

Algorithms

An **algorithm** is a sequence of ordered instructions that are followed step-by-step to solve a problem. This does *not* need to be on a computer.

Decomposition is the breaking down of a complex problem into smaller more manageable problems that are easier to solve.

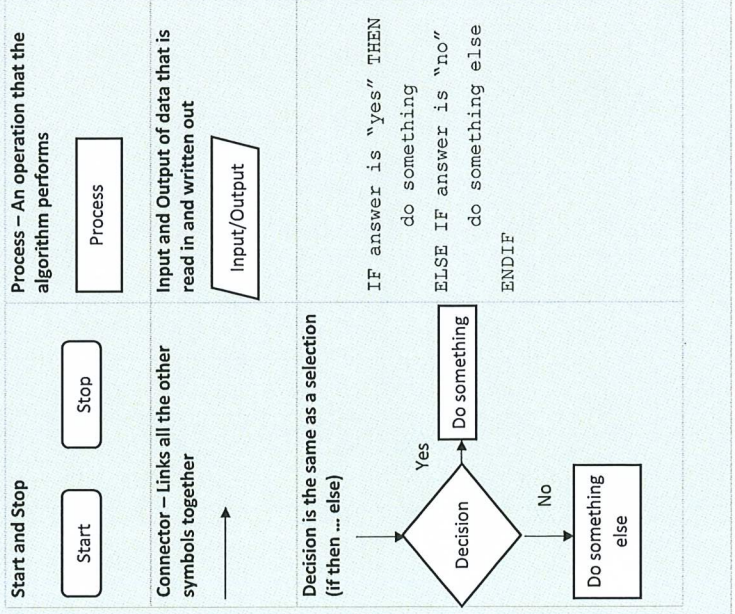
Abstraction allows us to remove unnecessary detail from a problem leaving us with only the relevant parts of a problem thereby making it easier to solve.

Algorithm Efficiency More than one algorithm can be used to solve the same problem. Normally we use the algorithm that solves the problem in the quickest time with the fewest operations or makes use of the least amount of memory.

Dry run testing is carried out using **trace tables**. The purpose of the trace tables is for the programmer to track the value of the variables and outputs at each step of the program and to track how they change throughout the running of the program.

Flowchart Symbols

We can represent algorithms using flowcharts



Pseudocode

We can represent algorithms using pseudocode

Variable assignment	Example	Python equivalent
constant PI ← 3.142	a ← 10	a = 10
Input	a ← USERINPUT	a = input()
Output	OUTPUT "Bye"	print("Bye")
Arithmetic Operators		
Add	+	+
Multiply	*	*
Divide	/	/
Subtract	-	-
Integer division	a ← 7 DIV 2	a = 7 // 2
Modulus (remainder)	a ← 7 MOD 2	a = 7 % 2
Relational Operators		
Less than	<	<
Greater than	>	>
Equal to	=	==
Not equal to	≠ or <>	!=
Less than or equal to	≤	<=
Greater than or equal to	≥	>=
Boolean Operators		
AND	AND	AND
OR	OR	OR
NOT	NOT	NOT
Selection		
if ..	IF i > 2 THEN j ← 10 ENDIF	if i > 2: j=10
if .. else ...	IF i > 2 THEN j ← 10 ELSE j ← 3 ENDIF	if i > 2: j=10 else: j=3
if ... else if ... else	IF i ==2 THEN j ← 10 ELSE IF i==3 THEN	if i ==2: j=10 elif i==3: j=3

	<pre> j ← 3 ELSE j ← 1 ENDIF else: j=1 </pre>
Iteration	
While loops	<pre> a ← 1 WHILE a < 4 OUTPUT a a ← a + 1 ENDWHILE for a in range(3): print(a) </pre>
For loops	<pre> FOR a ← 0 TO 3 OUTPUT a ENDFOR a ← 1 REPEAT OUTPUT a UNTIL a=4 </pre>
Repeat loops	
Subroutines	
procedure	<pre> SUB hello() OUTPUT "hello" ENDSUB def hello(): print("hello") </pre>
Function (with parameters and return)	<pre> SUB add(n) a ← 0 FOR a ← 0 TO n a ← a + n ENDFOR RETURN a ENDSUB def add(n): a=0 for a in range(n+1): a=a+n return a </pre>
Built-in functions	
Length of array	LEN(a)
Random integer	RANDOM_INT(0, 9) import random random.randint(0,9)

Computer Networks

A network is a set of computers that are connected to one another.

Standalone computers are isolated from other devices.

Advantages of a network

- ✓ Share resources, such as software applications, files and hardware (eg printers).
- ✓ Allows communication (eg email) and can transfer files easily.
- ✓ Easier network management (eg can backup data onto a central fileserver; updates can be sent to all computers; users on a network can login to any computer)

Disadvantages of a network

- ✓ Greater security risk as computers can be hacked if they are connected to the internet.
- ✓ Worms can spread from one computer to another
- ✓ A problem with any shared resource, (eg file server goes down) can impact the whole network.

Types of Computer Networks

Personal Area Network (PAN)

Many people have multiple devices such as tablets, phones and computers that can be interconnected using a PAN. A Bluetooth PAN uses radio waves to communicate wirelessly between devices over a range of a few metres.

