PDST

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

LEAVING CERTIFICATE COMPUTER SCIENCE

National Workshop 4

Table of Contents

Introduction

Key Messages

There are many ways to use the LCCS specification.

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

LCCS can be mediated through a constructivist pedagogical approach.

ALTs

ALTs provide an opportunity to teach theoretical aspects of LCCS.

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

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

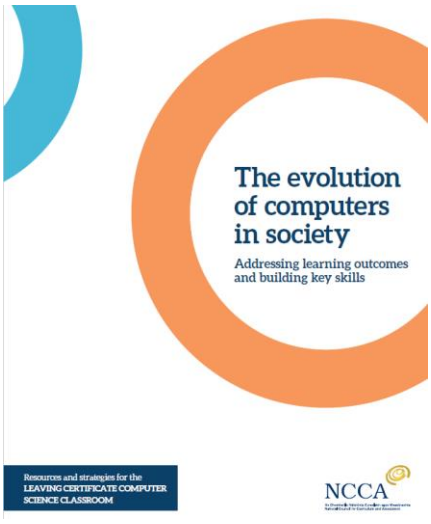
Notes

Session 1: Computers & Society I

Stimulate a Debate

The Evolution of Computers in Society: Resources and Strategies for the Classroom

Notes on using the Stimulate a Debate strategy in your classroom



Session 2: Algorithms II

Unconscious Bias

Read the following scenario once and complete the short survey that follows.

A builder, leaning out of the van, shouts "nice legs" to a nurse passing by. The same nurse arrives at work, and casually mentions this to a senior doctor. The doctor said," I'd never say that". The doctor has two grown up children who are 22 and 30. They get on very well. One is a Sergeant in the Army; the other is training to be a beauty therapist. The doctor divorced last year and is currently dating someone else.

Activity 1

Complete the following survey based on the story above. Tick the appropriate box for each statement.

	True	False	Don't know
The builder was driving a van			
The van was travelling quicker than the nurse			
There was at least one man in the van			
Not every man mentioned would shout 'nice legs'			
The doctor is no longer living with his wife			
The doctor has a new girlfriend			
The doctor's son is in the army			
The youngest child is training to be a beauty therapist			
At some point a man spoke to a woman			
At least two of the people mentioned are men			
A woman was shouted at			

The scenario did not provide enough information to answer True or False to any of the statements.

Consider why you might have ticked *True* or *False* for any of the above statements

What is unconscious bias and why is it important?

Notes

Algorithmic Bias

Activity 2

Open up a text messaging app on your phone and type in separately the two sentences given below. Record the predictions for the next word in the space provided.

Record suggestions here
"The nurse said that…" **"The pilot said that…"**

Consider the following sentence…predict what word(s) would be suggested in this example in the space provided.

Record your predictions here
"The computer programmer said that…"

Personal reflection
What are my values as a teacher?

Introduction to algorithms (revisited)

Activity 3

Read the scenario below carefully and then watch the video "The Secret Rules of Modern Living Algorithms" (BBC documentary with Marcus Du Sautoy) from 23:44 to 26:53.

The Stable Marriage Problem (David Gale and Lloyd Shapely, 1962 and later Alvin Roth)
Suppose you had a group of men and a group of women who wanted to get married. The goal is to find stable matches between two sets of people who have different preferences and opinions on who is their best match. The central concept is that the matches should be stable: There should be no two people who prefer each other to the partners they actually got e.g. an unstable match would be if Mary and John like each other better than their partners. The problem is to develop a formula to pair everyone off as happily as possible.

What features of an algorithm are demonstrated in the video?

Sometimes solutions to problems can have varied (and unexpected) applications.

In what other contexts do you think the Gale-Shapley algorithm could be used?

Searching algorithms: Linear search

A **linear search** compares what you are looking for (a number, word, character, etc) with each item in a list until it finds what it is looking for (or reaches the end of the list). If it finds the item it is looking for, it returns the **position** in the list of the item. If the item is not found, it simply returns **-1**.

