

**Course:** 33:136:400 Business Decision Analytics under Uncertainty  
**Term:** Spring 2017  
**Classroom:** 100 Rockefeller Road (BRR), Room 3031 (Livingston Campus)  
**Time:** Monday/Wednesday 1:40pm (section 01) or 3:20pm (section 02)  
**Instructor:** Professor Jonathan Eckstein  
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## 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 important concepts relating to how one solves them.

The course will be divided into three modules: the first two modules will cover techniques in which it is possible to examine (perhaps after some approximation) all the possible outcomes of an uncertain situation. The first module primarily covers *decision tree* analysis, a technique in which one draws a steadily unfolding “tree” of all the possibilities that might occur. It also covers a related technique called *critical fractile analysis*.

The second module covers *dynamic programming*. This analytical method is conceptually similar to decision trees, in fact, decision trees are a special case of dynamic programming. In dynamic programming, we still consider every possible eventuality that could occur, and process each eventuality in a similar way, but we structure the calculations so that we do not necessarily produce a tree of outcomes that grows rapidly with time. When applicable, it is a very powerful technique. Dynamic programming calculations tend to be tedious when performed by hand, and are often painful to implement in spreadsheets, so we will learn how to perform them using simple computer programs. These programs will be in the Python language, and the module will include a basic introduction to Python programming.

Finally, to deal with situations in which the kind of exhaustive analysis covered in the first two modules is too difficult, the last module of the course will deal with *simulation* methods in which one samples the possible outcomes and evaluates different courses of action by examining their performance on the sample. We will cover both *Monte Carlo simulation*, using the YASAI Excel add-in also used in the *Operations Management* course (but solving more complicated problems), and *discrete-event simulation* using the Arena package. This module will also cover the basics of *queueing theory*, the mathematics of waiting in line.

The course will be taught in a lecture format. I will use the whiteboard to emphasize key points and perform example calculations, and the computer projector to demonstrate computer techniques such as Python programming, Excel calculations, and Arena models. I rarely use PowerPoint slides, and have never used them in this particular course.

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## COURSE MATERIALS

- Required textbook: *Introduction to Probability Models -- Operations Research*, Volume Two, 4<sup>th</sup> edition, by Wayne L. Winston, Cengage Learning, ISBN 9780534405724.
  - Some Harvard/Darden cases may be assigned online for a small fee
  - Other online materials (free of charge) may be assigned
  - Occasionally, brief course notes will be distributed in class and made available online.
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## COURSE TECHNOLOGY

- Websites:
    - o The main website for the course is <http://eckstein.rutgers.edu/bdaau>.
    - o For material that cannot be publicly released, refer to [BlackBoard](#); the main site will note when material is available on [BlackBoard](#).
  - During the second and third modules, it is recommended that you bring your laptop to most classes. The necessary software is
    - o Excel and the [YASAI](#) add-in (open-source freeware).
    - o The [PyCharm](#) package for Python programming (freeware).
    - o The [Arena](#) discrete-event simulation package (free student version only).
  - Check your officially registered Rutgers email account regularly for class announcements.
  - It is likely that some assignments may be handed in electronically through [BlackBoard](#). I will make announcements if this is the case.
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## LEARNING OBJECTIVES

The business school dean's office requires that each course have learning objectives explicitly tied to those of its academic program (in this case the New Brunswick undergraduate business program). Students successfully completing this course should be able to demonstrate the following:

- Ability to use standard operations research techniques such as decision trees or simulation to evaluate business plans and decisions in an uncertain environment [BAIT major objective (d)]
- Ability to ... apply quantitative modeling techniques to analyze business plans and decisions [The second part of overall program objective 1(d)]
- Students will demonstrate fundamental computer programming skills in a modern programming language such as Python, Java, or C++ [in this case, Python; BAIT major objective (a)]

Students will demonstrate these capabilities by correctly solving microeconomic business decision and planning problems by using appropriate methodology, which could involve applying an appropriate computer tool or writing a specialized Python program.