Local Area Network (LAN) covers a relatively small geographical area typically extends over the range of a single organisation such as a university campus, school site. LANs are usually managed by a single organisation.

Wide Area Network (WAN) made up of many local area networks and covers a much wider geographical area. The internet the ultimate WAN. It is a network of networks with billions of interconnected devices. No single person or organisation has control over a WAN.

Network Topology

A network topology describes how a set of computers are arranged within a network.

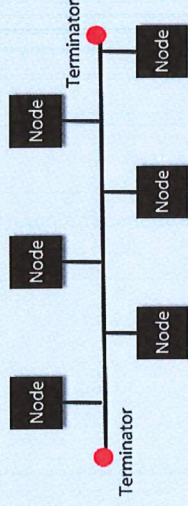
Bus network topology All devices including clients, servers, printers and so on are connected to a cable called a bus. All communication is via the shared bus. At either ends of the bus is a terminator.

Advantages

- ✓ Easy and cheap to install and does not require much cable
- ✓ Easy to add more computers

Disadvantages

- ✓ If the main cable fails then the whole network fails.
- ✓ Less secure as data are broadcast to all devices on the network.
- ✓ Can be slow as there are collisions between data along the shared bus.
- ✓ Will get slower as more computers are added.



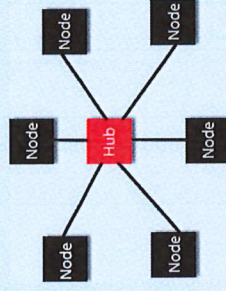
Star network topology all devices including clients, servers, printers and so on are connected to a central hub or switch. All communication is via the hub

Advantages

- ✓ Greater security as data are only sent to the intended recipient.
- ✓ If any of the connections fail only a single node will be affected.
- ✓ Fewer collisions between data packets

Disadvantages

- ✓ If the central hub fails then every computer on the network is affected.
- ✓ Expensive as extra cable and hardware (hubs) are needed.



Wired and Wireless

Computers can be connected using wired or wireless methods

Wired transmission methods use cables to communicate

Wireless transmission use radio waves communicate (eg Wi-Fi).

Advantages of wireless

- ✓ Can use computer anywhere and not constrained by cables

Disadvantages of wireless

- ✓ Packets can be intercepted more easily than wired connections
- ✓ Security is a much more difficult challenge, as the network can be accessed from outside the confines of a building.

- ✓ Slower than wired methods
- ✓ Signal can be interfered with by other electronic devices.

Advantages of wired

- ✓ Allows more control, security and reliability. Can restrict who has access to the network.
- ✓ Wired methods have greater speeds than wireless methods.

Disadvantages of wired

- ✓ Cables can be difficult to maintain in big organisations

Wired networks use a variety of cables, including copper and fibre optic.

Copper cables use electrical signals to transmit data. Three main types:

- ✓ **Coaxial cable** – the signal loses strength over long distances
- ✓ **Unshielded twisted pair** – A pair of copper cables are twisted together and allows data to be transmitted over longer distances
- ✓ **Shielded twisted pair** – Shielding around the twisted cables means the signal is less susceptible to interference.

Fibre optic cables are glass or plastic and use pulses of light to transmit data

Advantages of copper cables

- ✓ Cheaper than fibre optic
- ✓ Reliable because a telephone is powered from the copper cable and does not rely on a separate electrical power supply

Advantages of fibre optic

- ✓ Slow
 - ✓ Low capacity
 - ✓ Can only be used over short distances
 - ✓ Interference can occur
- Advantages of fibre optic**
- ✓ Higher bandwidth than copper so can transmit more data
 - ✓ Less attenuation (degrading) of the signal so fibre optic is more suitable over long distances
 - ✓ Less “cross talk” interference between fibres compared with copper so the quality of the signal is better

Disadvantages of fibre optic

- ✓ Expensive
- ✓ Difficult to install

Network Security and Protocols

Why do we need network security?

- ✓ To prevent unauthorised access to our electronic devices
- ✓ To protect our data eg to prevent sensitive data being stolen
- ✓ Prevent cyberattacks

Methods of Network Security

Authentication allows us to confirm the identity an individual.

There are lots of ways of confirming the identity of an individual that come under one of three factors:

- ✓ Knowledge factor: Something the user knows, eg a password
- ✓ Possession factor: Something the user owns eg a mobile phone
- ✓ Biometric factor: eg Fingerprint, iris scan

Encryption The message is garbled so if it gets intercepted during transmission it will be almost impossible for anyone without the key to read the original message.

Firewall prevents packets containing malware getting on to the computer

MAC address filtering A MAC (Media Access Control) address is a unique identifier for any device that is connected to a network. Each network interface card has a unique MAC address that is a 12 digit hexadecimal code (e.g. 12-F3-EE-56-44-A1).

- ✓ *White list filtering* only allows devices on a list to connect to the network.
- ✓ *Black list filtering* devices in a black list blocked from accessing the network.

Network Protocols

A **network protocol** is a set of rules that allow computers to communicate and exchange information over a network. There are many types of protocols depending on the application.

