Year 10 Curriculum Overview Computer Science 2023-24

	Term 1		
Unit Title	2.1 Computational thinking	2.2 Programming techniques	2.2 Programming techniques
Approximate Number of Lessons	6	10	12
Curriculum Content	Understand the computational constructs Understand programming syntax Understand the facilities of languages and translators Understand how to break problems down	Understand syntax for logical programming Understand syntax for iteration Understand how nesting can be used	Understand different types of error Understand how to make code more maintainable Understanding string manipulation techniques
Links to prior learning	Links to programming in Year 8/9	Computational thinking methods and constructs	Previous programming techniques and Computational thinking
Cultural Capital Opportunities	Links to other uses of problem solving including real world problems	Bebras challenge Robotics trip- adastral park How tech works	Links to real world programming How tech works Solving real world problems
Assessment Focus	One 50-mark, 1 hour assessment each half term focusing on all topics up to this point		
Name of Knowledge Organiser: These can be found on Brightspace	2.1 Algorithms	2.1 Algorithms 2.2 Programming Fundamentals	2.1 Algorithms 2.2 Programming Fundamentals

Year 10 Curriculum Overview Computer Science 2023-24

	Term 2		
Unit Title	2.2 Programming techniques	2.2 Programming techniques	2.2 Programming techniques
Approximate Number of Lessons	12	4	8
Curriculum Content	Understand different data structures and why they are needed Understand how to access files and databases	Understand defensive design considerations Understand different types of error Understand how to test solutions thoroughly	Using skills learnt to solve a programming project
Links to prior learning	Previous programming techniques and Computational thinking	Previous programming techniques and Computational thinking	Previous programming techniques and Computational thinking
Cultural Capital Opportunities	Links to real world programming How tech works Solving real world problems	Links to real world programming How tech works Solving real world problems	Links to real world programming How tech works Solving real world problems
Assessment Focus	One 50 mark, 1 hour assessment each half term focusing on all topics up to this point		
Name of Knowledge Organiser: These can be found on Brightspace	2.1 Algorithms 2.2 Programming Fundamentals	2.1 Algorithms 2.2 Programming Fundamentals 2.3 Producing Robust Programs	

Year 10 Curriculum Overview Computer Science 2023-24

	Term 3				
Unit Title	Boolean Logic	Standard algorithms	Translators and the IDE	Systems architecture	Memory and storage
Approximate Number of Lessons	6	6	2	5	10
Curriculum Content ***Note: Where appropriate, lessons will also include programming tasks***	Students will study logic circuits and how data flows through them following the laws of Boolean logic.	Students will study the standard search and sort algorithms that are used widely in programs. This will include how to trace them and write them.	Students will recap how an IDE can help write and debug programs and they will also learn about different types of programming languages.	Students will learn about the CPU and how it is used with other components of a computer.	Students will learn how data is stored by computers. This will include the devices data is stored on and how each type of data can be represented in binary.
Links to prior learning	Boolean operators	Programming techniques	Programming techniques	Programming techniques	Systems architecture Programs Boolean logic Basic numeracy skills (Maths)
Cultural Capital Opportunities	Visit www.georgeboole.com Visit Computing history centre in Cambridge or the National museum of computing at Bletchley park	Play a card game (sorting the cards in your hand)	Visit Computing history centre in Cambridge Watch/ read Hidden figures	Visit Computing history centre in Cambridge or the National museum of computing at Bletchley park Watch Tron	Watch The Emoji movie, The Martian, Tron, Calculating Ada Visit Computing history centre in Cambridge or the National museum of computing at Bletchley park
Assessment Focus	One 50 mark, 1 hour assessment each half term focusing on all topics up to this point				
Name of Knowledge Organiser: These can be found on Brightspace	2.4 Boolean Logic	2.1 Algorithms 2.2 Programming Fundamentals 2.3 Producing Robust Programs	2.5 Programming languages and Integrated Development Environments (IDE)	1.1 CPU architecture, CPU performance and Embedded systems	1.2 Memory and Storage 1.2 Number representation 1.2 Units of storage and compression 1.2 Images, Text and Sounds

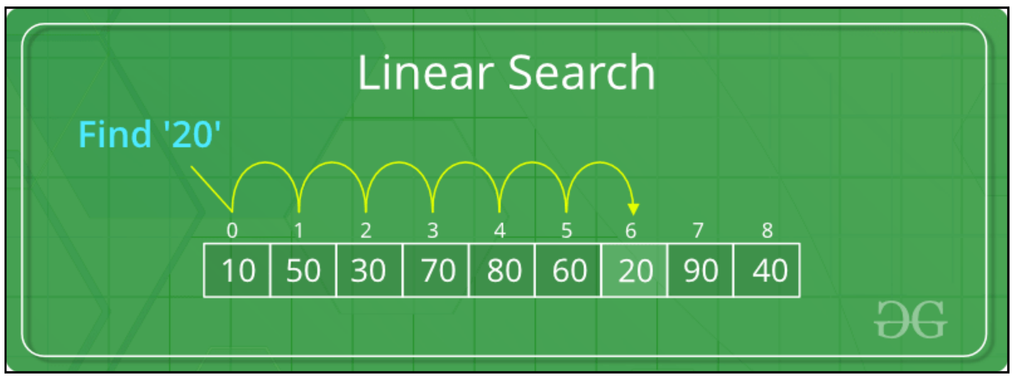
2.1 Algorithms Knowledge Organiser

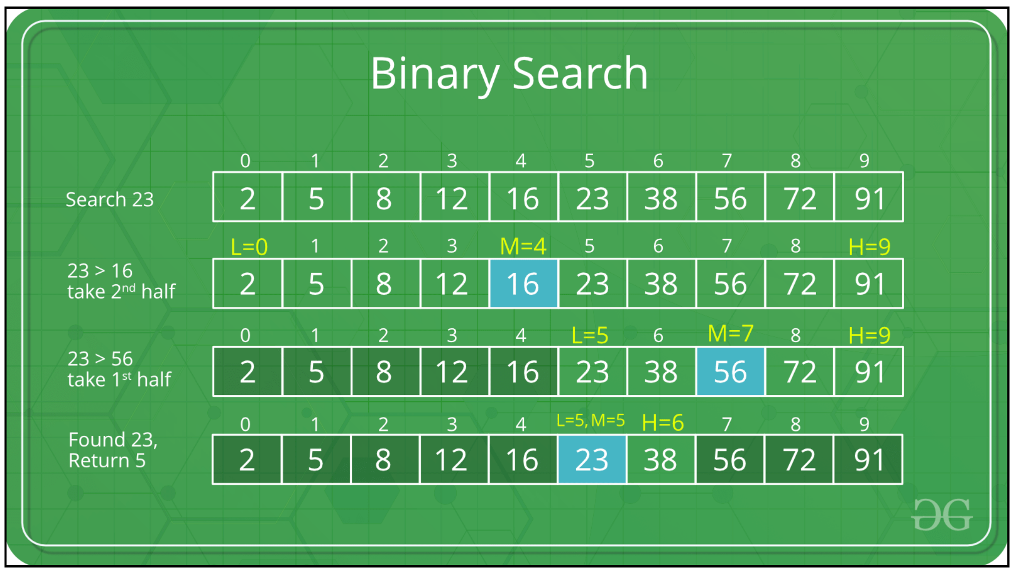
Key learning

- Computational thinking:
    - Abstraction
    - Decomposition
    - Algorithmic thinking
- Standard searching algorithms:
    - Binary search
    - Linear search
- Standard sorting algorithms:
    - Bubble sort
    - Merge sort
    - Insertion sort
- How to produce algorithms using:
    - Pseudocode
    - Using flow diagrams
    - Interpret, correct or complete algorithms

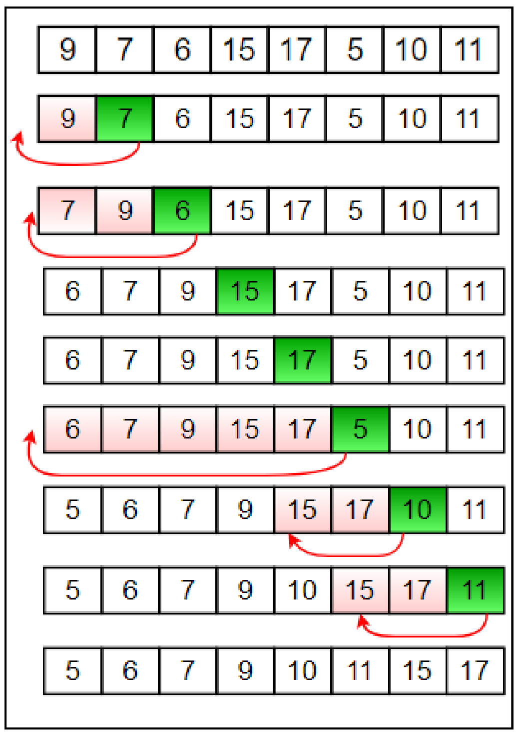
Key terms

Algorithm	A set of instructions to complete a task.
Abstraction	Removing unnecessary detail from a problem to make it easier to solve.
Decomposition	Breaking down a problem into smaller parts to make it easier to solve.
Algorithmic thinking	Identifying the steps needed to solve a problem.
Searching	An algorithm designed to find a piece of data in a list.
Sorting	An algorithm designed to sort a list into alphabetical or numerical order.
Pseudocode	A form of code which does not link to any programming language. It is used for planning.
Flow chart	A way of planning an algorithm using shapes to represent types of instruction.

