88-312 Decision Models and Games

Carnegie Mellon University
Department of Social and Decision Science
Spring 2022

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Lectures: Mon & Wed- 3:05PM-4:25PM – In-person Expectation
PH A18B

TA office Hours Ngoc Nguyen
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Tuesdays: 3-4PM and Fridays: 3-4PM– In person PH-223G
If you prefer a synchronous remote meeting, join the Zoom link during the same times:

https://cmu.zoom.us/j/91807101536?pwd=TWZKODJIcWZrL2N0blplckF0NVM1UT09

Meeting ID: 918 0710 1536
Passcode: 609316

Additional office hours: To set up an appointment with Coty or additional office hours with Ngoc, please send an E-mail.

Prereq: 36-200 Reasoning with Data.

Relevance: Computational Thinking; Complex Problem Solving; Interdisciplinary Perspectives.

Course Description:

Humans often make decisions in changing and uncertain situations. A car driver entering a new city must adjust decisions rapidly while moving along heavy traffic; firefighter crews entering a burning building must maintain awareness of the development of fire; citizens in a country must change their activities based on the evolution of a pandemic and the restrictions imposed. While challenging, humans are adaptable species. We plan and re-adjust our plans to changing conditions; we keep aware of potentially new courses of action; and we manage our limited time, information, and attention to changing environments. How do humans make decisions in dynamic situations?

This course will explore human decision making as a dynamic process resulting from human interactions with the environment. The course uses decision games to illustrate how humans learn and adapt to changing conditions of choice, and computational models to simulate decision processes and environmental dynamics.

Decision Models and Games will provide: (1) foundational perspectives for using models to represent the dynamics of environments and human decision processes; (2) tools to build computational models of human decision making and of dynamic environments; and (3) practical illustrations of how models and games can be used to understand and generate solutions to a wide range of decision problems, from simple choices to large scale consequential decisions.

No previous experience with programing or computational model is needed.

Learning Objectives:

By the end of this semester students will be able to:

- Critically analyze dynamic decision making situations to determine the role of experience, memory, and learning in making decisions in dynamic situations.
- Utilize games of dynamic decision making problems to analyze dynamic decision situations and be able to determine: stakeholders, alternatives, internal and external factors that influence decisions.
- Learn to interpret cognitive models of decision making from simulations and computational tools. Be able to outline the development of cognitive processes involved in making decisions from experience.
- Learn to represent a dynamic system into a model using diagram tools: Causal loop diagrams and Stock and Flow diagrams.
- Learn to build, test, and use models of dynamic systems to simulate, experiment, and learn about the system's dynamic behavior.
- Learn to interpret the dynamics and the outcomes of System Dynamics models, and to use these models to propose solutions to decision problems.

Learning Resources:

Given the novelty and diversity of the topics discussed in this course, no textbook is published yet to fit the plan for this course. To help you in getting information from various sources, I will provide book chapters and research articles that support the different topics of the course. You will be able to access those materials electronically through Canvas.

During the course you will also need to use decision games (a.k.a. Microworlds), modeling products to represent human decision processes (i.e., Shinny Instance-Based Learning), and simulation products to represent dynamic systems (i.e., Vensim-PLE). All the software to be used in this course is cost-free and you will be given additional instructions on how to get access, when needed.

Assessment Structure:

We will use a point grading system where points accumulate from 0 to up to 100 points throughout the semester. Your final letter grade will be based on your cumulative point total for the components listed below:

- **4 Projects (60 points)**, 15 points each;
- **2 in-class exams (30 points)**, 15 points each;
- **20 in-class quizzes (10 points),** 0.5 points each.

Your total number of points will be updated in Canvas within one week of the due date of the assignment or exam, and after each class for the quizzes.

At the end of the semester, the sum of your points will be converted to a letter grade after rounding up the points as follows: 90-100 points (A), 80-89 points (B), 70-79 points (C), etc. The points will be rounded-up at the end of the semester, but no curves or adjustments are done to the accumulated points otherwise.

Project Assignments.

