RUTGERS
Rutgers Business School
Newark and New Brunswick

# Business Analytics & Information Technology
# COURSE NUMBER: 33:136:400
# COURSE TITLE: Business Decision Analytics under Uncertainty

## COURSE DESCRIPTION

The course focuses on the quantitative analysis of business problems requiring decision making in an uncertain environment. Some deterministic (that is, without uncertainty) problem-solving techniques are also covered, especially when they are similar to techniques used in the presence of uncertainty. This course extends and complements the required core course "Operations Management" (33:136:386).

Unlike Operations Management, this course emphasizes not only *modeling* decision problems, but also some details of how one solves them. In the course of analyzing simple inventory systems and decision problems, we will encounter some key analytical techniques, including simple decision trees, and various forms of a technique called *dynamic programming* -- informally, "thinking backwards" through all possible states of a system, starting at the possible outcomes and working back towards the present.

Roughly speaking, the course will be divided into two halves: the first half will cover techniques in which one examine all possible outcomes of an uncertain situation. To deal with situations in which this kind of exhaustive analysis is too difficult, the second half of the course will deal with approximation methods, most of which are simulation approaches in which one samples the possible outcomes and evaluates different courses of action by examining their sample performance. The basic topic sequence I am planning is:

- Decision tree methods for dealing with uncertainty
- Dynamic programming -- both deterministic and probabilistic. This topic generalizes the ideas used in decision trees
- Spreadsheet-based dynamic simulation, extending the Monte Carlo techniques taught in Operations Management to situations

with multiple fixed time periods

- Queuing theory -- the analysis of simple systems in which people or things wait in line for service Discrete-event simulation -- empirical computer analysis of (relatively) complicated systems in which events may occur at arbitrary times.
- Additional topics as time permits. One possibility is stochastic programming optimization models.

## GENERAL INFORMATION

- **Attendance**: I plan to pass around and attendance sheet during most classes. If you miss more than a certain "threshold" number of classes, there will be small percentage penalty on your grade for each class missed beyond the threshold. For example, in one of my recent classes, there was an 0.4% deduction for each meeting missed beyond 4 classes. On purpose, however, I do not announce the exact threshold and percent deduction in advance. If you don't come to class (no matter how good your reason), please don't come to office hours with questions about the material I discussed there.

- **Weather and Other Disruptions:** In severe weather, please check the class website -- if at all possible, I will post any class cancellation or schedule change information there as soon as I can. Also, check your Rutgers e-mail for any announcements of class cancellations. You can also monitor the Rutgers New Brunswick operating status page or the other resources listed on that page. My general policy is to hold class when the campus is open, and cancel class when the campus is closed.

- **E-Mail List:** I will sometimes use the Sakai mail tool or Rutgers' RAMS mail system to distribute important information such as class cancellations or homework assignment corrections and hints. Please check your e-mail regularly for class announcements -- it will be your responsibility if you miss one of these announcements. Sakai and RAMS use whatever e-mail Rutgers has on file for you. You may update the address Rutgers officially has on file by modifying your student record online at https://personalinfo.rutgers.edu/pi/updateAddress.htm (log in with your NetID).

- **Questions**: Unless you have skipped class, questions are strongly encouraged during class, during office hours, and via e-mail.

- **Exams**: There will be one in-class midterm exam and a final. Both exams will be open book. The final will be "cumulative", covering all topics in the course.

- **Homework**: I am planning on handing out homework assignments every one to two weeks (last time I taught this course, I gave 8

assignments). Typically, homework assignments will be handed out on Wednesday, and due in class the following Wednesday. There is *zero* credit for late homework (although I may excuse students from specific homework assignments in *documented* cases of genuine medical or family emergency). I will drop your *one* lowest assignment score in computing your overall homework performance, with late or missing assignments counting as a score of zero. This policy effectively allows you to skip one homework assignment without penalty. However, I would definitely recommend against skipping a homework early in the term.