Breakout task: PRIMM activity on linear search

Download and save the starter code for this task in your Python IDE. The starter code is available from tinyurl.com/LCCSlinearSearch.

```
1. # A program to perform a linear search
2.
3. # linearSearch function
4. # takes two parameters: num is the target value, myList is the list to search
5. # if target value found, returns position (index) of 'num'; otherwise, returns  -1
6. def linearSearch(num, myList):
7.     for i in range(len(myList)):
8.         if myList[i] == num:
9.            return i
10.    return -1
11.
12. # PYTHON STARTS EXECUTING FROM HERE ...
13. listToSearch = [1,2,3,4,5,6,7,8,9,10]
14. userNum = int(input("Enter the number you want to find:"))
15.
16. # function call
17. position = linearSearch(userNum, listToSearch)
18.
19. # display the result of the linear search
20. print("The number is at position", position)
```

PREDICT

Predict the output of this program for the following four test cases: 3, 8, 12, -2.

Note: the program starts executing at line 13.

RUN

Run the code making sure there are no syntax errors. Were you correct in your earlier prediction(s) for the output? Consider debugging some of the test cases above.

INVESTIGATE

1. Try changing '==' to '!=' on line 8. What happens?

2. What if '==' was changed to '=' on line 8?

3. What happens if you don't enter an integer?

4. Explain the purpose of the two *return* statements on lines 9 and 10? Why are they at different levels of indentation? Under what circumstances does the return statement on line 10 get executed?

5. What is the purpose of *int* on line 14? What would happen if you removed it? Try it and see.

6. Switch *userNum* with *listToSearch* on line 17. What happens?

a. What would happen if you removed both *userNum* and *listToSearch* from this line?

7. Remove a bracket (either one) from line 20. What happens?

8. Add comments to explain the code.

9. What happens if there is more than one occurrence of the item you are searching for?

MODIFY

1. If the number entered by the user is not found, the program will display "*The number is at position -1*". Extend the code so that it displays a more meaningful message if the number is not found e.g. "*The number you entered was not found in the list*" (or something similar).

2. Currently, the elements of *listToSearch* are hard-coded on line 13. Modify the code to use a **for loop** to populate this list. You should make the list bigger also, say 20, 50 or even 100 elements (or prompt the user to enter the length of the list *listToSearch* before it is populated). Consider using **random** to populate the list *listToSearch*.

3. Extension exercise: An alternative implementation of the *linearSearch* function uses a variable to store the result of the search which is then returned in a single return statement. Implement a new *linearSearch* function in this way. You should call it *linearSearchV2* (or similar) and consider the following:
    a. What should the return variable be initialised to? Under what circumstances will it change value?

    b. Should the search stop once the target value is found? If so, how can you achieve this?

MAKE

Write a program which finds the minimum and maximum number in a list.

Notes

Searching algorithms: Binary search

Notes

Session 3: Computer Systems III

Basic Electronic Components

Basic Electronic Terms and Symbols

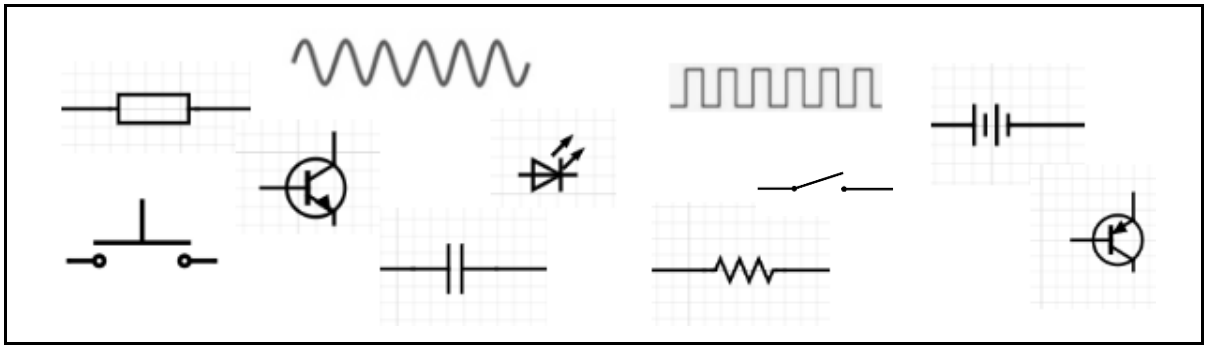
Complete the table below using the descriptions and symbols on the next page to help you.

