Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professiona Learning of School Leaders and Teachers

Leaving Certificate Computer Science

National Workshop 3

Day 1

Workshop Overview

Session 1 10:00 - 11:30	Computational thinking III
Tea/Coffee 11:30 – 12:00	
Session 2 12:00 - 13:30	Algorithms I
Lunch 13:30 - 14:30	
Session 3 14:30 - 16:30	Computer systems II

Supports Provided by Oide

National Workshops	Webinars	School Support	Scoilnet
Skills Workshops	Collaboratives	Oide website	CompSci

Mentoring

- A mentor is not an instructor; a mentee is not a student
- Mentoring involves talking about teaching & learning, strategies and successes
- It offers support (beyond the technical!)… wellbeing, planning, reflective… an ear to listen
- It can lead to WOW conversations (Wins, Obstacles, Wonderings)

Purpose for the Day

To allow Phase 5 LCCS teachers to engage with the core concepts of Computational Thinking and Computer Systems.

To experience ALT2 through the eyes of the student by engaging with the Design Process.

Key Messages

Leaving Certificate Computer Science aims to develop and foster the learner's creativity and problem-solving, along with their ability to work both independently and collaboratively

Computing technology presents new ways to address problems and computational thinking is an approach to analyse problems, design, develop and evaluate solutions.

The ALTs provide opportunities for students to develop their theoretical and procedural understanding of the course.

The externally assessed coursework will be based on all learning outcomes, with those of strand 3 being particularly relevant.

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

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

NW3 Session 1: Computational Thinking III

LEAVING CERTIFICATE COMPUTER SCIENCE

Overview of the session

Part 1	Warm-up activities
Part 2	Computational thinking: thoughts and models
Part 3	Further activities

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Warm Up Activities

LEAVING CERTIFICATE COMPUTER SCIENCE

By the end of this session..

Participants will be enabled to…

…work in groups on problem solving

…develop their understanding and experience in using some of the pillars of Computational Thinking

…assess and analyse research in the area of CT

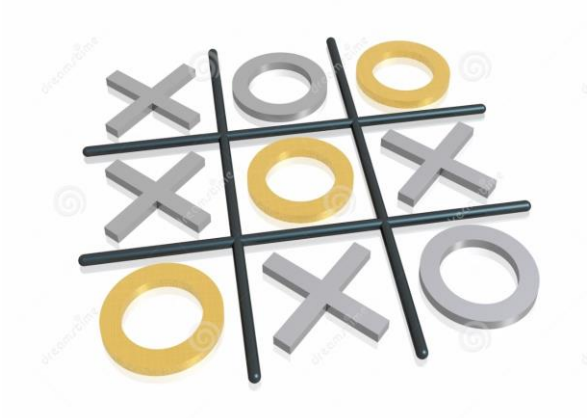
One model of Computational Thinking

- Decomposition
- Pattern recognition
- Abstraction
- Algorithm design

Xs and Os: Developing a winning strategy

Which pillars of Computational Thinking are used?

Abstraction? Decomposition? Pattern Recognition? Algorithm formation?

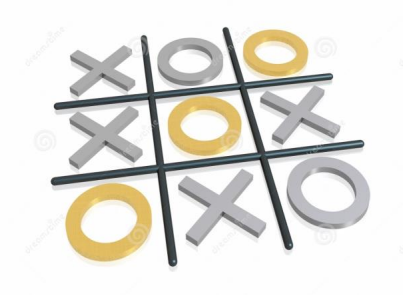


Xs and Os: Developing a winning strategy

Move 1: Go in a corner.

Move 2: IF the other player did not go to opposite corner
THEN go in the opposite corner to move
ELSE
go in a free corner.

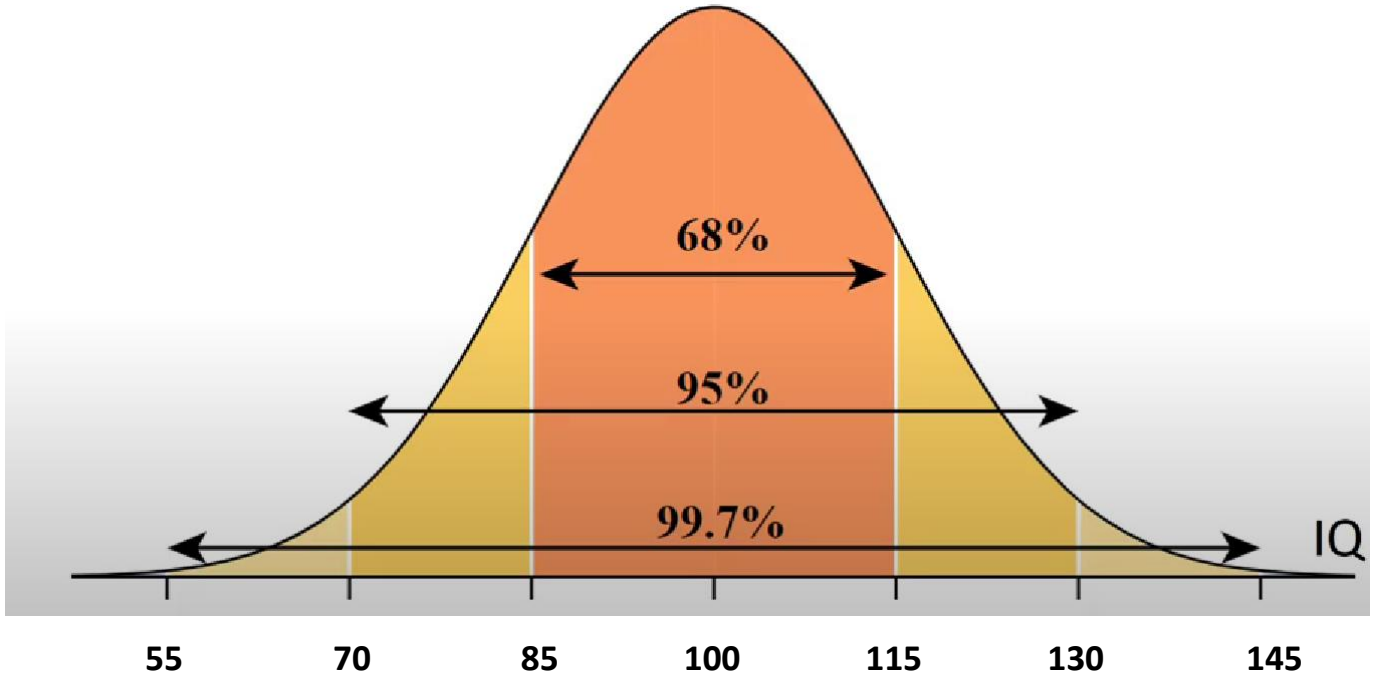
Move 3: IF there are 2 Xs and a space in a line
THEN go in that space.
ELSE IF there are 2 Os and a space in a line
THEN go in that space.
ELSE go in a free corner…..

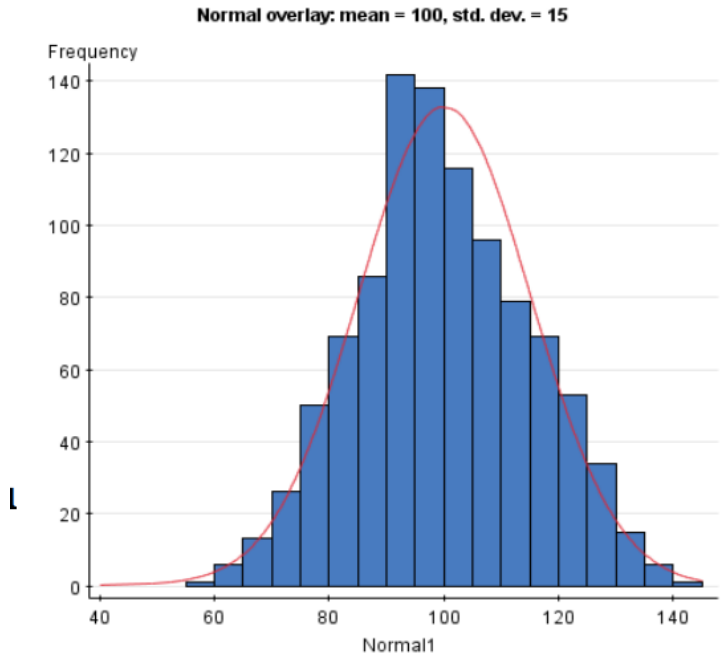


http://www.cs4fn.org/teachers/activities/intelligentpaper/intelligentpaper.pdf

ALT2 – IQ Tests

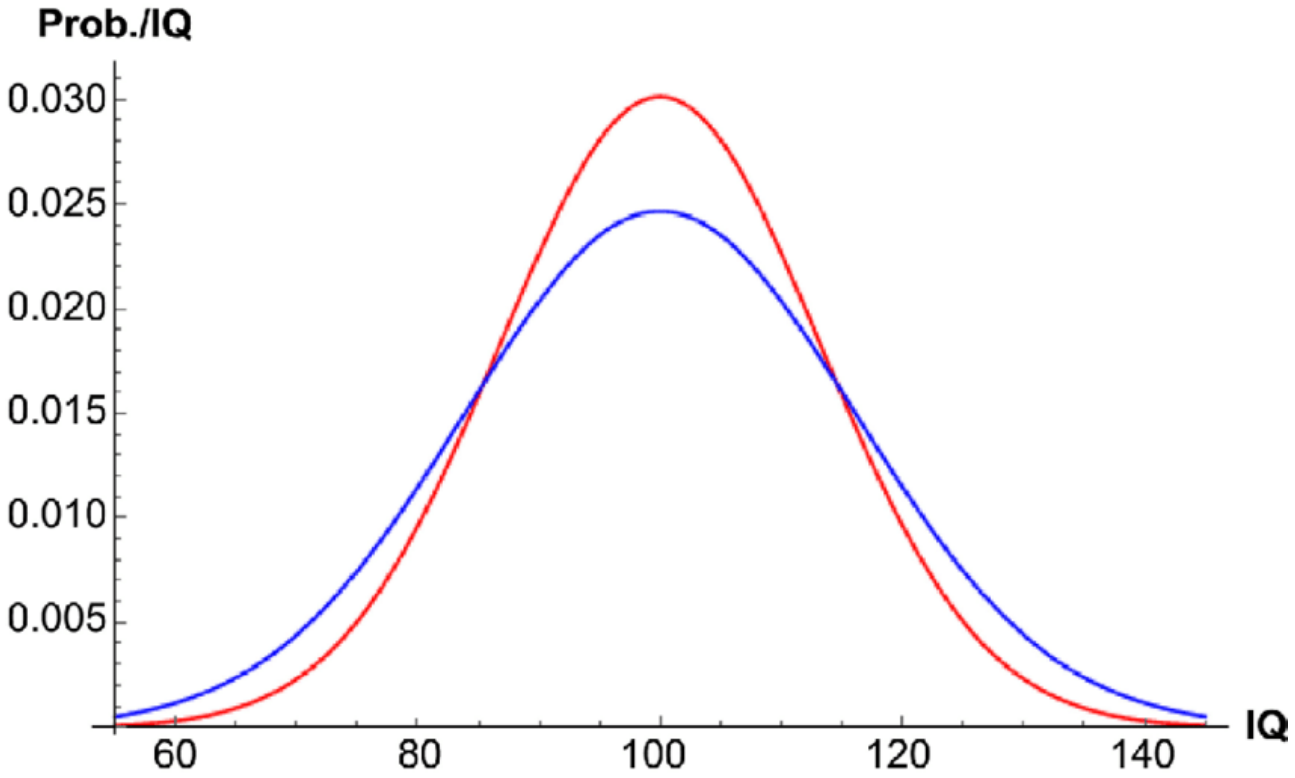
IQ scores are normally distributed with a mean of 100 and a standard deviation of 15

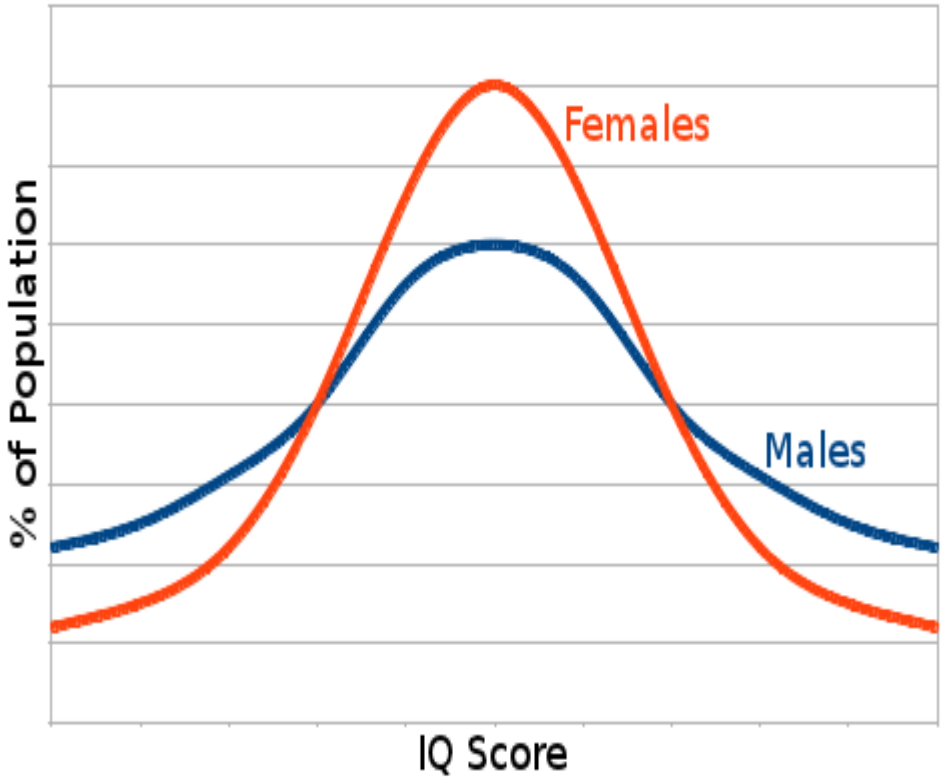




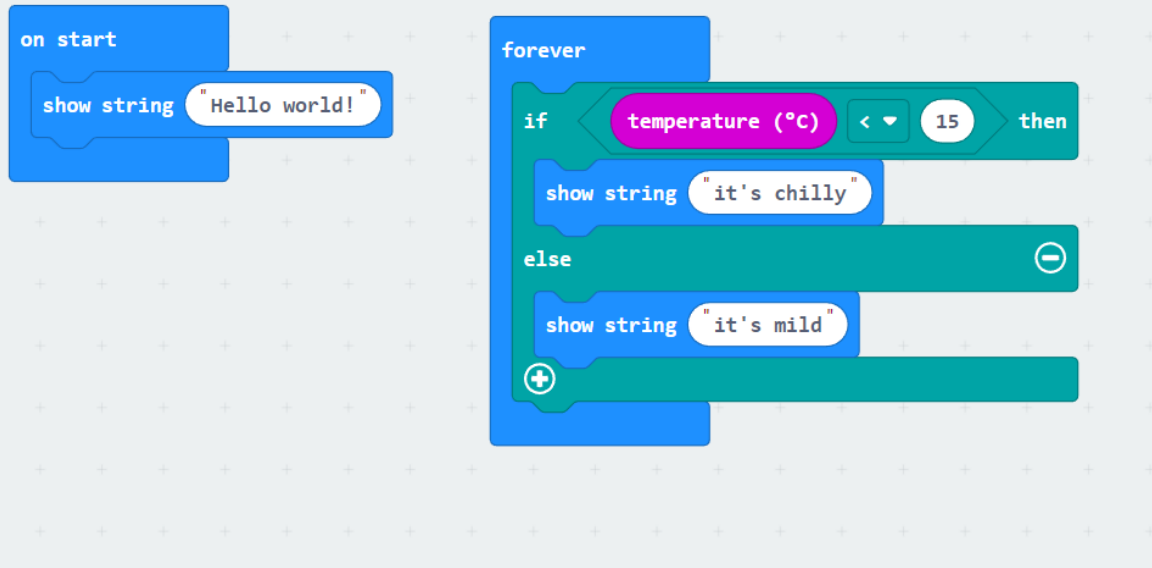
ALT2 – Mean and Median

Test the assertion (hypothesis) “Females are more intelligent than males”, by considering median, mean, mode and spread in the graph shown.





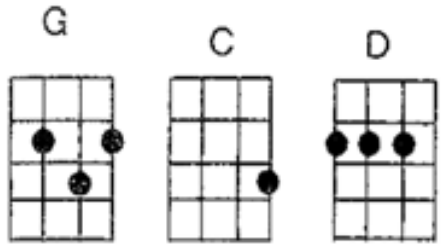
Microbit




```
1   basic.showString("Hello world!")
2   basic.forever(function () {
3       if (input.temperature() < 15) {
4           basic.showString("it's chilly")
5       } else {
6           basic.showString("it's mild")
7       }
8   })
```

Music: 3-chord trick

Robert Zimmerman



G C G C G D
How many roads must a man walk down, before he is called a man? *
G C G C D
How many seas must the White Dove sail, before she sleeps in the sand? *
D G C G C D
And how many times must a cannonball fly, before they are forever banned?

D C D G C
The answer my friend, is blowin' in the wind,
C D G
The answer is blowin' in the wind.

Changing key and the 3-chord trick

A	B	C	D	E	F	G		

A B C D E F G

3-chord trick – pick a letter (no 1) – choose no 4, 5
So for A, the other two are D, E

What are the other 2 chords for C?
And for G?

Unplugged activity – give the general solution to change key

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

CT Thoughts and Models

LEAVING CERTIFICATE COMPUTER SCIENCE

Wing V Denning

Read both viewpoints and consider the following questions

- What is computational thinking?
- Is Computational Thinking good for everyone?
- How does Computational Thinking relate to programming
- How does Computational Thinking relate to other subjects?
- How can Computational Thinking be assessed?
- How might you approach this aspect of the course with your students / do you think Computational Thinking is best taught or learned?

Jeanette Wing

"Computational thinking is the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively ***carried out by an information-processing agent***."

Peter Denning

"Computational thinking (CT) is a popular phrase that refers to a collection of computational ideas and habits of mind that people in computing disciplines **acquire through their work** in designing programs, software, simulations, and computations performed by machinery."

