# Intro to Simulations

## Simulations for Biologists

# Welcome to Simulations for Biologists!

# Course Schedule

**Wednesday**

**10:00 - 11:00 | Intro to Simulations**
**11:00 - 12:00 | Probability Distributions**
**— — Lunch — —**
**13:00 - 15:00 | Simulation Practical**

**Thursday**

**10:00 - 11:00 | Optimizing Sims**
**11:00 - 12:00 | Primer on ABC**
**— — Lunch — —**
**13:00 - 14:00 | Running ABC**
**14:00 - 15:00 | Simulation Software**

# Where to find Course Materials

https://github.com/AlecJacobsen/Simulation_for_Biologists

# Simulations for Biologists

# Goal of this lecture

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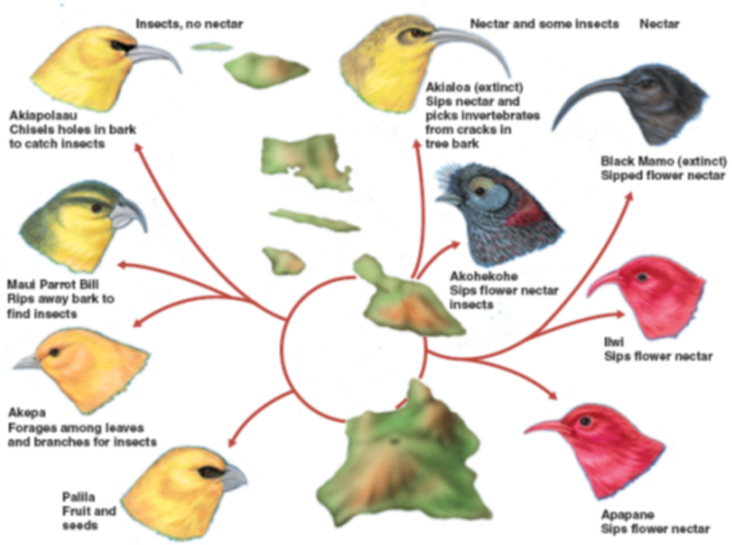
What is a simulation?

# Goal of this lecture

What is a simulation?

Why simulate?

# My motivation for this course



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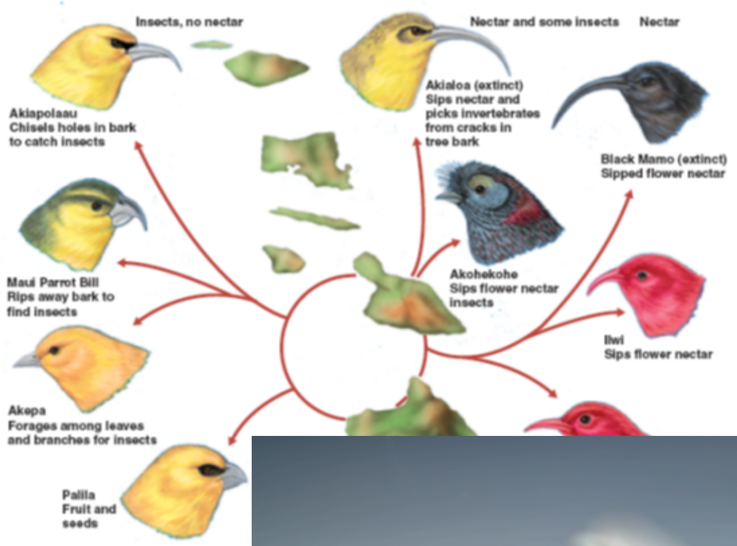


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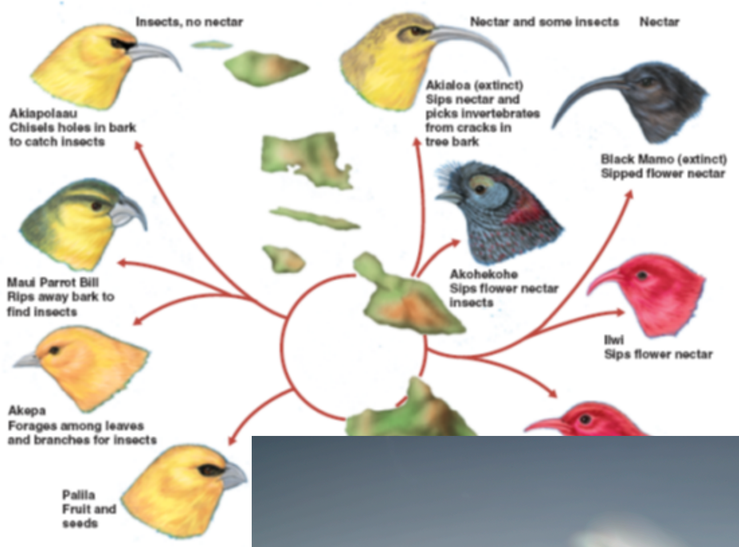


