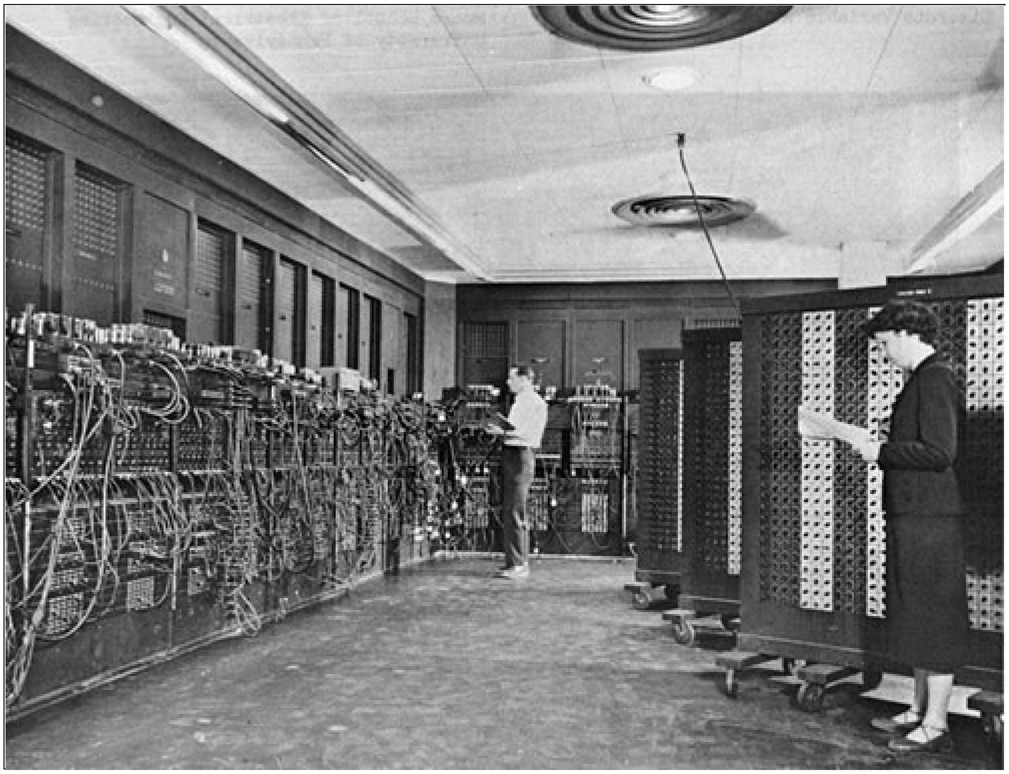
Topic 2: Computer Organisation



The ENIAC in the Army's Ballistic Research Laboratory. (L: Glen Beck, R: Frances Holberton) Credit: K. Kempf "Historical Monograph: Electronic Computers Within the Ordnance Corps," U.S. Army Photo.

Computer Architecture

2.1.1 CPU Architecture

Key Terms

- Central Processing Unit (CPU)
- Arithmetic and Logic Unit (ALU)
- Control Unit (CU)
- Registers
- Memory Address register (MAR)
- Memory Data Register (MDR)
- Bus

The CPU acts as the brain of the computer. It carries out the instructions for input and output processes and arithmetic and logical operations. It is generally an integrated circuit printed on a silicon chip called a microprocessor.

Two important elements of the CPU are the arithmetic and logic unit (ALU) and the control unit (CU).