One model of Computational Thinking

- Decomposition
- Pattern recognition
- Abstraction
- Algorithm design

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

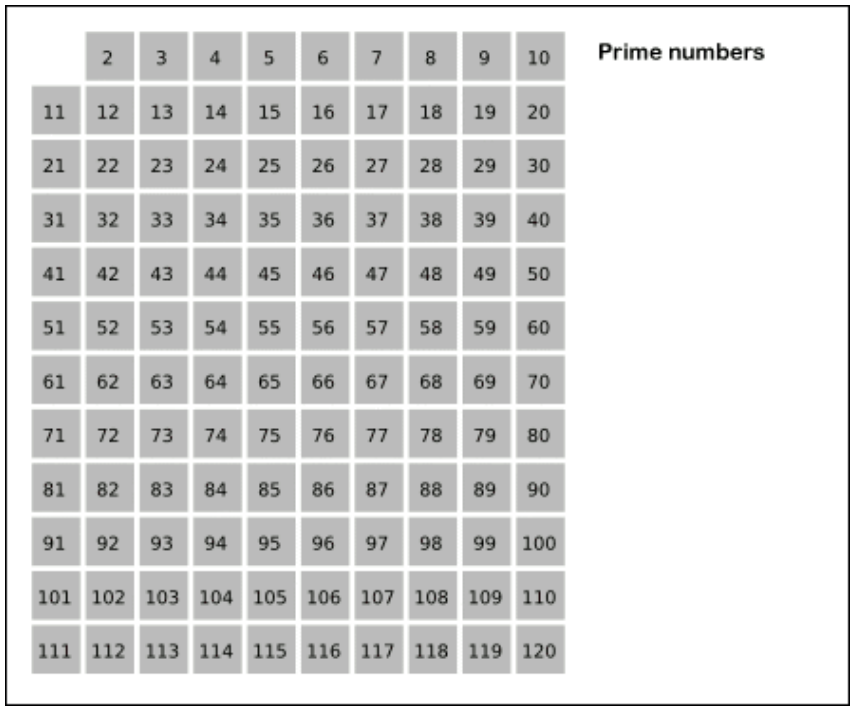
Further CT Activities

LEAVING CERTIFICATE COMPUTER SCIENCE

Sieve of Eratosthenes

List the prime numbers between 1 and 100

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100



https://www.w3resource.com/w3r_images/Sieve_of_Eratosthenes_animation.gif

Mining Cryptocurrencies: Factors of Semi-Primes

Oide

Semi –prime number only has two other factors, apart from itself and 1 (eg. 35)

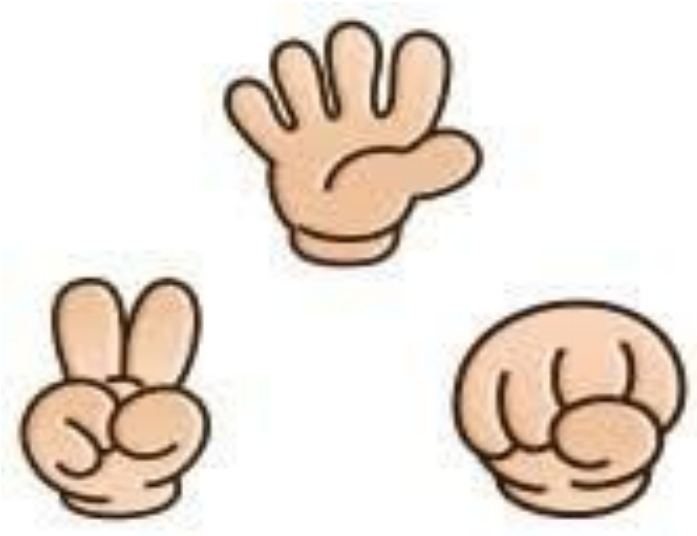
Finding the factors of (really big) semi-primes was one way to harvest cryptocurrencies

323 is a semiprime – what are the factors?

- Develop a general solution (English/pseudocode/code) to semi-prime problems
- Use Computational Thinking to enhance your solution
  (Remember the semi-primes are huge – hundreds of digits so efficiency is important)

Rock-Paper-Scissors

- Write code/pseudocode to determine the winner
- Make the code more efficient
- Develop a winning strategy



Group Activity: Breakout

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Session2: Algorithms I

LEAVING CERTIFICATE COMPUTER SCIENCE

Overview of the session

Part 1	Introduction to algorithms
Part 2	Algorithms for mean, median and mode
Part 3	Breakout activity (Python)

By the end of this session..

Participants will have…

…reflected on the importance of and the ubiquitous nature of algorithms in today's society

…participated in a coding activities relating to measures of central tendency

…reflected on ideas to facilitate the effective learning of algorithms in their own classrooms and, in particular, in relation to ALT2

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Introduction to Algorithms

LEAVING CERTIFICATE COMPUTER SCIENCE

Algorithms and the Specification

"Computer science is the study of computers and algorithmic processes. Leaving Certificate Computer Science includes how programming and computational thinking can be applied to the solution of problems, and how computing technology impacts the world around us."

NCCA Curriculum specification, Page 1

Strand 1: Practices and principles	Strand 2: Core concepts	Strand 3: Computer science in practice
▸ Computers and society ▸ Computational thinking ▸ Design and development	▸ Abstraction ▸ Algorithms ▸ Computer systems ▸ Data ▸ Evaluation/Testing	▸ Applied learning task 1 - Interactive information systems ▸ Applied learning task 2 - Analytics ▸ Applied learning task 3 - Modelling and simulation ▸ Applied learning task 4 - Embedded systems

Page 11

LCCS Learning Outcomes

2.5 use pseudo code to outline the functionality of an algorithm

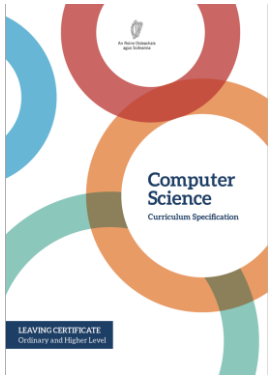
2.6 construct algorithms using appropriate sequences, selections/conditionals, loops and operators to solve a range of problems, to fulfil a specific requirement

2.7 implement algorithms using a programming language to solve a range of problems

2.8 apply basic search and sorting algorithms and describe the limitations and advantages of each algorithm

2.9 assemble existing algorithms or create new ones that use functions (**including recursive**), procedures, and modules

2.10 explain the common measures of algorithmic efficiency using any algorithms studied



S2: Algorithms

Programming concepts

Sorting: Simple sort, Insert sort, Bubble sort, **Quicksort**

Search: Linear search, Binary search

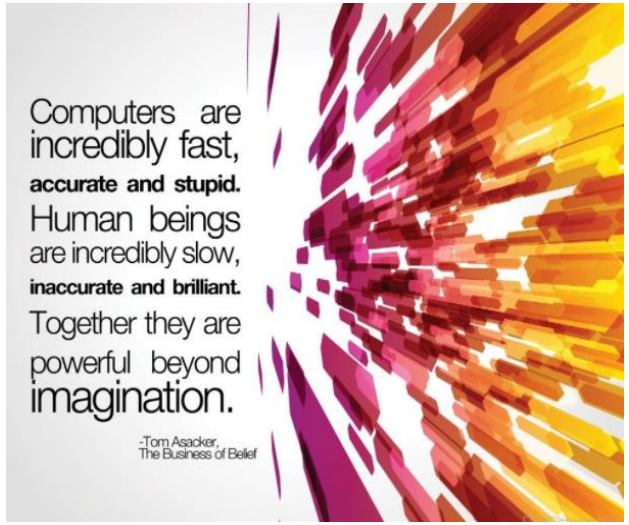
Algorithmic complexity

See also learning outcomes 1.6, 1.7 1.14, 1.22, 2.3, 3.4 and 3.7 … plus others

What is an algorithm?

“A step-by-step procedure for solving a problem or accomplishing some end especially by a computer” Merriam-Webster

Because of their speed and reliability computers are an ideal tool for running algorithms.



Algorithms are:

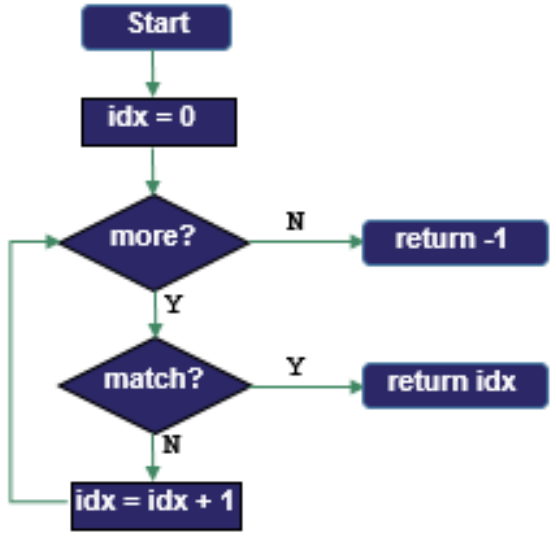
- a sequence of instructions
- a way of capturing intelligence
- general solutions to problems
- expressed in a variety of different ways
- Characterised by input, processing and output

Some examples

Chocolate Cream Pie

1. Heat milk, marshmallows and chocolate in 3-quart saucepan over low heat, stirring constantly, until chocolate and marshmallows are melted and blended. Refrigerate about 20 minutes, stirring occasionally until mixture mounds slightly when dropped from a spoon.

2. Beat whipping cream in chilled small bowl with electric mixer on high speed until soft peaks form. Fold chocolate mixture into whipped cream. Pour into pie shell. Refrigerate uncovered about 8 hours or until set. Garnish with milk chocolate curls and whipped cream.

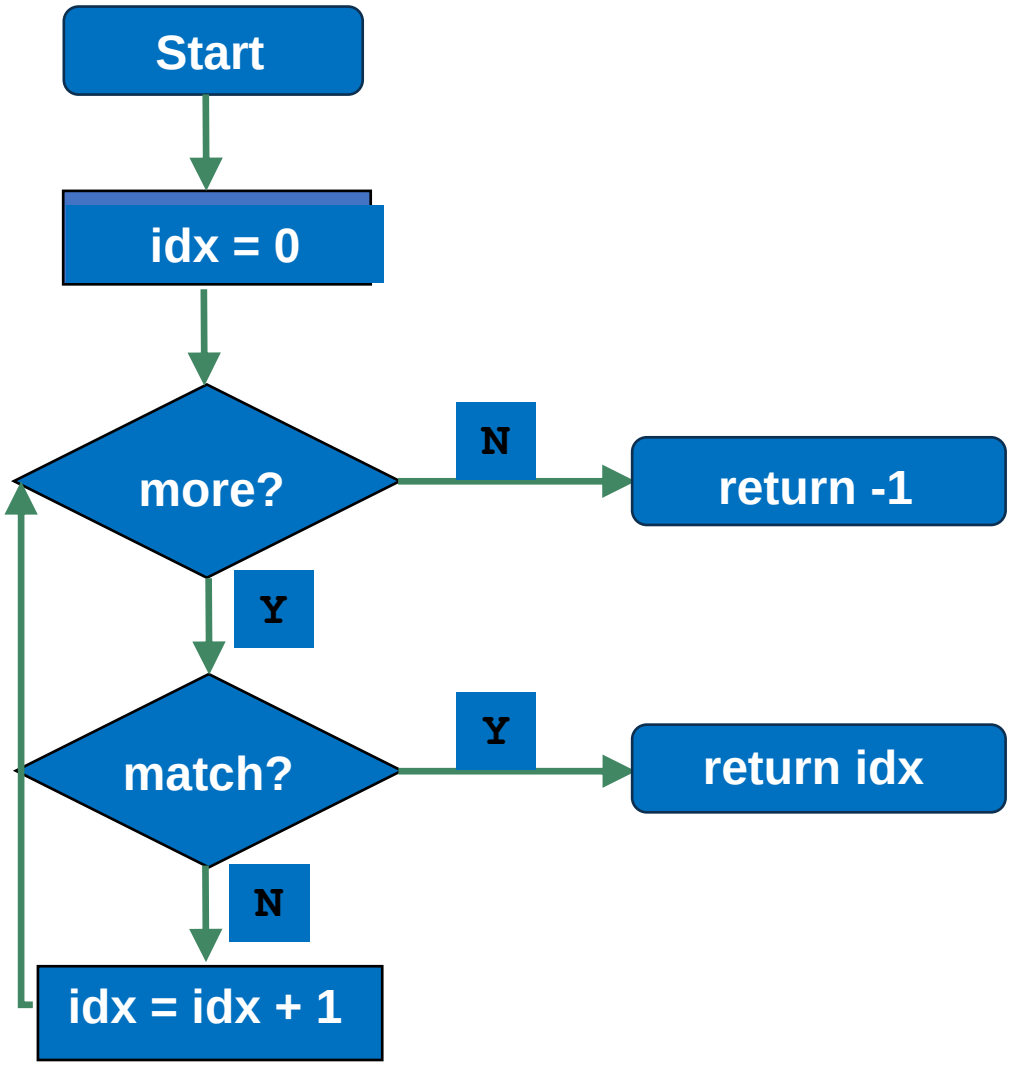


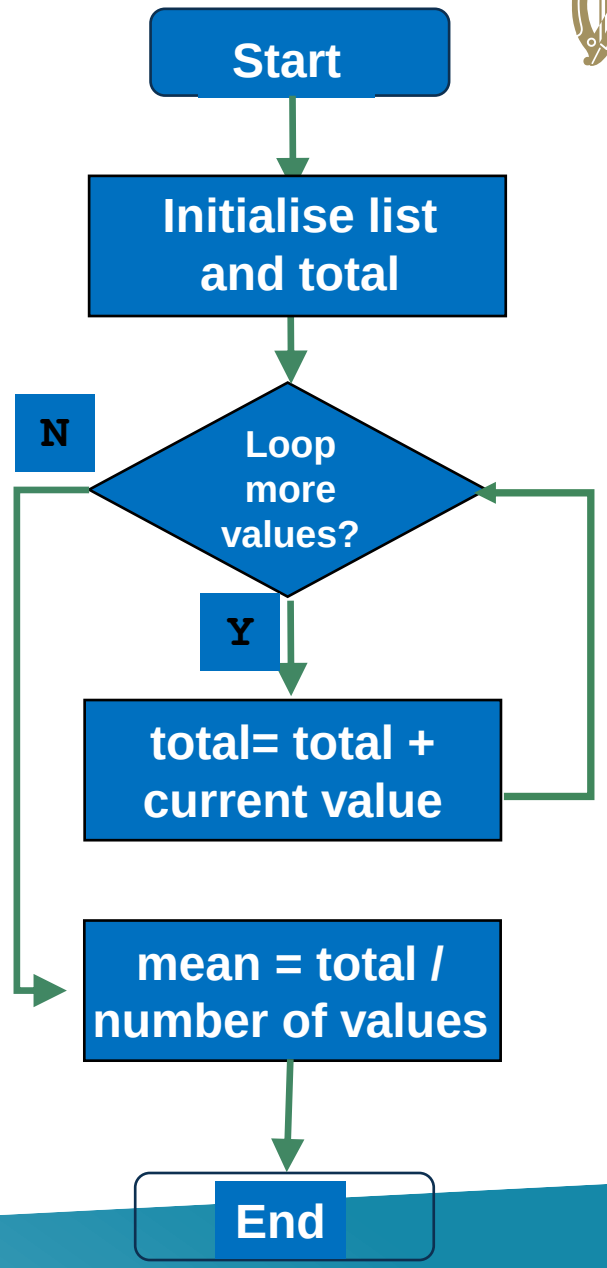

```
1. Set low = 0
2. Set high = length of list - 1
3. Set index = (low+high)/2, rounded down to an integer
4. If the value at the index position is the same as the target value
      Return index
   Else If the value at the index position is less than the target value
      Set low = index + 1
   Else If the value at the index position is less than the target value
      Set high = index - 1
5. Go back to step 3 above
6. Return -1
```

```
p = 1029
q = 462

r = p%q # step 1
while (r != 0): # step 2
    p = q # step 3
    q = r # step 3
    r = p%q # step 1 (again)

print("GCD is", q)
```


DESIGN
create a representation, decide on tools

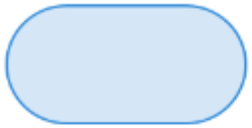
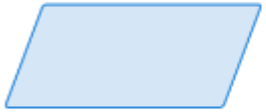
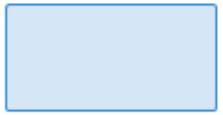
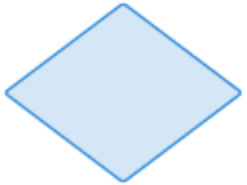
Flowcharts


Start
idx = 0
more?
N
return -1
Y
match?
Y
return idx
N
idx = idx + 1


Start
Initialise list and total
N
Loop more values?
Y
total= total + current value
mean = total / number of values
End

Quizlet (flowcharts)

https://quizlet.com/758767872/match

Symbol	Name	Function
	Start/End	An oval represents a start or end point
	Arrows	A line is a connector that shows relationships between the representative shapes
	Input/ Output	A parallelogram represents input or output
	Process	A rectangle represents a process
	Decision	A diamond indicates a decision

Oide

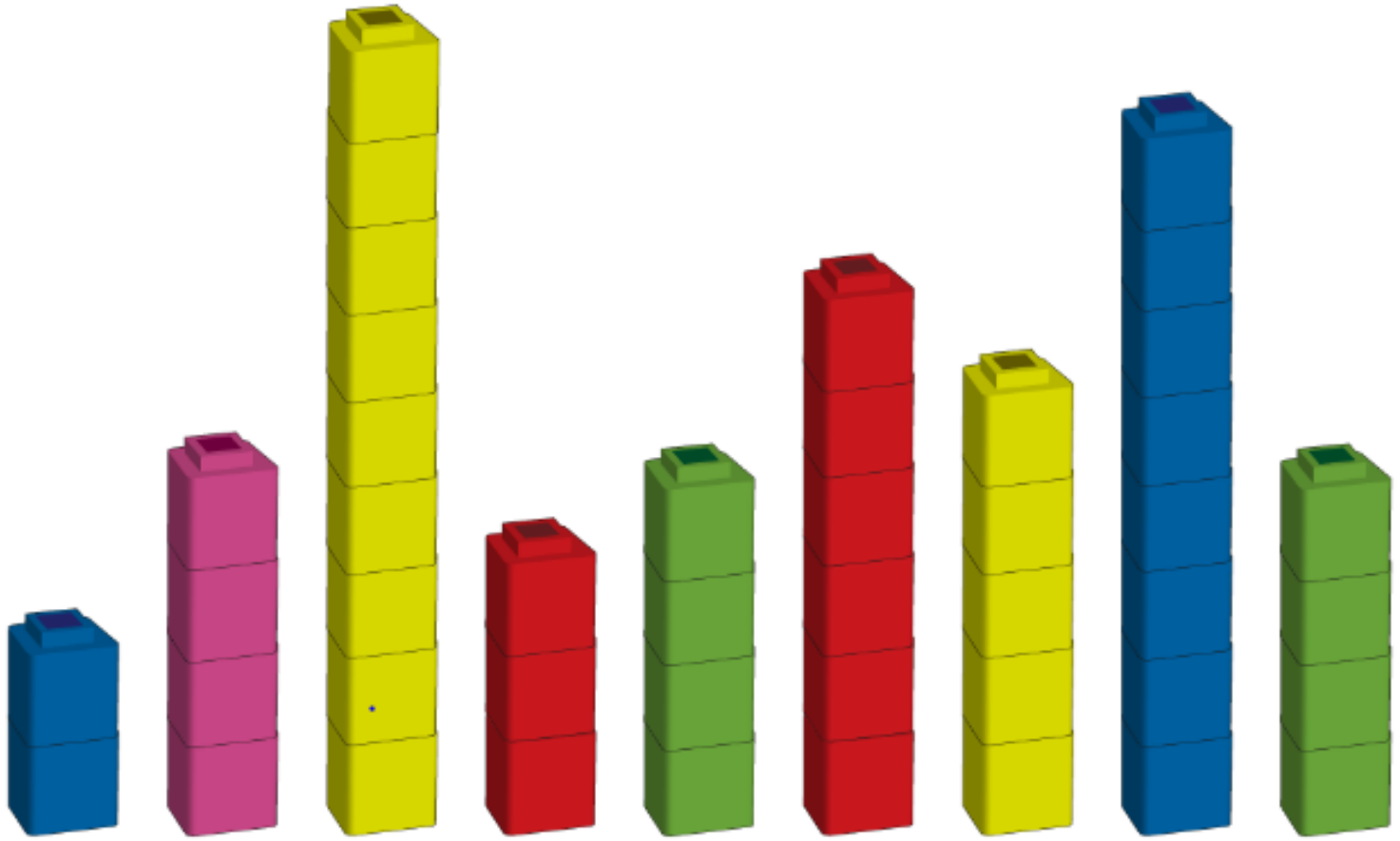
Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Algorithms for mean, median and mode

