

**FALL 2025**

# MEETING #1

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Computational Modeling in Engineering and the Sciences

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# AGENDA

- Introductions
- Introducing computational modeling
- Goals
- Mentee survey
- Demo: set up Python

**Assignment: Read Konstantinovsky - Mastering the SEIR Model.  
We'll discuss next week.**

# Introductions

## Introductions

- Name
- Major and year
- Something fun you did this summer
- Academic, research, and professional interests

# Introducing Computational Modeling

## Introducing Computational Modeling

### **modeling**

creating a conceptual representation of a system,  
situation, or process, which is used to understand or  
predict that thing



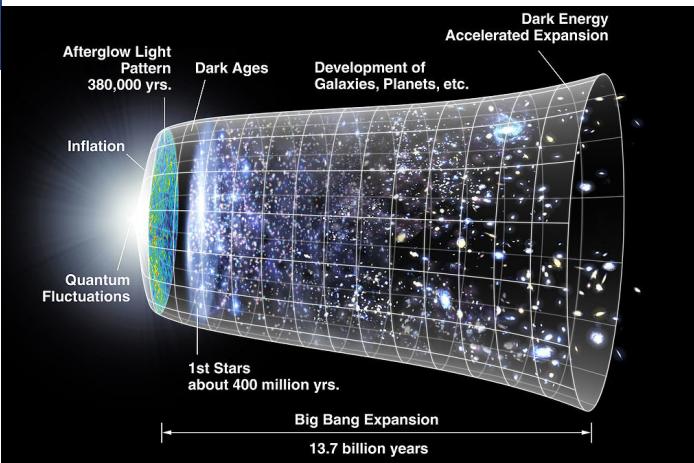
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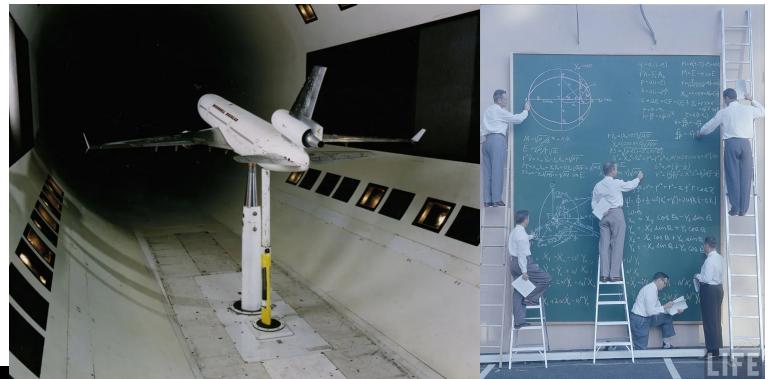
## Introducing Computational Modeling



