

CS

00100101

AI

FaceID

Scans the scene in real-time and uses facial recognition, which uses image recognition while monitoring every image taken individually to identify matching shapes to a 'person'/face by analyzing pixels against stored patterns for the person/face. The camera focuses on the **pattern** identified.

Siri

It uses speech recognition to identify keywords spoken, match them to a database, and generate the most likely sentence.

Chess

AI will look at possible moves, analyze the pattern of past choices, and choose the most likely successful move.

Airport

Faster boarding and catching criminals.

- + Faster
- + Less cost

RLE

R→Reduces the file size, so less storage space is used and less time to transmit because it takes less bandwidth, allowing faster transmission, and if the original file is too large for email attachment.

Run-length encoding

Replace sequences of the same **repeated** color pixel/character with color/character code and the number of identical pixels/character.

* An image/text may not have many sequences of the same color/character. It would need to store each color/character and then the number 1 which adds data. E.g. Red-Green-Blue would become Red 1 Green 1 Blue 1

Sound

Use RLE where consecutive sounds are the same to record the binary value of the sound and the number of times it repeats.

No lossy for text because none of the original data can be lost, which would corrupt the file.

Image

Vector

Property: data about the shapes: the color of the triangle

Drawing list: list of all the drawing objects involved in an image: triangle

Bitmap

Pixel: The smallest addressable, identifiable element in an image

File header: Stores data about the bitmap image: Image resolution, file type, compression type

VS

→ Bitmap is made up of pixels whereas vector graphics store a set of instructions about how to draw the shape.

→ When a bitmap is enlarged the pixels get bigger and pixelate whereas the vector is recalculated and does not pixelate.

Sound

The amplitude is recorded a set number of times a second with each amplitude being given a corresponding binary number, which is saved in sequence.

Sample rate

Def: the number of samples taken per second

Time gaps between the samples get smaller. It makes the digital sound wave more accurate and closer to the analog **waveform**—smaller quantization errors. More samples are taken, so more bits are stored altogether.

Sampling resolution

Increasing the number of bits per sample means that the file size increases and makes the sound file more accurate. The digital waveform is closer to the analog waveform with smaller quantization errors since each binary amplitude is closer to the analog amplitude.

Microphone

The microphone has a diaphragm, which vibrates due to incoming sound waves, causing a coil to move past a magnet, producing an electrical signal.

3D

Starting from the bottom, using x, y, and z coordinates, it builds up the model one layer at a time.

ASCII

Character set: **All** of the characters that the computer can use. Each character has its unique code and is replaced by its code. The codes are stored in the order in the word.

ASCII

7 bits

128 characters

Only English

Extended ASCII

8 bits

256 characters

Only English

UNICODE

16 bits

Multiple languages

XNOR

Immediate addressing → operand is the data

Direct addressing → operand holds the memory address of the data.

Indirect addressing → the address to be used is at the given address

Indexed addressing → form the address from the given address plus the contents of the index register

Relative addressing → (R → To allow for **re-locatable** code) the address to be used is an offset number + the address of the current instruction

Compare instructions→Compare the result to another value
Unconditional or conditional instructions→Move to another instruction

DBMS

A DBMS provides data management. This includes the logical schema, though independent of any particular DBMS, that uses methods such as an E-R diagram to show the database structure and its relationships. The query processor allows a user to perform searches to find specific data by enabling the user to enter criteria, search for the data that meets the entered criteria, organizing using the results to be displayed to the user. The DBMS also provides a developer interface allowing users to create tables, forms, and reports.

Entity	Field	Column	Attribute
Row	Any	object	that
Tuple	data	can	be
Record	stored	about	

PK→Unique attribute used to identify a tuple
Candidate key→An attribute that could be PK
FK→Field in one table **linked to PK** in another table
Secondary key→A candidate key that has not been chosen as PK.

1NF→No repeating groups of attributes
2NF→No partial dependencies
3NF→No non-key dependencies. All fields in all tables are dependent fully on the PK and no other fields.

Database>File

It reduces data redundancy because each item of data is only stored once. Maintains data consistency because changes in one table will automatically update in another. It can provide different views so users can only see specific aspects of the database. Complex queries are easier to run.

Data dictionary

R→ Stores metadata about the database: Primary key, field name, relationships

Referential integrity→Property of a database that ensures that every FK has a **corresponding** PK, data stays up-to-date and consistent, and is enforced to preserve data integrity.

