Course Notes

Mathematical Models, Spring 2020

Queens College, Math 245

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http://qcpages.qc.cuny.edu/~chanusa/courses/245/20/

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?
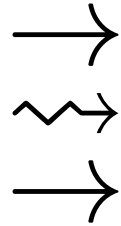
$\longrightarrow$
$\rightsquigarrow$
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observed real-world behavior
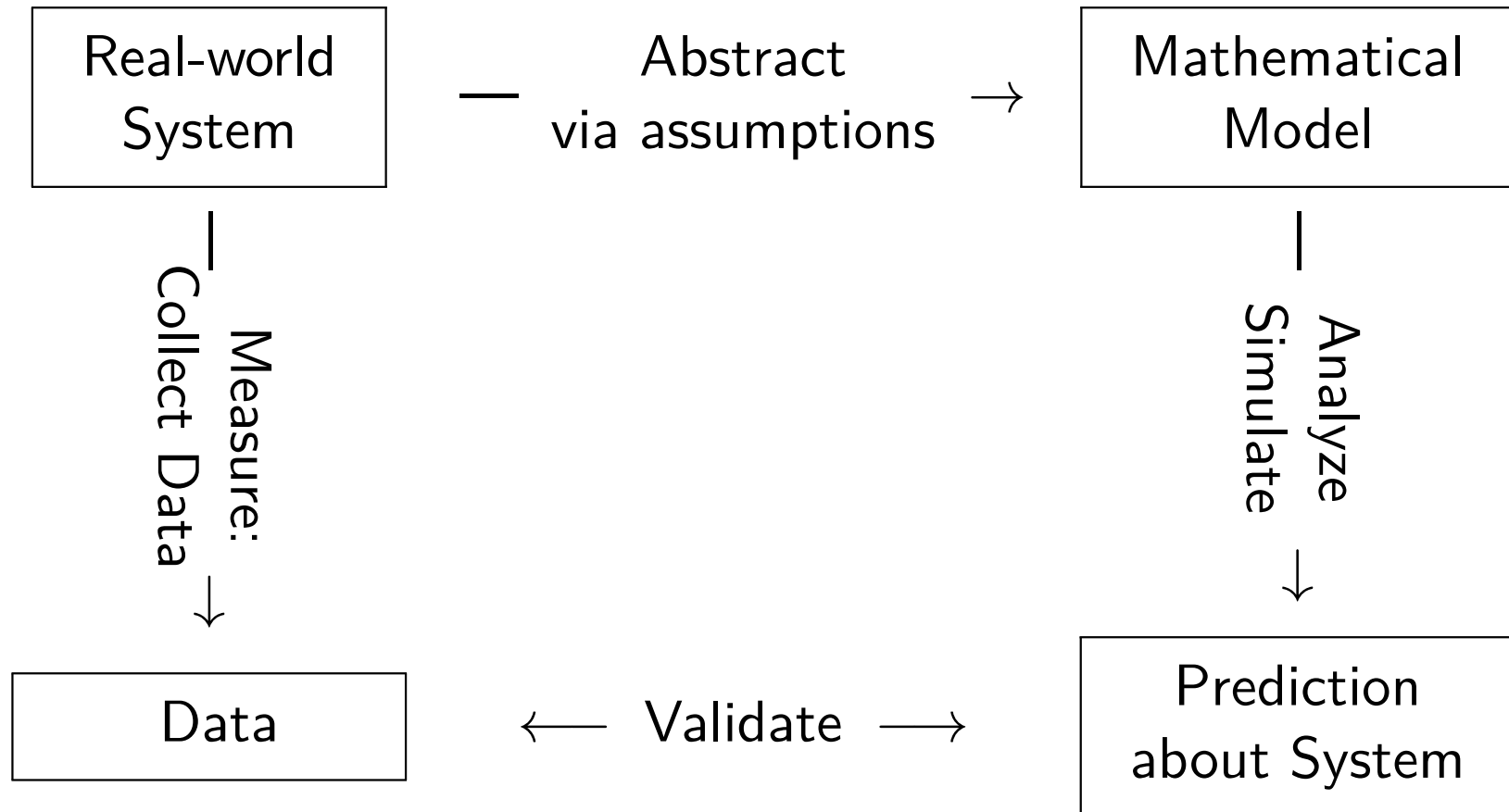
As scientists, we want to understand how the world works.

► 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?

Real-world System	— Abstract via assumptions →	Mathematical Model

Measure: Collect Data ↓

Analyze Simulate ↓

Data	← Validate →	Prediction about System

- ▶ 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.
- ▶ First 20–30 pages for homework, the rest for class notes.
- ▶ Label each page 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. Take some time to get to know your groupmates:

▶ 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 it.
  ▶ *Draw* something in the remaining space.

▶ Exchange contact information. (phone / email / other)

▶ *Small talk suggestion:* What kept you busy this past month?

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/245/20/`

▶ 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** `notebooks` **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.