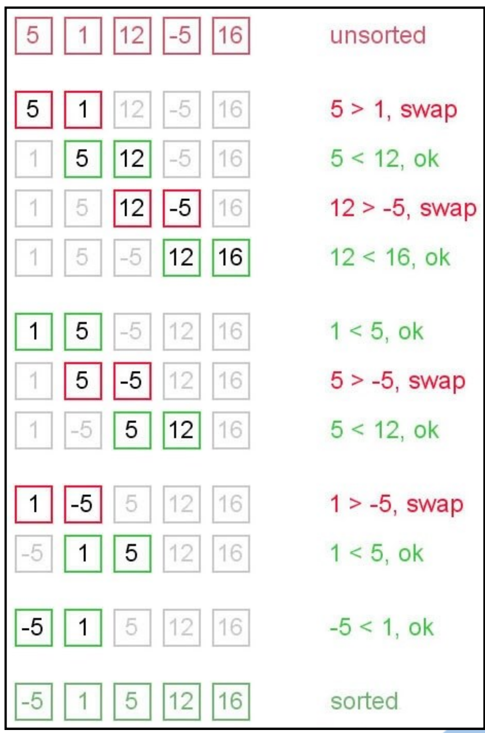


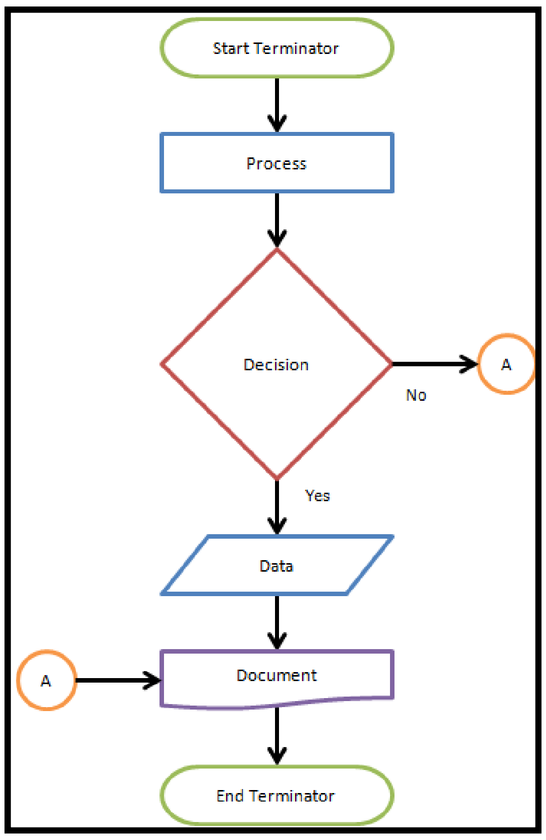


Insertion sort



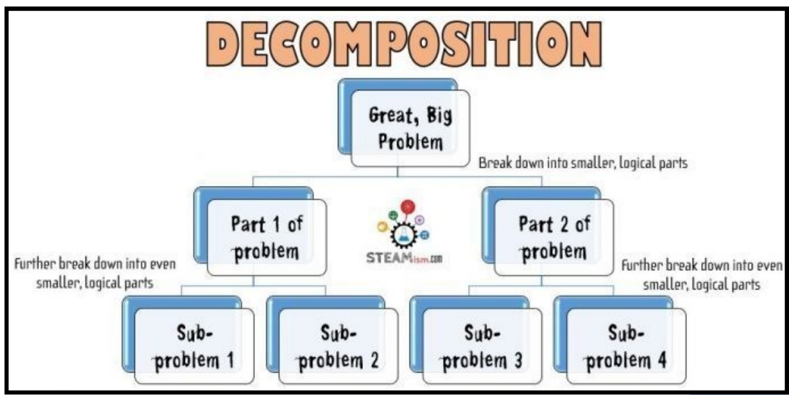
Bubble sort



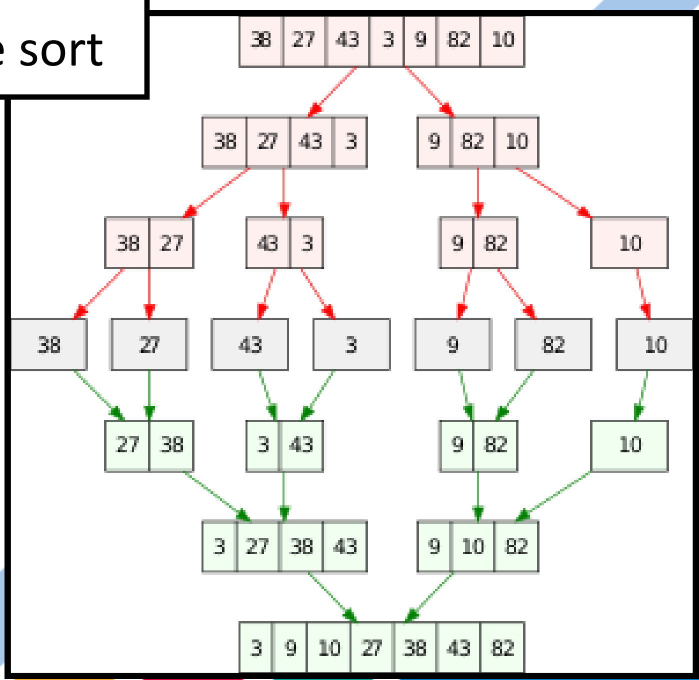


Pseudocode

- Use naming conventions
- Use indentation
- Make sure function names are clear
- Comment code



Merge sort



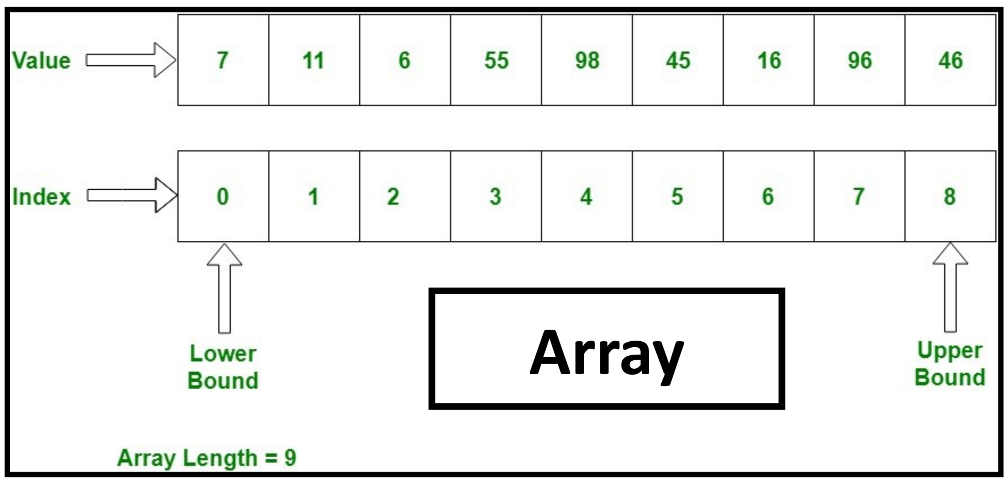
2.2 Programming Fundamentals Knowledge Organiser