LEAVING CERTIFICATE COMPUTER SCIENCE

Measures of Central Tendency



A look ahead to ALT2

3.4. Develop algorithms that can find the frequency, mean, median and mode of a data set.

3.5. Structure and transform raw data to prepare it for analysis.

3.6. Represent data to effectively communicate in a graphical form.

3.7. Use algorithms to analyse and interpret data in a way that informs decision-making.

Measures of Central Tendency

```
# A program to demonstrate the use of some statistics functions
import statistics

# Initialise a list of values
values = [2,3,5,2,4]

# Compute the 3 averages
arithmetic_mean = statistics.mean(values)
median_value = statistics.median(values)
modal_value = statistics.mode(values)

# Display the answers
print("The mean is ", arithmetic_mean)
print("The median and mode are %d and %d" %(median_value, modal_value))
```

When the program is run the output looks like this:

```
The mean is  3.2
The median and mode are 3 and 2
>>>
```

Mean

A representative value

Input: A list of values

18	27	15	13	22

Step 1. Add the values

18	27	15	13	22

0+18= 18

18+27 = 45

45+15 = 60

60+13 = 73

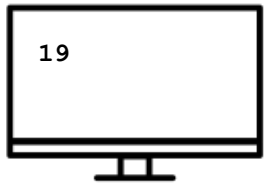
73+22= 95

Step 2. Calculate the mean

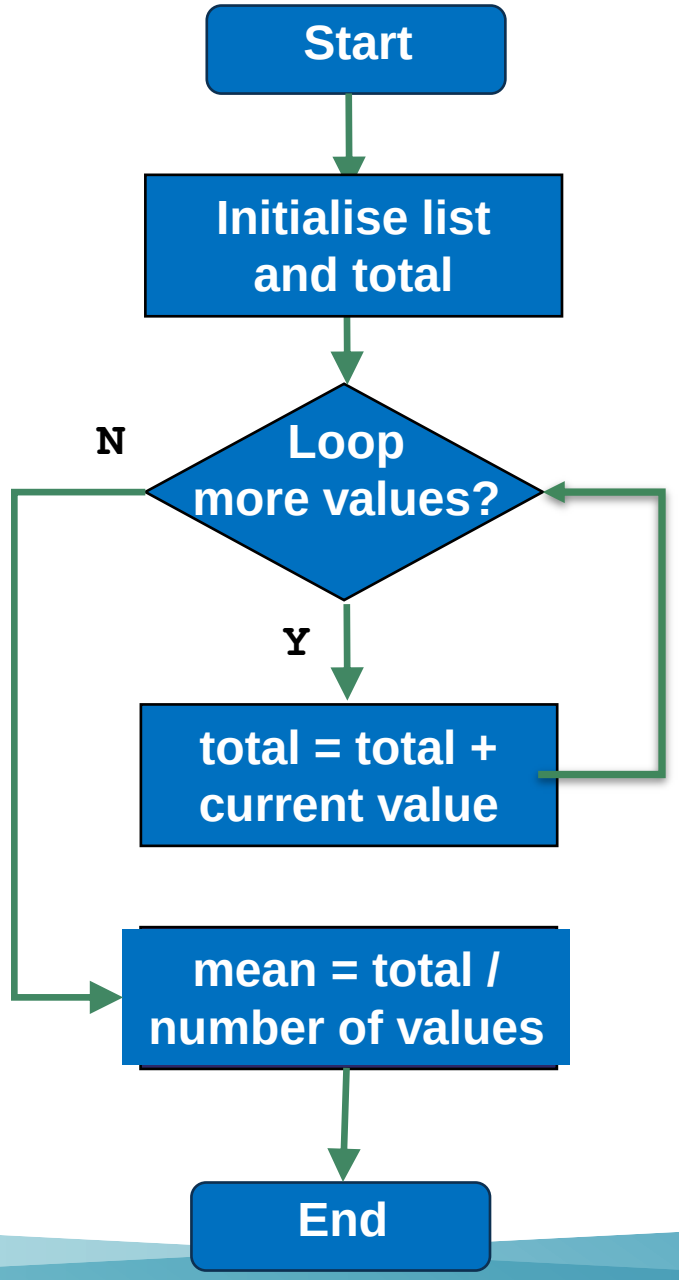
Divide the total by the number of values

95/5 = 19

Output: The mean



Mean: Flowchart and code




```
# Program to find the mean of a list of values
# Version 1

# Calculate and return the mean of all the values
in L
def arithmetic_mean(L):

    # set the initial value of total to zero
    total = 0 # running total of values in L

    # Now loop over the list
    for v in L:
        total = total + v # running total

    # Divide by the total by the number of values
in L
    return total/5

# PYTHON STARTS EXECUTING FROM HERE ...
# Initialise a list of values
my_list = [18, 27, 15, 13, 22]
# Call the function
my_mean = arithmetic_mean(my_list)
# Display the answer
```

Mean

Initialise the list

```
L = [18, 27, 15, 13, 22]
```

Compute a running total

```
total = 0
for v in L:
    total = total + v
```

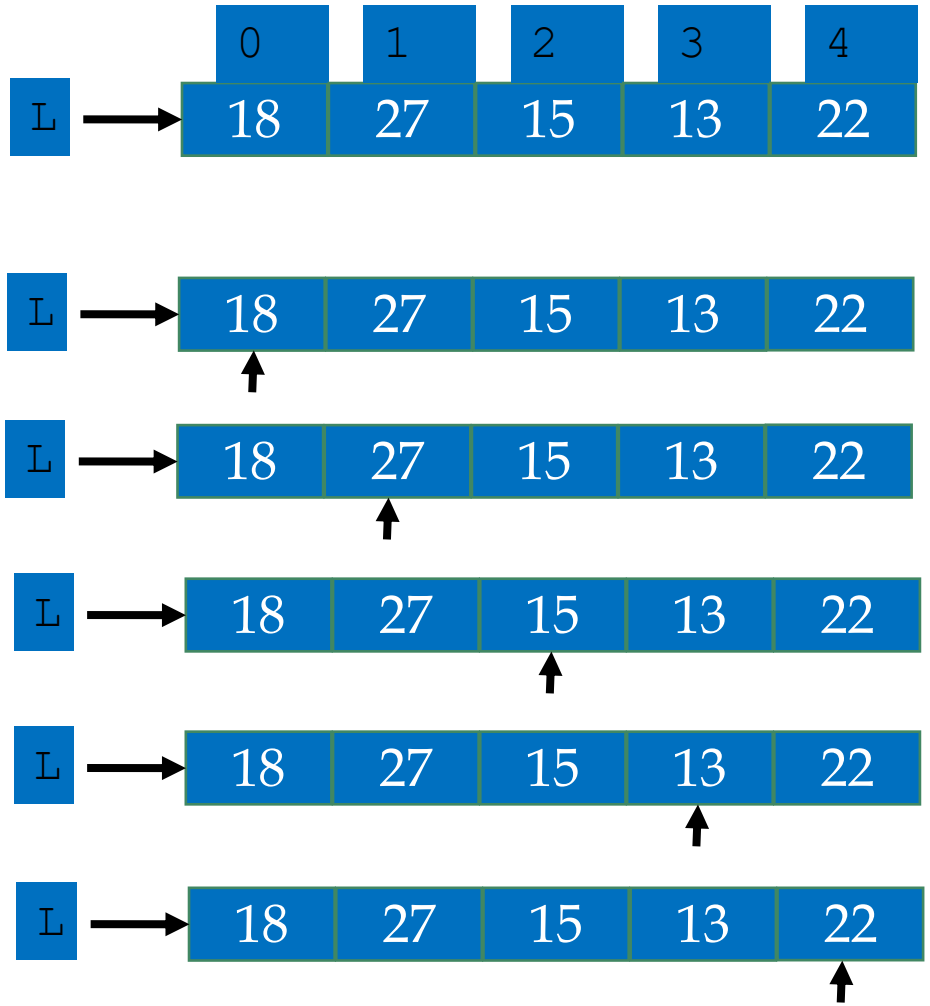
Compute and display the mean

```
mean = total/5
print(mean)
```

The current value

v

v
18
27
15
13
22



This is a running total of all the values

total
18
45
60
73
95

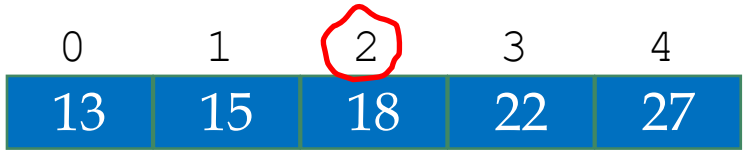
Median

Middle value in a sorted list

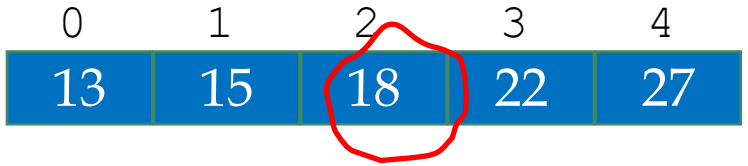
Input: A list of values

Step 1. Sort the list

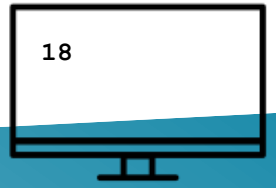
Step 2. Find middle position



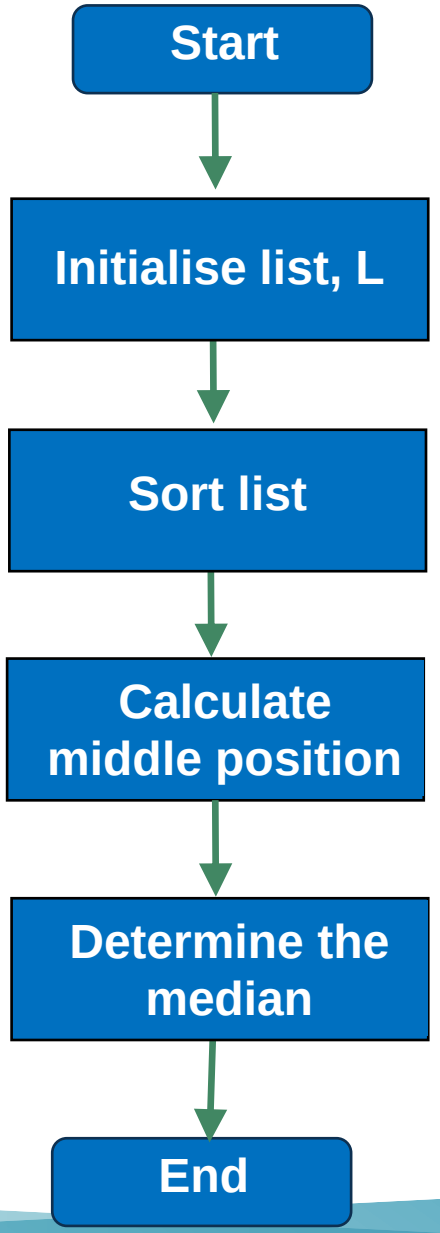
Step 3. Determine the median



Output: The median

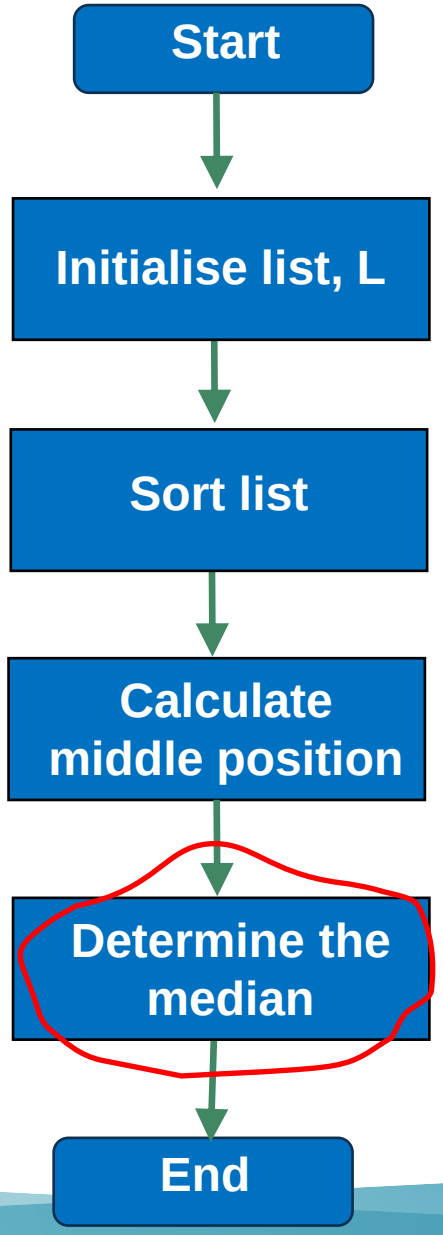


Median




```
# A program to find the median of a list of values
# Version 1

L = [18, 27, 15, 13, 22]

# To find the median we need to sort the list
L.sort() # the values are sorted 'in place'

# The next step is to find the index of the middle value
num_values = len(L)
mid = num_values//2

median = L[mid] # the median is in the middle

# Display the result
print("The median value is: %.2f" %median)
```

Median (dealing with an even number of values)



In a list with 5 values the median is at index 2.

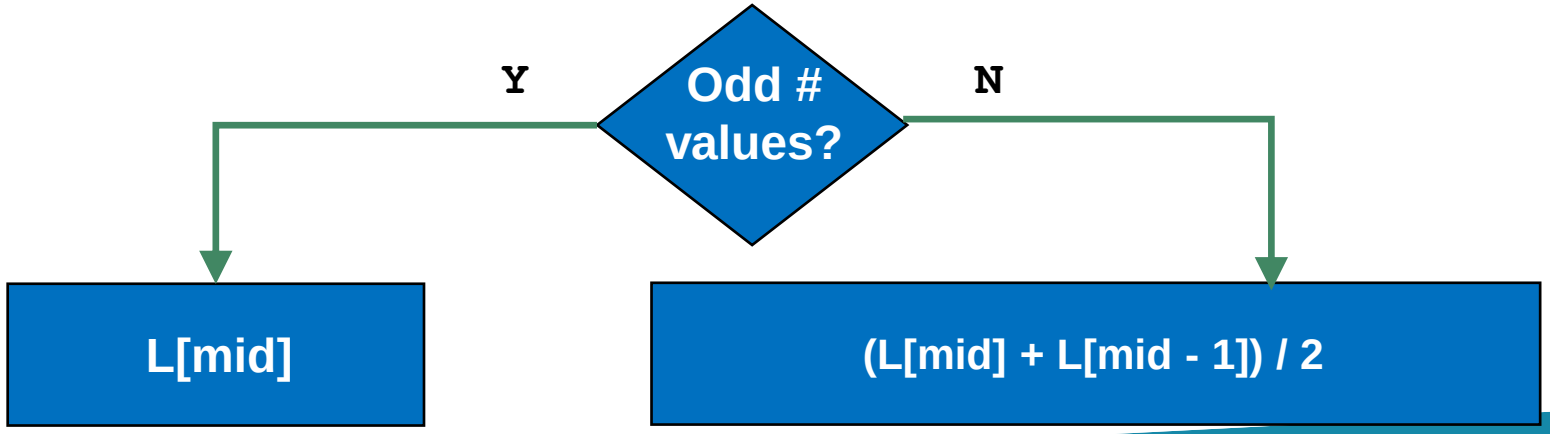
0	1	2	3	4
13	15	18	22	27

In a list with 4 values we need to use indices 1 and 2

0	1	2	3
13	15	18	22

The median is (15 + 18) / 2

The median is 16.5

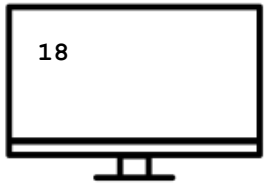


Mode

The most frequently occurring value

Input: A list of values

Output: The mode



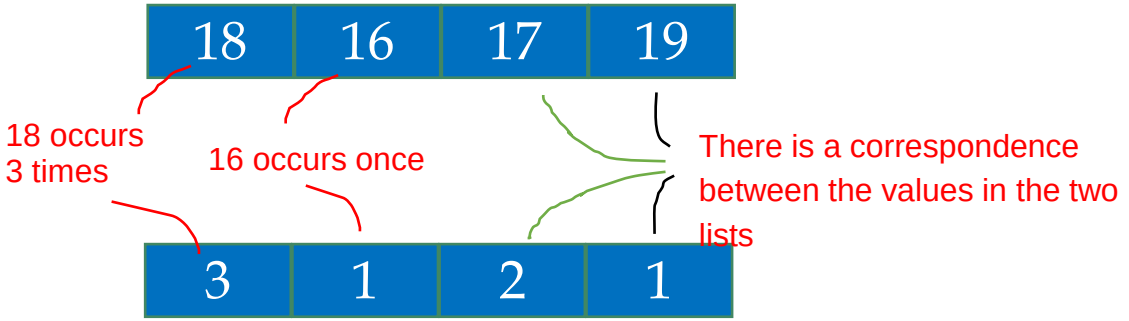
At a glance we can see the mode is 18 but how do we capture this algorithmically?

Mode

The most frequently occurring value

Input: A list of values

Step 1. Create a list of unique values



Step 2. Create a list of frequencies

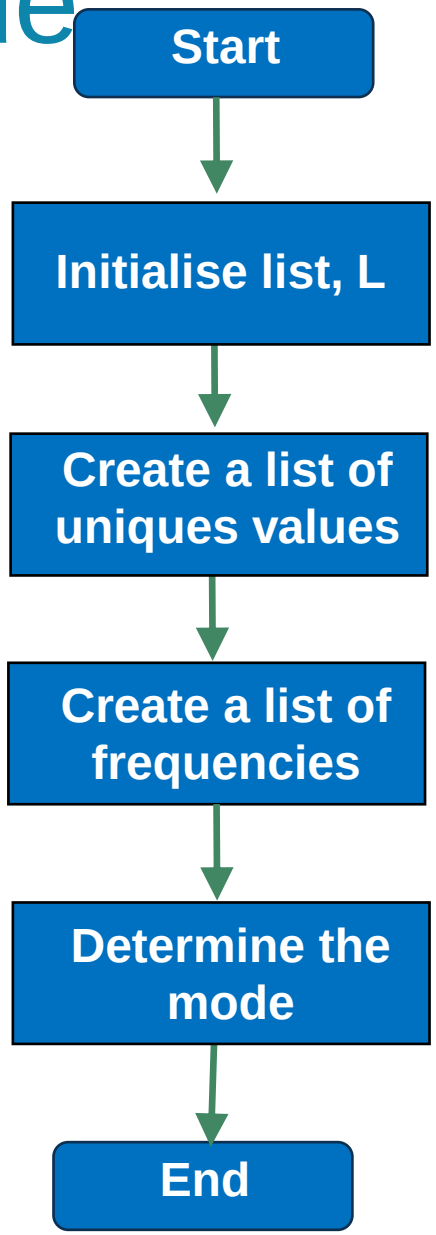
The two lists tell us the frequency of each value

Step 3. Determine the mode

The value that corresponds to the highest frequency

Output: The mode

Mode




```
# A program to find the mode of a list of values
# Version 1

# Initialise a list of values
L = [18, 16, 17, 18, 19, 18, 17]

# Build up a list of unique values
unique_values = []
for value in L:
    if value not in unique_values:
        unique_values.append(value)

# Build up a list of frequencies
frequencies = []
for value in unique_values:
    frequency = L.count(value)
    frequencies.append(frequency)

# Find the mode
max_frequency = max(frequencies)
max_frequency_pos = frequencies.index(max_frequency)
mode = unique_values[max_frequency_pos]

print("Mode is", mode)
```

Group Activity

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Session 3: Computer Systems II

LEAVING CERTIFICATE COMPUTER SCIENCE

Overview of the session

Part 1	Hexadecimal, ASCII, Hitomezashi Stitching
Part 2	Computer systems part picker activity
Part 3	Presentation and discussion on activity

By the end of this session..

