

Course Notes

Mathematical Models, Fall 2019

Queens College, Math 245

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<http://qcpages.qc.cuny.edu/~chanusa/courses/245/19/>

A definition

What is a model?

- ▶ Miniature representation of something (Model airplane)
- ▶ An example for imitation or emulation (Sewing pattern)
- ▶ An analogy to aid in visualization / conceptualization (Drawing of an atom; Pendulum for public opinion.)
- ▶ A detailed description of a situation.
(System of assumptions, data, inferences describing a situation)

A **mathematical model** is a representation of a real-world situation using mathematical terms.

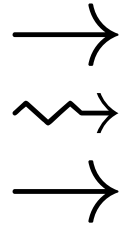
We will see: **Math is Everywhere.**

Models underlie many real-world situations

- ▶ Countdown clocks: When will the next bus/train arrive?
- ▶ Product management: How many items will a store sell?
- ▶ Sea rise: How much higher will the oceans be in 50 years?
- ▶ Population: How many people will live in NYC in 2030?
- ▶ Student demand: How many sections of Math 245 to run?

A justification

Why do we model?



observed real-world
behavior

As scientists, we want to understand how the world works.

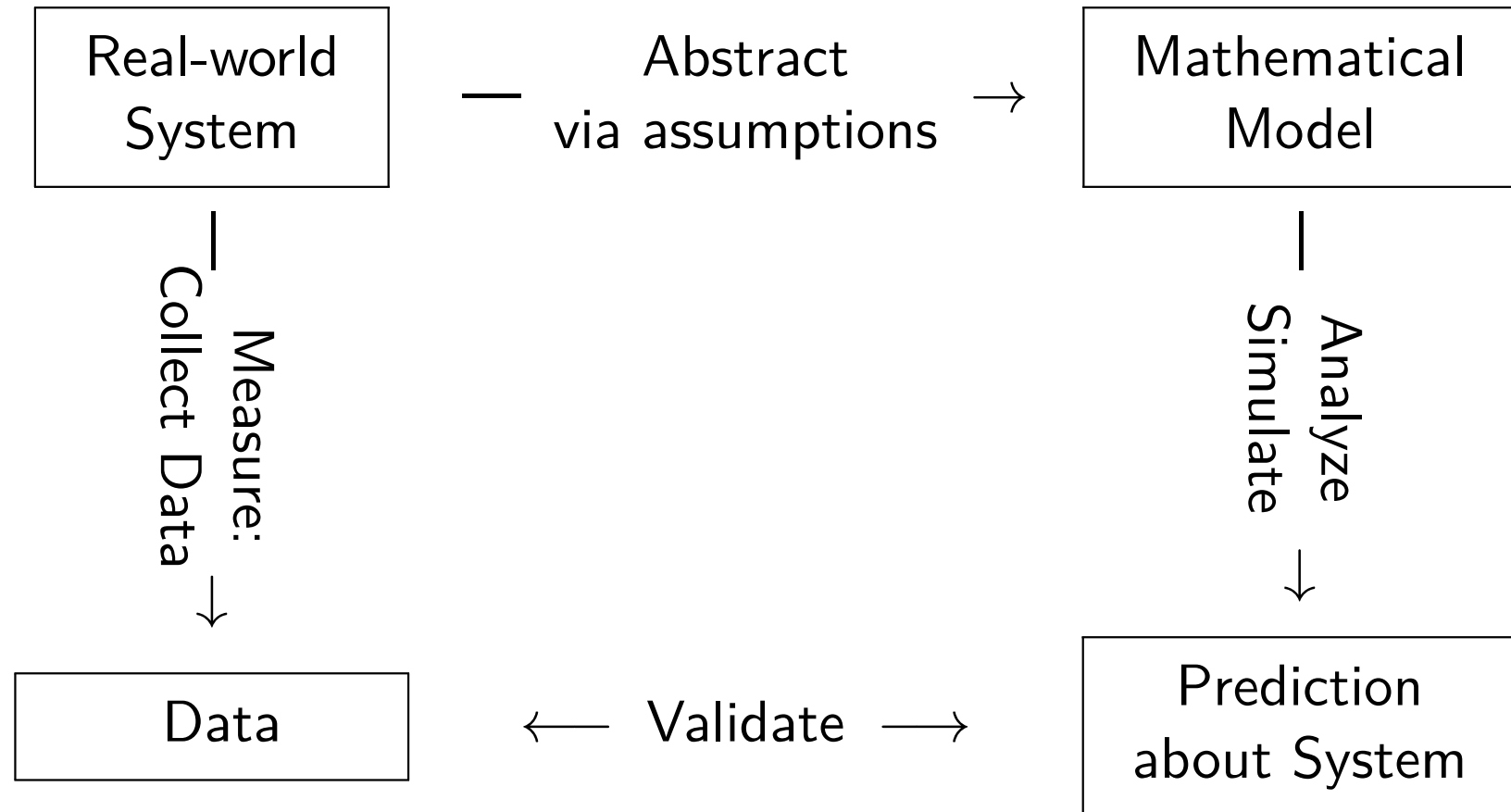
- ▶ What is happening?
- ▶ What are the reasons for the behavior?
- ▶ How do we convey that our reasoning is plausible?