Key learning

- The use of variables, constants, operators, inputs, outputs and assignments
- The use of the three basic programming constructs used to control the flow of a program:
  - Sequence
  - Selection
  - Iteration (count and condition controlled loops)
- The use of basic string manipulation
- The use of basic file handling operations:
  - Open
  - Read
  - Write
  - Close
- The use of records to store data
- The use of SQL to search for data: SELECT, FROM, WHERE
- The use of arrays (or equivalent) when solving problems, including both one and two dimensional arrays
- How to use sub programs (functions and procedures) to produce structured code
- Random number generation
- The use of data types:
  - Integer
  - Real
  - Boolean
  - Character and string
  - Casting
- The common arithmetic operators: +, -, /, *, ^ MOD, DIV
- The common Boolean operators: AND, OR, NOT
- The common comparison operators: ==, !=, <, <=, >, >=

Key terms

Variable	A named location in memory storing a single piece of data that can change.
Constant	A named location in memory storing a single piece of data that cannot change.
Array	A named location in memory that can hold multiple pieces of data of the same type.
SQL	A language used to retrieve and manipulate data in a database.
Sub programs	A named section of code which completes a sub task that can be reused.
Function	A type of sub program that returns a value.
Procedure	A type of sub program that doesn't return a value.
Comparison operator	An operator used to compare two values. Commonly used in an if statement.
Arithmetic operator	An operator used to carry out a mathematical function such as addition or subtraction.
Casting	Converting one data type to another
Concatenation	Joining two or more stings together



Data Types

Integer	A whole number, e.g. -1, 3 etc.
Float/ Real	A decimal number, e.g. 1.4
Boolean	A true or false value
Char	A single character, e.g. a
String	A combination of characters, e.g. 'hello'

SQL example

SELECT Syntax

```
SELECT column1, column2, ...
FROM table_name;
```

Here, column1, column2, ... are the field names of the table you want to select data from. If you want to select all the fields available in the table, use the following syntax:

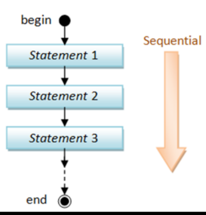
```
SELECT * FROM table_name;
```

Programming Constructs

Sequence

A set of instructions in order.

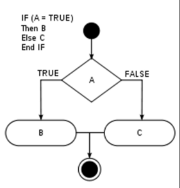
```
OUTPUT "1"
OUTPUT "2"
OUTPUT "3"
OUTPUT "4"
OUTPUT "5"
```

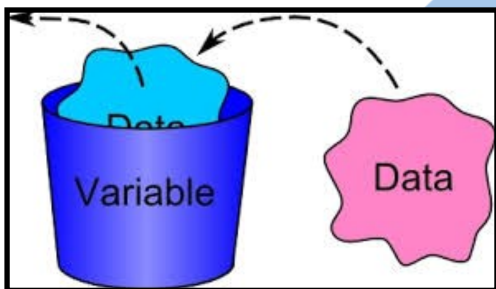


Selection

Where the algorithm makes a decision based on a choice of different paths.

```
weather ← USERINPUT
IF weather = "Rain" THEN
    OUTPUT "Take a brolly"
ELSE
    OUTPUT "Have a nice day"
```



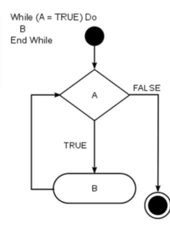


Iteration

Also known as a loop, this is the process of repeating a set of instructions.

```
FOR i ← 1 TO 5
    OUTPUT i
```

```
a←1
WHILE a < 6 THEN
    OUTPUT a
    a←a+1
```



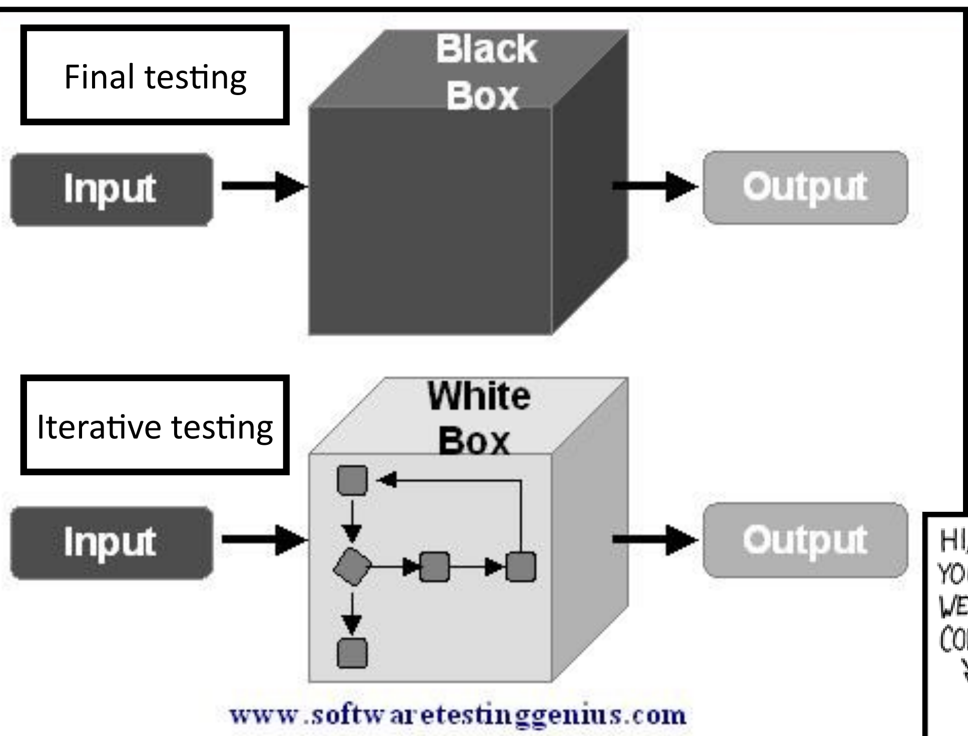
2.3 Producing Robust Programs Knowledge Organiser

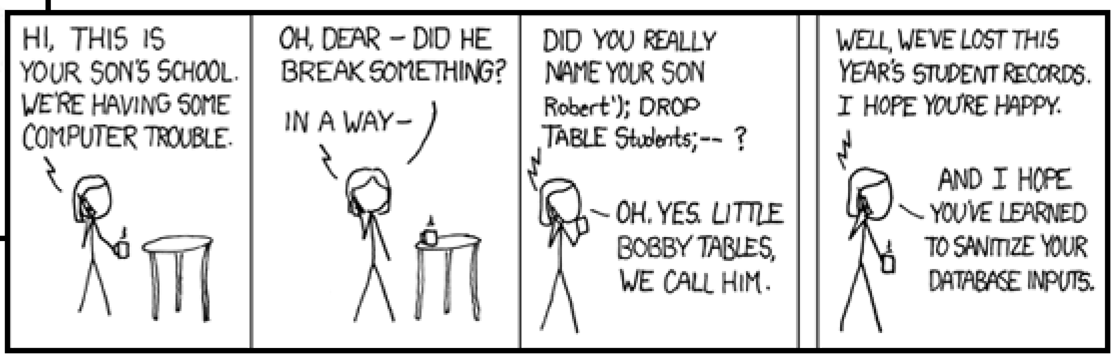
Key learning

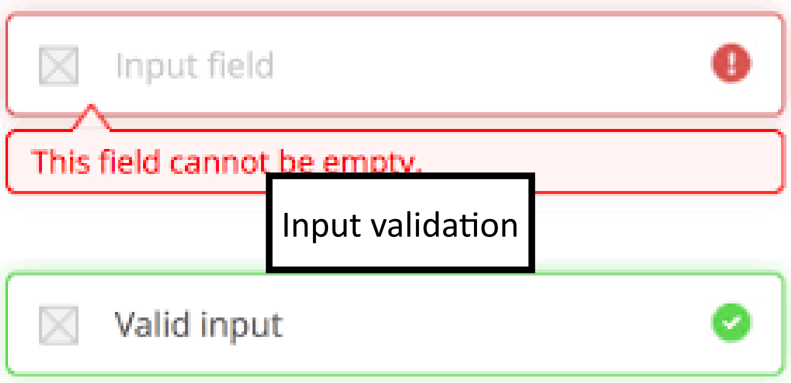
- Defensive design considerations:
  - Anticipating misuse
  - Authentication
- Input sanitisation/validation
- Maintainability:
  - Comments
  - Indentation
  - Use of functions
  - Sensible variable names
- The purpose of testing
- Types of testing:
  - Iterative
  - Final/terminal
- How to identify syntax and logic errors
- Selecting and using suitable test data
- Refining algorithms

