Please note that the non-administrative bits of this document are updated frequently.

PREDICTION: THE PAST & PRESENT OF THE FUTURE

Harvard GenEd 1112

COURSE CANVAS SITE • PREDICTION PROJECT WEB SITE

INSTRUCTOR

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INSTRUCTIONAL STAFF

Teaching Fellows in this course will lead discussion sections once per week, at times to be arranged. Each will have a one-hour office hour, with times to be arranged once section timing is known.

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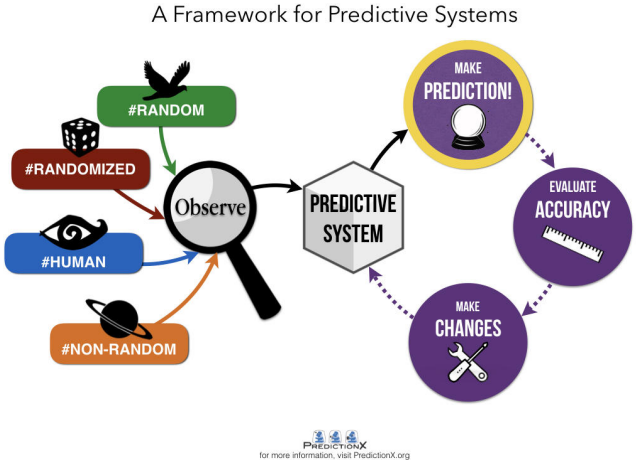
STUDENTS

We value contributions from each student, and we hope to get to know you. Please fill out your biographical profiles on Canvas to help us learn more about you!

COURSE CATALOG DESCRIPTION

Human beings are the only creatures in the animal kingdom properly defined as worriers. We are the only ones who expend tremendous amounts of time, energy, and resources trying (sometimes obsessively) to understand our futures before they happen. While the innate ability of individual people to predict has not changed much in the past few millennia, developments in mathematical and conceptual models have inordinately improved predictive systems. These systems have integrated comparisons to past results and quantified how "certain" we can be about various aspects of the future – processes that were, in many cases, inconceivable at one point in the past. This course is a coordinated investigation of the history and future of prediction, beginning with Ancient Mesopotamians reading signs in sheep entrails and ending with modern computer simulations for climate, health, wealth, and the fate of our Universe. In this class, you may also design your own predictive systems to critically engage with assumptions about how the world works and situate your explorations in a study of how motivations and techniques for divining the future have changed–and not changed–throughout human history.

COURSE OBJECTIVES & EXPECTATIONS



The **Framework for Predictive Systems** shown here captures much of the fundamental content of our curriculum. By the end of GenEd 1112, all students should be able to apply this Framework to the analysis of any predictive system.

Students will become familiar with various **PREDICTIVE SYSTEMS** (shown as a grey box in the Framework). Over the course of the term, each student will choose to analyze particular extant systems, as well as potentially invent their own, so *not all students will be expert on the same systems*. Instead, the goal is to gain and appreciate expertise on just a few systems, or types of systems, while using the Framework to understand how many systems fall into general groupings, appreciating the general features of those groupings. By way of a simple example: predictive systems with a great deal of #HUMAN input can all be very subjective.

The bubble in the Framework labeled **EVALUATE ACCURACY** is also key to GenEd 1112, as it encompasses the concept of **Uncertainty**. There are vast differences in how uncertainty is and has been evaluated (if at all) and valued in predictive systems throughout history. By the end of GenEd 1112, students will have a deep appreciation

for how, for example, Ancient Greeks may have thought about the Oracle of Delphi's accuracy, while also appreciating how to understand the uncertainty associated with weather forecasts, or Bayesian analyses of jury trials' likely outcomes.