(Note: There may be more than one symbol for some of the components! Description only for 11 - 13)

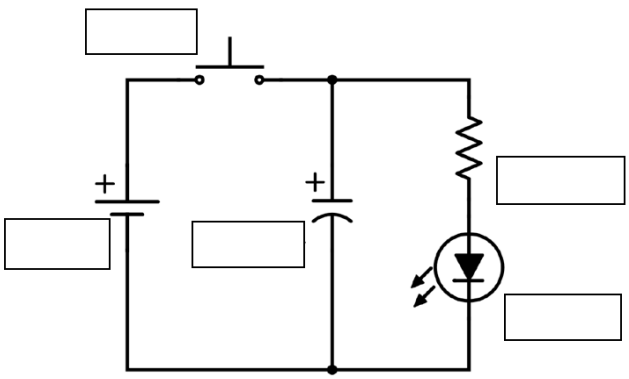
Component		Description	Symbol
1	Voltage		
2	Battery		
3	Switch		
4	Current		
5	Resistor		
6	Capacitor		
7	Transistor		
8	Light Emitting Diode (LED)		
9	Analogue signal		
10	Digital signal		
11	Logic Gate		
12	Integrated Circuit (IC)		
13	Circuit diagram		

Basic Electronics - descriptions and symbols

A device that stores electrical charge	Building blocks for electrical circuits made up of transistors		A non-continuous signal that has discrete values, e.g. 2 values ON or OFF
Describes the pressure that pushes electricity	A set of electronic circuits on a semiconductor wafer on which thousands or millions of tiny resistors, capacitors, diodes, and transistors are fabricated		
Used to reduce current flow or to divide voltages	A continuous signal, e.g. radio, sound, light waves	A source of electric power	Electrical charge in motion/flow of electrons
A basic element in an IC, that acts as a switch, controlling the flow of electrical signals in a circuit.	Also called a schematic diagram, uses internationally recognised symbols to represent the electrical connections, components and operation of a particular electrical circuit or system.		Emits light when current flows through it used to interrupt the flow of electrons in a circuit



Identify the components in the schematic below.



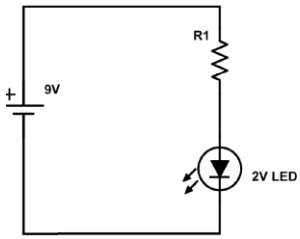
Building Circuits

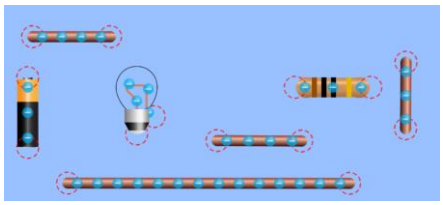
Open up the PHET simulator and build the two circuits:

https://phet.colorado.edu/sims/html/circuit-construction-kit-ac-virtual-lab/latest/circuit-construction-kit-ac-virtual-lab_en.html

Circuit with Resistor

1. Given the components (Battery, wires, light bulb, resistor) build the circuit to turn light bulb on.





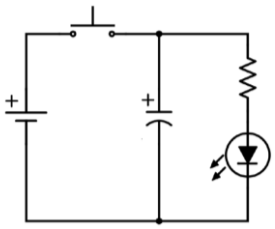
2. What do you notice about the **direction** of flow of electrons vs flow of current?

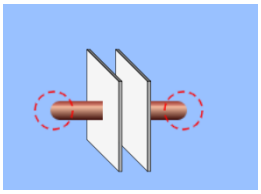
3. Change the value of the resistance (or voltage). What do you notice about the current? What do you notice about the light?