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### **PREREQUISITES AND EXPECTED BACKGROUND**

- 33:136:386 *Operations Management* is required
  - 33:136:388 *Foundations of Business Programming* (or similar prior programming experience) is recommended but not required
  - Knowledge of basic probability theory at the level of 01:960:285 *Introductory Statistics for Business* is expected (this is also effectively a prerequisite given the school's registration rules).
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### **ASSIGNMENTS, EXAMS, AND ACADEMIC INTEGRITY**

**All policies are subject to change at the instructor's discretion:**

Assignments:

- I am planning for 10 homework assignments, given out each Wednesday starting January 25, except for the classes immediately preceding exams. Assignments are planned to be due one week after distribution, except when spring break intervenes (in which case you will have two weeks).
- Collaboration in small groups **is permitted** on homework assignments. I have found that working in small groups can often help the learning process, and stricter policies are a waste of my time to enforce. You should hand in your own individual assignment even if you collaborated with other students.
- Due to the difficult logistics of tracking large numbers of students, there is no credit for late assignments. You will receive a zero score for any late assignments. However, I will drop your one lowest homework score when computing your overall course score.

Exams:

- My plan is to administer a midterm exam three classes after the conclusion of each of the first two modules (February 20 and April 3). This format gives you time to complete the last homework of the module, plus an additional 5 days for study, before taking the exam. The two classes between the end of a module and its midterm exam will be a mixture of review and the material beginning the next module. Each midterm exam will cover only the material in the preceding module.
- The material in the third module will be covered on the final exam, which will be cumulative (covering all material in the course).
- Plan to bring a calculator to every exam. All exams are planned to be open book and open notes. No computers, tablets, or phones of any kind are permitted in exams, so if you use a laptop or tablet to take notes, please print your notes and take only the printout to the exam. You may not use a smartphone as a calculator during an exam.
- No collaboration with any other individual is permitted on exams.
- If I detect any violation of exam policies, I will prosecute them as a violation of the RU academic integrity policy outlined here:

[http://academicintegrity.rutgers.edu/files/documents/AI\\_Policy\\_2013.pdf](http://academicintegrity.rutgers.edu/files/documents/AI_Policy_2013.pdf)

Students are expected to be familiar with the school's academic integrity policies. Additional information may be found at <http://business.rutgers.edu/ai>.

- Final exam scheduling conflicts will be managed in strict adherence to university regulations, with first preference for any students needing make-up exams to take the exam offered for the other section of the course. I will make announcements about final exam conflicts topic as the exam period nears. Any student with a final exam conflict must e-mail me a screenshot of their entire final exam schedule for the semester.

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## **OFFICE HOURS**

**These office hours are subject to change based on their convenience to student schedules and other factors.**

- Regular office hours will be Tuesdays 2pm-5pm, January 24 through April 25.
- Regular office hours will **not** be held on the days immediately following midterm exams, currently planned for February 21 and April 4.
- I am planning special pre-midterm-exam office hours on the weekday before each midterm exam. My current plan is to hold these office hours 1:30am-4:00pm on Friday, November 17 and Friday, March 31.
- Special pre-final-exam office hours will be offered during exam period at times to be announced later.
- If you cannot make it to scheduled office hours, you are free to send me e-mail to ask questions or request an office appointment at a different time. I obviously cannot promise to honor all appointment requests, but I will make my best effort to find a mutually possible time to meet students unable to attend scheduled office hours.
- I am also often available to talk to students immediately before or after class, but sometimes I will need to concentrate on being ready for class and occasionally I may need to leave promptly at the end of class.
- Please do not use office hour time to try to catch up on missed classes, no matter how good your reason for missing them (see the attendance policy below).
- During office hours, do not simply hand me a draft of your homework assignment and ask me to check whether it is correct. Instead, please formulate specific questions about points about which you are unsure or confused.
- If it is possible to arrange additional office hours with a TA, I will make an announcement to that effect.