To attain this deep understanding of Predictive Systems and the inherent uncertainty associated with them, students will:

1. Attend one 2.5-hour **session** led by Prof. Goodman each week. These sessions will take place in-person, and will include group activities and discussions. These activities will be interwoven with presentations and demonstrations by Prof. Goodman and guests.
2. Carry out the **readings**, **preparation**, and **assignments** summarized below, and explained on the Canvas Assignments page. Please note that in order to adapt well to student interests as the course proceeds, assignment details will only be finalized on Canvas a week or two before they are relevant, so do check back as the semester proceeds. In other words, assignments listed below are estimates about the future, with some "*uncertainty*"! **Please consider Canvas the definitive source of your assignments.**
3. Post to the "Forum" page at PredictionX.org. Most weeks, a new discussion thread will be created corresponding to a topic we discussed in class. The discussion thread will have a short reflective prompt for you to answer in a minimum of 100 words. In addition to posting your own response, you will also reply to one of your classmates' posts. This will count towards your participation grade for the class and is meant to be a low-stress way for you to think about how prediction impacts your everyday life or academic field. **Please remember that this forum is open to the general public, so don't post anything you would not want the world to see.** If you have any concerns about participating in the forum, please reach out to your TF to discuss alternative arrangements. (Signup at the forum page, or this link.)
4. Create two substantial projects: a **Prediction Journal** (added to periodically over the course of the semester) and an online final project. *GenEd 1112 has no midterm or final, and instead relies on evaluation of each student's Prediction Journal and Final Project.* Detailed instructions for the Journals and Final Project will be provided in class, in section, and on Canvas. A preliminary description of the Final Project options is online here, and will be updated on Canvas by week 5. Teaching Fellows will provide personalized support for students on these projects, in person during office hours, in **section**.
5. Attend **sections**, which will often offer enriching material not available in class or elsewhere online, and TFs will customize sessions based on their own expertise. Attendance in section will be noted, and it is strongly suggested that you attend.

Students *should* bring **laptops** or **tablets** to class, as much class time will involve realtime research and the creation of collaborative (Google) documents. Please do not be distracted by the internet when other people are presenting.

There are no prerequisites for GenEd 1112.

MATERIALS AND ACCESS

Books for GenEd 1112

Amazon and/or publisher links are below, but all books should also be at the Harvard Coop, using this convenient link.

click here to access GenEd 1112 Canvas site directly

Required

1--The Signal and the Noise: Why So Many Predictions Fail-but Some Don't, by Nate Silver [read online]

2--To Explain the World, the Discovery of Modern Science, by Stephen Weinberg [read online]

Recommended

Specific chapters or sections of some, but not all, of these works will be suggested or assigned, often with a link to read online for free. NO need to purchase these–this list is mostly just for students' reference.

1. Climate of Hope: How Cities, Businesses, and Citizens Can Save the Planet, by Michael Bloomberg & Carl Pope [read online] (re:Modern Prediction)
2. The House of Wisdom: How Arabic Science Saved Ancient Knowledge and Gave Us the Renaissance, by Jim Al-Khalili [not yet available online] (re:Data to Theory)
3. Prediction Machines, by Ajay Agrawal, Joshua Gans, & Avi Goldfarb [read online] (re:Modern Prediction)
4. The Knowledge Machine, by Michael Strevens [not yet available online, search only here] (re:Data to Theory, and Modern Prediction)
5. On The Future, by Martin Rees [read online] (re:Modern Prediction)
6. Thinking Fast, and Slow, by Daniel Kahneman [read online] (re:Human Behavior)
7. The Primacy of Doubt: From Quantum Physics to Climate Change, How the Science of Uncertainty Can Help Us Understand Our Chaotic World, by Tim Palmer [not yet available online] (re:Modern Prediction)
8. The Map of Knowldege, by Violet Moeller [not yet available online] (re:Data to Theory)
9. The Swerve: How the World Became Modern, by Stephen Greenblatt [read online, 1 hour at a time] (re:Data to Theory)
10. The Ministry for the Future, by Kim Stanley Robinson (a view of a climate-change dominated future) (re:Modern Prediction)
11. The Light Ages: The Surprising Story of Medieval Science, by Seb Falk (re:Data to Theory)
12. The Code Breaker, by Walter Isaacson (re:Data to Theory & Modern Prediction)

13. Special report: The simulations driving the world's response to COVID-19, Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand | Imperial College London (re: Modern Prediction, specifically, COVID)

14. More, potentially from predictionx.org/extraresources/

Also, copies of "The Pursuit of Destiny," by Halpern--a very useful reference, can be downloaded from this Scribd PDF link or this Google Drive link. (The book is out-of-print.)