HTTP (Hypertext transfer protocol) is the protocol used for the World Wide Web. An exchange begins with a request for a web page from a client web browser to a web server. The server then sends the web page to the client.

HTTPS (Secure Hypertext transfer protocol) is a secure way of transferring data between a web browser and a server because the data are encrypted during transfer. Used for e-commerce and online banking.

FTP (File Transfer Protocol) is usually used to download or upload large files from a server to a client.

Ethernet is not a single protocol but a collection of related protocols. LANs most commonly use ethernet. The following is a simplified procedure:

- 1) Check whether there is any traffic on the ethernet
- 2) If so wait for traffic to clear
- 3) Send the packet
- 4) If collision detected, go to step 1 to resend.

Wi-Fi is a collection of protocol that use radio waves to transmit data between devices. Wi-Fi is a trademark and WLAN (Wireless LAN) is the generic term. Data are transmitted when the medium is clear, and an acknowledgement is received if the transmission was successful. If no acknowledgement is received, then the data are resent as it is assumed that a collision occurred, and the packets did not reach their destination.

Email protocols

SMTP (simple mail transfer protocol) Sends the mail from the user onto the mail server.

IMAP (Internet Message Access Protocol) Retrieves the mail from the mail server to the client (user) and allows access from anywhere on any device because the email remains on the server.

TCP (Transport Control Protocol) When files are sent over the internet they are broken up into small chunks called packets. When they arrive at the destination computer they are reassembled back into the original format. TCP handles and controls all this. TCP waits for acknowledgements to verify whether the packets have reached their destination. TCP will also retransmit packets of they have not arrived at the destination or become corrupted.

IP (Internet Protocol) The internet protocol is a set of rules that govern the transmission of data across the internet.

UDP (User Datagram Protocol) is used as an alternative to TCP. It is used in video conferencing and online gaming when speed is necessary as huge volumes of data are transferred in real time. It improves speed by not checking for lost packets so they do not get re-sent.

TCP/IP

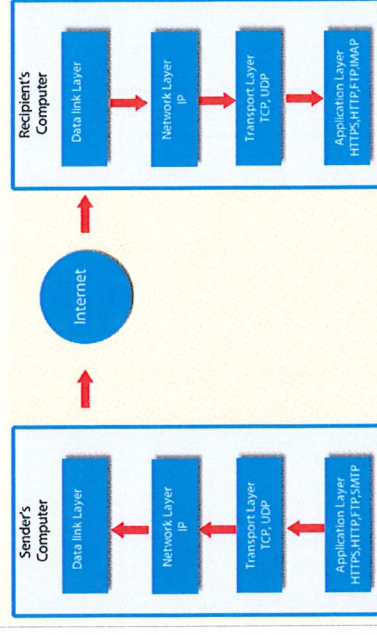
The TCP and IP protocol work closely together and are referred to as TCP/IP. The TCP/IP model consists of four layers that pass data between each layer.

Application layer contains protocols related to the application such as HTTP, HTTPS for web browsers, FTP for file transfer and SMTP and IMAP for email. The application layer interacts with the user via appropriate application software (eg web browser / ftp client).

The **transport layer** establishes the end to end connection. When files are sent over the internet, they are broken up into small chunks called packets. When they arrive at the destination computer they are reassembled back into the original format. It is the role of the transport layer to split the data into packets and pass the data onto the network layer. On the recipient's computer the transport layer reassembles the packets into the original form. The packets are numbered by this layer to allow them to be reassembled. The transport layer chooses the port number for sender and receiver. TCP and UDP are the main protocols used in this layer.

The **network layer** adds the source and destination IP address and route the packets over the network. At the destination the network layer strips out the IP addresses. The IP operates on this layer.

The **data link layer** has a network card and deals with the physical connection and adds the physical addresses (MAC address) of the hardware to the packets that it receives from the network layer. For each step the sender and receiver MAC address is removed then a new sender and receiver MAC address is added. The receiver MAC address becomes the sender MAC address.



Cybersecurity

Cybersecurity is concerned with the protection of computer systems, computer networks and data. Its purpose is to:

- to protect computers and networks from cyberattacks
- to prevent unauthorised access to computers
- to protect computers against damage caused by malicious software
- to prevent data from being stolen
- to protect against the disruption of services running on the computer

Cyber Security Threats

Malware is software that has been purposely developed to damage, disrupt or take control of computer systems.

Social engineering techniques manipulate people into giving away confidential and personal information.

Weak passwords are easy to guess. Passwords that use words are easy to crack using an algorithm that systematically goes through all the words in a dictionary until the word matches the password.

Default passwords Upon registration for an online account, users may be given a default password that they do not change. Often these passwords are sent out unencrypted via email so pose a major security vulnerability.

Removable media such as a USB pen drive can be a vector for transmitting malware.

Unpatched/outdated software Software needs regular updates to fix security vulnerabilities in computer systems. Software that remains unpatched is vulnerable to attack.

Misconfigured access rights Users should only have access to files and data that they need, but sometimes they have access that they should not.

Penetration Testing

Penetration testing is legitimate testing of an organisation's computer system to identify whether there are any vulnerabilities that an attacker could exploit. By identifying vulnerabilities, these can be patched before the system gets attacked.

