INQ 241 B, Spring 2018: Making Better Decisions Through Game Theory and Probability

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Class Meetings Mondays, Wednesdays, and Fridays: 9:40 AM - 10:40 AM in Trexler 374

Office Hours In an effort to be more available to students while also acknowledging that meetings occur in my schedule that are outside of my direct control, rather than specify office hours specifically, I have chosen to use the "You Can Book Me" online scheduling tool so that you can schedule an appointment whenever, and your appointment will be put on my schedule (this online tool uses my live availability). Note that I am *generally* on campus all weekdays from 9 AM to 2 PM and you are still welcome to stop by without an appointment, but I may or may not be able to meet at any given time. You can access the online scheduler at:

- drtaylorofficehours.youcanbook.me

Focus of Inquiry There are many ways to improve decision-making skills; the most common is learning as much as possible before making a choice. This course focuses on how mathematics can be used to inform decisions to be made. Specifically, we explore game theory, which is "the study of mathematical models of conflict and cooperation between intelligent, rational decision-makers" and, while most often applied to economics, has connections to political science, psychology, biology, and other fields. When a decision doesn't involve other people, probability theory guides our thoughts and is the second topic we will explore. Why is one choice better than another? How does another person's desire to compete or be cooperative inform our choices? When chance is involved, how can we make the best choice possible? We address all of these questions, and as time allows we will bring in ideas from combinatorial game theory, information theory, and other related topics.

Intended Learning Outcomes By the end of this course, successful students will be able to:
- describe and apply methodologies of mathematics or computer science appropriate for the course's discipline and topic,

- write about course topics clearly and effectively,

- interpret quantitative information related to the course topic.

Required Materials **Textbook 1**: *Game Theory and Strategy*, by Philip D. Straffin, MAA Press, ISBN 0-88385-637-9
Textbook 2: *The Mathematics of Games: An Introduction to Probability*, by David G. Taylor, CRC Press, ISBN 978-1-4822-3543-2
Reference Book: *A Writer's Reference* by Diana Hacker, RC Edition or *Easy Writer* by Andrea A. Lunsford, 6th Edition
Calculator: You need a calculator able to perform some combinatorial operations (nCr and nPr); a TI-83 is great, but consult the instructor for more details. **Other**: Other readings will be provided as needed.

Course Grades   The following table lists the weights for the various forms of assessment for this class.

Homework	10%
Papers/Projects	30%
Tests	48%
Final Exam	12%

A grade scale will be determined after final grades are computed, but will be no worse than the scale given on the next page.

		B+	87-89	C+	77-79	D+	67-69		
A	93-100	B	83-86	C	73-76	D	63-66	F	0-59
A-	90-92	B-	80-82	C-	70-72	D-	60-62		

Homework   Homework is assigned regularly in this class and will generally be routine problems from the textbooks that serve as good examples to use in class to reinforce certain topics. Homework will be discussed in class and also collected so that the instructor can provide feedback to you. Completing homework and doing problems is the best way to become familiar with the material! You are encouraged to visit my office hours or ask questions through email about the homework problems, and you are definitely encouraged to work together on the homework! However, please be sure that the final version of your solutions are written independently of others.

Tests   There will be four tests this semester; the tests will focus primarily on the content of this course, but will also emphasize critical thinking and writing! Homework and class notes are absolutely the best sources of review! The tests will not be designed to be cumulative, but as with any course involving mathematics, material from previous tests can be thought of as a prerequisite for future tests. Note that the first two tests will primarily focus material regarding game theory and the second two tests will primarily focus material regarding probability.

Papers/Projects   There will be two major projects in this class that both result in a formal paper. For each of these, while you may certainly use Microsoft Word and similar programs, you are encouraged to explore using the typesetting language L^{A}TEX to type your papers as it makes expressing mathematics much easier. You can learn L^{A}TEX online and use web sites such as http://www.overleaf.com to learn and see your results.

The first paper will allow you to explore a connection of game theory to a discipline other than mathematics. You will be required to use our textbook and/or other sources to connect game theory to a question in a different discipline and explain how game theory can be used to answer that question. At least one source other than our textbook is required. The end product will be a paper that is approximately 4 to 5 pages in length.

The second paper will allow you to explore the mathematics and probability that is found in some game or phenomenon not discussed in class. While this may require some research, the primary focus of this paper is for you to explore the mathematics behind a question that we do not explore together. For instance, you might consider how probability affects decisions made in your favorite board game. This paper should be approximately 3 to 4 pages in length.

