Model Thinking

University of Michigan

About this Course

We live in a complex world with diverse people, firms, and governments whose behaviors aggregate to produce novel, unexpected phenomena. We see political uprisings, market crashes, and a never ending array of social trends. How do we make sense of it? Models. Evidence shows that people who think with models consistently outperform those who don't. And, moreover people who think with lots of models outperform people who use only one. Why do models make us better thinkers? Models help us to better organize information - to make sense of that fire hose or hairball of data (choose your metaphor) available on the Internet. Models improve our abilities to make accurate forecasts. They help us make better decisions and adopt more effective strategies. They even can improve our ability to design institutions and procedures. In this class, I present a starter kit of models: I start with models of tipping points. I move on to cover models explain the wisdom of crowds, models that show why some countries are rich and some are poor, and models that help unpack the strategic decisions of firm and politicians.

The models covered in this class provide a foundation for future social science classes, whether they be in economics, political science, business, or sociology. Mastering this material will give you a huge leg up in advanced courses. They also help you in life. Here's how the course will work. For each model, I present a short, easily digestible overview lecture. Then, I'll dig deeper. I'll go into the technical details of the model. Those technical lectures won't require calculus but be prepared for some algebra. For all the lectures, I'll offer some questions and we'll have quizzes and even a final exam. If you decide to do the deep dive, and take all the quizzes and the exam, you'll receive a Course Certificate. If you just decide to follow along for the introductory lectures to gain some exposure that's fine too. It's all free. And it's all here to help make you a better thinker!

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Taught by: Scott E. Page, Professor of Complex Systems, Political Science, and Economics

Center for the Study of Complex Systems

Commitment	4-8 hours/week

Language	English, **Subtitles:** Arabic, Ukrainian, Chinese (Simplified), Portuguese (Brazilian), Turkish Volunteer to translate subtitles for this course
How To Pass	Pass all graded assignments to complete the course.
User Ratings	★★★★½ 4.8 stars

Syllabus

WEEK 1

Why Model & Segregation/Peer Effects

In these lectures, I describe some of the reasons why a person would want to take a modeling course. These reasons fall into four broad categories: 1)To be an intelligent citizen of the world 2) To be a clearer thinker 3) To understand and use data 4) To better decide, strategize, and design. There are two readings for this section. These should be read either after the first video or at the completion of all of the videos.We now jump directly into some models. We contrast two types of models that explain a single phenomenon, namely that people tend to live and interact with people who look, think, and act like themselves. After an introductory lecture, we cover famous models by Schelling and Granovetter that cover these phenomena. We follow these with a fun model about standing ovations that I wrote with my friend John Miller.

More

12 videos, 6 readings

1. **Reading:** Welcome
2. **Reading:** Grading Policy
3. **Reading:** Course FAQ
4. **Reading:** Syllabus
5. **Reading:** Help us learn more about you!
6. **Video:** Thanks and Welcome
7. **Video:** Why Model?
8. **Video:** Intelligent Citizens of the World
9. **Video:** Thinking More Clearly
10. **Video:** Using and Understanding Data
11. **Video:** Using Models to Decide, Strategize, and Design
12. **Reading:** Segregation and Peer Effects
13. **Video:** Sorting and Peer Effects Introduction

14. **Video:** Schelling's Segregation Model
15. **Video:** Measuring Segregation
16. **Video:** Peer Effects
17. **Video:** The Standing Ovation Model
18. **Video:** The Identification Problem

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Graded: Why Model? & Segregation and Peer Effects

WEEK 2

Aggregation & Decision Models

In this section, we explore the mysteries of aggregation, i.e. adding things up. We start by considering how numbers aggregate, focusing on the Central Limit Theorem. We then turn to adding up rules. We consider the Game of Life and one dimensional cellular automata models. Both models show how simple rules can combine to produce interesting phenomena. Last, we consider aggregating preferences. Here we see how individual preferences can be rational, but the aggregates need not be.There exist many great places on the web to read more about the Central Limit Theorem, the Binomial Distribution, Six Sigma, The Game of Life, and so on. I've included some links to get you started. The readings for cellular automata and for diverse preferences are short excerpts from my books Complex Adaptive Social Systems and The Difference Respectively.

