62-233
Section F	Thursday	1:00-2:00	E51-395

Recitation periods are used to review and reinforce material covered in the lectures, and to review the ins and outs of using modeling software for the course. Recitation attendance is encouraged, but it is not mandatory. Some students find the recitation period a very efficient time to absorb and reinforce the class material, while other students may prefer to absorb the class material at their own desired time. All recitations are run by the Teaching Assistants.

We will conduct a final exam review session on Saturday, December 12, in Wong Auditorium, time TBA.

15.060: Data, Models, and Decisions -- Fall 2014 Intended Schedule

DATE	TOPIC	WORKLOAD
Wednesday, September 9	Decision Analysis - Kendall Crab & Lobster Case	
Monday, September 14	Decision Analysis II – Conditional Probabilities	
Wednesday, September 16	Discrete Probability Distributions	TEAM CASE
Monday, September 21	Continuous Probability Distributions	HWK
Wednesday, September 23	The Normal Distribution	
Monday, September 28	Simulation I - Gentle Lentil Case	HWK
Wednesday, September 30	Regression Models I	
Monday, October 5	Simulation II - Ontario Gateway Case	CASE
Wednesday, October 7	Regression Models II	HWK
Monday, October 12	**No Class Meeting (Columbus Day)**	
Tuesday, October 13	Regression Models III	HWK
Wednesday, October 14	Revenue Management at Atlantic Air	
Monday, October 19	**No Class Meeting (Sloan Innovation Period)**	
Wednesday, October 23	**No Class Meeting (Sloan Innovation Period)**	
Monday, October 26	Regression Case and Machine Learning	CASE
Wednesday, October 28	Quiz	
Monday, November 2	**No Class Meeting**	
Wednesday, November 4	**No Class Meeting**	
Monday, November 9	Introduction to Linear Optimization	
Wednesday, November 11	**No Class Meeting (Veterans' Day)**	
Monday, November 16	Solving and Analyzing Linear Optimization	HWK
Wednesday, November 18	Filatoi Riuniti Case	HWK/CASE
Monday, November 23	Nonlinear Optimization Models	
Wednesday, November 25	**No Class Meeting (Thanksgiving Day)**	
Monday, November 30	Discrete Optimization Models	CASE
Wednesday, December 2	International Industries Case	HWK
Monday, December 7	Summary and Look Ahead	
Wednesday, December 9	**No Class Meeting**	
Saturday, December 12	Final Exam Review	
Monday, December 14	Final Exam	

CASE: Indicates that an individual CASE WRITE-UP is due.
TEAM CASE: Indicates that a CASE (one WRITE-UP for each team) is due.
HWK: Indicates that an individual HOMEWORK ASSIGNMENT is due.

15.060: Data, Models, and Decisions
Course Outline and Assignments

(Subject to minor changes as we refine the material)

All readings of the text refer to the textbook *Data, Models, and Decisions: The Fundamentals of Management Science* by Bertsimas and Freund, Dynamic Ideas LLC, 2004.

All materials are either in the text or will be posted on Stellar during the term.

Class 1: Decision Analysis I -- Kendall Crab and Lobster Case
Wednesday, September 9

Read Chapter 1 of the text. Prepare the Kendall Crab and Lobster Case (at the end of Chapter 1), and be ready to discuss the following questions in class: What are the choices that Jeff Daniels faces? What are the sources of uncertainty in the case? What are the consequences of the various possible outcomes? What course of action would you recommend for Jeff Daniels?

Class 2: Decision Analysis II – Conditional Probabilities
Monday, September 14

Read Sections 2.1 through 2.3 of Chapter 2 of the text. Read and prepare the case "Great Apps of Ann Arbor" which is posted on Stellar. We will discuss this case, plus conditional probabilities and Bayes' Rule, in class.

Class 3: Discrete Probability Distributions
Wednesday, September 16

The next three classes lay the basic groundwork of probability distributions. We will see how data can be characterized as observed values of random variables and study three important probability distributions: the uniform distribution, the binomial distribution, and the Normal distribution. Read Sections 2.4-2.7 and 2.13 of Chapter 2.

TEAM ASSIGNMENT DUE: "Time-Critical Management of AOG (Airline on Ground) at Latin Airlines". ANALYZE AND HAND IN YOUR ANALYSIS OF THE CASE (ONE CASE PER TEAM).

Class 4: Continuous Probability Distributions
Monday, September 21

Read Sections 2.8-2.11, 3.1-3.3 of Chapter 3.

HOMEWORK ASSIGNMENT DUE. To be announced in class.