White box testing testers are given some information about the network, such as network architecture, source code, and IP addresses. This is designed to simulate an attack by a malicious insider.

Black box testing testers are given very little information about the network before the test. This is designed to simulate an outside attack or cyber warfare attack.

Cyber Security Threats - Malware

Computer viruses replicate themselves and can transfer from one computer to another. They are activated by a user often as email attachments and attachment to other files and programs.

Trojan gains access to a computer by pretending to be legitimate software. The trojan allows unauthorised backdoor access to a computer without the user being aware.

Spyware records the activity on your computer such as your keystrokes, thereby logging your passwords for instance and then send the data back over the network to a hacker. Spyware can also be used to control your webcam and microphone.

Adware includes banners and popups that are automatically installed onto a computer. Whilst this does not cause any, adware is undesirable and can slow down the performance of a computer.

Worms spread like viruses but do not require human intervention. They attach themselves to network tools to spread automatically around a network very quickly.

Methods to detect and prevent cyber security threats

Biometric measures such as fingerprints, facial recognition and iris scans are increasingly being used to verify a user's identity for mobile devices. These are more secure than passwords that can be guessed and forgotten. Biometric measures require a user to be present when signing into a system.

Automatic software updates to firewalls, operating systems, antivirus and other security software are needed so that software can be kept up-to-date against new malware and to fix recently discovered vulnerabilities.

CAPTCHA is a test that can distinguish between humans and bots. It uses images that machines cannot interpret but humans can.

Password systems Virtually all accounts require passwords to access. Some secure sites such as online banking require 2 passwords. Banks may also contact you by phone to confirm a large transaction. This is called two-factor authentication. Password systems can force users to have strong passwords that regularly need to be changed.

Using email to confirm a person's identity Often when you register for an online service you need to provide your email address. You are then requested to activate a link sent to you in an email. This is to confirm that the email account is actually active. Helps to ensure that the users are human and not bots.

Anti-virus software scans the computer intermittently to identify whether there is any malware on the computer. The software

compares each file against a database of known virus codes. If viruses are found (ie contains code that is in the database) the file is quarantined. That is the file cannot be run without explicit authorisation from the user. New malware are regularly being created and so anti-virus software needs to be updated to identify the new viruses. That is why anti-virus software is regularly updated.

Cyber Security Threats – Social Engineering

Blogging (Pretexting) Fraudsters make up a scenario to con victims into revealing something they would not ordinarily do. They may have found out some personal information about you from social media sites, to pretend they already know you.

How to prevent

- Use biometric measures because these cannot be divulged.
- Ensure you have your privacy settings on any social media to maximum so that fraudsters cannot find information about you such as your date of birth, where you live etc.

Phishing Normally an email or text messaging scam where victims are conned into believing that they are being contacted by their bank for instance and can give sensitive personal details such as bank account passwords.

How to prevent

- Awareness and vigilance. Be particularly aware of unsolicited texts, emails and phone calls. Do not give personal confidential information away. Official organisations such as banks will never ask for this information.
- Apply email filtering to prevent dubious emails getting through.

Pharming Users are redirected to a fraudulent website that they believe to be genuine because it looks like the real site. For instance, you could be directed site that pretends to be an online store that asks you for your credit card information.

How to prevent

- Check the URL in the web address. For secure websites such as banking or e-commerce sites the HTTPS protocol should be used.
- Website filter

Shoulder surfing Fraudsters look over the shoulder of users to see what passwords or pin numbers that are being typed into the device. This can easily occur at computer terminals and at ATMs that are out in the street.

How to prevent

- Be aware of who is around you when typing in your pin into an ATM or into a chip and pin device. Make sure you cover your hands and they are shielded from prying eyes.
- Place computers in locations that makes shoulder surfing difficult

Databases

A database is a collection of data stored in an organised and logical way. Data are stored in tables and tables are made up of records (rows) which can have 1 more attributes (columns). An example of a table is given here:

Student ID	First Name	Surname	DateOfBirth	FormTutor
712	Bart	Simpson	1/4/10	Principal Skinner
423	Lisa	Simpson	20/5/12	Mrs Krabapple
917	Ralph	Wiggum	16/6/10	Mrs Krabapple
124	Nelson	Muntz	14/9/09	Principal Skinner

ENTITY

Each table contains information about an entity. A database entity is an object, person, item or thing about which you want the data stored. Examples of database entities are:

Person entity	Object entity	Item entity
✓ Customer	✓ Book	✓ Sale transaction
✓ Employee	✓ Car	✓ Appointment
✓ Student	✓ House	
✓ Teacher		

DATA

Data are atomised facts, values and observations that are stored in a database. That is they cannot be broken up further. Data can be stored as any data type.

Field	Student ID	First Name	Height	Date of Birth	Had Flu
Date Type	Integer/number	Text/string	Real/float	date	Boolean – Yes/no or true/false
Record 1	712	Bart	1.35	1/4/2010	True
Record 1	423	Lisa	1.16	20/5/2012	True
Record 1	917	Ralph	1.05	16/6/2010	False

DATABASE INDEX

A database index allows for quick speed of retrieval of data from searches of tables. The index is a separate file that has a sorted column of values that link to records in a table.