Show less

12 videos, 1 reading

1. **Video:** Aggregation
2. **Video:** Central Limit Theorem
3. **Video:** Six Sigma
4. **Video:** Game of Life
5. **Video:** Cellular Automata
6. **Video:** Preference Aggregation
7. **Reading:** Decision Models
8. **Video:** Introduction to Decision Making
9. **Video:** Multi-Criterion Decision Making
10. **Video:** Spatial Choice Models

11. **Video:** Probability: The Basics
12. **Video:** Decision Trees
13. **Video:** Value of Information

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Graded: Aggregation & Decision Models

WEEK 3

Thinking Electrons: Modeling People & Categorical and Linear Models

In this section, we study various ways that social scientists model people. We study and contrast three different models. The rational actor approach, behavioral models, and rule based models . These lectures provide context for many of the models that follow. There's no specific reading for these lectures though I mention several books on behavioral economics that you may want to consider. Also, if you find the race to the bottom game interesting just type "Rosemary Nagel Race to the Bottom" into a search engine and you'll get several good links. You can also find good introductions to "Zero Intelligence Traders" by typing that in as well.

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12 videos, 1 reading

1. **Video:** Thinking Electrons: Modeling People
2. **Video:** Rational Actor Models
3. **Video:** Behavioral Models
4. **Video:** Rule Based Models
5. **Video:** When Does Behavior Matter?
6. **Reading:** Categorical and Linear Models
7. **Video:** Introduction to Linear Models
8. **Video:** Categorical Models
9. **Video:** Linear Models
10. **Video:** Fitting Lines to Data
11. **Video:** Reading Regression Output
12. **Video:** From Linear to Nonlinear

13. **Video:** The Big Coefficient vs The New Reality

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Graded: Modules Thinking Electrons: Modeling People & Categorical and Linear Models

WEEK 4

Tipping Points & Economic Growth

In this section, we cover tipping points. We focus on two models. A percolation model from physics that we apply to banks and a model of the spread of diseases. The disease model is more complicated so I break that into two parts. The first part focuses on the diffusion. The second part adds recovery. The readings for this section consist of two excerpts from the book I'm writing on models. One covers diffusion. The other covers tips. There is also a technical paper on tipping points that I've included in a link. I wrote it with PJ Lamberson and it will be published in the Quarterly Journal of Political Science. I've included this to provide you a glimpse of what technical social science papers look like. You don't need to read it in full, but I strongly recommend the introduction. It also contains a wonderful reference list.

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13 videos, 1 reading

1. **Video:** Tipping Points
2. **Video:** Percolation Models
3. **Video:** Contagion Models 1: Diffusion
4. **Video:** Contagion Models 2: SIS Model
5. **Video:** Classifying Tipping Points
6. **Video:** Measuring Tips
7. **Reading:** Economic Growth
8. **Video:** Introduction To Growth
9. **Video:** Exponential Growth
10. **Video:** Basic Growth Model
11. **Video:** Solow Growth Model
12. **Video:** Will China Continue to Grow?
13. **Video:** Why Do Some Countries Not Grow?
14. **Video:** Piketty's Capital: The Power of Simple Model

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Graded: Modules Tipping Points & Economic Growth

WEEK 5

Diversity and Innovation & Markov Processes

In this section, we cover some models of problem solving to show the role that diversity plays in innovation. We see how diverse perspectives (problem representations) and heuristics enable groups of problem solvers to outperform individuals. We also introduce some new concepts like "rugged landscapes" and "local optima". In the last lecture, we'll see the awesome power of recombination and how it contributes to growth. The readings for this chapters consist on an excerpt from my book The Difference courtesy of Princeton University Press.