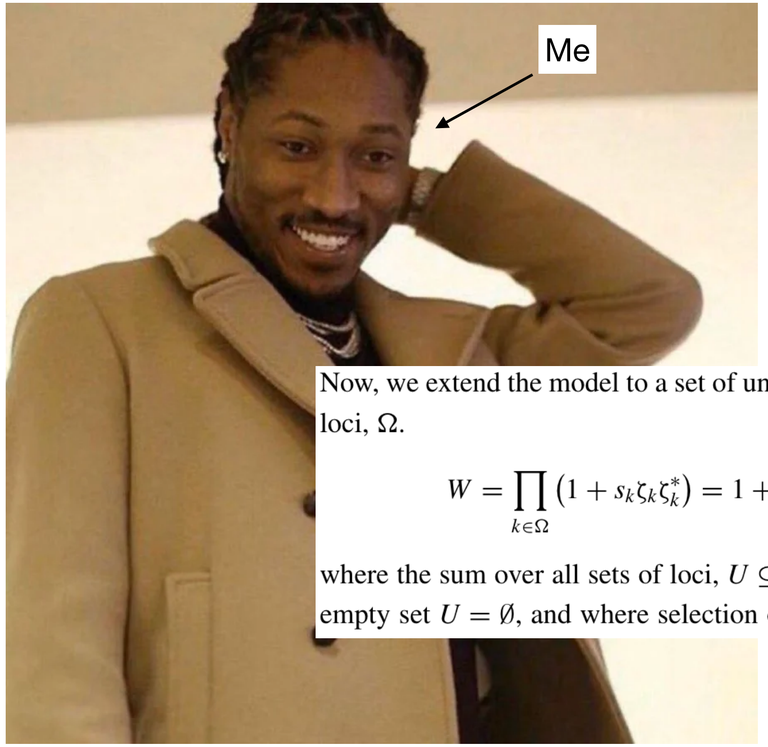


Now, we extend the model to a set of underdominant or assorting loci, $\Omega$.

$$W = \prod_{k\in\Omega}\left(1 + s_k\zeta_k\zeta_k^*\right) = 1 + \sum_{U\subseteq\Omega} s_U\zeta_U\zeta_U^*, \qquad (11)$$

where the sum over all sets of loci, $U \subseteq \Omega$, does not include the empty set $U = \emptyset$, and where selection on a set, $U$, of loci is the

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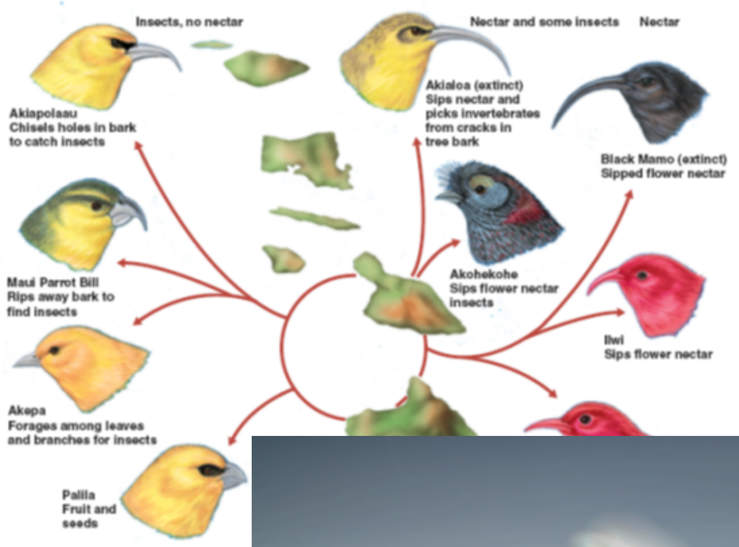



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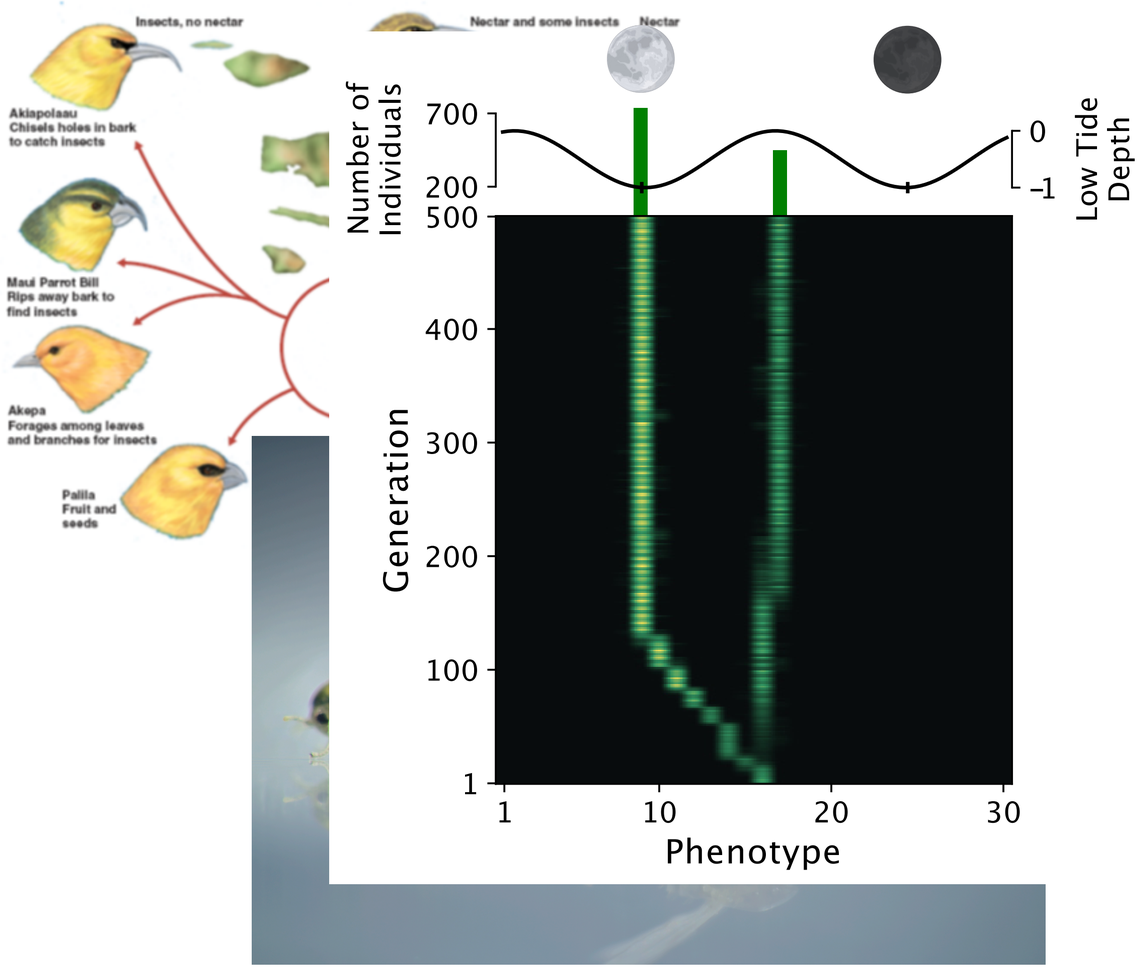