RECORD

A record is a single row in a table that can have data stored as 1 or more fields (columns). A record needs to be uniquely identifiable and needs an entity identifier which in this example is Student ID. A table contains multiple records. The following example contains 4 records.

StudentID	FirstName	Surname	DateOfBirth	FormTutor
712	Bart	Simpson	1/4/10	Principal Skinner
423	Lisa	Simpson	20/5/12	Mrs Krabapple
917	Ralph	Wiggum	16/6/10	Mrs Krabapple
124	Nelson	Muntz	14/9/09	Principal Skinner

The Student ID field contains unique values for each record; this means that each value is different. The Surname field does not contain unique values. For instance, Simpson appears twice.

FIELD

Fields / attributes form the columns of the database table and refer to the characteristics of a record. For instance, the fields of the table below include:

- ✓ Student ID
- ✓ First name
- ✓ Surname
- ✓ Date of Birth
- ✓ Form tutor

Fields

Student ID	First Name	Surname	Date of Birth	Form Tutor
712	Bart	Simpson	1/4/10	Principal Skinner
423	Lisa	Simpson	20/5/12	Mrs Krabapple
917	Ralph	Wiggum	16/6/10	Mrs Krabapple
124	Nelson	Muntz	14/9/09	Principal Skinner

DATA REDUNDANCY

Data redundancy occurs when the same data are stored in multiple places and so we have repeating data. As a result more space is needed to store the same values several times which is not efficient. In the table below notice how the Author Name fields are repeated.

BookID	Title	FirstName	Surname
1	Fantastic Beasts and Where to Find Them	J.K.	Rowling
2	Harry Potter and the Chamber of Secrets	J.K.	Rowling
3	Harry Potter and Order of the Phoenix	J.K.	Rowling
4	The BFG	Roald	Dahl
5	Going Solo	Roald	Dahl
6	Danny Champion of the World	Roald	Dahl
7	War Horse	Michael	Morpurgo
8	Private Peaceful	Michael	Morpurgo

DATA INCONSISTENCY

Data inconsistency occurs when data pertaining to the same object are in fact stored in a different format. For instance, J.K. Rowling and Joanne Rowling refer to the same person, but the database may record these as two separate authors.

BookID	Title	FirstName	Surname
1	Fantastic Beasts and Where to Find Them	JK	Rowling
2	Harry Potter and the Chamber of Secrets	Joanne	Rowling
3	Harry Potter and Order of the Phoenix	Joanne	Rowling
4	The BFG	Roald	Dahl
5	Going Solo	Roald	Dahl
6	Danny Champion of the World	Roald	Dahl
7	War Horse	Michael	Morpurgo
8	Private Peaceful	Michael	Morpurgo

RELATIONAL DATABASES

Complex databases can be made up of multiple tables linked together by shared values called a key. These relational databases make it easier to search and find information that you want. Relational databases reduce the amount of duplication (redundancy) of data and reduces inconsistencies in the data.

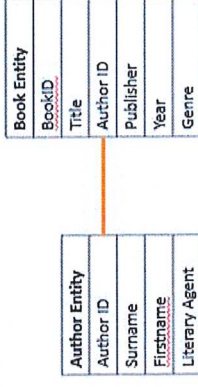
PRIMARY KEY

All tables have a field that is the primary key and uniquely identifies each record. This is also known as entity identifier

FOREIGN KEY

These are primary keys that are held as fields in other tables to cross reference tables. They allow tables to be linked together.

For instance, in a book database with two tables including Author table and Book table, AuthorID is primary key in Author table and is used to cross-reference with the AuthorID in the book table which is the foreign key so the two tables can be linked.



Primary key

AuthorID	Firstname	Surname	LiteraryAgent
1	Joanne	Rowling	Neil Blair
2	Roald	Dahl	David Higham Associates
3	Michael	Morpurgo	David Higham Associates

Foreign key

BookID	AuthorID	Title	YearPublished	Publisher	Genre
1	1	Fantastic ...	2001	Bloomsbury	Fantasy
2	1	... Chamber of Secrets	1998	Bloomsbury	Fantasy
3	1	... Order of the Phoenix	2003	Bloomsbury	Fantasy
4	2	The BFG	1982	Penguin	Fantasy
5	2	Going Solo	1986	Jonathan Cape	Autobiography
6	2	Danny Champion...	1975	Jonathan Cape	Children
7	3	War Horse	1982	Keye & Ward	Historical fiction
8	3	Private Peaceful	2003	HarperCollins	Historical fiction

STRUCTURED QUERY LANGUAGE

We will use this book table in the examples that follow.