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10 videos, 1 reading

1. **Video:** Problem Solving and Innovation
2. **Video:** Perspectives and Innovation
3. **Video:** Heuristics
4. **Video:** Teams and Problem Solving
5. **Video:** Recombination
6. **Reading:** Markov Processes
7. **Video:** Markov Models
8. **Video:** A Simple Markov Model
9. **Video:** Markov Model of Democratization
10. **Video:** Markov Convergence Theorem
11. **Video:** Exapting the Markov Model

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Graded: Diversity and Innovation & Markov Processes

WEEK 6

Midterm Exam

Graded: Modules 1-10

WEEK 7

Lyapunov Functions & Coordination and Culture

Models can help us to determine the nature of outcomes produced by a system: will the system produce an equilibrium, a cycle, randomness, or complexity? In this set of lectures, we cover Lyapunov Functions. These are a technique that will enable us to identify many systems that go to equilibrium. In addition, they enable us to put bounds on how quickly the equilibrium will be attained. In this set of lectures, we learn the formal definition of Lyapunov Functions and see how to apply them in a variety of settings. We also see where they don't apply and even study a problem where no one knows whether or not the system goes to equilibrium or not.

Show less

11 videos, 1 reading

1. **Video:** Lyapunov Functions
2. **Video:** The Organization of Cities
3. **Video:** Exchange Economies and Externalities
4. **Video:** Time to Convergence and Optimality
5. **Video:** Lyapunov: Fun and Deep
6. **Video:** Lyapunov or Markov
7. **Reading:** Coordination and Culture
8. **Video:** Coordination and Culture
9. **Video:** What Is Culture And Why Do We Care?
10. **Video:** Pure Coordination Game
11. **Video:** Emergence of Culture
12. **Video:** Coordination and Consistency

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Graded: Lyapunov Functions & Coordination and Culture

WEEK 8

Path Dependence & Networks

In this set of lectures, we cover path dependence. We do so using some very simple urn models. The most famous of which is the Polya Process. These models are very simple but they enable us to unpack the logic of what makes a process path dependent. We also relate path dependence to increasing returns and to tipping points. The reading for this lecture is a paper that I wrote that is published in the Quarterly Journal of Political Science

10 videos, 1 reading

1. **Video:** Path Dependence
2. **Video:** Urn Models
3. **Video:** Mathematics on Urn Models
4. **Video:** Path Dependence and Chaos
5. **Video:** Path Dependence and Increasing Returns
6. **Video:** Path Dependent or Tipping Point
7. **Reading:** Networks
8. **Video:** Networks
9. **Video:** The Structure of Networks
10. **Video:** The Logic of Network Formation
11. **Video:** Network Function

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Graded: Path Dependence & Networks

WEEK 9

Randomness and Random Walks & Colonel Blotto

In this section, we first discuss randomness and its various sources. We then discuss how performance can depend on skill and luck, where luck is modeled as randomness. We then learn a basic random walk model, which we apply to the Efficient Market Hypothesis, the ideas that market prices contain all relevant information so that what's left is randomness. We conclude by discussing finite memory random walk model that can be used to model

competition. The reading for this section is a paper on distinguishing skill from luck by Michael Mauboussin.

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11 videos, 1 reading

1. **Video:** Randomness and Random Walk Models
2. **Video:** Sources of Randomness
3. **Video:** Skill and Luck
4. **Video:** Random Walks
5. **Video:** Random Walks and Wall Street
6. **Video:** Finite Memory Random Walks
7. **Reading:** Colonel Blotto
8. **Video:** Colonel Blotto Game
9. **Video:** Blotto: No Best Strategy
10. **Video:** Applications of Colonel Blotto
11. **Video:** Blotto: Troop Advantages
12. **Video:** Blotto and Competition

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Graded: Randomness and Random Walks & Colonel Blotto

WEEK 10

Prisoners' Dilemma and Collective Action & Mechanism Design

In this section, we cover the Prisoners' Dilemma, Collective Action Problems and Common Pool Resource Problems. We begin by discussion the Prisoners' Dilemma and showing how individual incentives can produce undesirable social outcomes. We then cover seven ways to produce cooperation. Five of these will be covered in the paper by Nowak and Sigmund listed below. We conclude by talking about collective action and common pool resource problems and how they require deep careful thinking to solve. There's a wonderful piece to read on this by the Nobel Prize winner Elinor Ostrom.