Information on **additional library materials,** study group options, etc., will appear here during the course.

Much of the material you'll be asked to read/watch is online, via edX, LabXchange, and the PredictionX.org website. Specific links will be provided as-needed. Curious students can see sample material for edX (as featured on Mashable) here, on LabXchange here, and/or at the PredictionX website.

In addition to the more formal educational materials, we recommend a list of prediction-relevant movies, and we may offer movie nights for students during the term, if there's interest. (These are *not* required.)

ASSIGNMENTS , GRADING PROCEDURES & ATTENDANCE

Credit awarded, in "units" not related to percentages, is proportional to the difficulty of assignments. Weekly **homework** requests, including incremental additions to Journals: ~**100** units. The **Prediction Journal** (**400** units) plus **Final Project** (**600** units) will determine about the same fraction of your course grade as all other homework assignments combined. Class/section **participation** (including **Forum** posts): ~**250** units total. Please take note that a grade such as "140 out 150," while 87%, is not an "87" or a B+, it's just 140 points toward your total in the class when you could have had 150. Your grade for the full course will be calculated "on a curve" using point totals. Students who do very well will receive a flavor of A, and if the class does very well overall, there will (should!) be many As. If you put full effort into the class and complete all assignments effectively, you can expect a B or better. Missing class or section, especially more than once, will impact your participation grade, so please let your TF know in advance if you'll need to miss anything, and we will try to arrange a way for you to make up what you miss. So, in summary, *all students who attend class, participate fully, make good use of section time and office hours, and create a meaningful Prediction Journal and Final Predictive System Project should be able to receive a good grade.*

Details on grading policies

Harmonizing grades across sections/TFs: When this class concludes, we will adjust scores issued by TFs to make the average (mean) and spread (dispersion) of grades given by each TF as similar as possible. Even though students and TFs are given instructions on what each assignment requires, grading of anything other than

multiple-choice exams always has a subjective component. The end-of-term re-calibration should remove effects of small variations caused by multiple graders.

Late assignments: Deadlines are clearly specified on Canvas, and students should work to those deadlines. In the unlikely event that a deadline is changed for everyone, a notification will be sent out. Barring changes, we will allow a **1-hour grace period** past the deadline (with the caveat that no assignments can be turned in during class time unless explicitly requested for then), but beyond that, **10 percent of the total available will be subtracted per day of lateness.** Requests for extensions may be granted at the discretion of your TF, as long as they are requested a day or more in advance. Tardiness due to illness or other personal crises can be excused, with appropriate documentation, upon request to your TF.

Disputing a grade: Requests for re-grading should be made sparingly. We warn that a request for re-grading can cause grades to rise, or fall, so do not make such requests lightly. TFs will need to seek permission from Prof. Goodman for re-grading if any student makes more than one such request.

ACADEMIC INTEGRITY

Collaboration is encouraged in this course. That said, the work you add to your Prediction Journals and final project should be your own. When you are explicitly asked to record work done in groups, as you will frequently be in class and in section, please remember to include the names of all group members (e.g. in a Google Doc or video you create). As a reminder, the Harvard Honor Code is online for your reference.

In all formal assignments, including your Prediction Journals, final project, as well as week-to-week requests, **please CITE your sources according to these examples:**

> **Traditional materials**--The Modern Language Association citation format, or some similar variant of it, is fine. Here's a page of examples.
>
> **Online material**--as much like the following example as is feasible (allowing for the possibility that author names or publication dates may be missing)
>
> Sample, Ian. "Astronomers discover huge gaseous wave holding Milky Way's newest stars," TheGuardian.com, *The Guardian*. Published 07 January 2020, online. Retrieved 24 January, 2020, from: <https://www.theguardian.com/science/2020/jan/07/astronomers-discover-huge-gaseous-wave-holding-milky-ways-newest-stars>. Format: text and graphics-based web page [or use instead, video, audio file, other media designation as-needed]

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Students needing academic adjustments or accommodations because of a documented disability must present their Faculty Letter from the Accessible Education Office (AEO) and speak with Prof. Goodman by the end of the

second week of the term. All discussions will remain confidential. Please make sure your TF is aware of any requests related to documented disabilities, in advance of any extensions of time that might be needed.