Book ID	Title	Author	Year Published	Publisher	Genre
1	Fantastic Beasts and Where to Find Them	J.K Rowling	2001	Bloomsbury	Fantasy
2	Harry Potter and the Chamber of Secrets	J.K Rowling	1998	Bloomsbury	Fantasy
3	Harry Potter and Order of the Phoenix	J.K Rowling	2003	Bloomsbury	Fantasy
4	The BFG	Roald Dahl	1982	Penguin	Fantasy
5	Going Solo	Roald Dahl	1986	Jonathan Cape	Autobiography
6	Danny Champion of the World	Roald Dahl	1975	Jonathan Cape	Children
7	War Horse	Michael Morpurgo	1982	Keye & Ward	Historical fiction
8	Private Peaceful	Michael Morpurgo	2003	HarperCollins	Historical fiction

SELECT

To retrieve data from the table

To retrieve all records, data from the table we can use the SELECT statement with the wild card operator *

```
SELECT *
FROM tab1eName

EXAMPLI
SELECT *
FROM book
```


RETRIEVED DATA

ID	Book Title	Author	Year Published	Genre
1	Fantastic Beasts ..	JK Rowling	2001	Bloomsbury
2	..Chamber of Secrets	JK Rowling	1998	Bloomsbury
3	..Order of the Phoenix	JK Rowling	2003	Bloomsbury
4	The BFG	Roald Dahl	1982	Penguin
5	Going Solo	Roald Dahl	1986	Jonathan Cape
6	Danny Champion ..	Roald Dahl	1975	Jonathan Cape
7	War Horse	Michael Morpurgo	1982	Kaye & Ward
8	Private Peaceful	Michael Morpurgo	2003	HarperCollins

We can also choose the fields that we wish to retrieve:

```
SELECT field1, field2, ...
FROM tableName
```

EXAMPLE

```
SELECT Author, Title
FROM book
```

RETRIEVED DATA

Book Title	Author	Year Published	Genre
Fantastic Beasts and Where to Find Them	JK Rowling	2001	Children
Harry Potter and the Chamber of Secrets	JK Rowling	1998	Children
Harry Potter and Order of the Phoenix	JK Rowling	2003	Children
The BFG	Roald Dahl	1982	Children
Going Solo	Roald Dahl	1986	Children
Danny Champion of the World	Roald Dahl	1975	Children
War Horse	Michael Morpurgo	1982	Children
Private Peaceful	Michael Morpurgo	2003	Children

We can sort the output of our SELECT statement by using the ORDER BY clause. ASC and DESC refer to sorting ascending and descending alphabetically or numerically of a specified field.

```
ORDER BY fieldName ASC|DESC
```

EXAMPLE SORT ASCENDING

```
SELECT Author, Title
FROM book
ORDER BY Title ASC
```

Book Title	Author	Year Published	Genre
Danny Champion of the World	Roald Dahl	1975	Children
Fantastic Beasts and Where to Find Them	JK Rowling	2001	Children
Going Solo	Roald Dahl	1986	Children
Harry Potter and the Chamber of Secrets	JK Rowling	1998	Children
Harry Potter and Order of the Phoenix	JK Rowling	2003	Children
Private Peaceful	Michael Morpurgo	2003	Children
The BFG	Roald Dahl	1982	Children
War Horse	Michael Morpurgo	1982	Children

EXAMPLE SORT DESCENDING

```
SELECT Author, Title
FROM book
ORDER BY Title DESC
```

Book Title	Author	Year Published	Genre
War Horse	Michael Morpurgo	1982	Children
The BFG	Roald Dahl	1982	Children
Private Peaceful	Michael Morpurgo	2003	Children
Harry Potter and Order of the Phoenix	JK Rowling	2003	Children
Harry Potter and the Chamber of Secrets	JK Rowling	1998	Children
Going Solo	Roald Dahl	1986	Children
Fantastic Beasts and Where to Find Them	JK Rowling	2001	Children
Danny Champion of the World	Roald Dahl	1975	Children

WHERE CLAUSE

We can filter our selection using the WHERE clause

```
WHERE fieldName operator value
```

Operator	Description
=	Value equal to
!=	Value not equal to
<	Value less than
>	Value greater than
<=	Value less than or equal to
>=	Value greater than or equal to

SELECT USING WHERE CLAUSE

```
EXAMPLE 1 – SELECT BOOKS WRITTEN SINCE 2000
```

```
SELECT Title, Author, YearPublished
FROM book
WHERE YearPublished > 2000
```

Book Title	Author	Year Published	Genre
Fantastic Beasts and Where to Find Them	JK Rowling	2001	Children
Harry Potter and Order of the Phoenix	JK Rowling	2003	Children
Private Peaceful	Michael Morpurgo	2003	Children

```
EXAMPLE 2 – SELECT BOOKS WRITTEN BY MICHAEL MORPURGO
```

```
SELECT Title, Author
FROM book
WHERE Author = "Michael Morpurgo"
```

Notice how the author name is in speech marks because it is a string datatype.

Book Title	Author	Year Published	Genre
War Horse	Michael Morpurgo	1982	Children
Private Peaceful	Michael Morpurgo	2003	Children

EXAMPLE 3 – SELECT BY DATE

```
WHERE Date < #1/1/2010#
For data type date you need to use #. Eg
```

BOOLEAN OPERATORS

We can use Boolean and relational operators with the WHERE clause if we have multiple conditions that need to be met.