4. Add a switch to the circuit. What do you notice if you open/close the switch?

Circuit with Capacitor

5. Add a capacitor into the circuit and build the circuit as shown in the schematic diagram.





6. What do you notice about the position of the capacitor?

7. Close the switch. What do you notice?

8. Open the switch. Does the light bulb turn off? Explain.

9. Place the capacitor in series - what do you notice?

10. Change the display on the simulation to show the circuit diagram/schematic instead.

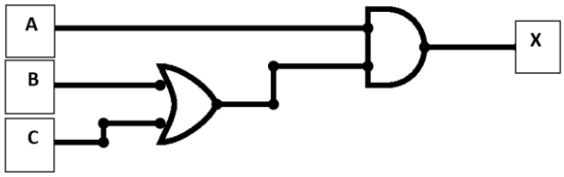
Logic Gates

Gate	Symbol	Truth Table	Boolean Expressions
NOT		A | X 0 | 1 |	
AND		A | B | X 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |	
OR		A | B | X 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |	

Gate	Symbol	Truth Table	Boolean Expressions
NAND		A | B | X 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |	
NOR		A | B | X 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |	
XOR		A | B | X 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |	

Complete the Truth Tables for the following circuit diagrams

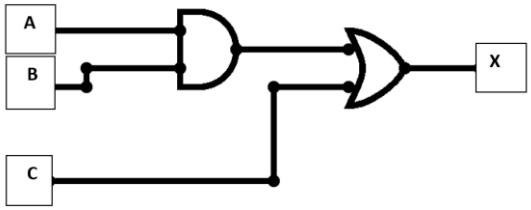
Circuit Diagram



Boolean Expression:

Truth Table

A	B	C		X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		



Boolean Expression:

A	B	C		X

Half-Adder

The basic building blocks of an ALU are simple logic gates. One of the most fundamental elements of an ALU is the half-adder. The half-adder takes two inputs in the form of bits, and outputs the sum and the carry-over. The addition and the Truth Table are shown here.

Addition of 2 bits
A + B = CS
0 + 0 = 00
0 + 1 = 01
1 + 0 = 01
1 + 1 = 10

INPUTS		OUTPUT	
A	B	Sum (S)	Carry (C)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

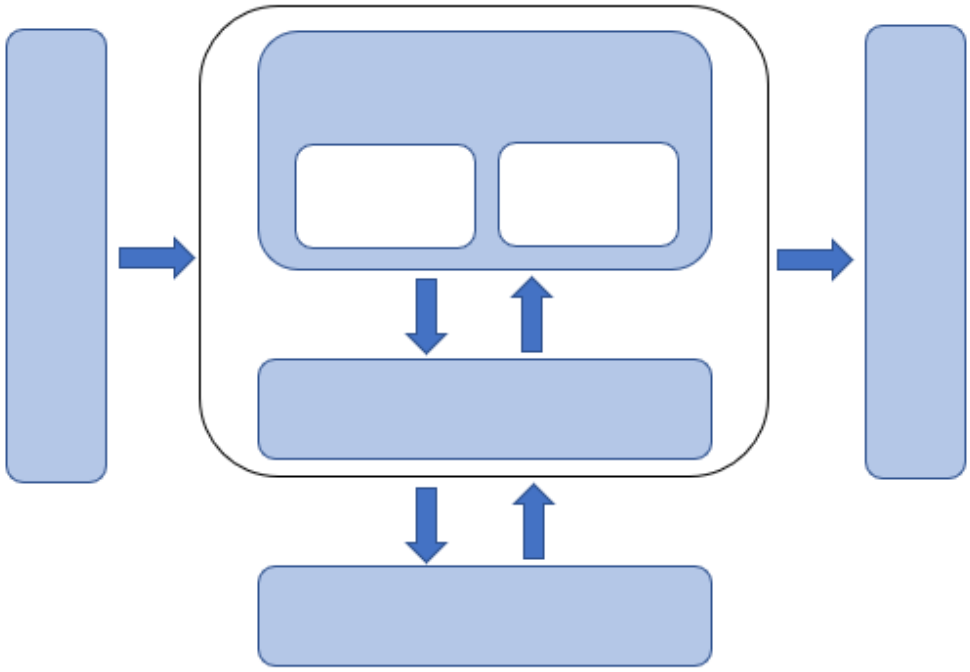
1) Draw the Logic Gates (e.g. digital circuit diagram) required for the Half-Adder:

2) Design a half-adder in Python (p23 “The Evolution of Computers in Society”)

Von Neumann Architecture

Basic components of a computer

Place the names of the components in the correct position:



Input Device

Primary Memory

Central Processing Unit (CPU)

Output Devices

Arithmetic Logic Unit (ALU)

Secondary Storage Devices

Control Unit (CU)

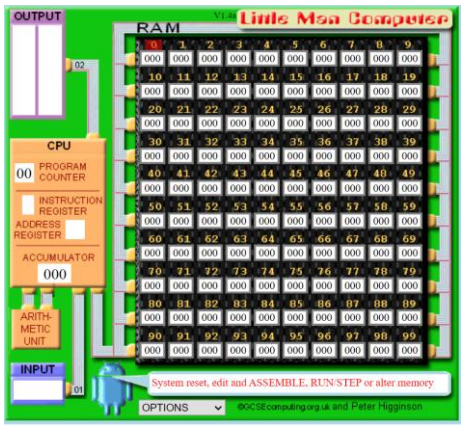
Little Man Computer

LMC Instruction Set

Activity:

Open up the Little Man computer (LMC) simulator https://peterhigginson.co.uk/LMC/.

Use the instruction table below to find the codes to add two numbers.



Note: xx refers to a memory address

Code	Description	Name
000	Stop	HLT
1xx	Add the contents of the memory address to the Accumulator	ADD
2xx	Subtract the contents of the memory address from the Accumulator	SUB
3xx	Store the value in the Accumulator in the memory address given.	STA or STO
4xx	This code is unused and gives an error.	
5xx	Load the Accumulator with the contents of the memory address given	LDA
6xx	Branch - use the address given as the address of the next instruction	BRA
7xx	Branch to the address given if the Accumulator is zero	BRZ
8xx	Branch to the address given if the Accumulator is zero or positive	BRP
901	Retrieve user input and put it in the accumulator (calculator)	INP
902	Copy the value from the accumulator (calculator) to the OUTBOX.	OUT
	Used to indicate a location that contains data.	DAT

Little Man Computer HELP (LMC) https://peterhigginson.co.uk/LMC/help.html

Session 4: Introduction to Modelling and Simulation

Introduction

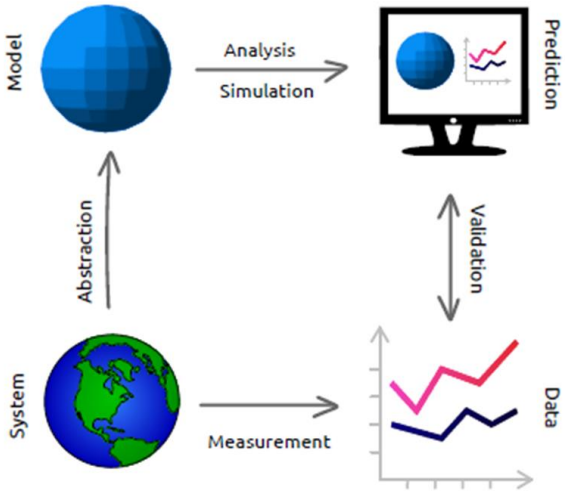
Think: As you watch the video record your thoughts on what a computer model is

Pair: Participants turn to the person next to them to discuss their ideas with a partner.

Share: Participants share their answers with another group

Question	What I thought	What my partner thought	What we will share
What is a computer model?			
Everyday examples of computer models?			