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*Reading, media assignments, and journaling activities are to be done **in advance** of class for the week listed.*
This "live" (evolving) syllabus is meant as a guide to course content,
*while the GenEd 1112 **Canvas site** gives links to slides, handouts, and **definitive details** on assignments.*

Please consider materials posted to Canvas as the up-to-date version of this Syllabus.

All slides and handouts are in the "Files" tab, and all readings and assignments are under "Assignments." Also, "Modules" organize materials week-by-week.

We also update the portion of this Google Doc below this point as time permits,
mostly for planning purposes, so please do refer to Canvas to see more exactly what's coming up.

Week 1 (1-25-23)

TOPIC What is Prediction? Why Predict? **CASE Student Conceptions of Prediction**

In class this first week, Prof. Goodman will tell the story of how she became interested in the past, present, and future of prediction. Then, she will offer a presentation that introduces the course material, inspiring students to think about why, when, and how predictions are made. After these introductory remarks, we will collect and discuss student views on prediction, and discuss them in small groups and as a class. It's likely that a range of opinion will emerge, guiding us toward an initial appreciation of one of this class' core precepts: *"Prediction" as a subject, is part art, part science, and as-such, there are often no purely "right" answers to questions about it.*

Some sample motivating ideas and questions that will be covered in Week 1...
"Prediction" is a very common word in English, but what does it mean? Sure, most people will say "prediction" has something to do with the *future*-–but questions linger. How far is this "future"? Is testability required? Is a prediction always part of a decision? How is a decision different from a prediction? Who really knows and doesn't know the future? Why do we want to know? How can we know? How does prediction manifest in your everyday life? In society? Today? In the past? In the future?

We will also have a preliminary discussion of weather prediction, using takeasweater.com, and we will take a look at some of the "Essentials" from PredictionX to be used in GenEd 1112, most importantly the "Framework" diagram. And, of course, we will have an overview of course logistics.

Week 2 (2-1-23)

TOPIC Conceptions of Time and Space **CASE Ancient Predictive Systems**

As we introduce some of the ancient predictive systems highlighted in PredictionX "Omens & Oracles," we will contextualize them using the "Framework for Predictive Systems" developed as part of the PredictionX project. (Small groups of students will apply the **Framework** to selected systems.)

We can think about our yearning to know what comes next in **time** as analogous to our wishes to see further in **space**. In Week 2, we will ponder this time-space parallel, and ask which aspects of predictive systems are common, uncommon, ancient, or modern, and which seem constant across cultures. We will also consider what assumptions justify or underpin "non-scientific" systems.

*By the end of the week, each student will choose one non-scientific predictive system, from the Diviner's Guide, or other (e.g. see long Wikipedia list of "Methods of Divination,") to research and present at our first "Fair," in-class, during **Week 3**.*

Reading	Online	Watching	Journal	Submit
Introduction and Chapter 1 of Pursuit of Destiny (PDF) Framework definitions	PredictionX: Omens, Oracles & Prophecies For reference: Wikipedia Page on "Methods of Divination"	Choose from any film at this list, or ask the teaching staff about adding another (optional)	Begin your *Prediction Journal* by writing a *personal definition of prediction,* and explain how in-class discussions did or did not affect your thinking (approximately 1 page). Track your predictive behavior for one day of the week. List and briefly explain at least 5 predictions you made or used over the course of a single day in your Journal. (Details in Assignments)	Use the Google Doc to be set up for you by staff [100 units]

Week 3 section: Discuss student prediction journals, substance and OneNote issues, also look into astrology & tarot.

We'll also introduce the "**free will vs. determinism"** dichotomy--asking why some cultures believe(d) fate is written in advance, and others do not. Students will begin to discuss how ideas around free will interact with predictive traditions.