Participants will have…

… developed a clear understanding of why the binary number system is fundamental in digital computing

… explored the Hexadecimal Number System

… gained proficiency in converting numbers between binary, hexadecimal, and decimal formats

… gained knowledge about ASCII, Unicode, and UTF-8 encoding

… personalised their initials by converting them into binary using ASCII and/or UTF values and represent using Hitomezashi stitching technique

… describe different components within a computer and the function of these components

Oide

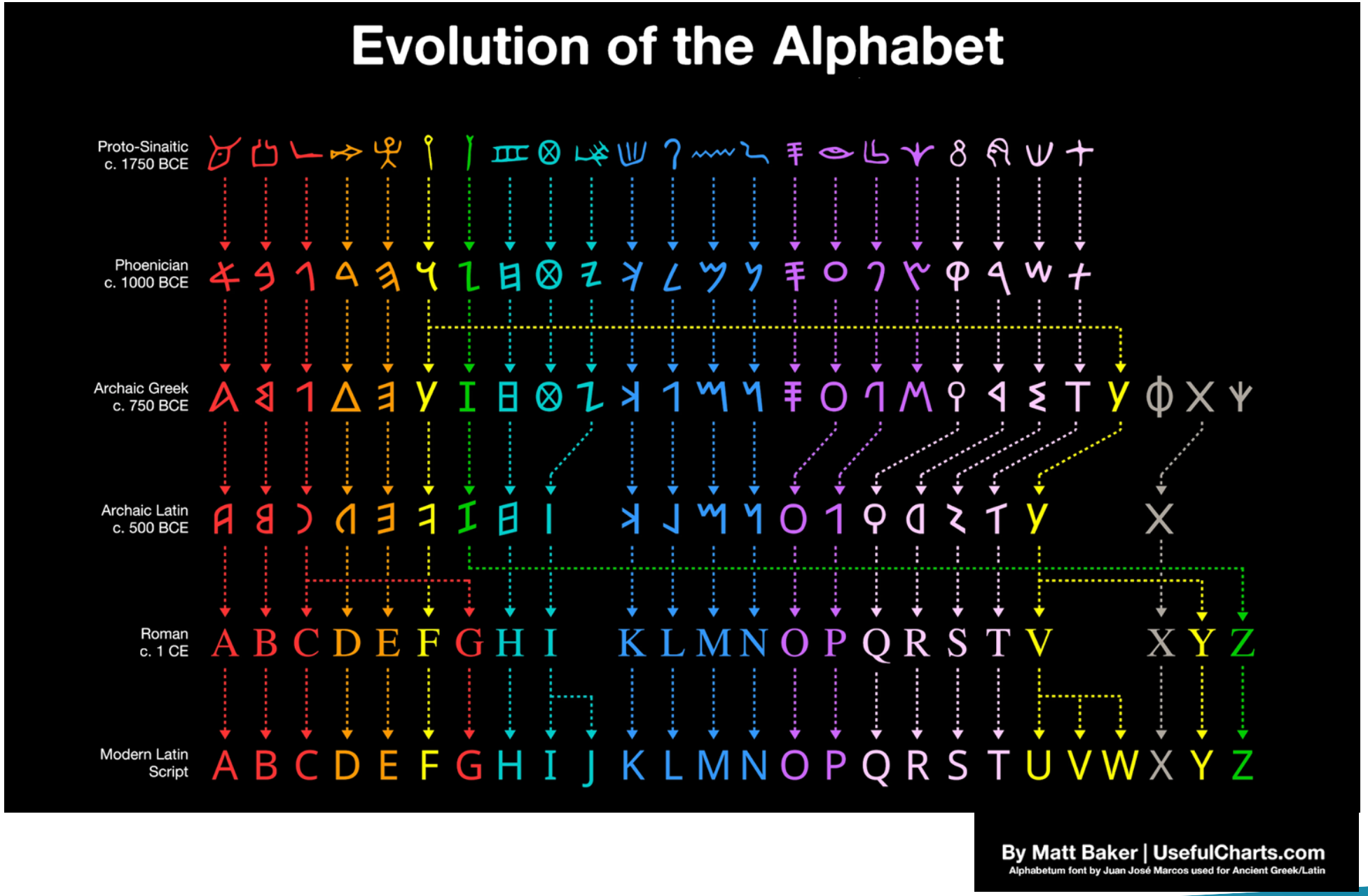
Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Number Systems

Hexadecimal, ASCII and Hitomezashi Stitching

LEAVING CERTIFICATE COMPUTER SCIENCE


Evolution of the Alphabet
Proto-Sinaitic
c. 1750 BCE
Phoenician
c. 1000 BCE
Archaic Greek
c. 750 BCE
Archaic Latin
c. 500 BCE
Roman
c. 1 CE
A B C D E F G H I K L M N O P Q R S T V X Y Z
Modern Latin
Script
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
By Matt Baker | UsefulCharts.com
Alphabetum font by Juan José Marcos used for Ancient Greek/Latin

Oide

Everything is 1s and 0s

All information that passes through a computer is formed from the controlled flow of electricity through its various components.

The information contained in this electricity flow is interpreted as:

On = 1 and **Off** = 0.

We can, therefore, consider information flow through a computer in terms of 1s and 0s.

But how is this flow of 1s and 0s turned into something useful (and how do we turn something useful into 1s and 0s so that it may be worked on by a computer)?

Hexadecimal

Base 16 number system (has 16 digits, decimal has 10, binary has 2)

0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

Human-friendly gateway between decimal and binary

Used most notably for encoding colour information - Hex colouring

Red, Green and Blue can be a value from 00 to FF (0 – 255)

#000000 is black #FFFFFF is white #34ab2c is greenish

https://www.color-hex.com/

ASCII, Unicode, UTF8

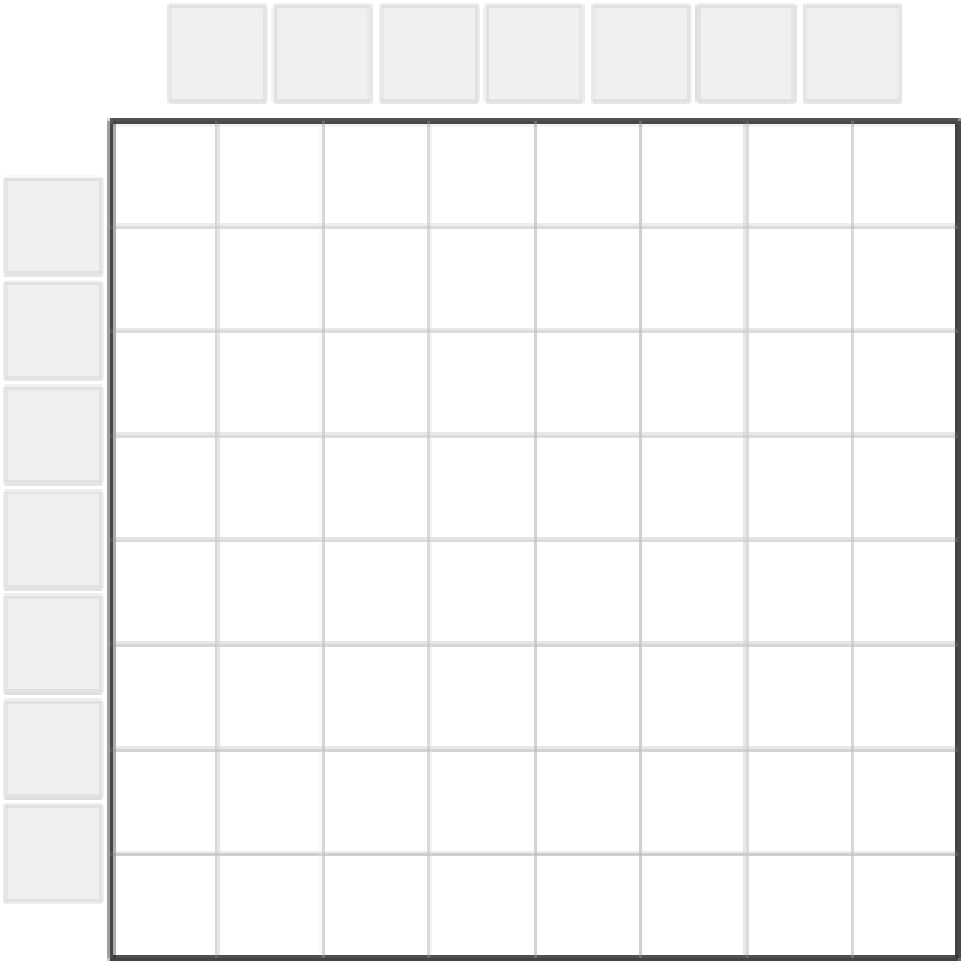
- Character encoding standards are used to ensure smooth and consistent information exchange
- ASCII uses 7 bits to encode 128 different characters (2^7)
- Include Arabic numerals and the English alphabet
- Unicode is an extension of ASCII, allowing for other alphabetic symbols to be encoded and transmitted
- UTF (Unicode Transformation Format) 8 is the most common format.

U+1F601	😁	beaming face with smiling eyes	beaming face with smiling eyes | eye | face | grin | smile
U+1F606	😆	grinning squinting face	face | grinning squinting face | laugh | mouth | satisfied | smile
U+1F605	😅	grinning face with sweat	cold | face | grinning face with sweat | open | smile | sweat
U+1F923	🤣	rolling on the floor laughing	face | floor | laugh | rofl | rolling | rolling on the floor laughing | r
U+1F602	😂	face with tears of joy	face | face with tears of joy | joy | laugh | tear
U+1F642	🙂	slightly smiling face	face | slightly smiling face | smile

ASCII Characters in Hexadecimal

Hex	Value	Description	Hex	Value	Description	Hex	Value	Description	Hex	Value	Description
40	@	"at" symbol	50	P	Capital P	60	`	Grave / accent	70	p	Small p
41	A	Capital A	51	Q	Capital Q	61	a	Small a	71	q	Small q
42	B	Capital B	52	R	Capital R	62	b	Small b	72	r	Small r
43	C	Capital C	53	S	Capital S	63	c	Small c	73	s	Small s
44	D	Capital D	54	T	Capital T	64	d	Small d	74	t	Small t
45	E	Capital E	55	U	Capital U	65	e	Small e	75	u	Small u
46	F	Capital F	56	V	Capital V	66	f	Small f	76	v	Small v
47	G	Capital G	57	W	Capital W	67	g	Small g	77	w	Small w
48	H	Capital H	58	X	Capital X	68	h	Small h	78	x	Small x
49	I	Capital I	59	Y	Capital Y	69	i	Small i	79	y	Small y
4A	J	Capital J	5A	Z	Capital Z	6A	j	Small j	7A	z	Small z
4B	K	Capital K	5B	[	left/opening bracket	6B	k	Small k	7B	{	left/opening brace
4C	L	Capital L	5C	\	back slash	6C	l	Small l	7C	|	vertical bar
4D	M	Capital M	5D	]	right/closing bracket	6D	m	Small m	7D	}	right/closing brace
4E	N	Capital N	5E	^	caret/circumflex	6E	n	Small n	7E	~	tilde
4F	O	Capital O	5F	_	underscore	6F	o	Small o	7F	DEL	delete

Hitomezashi Stitching



Oide

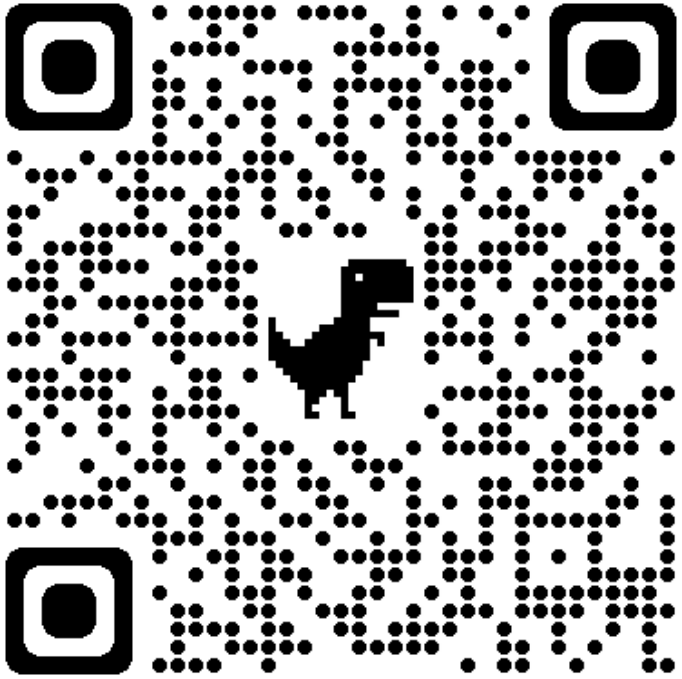
Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Computer Systems

LEAVING CERTIFICATE COMPUTER SCIENCE

Quizlet Activity -
The Main Components of a Computer



https://quizlet.com/758765435/match

The Main Components of a Computer

The **Motherboard** is a Printed Circuit Board (PCB) that acts as the central hub of the computer. All devices and components are connected to it and all communication between devices is done through it.

Storage, either on Hard Disk Drives (HDD) or Solid State Drives (SSD) is where the Operating System, software, and files are stored and accessed by other components, as required. HDDs are cheap and can hold large amounts of data. SSDs are faster but currently more expensive for larger sizes.

Memory. Random Access Memory (RAM) is where the computer will temporarily store information required to complete tasks or keep software running. RAM is accessed/written faster than a disk drive. More RAM means that more and larger files can be stored and accessed ay any one time, leading to more efficient and quicker performance. Anything stored in RAM will erase when the power is turned off.

Group Activity

Breakout task – Build a desktop computer

Each group will be asked to research, design, and price a computer for a particular set of criteria.

Various websites are available to help you with this, including:

https://pcpartpicker.com/

https://www.reddit.com/r/buildapc/

https://www.custompc.ie/

https://www.tomshardware.com/topics/pc-builds

Please feel free to find and share your own sources of help!

Breakout task – Build a desktop computer

	Specification	**Budget**
Groups 1 & 5	General purpose home office computer	€500
Groups 2 & 6	Budget gaming computer	€800
Groups 3 & 7	Content creator's machine for video editing	€1000
Groups 4 & 8	A no compromises, simply ludicrous machine	€8000

Things to think about

What are the unique requirements of each computer’s intended function?

What will the users of these machines require in order to work most effectively?

Compromises will have to be made. There may be no one best compromise to make.

Discussion and presentation

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professiona Learning of School Leaders and Teachers

Leaving Certificate Computer Science

National Workshop 3

Day 2

Workshop Overview

Session 4 9:00 - 11:00	Introduction to Data Analytics and ALT2 (Investigate)
Tea/Coffee 11:00 – 11:30	
Session 5 11:300 - 13:00	ALT2: Plan and Design
Lunch 13:00 - 14:00	
Session 6 14:00 – 15:30	Python libraries, NCCA resources and Curriculum planning

By the end of this session..

Participants will have…

…Deepened their understanding of data science and ALT2

…Worked in groups to develop an ALT, including approaching datasets

…Enhanced their understanding of the Investigate, Plan, Design and Create stages of the Design Process with particular focus on ALT2

…Considered their next steps in relation to Curriculum Planning

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Session 4: Introducing data analytics and ALT2 (investigate)

LEAVING CERTIFICATE COMPUTER SCIENCE

Overview of the session

Part 1	Introduction to data analytics
Part 2	Introducing ALT2
Part 3	ALT2 Investigate

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Introducing Data Analytics

LEAVING CERTIFICATE COMPUTER SCIENCE

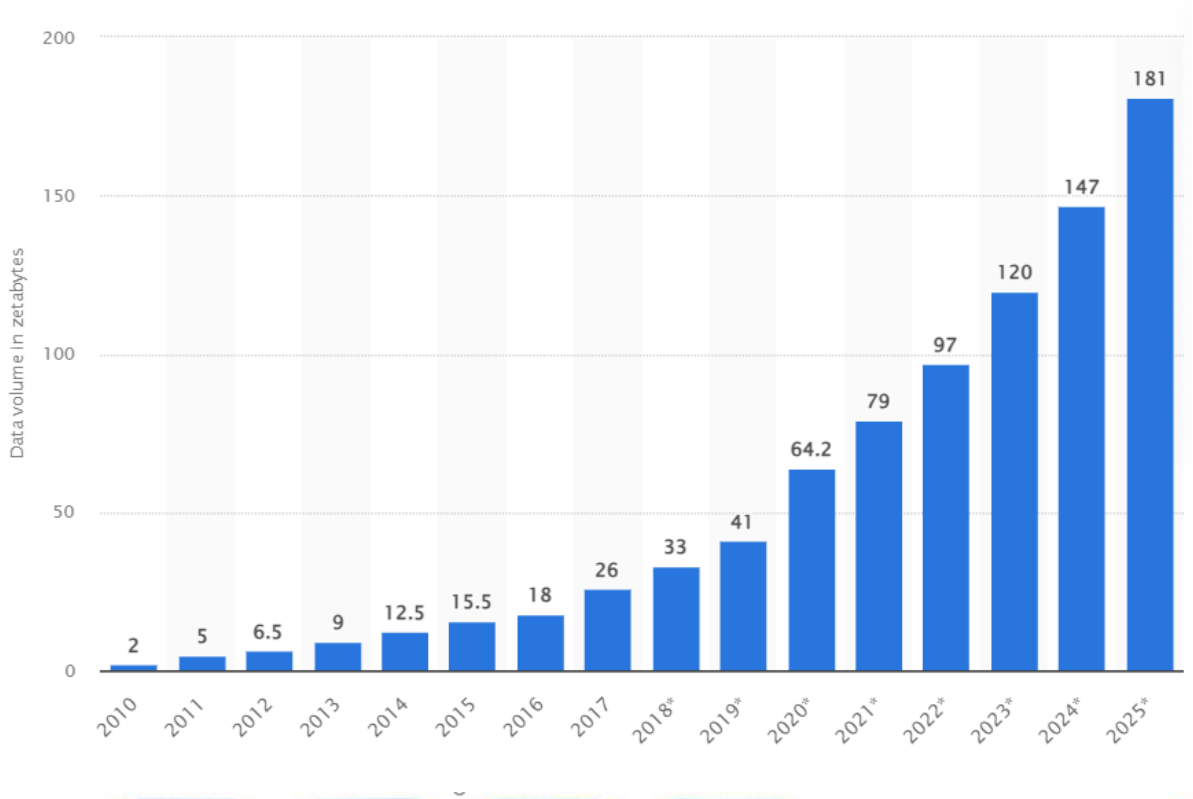
“Data is the new oil”

Clive Humby, 2006

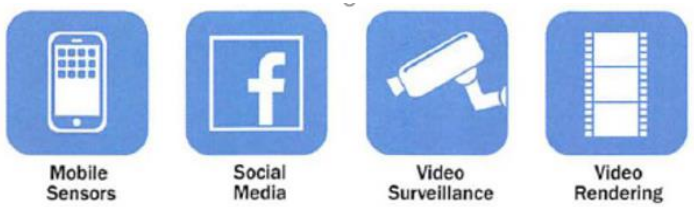
https://youtu.be/D049hhpD6WA

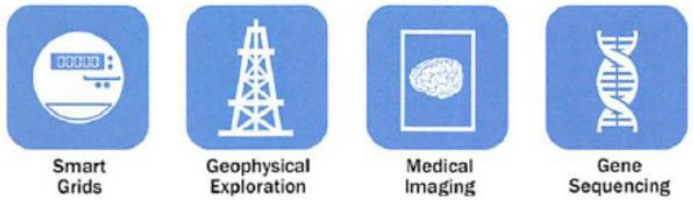
What words do you associate with Data Science/Data Analytics?