Windows

John von Neumann

PC holds the address of the next instruction to be loaded. Memory Address Register stores the next address, held in the PC, to be fetched. The data at this address is then fetched. MDR holds the data fetched from the address the MAR pointed to, which is copied to the CIR and the Control Unit decodes and executes the instruction's opcode. The PC **contents** are incremented.

```
MAR ← [PC]  
PC ← [PC]+1  
MDR ← [[MAR]]  
CIR ← [MDR]
```

SR: store flags which are set by events

IX: store a value that is added to an address to give another address

Special purpose vs General purpose

SP holds the status of a program, specific use, certain instructions

GP holds the temporary data, any purpose, most instructions

Control unit

Initiates data transfer, synchronizes the actions of other components in the CPU, and manages the execution of instructions by generating signals to be sent on the control bus.

Stored program concept: Instructions and data are stored in **the same** memory space

Immediate access store: It is a volatile memory with fast access time to hold all the current data.

Hardware

Core

Each core processes one instruction per clock pulse. More cores mean that **sequences of instructions** can be split between them and so more than one instruction is executed per clock pulse. **More** cores decrease the time to complete a task because more instructions can be carried out simultaneously.

*Multiple cores introduce additional overheads because of the need for communication between cores. Software may not be designed for multiple cores, leaving one idle. Memory access speed may not match the speed of cores causing delay.

Clock

R→synchronize operations by creating timing signals via the control bus

Each instruction is executed on a clock pulse so the clock speed dictates the number of instructions that can be run per second. The **faster** the clock speed the more instructions can be run per second.

Cache

The higher the capacity the more frequently used instructions it can store and transfer for faster access with less swapping between RAM and cache to prevent CPU idling while waiting for data.

Windows

R→ Provide a user interface and a platform for software to run

File management

Provides file naming conventions, specifies the logical method of file storage, implements access rights, and maintains/creates directory structures.

Memory management

Dynamically allocates memory to processes

RAM management

It prevents two programs from occupying the same area of RAM at the same time and manages paging, segmentation, and virtual memory

Process management

Decides which order to run processes, manages which resources they require such as allocating memory, and prevents interference between them. It allows multitasking and enables processes to share data.

Hardware management

Installs device drivers, handles buffers for data transfer and manages interrupts.

Interrupt

R→**send a signal** via control bus from a process seeking the attention of the processor

After completion of the execute stage at the end of an FE cycle, priority is checked for higher than the current process to store registers on stack. Then, appropriate ISR is called to handle according to the identified type of interrupt. If there are no further higher-priority interrupts, stack data is loaded and the previous process is continued.

Hardware

Power failure

Printer is out of paper

User has pressed a key on the keyboard

Software

Buffer full

Stack overflow

Division by zero

Buffer

Act as a temporary storage to store data before it is used by the receiving device to allow processes to operate at different speeds. E.g. YouTube

Utility

R→Help users maintain the computer by e.g. making memory allocation more efficient.

Defragmentation

Moves parts of files so that each file is contiguous in memory and improves disk access times by lessening the time to access files because each occupies contiguous blocks and free space is together, so there is less head movement.

Disk repair

Scan for errors and inconsistencies on a disk and correct them. It prevents bad sectors from being used because it identifies them.

Disk formatter

Initialize a disk so it is ready to store files

Embedded systems

Embedded system: Microprocessor that performs one specific task

- Built into the system
- Only one specific task
- Not easily updated by the user

— Upgrading is a specialist task.

RAM

Stores the data read from the sensors

SRAM uses transistors arranged as flip-flops.

+Faster access time because it does not need to be refreshed, so it is used on the CPU cache

DRAM uses transistors and capacitors.

+Costs less per unit

+Higher storage density

ROM

Stores the start-up instructions, kernel of OS, BIOS, and other data even when a device is without power.

EPROM is erased using UV light, EEPROM is erased using voltage.

PROM can be set once, but EPROM and EEPROM can be overwritten multiple times.

EPROM must be entirely erased before rewriting, EEPROM does not have to be entirely erased.

Sensors

Control vs Monitor

The system uses feedback to produce an action.

Actuators

It converts electrical energy into a mechanical force.

