

**Business Analytics and 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. It also covers some deterministic (that is, without uncertainty) problem-solving techniques, 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 includes a related technique called *critical fractile analysis*. The study of decision trees will incorporate some work on Bayesian probability calculations.

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, 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 decision policies 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.

## COURSE MATERIALS

- Required textbook: you may use either one of the following:
  - o *Business Analytics 136:400*, collection of loose-leaf pages available from the campus bookstore
  - o *Or* a used copy of *Introduction to Probability Models — Operations Research*, Volume Two, 4<sup>th</sup> edition, by Wayne L. Winston, Cengage Learning, ISBN 9780534405724.The two textbook options contain identical material; you may use either one.
- Some Harvard/Darden cases may be assigned online for a small fee (but probably not)
- Other online materials (free of charge) may be assigned
- Occasionally, supplementary course notes will be distributed in class and made available online.

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## LEARNING GOALS AND 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 course is also effectively a prerequisite given the school's registration rules).

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## ACADEMIC INTEGRITY

*I do NOT tolerate cheating.* Students are responsible for understanding the RU Academic Integrity Policy

(<http://academicintegrity.rutgers.edu/>).

I will strongly enforce this Policy and pursue *all* violations. On all examinations and assignments, students must sign the RU Honor Pledge, which states, “On my honor, I have neither received nor given any unauthorized assistance on this examination or assignment.” I will screen all written assignments through *SafeAssign* or *Turnitin*, plagiarism detection services that compare the work against a large database of past work. Don’t let cheating destroy your hard-earned opportunity to learn. See [business.rutgers.edu/ai](http://business.rutgers.edu/ai) for more details.

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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.
- 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 (all of which are strongly discouraged). If homework is due during a class you plan to miss, please hand it in early at my office or have another student hand in your paper for you during class.
- 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:

- Your primary source of information for whether the campus is open is the [Rutgers New Brunswick operating status page](#).
- Any announcement regarding course will be posted on Canvas.

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## ASSIGNMENTS, EXAMS

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

Assignments:

- There will be 6 assignments throughout the semester. Assignments are planned to be due one week after distribution.
- Collaboration in small groups **is permitted** on homework assignments. However, you should hand in your own individual assignment even if you collaborated with other 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. 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 Rutgers University academic integrity policy outlined here: (<http://academicintegrity.rutgers.edu/>).
  - 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 by the last day of classes or have to take the exam at the regularly scheduled time.
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## COURSE TECHNOLOGY

- Websites:
    - o I will use Canvas for announcements however for any information or assignments you can use the main website
  - During the second and third modules, it is recommended that you bring your laptop to most classes. The necessary software is Excel and the **YASAI** add-in (open-source freeware).
    - o The **PyCharm** environment for Python programming (freeware).
  - If time permits, I am also planning to cover discrete event simulation for which you would require to have **Arena** discrete-event simulation package (free student version only)
  - Please check your officially registered Rutgers email account regularly for class announcements.
  - Portions of some of the assignments will be handed in electronically through **Canvas**. I will make announcements when this is the case. When a portion of an assignment is handed in electronically, there will also still be a hardcopy portion. A common student mistake is to hand in only the electronic or only the hardcopy part of such an assignment, so please make sure you hand in all portions of each assignment as instructed.
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## GRADING POLICIES

**I reserve the right to make changes to grading policies.**

- 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.

- 20% for each midterm exam
  - 40% final exam
  - 20% average homework score
  - 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 one of the midterms.
- 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 from other sections when the exams taken by the sections are not identical.
- I would like to reward students who wake up early and attend the class. Therefore, I am planning to give extra credits to students whose attendance is above some threshold. I will determine the amount of extra credit and the threshold through the end of the semester.
  - I plan to post homework and exam grades on [Canvas](#).
  - 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 by appointment.
  - If you believe there is a mistake in grading, feel free to get in contact with me. I will be happy to regrade any assignment or exam on which you believe there might have been an error.
  - I cannot allow external considerations such as scholarships with GPA requirements to affect my grading.

## COURSE SCHEDULE

The planned lecture, assignment and readings schedule

Class	Topics	Readings	Homework Distributed	Homework Due
1	Introduction and procedures, introduction to decision making under uncertainty			
2	Introduction to decision trees, probability theory review	2.4 (except "incorporating risk aversion") 1.4		
3	Conditional Probability and Bayes' formula	1.5-1.6	1	
4	Bayes' formula and decision trees, start revisiting non-EMV decision-making	2.5		1
5	Risk aversion and utility functions	2.1, supplementary readings		
6	Critical fractile analysis	4.1-4.4		
7	Critical fractile case study	Supplementary readings	2	
8	Deterministic dynamic programming: shortest path.	6.1-6.2		2