All the requirements for each of the four **projects** will be described in detail at the beginning of each module corresponding to the project. All projects are **due at 3:00PM of the due day identified in the schedule below**. We will use Canvas submission time to determine the lateness of your assignment. **No late submissions are allowed**: **all points will be forfeited for assignments handed in late.**

In-class Exams

Two **closed-book exams** will include multiple-choice and True/False questions. Questions may need you to perform some analyses/calculations or critical thinking before an answer can be found. **Exams will NOT be cumulative**. They will only cover materials not covered in the previous exam. The exams will be based on lecture materials and the content of articles and materials assigned for reading. Exams will take place during class time, on the dates **identified in the schedule below, and will start at 3:05 sharp.**

In-class Quizzes.

Students will get **closed-book quizzes** to cover research articles and other reading materials assigned for the particular day as **identified in the schedule below**. Quizzes will include multiple-choice and True/False questions

or short answers and will be directly related to the readings assigned for the lecture of the day. The quiz will start **at the beginning of each class: from 3:05-3:10PM**. No make-up quizzes are possible and there is no option to take the quiz at a different time. **Thus, you must be present at 3:05PM in order to take the quiz**. An access code will be provided to take the quiz for each class. **This code cannot be shared to students that are not attending the class.**

Course Policies:

Well-Being, Diversity Equity and Inclusion statement.

I value, welcome, and respect differences in intellectual exchange and diversity of all kinds. I aim at making this course and myself approachable to everyone. Please contact me (in person or via email) if you have any suggestions to make this course more manageable and inclusive. I aim at creating a learning environment where all my students from a diversity of thoughts, perspectives, identities (including race, gender, class sexuality, religion, ability, etc.) feel welcomed and encouraged to approach me. If you feel that your performance in the class is being impacted by your outside experiences, please don't hesitate to contact me. The TA and myself are here for you and to help you. Students with special accommodations are encouraged to discuss with me as needed.

Academic Integrity.

Students are expected to respect the integrity of their work as well as that of their classmates. Please refer to the University Policy for further detail. Evidence of cheating or plagiarism will be referred to the Department Head and/or the College. Depending upon the individual violation, students could face penalties ranging from failing the assignment to failing the class. All violations will be reported through the University's Academic Disciplinary Action Procedures for Undergraduate Students, which is published in The WORD student handbook. To learn more about the disciplinary actions that can result from dishonesty, refer to the Office of Community Standards & Integrity**.**

Do not accept or use copies of previous exams, problem sets, or other assignments from this course that you receive from any source. Use of previous course materials from any outside source (e.g., fraternity file or other students) will be considered a **violation of academic integrity**, and if you are found to have obtained or distributed such materials, you will be subject to disciplinary actions.

The instructor may provide lecture materials such as copies of lecture slides posted to the Canvas course site. These materials are the intellectual property of the instructor and are provided for use only by students registered for the course in the current semester. **Do not share these materials** with people outside the current class or post them to online repositories such as Course Hero. If you are found to have shared course materials inappropriately, you will be subject to disciplinary actions.

Course structure and schedule:

The material is divided into four modules: Module I: Foundations of Dynamic Decisions; Module II: Learning and Decisions from Experience; Module III: Concepts of Dynamic Systems; Module IV: System Dynamics Modeling. The lecture sessions are designed to provide conceptual knowledge, but lectures will also provide opportunities for interactive learning, using decision games and modeling tools in the classroom.