Annual Size of the Global Datasphere



yotta	Y	10^{24}	1 000 000 000 000 000 000 000 000
zetta	Z	10^{21}	1 000 000 000 000 000 000 000
exa	E	10^{18}	1 000 000 000 000 000 000
peta	P	10^{15}	1 000 000 000 000 000
tera	T	10^{12}	1 000 000 000 000
giga	G	10^{9}	1 000 000 000
mega	M	10^{6}	1 000 000
kilo	k	10^{3}	1 000
hecto	h	10^{2}	100
deca	da	10^{1}	10
-	-	10^{0}	1
deci	d	10^{-1}	0,1
centi	c	10^{-2}	0,01
mili	m	10^{-3}	0,001
micro	μ	10^{-6}	0,000 001





Data Capacity / Information Representation

A single bit can be used to encode (represent) two pieces of information

3 bits 8 things – 7 colours of the rainbow

7 bits **can** represent 128 ASCII values

8 bits == 1 Byte

Unit	Symbol	Powers of 2	Decimal
Kilobyte	1KB		
Megabyte	1MB		
Gigabyte	1GB		
Terabyte	1TB		
Petabyte	1PB		

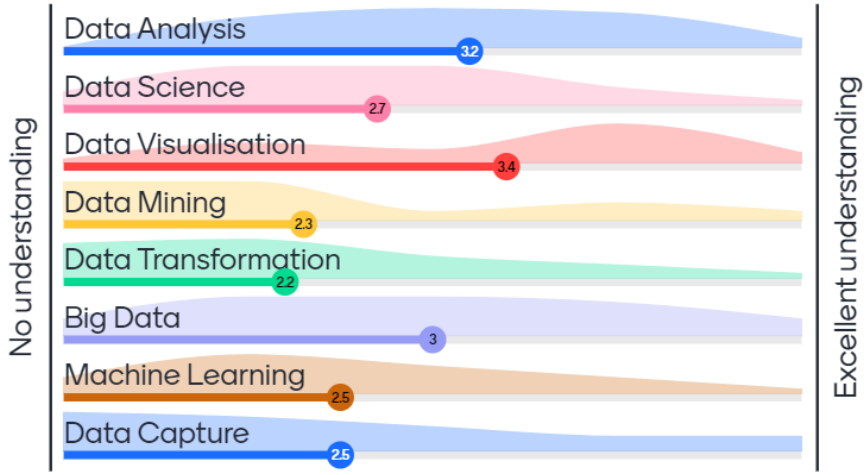
Q. How many bytes would it take to store your name?

200 years in 4 minutes

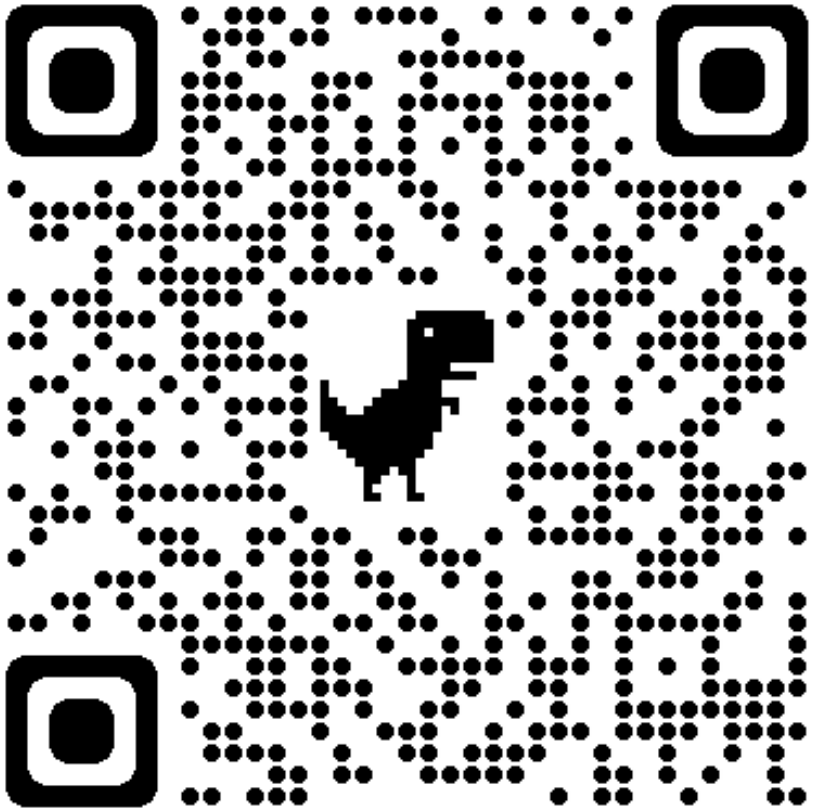
https://youtu.be/Z8t4k0Q8e8Y

Reflection

Assess your own knowledge/skill in relation to the following Data Science terminology:



Quizlet Activity (data science terminology)



https://quizlet.com/762045425/match

Data Science … Analysis … Big Data

Data Science is an interdisciplinary field that uses scientific methods, processes, algorithms and systems to extract knowledge and insights from data in various forms, both structured and unstructured, similar to data mining.

Data Analysis is a process of inspecting, cleansing, transforming, and modelling data with the goal of discovering useful information, informing conclusions, and supporting decision-making

Big Data is extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions.

Data Mining is the practice of examining large pre-existing databases in order to generate new information.

Machine Learning is a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention.

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Introducing ALT2

LEAVING CERTIFICATE
COMPUTER SCIENCE

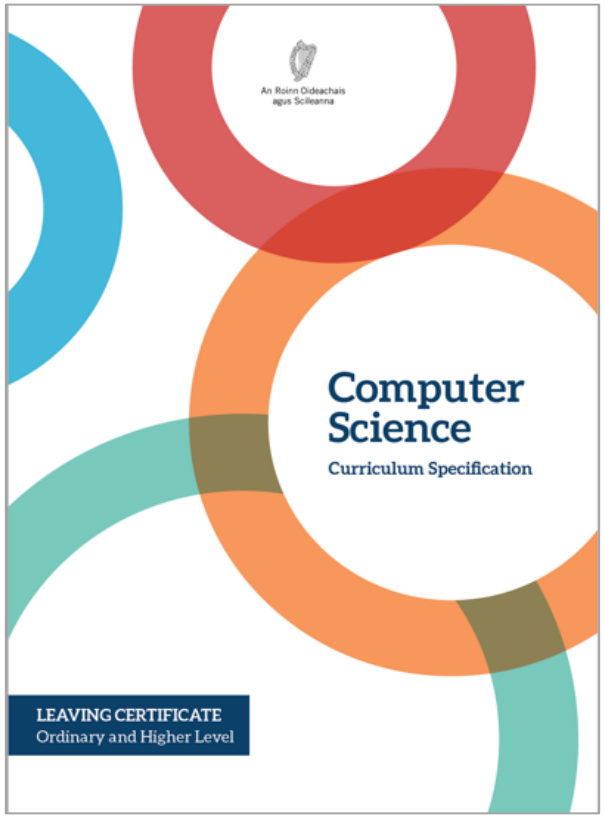
Context

Strand 1: Practices and principles	Strand 2: Core concepts	Strand 3: Computer science in practice
▸ Computers and society ▸ Computational thinking ▸ Design and development	▸ Abstraction ▸ Algorithms ▸ Computer systems ▸ Data ▸ Evaluation/Testing	▸ Applied learning task 1 - Interactive information systems ▸ Applied learning task 2 - Analytics ▸ Applied learning task 3 - Modelling and simulation ▸ Applied learning task 4 - Embedded systems

Applied Learning Tasks (ALTs)

‘Each of which results in the creation of a real or virtual computational artefact and a report.’

‘Where possible, the artefacts should be beneficial to the community and society in general.’



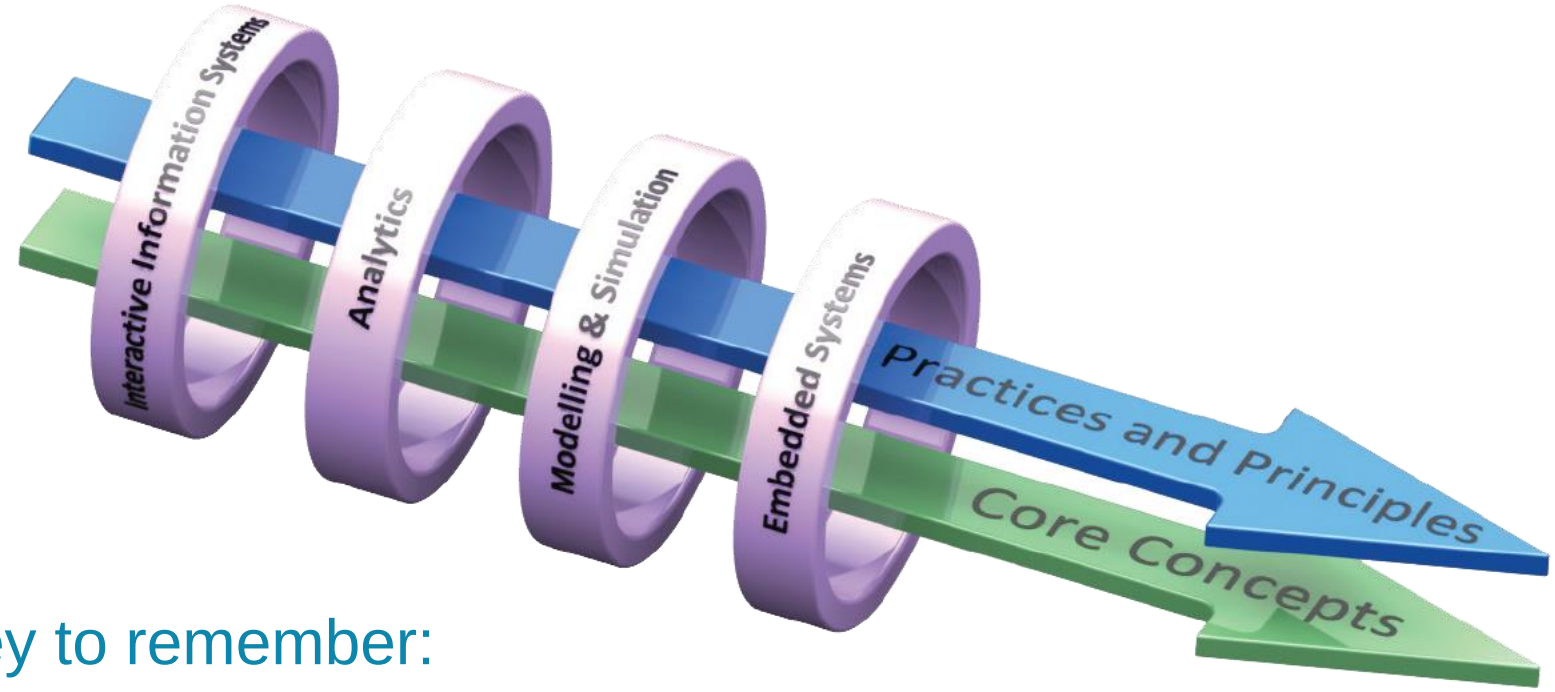
‘These artefacts should relate to the students’ lives and interests.’

‘Examples of computational artefacts include programs, games, web pages, simulations, visualisations, digital animations, robotic systems, and apps.’

'Students work in teams to carry out four applied learning tasks over the duration of the course.'

LCCS Interwoven

The four applied learning tasks explore the four following contexts:



1 - Interactive information systems
2 - Analytics
3 - Modelling and simulation
4 - Embedded systems.

Key to remember:

Explore and teach the LOs through the lens of ALTs.

Applied Learning Task 2: Analytics

“Hypothesising, making predictions, examining evidence, recognising patterns and reaching conclusions are at the heart of computer science”

“Students will identify an interdisciplinary topic, develop a hypothesis and utilise existing resources to highlight the salient information and inform future decisions”

“By identifying, analysing, and deconstructing a problem, students will deepen their understanding of the practices and principles of computer science”

LCCS Specification: p22

Hypothesising

Hypothesis originates from the Greek work hupo (under) and thesis (placing).

It means an idea made from limited evidence.

It is a starting point for further investigation.

ALT2 Learning Outcomes

3.4. Develop algorithms that can find the frequency, mean, median and mode of a data set.

3.5. Structure and transform **raw** data to prepare it for analysis.

3.6. Represent data to effectively communicate in a graphical form.

3.7. Use algorithms to analyse and interpret data in a way that informs decision-making.

Reflection: Considering ALT2

1. What prior knowledge will students have that is relevant to ALT2?

2. What may challenge students in dealing with ALT2?

3. What approach could you take to introduce ALT2 to your students and support their progress?

Record your answers in your participant booklet.

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

ALT2 Investigate

LEAVING CERTIFICATE
COMPUTER SCIENCE

Considering the Data Science Arc

ASK – The Question that starts the journey

PREPARE – Sketch out, think through ideas to organise work.

GET DATA – Collect, enter, reuse or repurpose.

CLEAN – Format, layout, organise.

ANALYSE – Format, layout, organise, sort, filter, summarize, triangulate.

VISUALISE – Format charts, tables, add logos, branding, colours.

REVIEW – Gather feedback, find errors, check interpretations.

PUBLISH – Secure and share within or outside the team.

Considering the Data Science Arc

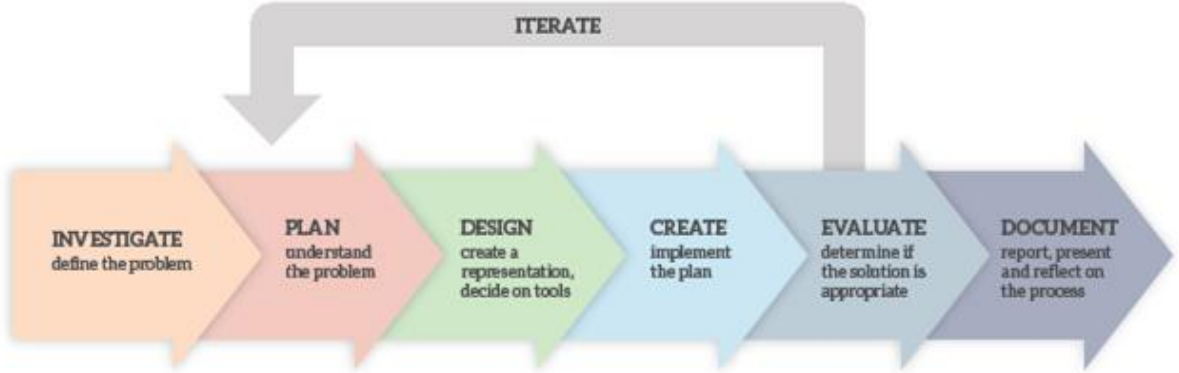


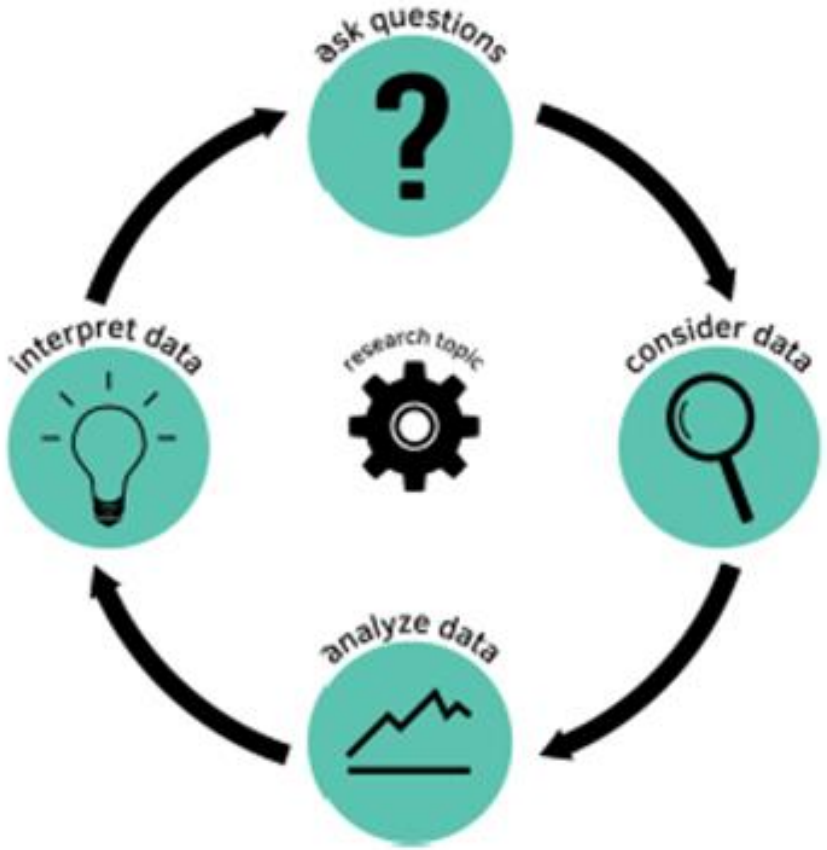
Figure 3: Overview of a design process

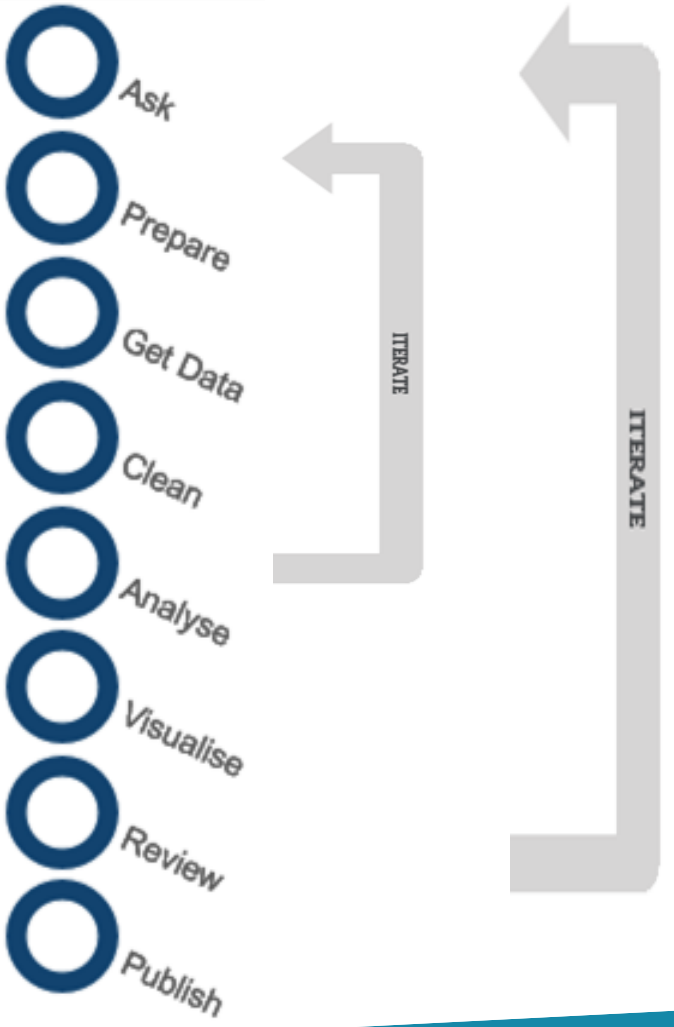
What is data cleansing?