Operator	Description
OR	Allows us to combine multiple conditions. Any of the conditions can be true for the overall expression to return true
AND	Allows us to combine multiple conditions. All conditions need to be true for the overall expression to return true
NOT	Reverses the value of a condition. If it is true it will be false and vice versa

```
EXAMPLE – SELECT ALL BOOKS WRITTEN BY MICHAEL MORPURGO SINCE 2015
```

```
SELECT Title, Author FROM book
WHERE Author="Michael Morpurgo"
AND YearPublished > 2000
```

Book Title	Author	Year Published	Genre
Private Peaceful	Michael Morpurgo	2003	Children

UPDATE – TO UPDATE RECORDS IN A DATABASE

To make changes to a record that is already in a table we can use the UPDATE statement.

```
UPDATE book
```

```
SET Genre="Children"
```

```
WHERE Author="JK Rowling"
```

EXAMPLE 1: Update the book table to change the genre of all fields to Children

```
UPDATE book
```

```
SET Author="Joanne Rowling"
```

```
WHERE Author="JK Rowling"
```

```
UPDATE book
```

```
SET Author="JK Rowling"
```

Book ID	Title	Author	Year Published	Publisher	Genre
1	Fantastic Beasts .	Joanne Rowling	2001	Bloomsbury	Children
2	Harry Potter ..	Joanne Rowling	1998	Bloomsbury	Children
3	Harry Potter ...	Joanne Rowling	2003	Bloomsbury	Children
4	The BFG	Roald Dahl	1982	Penguin	Children
5	Going Solo	Roald Dahl	1986	Jonathan Cape	Children
6	Danny .	Roald Dahl	1975	Jonathan Cape	Children
7	War Horse	Michael Morpurgo	1982	Kaye & Ward	Children
8	Private Peaceful	Michael Morpurgo	2003	HarperCollins	Children

INSERT INTO – ADDING NEW RECORDS

INSERT INTO is a commonly used command in SQL for adding new records to database tables. To insert all attributes for a table we can use:

```
INSERT INTO table
VALUES (value1, value2, ...)
```

EXAMPLE

```
INSERT INTO book
```

```
VALUES ('Boy', 'Roald Dahl', 1984, 'Penguin',
'Autobiography')
```

Sometimes we do not enter data into every field. Instead we can explicitly state which fields we would like to add the data to.

```
INSERT INTO table (field1, field2,...)
VALUES (value1, value2,...)
```

The values correspond to the fields in the table i.e.:

- ✓ Field 1: Book ID
- ✓ Field 2: Title
- ✓ Field 3: Author
- ✓ Field 4: YearPublished
- ✓ Field 5: Publisher
- ✓ Field 6: Genre

EXAMPLE

```
INSERT INTO book (Title, Author, YearPublished,
Publisher, Genre) VALUES ('Boy', 'Roald Dahl', 1984,
'Penguin', 'Autobiography')
```

DELETING RECORDS

To delete a record we specify which record(s) from which table we wish to remove.

```
DELETE FROM table WHERE condition
```


EXAMPLES

```
Remove all books
DELETE FROM book
DELETE * FROM book
```

The WHERE clause is used to filter records so that we do not apply a statement to a whole table.

Remove all books written by JK Rowling:

```
DELETE FROM book WHERE Author='JK Rowling'
```

Remove all books written by Michael Morpurgo and written before 2000

```
DELETE FROM book WHERE Author='Michael Morpurgo' AND
YearPublished < 2000
```

SELECT ATTRIBUTES FROM MULTIPLE TABLES

So far we have looked at a database made up of a single table. databases can be made up of multiple tables. We can link tables together using primary keys and foreign keys. We can use SQL statements to select data from multiple tables. When selecting the data from multiple tables we need to specify the name of the table from which each attribute we are wishing to retrieve.

We will use the following database table as an example case study.

Primary key		Author Table	
AuthorID	Surname	LibreryAgent	
1	Joanne Rowling	Neil Blair	
2	Roald Dahl	David Higham Associates	
3	Michael Morpurgo	David Higham Associates	

Foreign key		Book Table		
BookID	Title	Surname	YearPublished	Publisher
1	Fantastic Beasts and Where to Find Them	2001	Fantasy	Fantasy
2	Harry Potter and the Chamber of Secrets	1998	Bloomsbury	Fantasy
3	Harry Potter and Order of the Phoenix	2003	Bloomsbury	Fantasy
4	The BFG	1982	Penguin	Fantasy
5	Going Solo	1996	Jonathan Cape	Autobiography
6	Danny Champion of the World	1975	Jonathan Cape	Children
7	War Horse	1982	Keyp & Ward	Historical fiction
8	Private Peaceful	2003	HarperCollins	Historical fiction

We need to specify that we only wish to select the records where the primary key and foreign key match.