Feedback

Ensures the system operates with the given criteria by enabling system output to affect subsequent system input thus allowing conditions to be automatically adjusted.

HDD

HDD has rotating disks, mounted on a spindle, that have magnetized surfaces and store data in each block, one track in one sector, as a magnetic pattern.

+Costs less per unit

+More longevity



Privacy

Privacy: protection of data against unauthorized access

Unauthorized access

- Data needs protection from someone amending it
- System needs protection to stop people from installing malware

Security

Security: protection of data against loss/corruption

Protection

Up-to-date Anti-virus/Anti-spyware

Scan files on the hard drive for malicious software and check against a stored database of viruses to quarantine them if found. Compares downloaded files to a database of known viruses/spyware and prevents the download from continuing.

Firewall

Monitors incoming and outgoing packets, **checks them against** a deny list of IP addresses, and rejects the ones that disqualify criteria.

Access rights

Give managers access to different elements by having different accounts that have different access rights e.g. read-only, no access, or read-and-write.

Encryption

Data is **encoded** into cipher text so it cannot be understood if intercepted **without the decryption key**

Backup

Create copies of files **at regular intervals to retrieve** data in case the original is lost.

Threats

Hacker (Firewall)

Unauthorised access to the computer **with malicious intent**

Spyware (Anti-spyware) vs Virus (Anti-virus)

Both run in the background

Both are installed without the user's knowledge

Malicious software that replicates itself and can damage computer data.

Spyware only records data and sends recorded data to third parties.

Integrity

Integrity: ensuring the consistency/accuracy of the data

Verification

Double entry: Enter the mark twice and **the computer** compares them

Visual check: **manually** compare the mark entered with the mark on the input document

Checksum

Checksum value is calculated from the data before transmission and transmitted with the data so that the receiving computer can recalculate the checksum from the received data and compare the received and calculated values of checksum.

Validation

Presence, existence, format, length, type, range

*Validation checks that data is reasonable/sensible. It does not check that accurate data has been entered. Verification checks that data is the same as the original. It does not check if the **original** data is accurate.

Digital signature

The message is hashed to produce a digest which is encrypted with the sender's private key. The signature can **only** be decrypted with the matching sender's public key to reproduce the digest. The receiver uses the same hashing algorithm and compares both digests.

Copyright

Copyright: The **formal and legal rights** to ownership against **unauthorized** reproduction of work.

Open source license

 Allow collaboration and errors to be reported by users

Commercial license

 A fee can be charged for the program and enables the program to be copyrighted

Statement	Free Software Foundation	Open Source Initiative	Shareware	Commercial Software
The user can edit the source code	✓	✓		
The user must always pay before being able to use the software				✓
The user can redistribute the software	✓	✓	✓	
The user always gets a trial period			✓	

Ethics

+ Team members feel valued while working well together

Professional ethical body

+ Clients know one is reputable and recognize one's skills.

+ Provision of help and support e.g. legal advice.

NET

Wired vs Wireless

More secure

Faster connection so less latency

More reliable because less susceptible to issues with walls

Less cabling makes the initial setup less expensive

Freedom of movement so can move between different rooms and still transmit data.

WAP	Hardware that allows connection of devices to the central device using radio signals.
Repeater	Restores the digital signal so it can be transmitted over greater distances.

Ethernet	A protocol, which uses CSMA/CD, for data transmission over wired network connections
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Switch	To connect individual devices.
Bridge	To connect two LANs with the same protocol

	Thin	Thick
Server	All processing	Minimal processing
Client	Only sends requests	Most processing

Router

Find the most efficient path to the destination

Receives packets from devices or the Internet

Assign private IP addresses to devices on LAN

★ Devices are connected directly to the router independently

WNIC

Provide interface to wireless network as an antenna

Receives analog radio waves and converts them to digital

Fibre-optic vs Copper cable

Fibre optic has higher bandwidth than copper cable

Fibre optic is more prone to damage than copper cable

Fibre optic is more difficult to hack into than copper cable



⊕ Allows access in remote areas

— Direct line of sight needed

— Signal is affected by **bad weather**

CSMA/CD

→ Send data only when the line is idle

→ Calculate random wait time then transmit the data after that time

Before transmitting, a workstation checks if the channel is busy and data is only sent when the channel is free. Because there is more than one computer connected to the same transmission

medium two workstations can start to transmit at the same time, causing a collision. If a collision happens, the workstations abort transmission and each waits a random amount of time before attempting to resend.