Functions of the ALU

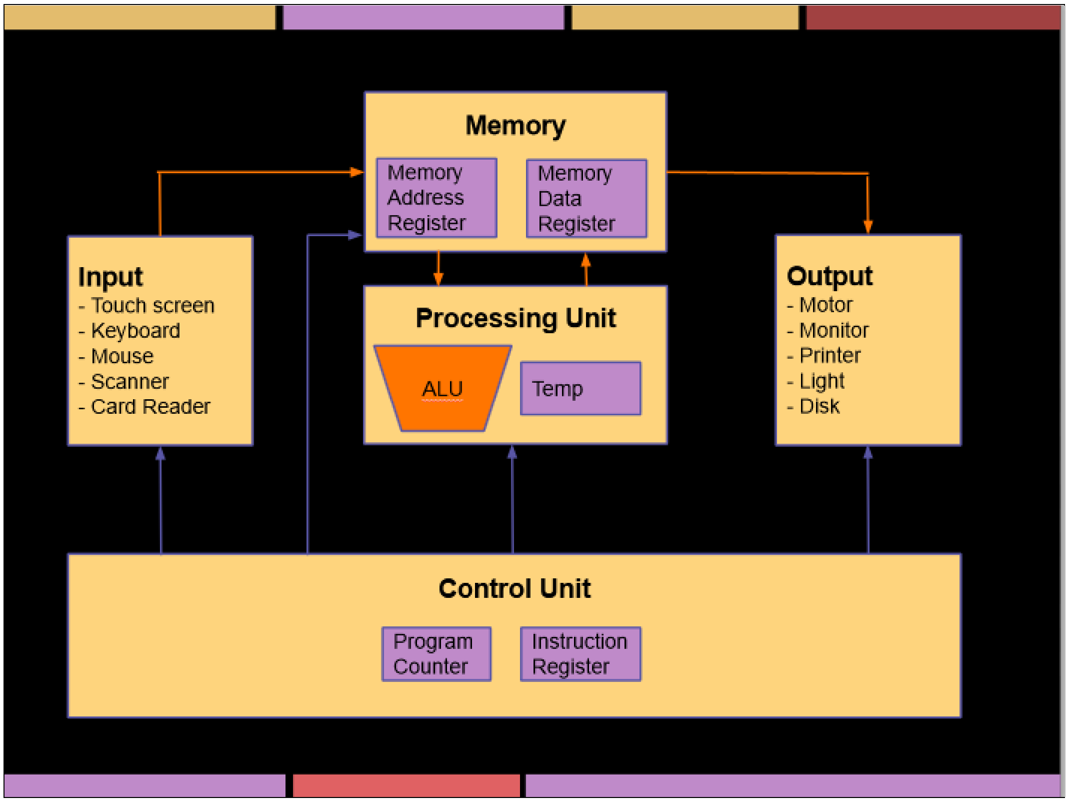
- The ALU carries out all the arithmetic and logical operations
- Performs the following operations:
    - ADD, SUBTRACT, AND, OR, NOT
- Contains registers for storing temporary data
- Input quantities relate to the word size of the computer (eg. 32bit or 64bit)

Functions of the CU

- Manages the ALU
- Controls communication between CPU and memory
- Step by step processing
- Contains registers such as:
    - Instruction register (stores the current instruction)
    - Program counter (stores the address of the instruction)

Registers

Registers are very small, extremely fast blocks of memory within the CPU. There are many registers in the CPU some of which can be seen in the image below.



There are two registers you need to know about for your exams. The memory address register and the memory data register. The CPU contains buses for transmitting data. The address bus will transmit information about where things are located and the data bus will transmit the data from the appropriate address.

