

Intro to sims lecture:

Welcome and overview of the course

Course is two days, four blocks

Starting at 10:00, break for lunch at 12:00, then restart at 13:00 and end hopefully around 15:00

First day:

Intro to simulations

Probability distributions

Luria delbruck practical

Second day:

Optimizing code

Primer on abc

Short abc practical

SLiM

Where to find course materials

Goal of this lecture:

- Answer two questions:
 - What is simulation?
 - Why simulate?

My motivation for teaching the course:

- I got into sims because I wanted to play around with diff ideas - have fun be creative
 - Interest in speciation and pop gen
 - Very complicated process
 - Don't know math, new some coding
 - So I just coded it
 - Mentioned it to person at conference
 - Had stumbled upon agent based modeling
- Done modeling without the math
- Mental divide bw theory people and experimental
 - False dichotomy
 - All experimentals are modelers
 - Hypo derived from mental model
 - Theory people test logic of model
 - Expos test model with exp

- Why not do both?
- Wanted to teach course in order to share this super power with others
- Idea not to teach code or be technical
 - Rather to help just get started
 - Give a few “search terms”

Back to questions: already started answering second one

- Test your logic. Does your mental model work like you think

Let's talk about the first one

- By doing so, we will more thoroughly answer the second question

What is a simulation:

- Wiki def is “an imitative representation of a process or system that could exist in the real world”
- Doesn't have to be a computer script
 - Example is NASA space pool
 - Cancer simulator
- Also doesn't have to be for science
 - Most simulations aren't
 - The first video game was a simulation of tennis
 - Developed by a physicist
 - Wanted something fun for public day at Brookhaven national laboratory
 - Reused computer that was intended to calculate ballistic missile trajectories
 - Video games simulate reality
 - Training sims -airplanes
 - Tractor simulator
 - Train sim for sh
- All these things help us to work with a problem
 - play with a system
 - see how it behaves
 - Key point here:
 - **Simulations build intuition for complex things**

To bring back to more scientific; What is a sim for science?

- Computer simulations
- Take your mental model and put it into a computer
- First to do this was Jon von Neumann and Stanislaw Ulam in the 1940s at Los Alamos
 - Both were working on developing the nuclear bomb during WW2
 - Big problem: how much tonnage
 - Way a nuclear bomb works
 - Tonnage then depends on knowing how far the neutrons will go
 - The math didn't exist for this - too complicated
 - Ulam had the idea to simulate

- “Insert quote”
- They came up with a program to sim neutrons moving through a material
- Simulated on eniac
 - Electronic numerical integrator and computer
 - Ran for 5 days
- This was the first instance of the Monte Carlo method
 - Named after ulama uncle, who borrowed money from family to gamble at Monte Carlo alot
- Now one of the most widely used computational methods
 - Used across scientific disciplines
 - Used in inferring phylogenies
 - Demography inference - basis of monte-carlo markov chain
 - All manner of applied statistics

this story emphasizes another reason why you simulate - you don't know the math!!

More biological example to emphasize size the point - start seeing how to do a simulation

Lotka-volterra model in Python example

More than just building intuition, testing your mental models logic, and getting around tricky math

Simulations can be really useful for designing experiments!!

Gwas sim in Python example