Now, we extend the model to a set of underdominant or assorting loci, Ω.

# Experimentalists VS Modelers


Are
Experimentalists VS Modelers

# Experimentalists ~~VS~~ Are Modelers

Simulations let you test your mental model!

Motivation:
- Share this insight
- Give a few “search terms"

# Goal of this lecture

What is a simulation?

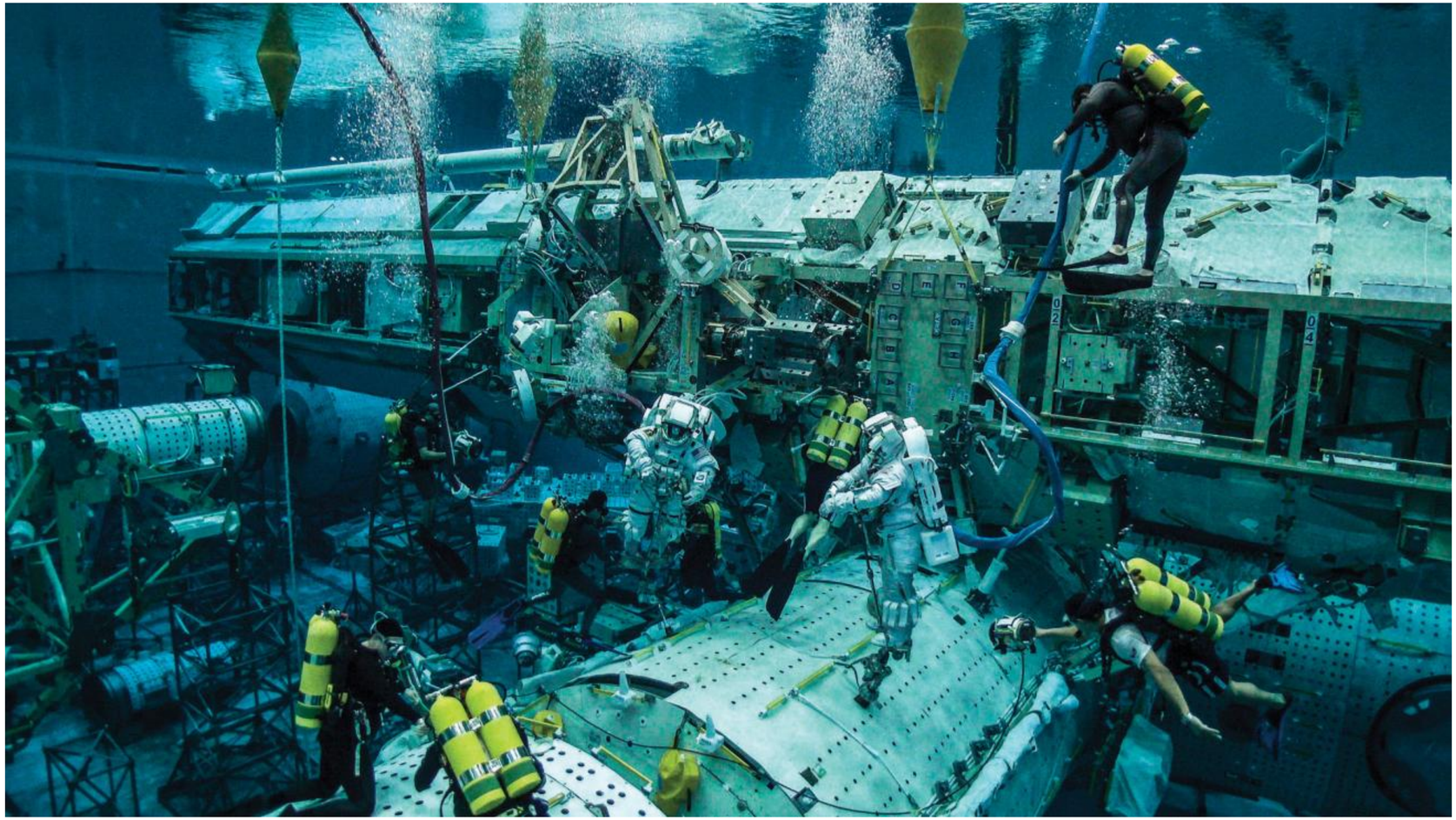
Why simulate?