Modeling is an **ACTIVE** process.

- ▶ Requires in-depth thought in order to understand and convey the essence of a situation.

In this class: We are going to create computer simulations in Python and use the language of mathematics to model the real world.

How do we model?



- ▶ Identify the most important variables in a real-world system
- ▶ Analyze the model / Create a computer simulation
- ▶ Collect some data from the real world system
- ▶ Validate your model and refine / revise!

A normal day in this class

Outside
class

- ▶ Preparing for class
 - ▶ Pre-reading, Answer Daily Question, Prepare questions.

In class

- ▶ Arrive on time & Be ready to participate!
- ▶ Discussion of homework questions, Daily Question.
- ▶ New content
 - ▶ Theory and Practice of Modeling
 - ▶ Algorithm design and coding details
 - ▶ **Take notes!**
- ▶ Project Work
 - ▶ Dedicated time to make progress and ask questions on project

Outside
class

- ▶ Learning after class
 - ▶ Review notes, Do homework, Project work

Class Notebook

- ▶ Acquire a notebook (50–80 pages) and bring it to class everyday. (Quarantine it from other classes.)
- ▶ I will collect them every few weeks and check for completion.
- ▶ Label pages with the date and label each question.

Question 1-1. (problem statement here)

Answer the question in complete sentences.

(Leave some space for notes from discussion.)

Question 1-2. (problem statement here)

⋮

To do well in this class:

- ▶ **Form good study groups.**
 - ▶ Discuss homework and classwork.
 - ▶ Bounce around ideas, topics, questions.
 - ▶ It helps to have people to talk through things with.
- ▶ **Put in the time OUTSIDE class.**
 - ▶ Three credits = 6–9 hours / week out of class.
 - ▶ Homework stresses key concepts from class; learning takes time.
- ▶ **Come to class prepared.**
 - ▶ Review previous day's notes.
 - ▶ Do the homework & work on your projects.
- ▶ **Stay in contact.**
 - ▶ If you are confused, ask questions (in class and out).
 - ▶ Don't fall behind in coursework or homework.
 - ▶ I need to understand your concerns.

Everything posted online; first one (many parts) due Wednesday.

Meet the modelers

Group Activity. Get into groups of four-ish people, with people you don't know. Take some time to get to know them:

- ▶ Introduce yourself. (your name, where you're from, your major)
- ▶ Fill out **the blank side of** your notecard:
 - ▶ Write your name. (Stylize if you wish.)
 - ▶ Write a few words about your name to help me remember.
 - ▶ *Draw* something in the remaining space.
- ▶ Discuss with your groupmates why you wrote what you wrote.
- ▶ Exchange contact information. (phone / email / other)
- ▶ *Small talk suggestion:* What kept you busy this summer?

Thought Question. Brainstorm real-world situations where you interact with a mathematical model. Choose one. How does the mathematical model (or its conclusions) impact your life?

We are going to learn math modeling and python together.

Let's get Started!

- ▶ Grab a computer / Bring your own.
- ▶ Go to our course webpage:
`qcpages.qc.cuny.edu/~chanusa/courses/245/19/`
- ▶ Find the day's plan > Content.
- ▶ Head to > Software.
- ▶ Use your Office365 account to access Azure Notebooks.
- ▶ Import the python notebooks from GitHub.
- ▶ While they are importing, access Google Classroom.
- ▶ Take a minute to answer the Daily Question.

Jupyter notebook advice

Jupyter is the notebook environm't. **Python** is the progr. language.

- ▶ **Always work in the code directory.**
- ▶ Make a new copy of the notebook before any modifications.
- ▶ Each time we start the server, all previous definitions are lost.
- ▶ Use the Python 3 kernel, not the Python 3.6 kernel.
- ▶ Jupyter notebooks look linear. They are not.
- ▶ Always evaluate the cells in order from top to bottom.

Let's flip a coin!

- ▶ We are using the `modsim` package; it must be imported each time we open the notebook.
- ▶ `modsim` relies on the `pint` package, so load it first.