Maybe you want to predict the future



Or understand something that you can't easily test in a lab



Traditionally, your options were relatively limited

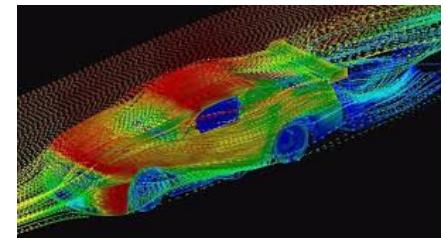
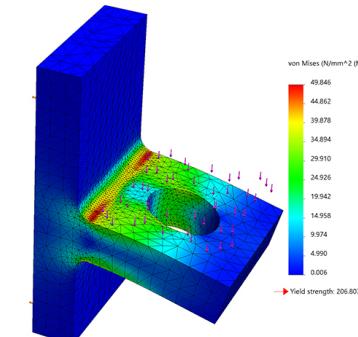
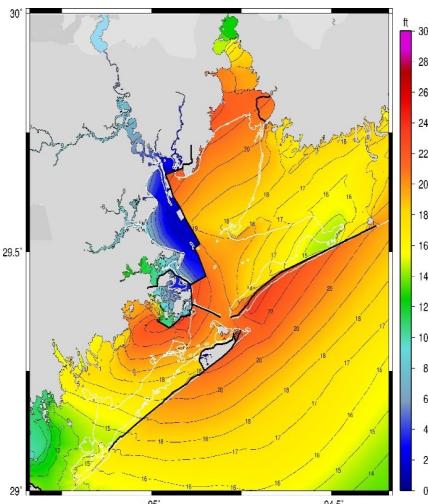
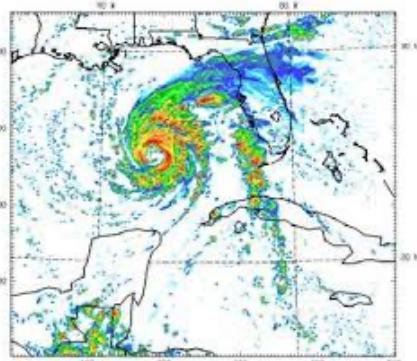
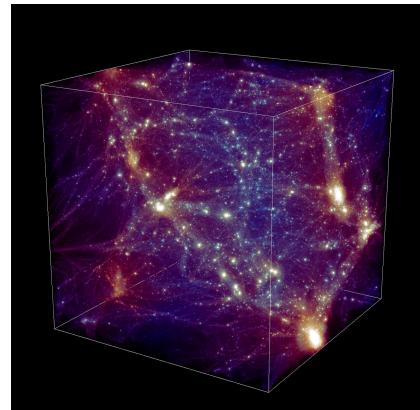
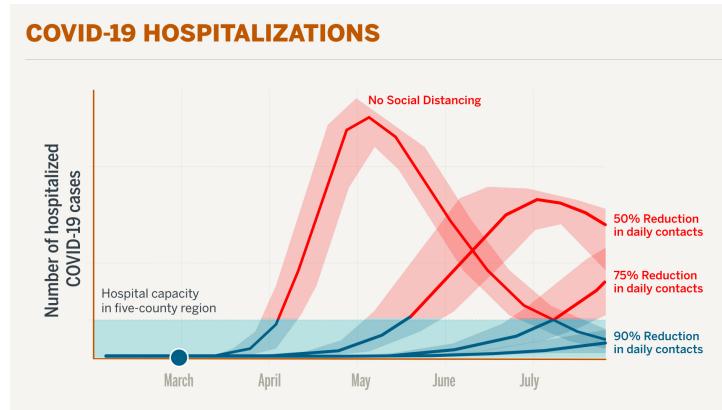
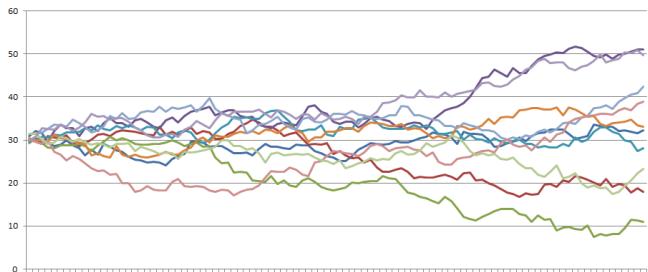


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# Introducing Computational Modeling

Computers enable bigger and more complicated models



# Introducing Computational Modeling

Computational modeling is very **interdisciplinary**. Computer scientists play an important role in this field of research.

## Domain Science

(understanding the thing itself)

## Modeling Techniques

(linear algebra, calculus, differential equations, statistics, ML, etc.)

## Computer Science

(making computers do big math fast)

# Introducing Computational Modeling

Kinds of problems (not comprehensive)

- Forward problems: cause to effect
  - E.g. computational fluid dynamics, COVID forecasting
- Inverse problems: effect to cause
  - E.g. parameter estimation, MRI image reconstruction
- Optimization: finding something that minimizes/maximizes an objective
  - E.g. tumor treatment optimization, best signal to stop a seizure
- Uncertainty quantification: accounting for messy data, uncertain parameters

# Introduction to Computational Modeling

Modeling techniques (not comprehensive)

- Differential equations: express how quantities of interest relate to each other using derivatives
  - Solved with FEM, FDM, FVM, spectral methods, etc.
  - E.g. orbital mechanics (ODEs), finite element analysis (PDEs), stock options (stochastic PDEs)
- Data-driven methods: starting with raw data to inform a model, as opposed to principles
  - E.g. regression, statistical fits, machine learning, etc.

# Goals

## Goals

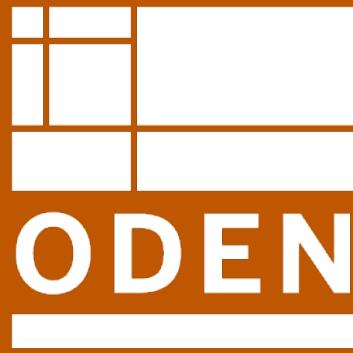
“DiRP is a program to help undergraduate students get involved with computer science research. Mentors can lead reading groups, project groups, or propose their own format.”

- Learn about computational modeling
- Explore research and academia
- Mentorship
- Build up math and coding skills
- “Leave things better than we found them”

See syllabus for details

# Mentee Survey

## Demo: Set up Python



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