Week 3 (2-8)

TOPIC **Free Will & Determinism** **CASE** **Ancient Predictive Systems Fair**

SPECIAL EVENT: PREDICTIVE SYSTEMS FAIR

For most of the class time, we will hold a **Predictive Systems Fair,** as described under the Week 3 Assignments on Canvas.

Students will switch between presenting their predictive system and visiting various other presentations. Visitors will ask questions that the presenter will answer, potentially including:
How does your system fit into the Framework? When & where did this system come from? Did it change over time? Is this system still used? If so, by whom? Do you need much training to use the system? Would you use this system today? For important issues? For fun? How accurate? Does that matter?

Afterwards, we will break into groups discussing various aspects of predictive systems, including the effects of historiography, the role of religion in science and prediction, the level of detail used in models, the significance of free will, and the amount of training needed.

Reading	Online	Watching	Journal	Present
Student-specific research on the system each student will present in this week's Fair. (Ch 2) "The Lathe of Laplace" from Pursuit of Destiny	Cross-Cultural Conversations portion of PredictionX: Omens, Oracles & Prophecies			For your chosen predictive system, be prepared to share your methods with other students seeking to know their future. If equipment you do not have is needed, please use drawings, videos, and online tools. Costumes optional.

Week 4 Section notes: Learn the Physics behind Newton's Laws of Gravity, and several of the other ideas that prove critical to the Path to Newton.

Week 4 (2-15)

TOPIC From Phenomenon to Theory **CASE The Path to Newton, Darwin & AI, The History of Motion**

In this class, we will bridge between the Ancient predictive systems into the **Rise of Theory**, focusing on the **slow** evolution in assumptions about the world as ways of measuring/thinking about the world improved. Guided by the submitted thoughts and questions of students, we'll discuss the design and motivation of the **Path to Newton** before reviewing the logistics of the upcoming Path to Newton Fair.

Then we'll use toy "hand-slingshots" to simulate the experiments and discussion behind theories of **terrestrial motion**, contrasting Aristotelian views, impetus theory, and (eventually) Newton's laws. We will also use WorldWideTelescope to compare historical and modern models of **celestial motion**, then break into groups to discuss the relation between the two different types of motion.

Reading	Online	Watching	Journal	Submit
please read all of the text at http://path-to.org/newton.html and submit three questions about the materials **Recommended:** To Explain the World by Steven Weinberg The House of Wisdom by Jim Al-Khalili The Knowledge Machine by Michael Strevens	Please sign up for one item on the Path to Newton. You will represent the ideas associated with this item (usually a person, or person+idea) in-class at our "Path to Newton" Fair on 2/23	Cosmos Ep. 3, "When Knowledge Conquered Fear" (optional) (Amazon Prime, Free on Fox)	Think of a type of testable prediction you make or use at least once per day. By "testable" we mean that you can evaluate the accuracy of the prediction. Choose a relatively short-term kind of prediction, such as: weather; time it takes to complete assignments; outcome of sporting events, etc. (Details in Assignments)	Create a "hand-slingshot" before class to prepare for the discussion on ancient and modern ideas of motion. Before next class, create a first draft of your "My Hero" Google Doc and prepare an informational slide.

Movies: Cosmos Newton/Halley Episode; maybe also Galileo video? (optional on Evolution, this NOVA episode on how Darwinian Evolution works,
Books: The House of Wisdom by Jim Al Khalili, To Explain the World by Steven Weinberg, The Gene: An Intimate History by Mukherjee

Week 5 (2-23)

TOPIC Origins of Scientific Prediction **CASE The Path to Newton Fair**

SPECIAL EVENT: PATH TO NEWTON FAIR

Most of this class will be spent holding the **Path to Newton Fair**. After explaining the logistics, students will make a line around the room in their characters' chronological order and introduce themselves in-character. We will then split into subgroups based on geography and time period, and students will simulate characters on the Path discussing (and likely bickering) about their various findings. **Students should be sure to use this time to connect with "neighbors" on the Path for the final draft.**