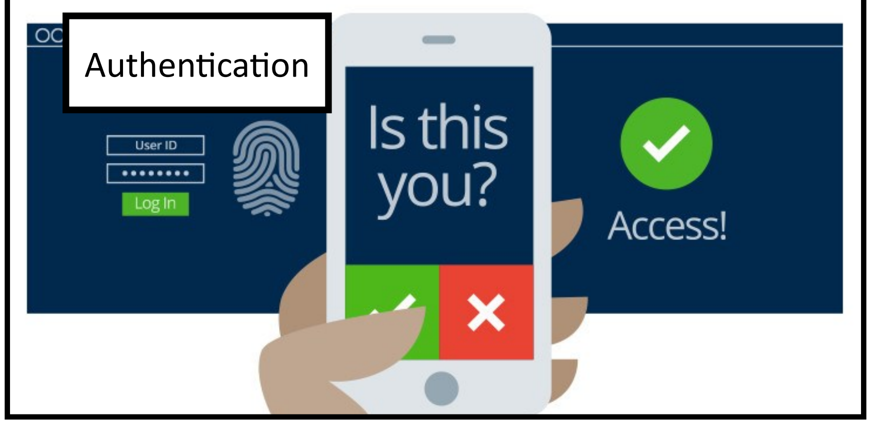
Key terms

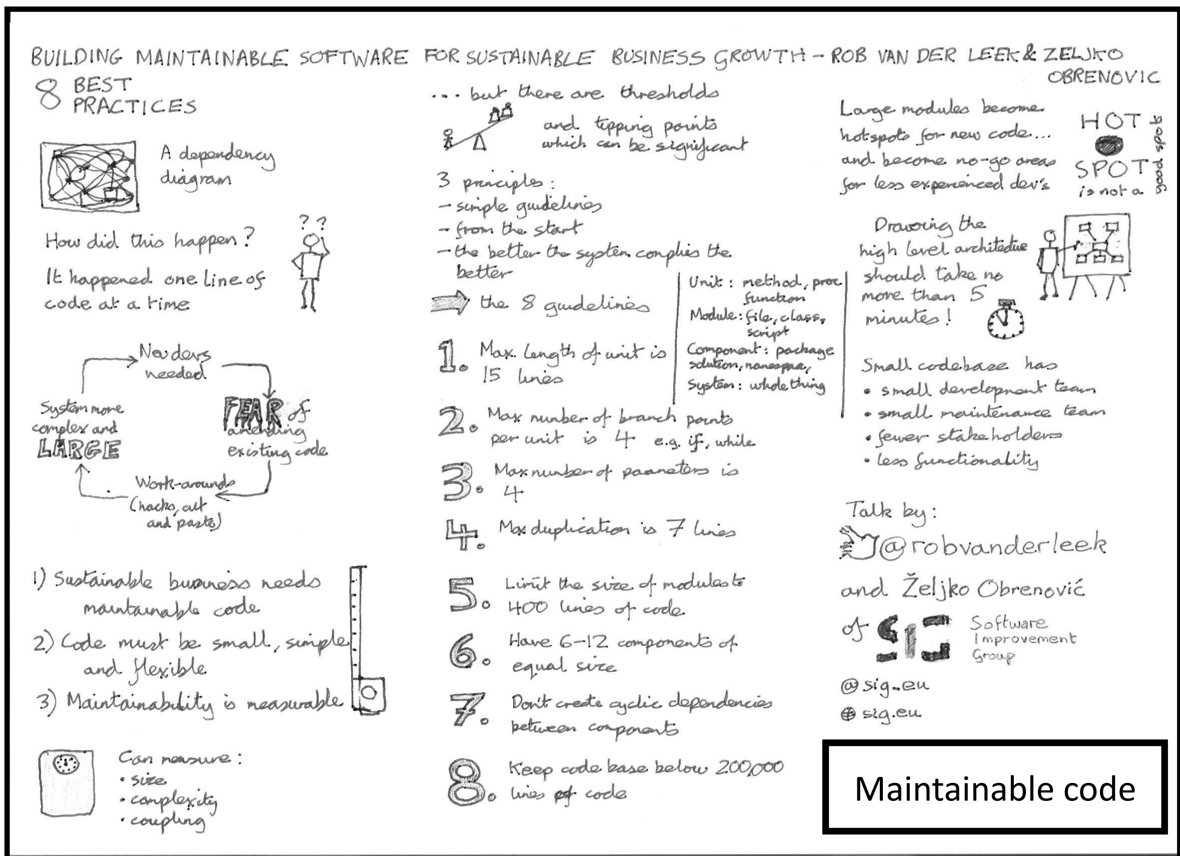
Input sanitation	Removing unwanted characters, such as spaces or punctuation, from inputs.
Input validation	Checking that an input is reasonable, for example age needs to be > 0.
Contingencies	Planning for when something doesn't work as expected.
Authentication	Making sure user have to sign in to access and change data.
Normal test data	Data that should be accepted.
Boundary test data	Data that should be accepted but is borderline.
Erroneous test data	Data that should not be accepted.
Syntax error	An error that causes a program to stop running due to the code not following the rules of the language.
Logic error	An error where the program can still run but will not give the expected output.
Runtime error	An error where the program will stop running due to the program not being able to carry out the instruction.











2.4 Boolean Logic Knowledge Organiser

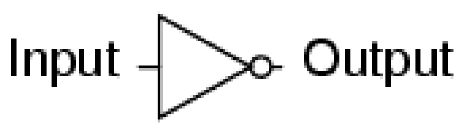
Key learning

- Why data is represented in computer systems in binary form
- Simple logic diagrams using the operations AND, OR and NOT
- Truth tables
- Combining Boolean operators using AND, OR and NOT to two levels
- Boolean notation
- Applying logical operators in appropriate truth tables to solve problems

Key terms

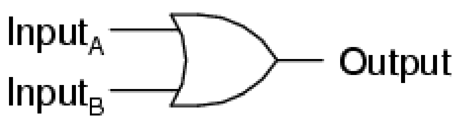
Binary	A series of 1s and 0s used for data and instructions represented by switches/ transistors.
Boolean logic	A form of logic centred around operations between combinations of 1s ad 0s.
AND (Conjunction)	A Boolean operation where both inputs must be a 1 for the output to be 1.
OR (Disjunction)	A Boolean operation where at least one input needs to be a 1 for the output to be 1.
NOT (Negation)	A Boolean operation where the output is the inverse of the input.
Truth table	A table which can be used to work out the output for different combinations of inputs being used with Boolean operators.
Logic diagram	A way to visualise how data passes through different gates.