The data set below shows the raw data collected from the result of a 100m school race.

Surname	Gender	Age	Time
Murphy	M	17	13,12
Ogene	M	16	12.14
Ogene	M	16	12.14
Mc Intyre	F.	17	12.87
Lopez	F	-18	14.01
	F	17	1 329
McCarthy	M	77	13.65
Ó Brádaigh	f	16	13.09

The data cycle - an alternative framework





Why use ready-made datasets?

Curated

Differentiation

Scaffolding

Authentic

Students should be able to:	
3.4	develop algorithms that can find the frequency, mean, median and mode of a data set
3.5	structure and transform **raw** data to prepare it for analysis
3.6	represent data to effectively communicate in a graphical form
3.7	use algorithms to analyse and interpret data in a way that informs decision-making

Data Science Supports

Agriculture Section of CSO Website: https://www.cso.ie/en/statistics/agriculture/

Our World in Data: https://ourworldindata.org/population-growth

IBM Data Science Community: https://community.ibm.com/community/user/datascience/home

Open Data Science: https://ods.ai/

Data Science Central: https://www.datasciencecentral.com/

Driven Data: https://www.drivendata.org/

Central Statistics Office: https://data.gov.ie/organization/central-statistics-office

Census at School: https://censusatschool.ie/

Kaggle: https://www.kaggle.com/

A data science resource

Searchable repository of user-generated datasets

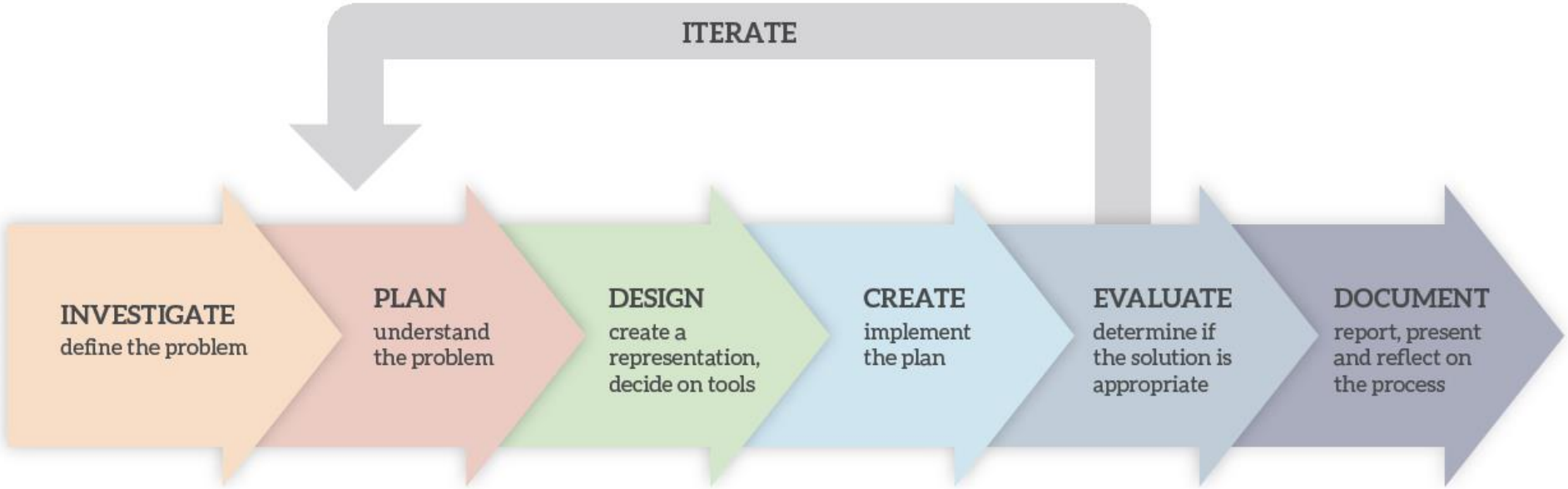
Detailed and user-friendly search function

Free courses on Python, Machine Learning, Pandas, SQL, etc.

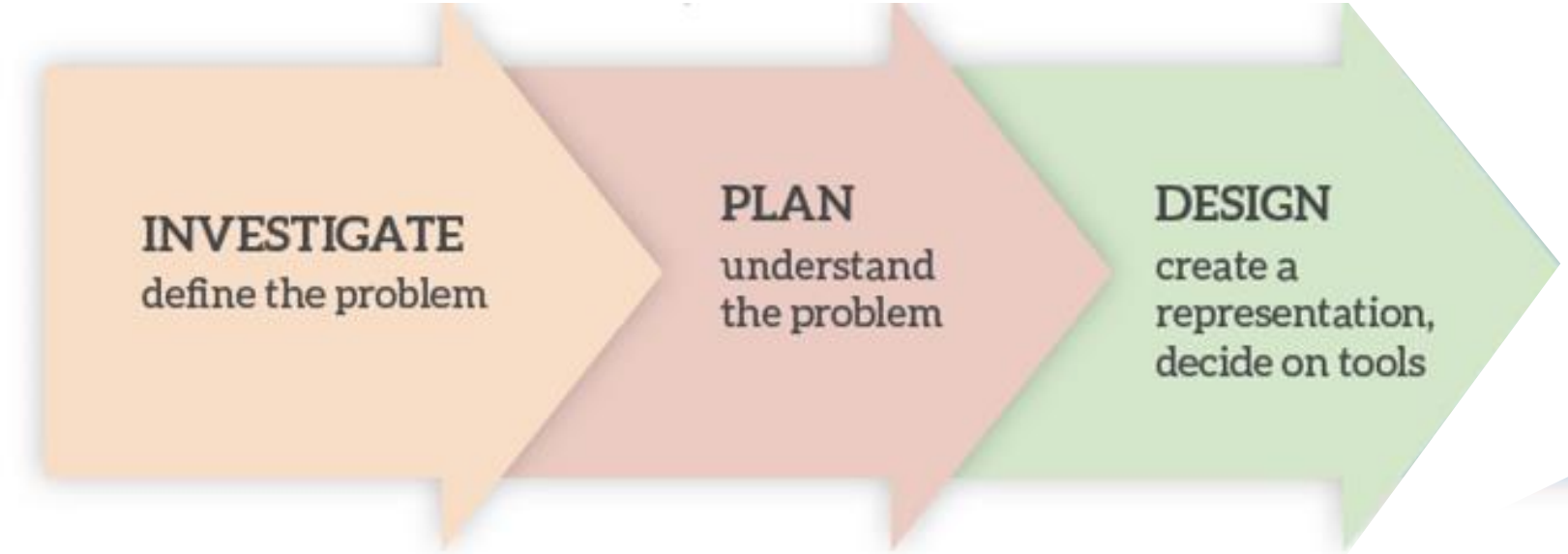
kaggle

Group Activity

The Design Process



Focus of today's workshop



Focus of this morning's workshop

Group Activity: ALT 2 - Investigate

In your groups, brainstorm possible hypotheses for your dataset.

Aim for as many ideas as you can.

Group activity: ALT 2 - Investigate

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

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Session 5: ALT2 Plan and Design

LEAVING CERTIFICATE COMPUTER SCIENCE

Overview of the session

Part 1	ALT2 Plan
Part 2	Feedback
Part 3	ALT2 Design

Oide

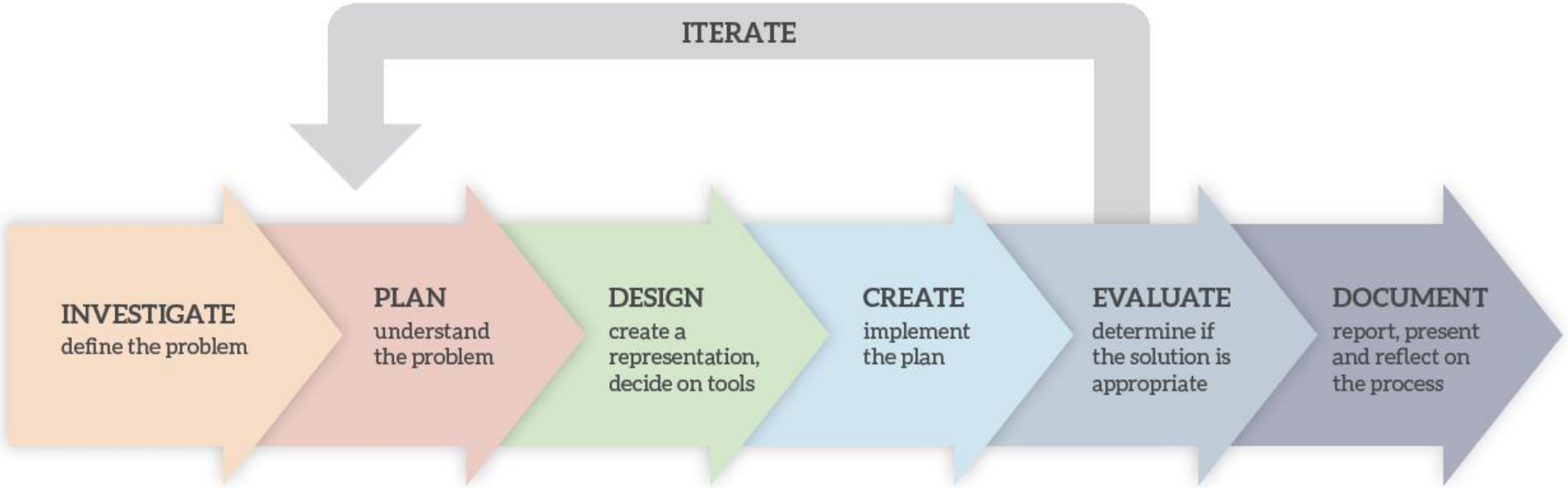
Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

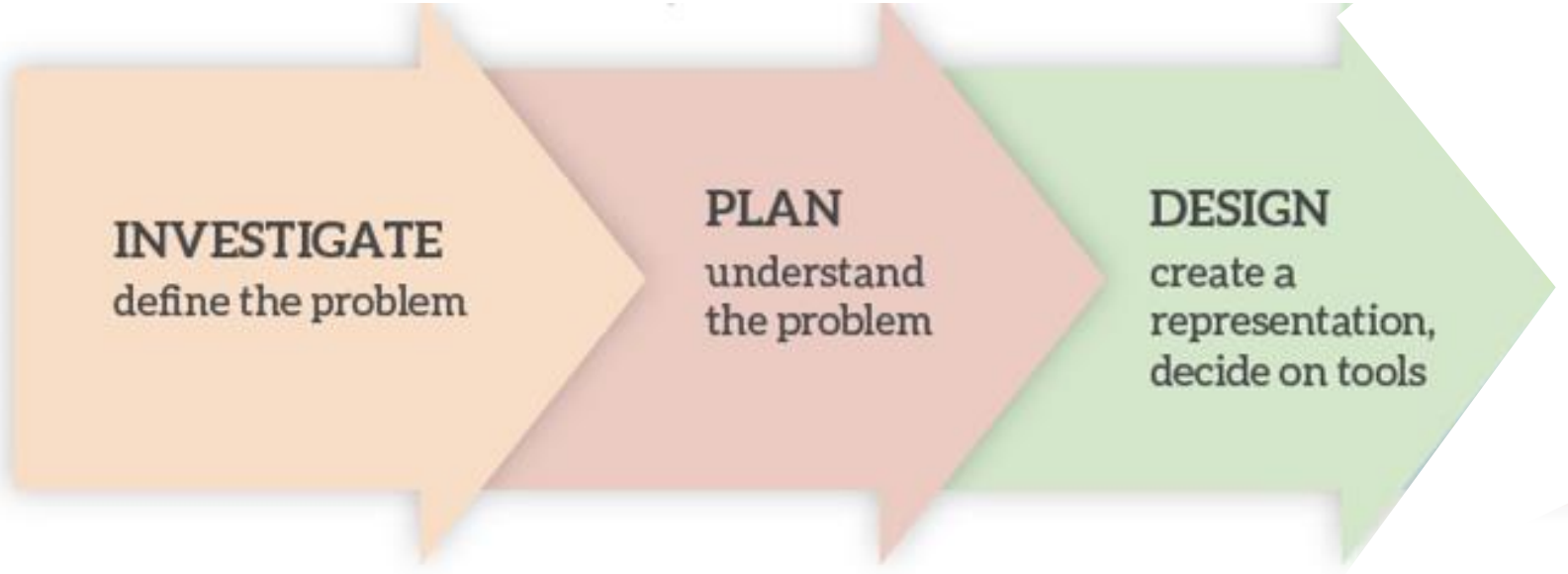
Supporting the Professional Learning of School Leaders and Teachers

ALT2: Plan

LEAVING CERTIFICATE COMPUTER SCIENCE

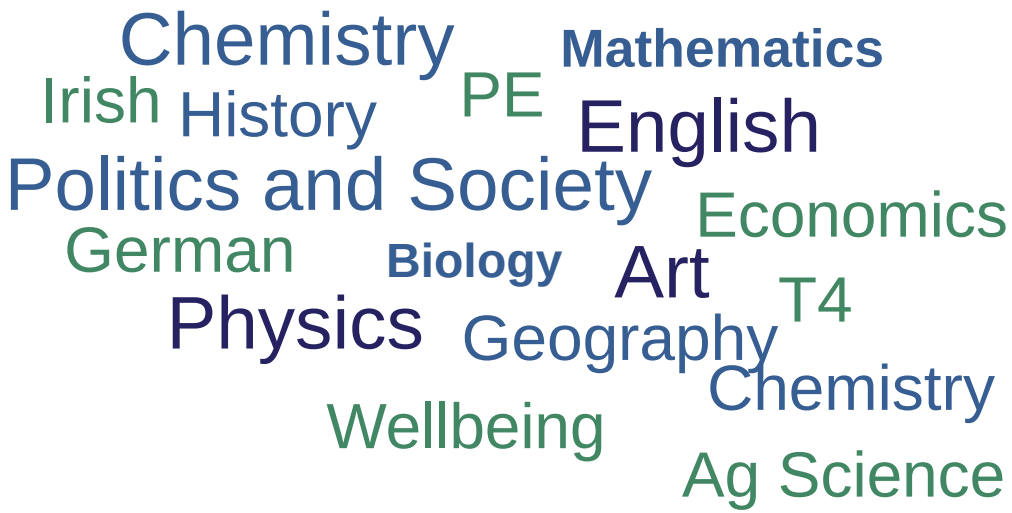
The Design Process




INVESTIGATE
define the problem
PLAN
understand
the problem
DESIGN
create a
representation,
decide on tools

Plan

The interdisciplinary nature of data (LC)



Group Activity: ALT 2 - Plan

Choose one hypothesis and consider the following prompts:

What does your project do/not do?

Aims? Any limitations?

Who are the end users?

What are the tools/materials required?

What are the roles and responsibilities?

Does your project cover all the LOs for this ALT?

Are there any ethical issues?

20 minutes

Feedback

Oide

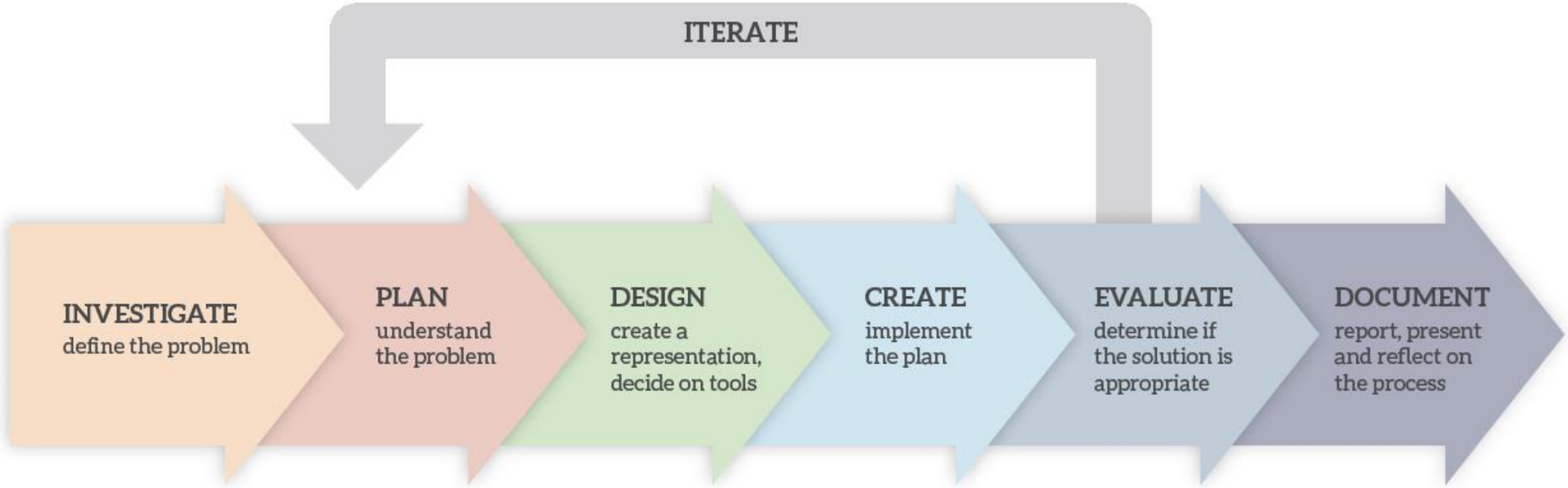
Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

ALT2: Design

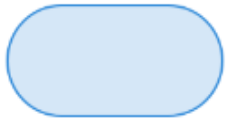
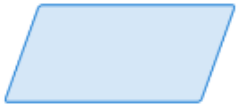
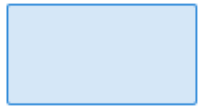
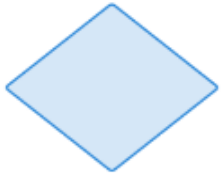
LEAVING CERTIFICATE COMPUTER SCIENCE

The Design Process

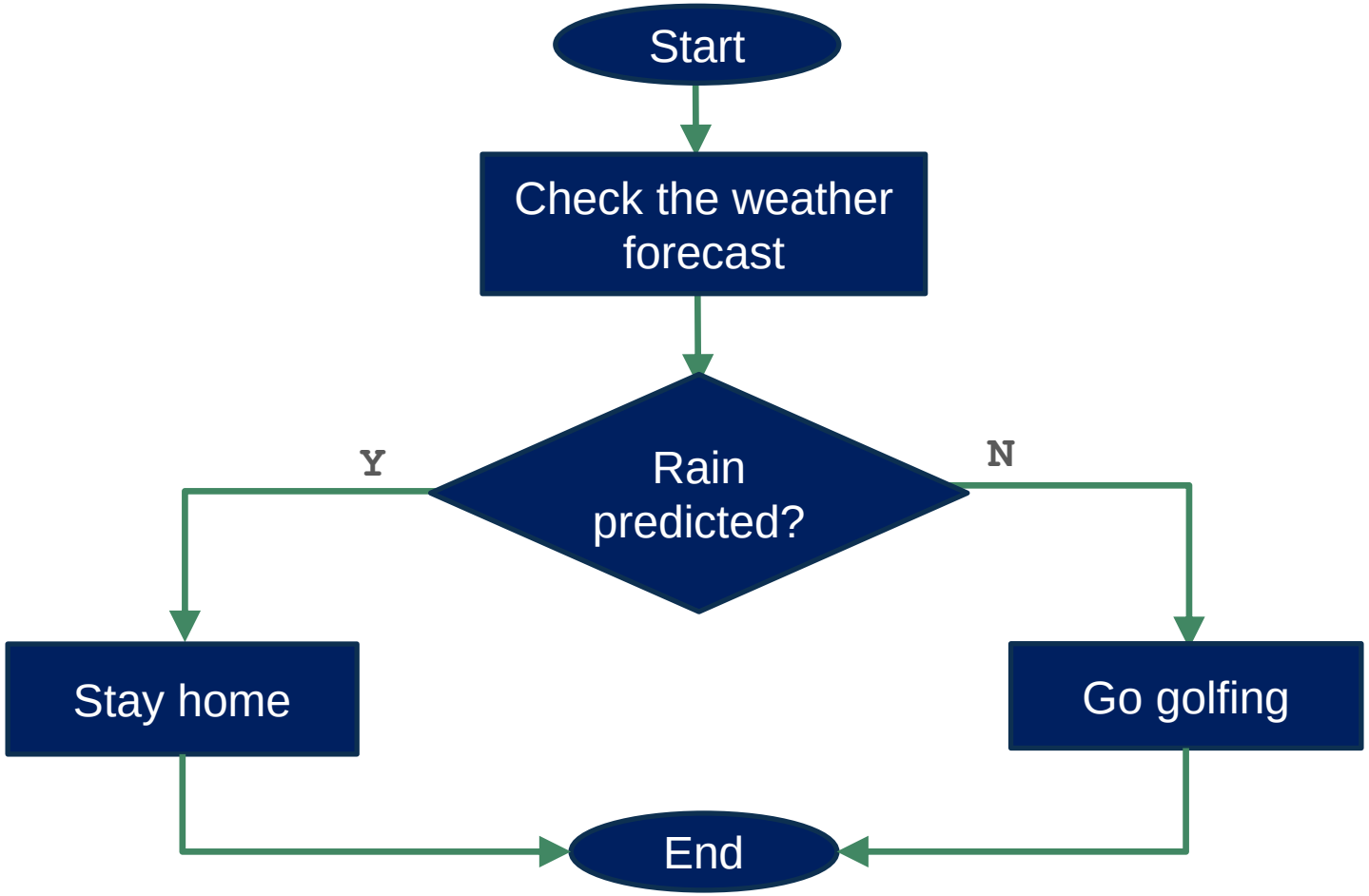


Design

Flowcharts

Symbol	Name	Function
	Start/End	An oval represents a start or end point
	Arrows	A line is a connector that shows relationships between the representative shapes
	Input/ Output	A parallelogram represents input or output
	Process	A rectangle represents a process
	Decision	A diamond indicates a decision

Flowchart: Should I play golf?