Reading	Daily reading of assigned sections from our textbook is expected. You should come to class prepared to discuss the material that you have read. You can find an approximate list of sections assigned for any given few weeks on the last page of this syllabus, and deviations from his list will be announced in class and posted on Inquire. Readings from other sources will be assigned as appropriate.
Final Exam	The final exam will be comprehensive and given during the scheduled time for the final exam for Block 2. As with the tests, it will also emphasize critical thinking and writing. The best way to review for the final is to review your performance on the four tests; focus on material that you did not master the first time around, and review the topics that you did master. Any extra material discussed not present on the first four tests will appear on the final exam.
Expected Workload	You are expected to spend at least 12 hours, on average, per week for this class, including hours inside and outside of class.
MCSP Conversation Series	The Department of Mathematics, Computer Science and Physics offers a series of discussions that appeal to a broad range of interests related to these fields of study. These co-curricular sessions will engage the community to think about ongoing research, novel applications and other issues that face our discipline. Members of this class are invited be involved with all of these meetings; however participation in **at least one** of these sessions is mandatory. After attending, students will submit a one page paper reflecting on the discussion. This should **not** simply be a regurgitation of the content, but rather a personal contemplation of the experience. This reaction paper will be counted as two homework assignments.
Attendance & Make-Up Work	Attendance is critical to the understanding of the material in the course; it is both required and expected. Any absence that is not discussed with the instructor prior to the missed class is considered unexcused. When absent, excused or unexcused, you are responsible for all material covered in class. **You will not be allowed to make up any work missed due to an unexcused absence.**
Academic Integrity	Students are expected to adhere to the Academic Integrity policies of Roanoke College. All work submitted for a grade is to be your own work! No electronic devices other than calculators can be taken out during any class or testing period (this includes cell phones; please turn them **off** before class). Note that looking at or using your cell phone during a test is considered a violation of Academic Integrity regardless of your purpose or intent in doing so.

Course Schedule The following schedule is approximate and subject to change. This mainly lists the topics to be covered, paper time lines, and tests. Other readings will be assigned when appropriate, and especially for the last three days of class. Note that chapters with an [S] refer to *Game Theory and Strategy* by Staffin and chapters with a [T] refer to *The Mathematics of Games: An Introduction to Probability* by Taylor.

Mon	Jan 15	Chapter 1 [S]	The Nature of Games
Wed	Jan 17	Chapter 2 [S]	Matrix Games: Dominance and Saddle Points
Fri	Jan 19	Chapter 3 [S]	Matrix Games: Mixed Strategies
Mon	Jan 22	Chapter 3 [S]	Matrix Games: Mixed Strategies
Wed	Jan 24	Chapter 7 [S]	Game Trees
Fri	Jan 26	Chapter 7 [S]	Game Trees
Mon	Jan 29	Chapter 9 [S]	Utility Theory
Wed	Jan 31	Chapter 9 [S]	Utility Theory, **Review for Test 1**
Fri	Feb 2		**Test 1**

Mon	Feb 5	Chapter 10 [S]	Games Against Nature
Wed	Feb 7	Chapter 11 [S]	Nash Equilibria and Non-Cooperative Solutions
Fri	Feb 9	Chapter 11 [S]	Nash Equilibria and Non-Cooperative Solutions
			Paper #1 Information Discussed
Mon	Feb 12	Chapter 12 [S]	The Prisoner's Dilemma
Wed	Feb 14	Chapter 14 [S]	Strategic Moves
Fri	Feb 21	Chapter 14 [S]	Strategic Moves
		Chapter 16 [S]	The Nash Arbitration Scheme and Cooperative Solutions
Mon	Feb 19	Chapter 16 [S]	The Nash Arbitration Scheme and Cooperative Solutions
Wed	Feb 21	Chapter 19 [S]	An Introduction to *N*-Person Games, **Review for Test 2**
Fri	Feb 23		**Test 2**
Mon	Feb 26	Chapter 1 [T]	Probability Basics
Wed	Feb 28	Chapter 1 [T]	Probability Basics
Fri	Mar 2	Chapter 2 [T]	Expected Value, Roulette, and Craps
			Paper #1 Due
			Spring Break
Mon	Mar 12	Chapter 2 [T]	Expected Value, Roulette, and Craps
Wed	Mar 14	Chapter 2 [T]	Expected Value, Roulette, and Craps
Fri	Mar 16	Chapter 3 [T]	Combinatorics and Poker
Mon	Mar 19	Chapter 3 [T]	Combinatorics and Poker
Wed	Mar 21	Chapter 4 [T]	Decision Trees and Blackjack, **Review for Test 3**
Fri	Mar 23		**Test 3**
Mon	Mar 26	Chapter 5 [T]	Binomial Distributions and Dice Games
Wed	Mar 28	Chapter 5 [T]	Binomial Distributions and Dice Games
Fri	Mar 30		**No Class: Good Friday**
Mon	Apr 2	Chapter 6 [T]	Cyclic Board Games and Stochastic Matrices
Wed	Apr 4	Chapter 6 [T]	Cyclic Board Games and Stochastic Matrices
Fri	Apr 6	Chapter 7 [T]	The Gambler's Ruin
			Paper #2 Information Discussed
Mon	Apr 9	Chapter 8 [T]	More Probability Questions
Wed	Apr 11	Chapter 8 [T]	More Probability Questions
Fri	Apr 13		**Review for Test 4**
Mon	Apr 16		**Test 4**
Wed	Apr 18		Special Topics
Fri	Apr 20		Special Topics
Mon	Apr 23		Special Topics, **Review for Final Exam**
Thu	Apr 26		**Final Exam: 2:00 PM - 5:00 PM**
			Paper #2 Due