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## **ATTENDANCE AND CLASS CANCELLATION POLICIES**

Attendance:

- I plan to pass around an attendance sheet during most classes and record the results in my private grading spreadsheet.
- If you miss more than a certain "threshold" number of classes, there will be small percentage penalty on your overall aggregate course score for each class missed beyond

the threshold. For example, in one of my recent courses, there was a 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. In the past, however, the threshold has never been below 4 classes, and has often been 5 classes.

- It is **not** generally necessary to inform me if you will be missing a class due to an illness, job interview, religious observance or other reason, unless you are missing an exam or missing more than 4 total class meetings (which is strongly discouraged).
- The goal of my attendance policy is to encourage good attendance, not to enforce or reward perfect attendance. I understand that students are occasionally ill or have job or internship interviews that are inflexibly scheduled. But keep in mind that good attendance and paying attention in class will be critical for most students to perform well in this course.
- If you miss an exam or homework due to illness, please contact me to see whether any accommodation is possible. Severe illness or personal emergency is typically the only reason I make accommodations, and there must be written, verifiable documentation. Otherwise, you will receive a zero score on the missed assignment or exam.

Severe weather and other cancellations:

- My general policy is to hold class whenever the campus is open and class is scheduled, regardless of the weather or religious observances.
- Your primary source of information for whether the campus is open is the [Rutgers New Brunswick operating status page](#).
- You may also check the course website at <http://eckstein.rutgers.edu/bdauu>, where I will try to post cancellation information if possible.
- If it is impossible or unsafe for me to attend class and I cannot find a substitute lecturer, I will make every effort to send an e-mail announcement (to your e-mail address officially registered with Rutgers) and post an announcement on <http://eckstein.rutgers.edu/bdauu>. This eventuality is highly unlikely if the campus is open (I have only cancelled class once in 20 years, due to a severe illness).

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## GRADING POLICIES

**I reserve the right to make changes to grading policies.** (Although I rarely do so.)

- I will plan to use a TA or grader to grade homework assignments. I plan to perform most of the exam grading myself, but I might use the TA/grader for limited amounts of 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 overall aggregate score, which combines your scores on all written class work with following weights.
  - o 20% for each midterm exam
  - o 40% final exam
  - o 20% average homework score, with your lowest score dropped
  - o If your final exam grade is higher than the lower of your two midterm exam grades, 10% grading weight will be transferred from the lower midterm score to

the final exam (so the weights will become 10% lower midterm, 20% higher midterm, 50% final, and 20% average homework). This policy is intended to allow students to recover from poor performance on a midterm.

- I assign letter grades based on your overall aggregate score. I do not use fixed cutoff values, but instead use my judgment to select cutoffs that make sense for each particular course and semester. The cutoffs may vary by section when the exams taken by various sections are not identical.
- I never offer extra credit work to improve grades after they have been issued. Such a policy is not fair to other students: extra credit opportunities would have to be offered to every student whose grade was below “A”, and each course would drag out interminably.
- I plan to post homework and exam grades on [BlackBoard](#).
- I will attempt to return graded homework assignments at the beginning of class, usually one week after they are handed in. Any unclaimed homework will eventually go into a box outside my office door. Any homework still in this box 30 days after the end of the semester will be recycled.
- I will review the results of midterm exams in class, with each student receiving a copy of the exam, their answers, and a copy of my official solutions. I generally plan to review midterm results one week after each exam, but I will announce the definite date once the exams are graded. You must return the exam, your answers, and my solutions to me before leaving the classroom. If you miss the class in which exams were reviewed or want to look at your exam further, you may inspect your exam in my office, either during scheduled office hours or by appointment (see the office hour policy above).
- Students with particularly poor attendance or performance as of March 10 will be issued warning grades.
- I sometimes make mistakes in grading, and I will be happy to regrade any assignment or exam on which you believe there might have been an error. However, you should be aware that if there turn out to have been errors in your favor, then regrading has a chance of lowering your grade as well as raising it.
- I cannot allow external considerations such as scholarships with GPA requirements to affect my grading.