Modelling and Simulation



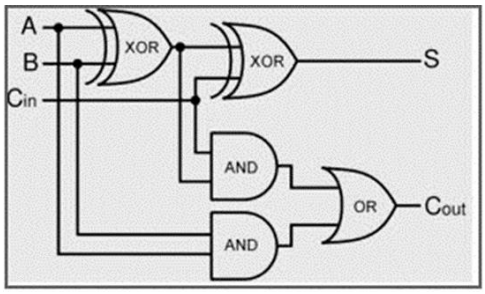
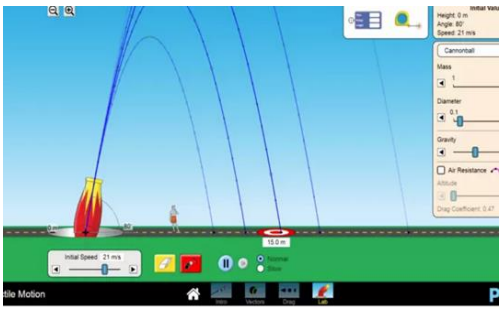
Source: https://greenteapress.com/wp/modsimpy/

A computer model is …

Simulation is …

Additional notes

Types of Models

Models can be …	
	**Physical:**
	**Schematic:**
	**Mathematical:**
	**Computational:**

Examples of Models

Examples of models include …

Benefits of Modelling

Some advantages of modelling are …

Modelling Fish Population

```
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()
```

Some points to consider

Is this model useful?

Could this model be used to test different scenarios? If so, what are they?

Making Predictions

This dataset holds driving test result information. Can we use it to predict an 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

In this dataset more information has been added. What about predicting an outcome now?

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	Musican	50000	PASS

Notes

The target feature is:

Activity 1 (creating a predictive model)

Create a predictive model based on the data contained in the dataset you have been assigned.

World Happiness Report 2015-2019

https://www.kaggle.com/unsdsn/world-happiness

IMDb Top 100 Movies

https://www.kaggle.com/datasets/themrityunjaypathak/imdb-top-100-movies

FIFA World Cup 2022

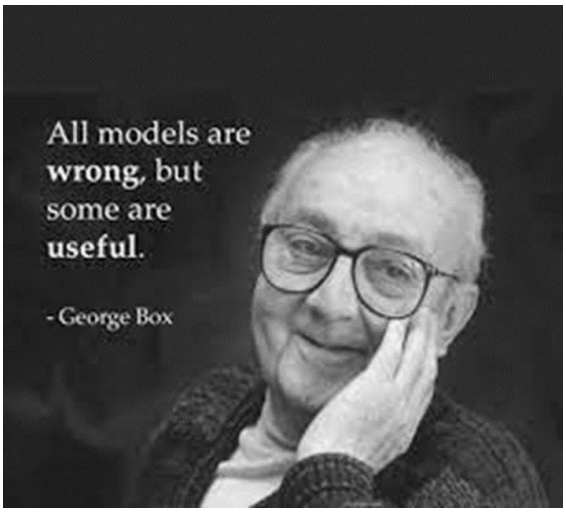
https://www.kaggle.com/datasets/die9origephit/fifa-world-cup-2022-complete-dataset

Significant Earthquakes 1965-2022

https://www.kaggle.com/usgs/earthquake-database

Notes

Discussion



Notes
Do you agree/disagree with George Box's assertion that all models are wrong but some are useful? Explain.

Activity 2 (cat and mouse model)

Download and run the Cat and Mouse code from GitHub and attempt the following questions.

List three descriptive features (variable) used in this model. What is the target variable?
1. **2.** **3.**
Describe two limitations of the model
1. **2.**
Suggest (and explain how you would implement) one change that would improve the model
1.

Agent Based Modelling (ABM)

Notes on an agent-based modelling systems
Notes on emergence/emergent behaviours

Reflection

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

Session 5: ALT 3 - Investigate & Plan

ALT 3: Investigate

In your groups, share potential ideas for ALT 3. Aim for as many ideas as you can,

Investigate

ALT 3: Plan

In your assigned groups, evaluate your potential ideas for ALT 3.
Choose one idea for further development.
Develop a functional specification for your chosen idea.
Hint: You may use the following prompt questions to help you:

What will your project do/not do?
Aims? Any limitations?
Who are the end users?
What are the group roles and responsibilities?
What are the tools/materials required?
Will your project allow you to make predictions/decisions more easily?
What is new and has to be researched further?
What other LOs can be experienced through the lens of this project?
Are there any ethical issues?