Memory address register

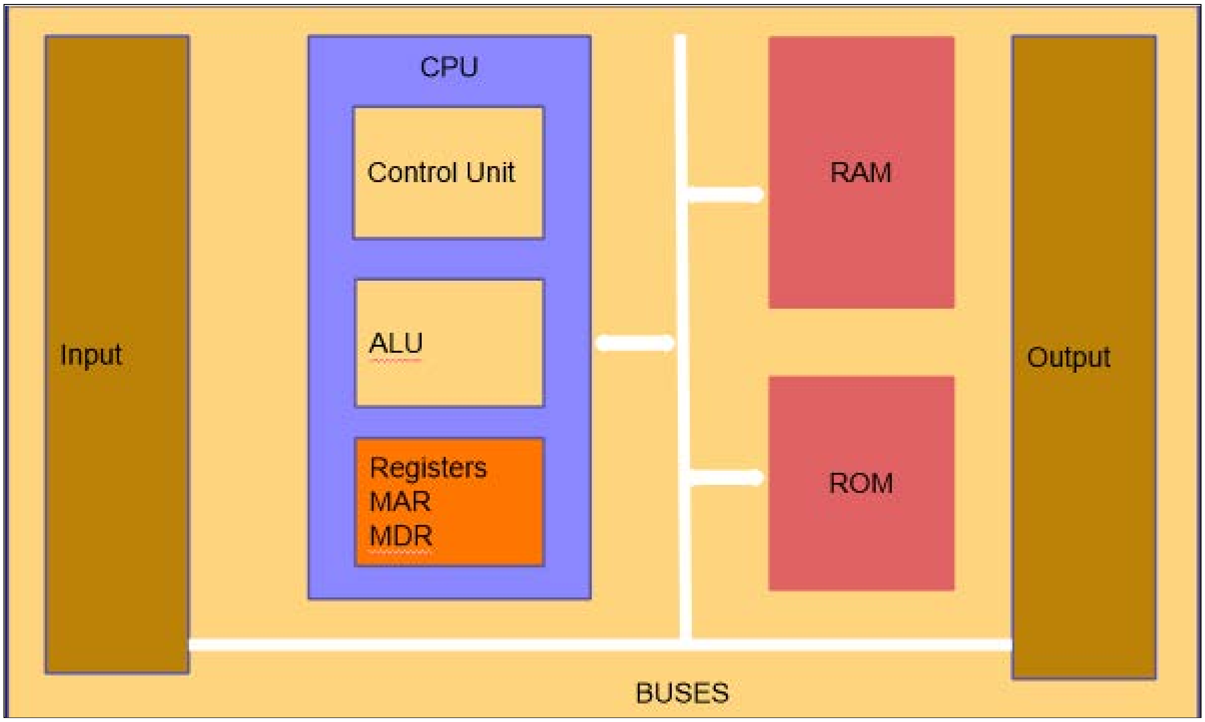
- The MAR is connected to the address bus.
- The MAR is how the CPU communicates with the address bus.
- The MAR can hold either an instruction address or a data address.

Memory data register

- The MDR is connected to the data bus.
- Data can go in both to and from memory,
- The MDR can load its data from:
  - the data bus (for reading data)
  - one of the CPU registers (for storing data.)

Block diagram

You may be asked to reproduce a block diagram of the CPU and associated memory in the exam. One can be seen in image below.



2.1.2 Describe primary memory

Key Terms

- Random Access Memory (RAM)
- Read Only Memory (ROM)
- Volatile
- Non volatile
- BIOS

Primary memory or main memory is another name for RAM (and ROM). It is primarily used to hold temporary data that is being processed by the computer.

RAM	ROM
Random Access Memory Volatile When the power is switched off all memory disappears.	Read Only Memory Non volatile When the power is switched off the memory remains.

RAM

Data can be written to and read from memory very quickly

RAM acts as temporary storage and working space for the operating system and its applications.

RAM takes the form of integrated circuits attached to the motherboard in slots (Figure 4).

ROM

Read Only Memory (ROM) is used to store instructions and data that will "never" change.

Typically the ROM in a computer contains instructions that control how a computer starts up, reads input, and writes output (BIOS).

The BIOS (basic input output system) contains the instructions necessary to boot the computer. In practice this is not strictly ROM as its contents can be altered (image above).

2.1.3 Explain cache memory

Key Terms

- Cache
- Cache hit
- L1,L2,L3

What is cache?

- Cache is a small, very fast, memory that stores the data from frequently used main memory addresses.
- It lies between the CPU and main memory.
- Cache is used by the CPU to reduce average memory access times.
- There are different types of cache (eg. L1, L2 and L3).

How does it work?

- Request made from CPU.
- Cache is checked for the data.
- If found - data returned from cache (cache hit).
- Else (cache miss) - information returned from main memory.

As cache memory is able to be accessed much faster than main memory any cache hit will produce an increase in the speed of operations. There are additional costs however when there is a cache miss as more than one memory must be checked. However this is normally offset by good processor design. The question then is why do we not make all main memory out of cache memory? The answer to that is generally a cost issue.

The table below shows the comparison of speed, size and cost for computing memory types.