-Test your logic

# What is a simulation?

“A **simulation** is an imitative representation of a process or system that could exist in the real world”
- wikipedia, 2024

# Not always computer based



# Don’t have to be for science

https://www.retrogamedeconstructionzone.com/2021/08/the-tennis-for-two-simulator-tets.html

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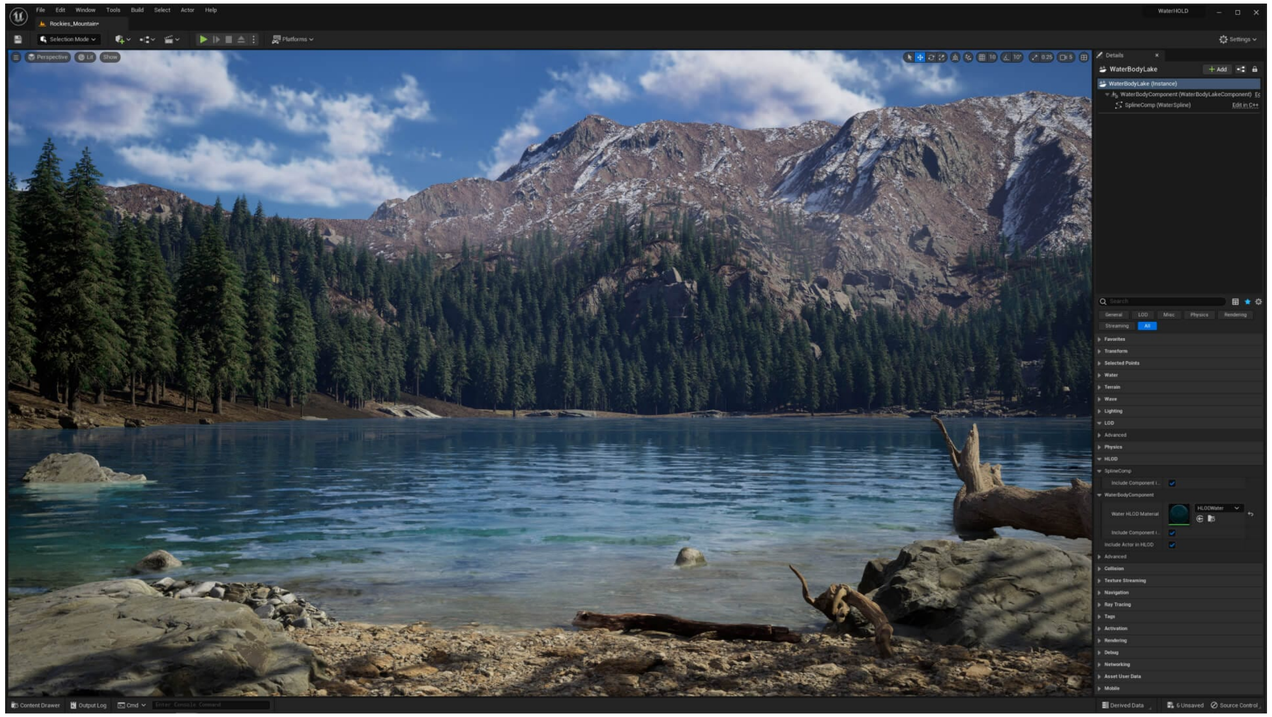

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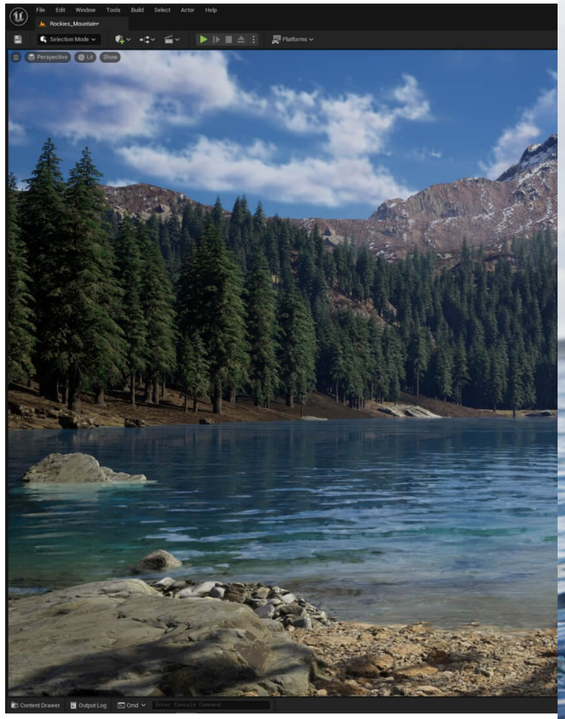


# Don’t have to be for science

# Used for training

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# Goal of this lecture

## What is a simulation?

- a model that tries to encapsulate the rules/behavior of a system

## Why simulate?

-Test your logic

# Goal of this lecture

## What is a simulation?

- a model that tries to encapsulate the rules/behavior of a system

## Why simulate?

-Test your logic
- Build your intuition of how a system works

# Simulations for science

Computer Simulations:
Transcribing your mental model into executable code

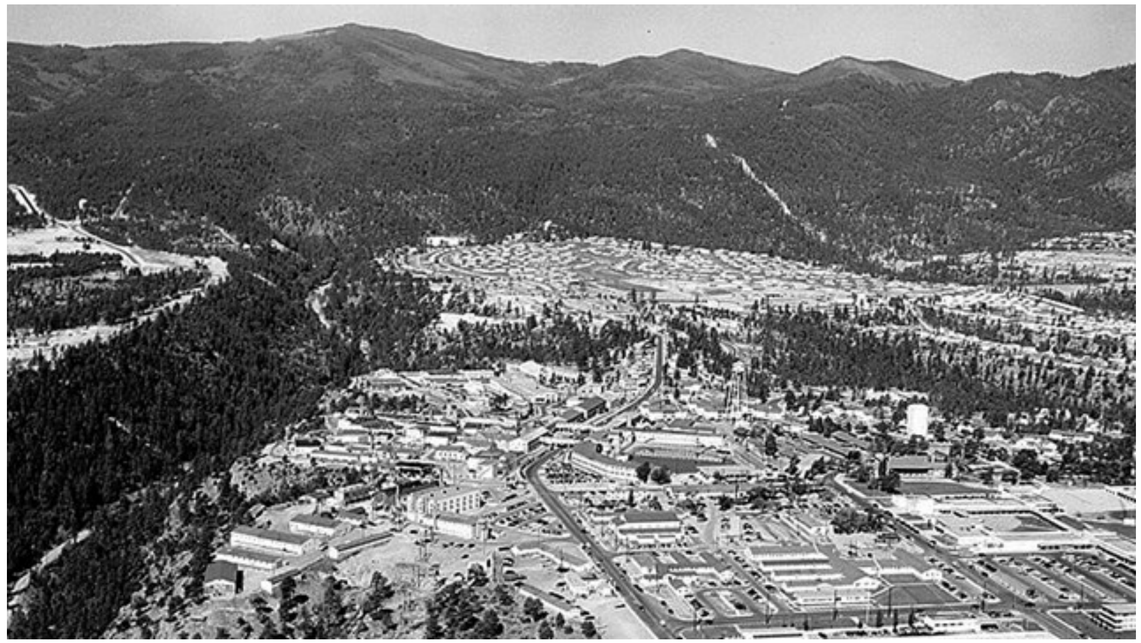

*"Now, this is just a simulation of what the blocks will look like once they're assembled."*

# First computer simulation

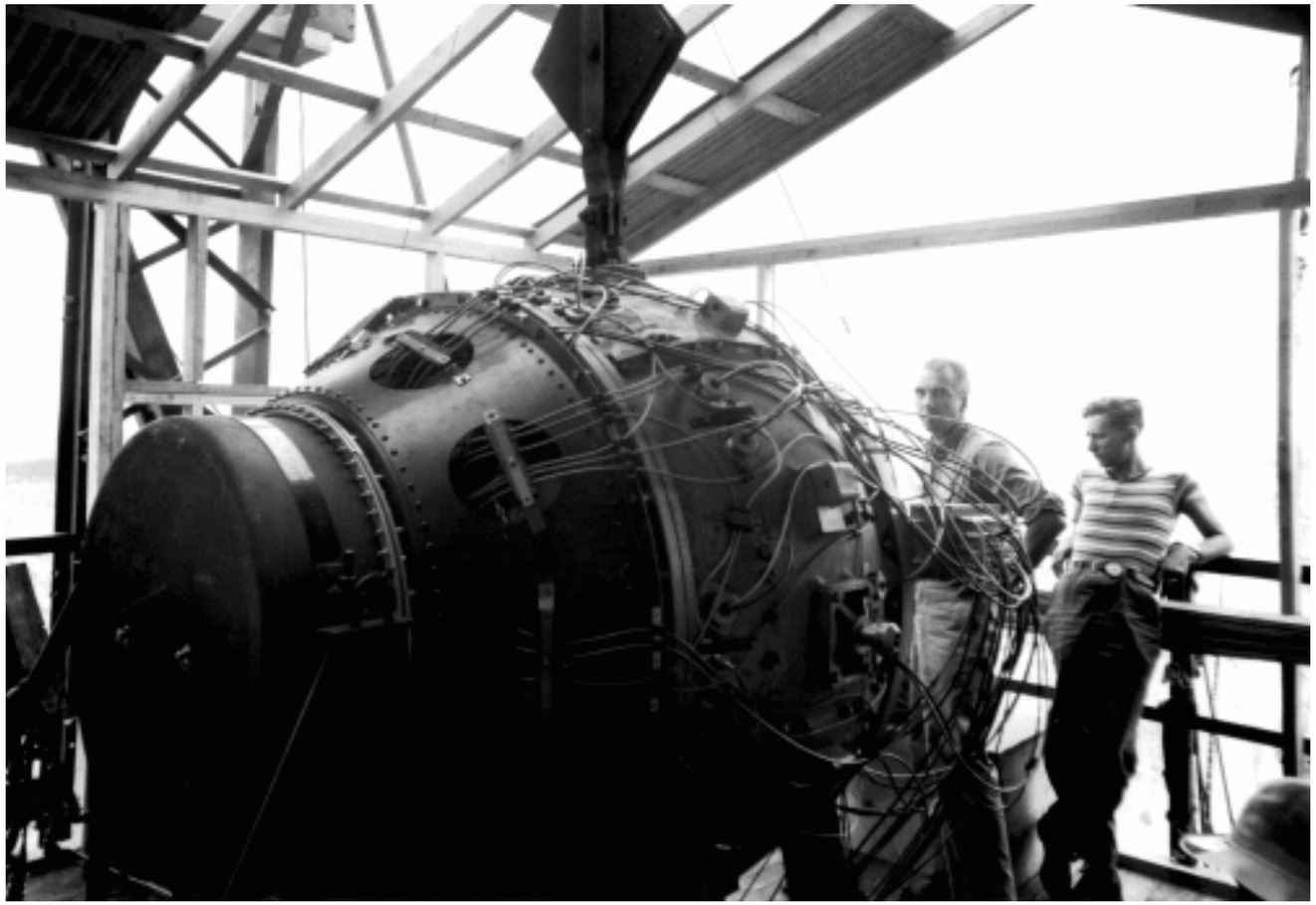
Stanislaw Ulam

John Von Neumann

Manhattan Project

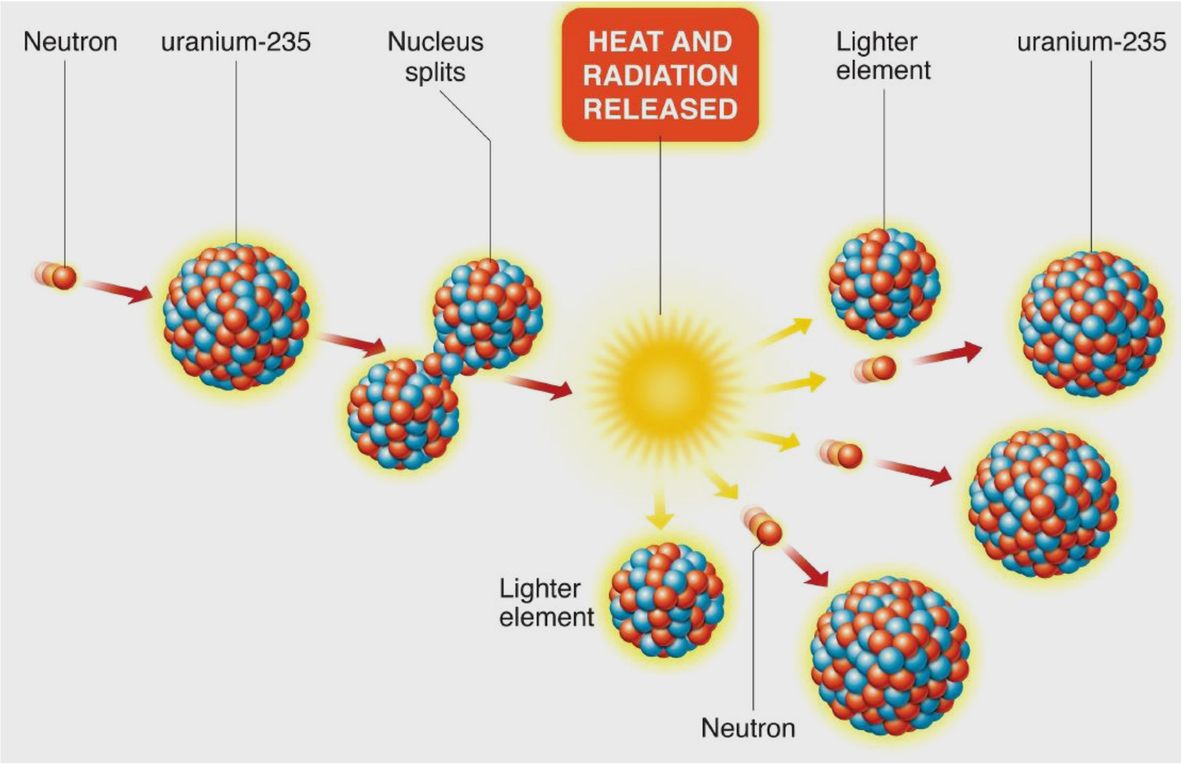


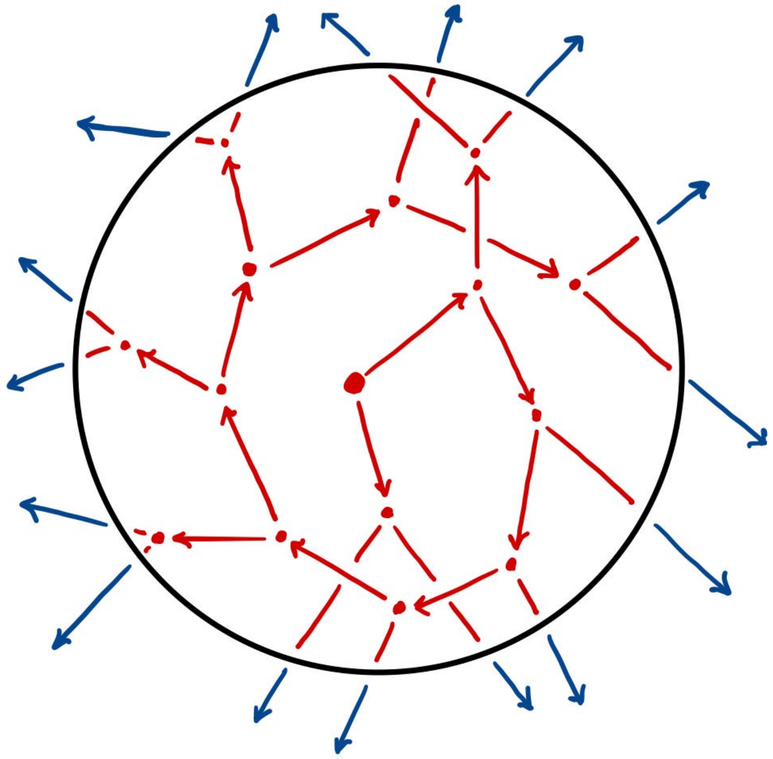
# How much tonnage?