Plan

Session 6: ALT3 - Design, Create & Document

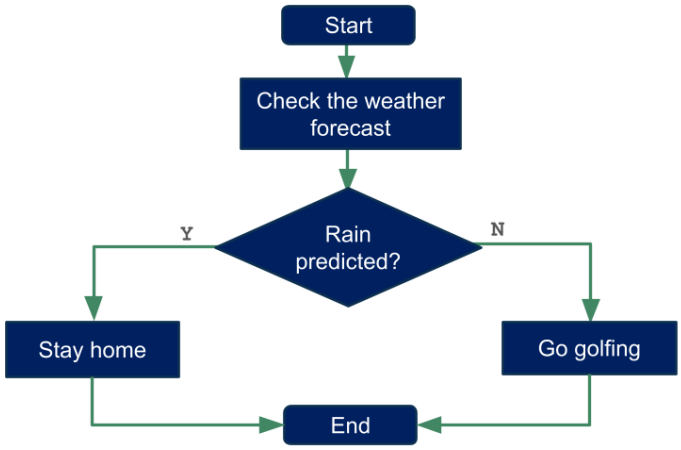
ALT 3: Design

Pseudo-code & flowcharts

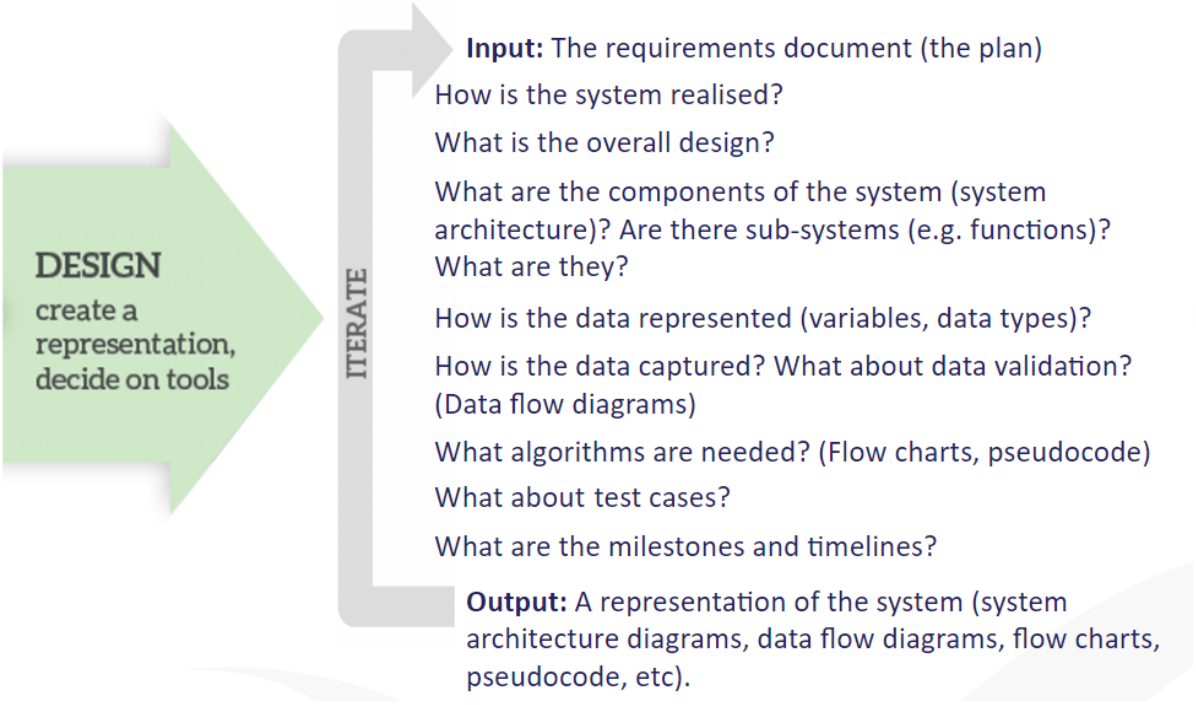
```
program start
check weather forecast

if rain predicted
    Stay home
else
    Go golfing
end if

program end
```