9	Review for first midterm exam			
10	<b>First midterm exam</b>			
11	More deterministic dynamic programming: knapsack and inventory	6.3-6.4		
12	Introduction to elementary Python: loops, lists, and Pycharm	Online resources		
13	Exam results, numpy arrays, simple deterministic dynamic programming in Python	Online resources	3	
14	More deterministic dynamic programming with Python	6.5		3
15	Introduction stochastic dynamic programming	7.1,7.2		
-	<i>NO CLASS</i>			
-	<i>NO CLASS</i>			
16	Stochastic DP with net present value, elementary stochastic processes	7.3,7.4		
17	More elementary stochastic processes, and their use with stochastic DP		4	
18	The curse of dimensionality, introduction/review for spreadsheet-based simulation	Online resources; concepts in chapter 11		4
19	Dynamic spreadsheet-based simulation (inventory), review for second midterm			
20	<b>Second midterm exam</b>			
21	Exam results, mode dynamic Monte Carlo simulation (part replacement)			
22	Monte Carlo simulation of queue-like systems			
23	Discrete-event simulation with Excel: an M/G/1 queue		5	
24	Queuing - Little's law and the Pollaczek-Khinchin formulas	8.1, 8.2		5
25	Pollaczek-Khinchin examples and introduction to discrete-event simulation	8.2, excepts from 8.4,8.8		
26	Learning to use the Arena discrete-event simulator	9.1,9.2,9.7,9.8,10.1,10.2		
27	More complicated Arena Problems	10.3-10.6	6	
28	Review for final exam			6
-	<b>Final Exam</b>	Topics: Cumulative - entire course		

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## SUPPORT SERVICES

If you need accommodation for a *disability*, obtain a Letter of Accommodation from the Office of Disability Services. The Office of Disability Services at Rutgers, The State University of New Jersey, 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. More information can be found at [ods.rutgers.edu](http://ods.rutgers.edu).

[Rutgers University-New Brunswick ODS phone (848)445-6800 or email [dsoffice@echo.rutgers.edu](mailto:dsoffice@echo.rutgers.edu)]

[Rutgers University-Newark ODS phone (973)353-5375 or email [ods@newark.rutgers.edu](mailto:ods@newark.rutgers.edu)]

If you are ***pregnant***, the Office of Title IX and ADA Compliance is available to assist with any concerns or potential accommodations related to pregnancy.

[Rutgers University-New Brunswick Title IX Coordinator phone (848)932-8200 or email [jackie.moran@rutgers.edu](mailto:jackie.moran@rutgers.edu)]

[Rutgers University-Newark Office of Title IX and ADA Compliance phone (973)353-1906 or email [TitleIX@newark.rutgers.edu](mailto:TitleIX@newark.rutgers.edu)]

If you seek ***religious accommodations***, the Office of the Dean of Students is available to verify absences for religious observance, as needed.

[Rutgers University-New Brunswick Dean of Students phone (848)932-2300 or email [deanofstudents@echo.rutgers.edu](mailto:deanofstudents@echo.rutgers.edu)]

[Rutgers University-Newark Dean of Students phone (973)353-5063 or email [DeanofStudents@newark.rutgers.edu](mailto:DeanofStudents@newark.rutgers.edu)]

If you have experienced any form of ***gender or sex-based discrimination or harassment***, including sexual assault, sexual harassment, relationship violence, or stalking, the Office for Violence Prevention and Victim Assistance provides help and support. More information can be found at <http://vpva.rutgers.edu/>.

[Rutgers University-New Brunswick incident report link: <http://studentconduct.rutgers.edu/concern/>. You may contact the Office for Violence Prevention and Victim Assistance at (848)932-1181]

[Rutgers University-Newark incident report link: [https://cm.maxient.com/reportingform.php?RutgersUniv&layout\\_id=7](https://cm.maxient.com/reportingform.php?RutgersUniv&layout_id=7) . You may also contact the Office of Title IX and ADA Compliance at (973)353-1906 or email at [TitleIX@newark.rutgers.edu](mailto:TitleIX@newark.rutgers.edu). If you wish to speak with a staff member who is confidential and does **not** have a reporting responsibility, you may contact the Office for Violence Prevention and Victim Assistance at (973)353-1918 or email [run.vpva@rutgers.edu](mailto:run.vpva@rutgers.edu)]

If students who have experienced a temporary condition or injury that is adversely affecting their ability to fully participate, you should submit a request via <https://temporaryconditions.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. <http://veterans.rutgers.edu/>

If you are in need of **mental health** services, please use our readily available services.

[Rutgers University-Newark Counseling Center: <http://counseling.newark.rutgers.edu/>]

[Rutgers Counseling and Psychological Services–New Brunswick: <http://rhscaps.rutgers.edu/>]

If you are in need of **physical health** services, please use our readily available services.

[Rutgers Health Services – Newark: <http://health.newark.rutgers.edu/>]

[Rutgers Health Services – New Brunswick: <http://health.rutgers.edu/>]

If you are in need of **legal** services, please use our readily available services: <http://rusls.rutgers.edu/>

Students experiencing difficulty in courses due to **English as a second language (ESL)** should contact the Program in American Language Studies for supports.

[Rutgers–Newark: [PALS@newark.rutgers.edu](mailto:PALS@newark.rutgers.edu)]

[Rutgers–New Brunswick: [eslpals@english.rutgers.edu](mailto:eslpals@english.rutgers.edu)]

If you are in need of additional **academic assistance**, please use our readily available services.

[Rutgers University-Newark Learning Center: <http://www.ncas.rutgers.edu/rlc>]

[Rutgers University-Newark Writing Center: <http://www.ncas.rutgers.edu/writingcenter>]

[Rutgers University-New Brunswick Learning Center: <https://rlc.rutgers.edu/>]

[Optional items that many faculty include:

- Students must sign, date, and return a statement declaring that they understand the RU Academic Integrity Policy.

- Students must sign, date, and return a statement declaring that they understand this syllabus.]