P2P

- 🔑 All computers are of equal status
- 🔑 Each computer is responsible for its security

- No central management of backup: if the data from one computer is not backed up it is lost to all of them
- Individual computers may respond slower: because they are being accessed by other computers

Mesh

Mesh: All computers are connected to at least one other device. There are multiple routes between devices.

- + Fewer collisions
- + If one line goes down there are more routes available

Subnetting

- + Reduce amount of traffic and congestion in network by localizing communications
- + Improves network security because not all devices can access all areas of the network
- + Allows for easier maintenance because only one subnetwork may need to be taken down while the rest of the network can continue

IP

Network ID + Host ID

Each subnetwork has a different network ID.

Every device in each subnetwork has a different host ID but the same network ID.

Cloud

Cloud computing: Accessing files on a remote server

Public: Computing services offered by 3rd party providers over the public Internet

Private: Computing services offered either over the Internet or a private internal network

- + Data can be easily shared

+ Can access data from any computer **with internet access**

- Reliant on someone else to backup
- Cannot access without internet access

E.g. Email

Programming

Libraries

Library: Set of pre-written subroutines that can be called in other programs by importing the library

- +** code is already tested so it is more robust
- +** saves time as code does not have to be written from scratch
- +** can perform complex calculations that the programmer may be unable to do

DLL

- +** maintenance does not need to be done by the programmer because the DLL is separate from program
- +** executable file size is smaller because the executable does not contain all the library routines

IDE

Writing

As the code is being written

Auto-complete

Suggest what to type next

Context-sensitive prompts

Display predictions of the code as it is entered

Dynamic syntax check

Underlines statements that do not meet the rules of the language

Visual presentation

Pretty printing

Identify key terms

Auto-formatting

Indent code blocks

Expand and collapse code blocks

Debugging

Breakpoints

Stops the code executing at a set line to check values

Report windows

Outputs the contents of variables and data structures to see how they change

Single stepping

Executes **one line of the program at a time** and then stops and does so line by line so the effects of each statement can be seen

Translators

Interpreter

It translates one line of a high-level language program at a time, executes that code, and stops when an error is encountered. Use while writing the program to debug the partially completed program because errors can be corrected in real-time and the program can continue from that point.

+ to avoid dependent errors

+ easier to debug the program: only reports one error at a time

+ developer can test when incomplete: small parts can be tested without having to test the rest of the program → if one section does not work others can still be tested

Compiler

It translates all the code and executes the program if there is no error. Use after the program is complete to create an executable file and to repeatedly test the same section without having to re-interpret every time.

- errors cannot be corrected in real-time
- program will not run if there is any error

- + user cannot sell the code
- + users do not need the translator to run the program
- + can be compiled for different hardware specifications



R → code is optimized for CPU as machine code is generated at run time
 R → code can be used on different platforms as they are interpreted when run

Assembler

First pass

R → To create a symbol table

Adds labels to the symbol table. Remove comments. Check the opcode is in the instruction set.
 Read the assembly language program one line at a time.

Second pass

Read the assembly language program one line at a time. Generate the object code.

CREATE DATABASE ORDERS;

```
CREATE TABLE RENTAL(
    RentalID INTEGER NOT NULL,
    HouseID VARCHAR (5) NOT NULL,
    MonthlyCost REAL NOT NULL,
    DepositPaid BOOLEAN NOT NULL,
    PRIMARY KEY (RentalID)
    FOREIGN KEY(TestID) REFERENCES TEST(TestID)
);
```

ALTER TABLE RENTAL ADD OrderDate DATE;

```
SELECT COUNT(Number), SUM(Quantity), AVG(Mark)
FROM CUSTOMER, RENTAL
AND RENTAL.CustomerID = CUSTOMER.CustomerID;
INNER JOIN FILM_FACT ON FILM_FACT.FilmID = Car.FilmID
WHERE ReleaseDate >= #01/01/2022# AND ReleaseDate <= #31/01/2022#
AND Price BETWEEN #2000# AND #5000#
AND CompanyID LIKE 'HW%';
AND DepositPaid = No
GROUP BY ShopID
INSERT INTO CAR
VALUES ("123AA", "Tiger")
```