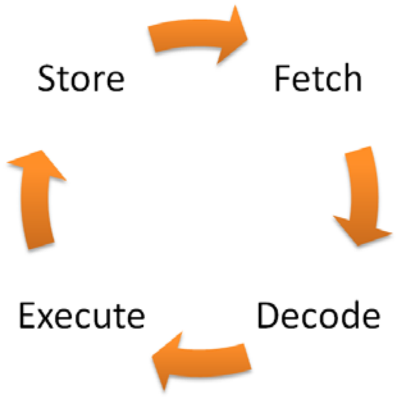
Memory Type	Speed	Size	Cost
CPU Register	Very fast	Very small (512B)	Very expensive (part of CPU)
Cache	Very fast	Small (12MB)	Very expensive ($150/MB)
RAM	Fast	Large (8GB)	Inexpensive ($0.58/MB)
Hard Disk	Slow	Very large (2TB)	Very inexpensive ($0.0025/MB)
Off line Storage	Very Slow	Potentially Huge (PBs)	Least expensive

2.1.4 Explain the machine instruction cycle

Key Terms

- Machine Instruction Cycle
- Data bus
- Address bus
- Fetch
- Decode
- Execute
- Store

Instructions are processed under direction of the control unit in step-by-step manner. There are four fundamental steps in the instruction cycle:



1. Fetch instruction
2. Decode instruction
3. Execute
4. Store result

Fetch

- Obtain next instruction from memory.
- Load instruction into instruction register IR.
- MAR is loaded with instruction pointer.
- The instruction is loaded through the MDR.
- Increment processor counter PC

Decode

- The instruction in the instruction register (IR) gets decoded.

Execute

- Code for the instruction is executed by the ALU.

Store

- Results of instruction written to memory.

Secondary Memory

2.1.5 Identify the need for persistent storage

Secondary storage deals with the storage of data in a known place so that we can access it at a later date. Secondary memory is non-volatile and the memory is persistent even when power is no longer supplied.

The storage device is sometimes fixed such as the hard disk of a computer or is removable such as a CD-ROM.

Operating systems and application systems

2.1.6 Describe the main features of an operating system

Key Terms

- Multitasking
- Device drivers
- Memory management
- File management
- User interface
- GUI
- CLI
- Security
- Networking

An operating system is a type of software that manages the operation of the computer. The operating system sits between the hardware and the application programs..
It is generally responsible for managing a number of areas of the system such as:

- Kernel
    - File management
    - Memory management
    - Multitasking
    - Interrupts
    - Device drivers
    - Virtual memory
- User interface
- Security
- Networking

Multitasking

This means running multiple programs on the same computer. Since computers can generally do only one or two things this is accomplished by time sharing.

Device drivers

The operating system is responsible for the management of peripherals such as printers, monitors, graphics cards etc. This is often done through device drivers which are programs that allow the OS to control the hardware.

Memory management

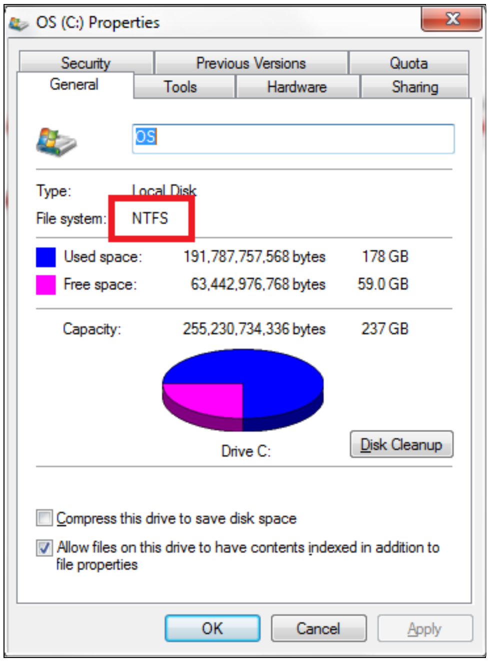
The operating system is responsible for managing the memory of the system to ensure that there are no conflicts of memory usage between all the currently running programs and processes.

This can sometimes involve using virtual memory where a portion of the disk drive is used as primary memory. This has major drawbacks as the speed of a hard disk is several orders slower than main memory.

File management

This is a central feature to operating systems allowing files to be stored in hierarchy of directories or folders in a directory tree.

Common systems include NTFS, FAT32, ext3.



OS (C:) Properties

OS

Type:	Local Disk	
File system:	NTFS	
🟦 Used space:	191,787,757,568 bytes	178 GB
🟪 Free space:	63,442,976,768 bytes	59.0 GB
Capacity:	255,230,734,336 bytes	237 GB

Drive C:

☐ Compress this drive to save disk space

☑ Allow files on this drive to have contents indexed in addition to file properties

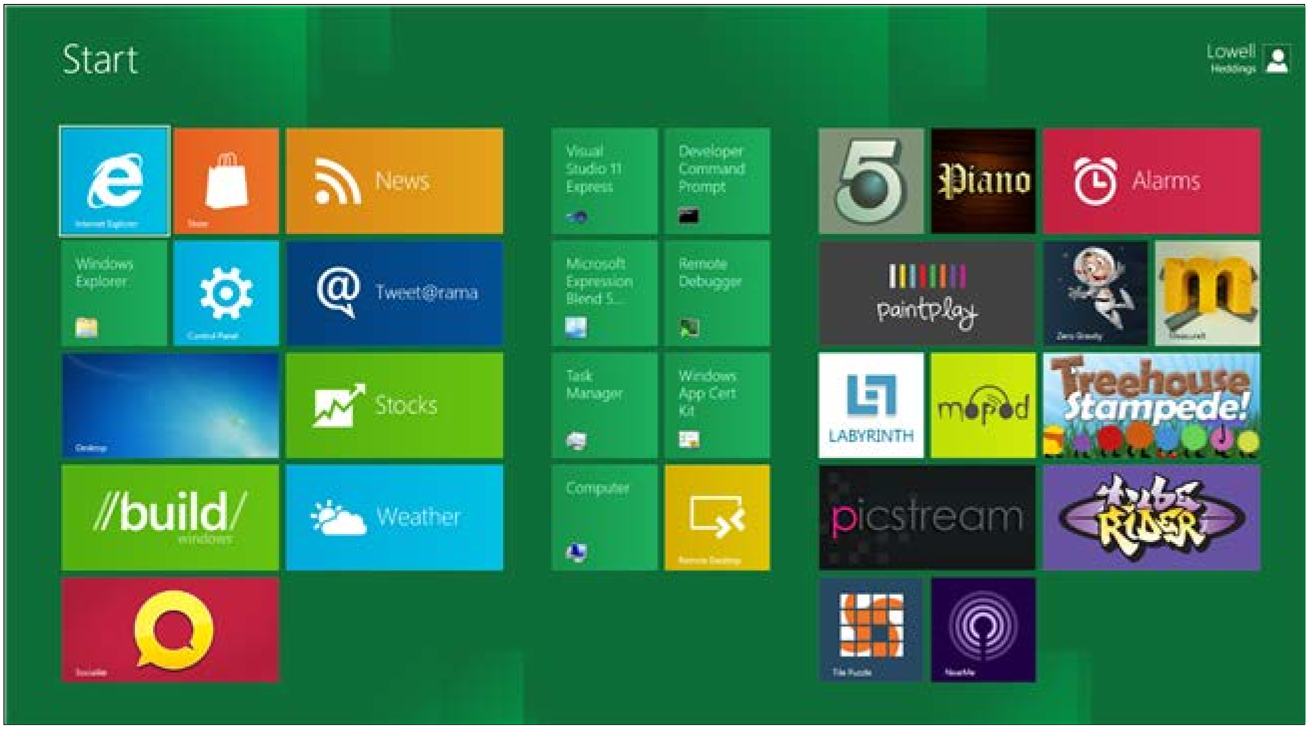
User interface

The most common forms of interface are the Graphical User interface (GUI) and the command line interface (CLI).

GUI

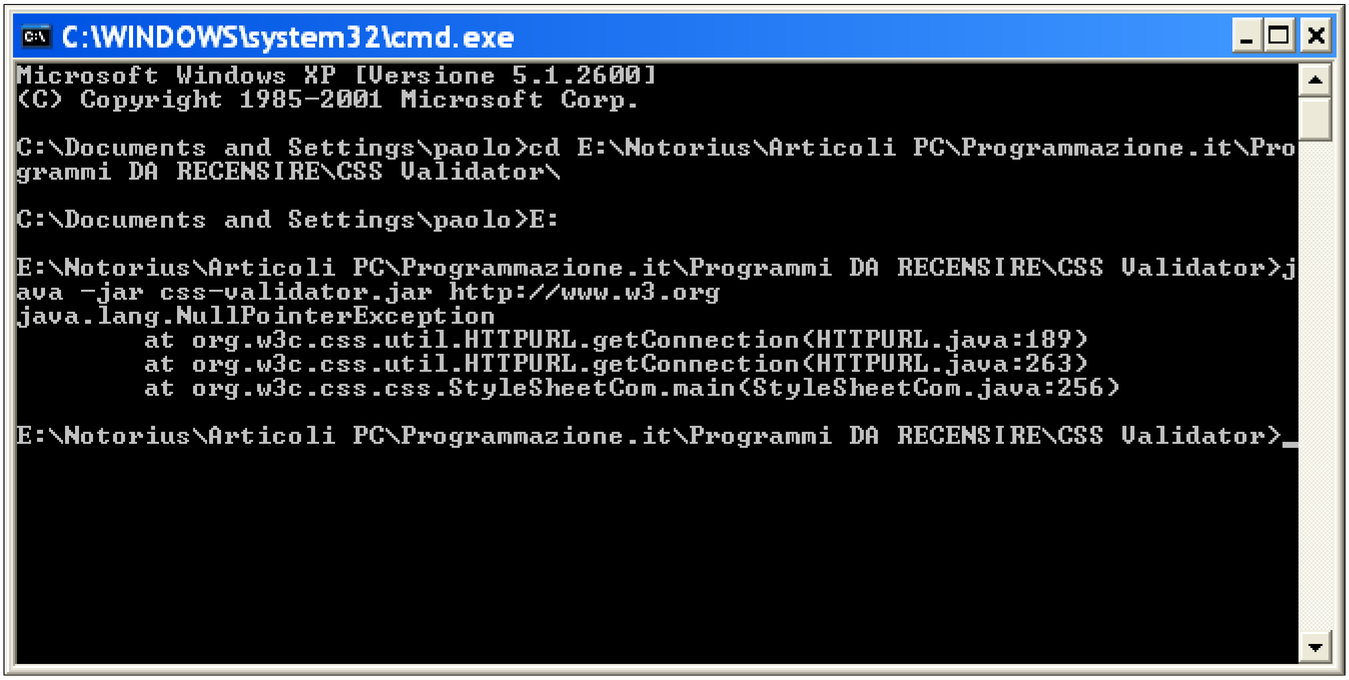
A GUI is normally built around visual (graphical) elements and is characterised by the acronym: WIMP

W - **Windows** are used to display information
I - **Icons** are small pictures used to grahically represent an element eg. a folder
M - **Menus** are used to provide the user with choices eg File>Save as..
P - **Pointer** is an arrow (or similar) that can be moved around the screen to select things.



CLI

Command line interfaces were most prevalent some time ago when computers were not as powerful. The advantage of such interfaces is that they use very little memory compared to a GUI and the commands can offer a greater range of control than most GUIs the disadvantage is that they require a more expert approach as all commands for even simple operations need to be known.



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Microsoft Windows XP [Versione 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\paolo>cd E:\Notorius\Articoli PC\Programmazione.it\Pro
grammi DA RECENSIRE\CSS Validator\

C:\Documents and Settings\paolo>E:

E:\Notorius\Articoli PC\Programmazione.it\Programmi DA RECENSIRE\CSS Validator>j
ava -jar css-validator.jar http://www.w3.org
java.lang.NullPointerException
        at org.w3c.css.util.HTTPURL.getConnection(HTTPURL.java:189)
        at org.w3c.css.util.HTTPURL.getConnection(HTTPURL.java:263)
        at org.w3c.css.css.StyleSheetCom.main(StyleSheetCom.java:256)

E:\Notorius\Articoli PC\Programmazione.it\Programmi DA RECENSIRE\CSS Validator>_
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Security

Operating systems handle security in a number of ways.

1. Account privileges can be set up to provide different users access to varying levels and authenticated with such methods as username and password/biometrics/smart cards etc.

2. Recording of user activity e.g. who opened what file and when.

Networking

Modern OS's support a variety of networking protocols, hardware and applications so that they can communicate with different OSs.

2.1.7 Outline the use of a range application software

Key Terms

- Word processors
- Spreadsheets
- Database management systems
- Email
- Web browsers
- Computer aided design (CAD)
- Graphic processing software

Word processors

Spreadsheets

Database management systems

Email

Web browsers

Computer aided design (CAD)

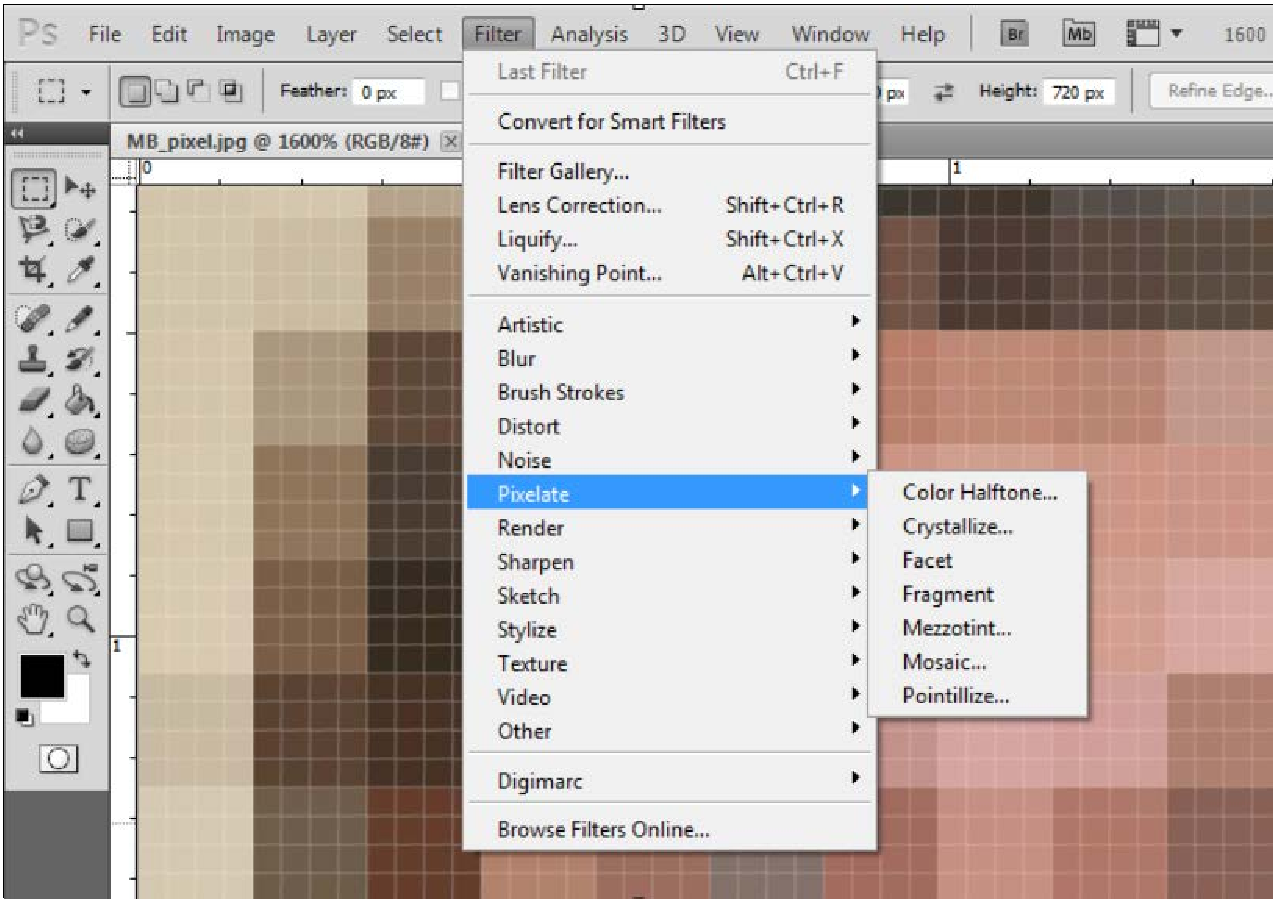
Graphic processing software.

2.1.8 Identify common features of applications

There are a variety of features that are common to many applications. These are described below.

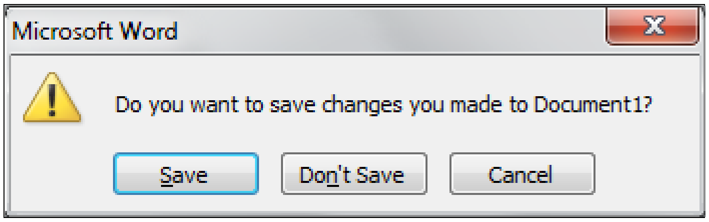
Toolbars

A toolbar is a GUI widget containing icons menus buttons or text. Toolbars are seen in many types of software such as browsers and graphic manipulation software.



Dialogue Boxes

In a graphical user interface the dialogue box is a window that allows the user to interact. It may be in the form of an alert or just provide information or request the user too make a choice.


Microsoft Word

Do you want to save changes you made to Document1?

GUI components

"GUIs use a consistent visual language to represent information in computers."

This is generally conveyed by the acronym WIMP. Windows, Icons, Menus, Pointing devices.

Binary representation

2.1.9 Define the terms: bit, byte, binary, denary/decimal, hexadecimal

Definitions

Bit (b)- A unit of information expressed as either a 0 or 1 in binary notation (A **b**inary dig**it**).
Byte (B) - It is generally accepted that the term byte refers to 8-bits taken together.

Binary, decimal, hexadecimal

There are three important number systems you need to know for this course. They are binary, decimal (denary) and hexadecimal. You are probably most familiar with the decimal system which utilises 10 symbols to represent each digit. namely 0 1 2 3 4 5 6 7 8 9. This system is referred to as base 10. Similarly binary is base 2 and hexadecimal is base 16. This can be seen in the table below:

Number system	**Base**	**Symbols**
Binary	2	0 1
Decimal	10	0 1 2 3 4 5 6 7 8 9
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 A B C D E F

The following table shows you how to count to 20 in each system.

Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F
10000	16	10
10001	17	11
10010	18	12
10011	19	13
10100	20	14

2.1.10 Outline the way in which data is represented in the computer

Strings

Strings can be made up of letters number and symbols. Spaces are also allowed. For example
"HaXX0r_111!!!111"
"2468WDwa$%"
"Harry"
"enquiries@helpdesk.com"
"123ABc"

Integers

An integer is a whole number it has no decimal or fractional parts. An integer can be positive or negative. For example:
23
7
457
-35

Characters

In programming terms a character or char is a single character. For example:
char gender = "m"

Colours

Bit mapped images are made up of a number of pixels. We can use 3 Bytes (24 bits) to represent the colour of each pixel. Each colour is made up of a combination of the three primary colours red, green and blue component (rgb). When working with colours we use the hexadecimal system for convenience as it is a more shorthand way of representing the colour. For example:

A red pixel will have the following colour components

	RED	GREEN	BLUE
Binary	1111 1111	0000 0000	0000 0000
Hexadecimal	FF	00	00

You can see that it is easier and more convenient (for humans) to represent the colour in hexadecimal as opposed to binary.
111111110000000000000000
FF0000

Simple logic gates

2.1.11 Define the Boolean operators: AND, OR, NOT, NAND, NOR and XOR

See 2.1.12

2.1.12 Construct truth tables using the above operators

Key Terms

- AND
- OR
- NOT
- NAND
- NOR
- XOR

AND

The output is true when A and B is true.

A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1

NAND

The output is true when A is false and B is false

A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

OR

The output is true when A is true or B is true, or both are true.

A	B	Z
0	0	0
0	1	**1**
1	0	1
1	1	1

NOR

The output is true when A is false or B is false, or both are false.

A	B	Z
0	0	1
0	1	0
1	0	0
1	1	0

XOR

The output is true when A is true or B is true (Note the “or both” condition does not apply).

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	0

NOT

The output is true when the input is false (unary operator).

A	Z
0	1
1	0

Now test yourself!!

Revise terms: https://quizlet.com/vn/522977660/

Booklet Test:https://quizlet.com/580968117/test?answerTermSides=2&promptTermSides=6&questionCount=39&questionTypes=14&showImages=true