

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?

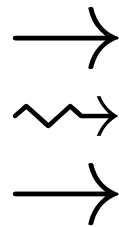
- ▶ Miniature representation of something (Model airplane)
- ▶ An example for imitation or emulation (Sewing pattern)
- ▶ An analogy to aid in visualization / conceptualization (Drawing of an atom; Pendulum for public opinion.)
- ▶ A detailed description of a situation.
(System of assumptions, data,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

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

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

A justification

Why do we model?



observed real-world
behavior

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

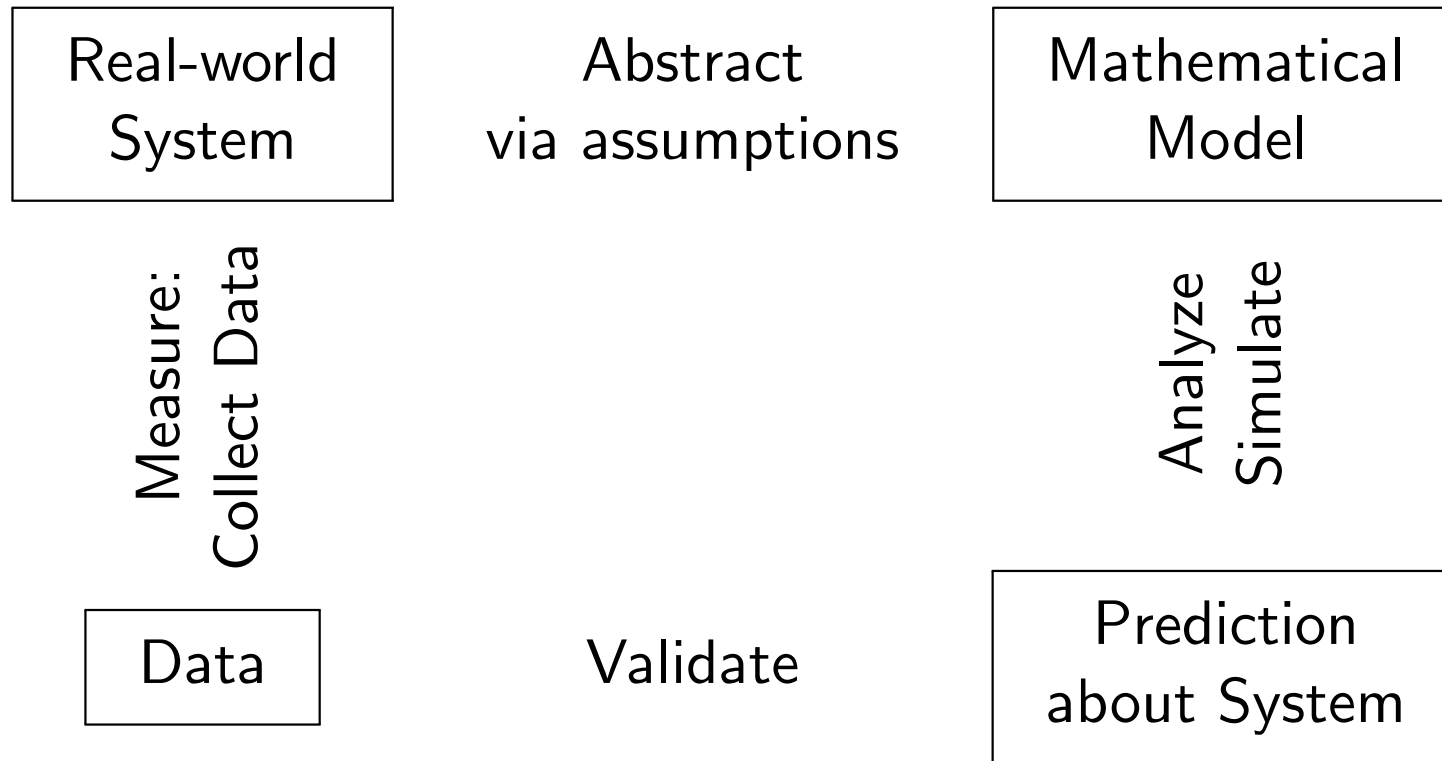
- ▶ What is happening?
- ▶ What are the reasons for the behavior?
- ▶ How do we convey that our reasoning is plausible?

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
 - ▶ Do homework, pre-reading, daily question, prepare questions.

In class

- ▶ Arrive on time & Be ready to participate!
- ▶ Discussion of homework questions, recap.
- ▶ Introduction to new concepts
 - ▶ Overview of the day, focus on complex concepts
- ▶ Groupwork
 - ▶ Work through Python notebook or textbook exercises
 - ▶ Explore, **Take notes in notebook**
 - ▶ Group Project Work

Outside
class

- ▶ Learning after class
 - ▶ Finish tutorials, review notes, project work

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.

Homework Notebook

- ▶ Acquire a homework notebook (~100 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)

⋮

Meet the modelers

Group Activity. Get into groups of 3–4 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 winter break?

Thought Question. There are mathematical models used everyday in the real world. Brainstorm as many as you can. How do they impact your life?

We are going to learn math modeling and python together.

Let's get Started!

- ▶ Grab a computer / Bring your own.

Login Information: **User:** Student – **Password:** Student1

- ▶ 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 environment. 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.