Pseudocode

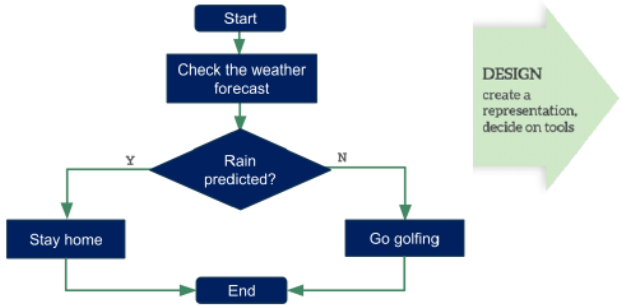
```
program start
check weather forecast

if rain predicted
        Stay home
else
        Go golfing
end if
program end
```

```
check weather forecast

if rain predicted
        Stay home
else
        Go golfing
end if
```

Group Activity: ALT 2 - Design

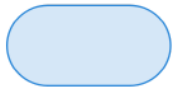
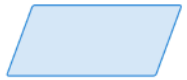
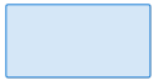
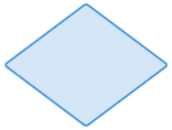
Pseudo-code

```
program start
check weather forecast

if rain predicted
    Stay home
else
    Go golfing
end if

program end
```



DESIGN
create a representation, decide on tools

Flowcharts

Symbol	Name	Function
	Start/End	An oval represents a start or end point
	Arrows	A line is a connector that shows relationships between the representative shapes
	Input/ Output	A parallelogram represents input or output
	Process	A rectangle represents a process
	Decision	A diamond indicates a decision

30 minutes

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Session 6: Python Libraries, NCCA examples and Curriculum Planning

LEAVING CERTIFICATE COMPUTER SCIENCE

Overview of the session

Part 1	Python libraries
Part 2	NCCA examples
Part 3	Curriculum planning

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

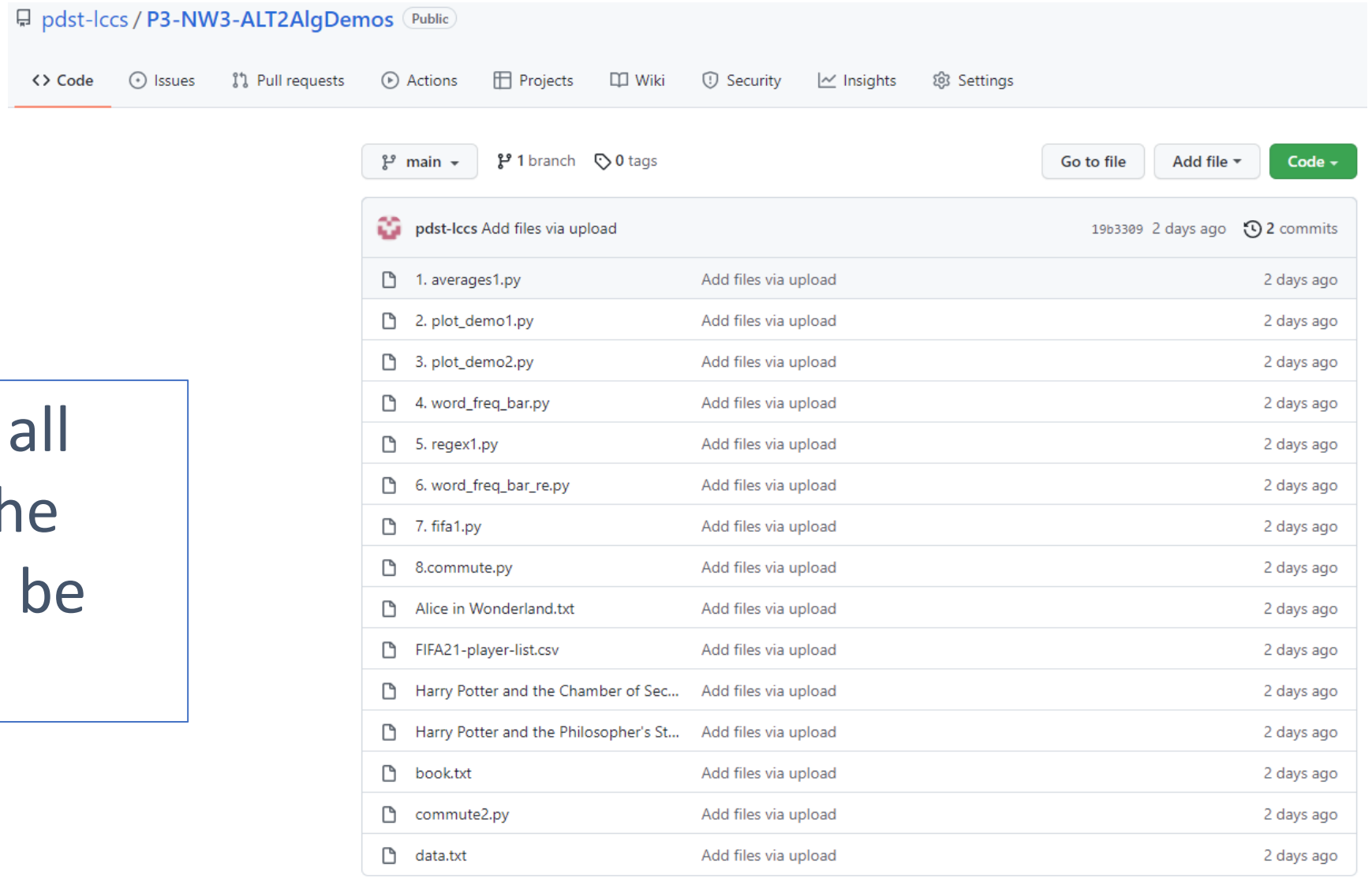
Supporting the Professional Learning of School Leaders and Teachers

Python Libraries for ALT2

LEAVING CERTIFICATE COMPUTER SCIENCE

Github

The source code for all the files shown on the upcoming slides can be found on GitHub



https://github.com/pdst-lccs/P3-NW3-ALT2AlgDemos

Measures of Central Tendency

Oide

```
# A simple program to calculate and display averages
from statistics import *

# Initialise a list of values
values = [2,3,5,2,4]

# Compute the 3 averages
arithmetic_mean = mean(values)
median_value = median(values)
modal_value = mode(values)

# Display the answers
print("The mean is ", arithmetic_mean)
print("The median and mode are %d and %d" %(median_value, modal_value))
```

When the program is run the output looks like this:

```
The mean is  3.2
The median and mode are 3 and 2
>>>
```

Measures of Central Tendency

Oide

Averages and measures of central location

These functions calculate an average or typical value from a population or sample.

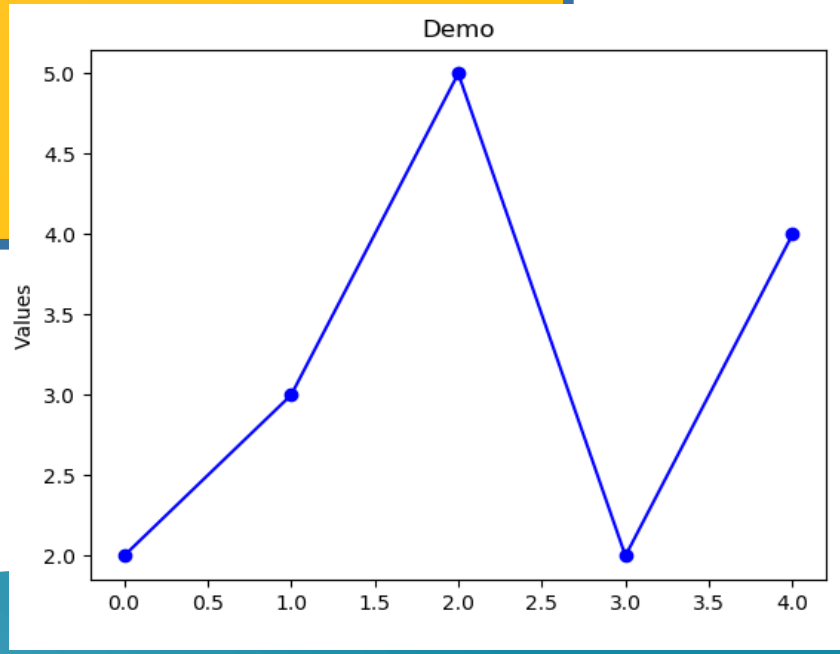
`mean()`	Arithmetic mean ("average") of data.
`fmean()`	Fast, floating point arithmetic mean.
`geometric_mean()`	Geometric mean of data.
`harmonic_mean()`	Harmonic mean of data.
`median()`	Median (middle value) of data.
`median_low()`	Low median of data.
`median_high()`	High median of data.
`median_grouped()`	Median, or 50th percentile, of grouped data.
`mode()`	Single mode (most common value) of discrete or nominal data.
`multimode()`	List of modes (most common values) of discrete or nomimal data.
`quantiles()`	Divide data into intervals with equal probability.

https://docs.python.org/3/library/statistics.html

Demonstration of matplotlib

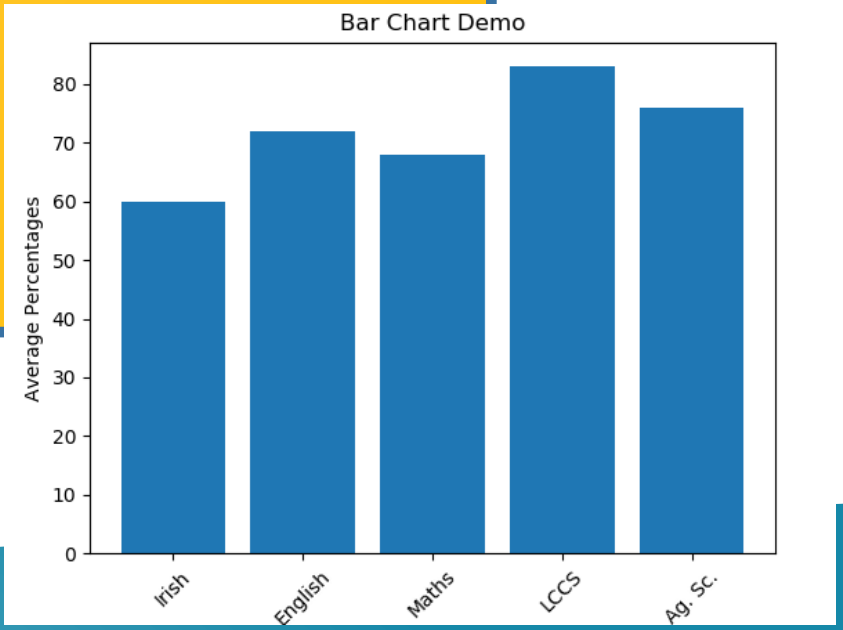
Oide

```
# A simple program to demonstrate use of matplotlib
from matplotlib import pyplot as plt

# Initialise a list of values
values = [2,3,5,2,4]

# Intervals for the x-axis
x_axis = [0, 1, 2, 3, 4]

plt.plot(x_axis, values, color='blue', linestyle='solid', marker='o')

plt.title("Demo") # graph title
plt.ylabel("Values") # label the y-axis
plt.show() # Display the plot
```



Demonstration of matplotlib


```
# A simple program to demonstrate use of matplotlib
from matplotlib import pyplot as plt

# Initialise a list of subjects
subjects = ['Irish', 'English', 'Maths', 'LCCS', 'Ag. Sc.']

percentages = [60, 72, 68, 83, 76] # Average percentages

# Plot a bar chart
plt.bar(subjects, percentages)

plt.title("Bar Chart Demo") # graph title
plt.ylabel("Average Percentages") # label the y-axis
# put the names of the subjects on the x-axis
plt.xticks(range(len(subjects)), subjects, rotation=45)

plt.show() # Display the plot
```



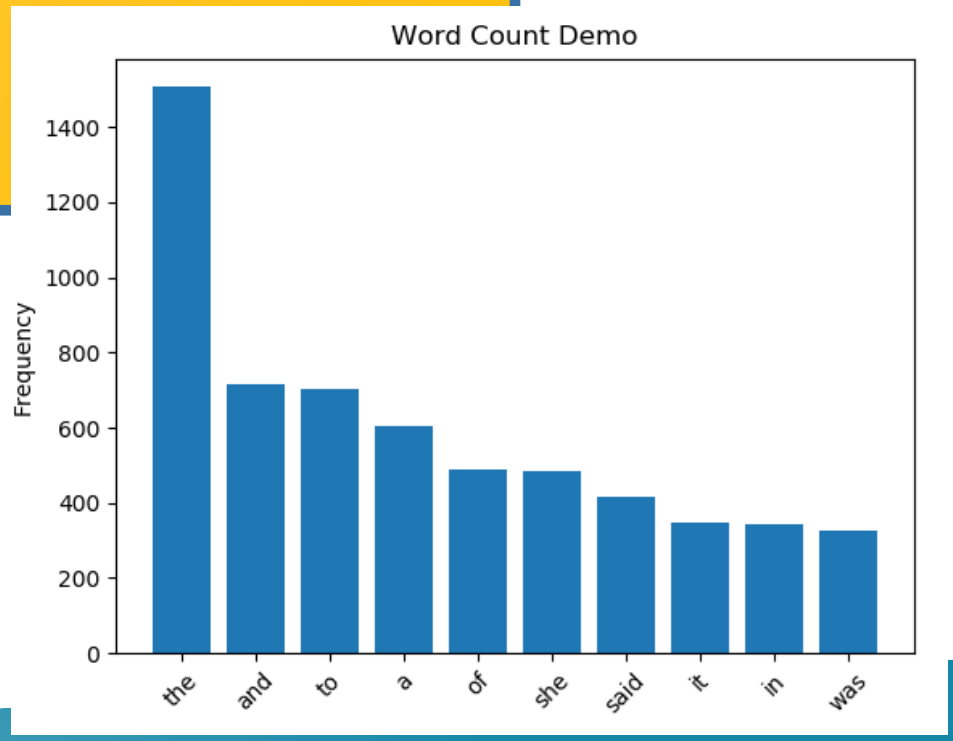
Text Analysis – word frequency


```
# A program to visualise the most common words in a file
from matplotlib import pyplot as plt
from collections import Counter

# IMPORTANT: Make sure book.txt exists in runtime directory
bookFile = open("book.txt","r") # Open the file
text = bookFile.read() # read the file
bookFile.close() # close the file
text_list = text.split() # create a list

# use counter to return the most common words
# format is .... [('the', 1507), ('and', 714), etc
most_common_words = Counter(text_list).most_common(10)

words = [] # an empty list of words
word_count = [] # an empty list of counts

# Build up the lists
for word, count in most_common_words:
    words.append(word) # append the word to the words list
    word_count.append(count)

# Now create and display the chart ….
```

Text Analysis – word frequency

… continued from previous slide

```
# Now create and display the chart ….

# Create the chart
plt.bar(words, word_count)
plt.title("Word Count Demo") # graph title
plt.ylabel("Frequency") # label the y-axis
# put the words on the x-axis
plt.xticks(range(len(words)), words, rotation=45)
plt.show() # display the chart
```



Regular Expressions

Oide

A language that enables us to look for patterns in strings

```
import re

text1 = "THERE are 99 RED balloons"
print(re.sub('[0-9]', '', text1)) # remove digits
print(re.sub('[A-Z]', '', text1)) # remove uppercase
print(re.sub('[A-Z0-9]', '', text1)) # remove uppercase and digits
print(re.sub('[^a-z]', '', text1)) # leave lowercase
print(re.sub('[^a-zA-Z ]', '', text1)) # leave letters and spaces
print(re.sub('[^a-zA-Z0-9]', ' ', text1)) # leave letters and digits
print(re.sub(r'\b\w{1,4}\b', '', text1)) # remove words of length 1-3

text1 = "$%**$%joe*&$%^&"
print(re.sub('[^a-zA-Z0-9]', '', text1))
```

Output

```
THERE are RED balloons
 are 99 balloons
 are balloons
areballoons
THERE are  RED balloons
THERE are 99 RED
balloons
THERE balloons
```

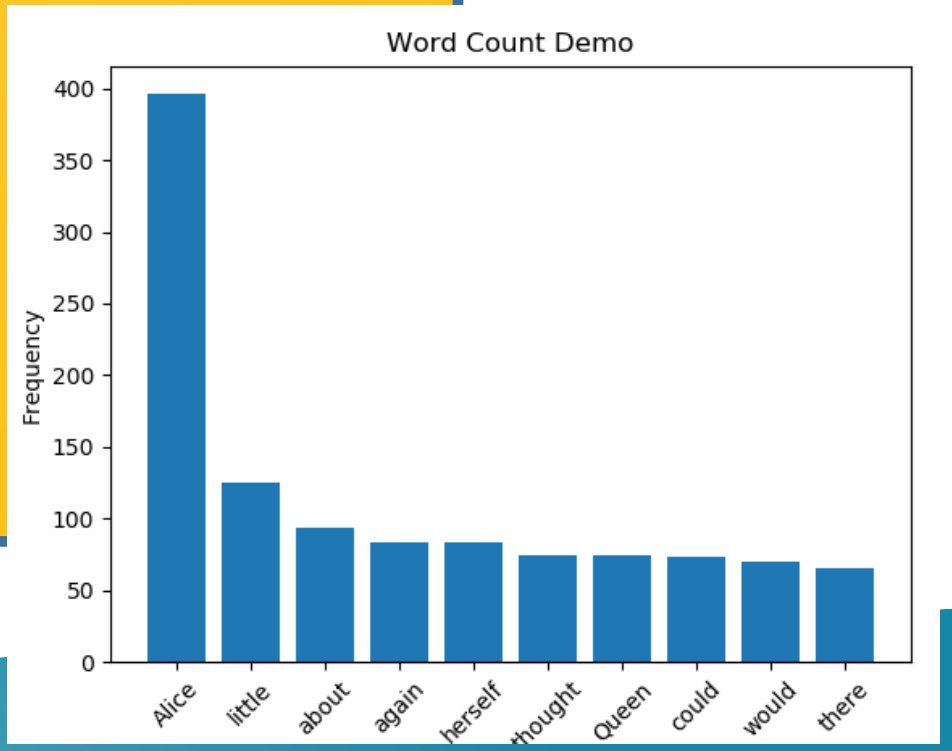
Text Analysis – word frequency

Oide

Eliminate words of three letters or less … use Regular Expressions

```
# A program to visualise the most common words in a file
from matplotlib import pyplot as plt
from collections import Counter
import re

# IMPORTANT: Make sure book.txt exists in runtime directory
bookFile = open("book.txt","r") # Open the file
text = bookFile.read() # read the file
bookFile.close() # close the file

text = re.sub('[^a-zA-Z0-9 \n]', ' ', text)
text = re.sub(r'\b\w{1,4}\b', '', text)

text_list = text.split() # create a list

# Continue as before …
```

What do you think is the most common word in Alice in Wonderland (longer than 3 letters)?