NOT gate truth table



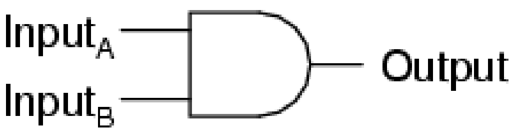
Input	Output
0	1
1	0

2-input OR gate

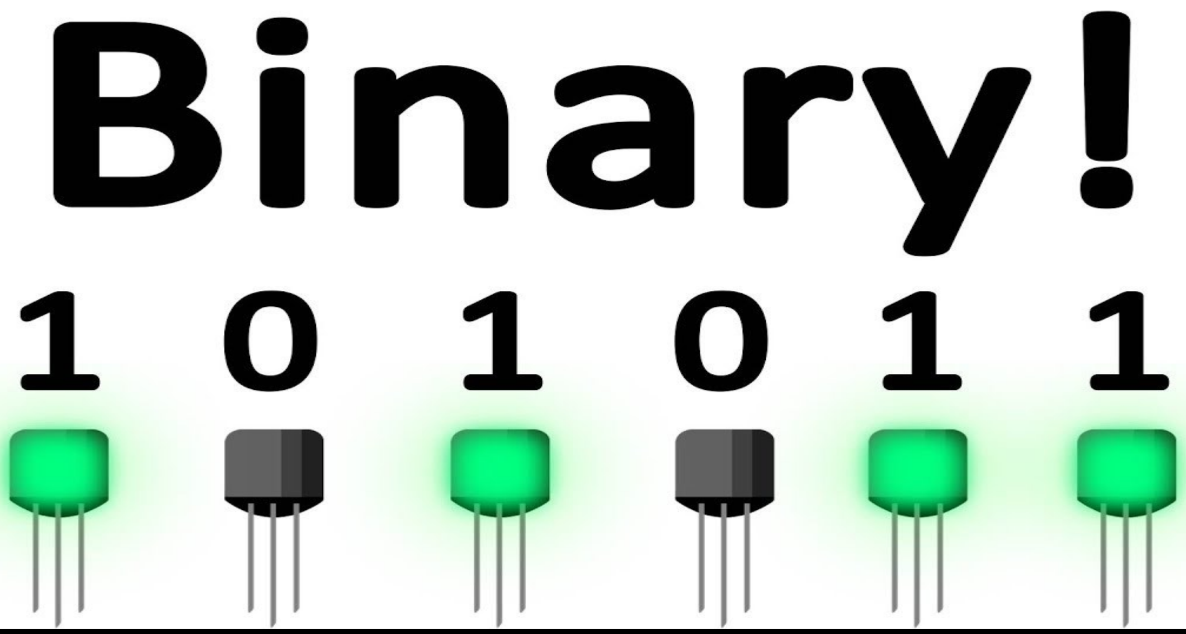


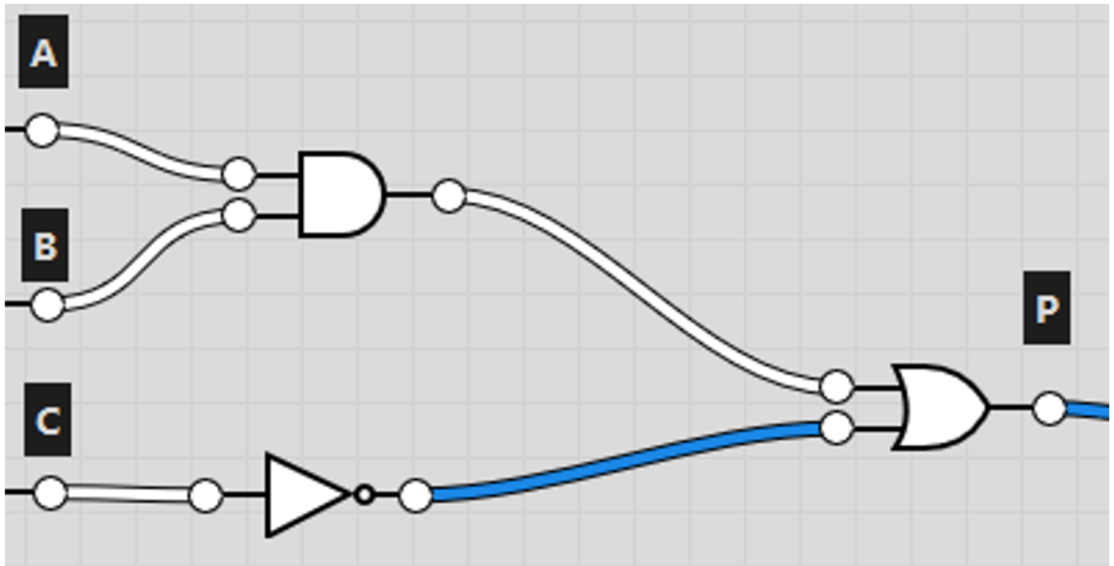
A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

2-input AND gate



A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1





Creating logical expressions

- P = (A AND B) OR NOT C
- P = (A ∧ B) ∨ ¬ C

2.5 Programming languages and IDEs Knowledge Organiser

Key learning

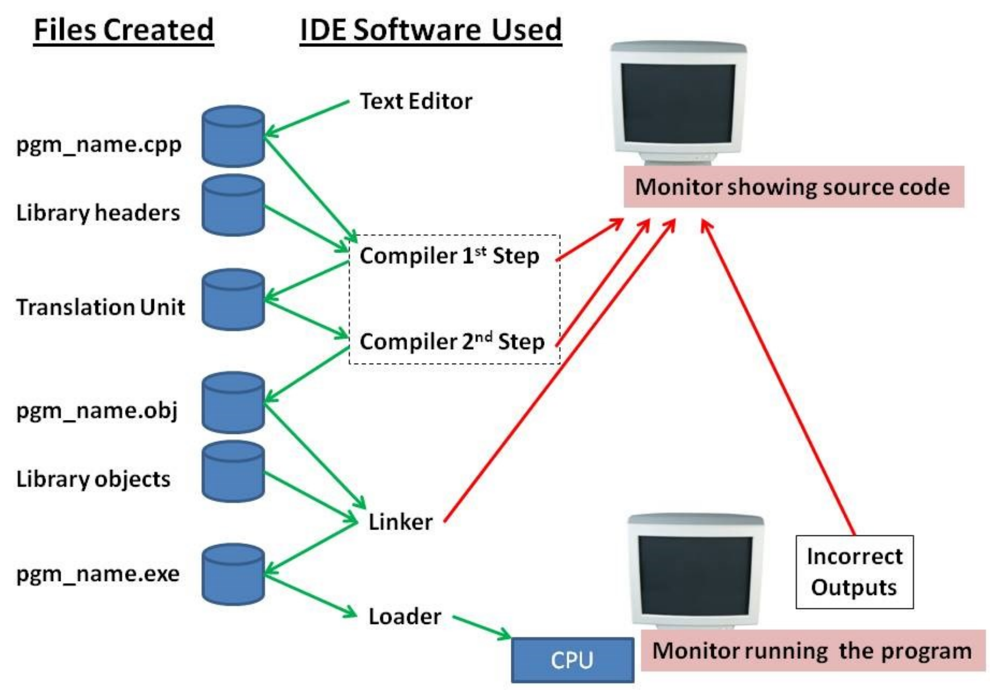
- Characteristics and purpose of different levels of programming language, including low level languages
- The purpose of translators
- The characteristics of a compiler and an interpreter
- Common tools and facilities available in an integrated development environment (IDE):
    - Editors
    - Error diagnostics
    - Run-time environment
    - Translators

Key terms

High level language	A programming language which closely resembles English, for example Python.
Low level language	A programming language in Binary designed for the CPU to understand.
Compiler	A translator that converts high level code into low level code in one go.
Interpreter	A translator that converts high level code to low level code line by line.
Editor	A program designed to make writing code easier usually including a range of tools such as colour coding.
Run-time environment	A program which executes code written and allows it to be checked for errors.
IDE	**Integrated Development Environment** is software that normally combines editors, debuggers, and translators.

Compiler	Interpreter
Takes entire program as input	Takes a single instruction at a time as input
Creates an intermediate object code	Doesn't generate object code
Code is compiled before being executed	Translation and execution take place at the same time
Faster to run once compiled	Slower to run
Displays all errors at the end of compilation	Displays each error as it finds it
Error detection is more difficult	Error detection is easier

High level language	Low level language
Close to English	Close to the native language of the computer
Faster to write	Written in Binary
Can run on any machine as long as suitable translator is used	Can only run on one device
No knowledge of hardware is needed	Linked to specific hardware
Examples include Python, C++, Java and Visual Basic	Also known as machine code