- **Collaboration and Cheating**: You *are allowed* to seek or give help to other students on *homework* assignments. However, although there is no formal penalty for copying homework, I have found it critical for the learning process that you work through the problems yourself and hand in your own work. Otherwise, you will probably "crash and burn" on the exams**.** *No collaboration of any kind is permitted on exams.*

- **Grading**: I will probably use a graduate student grader or TA to grade homework assignments. I plan to do some of the exam grading myself, but due to the size of the class I may also have to use a TA to do some exam grading. No letter grades are assigned to individual assignments or exams, only numeric scores from 0 to 100. Your course grade will be based on your aggregate score, combining your scores on all written class work with following weights:
  - 30% Midterm
  - 45% Final
  - 25% Homework (excluding your worst score)
  - A deduction for missed classes beyond the allowed threshold is subtracted from the total above.

**I reserve the right to make changes to the grade calculation scheme.**

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## Tentative Class Schedule

**Business Decision Analytics under Under Uncertainty (33:136:400), Fall 2015**
**Tentative Course Schedule and Reading Assignments**

| Class # | Date | | Topic | Readings |
|---|---|---|---|---|
| 1 | 2-Sep | Weds | Introduction and procedures, introduction to decision m aking under uncertainty | |
| 2 | 8-Sep | Tues | Decision trees and the value of information (EVSI and EVPI) | 2.4 (except "incorporating risk aversion") |
| 3 | 9-Sep | Weds | Probability theory review, Bayes' formula, and decision trees | 1.4, 1.5, 2.5 |
| 4 | 14-Sep | Mon | More Bayes and decision trees, non-EMV decision-mak ing | 2.1, supplementary readings |
| 5 | 16-Sep | Weds | More on non-EMV decision making, start critical fractil e analysis | 4.1-4.4 |
| 6 | 21-Sep | Mon | Critical fractile case study, more critical fractile | Supplementary readings |
| 7 | 23-Sep | Weds | Deterministic dynamic programming: inventory and reso urce allocation | 6.1-6.4 |
| 8 | 28-Sep | Mon | Python programming with loops and array-like structure s | Online resources |
| 9 | 30-Sep | Weds | Deterministic dynamic programming: knapsack and par t replacement | |
| 10 | 5-Oct | Mon | Deterministic dynamic programming: part replacement, gains/spoilage, NPV inventory | 6.5 |
| 11 | 7-Oct | Weds | Stochastic dynamic programming: inventory and part re placement | 7.1, 7.2 |
| 12 | 12-Oct | Mon | Elementary stochastic processes: Bernoulli, binomial, geometric, Poisson, exponential | 7.3, 7.4 |
| 13 | 14-Oct | Weds | More elementary stochastic processes, random incidenc e effects, more stochastic dynamic programming | |
| 14 | 19-Oct | Mon | More stochastic dynamic programming, combining Pois son processes | |
| 15 | 21-Oct | Weds | Review for midterm | |
| 16 | 26-Oct | Mon | **Midterm Exam** | |
| 17 | 28-Oct | Weds | Exam results, review of spreadsheet-based simulation | |
| 18 | 2-Nov | Mon | Fixed-time-step dynamic simulation: inventory (possible substitute instructor) | |
| 19 | 4-Nov | Weds | Part replacement by fixed-time-step simulation, more dynamic Monte Carlo simulation | |
| 20 | 9-Nov | Mon | Waiting in line: repair shop and horses | |
| 21 | 11-Nov | Weds | Discrete-event simulation with Excel: an M/G/1 queue | |
| 22 | 16-Nov | Mon | Queuing -- Little's law and the Pollaczek-Khinchin formulas | 8.1, 8.2 |
| 23 | 18-Nov | Weds | Pollaczek-Khinchin examples and introduction to discre te-time simulation | 8.2, excerpts from 8.4, 8.8 |
| 24 | 23-Nov | Mon | Learning to use the Arena discrete-event simulator | 9.1, 9.2, 9.7, 9.8, 10.1, 10.2 |
| -- | 25-Nov | Weds | *No class -- Friday classes held due to Thanksgiving bre ak* | |
| 25 | 30-Nov | Mon | More complicated Arena problems | 10.3-10.6 |
| 26 | 2-Dec | Weds | Catch-up topics or stochastic programming | |
| 27 | 7-Dec | Mon | Catch-up topics or stochastic programming | |
| 28 | 9-Dec | Weds | Review for final exam | |
| -- | 22-Dec | Tues | **Final Exam, 12-3pm** | Topics: cumulative -- entire course |

Detailed schedule, subject to change: