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Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí

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An Roinn Oideachais
Department of Education

National Workshop 4

Day 2 (of 2)

LEAVING CERTIFICATE
COMPUTER SCIENCE

Schedule

Session 4 9:00 - 11:00	Introduction to Modelling and Simulation
Tea/Coffee	
Session 5 11:30 - 13:00	ALT3: Investigate and Plan
Lunch	
Session 6 14:00 – 16:00	ALT3 Design/Create and Resources

Key Messages for National Workshop 4

There are many ways to use the LCCS specification.

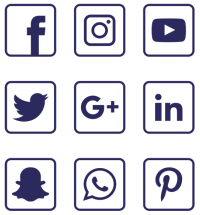
ALTs

ALTs provide an opportunity to teach theoretical aspects of LCCS.

The study of Computers and Society is one of the overarching principles of LCCS.

Critical reflection will be a central component of the student experience and the LCCS teacher's PD journey.

LCCS can be mediated through a constructivist pedagogical approach.



Digital technologies can be used to enhance collaboration, learning and reflection.

Learning intentions

By the end of the day participants will have had the opportunity to:

- enhance their understanding of modelling, simulation and ALT 3
- collaborate with others to **design one** potential solution for ALT 3, as well as, give and receive feedback on potential ALT 3 designs
- explore a variety of models from online resources and Python code provided
- reflect on their learning and ways by which learning outcomes from ALT 3 might be linked with other aspects of the course

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NW4 Session 4

Introduction to modelling and simulation

Session Overview

Section 1	Introduction to Modelling and Simulation
Section 2	Group Activities and Discussion
Section 3	Agent Based Modelling / Complex Systems

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Section I

Introduction to modelling and simulation

Activity #1 (Think)

Think

Participants spend time in silence writing or thinking about their own ideas

Pair

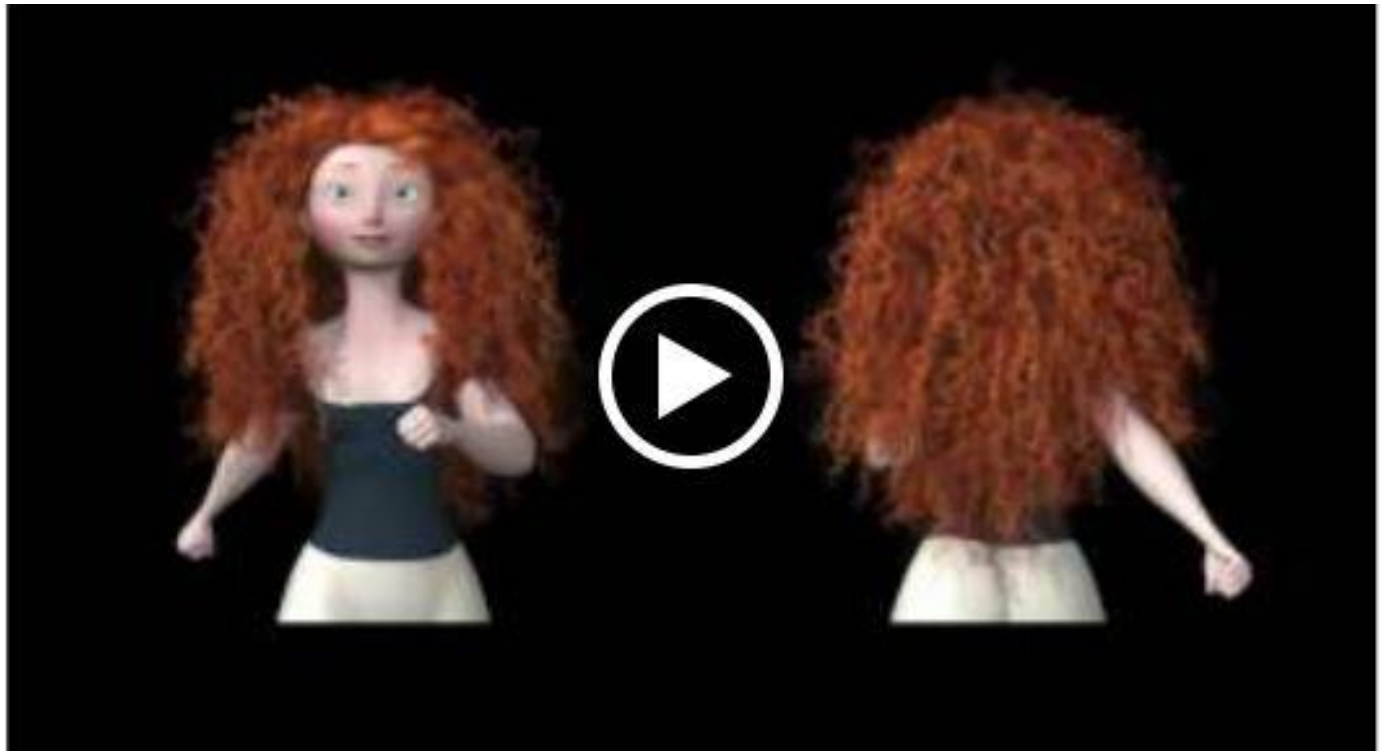
Participants turn to the person beside them to discuss their ideas

Share

Pairs share their answers with other pairs (square) or the wider group

THINK!
Watch the following video and jot down your own thoughts in your workbook.

Modelling and simulation at Pixar



Source: https://www.khanacademy.org/partner-content/pixar/simulation/hair-simulation-101/v/hair-simulation-intro)

Activity #1 (Pair and Share)

Think

Participants spend time in silence writing or thinking about their own ideas

Pair

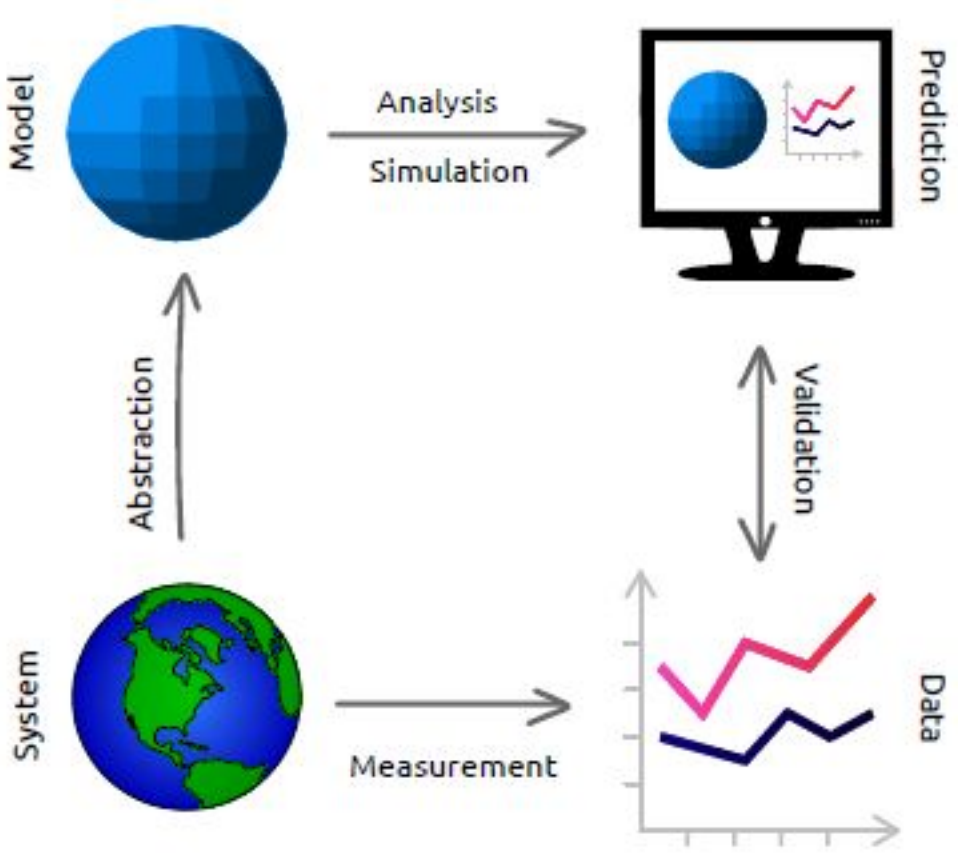
Participants turn to the person beside them to discuss their ideas

Share

Pairs share their answers with other pairs (square) or the wider group

PAIR AND SHARE!
What is a computer model?
Agree 3 - 5 examples of computer models.

Modelling and Simulation



Source: https://greenteapress.com/wp/modsimpy/

Models are systems created to imitate parts of the real world; systems which can be understood, manipulated and examined more easily.

A simulation is the process of running a computer program that uses the model to simulate the behavior of the system.

Modelling vs. Simulation
Simulations require the use of models; the model represents the key characteristics or behaviors of the selected system or process, whereas the simulation represents the evolution of the model over time. (https://en.wikipedia.org/wiki/Simulation).

★ **A model is a representation of a real world system or situation.**

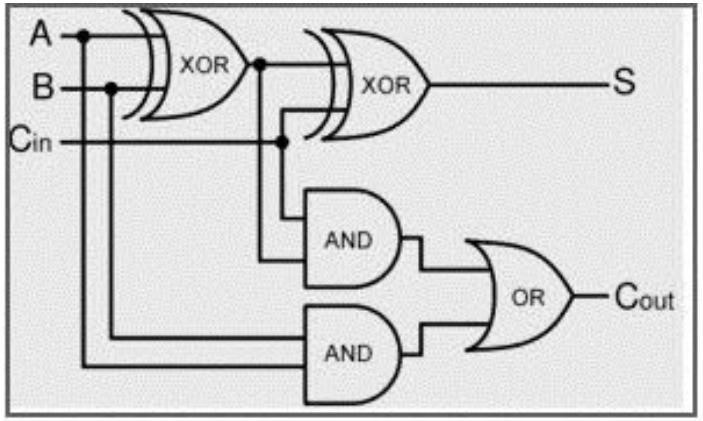
★ **A simulation shows what happens when a model is applied over time.**

Types of models

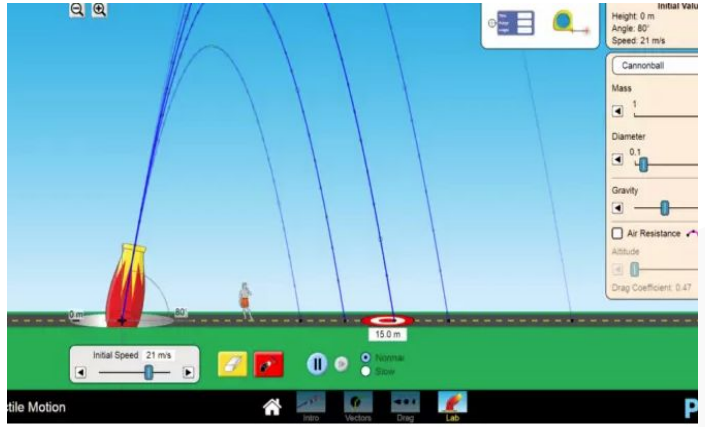
Physical

Mathematical

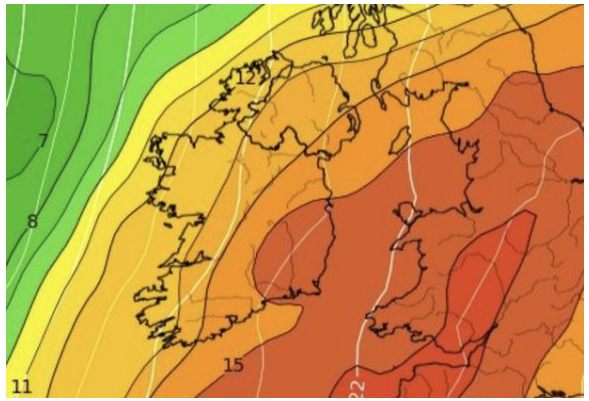
Schematic

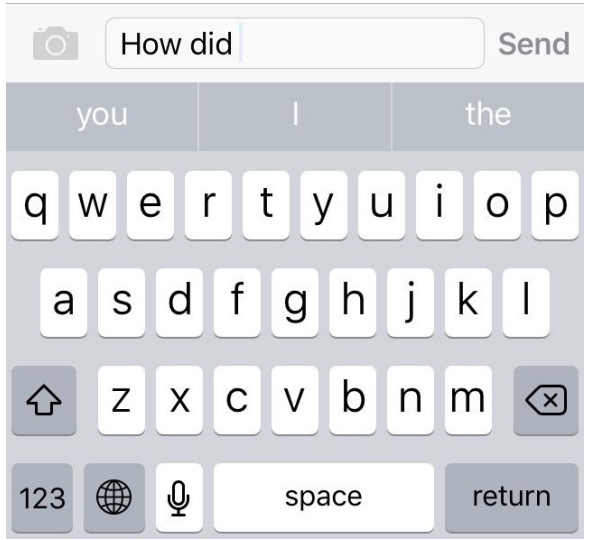


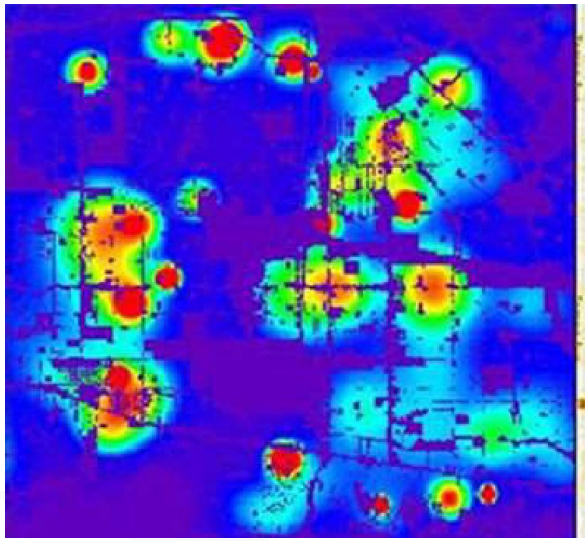
Computational

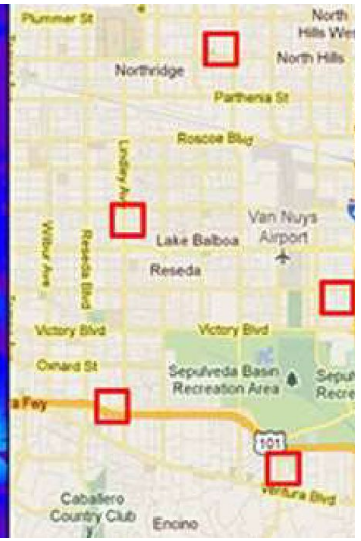


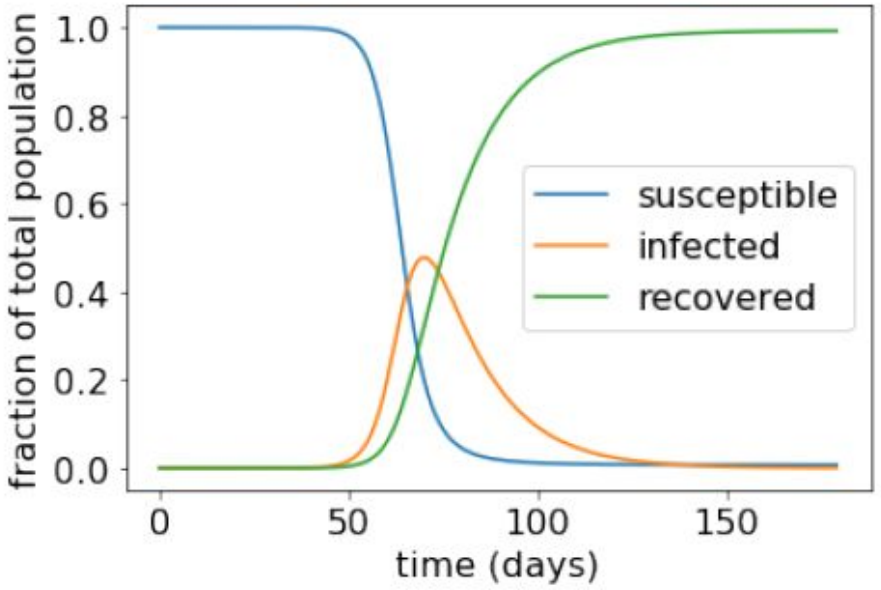
Examples of Computational Models











Benefits of modelling

- ✔ Test feasibility
- ✔ Gain insights/explore ‘what if’ questions
- ✔ Make predictions
- ✔ Cost/Safety
- ✔ Gaining competitive advantage

A Simple Fish Population Model

Problem statement: Is the fish population sustainable?

Variables: initial fish population, growth rate, allowable harvest number of years

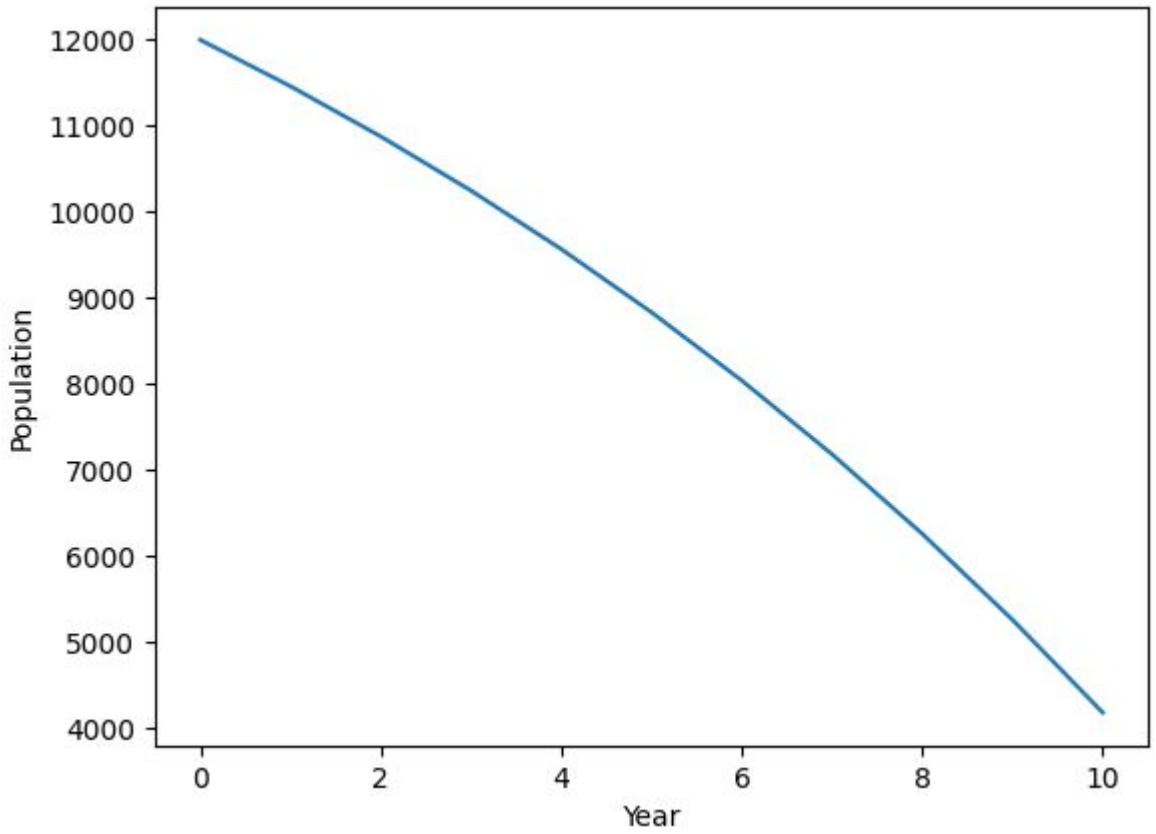
```
import matplotlib.pyplot as pyplot

# A simple population model
initial_population = int(input("Enter the starting population: ")) # e.g. 4000000
years = int(input("Enter the number of years: ")) # e.g. 10 or 100
growth_rate = int(input("Enter the percentage growth rate: ")) # e.g. 8
growth_rate = growth_rate/100
harvest = int(input("Enter the maximum annual harvest allowed: ")) # e.g. 1500

print("Year \t Population")
print("==== \t ==========")
population = initial_population
population_list = [ ]
population_list.append(initial_population)
for year in range(years):
    population = (1+growth_rate) * population - harvest
    population_list.append(population)
    print(year + 1, "\t", int(population))

print('The final population is %.2f' %population)

# Display the results graphically
pyplot.plot(range(years + 1), population_list)
pyplot.xlabel('Year')
pyplot.ylabel('Population')
pyplot.show()
```

A Simple Fish Population Model

Problem statement: Is the fish population sustainable?

Variables: initial fish population, growth rate, allowable harvest number of years

```
Enter the starting population: 12000
Enter the number of years: 10
Enter the percentage growth rate: 8
Enter the maximum annual harvest allowed: 1500
Year  Population
====  ==========
1     11460
2     10876
3     10246
4     9566
5     8832
6     8038
7     7181
8     6256
9     5256
10    4177
The final population is 4177.26
```



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Section II

Group activity on predictive models

Predictive Models

Devise a model to predict driving test outcome

ID	GENDER	AGE	CAR MODEL	OUTCOME
1	Male	17	Audi	FAIL
2	Female	28	Toyota	PASS
3	Female	20	VW	PASS
4	Male	18	Toyota	FAIL
5	Male	19	Renault	PASS
6	Male	18	Renault	FAIL
7	Female	17	Toyota	FAIL
8	Male	25	BMW	PASS
9	Female	19	VW	PASS
10	Female	23	Nissan	PASS

IF AGE >= 19 THEN

OUTCOME is PASS

ELSE

OUTCOME is FAIL

Predictive Models

ID	GENDER	AGE	CAR MODEL	OCCUPATION	INCOME	OUTCOME
1	Male	17	Audi	Student	NIL	FAIL
2	Female	28	Toyota	Teacher	43210	PASS
3	Female	20	VW	Student	5500	PASS
4	Male	18	Toyota	Student	NIL	FAIL
5	Male	19	Renault	Trainee Nurse	18250	PASS
6	Male	18	Renault	Student	NIL	FAIL
7	Female	17	Toyota	Student	8300	FAIL
8	Male	25	BMW	Vet	32750	PASS
9	Female	19	VW	Apprentice	21460	PASS
10	Female	23	Nissan	Nurse	28700	PASS
11	Male	22	BMW	Apprentice	21000	PASS
12	Male	20	Nissan	Student	NIL	FAIL
13	Female	17	Honda	Student	9200	FAIL
14	Male	19	Honda	Student	NIL	FAIL
15	Male	24	Audi	Teacher	38700	PASS
16	Female	19	Renault	Student	8800	PASS
17	Female	22	BMW	Musician	50000	PASS

IF AGE < 18 THEN

OUTCOME is FAIL

ELIF AGE >= 22 THEN

OUTCOME is PASS

ELIF GENDER = 'Female' AND AGE >=18 THEN

OUTCOME is PASS

ELSE

OUTCOME is FAIL

Activity #2

Task: create a model based on your assigned dataset

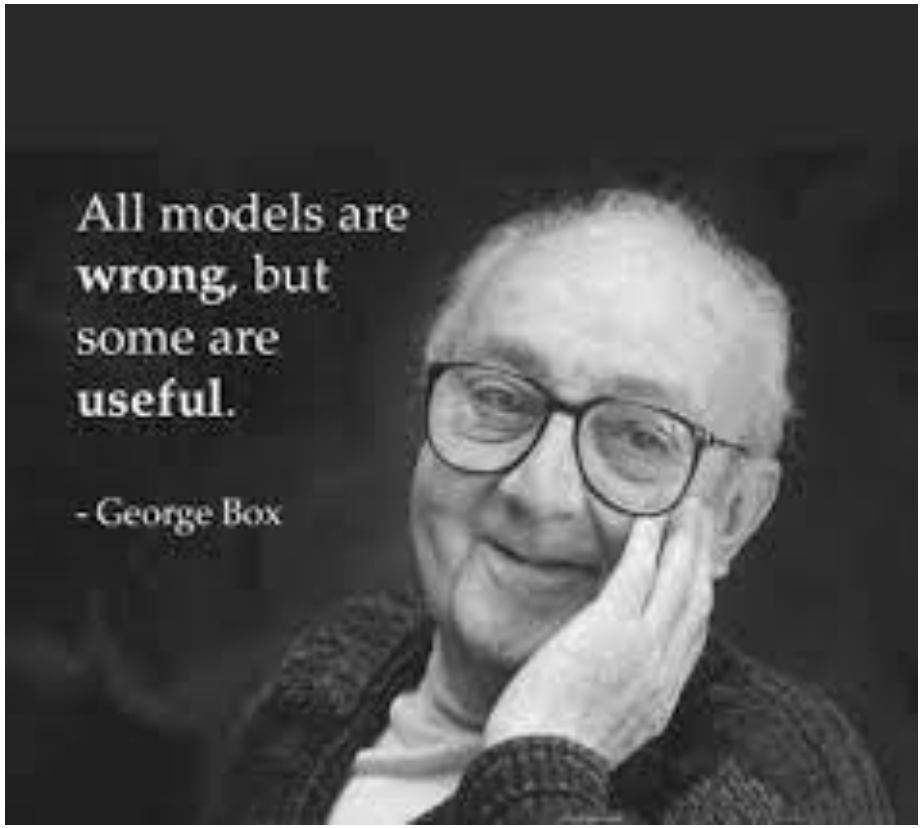
	Dataset
Groups 1 & 2	World happiness
Groups 3 & 4	IMDb Top 100 Movies
Groups 5 & 6	FIFA World Cup 2022
Groups 7 & 8	Significant earthquakes

INSTRUCTIONS

1. Decide on a target variable (this is what you are trying to model/predict).
2. Decide on the which features from the dataset to use to create your model.
3. Analyse the dataset for patterns.
4. Create your model.
5. Evaluate your model (it does not have to work 100% of the time).

Discussion

How do computer models work?



Do they have one or more of they following?

- ☐ Messy
- ☐ Real-life
- ☐ Not easily solved otherwise
- ☐ In the future – difficult to predict / forecast
- ☐ Involve assumptions
- ☐ Involve probabilities / random

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Section II

Group activity on random models

Activity #3

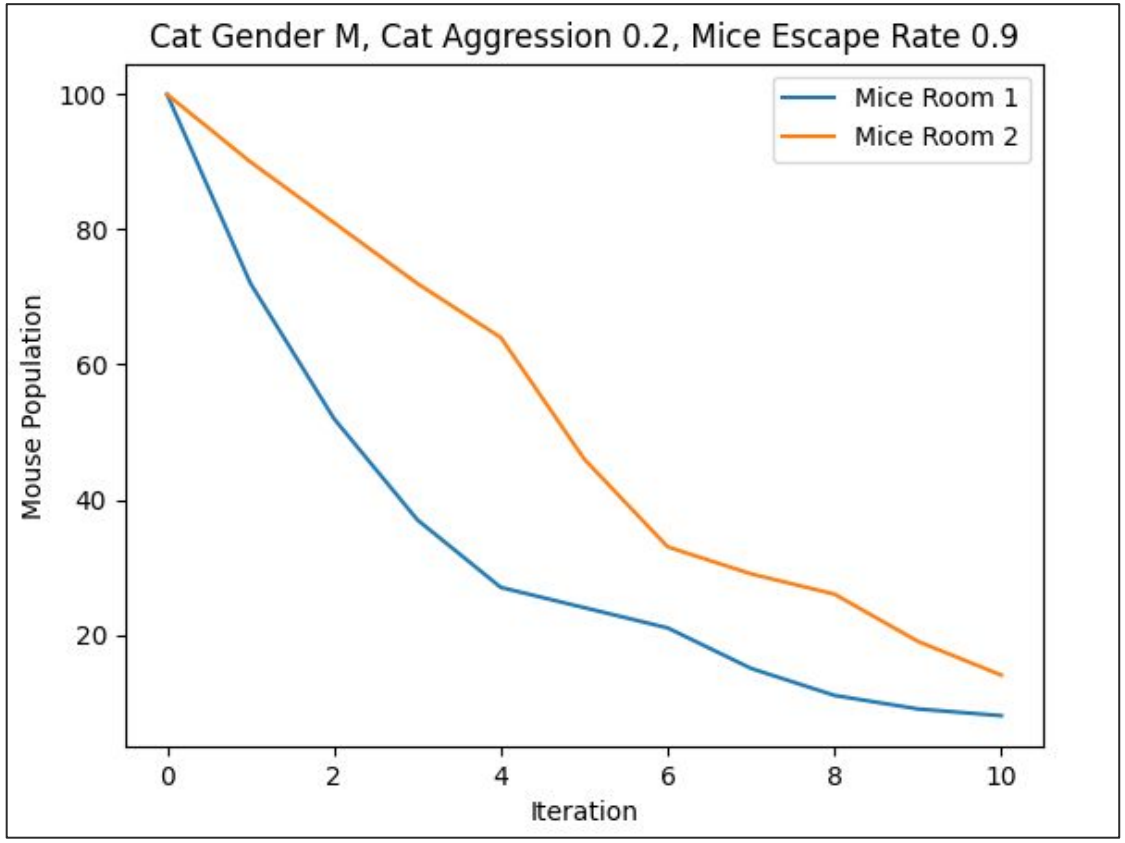
In your groups, explore the code provided and answer the questions provided/complete the tasks.

Nominate a chair, a notetaker, a timekeeper and a spokesperson (to provide feedback).

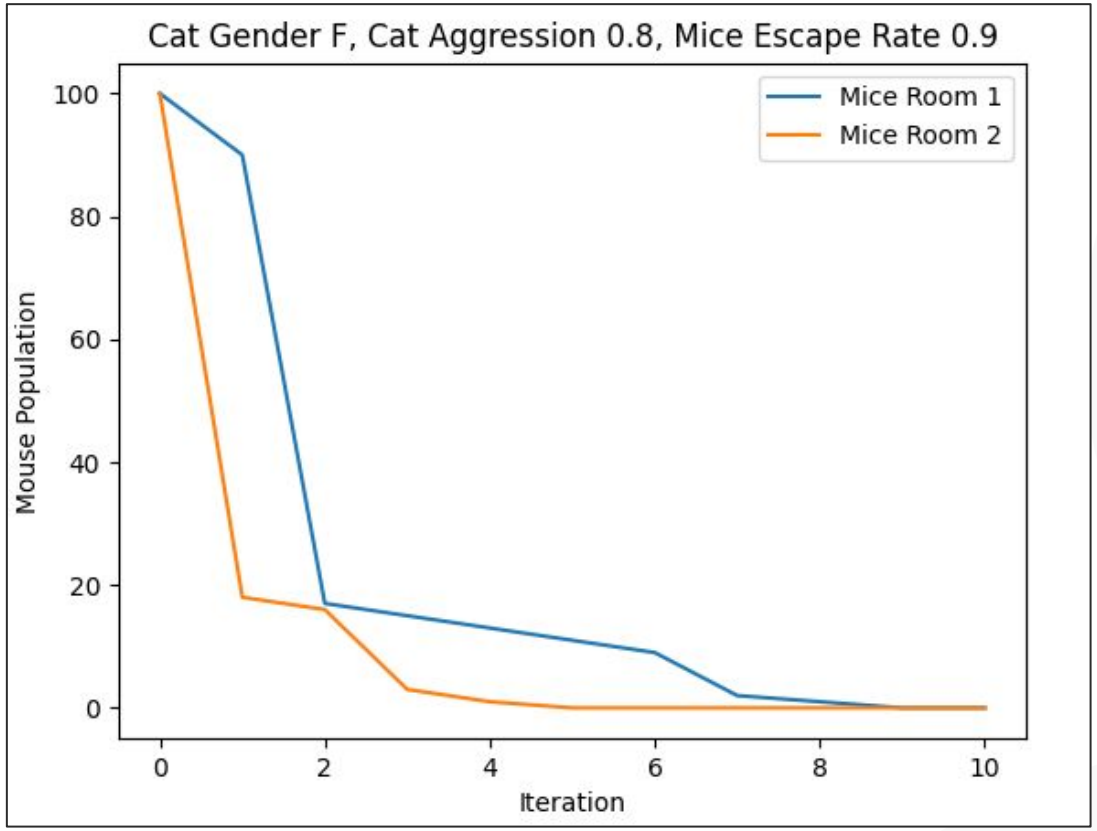
Present your findings to the other groups.

Cat and Mice Model (version 1)

Variables: initial mouse population, cat gender, cat aggression level, mouse escape rate



Scenario #1



Scenario #2

Instructions

Download the code from GitHub.

What could this model be used for?

What are its limitations?

How could the model be improved?

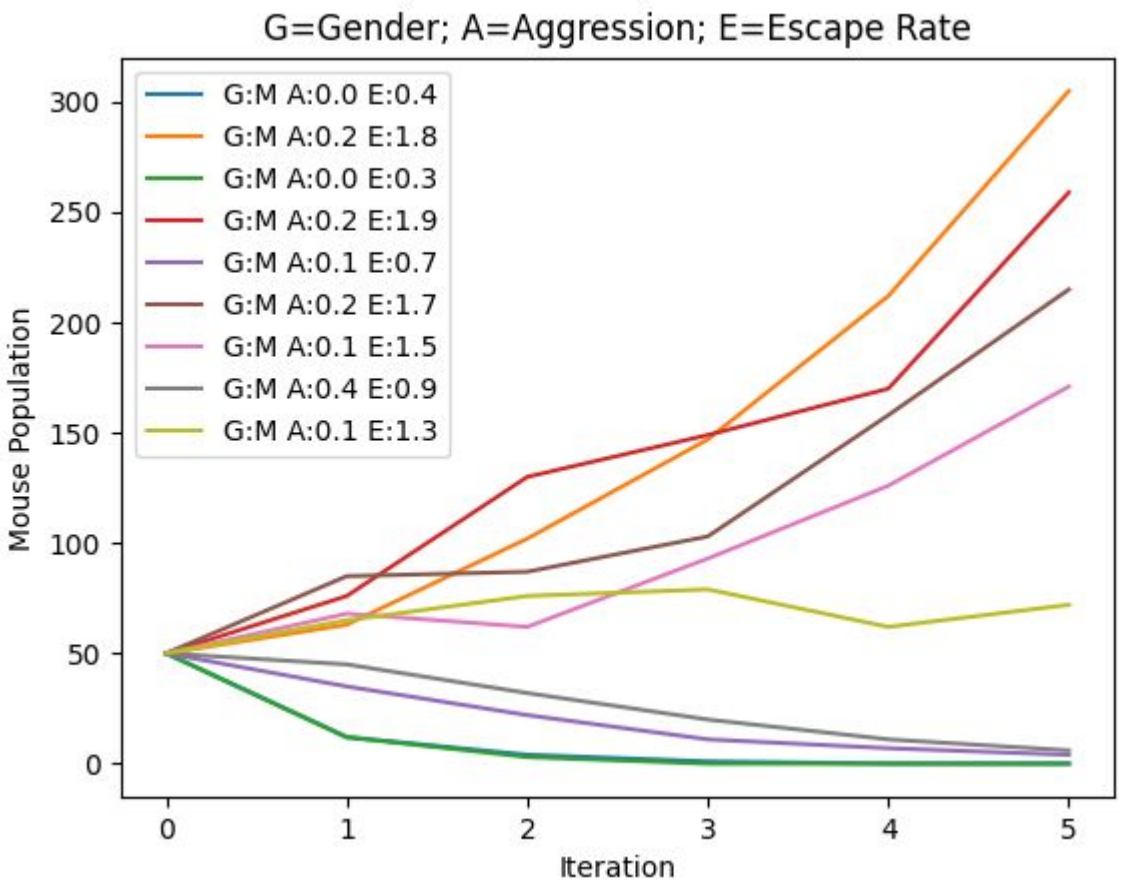
How could we extend the model?

How could this model be adapted to simulate multiple different scenarios? Graph the outcomes.

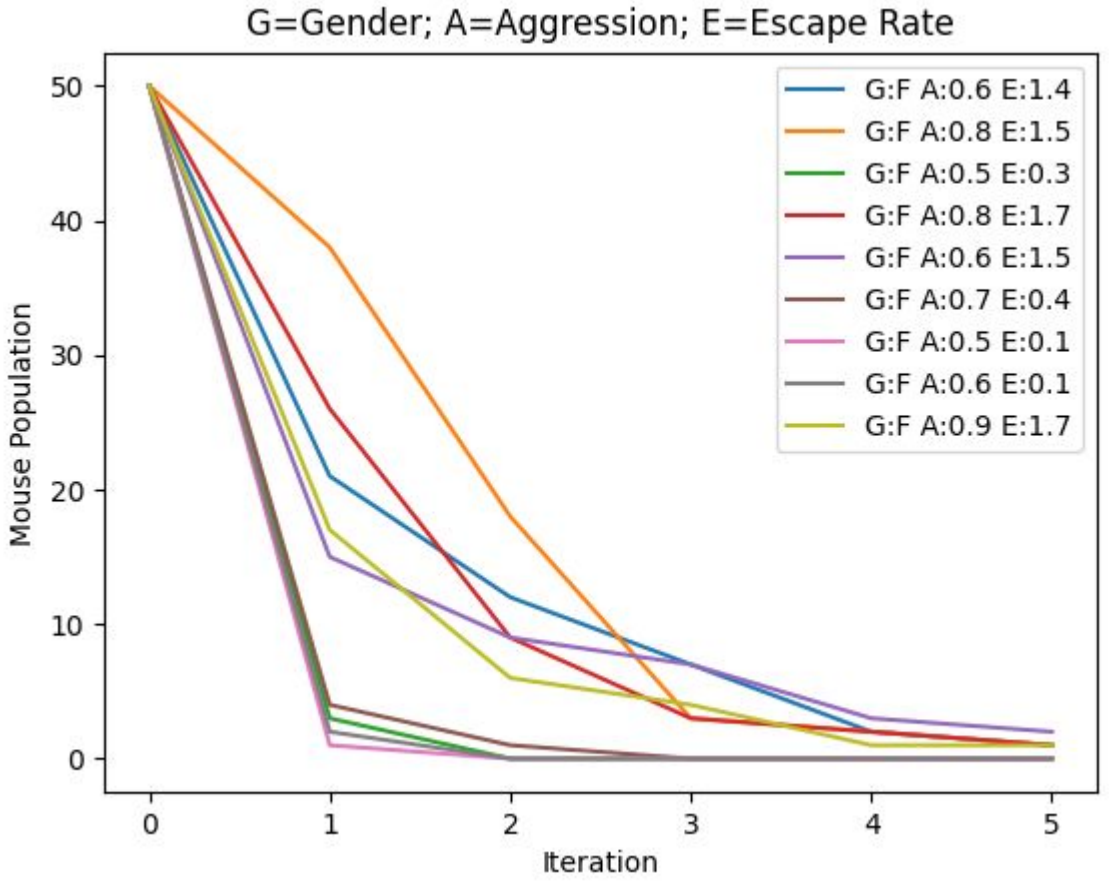
15 minutes

Group Activity: Feedback

Cat and Mice Model (version 2)



Scenario #1



Scenario #2

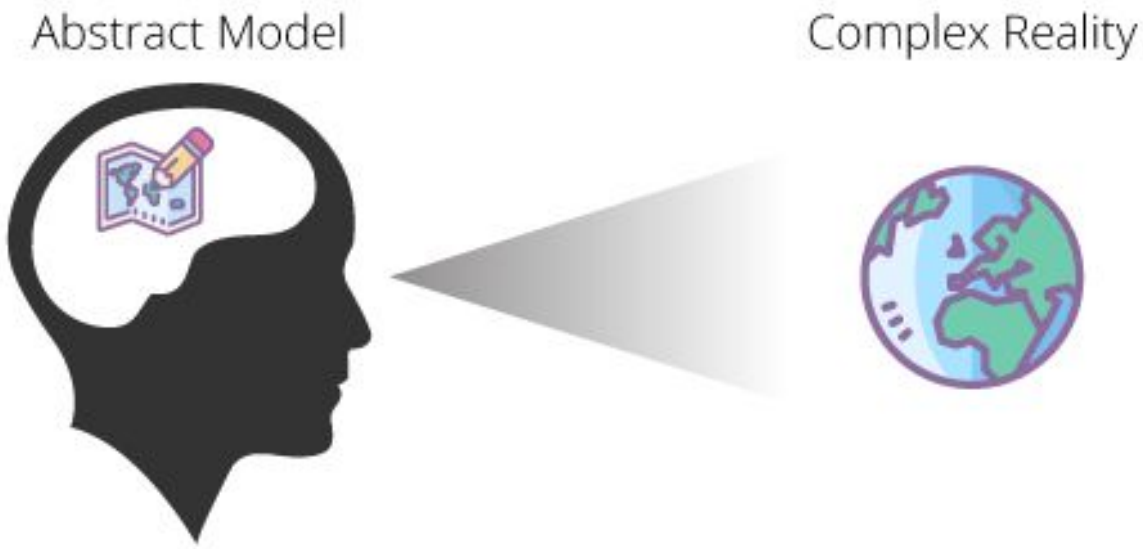
Summary

Modelling

The process by which phenomena or objects can be represented (a good example of abstraction).

A theoretical framework from which past performances can be used to make predictions about the future.

Can be physical or abstract (mathematical or computational).



Simulations

Show what happens when a model is run.

A third pillar of science (in addition to theory and experimentation).

http://greenteapress.com/complexity2/html/thinkcomplexity2010.html

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Section III

Agent-based Modelling / Complex Systems

ALT 3: Learning outcomes

3.8 develop a model that will allow different scenarios to be tested

3.9 analyse and interpret the outcome of simulations **both before and after modifications have been made**

3.10 explain the benefits of using agent-based modelling and how it can be used to demonstrate emergent behaviours

LCCS Specification: p23

Agent based modelling (ABM)

https://youtu.be/R4lov0SaFpI

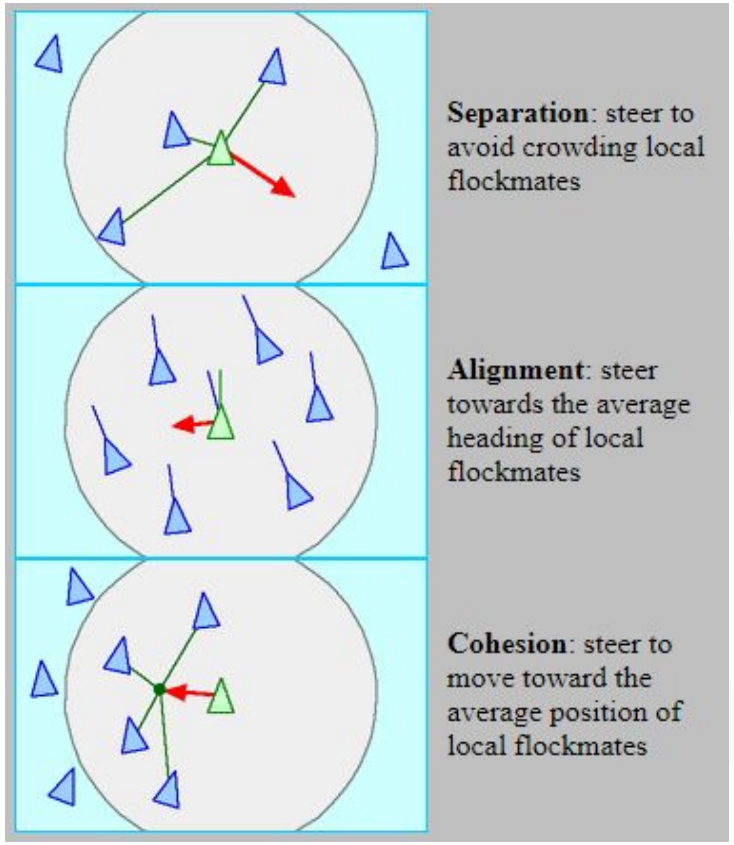
Agent Based Modelling

A kind of modelling used to explore the behaviour of large scale complex systems which are made up of autonomous individuals called agents

Each agent has a set of properties which change/can be modified.

Because the agents are autonomous the values of the properties for each individual agent can differ.

The behaviour of the overall system is determined by the collective (as opposed to the individual) behaviour.



Emergent Behaviours

A characteristic of a system that results from the interaction of its components.

Defining characteristic may be unpredictability.

If modeling a contagion with one person sick, doing a random walk amongst the population, then the model can demonstrate how that contagion spreads to the entire population.

If, instead of a random walk, the people behaved differently- congregated at the local supermarket for example and exercised social distancing otherwise - then the contagion's behaviour will differ too, spread slower hopefully.

If small fish for instance swam around randomly until they came close to another small fish. There after the two fish stayed together, collecting other small fish. What would emerge is a school of little fish, swimming around together, pretending to be one great big fish

If a population had to compete for a scarce food supply, then those who are faster/stronger might get that food for themselves, the weaker would starve and die off, and the food supply might become sufficient for the reduced population.