EXAMPLES

Retrieve data book title and author surname

```
SELECT book.Title, author.Surname
FROM author, book
WHERE author.AuthorID=book.AuthorID
```

Fantastic Beasts and Where to Find Them	JK Rowling
Harry Potter and the Chamber of Secrets	JK Rowling
Harry Potter and Order of the Phoenix	JK Rowling
The BFG	Roald Dahl
Going Solo	Roald Dahl
Danny Champion of the World	Roald Dahl
War Horse	Michael Morpurgo
Private Peaceful	Michael Morpurgo

Retrieve book title and author surname where genre is *fantasy*

```
SELECT book.title, author.surname
FROM author, book
```

```
WHERE author.AuthorID=book.AuthorID
AND book.Genre='Fantasy'
```

Fantastic Beasts and Where to Find Them	JK Rowling
Harry Potter and the Chamber of Secrets	JK Rowling
Harry Potter and Order of the Phoenix	JK Rowling
The BFG	Roald Dahl

Retrieve book title and author surname where genre is fantasy and sort in descending order Title

```
SELECT book.title, author.surname
FROM author, book
WHERE author.AuthorID=book.AuthorID
AND book.Genre='Fantasy'
ORDER BY title DESC
```

The BFG	Roald Dahl
Harry Potter and Order of the Phoenix	JK Rowling
Harry Potter and the Chamber of Secrets	JK Rowling
Fantastic Beasts and Where to Find Them	JK Rowling

Ethical, Legal and environmental impacts of digital technology on society

The Ten Commandments of Computer Ethics (From the Computer Ethics Institute)

Thou shalt:

1. not use a computer to harm other people
2. not interfere with other people's computer work
3. not snoop around in other people's computer files
4. not use a computer to steal
5. not use a computer to bear false witness
6. not copy or use proprietary software for which you have not paid (without permission)
7. not use other people's computer resources without authorization or proper compensation
8. not appropriate other people's intellectual output
9. think about the social consequences of the program you are writing or the system you are designing
10. always use a computer in ways that ensure consideration and respect for other humans

Environmental Impacts

- The disposal of computer waste is a big problem because they contain many toxic chemicals. Often old computing equipment is illegally shipped for disposal to developing countries.
- The growth in cloud computing means a greater need for storing data online. For this data centres are used but they require huge amounts of electricity, thereby contributing to climate change.
- Cobalt is a key element required for Lithium batteries for powering mobile devices. Much of the World's cobalt is mined in the Congo even by very young children in appalling conditions.

Environmental benefits

- Less reliance on paper saving resources
- More opportunity for online global communication and collaboration thereby saving on travel and associated pollution
- Greater insight of environment and climate through using computer to model and analyse and process environmental data

Legislation

Computer Misuse Act (CMA)

The purpose of the CMA is to prevent:

- unauthorised access to computers by hackers
- intentionally impairing the operation of computer systems or through denial of service (DOS) attacks on web servers or distributing viruses
- the theft of data

Three levels of offence:

- 1) Unauthorised access
- 2) Unauthorised access with intent to commit an offence
- 3) Unauthorised modification of data

Copyright, Designs and Patents Act (CDPA)

Copyright is a law that protects the creators of original pieces of work. No one else has the right to use or copy it without permission from the owner. This ensures that people can be rewarded for their work.

Plagiarism To pass off some else's work as one's own work.

Patent An inventor has the exclusive right to create, use and sell an invention for fixed period

Piracy Illegally copying and distributing copyrighted material.

Fair use allows copyrighted work to be used legally in certain situations

- personal or educational use (not commercial use)
- use only a small amount of the work (e.g. a short quote)
- acknowledge original source of the work

Copyright work can be copied, modified used even used for commercial gain as long as the derived works are also distributed under copyright.

Creative Common Licences (CCL) The creator of the work has explicitly given anyone permission to use the work.

Investigatory Powers Act This is legislation that allows public authorities to carry out mass surveillance on electronic communications.

Justification - By monitoring electronic communications security services can keep us safe from terrorists and other serious criminals

Concerns - Can infringe on our privacy and civil liberties

In a liberal democracy there will always a need to balance security and privacy, but where we draw that line will always be a matter of debate.

Some powers of the security services under the IPA

- can hack into computers, networks, mobile devices, servers
- internet service providers have to store which websites users visit for 12 months and allow access to authorities when requested
- carry out mass surveillance of communications; authorities can collect bulk data including data about people who are not suspected of anything.

- demand that an internet service provider provide access to a customer's communications including keys to encrypted data

General Data Protection Regulation (GDPR)

The purpose of the GDPR is to ensure that personal information collected by businesses and other organisations are protected.

Personal data is defined as anything that allows an individual to be identified (e.g. name, biometric data)

Six principles of the GDPR

Personal information must:

- be used fairly and lawfully
- be used only for specific purposes for which it was collected
- be adequate, relevant and not excessive
- be accurate and kept up to date
- be kept for longer than is necessary and deleted when it is no longer needed
- be kept secure against unauthorised access

Other aspects of the GDPR

- The data subject needs to be notified if their data are shared with other organisations
- Obtain consent from the data subject to their process data
- Obtain consent from parents or guardians to process children's data.
- Allow data subjects to have their data removed
- Allow data subjects to access the data held about them
- Pay big fines for a breach of the GDPR

Other Social Impacts

Artificial Intelligence is replacing people in jobs. More hi-tech jobs but less need for many lower skilled jobs.

The **digital divide** refers to the unequal access to information technology between different groups of people, and the knowledge and skills needed to use the technology.

Online trolling, cyber bullying and fake news on social media sites is undermining freedom of expression