1.1 CPU architecture, CPU performance and Embedded systems Knowledge Organiser

Mildenhall College ACADEMY

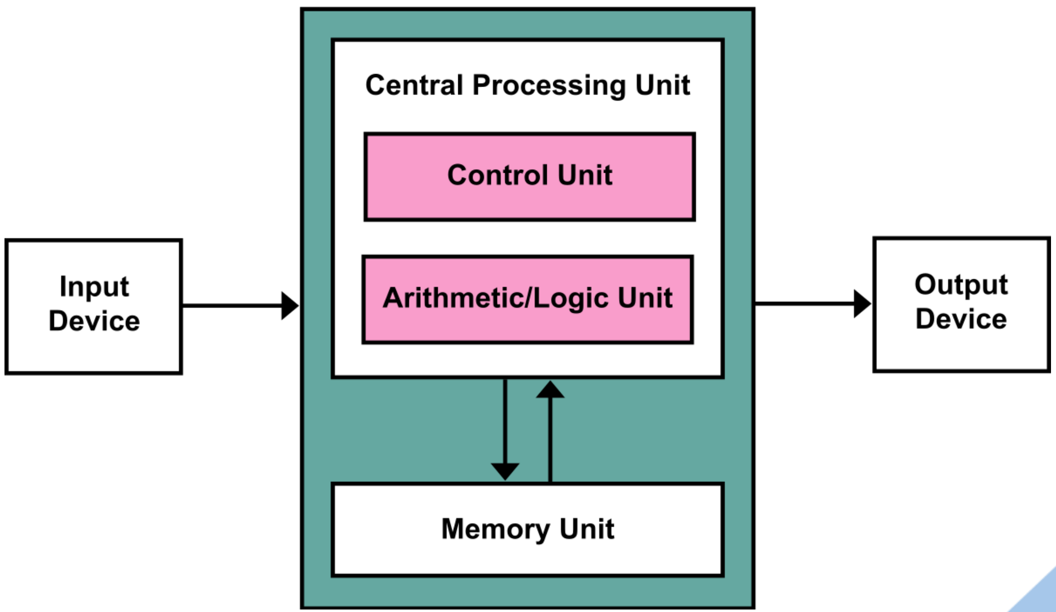
Key learning

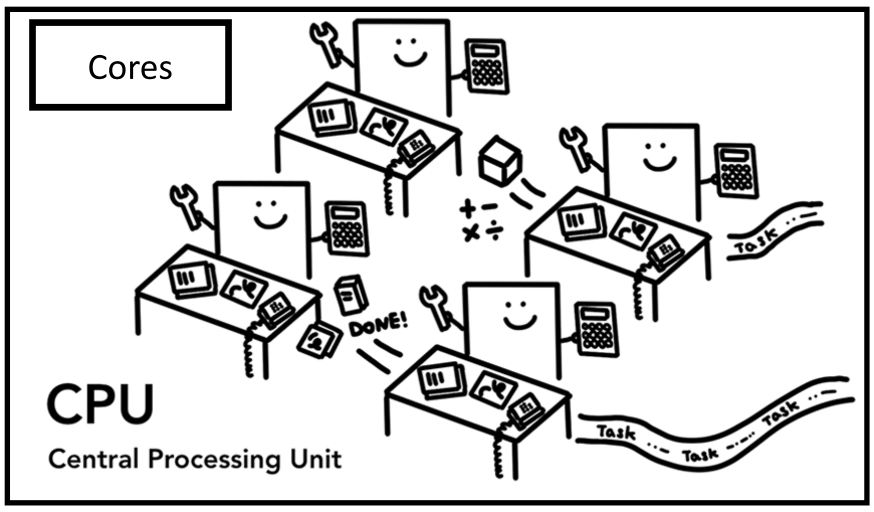
- The purpose of the CPU
- Von Neumann architecture:
  - MAR (Memory Address Register)
  - MDR (Memory Data Register)
  - Program Counter
  - Accumulator
- Common CPU components and their function:
  - ALU (Arithmetic Logic Unit)
  - CU (Control Unit)
  - Cache
- The role of the fetch and execute cycle
- How common characteristics of CPUs affect their performance:
  - clock speed
  - cache size
  - number of cores
- Embedded systems:
  - purpose of embedded systems
  - examples of embedded systems

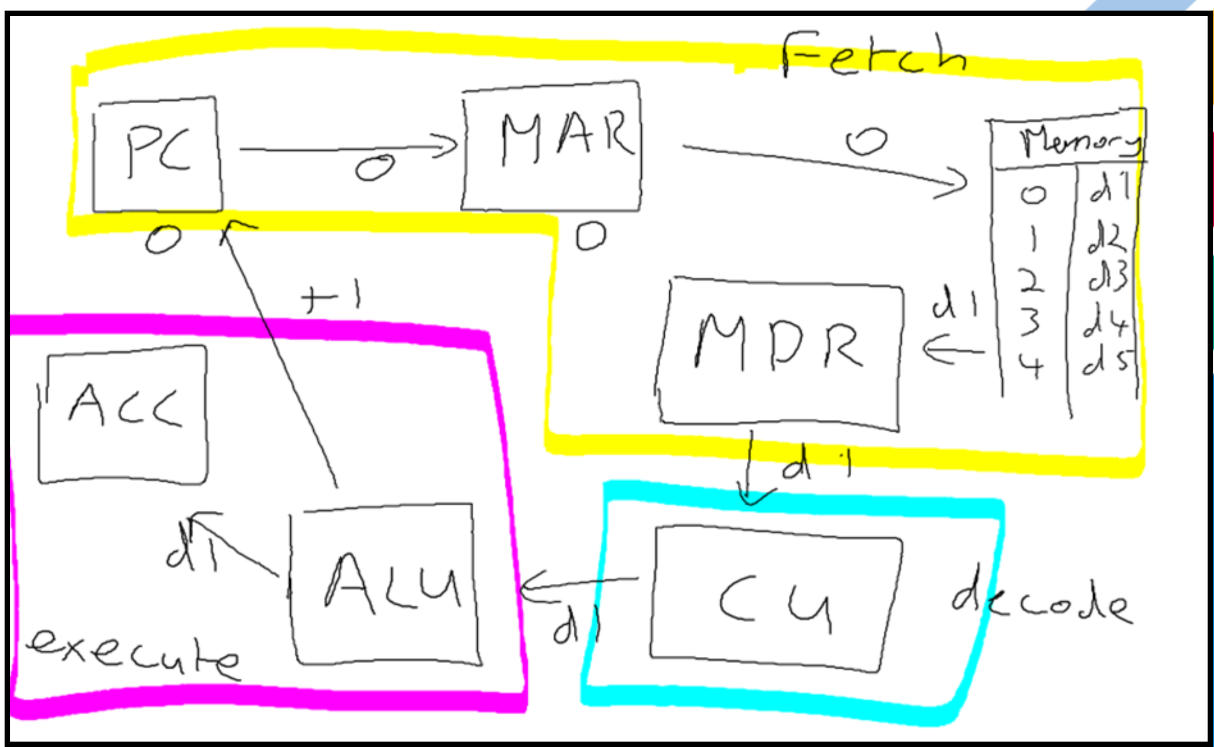
Key terms

CPU	The component responsible for executing instructions and processing data
Von Neumann	A type of design for a CPU
Register	A small data store on a CPU for a single piece of data (PC, MAR, MDR, ACC)
CU	The Control Unit is responsible for directing how to respond to instructions
ALU	The Arithmetic Logic Unit carries out the mathematical and logical operations
Fetch-execute cycle	The process of a CPU carrying out instructions stored in memory
Clock speed	The number of instructions processed per second
Cache	Fast memory, close to the CPU which stores frequently used instructions
Cores	Individual, sub processors on a CPU. Allows for multiple instructions to be executed at the same time.
Embedded system	A computer with a dedicated function built into an appliance.

Examples of Embedded Systems







1.2 Memory and Storage Knowledge Organiser

Key learning

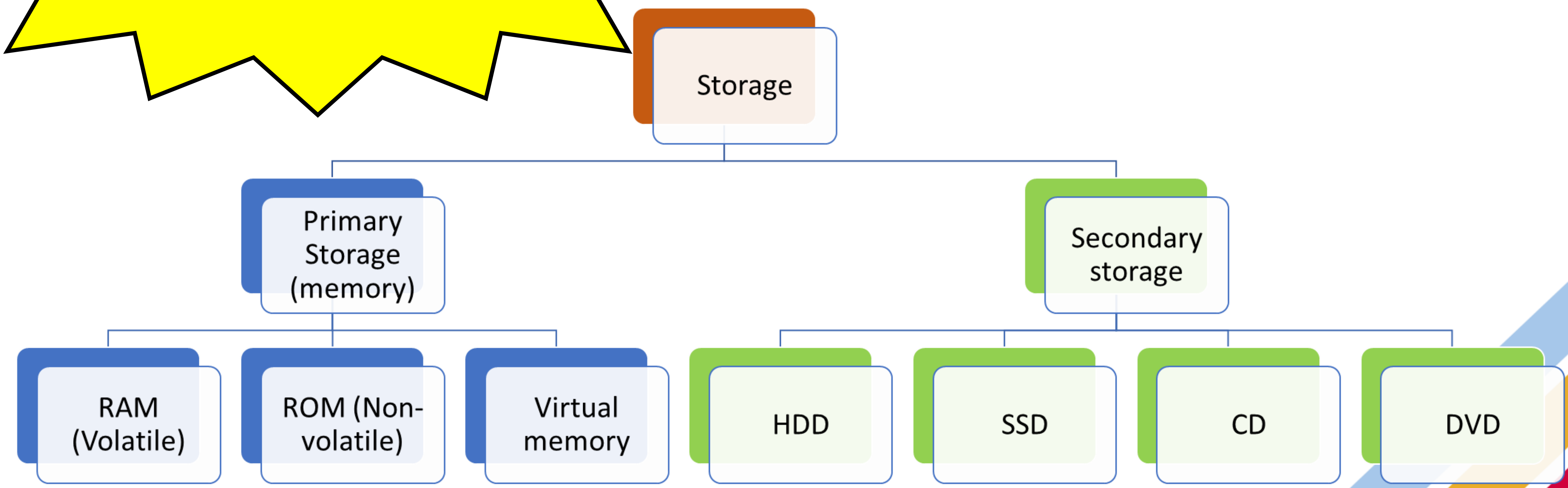
1.2.1 Primary Storage (Memory)
- The difference between RAM and ROM
- The purpose of ROM in a computer system
- The purpose of RAM in a computer system
- The need for virtual memory