Module I: Foundations of Dynamic Decisions				
Date	***Topic***	***Readings Due for Quiz***	***Projects Due***	***Quizzes, Games, Extra Readings***
1.Jan. 19	Discussion of course Goals, Syllabus, and Grading policies.			
2. Jan. 24	Overview of Dynamic Decision Making (DDM).	Gonzalez, Fakhari, & Busemeyer, 2017 Zeebrugge Ferry Disaster		Quiz 1 Gonzalez, 2021
3. Jan. 26	Decision Games and Microworlds	Gonzalez, Vanyukov, & Martin, 2005 WPP Task description. DSF Task description.		Quiz 2 The Water Purification Plant (WPP) game. Dynamic Stocks and Flows (DSF) game. Gonzalez et al. 2003 Gonzalez & Dutt, 2011
4. Jan. 31	Learning and Making Decisions under time constraints.	Gonzalez, 2004		Quiz 3 Gonzalez, 2005
5. Feb. 2	Uncertainty and Complexity in Dynamic Decisions.	Nguyen & Gonzalez, 2020 Gridworld Task description. One-Step Gridworld Task description. Minimap Task description.		Quiz 4 Gridworld game. One-Step Gridworld game. Minimap game. Nguyen & Gonzalez, 2021
Module II: Learning and Decisions from Experience				
Date	***Topic***	***Readings Due for Quiz***	***Projects Due***	***Quizzes, Games, Extra Readings***
6. Feb. 7	Learning and Instance-Based Learning Theory (IBLT)	Gonzalez, 2013	Project 1	Quiz 5 Gonzalez, 2012
7. Feb. 9	Decisions from Experience (DfE) in binary choice	Hertwig & Erev 2009		Quiz 6 Binary choice game. Hertwig et al., 2004
8. Feb. 14	IBL models of DfE and binary choice	Lejarraga, Dutt, & Gonzalez, 2012		Quiz 7 The *Shiny IBL* app
9. Feb. 16	Practice on Binary Choice Tasks and models in *Shiny IBL*			The *Shiny IBL* app
10. Feb. 21	DfE in 2-person games	Gonzalez, Ben-Asher, Martin, & Dutt, 2015		Quiz 8 Rock-Paper-Scissors game The Treasure Hunter game

11. Feb. 23	DfE in Groups	Gulati, Nguyen & Gonzalez, 2021 Team Minimap task description.	Project 2	Quiz 9 Team Minimap game Lejarraga et al., 2014
12. Feb. 28	In-Class questions/exercises and review for Exam 1			
13. Mar. 2	Exam 1: Modules I, II			Exam proctored by TA
March 7-11	SPRING BREAK – NO CLASSES			

Module III: Concepts of Dynamic Systems				
Date	***Topic***	***Readings Due for Quiz***	***Projects Due***	***Quizzes, Games, Extra Readings***
14. Mar. 14	Building blocks of dynamic systems: Stocks, Flows and Feedback Loops	Meadows, 2008 (chapter 1)		Quiz 10 Vensim-PLE installation Meadows, 2008 (chapter 2)
15. Mar. 16	Causal Loop Diagrams (CLDs), Stock and Flow Diagrams (SFDs), and fundamental patterns of behavior of dynamic systems	Kirkwood, 2013 (Chapters 1 and 2) Watch Video: How to build CLDs and DFDs with Vensim		Quiz 11 Vensim-PLE building CLDs and SFDs
16. Mar. 21	Stock and Flow Failure	Cronin, Gonzalez & Sterman, 2009		Quiz 12
17. Mar. 23	SF Failure in Climate Change and Other Global Problems	Sterman, 2008		Quiz 13 Dutt & Gonzalez, 2012
18. Mar. 28	The Beer Game: A practical SF problem in Management of Supply Chain	Sterman, 1989	Project 3	Quiz 14 Beer Game
Module IV: System Dynamics Modeling				
Date	***Topic***	***Readings Due for Quiz***	***Projects Due***	***Quizzes, Games, Extra Readings***
19. Mar. 30	Introduction to System Dynamics Modeling	Ford, 2010 (chapter 1)		Quiz 15 Vensim-PLE
20. Apr. 4	Case study: Brownies in the stomach and population growth	Ford, 2010 (chapter 2) Watch Video: Building a simple Vensim model.		Quiz 16 Vensim-PLE
21. Apr. 6	Case study: Savings and non-linear growth	Kirkwood, 2013 (chapter 8) Watch Video: Lookup Tables in Vensim.		Quiz 17 Vensim-PLE
22. Apr. 11	Case study: Catastrophe in Woodland	A Catastrophe in Woodland- Read case description		Quiz 18 Vensim-PLE

23. Apr. 13	Case study: Temperature Control on Daisyworld	Ford, 2010 (chapter 11)		Quiz 19 Vensim-PLE
24. Apr. 18	Case study: Epidemic SIR model	Ford, 2010 (chapter 8)		Quiz 20 Vensim-PLE
25. Apr. 20	Case study: Dynamic Model of Corona virus	Watch Video: Vensim Community Coronavirus Model Become familiar with: community-corona model in Vensim	Project 4	Vensim-PLE
26. Apr. 25	In-Class questions/exercises and review for Exam 2			
27. Apr. 27	Exam 2: Modules III and IV			Exam proctored by TA