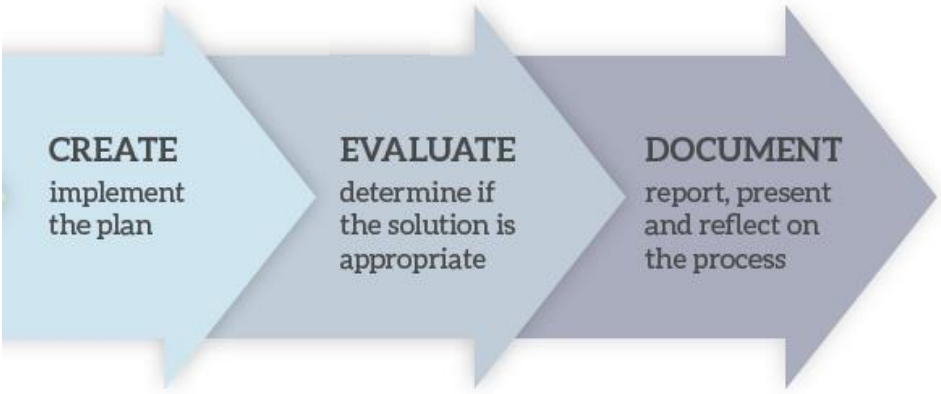


In your assigned groups, develop your design for your chosen idea. You may use the following prompt questions to help you.



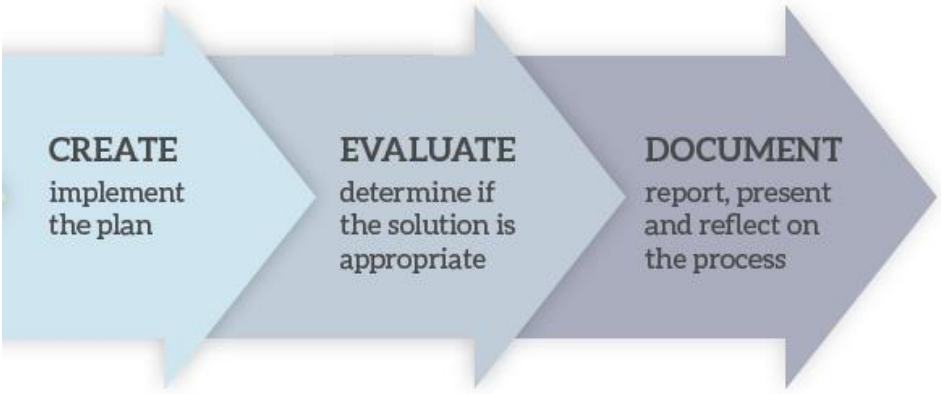
Design

ALT 3: Create



Notes

ALT 3: Document

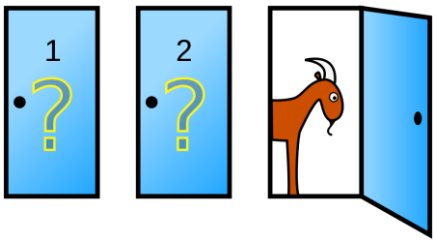


Notes

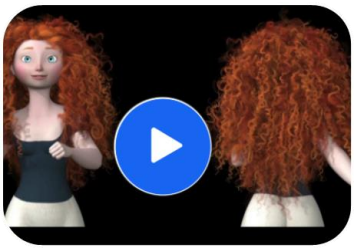
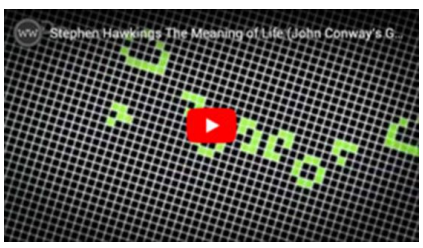
Examples and Resources

NCCA Population:

Monty Hall Problem



Online Resources

Some useful online resources	
	NetLogo:
	Project GUTS:
	PhET:
	**Pixar Animation / Khan Academy:**
	**Natural Selection / Evolution**
	**Game of Life:**

Notes:

Notes:

PDST
Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí
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An Roinn Oideachais agus Scileanna
Department of Education and Skills

Dublin West Education Centre

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