Through this exploration we should address:
- Truly predictive systems (as opposed to empirically derived rules)
- Individual contributions to history of ideas
- Importance of specific ideas and theories along the Path
- Importance of specific instruments to progress along the Path and correlations to ideas and theories
- Extrapolation to future (e.g. genome sequences)

Reading	Online	Watching	Journal	Submit
The Google Drive here contains a wealth of articles relevant to characters and ideas portrayed on the Path to Newton.	Coordinate with your "neighbors" (influencers & influenced) on the Path before you complete your final paper draft		Final version (worth 120 points) of your "My Hero" Google Doc, incorporating additional information from the Path to Newton Fair, especially about characters/ideas immediately adjacent to yours, will be due on 3/3. (Details in Assignments)	During the PtN fair, you will gather with similar characters/ideas to state your case (worth 50 points)

Books: To Explain the World: The History of Modern Science by Steven Weinberg; The Pursuit of Destiny, Paul Halpern

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Week 6 (3-1)

TOPIC Navigation as Prediction **CASE Lost without Longitude**

SPECIAL EVENT: OUTDOOR NAVIGATION EXERCISE as an ASSIGNMENT
-SPECIAL GUEST: Dr. Sara Schechner, David P. Wheatland Curator of the Harvard Collection of Historical Scientific Instruments
On Navigational Techniques & Instruments (with demos)

click here to access GenEd 1112 Canvas site directly

Building on the ideas of Lost without Longitude, we will begin with an Outdoor Navigation Exercise, where teams of students will be given a "navigational path" using distances in feet and compass directions and tasked to get as close to the intended destination as possible.

This experience leads into a discussion of the history of navigation, highlighting promising predictive models that failed due to lack of data and precision (lunars), the interaction between technology and uncertainty, and 'false' models that produced accurate predictions.

After a demonstration of historical navigational instruments with Dr. Sara Schechner, we will unpackage data from the Navigation Exercise to highlight overconfidence and repeatable uncertainty in predictions.

Reading	Online	Watching	Journal	Submit
	all of edX Lost without Longitude	Longitude (optional) (Youtube)	Follow the instructions issued "live" for your colored group (yellow, blue, orange, green, or pink) for the navigation exercise. Please take your phone outside with you. (Details in Assignments)	Complete "Navigating Harvard - Part 1" in class, and "Navigating Harvard - Part 2" before next class.

Week 7 (3-8)

TOPIC Health **CASE John Snow & Cholera**

Bridge between Rise of Theory and Modern Simulation

SPECIAL GUEST: Prof. Immaculata De Vivo, Epidemiologist, Author, and Professor at Harvard Medical School and the Harvard T.H. Chan School of Public Health

Drawing parallels with the John Snow material on edX and the recent coronavirus pandemic, we will discuss the advent of modern **epidemiology**. After reflecting on the role of prediction in the pandemic and reviewing the story of John Snow, we will introduce the mathematical predictive models used to predict spread of epidemics, discussing their comparative strengths and uncertainties.

Students will then discuss uncertainties, experiences, and questions from the COVID pandemic before diving into the significance of uncertainty ranges as introduced by Take a Sweater. After exploring different visualization and prediction tools for the COVID pandemic and final reflections, Prof. Immaculata De Vivo will discuss the importance of risk prediction tools and study design in epidemiology.

Reading	Online	Watching	Journal	Submit
	All of edX John Snow, +Megan Murray (optional) All 3 essays on the PredictionX site as well as this COVID prediction tool Full Cluster if students want to get the lay of the land in LabXchange: https://www.labxchange.org/library/clusters/lx-cluster:ModernPrediction		(Details in Assignments)	

SPRING BREAK

Week 8 (3-22)

TOPIC **Earth** **CASE** **Weather and Climate**

Continuing our exploration of modern prediction, we will review the Framework and introduce the categories of systems: "human," **statistical, simulation, and combinations**, as well as distinguish between **deterministic** and **probabilistic** predictions. Students will split into focus area tables based on their submitted articles to recontextualize their articles in the new categories, then we will dig into the importance of **resolution** and uncertainty in simulation models.