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## SUPPORT SERVICES

If you need accommodation for a *disability*, obtain a Letter of Accommodation from the Office of Disability Services. This office provides student-centered and student-inclusive programming in compliance with the Americans with Disabilities Act of 1990, the Americans with Disabilities Act Amendments of 2008, Section 504 of the Rehabilitation Act of 1973, Section 508 of the Rehabilitation Act of 1998, and the New Jersey Law against Discrimination. Please see <https://ods.rutgers.edu>.

If you are a military *veteran* or are on active military duty, you can obtain support through the Office of Veteran and Military Programs and Services. Please see <http://veterans.rutgers.edu/>.

If you are in need of *mental health* services, Rutgers has services available. Please see Rutgers Counseling and Psychological Services – New Brunswick at <http://rhscaps.rutgers.edu/>.

If you are in need of *physical health* services, Rutgers has services available. Please see Rutgers Health Services – New Brunswick at <http://health.rutgers.edu/>.

If you are in need of *legal* services, please see the services available at <http://rusls.rutgers.edu/>.

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## **COURSE SCHEDULE**

The planned course schedule is on the next page of this syllabus. Depending on the performance of the class and weather or other emergencies, it may prove necessary to deviate from this schedule.

**Business Decision Analytics under Under Uncertainty (33:136:400), Spring 2017**  
**Planned Lecture, Reading, and Assignment Schedule**

Class #	Date	Topic	Readings	Homework Distributed	Homework Due
1	18-Jan	Weds	Introduction and procedures, introduction to decision making under uncertainty		
2	23-Jan	Mon	Decision trees and the value of information (EVSI and EVPI), start formal probability theory		
3	25-Jan	Weds	More fundamental probability and random variables, Bayes' formula	1	
4	30-Jan	Mon	Bayes' formula and decision trees		
5	1-Feb	Weds	More Bayes and decision trees, non-EMV decision-making	2	1
6	6-Feb	Mon	More on non-EMV decision making, start critical fractile analysis		
7	8-Feb	Weds	Critical fractile case study, more critical fractile	3	2
8	13-Feb	Mon	Deterministic dynamic programming: shortest paths		
9	15-Feb	Weds	Review for first midterm exam		3
10	20-Feb	Mon	<b>First midterm exam</b>		
11	22-Feb	Weds	More deterministic dynamic programming: knapsack, resource allocation, and inventory	4	
12	27-Feb	Mon	Introduction to elementary Python: loops, lists, and PyCharm		
13	1-Mar	Weds	Exam results, "numpy" arrays, simple deterministic dynamic programming in Python	5	4
14	6-Mar	Mon	Deterministic dynamic programming with Python		
15	8-Mar	Weds	Introducing stochastic dynamic programming	6	5
--	13-Mar	Mon	<i>No class -- spring break</i>		
--	15-Mar	Weds	<i>No class -- spring break</i>		
16	20-Mar	Mon	Stochastic programming with net present value, elementary stochastic processes		
17	22-Mar	Weds	More elementary stochastic processes, more stochastic dynamic programming	7	6
18	27-Mar	Mon	Introduction/review for spreadsheet-based simulation		
19	29-Mar	Weds	Dynamic spreadsheet-based simulation (inventory), review for second midterm		7
20	3-Apr	Mon	<b>Second midterm exam</b>		
21	5-Apr	Weds	Exam results, more dynamic Monte Carlo simulation (part replacement)	8	
22	10-Apr	Mon	Monte Carlo simulation of queue-like systems		
23	12-Apr	Weds	Discrete-event simulation with Excel: an M/G/1 queue	9	8
24	17-Apr	Mon	Queuing -- Little's law and the Pollaczek-Khinchin formulas		
25	19-Apr	Weds	Pollaczek-Khinchin examples and introduction to discrete-event simulation	10	9
26	24-Apr	Mon	Learning to use the Arena discrete-event simulator		
27	26-Apr	Weds	More complicated Arena problems		10
28	1-May	Mon	Review for final exam		
--	9-May	Tues	<b>Final exam for 1:40pm section, 12-3pm</b>		
--	10-May	Weds	<b>Final exam for 3:20pm section, 12-3pm</b>		