Import the `re` library

Use the `sub` method

Pandas

Oide

Useful for very large files … this file was sourced on Kaggle

1	short_name	age	dob	height_cm	weight_kg	nationalit	club_nam	value_eur	wage_eur	player_po	preferred_
2	L. Messi	33	24/06/1987	170	72	Argentina	FC Barcelc	67500000	560000	RW, ST, CF	Left
3	Cristiano Ronaldo	35	05/02/1985	187	83	Portugal	Juventus	46000000	220000	ST, LW	Right
4	J. Oblak	27	07/01/1993	188	87	Slovenia	AtlÃ©ticc	75000000	125000	GK	Right
5	R. Lewandowski	31	21/08/1988	184	80	Poland	FC Bayern	80000000	240000	ST	Right
6	Neymar Jr	28	05/02/1992	175	68	Brazil	Paris Saint	90000000	270000	LW, CAM	Right
7	K. De Bruyne	29	28/06/1991	181	70	Belgium	Manchest	87000000	370000	CAM, CM	Right

… …

18911	C. Pizarro	20	18/09/1999	176	70	Chile	UniÃ³n La	45000	500	CB	Right
18912	Shan Huanhuan	21	24/01/1999	185	70	China PR	Dalian YiF	50000	2000	ST	Right
18913	R. Dinanga	18	06/12/2001	182	73	Republic c	Cork City	45000	500	ST	Right
18914	J. Browne	19	10/09/2000	180	73	Republic c	Finn Harps	45000	500	ST	Right
18915	P. McGarvey	16	02/08/2003	180	76	Republic c	Finn Harps	30000	500	GK	Right
18916	Xie Xiaofan	22	15/03/1998	177	75	China PR	Jiangsu Su	45000	2000	CM	Right
18917	Wang Haijian	19	02/08/2000	185	67	China PR	Shanghai (	45000	1000	CM	Right
18918	A. Cetiner	18	20/07/2001	175	70	Republic c	Shelbourr	40000	500	CM	Right
18919	Huang Jiahui	19	07/10/2000	186	74	China PR	Dalian YiF	40000	1000	CB	Right
18920	A. Phelan	19	20/06/2001	176	72	Republic c	Waterforc	40000	500	CM	Right
18921	J. Akintunde	24	29/03/1996	175	75	England	Derry City	40000	550	ST	Right

Let’s explore the player’s value

Pandas

```
# Using pandas - recommended for larger files
import statistics
import pandas

# Read the entire CSV file into a pandas DataFrame
df = pandas.read_csv('FIFA21-player-list.csv')

# Filter out the column, value_eur
player_values = df['value_eur']

# Compute and display the mean
mean_value = round(statistics.mean(player_values), 2)
print("Mean Value:", mean_value)

# Compute and display the median
median_value = statistics.median(player_values)
print("Median Value:", median_value)

# Compute and display the min and max values
print("Min: €%f, Max: €%f" %(min(player_values),max(player_values)))
```

Output looks like this:

```
Mean Value: 2224813.29
Median Value: 650000.0
Min: €0.000000, Max: €105500000.000000
```

Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

NCCA Examples

LEAVING CERTIFICATE
COMPUTER SCIENCE

Demonstration of Samples

Oide

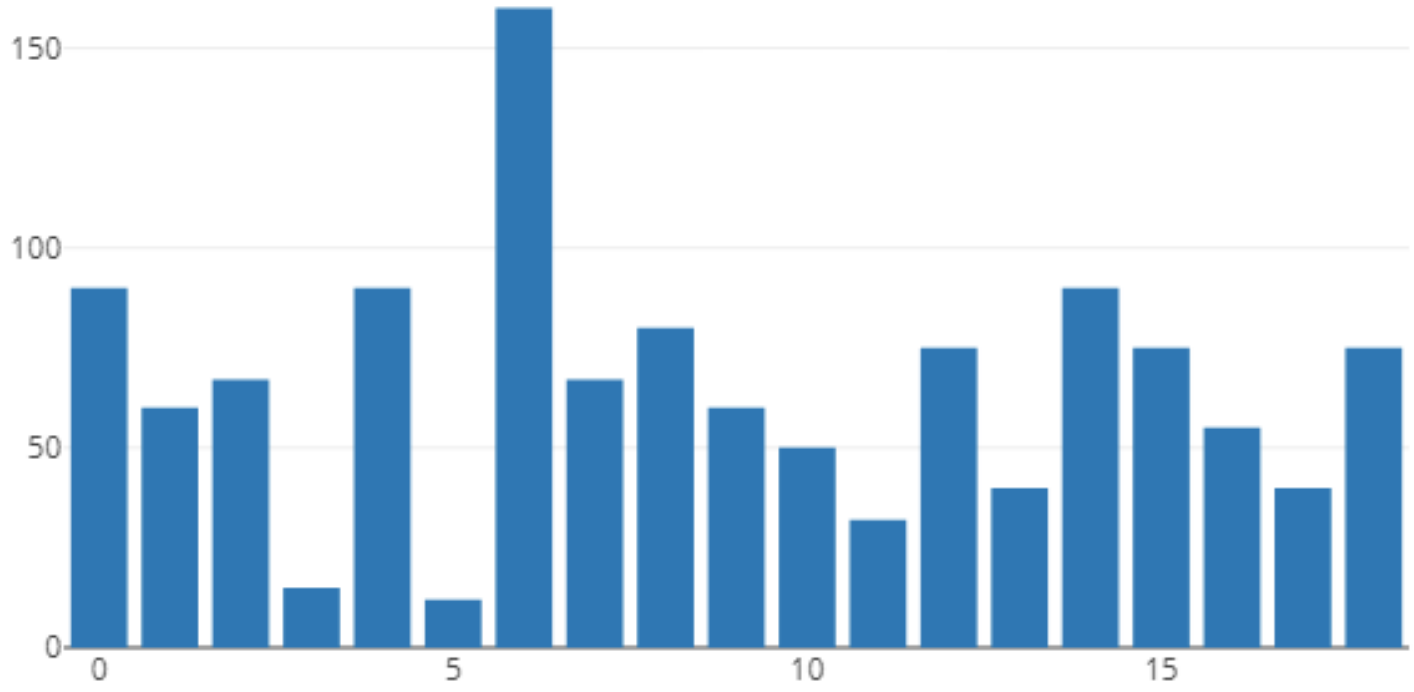
Commute Times

“Our topic is travel times, our data source are the other groups working and our hypothesis is that the average travel time will be 50 minutes and no one will have travelled for longer than 2 hours.”

data.txt - Notepad

File Edit Format View Help

```
90
 60
 67 minutes
 15
 90
 12 minutes
 160
 67 minutes
 80
 60 minutes
 50
 32
 32
 32
 32
 75
 40 minutes
 90 minutes
 75 minutes
 55 minutes
 40
 75 minutes
```



```
# Sample ALT2 - Commute times
import statistics
import re
import plotly.plotly
from plotly.graph_objs import Bar, Layout

# Open and read the data file
file = open("data.txt","r")
string = file.read()
file.close()

# Scrub the data
clean_string = re.sub(' minutes', '', string)
clean_string = re.sub(' ', '', clean_string)
string_array = clean_string.split('\n')

# Convert all the strings to integers
int_array = [int(i) for i in string_array]

# Determine and display the averages
mean_value = statistics.mean(int_array)
median_value = statistics.median_grouped(int_array, 1)
mode_value = statistics.mode(int_array)
print("Mean: %.2f, Median %d, Mode %d" %(mean_value, median_value, mode_value))

plotly.offline.plot({"data": [Bar(y=int_array)],
    "layout": Layout(title="word count")
})
```

Oide

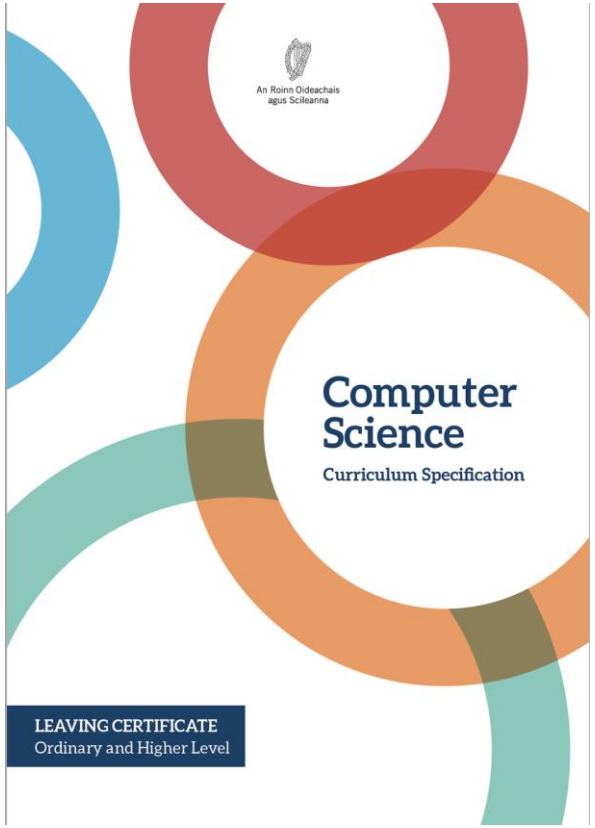
Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Curriculum Planning

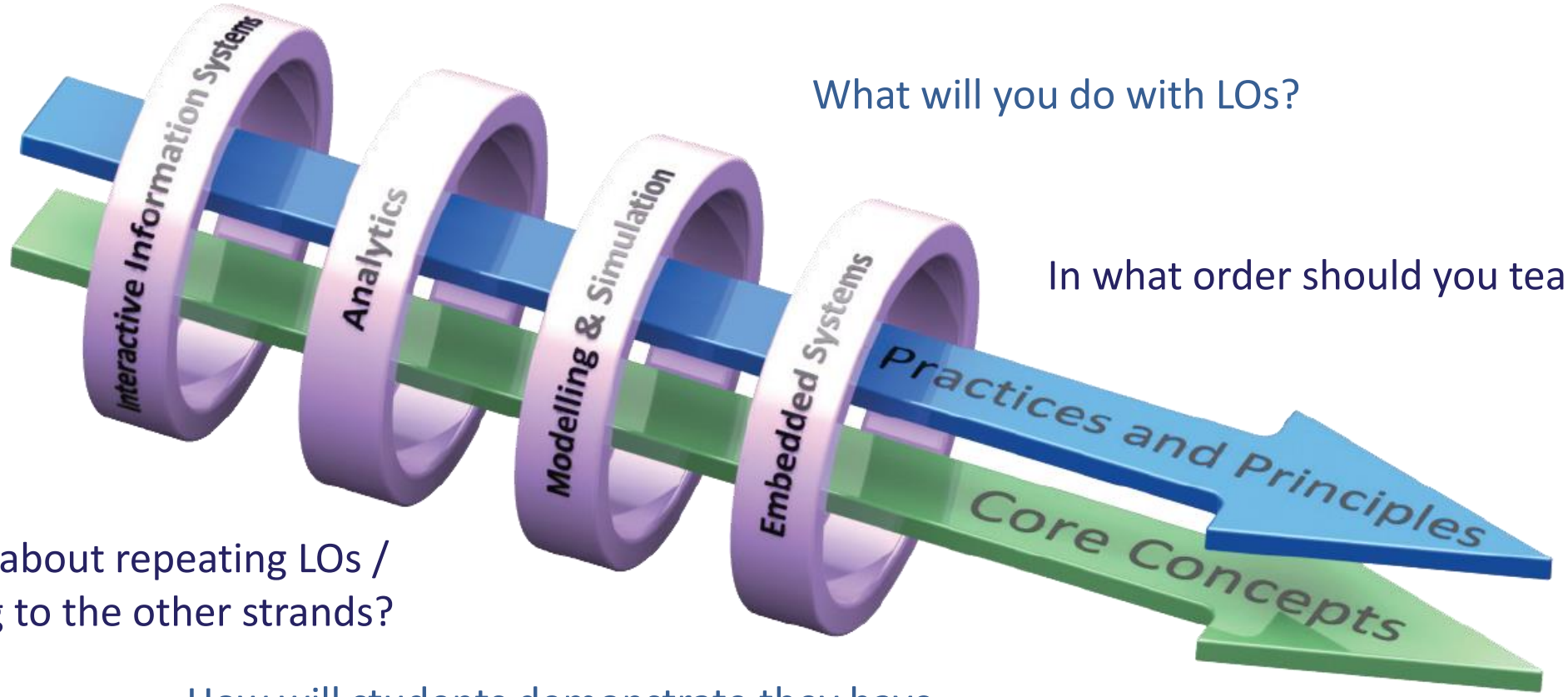
LEAVING CERTIFICATE
COMPUTER SCIENCE

Curriculum planning



*'Learning outcomes can best be defined as statements of what a learner **knows**, **understands** and is **able to do** after completion of learning.'*

Curriculum planning



What will you do with LOs?

In what order should you teach them?

What about repeating LOs / linking to the other strands?

How will students demonstrate they have achieved the LOs?

What content or resources do you need?

Key message to remember:

Explore and teach the LOs through the lens of ALTs.

There are several ways to achieve this

Group Activity

Develop a curriculum plan for January to April

Focus on ALT2

Group activity - instructions

Discuss your next steps in relation to curriculum planning.

Focus on ALT 2. Remember to teach the LOs through the lens of the ALTs - there are numerous ways to achieve this.

Consider topics, LOs, build up to ALT2, ALT2, equipment, resources, assessment, differentiation, etc.

What will you do with the LOs for ALT2?

In what order should you teach them?

What about repeating LOs / linking to the other strands?

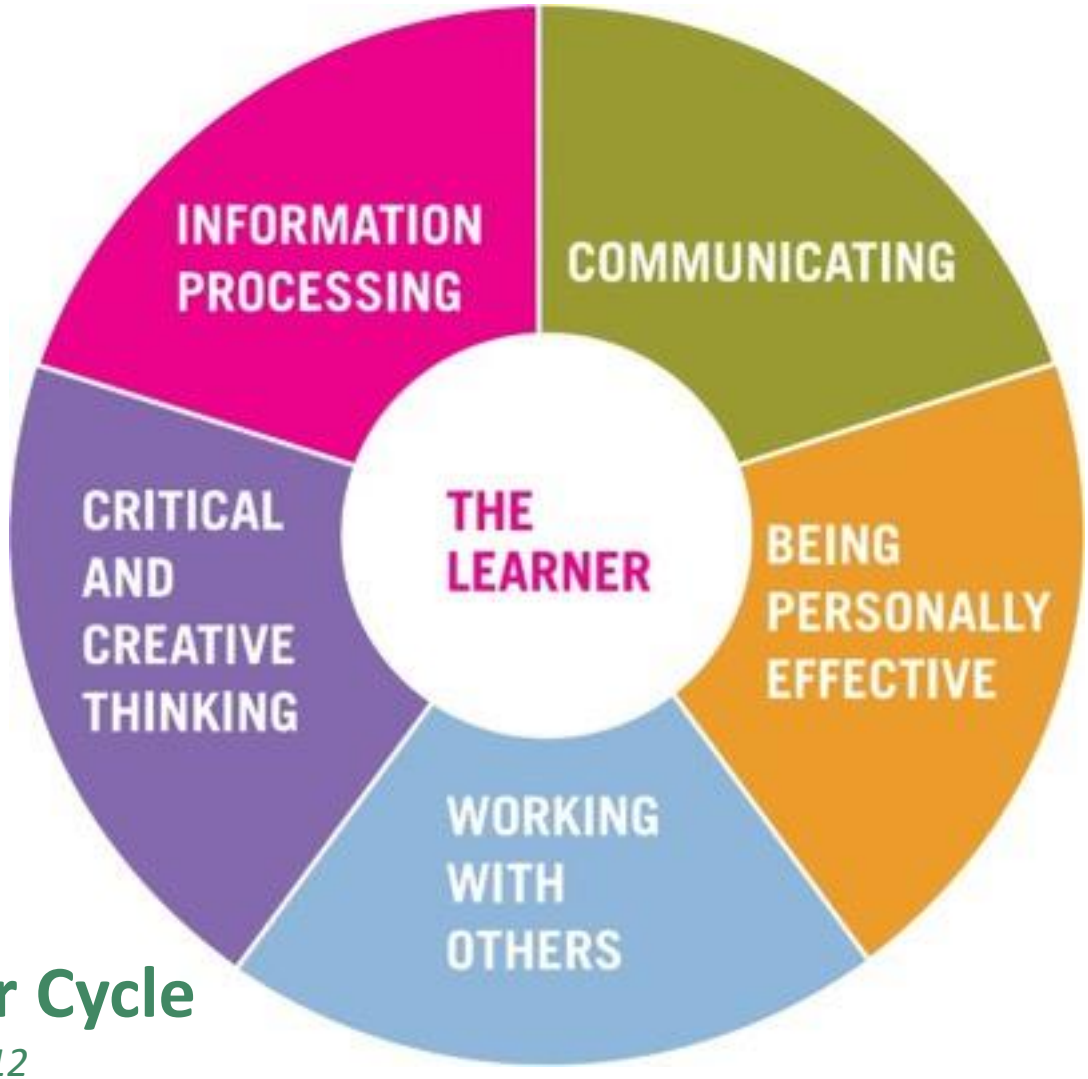
How will students demonstrate they have achieved the learning outcomes?

What content or resources will you need?

What can you include for Ordinary Level students?

Are there any considerations you should make for your students with SEN?

What about differentiation and extension of tasks?



Key Skills of Senior Cycle

LCCS Specification: p12

Group activity - instructions

Discuss your next steps in relation to curriculum planning.

Focus on ALT 2. Remember to teach the LOs through the lens of the ALTs - there are numerous ways to achieve this.

Consider topics, LOs, build up to ALT2, ALT2, equipment, resources, assessment, differentiation, etc.

Feedback

Oide

An Roinn Oideachais
Department of Education