Students will learn more about final project guidelines before we turn to the role of simulation in climate. Many important questions in this field will be posed:

- What measured inputs are important to numerical simulations of weather?
- What "rules" (e.g. physical and/or chemical principles) are used in numerical simulations of weather?
- What are the key outputs of weather simulation?
- What does uncertainty in weather forecasting show about climate change?
- What contributes to people's/ organizations' decisions regarding long term predictions like climate change?
- How are climate simulations created and what do they show?

We will briefly discuss Tim Palmer's views in "The Primacy of Doubt" and foreshadow what is to come in the following weeks.

Reading	Online	Watching	Journal	Submit
Nate Silver, *The Signal and the Noise*, (at least): Chapter 4 (Weather) and Chapter 12 (Climate)		The Day after Tomorrow (optional) (Amazon Prime, Youtube) An Inconvenient Truth (optional) (Youtube, Amazon)	Answer questions after watching each video (Details in Assignments)	Before section, find and read a journalistic article on modern prediction, and be prepared to discuss.

Week 9 (3-29)

TOPIC Modern Data Science **CASE Personal Health and Behavior**

Following up on the assigned Energy and Climate interviews, students will break into groups to analyze each other's forum posts and draft an outline of an op-ed piece on your interview's topic to present to other groups. We will then re-explore the topic of classifying predictive systems, quickly examining mental and physical "models" before diving into the nuances of **deterministic/rules-based** simulations. We discuss the way in which deterministic rules can produce probabilistic outcomes and tease the upcoming 3-body problem.

We then introduce and provide examples of the subtypes that make up **algorithmic prediction**: Data-Driven Estimation, Regression & Extrapolation, Bayesian Statistical Reasoning, AI/Machine Learning, Analytic Calculation, and Simulation. Using our **Padua Rainbow**, we comment on the predictive distinctions between biology and physics, distinguish between studying **mechanisms** and using **data science**. Pondering how current Big Data and future AI/machine learning may change these commonly-used practices, we consider different types of AI and reflect on how they may affect prediction and our daily lives.

Reading	Online	Watching	Journal	Submit
The Signal and the Noise (full book is best). Choose at least sections relevant to your research projects. Tim Palmer's "The	Optional: Brendan Meade and Susan Murphy (will watch for Week 12 also) An Energy Plan the Earth Can Live	Gattaca (optional) (Amazon Prime, Youtube)		Watch one of the Energy and Climate videos listed here For each video, identify and explain (in a paragraph) the most surprising bit of information you learned. (Each entry is worth 20 points, for a total of 60

Primacy of Doubt," Chapter 6 (On Climate Change)	With | Radcliffe Institute (extra video from Radcliffe talk by Kammen)			points) For any of the above three videos, if you had conducted the interview, what unasked and/or unanswered question would you have asked, and why? (20 points) (Details in Assignments) Select a topic for your final project

Movie: *Minority Report*

Week 10 (4-5)

TOPIC Wealth **CASE Personal & Global Finance**

Continuing our tour of modern prediction, we turn to predictive models in wealth and economics. We emphasize that finance connects to climate and other important predictive models, but is complex enough to warrant its own discussion. We overview the methods of economists in general (considering whether economics falls under the scientific umbrella) before contrasting two schools of thought, **rational choice theory** (which assumes individuals are fully rational and act to maximize their own interest) and **behavioral economics** (which emphasizes the role of psychological 'errors' preventing theoretical rationality) and mapping them to our predictive model classifications.

We then turn to explain and contrast two economic predictive tools, one a mainstay and the other up-and-coming; **regression** and **AI** respectively. We use an interview with Prof. David Laibson to get a deeper insight on their significance, before posing the general question of what we are able to simulate before and after artificial intelligence. Luckily, one video game franchise attempts to do it all at once - the Sims. Using "SimCity 2000," students break into groups and explore how decision-making and simulation is handled by the game, and what insight it sheds on simulations in general.