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9 videos, 1 reading

1. **Video:** Intro: The Prisoners' Dilemma and Collective Action

2. **Video:** The Prisoners' Dilemma Game
3. **Video:** Seven Ways To Cooperation
4. **Video:** Collective Action and Common Pool Resource Problems
5. **Video:** No Panacea
6. **Reading:** Mechanism Design
7. **Video:** Mechanism Design
8. **Video:** Hidden Action and Hidden Information
9. **Video:** Auctions
10. **Video:** Public Projects

Show less

Graded: Prisoners' Dilemma and Collective Action & Mechanism Design

WEEK 11

Learning Models: Replicator Dynamics & Prediction and the Many Model Thinker

In this section, we cover replicator dynamics and Fisher's fundamental theorem. Replicator dynamics have been used to explain learning as well as evolution. Fisher's theorem demonstrates how the rate of adaptation increases with the amount of variation. We conclude by describing how to make sense of both Fisher's theorem and our results on six sigma and variation reduction. The readings for this section are very short. The second reading on Fisher's theorem is rather technical. Both are excerpts from Diversity and Complexity.

8 videos, 1 reading

1. **Video:** Replicator Dynamics
2. **Video:** The Replicator Equation
3. **Video:** Fisher's Theorem
4. **Video:** Variation or Six Sigma
5. **Reading:** Prediction and The Many Model Thinker
6. **Video:** Prediction
7. **Video:** Linear Models
8. **Video:** Diversity Prediction Theorem

9. **Video:** The Many Model Thinker

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Graded: Learning Models: Replicator Dynamics & Prediction and the Many Model Thinker

WEEK 12

Final Exam

The description goes here

1 reading expand

1. **Reading:** Post-course Survey

Graded: Modules 12-21

View Less

How It Works

GENERAL

How do I pass the course?

To earn your Course Certificate, you'll need to earn a passing grade on each of the required assignments—these can be quizzes, peer-graded assignments, or programming assignments. Videos, readings, and practice exercises are there to help you prepare for the graded assignments.

What do start dates and end dates mean?

Most courses have sessions that run multiple times a year — each with a specific start and end date. Once you enroll, you'll have access to all videos, readings, quizzes, and programming assignments (if applicable). Peer-graded assignments can only be submitted and reviewed once your session has begun. If you choose to explore the course without purchasing, you may not be able to access certain assignments. If you don't finish all graded assignments before the end of the session, you can enroll in the next session. Your progress will be saved and you'll be able to pick up where you left off when the next session begins.

What are due dates? Is there a penalty for submitting my work after a due date?

Within each session, there are suggested due dates to help you manage your schedule and keep coursework from piling up. Quizzes and programming assignments can be submitted late without consequence. However, it is possible that you won't receive a grade if you submit your peer-

graded assignment too late because classmates usually review assignment within three days of the assignment deadline.

Can I re-attempt an assignment?

Yes. If you want to improve your grade, you can always try again. If you're re-attempting a peer-graded assignment, re-submit your work as soon as you can to make sure there's enough time for your classmates to review your work. In some cases you may need to wait before re-submitting a programming assignment or quiz. We encourage you to review course material during this delay.

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View the course in catalog

Related Courses

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Duke University

Think Again I: How to Understand Arguments

Duke University

Think Again III: How to Reason Inductively

Duke University

Econometrics: Methods and Applications

Erasmus University Rotterdam

Game Theory

Stanford University, The University of British Columbia