Neutron Diffusion Problem

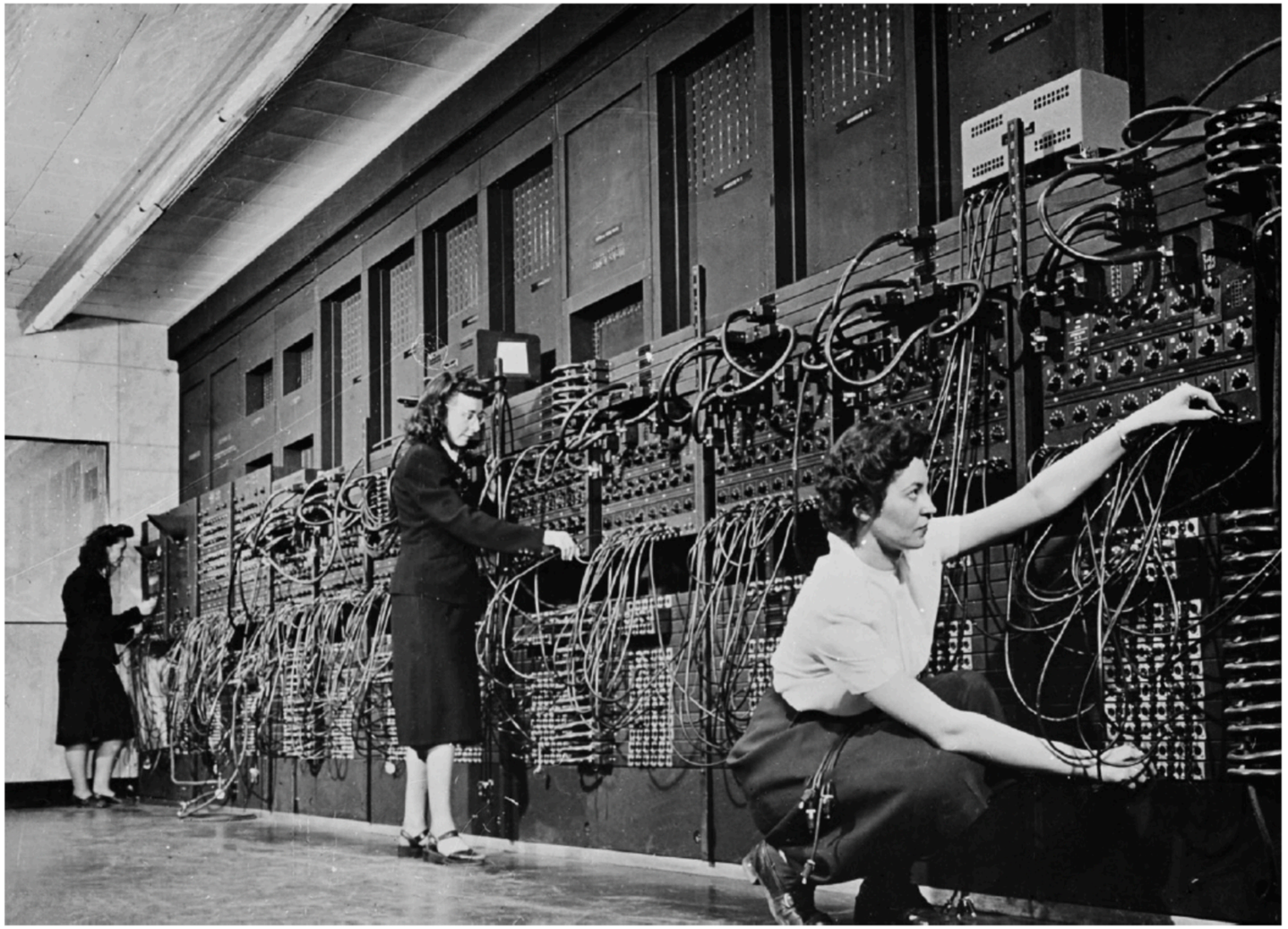
# Neutron Diffusion



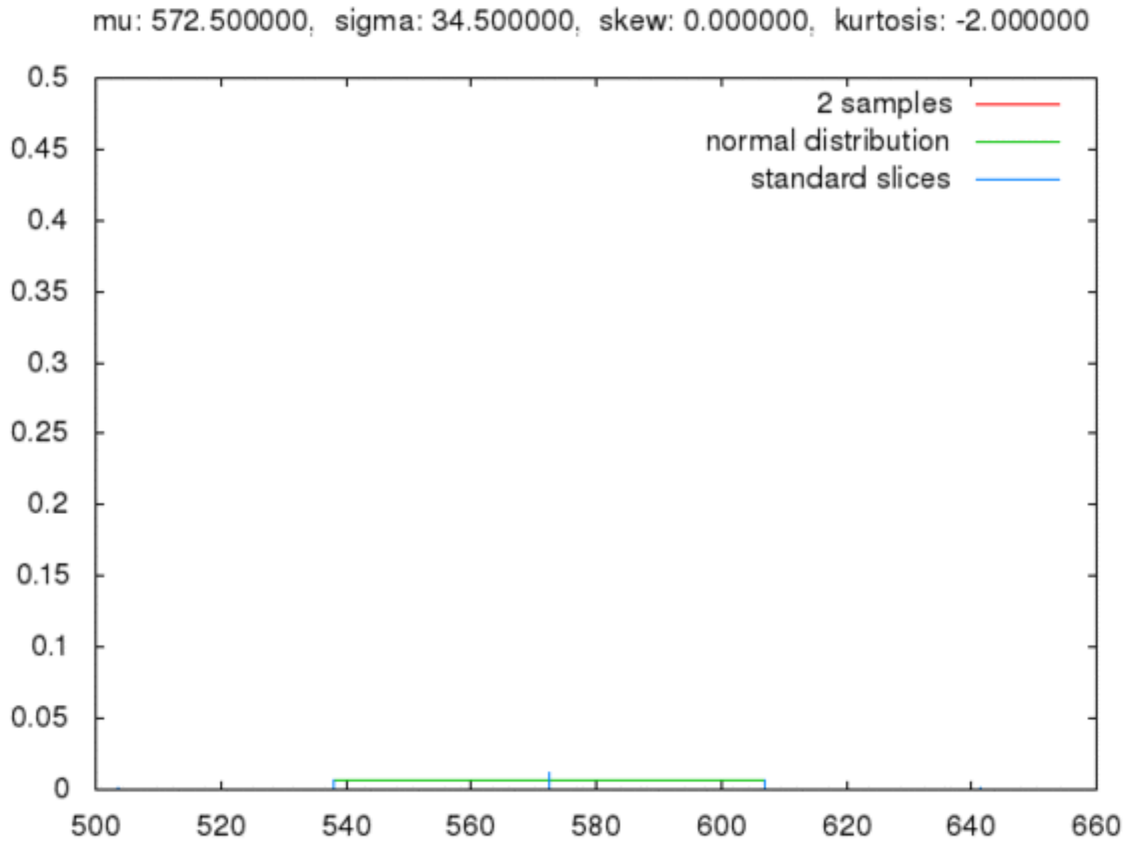



"The first thoughts and attempts I made to practice [the simulation] were suggested by a question which occurred to me in 1946 as I was convalescing from an illness and playing solitaires. The question was what are the chances that a Canfield solitaire laid out with 52 cards will come out successfully? After spending a lot of time trying to estimate them by pure combinatorial calculations, I wondered whether a more practical method than "abstract thinking" might not be to lay it out say one hundred times and simply observe and count the number of successful plays. This was already possible to envisage with the beginning of the new era of fast computers, and I immediately thought of problems of neutron diffusion and other questions of mathematical physics, and more generally how to change