Class 5: The Normal Probability Distribution
Wednesday, September 23

Read Sections 3.4-3.8 of Chapter 3.

Class 6: Simulation I - The Gentle Lentil Case
Monday, September 28

Read Sections 4.1 and 4.2 of Chapter 4, and all of Chapter 5. Read the Gentle Lentil Restaurant Case (at the end of Chapter 5) and prepare answers to the questions at the end of the case. (Note: you are NOT required to build a simulation model.) Decide how you would go about analyzing the salary implications of the two career decisions that Sanjay Thomas faces.

HOMEWORK ASSIGNMENT DUE. To be announced in class.

Class 7: Regression Models I
Wednesday, September 30

Read Sections 6.1 through 6.6 of Chapter 6.

Class 8: Simulation II – The Ontario Gateway Case
Monday, October 5

Read the Ontario Gateway Case (at the end of Chapter 5). Perform the case analysis modeling assignment for the Ontario Gateway Case described at the end of the case. HAND IN a management memorandum presenting your conclusions with appropriate but concise back-up enclosures to support your recommendations.

CASE ASSIGNMENT DUE: Ontario Gateway Case analysis and memorandum due in class.

Class 9: Regression Models II
Wednesday, October 7

Read Section 4.5 of Chapter 4 and Section 6.7 of Chapter 6.

HOMEWORK ASSIGNMENT DUE. To be announced in class.

Class 10: Regression Models III
Tuesday, October 13

Read Sections 6.8 through 6.10 of Chapter 6.

HOMEWORK ASSIGNMENT DUE. To be announced in class.

Class 11: Revenue Management at Atlantic Air
Wednesday, October 14

Read pages 486—490 and 503—507.

Class 12: Regression Case and Machine Learning
Monday, October 26

CASE ASSIGNMENT DUE: "Milagro: Predicting Store Profitability at a Fast-Casual Restaurant Chain" analysis and memorandum due in class

Class 13: Quiz
Wednesday, October 28

The 1.5-hour quiz will take place during regular class time. The quiz will cover all of the material we have considered so far in the course. The quiz will be closed-book with no notes allowed. You may use a non-communications-type calculator, but no communications devices (cellphones, graphing calculators) will be allowed. We will provide a sheet of formulas that will be posted on the course website before the quiz.

Class 14: Introduction to Linear Optimization Modeling
Monday, November 9

Read Sections 7.1-7.3 of Chapter 7. We will cover the basics of linear optimization, including formulations, key concepts, and graphical solution methods.

Class 15: Solving and Analyzing Linear Optimization Models
Monday, November 16

Read Sections 7.4-7.6 of Chapter 7. We will cover computer solution methods for linear optimization, basic sensitivity and economic analysis of a linear optimization model, as well as extensions of linear optimization and applied optimization modeling in general.

HOMEWORK ASSIGNMENT DUE. To be announced in class.

Class 16: Filatoi Riuniti Case: Production Management
Wednesday, November 18

Read and analyze the Filatoi Riuniti case at the end of Chapter 7. Be prepared to discuss this case in class.

HOMEWORK ASSIGNMENT DUE (includes Filatoi Riuniti Case).

Class 17: Introduction to Nonlinear Optimization
Monday, November 23

Read Sections 8.1-8.4 of Chapter 8. We will discuss the concepts of nonlinear optimization in class.

Class 18: Introduction to Discrete Optimization
Monday, November 30

Read Sections 9.1-9.4 of Chapter 9. We will discuss the concepts of discrete optimization in class.

CASE WRITE-UP DUE. Endurance Investors case analysis and memorandum due in class

Class 19: International Industries Case: Strategic Investment Management
Wednesday, December 2

Read (but do not hand in) the case "International Industries, Inc.'' at the end of Chapter 9. We will discuss the International Industries Case in class.

HOMEWORK ASSIGNMENT DUE. To be announced in class.

Class 20: Summary and Look-Ahead
Monday, December 7

In this last class session, we will present some extensions of the concepts and modeling tools developed in the course. We will also discuss possible follow-on classes at Sloan and elsewhere on campus. Last but not least, we will reserve part of this session to provide guidance as you prepare for the Final Examination.

Final Exam Review
Saturday, December 12

One or two 3-hour course/exam reviews will take place. We will review the most important aspects of the course. Details to be announced.

Final Exam
Monday, December 14,

The 3-hour final exam will cover the entire content of the course. The exam will be closed-book with no notes allowed. You may bring a non-communicating calculator with you to the exam. You will also be given a formula sheet and normal table, which will be posted on the course website prior to the exam.