Reading	Online	Watching	Journal	Submit
	Begin watching one of the Week 10/11 interviews	The Big Short (optional) (Youtube, Amazon Prime) Please visit the statistics primer page for introductory videos on statistics (optional)		After trying SimCity2000 with a partner, consider some of your takeaways, as well as the question of how AI would play the game, in a Canvas assignment.

Movie: *The Big Short*

Week 11 (4-12)

TOPIC Space **CASE Astrophysical Simulation & SETI**

We return to what generates theories and predictions, data - we are now well-acquainted with the "Rise of Theory," but is a "Fall of Theory" upon us? Perhaps there is a way to mediate traditional theory/mechanism with "Big" data-driven approaches, or a **spectrum of approaches** that lie between the extremes. With this motivation we will explore **triangulation**, combining approaches, and Bayesian statistical reasoning. Using these mindsets and the theory-data spectrum, students will analyze the content of their respective interviews in groups.

Turning back to simulation-based models, we will review the importance of resolution as an approximation for reality and use this lens to analyze modern astronomy. We will trace the historical path of comets as a remarkable example of prediction, beginning with their perception as "harbingers of doom" and ending with landing satellites on a moving comet. We will run into the infamous **3-body** (and later **n-body**) **problem**, and remark how simulated results of galaxies colliding align with observed galaxies. and end by asking whether we are alone in the multiverse using the **Drake Equation**.

Reading	Online	Watching	Journal	Submit
	Watch a Week 10/11 interview and submit a forum post.	The "bonus" video is of the TALK that Jill gave at Radcliffe's "Undiscovered"		In class, submit the slide your group made for the discussion of The Future of the Future. When you're done watching the videos, identify and explain (in a paragraph) the most surprising bit of information you learned. Second, if you had conducted the interview, what unasked and/or unanswered question would you have asked, and why? (Details in Assignments) Research check-in: Turn in an annotated bibliography listing sources you have consulted to-date in your research. At least five sources should be included, and the utility of each one

				should be explained in few lines of text per source.

Week 12 (4-19)

TOPIC Hypothesis-free Prediction? CASE AI/Machine Learning

SPECIAL GUEST: Federico Slepoi, Behavioral Economist for the City of Rome
SPECIAL PRESENTATIONS from TFs Dr. Pipit Triani and Dr. Mila Chadayammuri

In the course's final formal lecture, we will trace the historical path of comets as a remarkable example of prediction, beginning with their perception as "harbingers of doom" and ending with landing satellites on a moving comet. We will run into the infamous **3-body** (and later **n-body**) **problem**, and remark how simulated results of galaxies colliding align with observed galaxies.

We will also welcome Federico Slepoi as he sheds more light on the global practicality of behavioral economics through his experience designing public outreach for the city of Rome. We will then draw from the knowledge of our astrophysics-focused TFs to learn about the predictive power in studies concerning color spectra in galaxy formation and the use of mathematics to interpret complex phenomena.

Reading	Online	Watching	Journal	Present
	Choose one "Week 12" Interview from here	Next in (Data) Science (optional)	For the interview you chose, identify and explain (in a paragraph) the most surprising bit of information you learned. Second, if you had conducted the interview, what unasked and/or unanswered question would you have asked, and why? (Details in Assignments)	

Concluding Meeting (4-26)

TOPIC The Future of the Future CASE Integration: Health, Wealth, Earth, Space

In our final session, we will bring together all that we have studied - predictions ancient and modern, and in various fields. We'll look at simulation tools of energy use and climate change, and watch students' draft project videos to get a larger view of prediction. We will then use a diagram to consider how the four core ideas of our class relate to each other: **risk, uncertainty, prediction, and decision**, and from there students will break into

groups to brainstorm how to present a given predictive topic to **some general public**. We will conclude by drawing together prior material, student conceptions of the future, definition(s) of prediction, and how different predictive systems interact.

Reading	Online	Watching	Journal	Present
	Individual Links: Dan Gilbert, Agustin Rayo (optional), Stuart Firestein (optional, but highly recommended for enrichmnent!)	Wall-E (optional) (Amazon Prime, Youtube, Disney+)		Present draft videos of final project in section Please submit a URL pointing to your draft write-up Your final video and final write-up will be due on May 6th.