processes described by certain differential equations into an equivalent form interpretable as a succession of random operations. Later. . . [ in 1946, I ] described the idea to John von Neumann and we began to plan actual calculations."

# ENIAC



# Monte Carlo method



# Goal of this lecture

## What is a simulation?

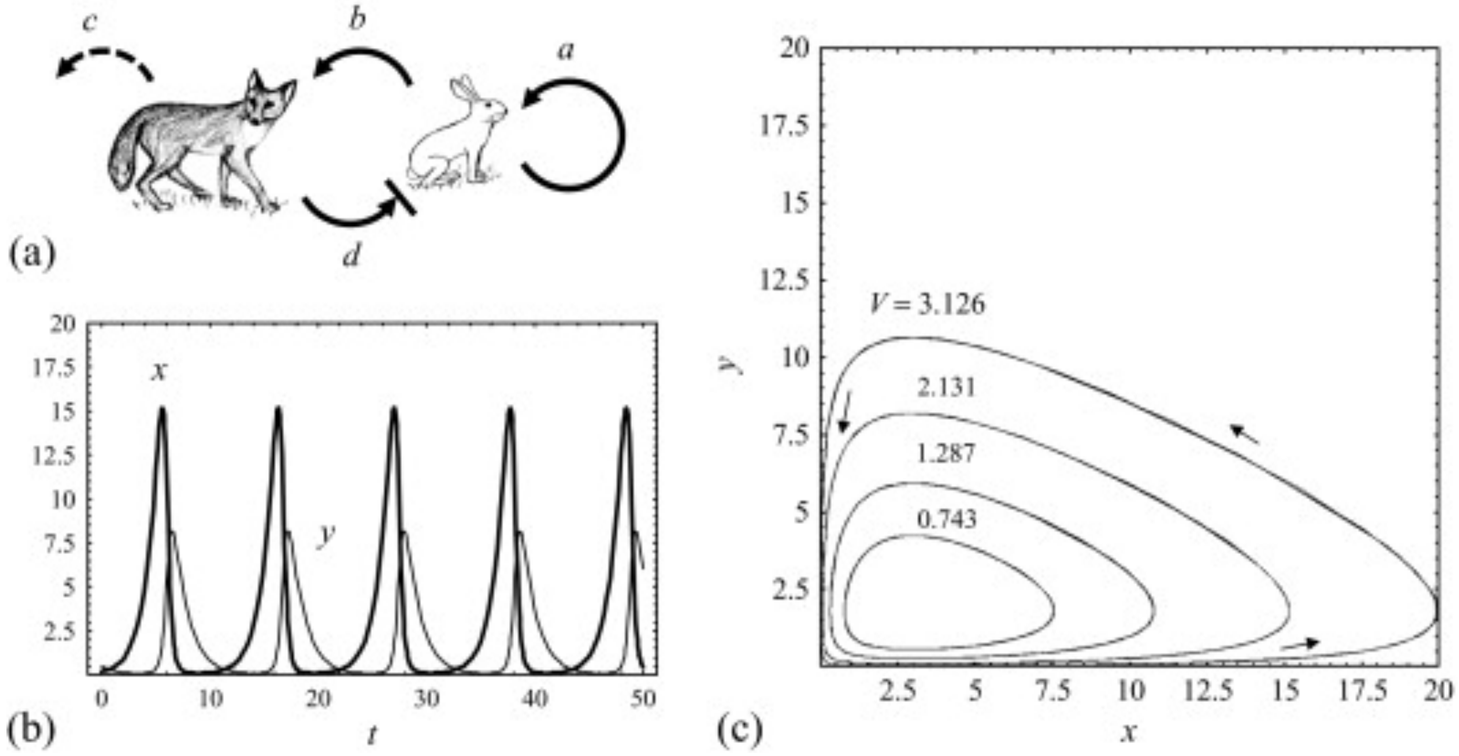
- a model that tries to encapsulate the rules/behavior of a system

## Why simulate?

-Test your logic
- Build your intuition of how a system works
- You don’t know the math!

# Biological Example

## Lotka Volterra



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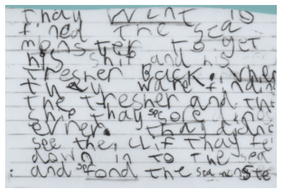

4. Write it as pseudocode

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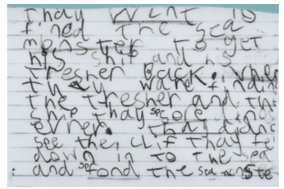

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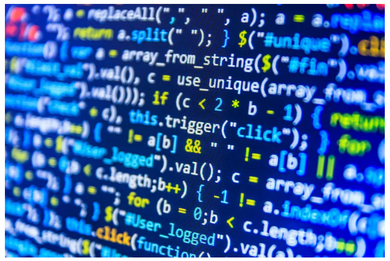

5. Turn the pseudocode to real code