

# Course Notes

Mathematical Models, Fall 2018

Queens College, Math 245

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<http://qcpages.qc.cuny.edu/~chanusa/courses/245/18/>

## What is a model?

A **model** is an object or concept used to represent something else. It converts reality to a form we can comprehend.

- ▶ **Reality:** How to understand the aerodynamics of an airplane?  
**Model:** Use a **model airplane** or a **computer simulation**.
- ▶ **Reality:** Politics flows between left-wing and right-wing ideas.  
**Model:** Think of public opinion as a **pendulum**.

A **mathematical model** is a model involving mathematical concepts.

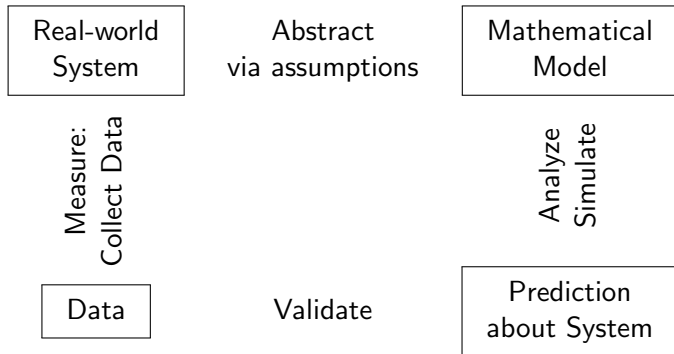
### IN THIS CLASS:

Start with a **real-world situation**, understand it mathematically, and create a computer simulation to model it.

- ▶ Model bike sharing using a **state diagram**.
- ▶ Model world population by using **growth functions**.
- ▶ Model infection rate using **differential equations**.

Then collect data and **analyze our models!**

## 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
  - ▶ Work on homework, do pre-reading, 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 tutorial, 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 summer?

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

## Programming Computers.

We are going to learn modeling and python together.

- ▶ Go to our course webpage:  
`qcpages.qc.cuny.edu/~chanusa/courses/245/18/`
- ▶ You'll explore it in detail. > Software.

Key things about Jupyter notebooks:

- ▶ Make a copy of the notebook before any modifications.
- ▶ Each time we start the server, all previous definitions are lost.
- ▶ Jupyter notebooks look linear. They are not.
- ▶ Always evaluate the cells in order from top to bottom.
- ▶ We are using the `modsim` package, so import it each time we open the notebook.
- ▶ `modsim` relies on the `pint` package, so load it first.