1.2.2 Secondary Storage
- The need for secondary storage
- Data capacity and calculation of data capacity requirements
- Common types of storage:
  - Optical
  - Magnetic
  - Solid state
- Characteristics and suitable uses of storage devices:
  - Capacity
  - Speed
  - Portability
  - Durability
  - Reliability
  - Cost

Key terms

Primary Storage (Memory)	A component which stores data and instructions for use by the CPU.
Secondary Storage	A component which stores files and data long term.
RAM	The computers working memory. It stores instructions and data whilst programs are running. This is volatile memory.
ROM	This is Read Only Memory normally used to store computer start-up instructions.
Virtual memory	A reserved part of the hard drive used like RAM.
Capacity	The amount of space available on a memory or storage device.
Magnetic	Data is stored using magnetic fields to represent 1s and 0s
Optical	Data is read using a laser to detect pits and falls on a CD/ DVD/ Blu-ray disc.
Solid state	Data is stored using electrical circuits with no moving parts.
Volatile	This is memory that will lose its data when power is lost.
Non-volatile	This is memory that doesn't lose its data when power is lost.

Common misconception:
Secondary storage is only used as a back up store or extra storage



	Capacity	Speed	Portability	Durability	Reliability	Cost
Magnetic	High	Mid	Mid	Mid	Mid	Low
Optical	Low	Low	High	Mid	Mid	Mid
Solid state	Mid	High	High	High	High	High

1.2 Number Representation Knowledge Organiser

Mildenhall College ACADEMY

Key learning

Numbers

- **How to convert positive denary whole numbers (0–255) into 8 bit binary numbers and vice versa**
- **How to add two 8 bit binary integers and explain overflow errors which may occur**
- **Binary shifts**
- **How to convert positive denary whole numbers (0–255) into 2 digit hexadecimal numbers and vice versa**
- **How to convert from binary to hexadecimal equivalents and vice versa**

Binary Addition

Rules

0 + 0 = 0

0 + 1 = 1

1 + 1 = 10

1 + 1 + 1 = 11

```
   0 1 1 0 0 1 1 1
+  1 0 0 1 1 1 0 1
 1 0 0 0 0 0 1 0 0
Carry 1 1 1 1 1 1 1 1
```

Binary shifts

Left shift

- Each **left shift** will **add one 0** to the **right hand side** of the binary number
- **Each shift doubles** the denary equivalent of the binary number
- If the **number exceeds maximum number** of bits then the **left digit is lost** this will **reduce the accuracy** of the number

Right shift

- Each **right shift** removes the **right hand digit** from the binary number
- **Each shift** will **divide** the denary equivalent of the number **by** 2
- If **1s** are removed then the **accuracy of the number is reduced**

Key terms

Bit	The smallest unit of data storage consisting of a single 1 or 0. This can be represented by a single transistor.
Nibble	A group of four bits (half a byte).
Byte	A group of 8 bits.
Binary	A base 2 system computers understand due to being made of transistors that can either be on or off.
Hexadecimal	A base 16 system used by humans to help remember and read binary code. Each binary nibble links directly to 1 hexadecimal digit.
Most significant bit	The left most digit of a binary number which has the highest value
Overflow error	When addition or left shifts lead to more than the original number of bits

Number conversions (Denary > Binary > Hex)

Binary to denary (01001101)

- Place the binary numbers under the **binary place values** starting from **right** to **left**
- **Add** together the headings **where there is a 1** underneath
- E.g. 64+8+4+1 =**77**

128	64	32	16	8	4	2	1
0	1	0	0	1	1	0	1

Denary to binary (56)

- Work from the **left** and attempt to **subtract** the heading from your number
- If you can do it without getting a negative number then put a 1 under the heading and use the answer in the next column
- If you can't put a 0 under the heading and move to the next column

128	64	32	16	8	4	2	1
0	0	1	1	1	0	0	0

Binary to hexadecimal (01001101)

- Split the **Byte** in half, this time use the top place values to convert each half (**nibble**) into **denary**
- If the **number is more than 9** use the letters **A to F** instead

A	10
B	11
C	12
D	13
E	14
F	15

E.G. the left would be 4, the right would be 8 + 4 + 1= 13

13 = D ➔ **Final answer = 4D**

8	4	2	1	8	4	2	1
128	64	32	16	8	4	2	1
0	1	0	0	1	1	0	1

Hexadecimal to Binary (F5)

- Use the **top headings** to convert each digit of the **hexadecimal** number to **binary**
- Make sure you keep them on the correct side (left to left and right to right)

F=15

8	4	2	1	8	4	2	1
128	64	32	16	8	4	2	1
1	1	1	1	0	1	0	1

1.2 Units of Storage and Compression Knowledge Organiser

Mildenhall College ACADEMY

Key learning

Units

- **Bit, nibble, byte, kilobyte, megabyte, gigabyte, terabyte, petabyte**
- **How data needs to be converted into a binary format to be processed by a computer**

Compression

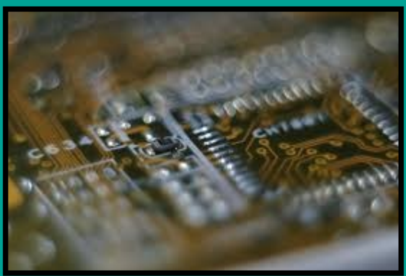
- **Need for compression**
- **Types of compression:**
    - **Lossy**
    - **Lossless**

Key terms

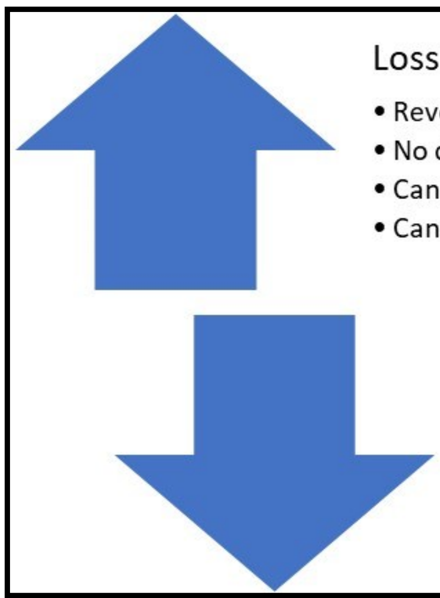
Bit	The smallest unit of data storage consisting of a single 1 or 0. This can be represented by a single transistor.
Nibble	A group of four bits (half a byte).
Byte	A group of 8 bits.
Compression	Reducing the file size to make it faster to send and take up less storage space.
Lossy	A method of compressing a file by permanently removing some data.
Lossless	A method of compressing a file keeping all of the data.

Why computers use binary

- Computers consist of many **transistors**
- Each **transistor** can only be **on** or **off**
- This can be used to represent **1** or **0**



Bit	Smallest unit of storage made of a sinlge 1 or 0
Nibble	A group of 4 bits
Byte	A group of 8 bits
Kilobyte	1 000 Bytes or 8 000 bits
Megabyte	1 000 Kilobytes or 1 000 000 Bytes
Gigabyte	1 000 Megabytes or 1 000 000 Kilobytes
Terabyte	1 000 Gigabytes or 1 000 000 Megabytes
Petabyte	1 000 Terabytes or 1 000 000 Terabytes