Online Resources

Netlogo

Project GUTS

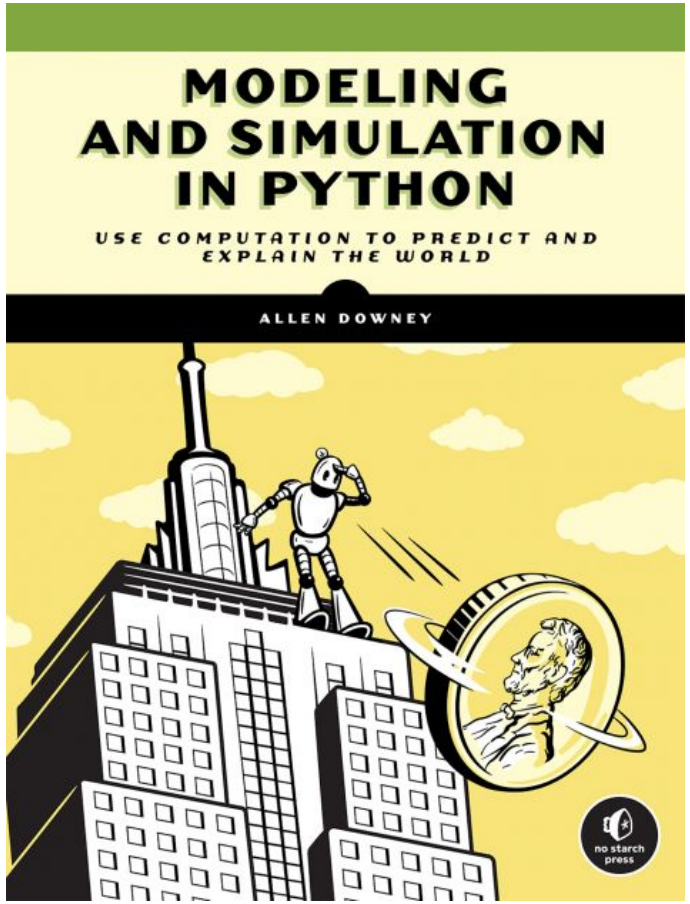
PhET

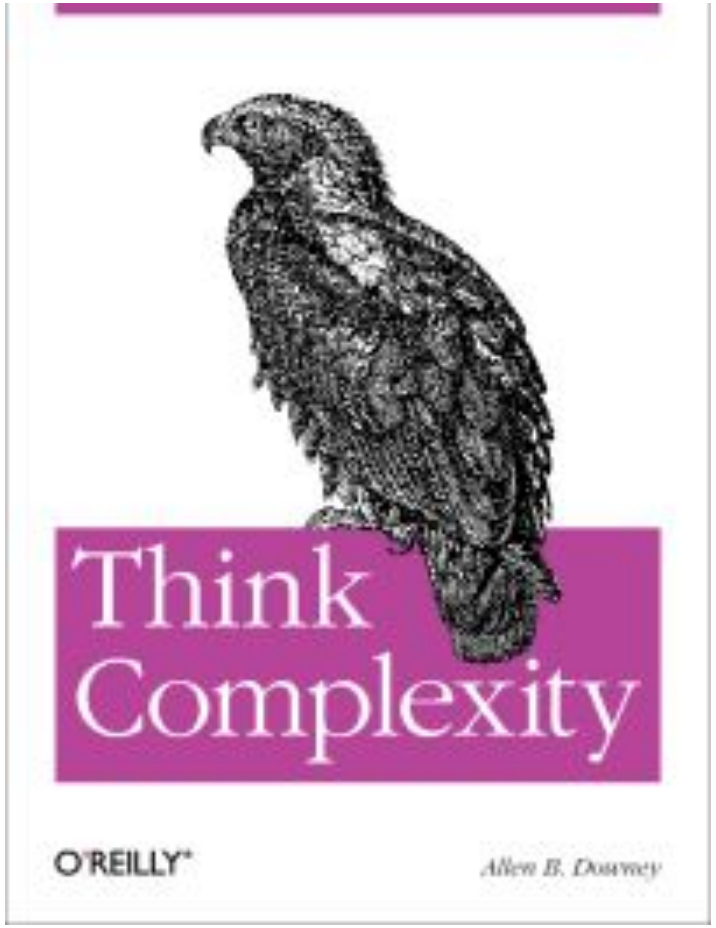
Pixar

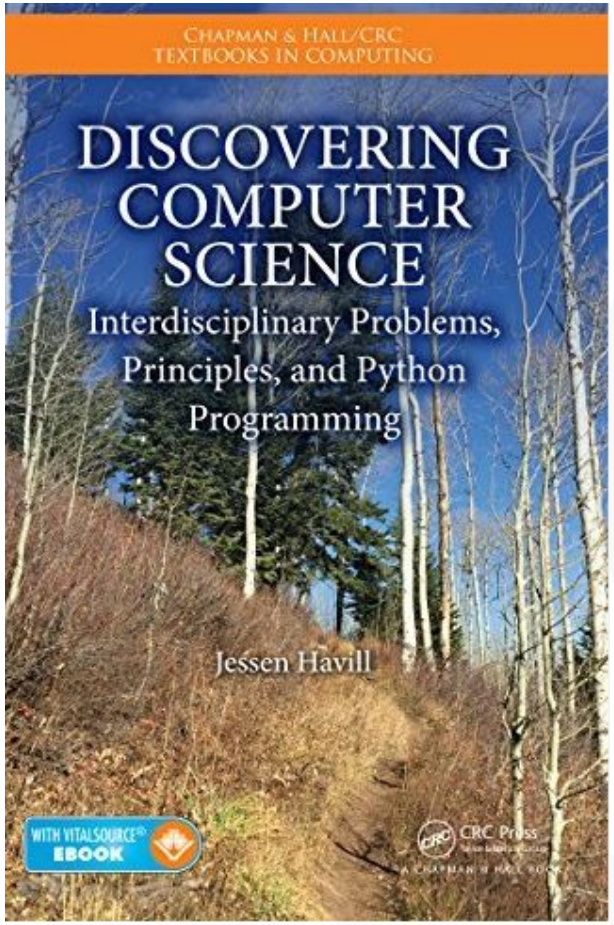
Natural Selection

Game of Life

Resources


MODELING
AND SIMULATION
IN PYTHON
USE COMPUTATION TO PREDICT AND
EXPLAIN THE WORLD
ALLEN DOWNEY
no starch
press


Think
Complexity
O'REILLY
Allen B. Downey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Reflection

Snowball Reflection (Wider Group Reflection)

Instructions :

Individually reflect on the question posed (next slide) and write your thoughts on the paper provided.

Scrunch up the page of paper and walk to the closest wall.

On “GO” throw the piece of paper towards the centre of the room.

Carefully, collect a “snowball” different from your own, read it, reflect upon it and discuss it with a colleague from a different table.

Snowball Reflection

How will I provide my students with opportunities to learn more about modelling and simulation?

An Roinn Oideachais
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