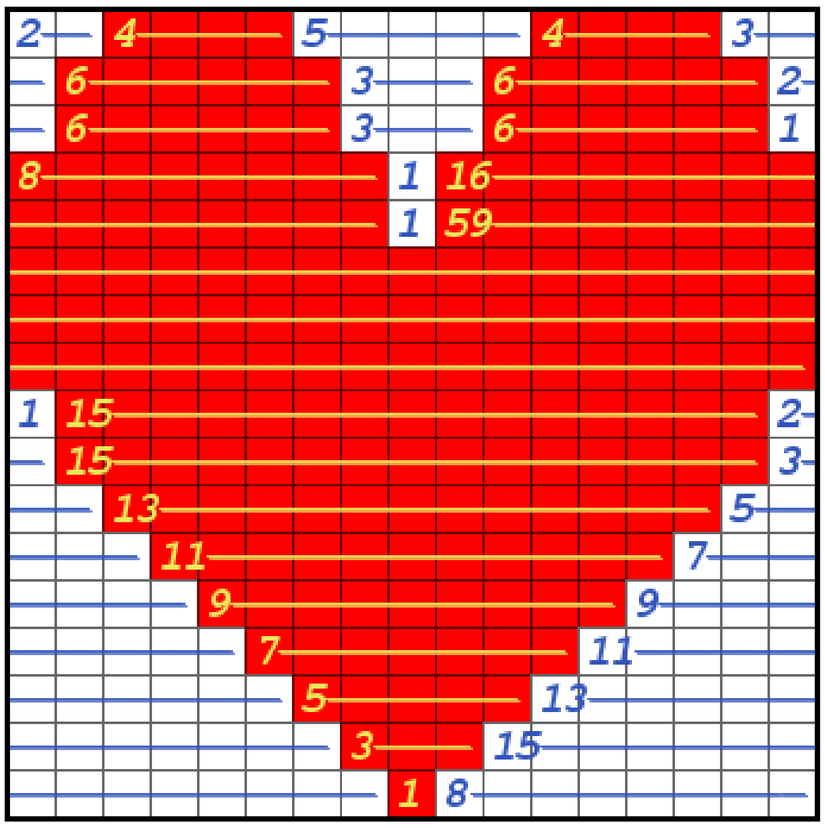
Lossless

- Reversible compression
- No data is lost
- Can be used on text
- Cannot be compressed as much as lossy

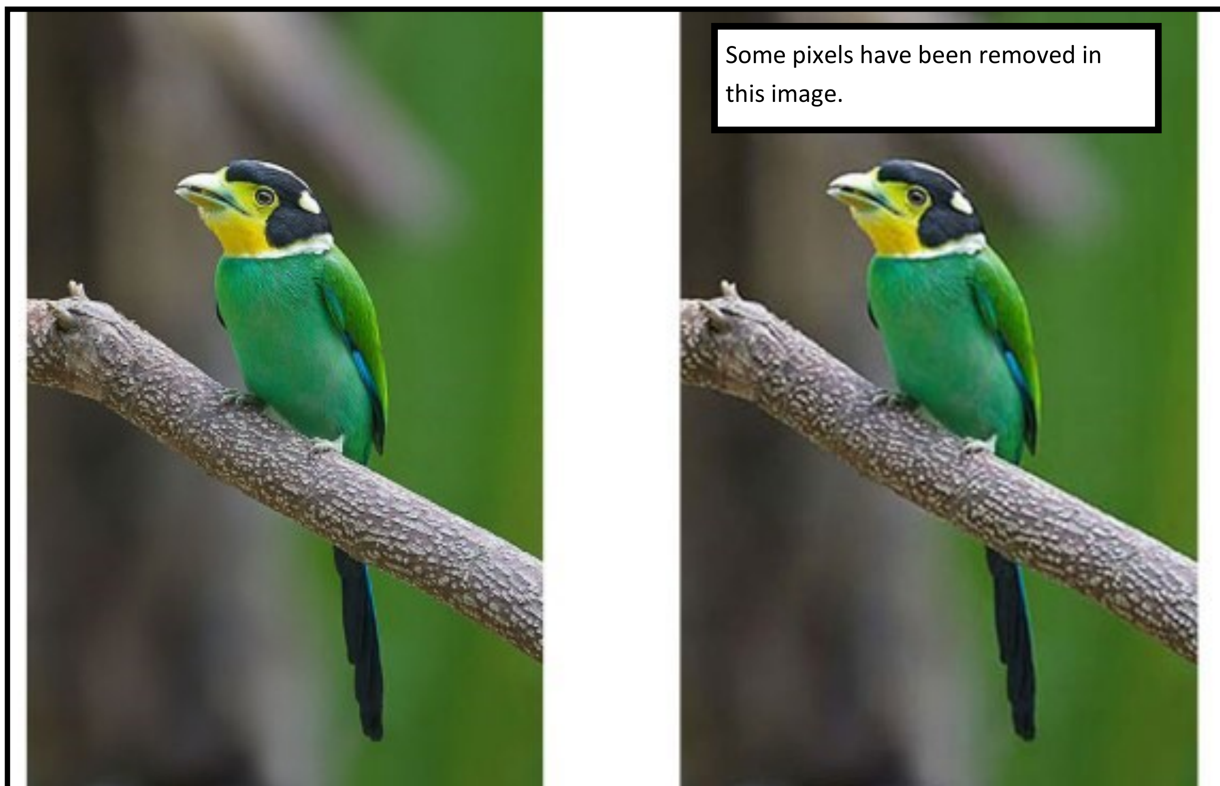
Lossy

- Permanent compression
- Some less innportant data will be lost
- Cannot be used on text
- Can be compressed more than lossless

Lossless compression



Lossy compression



1.2 Images, Text and Sounds Knowledge Organiser

Mildenhall College ACADEMY

Key learning

Characters

- **The use of binary codes to represent characters**
- **The term 'character-set'**
- **The relationship between the number of bits per character in a character set and the number of characters which can be represented (for example ASCII, extended ASCII and Unicode)**

Images

- **How an image is represented as a series of pixels represented in binary**
- **Metadata included in the file**
- **The effect of colour depth and resolution on the size of an image file**

Sound

- **How sound can be sampled and stored in digital form**
- **How sampling intervals and other factors affect the size of a sound file and the quality of its playback:**
- **Sample size**
- **Bit rate**
- **Sampling frequency**

Key terms

Pixel	The smallest element of an image (picture element).
Resolution	The number of pixels in an image or defined area.
Colour depth	Number of bits used to represent a pixel. This affects the number of colours which can be represented.
Meta data	Data about a file such as date, file type, author, resolution, bit depth, etc.
Character Set	The range of symbols a computer understands.
ASCII	A character set using 8 bits per character storing the Latin alphabet.
Unicode	A character set using 16 or 32 bits allowing other languages to also be represented.
Digital sound	The result of a sound being sampled and stored on a computer in binary.
Analogue sound	The original sound before it is sampled by a computer.
Sample	Measuring the height/ amplitude of a sound wave at a specific point in time.
Sample rate	The number of samples recorded every second.
Bit depth/ sample size	The number of bits used to represent each sample.
Bit rate	The number of bits being processed every second. Worked out by multiplying the sample frequency by the sample size.

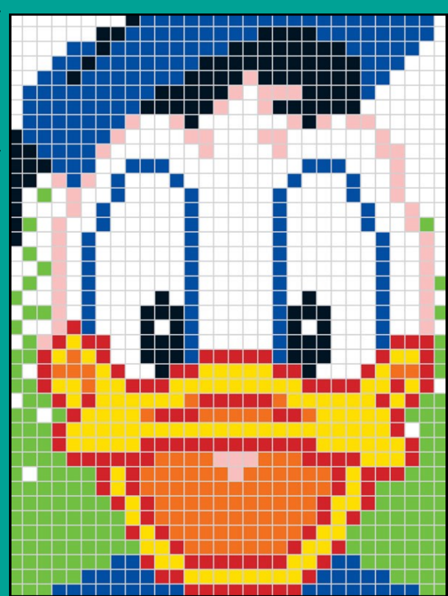
Text

Number	Letter
65	A
66	B
67	C
68	D

- Each **character** is given a **unique** number
- This is converted into binary
- Characters will always be in order, a, b, c, etc.
- A popular character set is **ASCII** which uses 8 bits per character
- ASCII can only store the Latin alphabet due to the **256** character limit
- **Unicode** is a character set which uses 16 or 32 bits per character
- **Unicode** includes **ASCII** as its first 256 characters
- **Unicode** then allows all other alphabets to be included, including emojis

Images

- Each image is made up of **pixels**
- The pixel is stored as a **binary number** which represents the colour of the pixel
- Each colour has a **unique** binary number
- The number of colours is determined by the **colour depth**
- The number of pixels in an image is known as its **resolution** which can be worked out by multiplying the **width** and **height**
- Each image will also store **metadata** such as **file type**, **date taken**, **author**, **location**, etc.
- The **file size** of an image can be worked out by multiplying the **resolution** by the **colour depth**.



Sounds

- Analogue sounds must be converted into digital sounds (binary)
- A **sample** is taken at **regular intervals (sample frequency)**
- A **sample** is a measurement of the amplitude at a set point in time
- Each **sample** is stored as a binary number
- The **accuracy of each sample** is determined by the **sample size**
- The **accuracy of the wave** is determined by the **sample frequency**
- Bit rate can be worked out by multiplying the **sample frequency** by the **sample size**
- File size can be worked out by multiplying the **bit rate** by the **length of the sound** in seconds