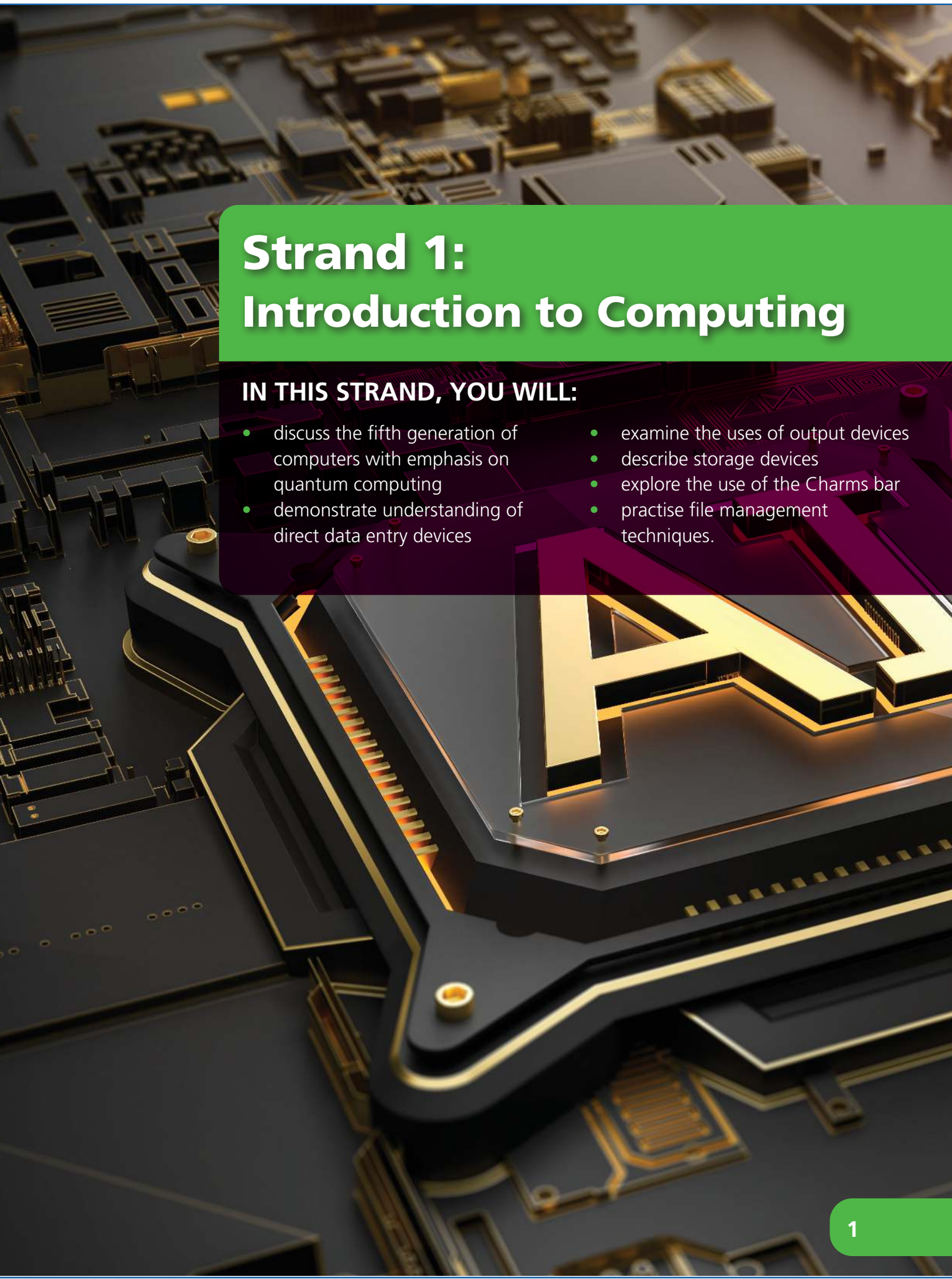


Strand 1: Introduction to Computing

IN THIS STRAND, YOU WILL:

- discuss the fifth generation of computers with emphasis on quantum computing
- demonstrate understanding of direct data entry devices
- examine the uses of output devices
- describe storage devices
- explore the use of the Charms bar
- practise file management techniques.

Sub-strand 1 Components of computers and computer systems

Introduction

Sub-strand 1 will provide a greater depth of information about subjects with which you are already familiar. New subjects will be covered too, such as quantum computing, programming and methods for finding errors in programming code.

You will:

- discuss the fifth generation of computers, which is based on hardware with parallel processing and artificial intelligence (AI) software
- find out about quantum computing
- identify and explore scanning devices
- explore the real-life uses of voice-recognition software that enables PCs and other devices to interact with you through voice responses
- find out about the uses and features of output devices
- learn about storage devices
- learn about file management techniques.

A woman giving voice commands to the virtual assistant on her office desk

The fifth generation of computers

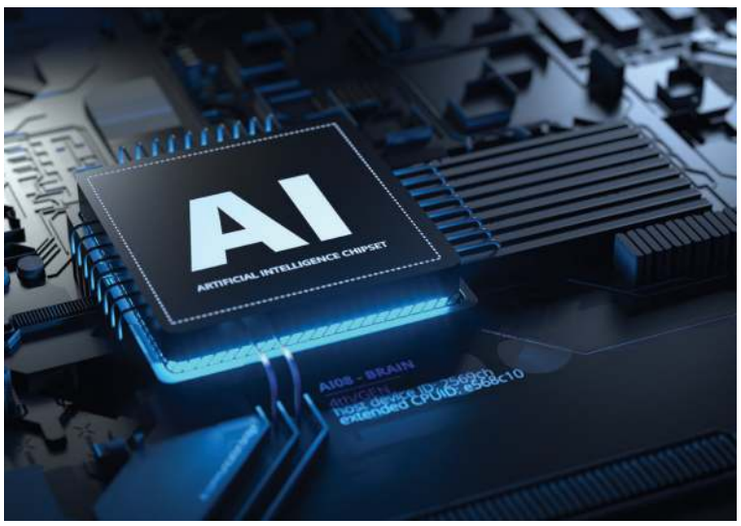
Fifth-generation computers are still developing. They use powerful multiprocessors that have many processing cores with parallel processing and AI software.

The goal of fifth-generation computing is to develop computers that can respond to natural language input and are capable of self-learning and self-organisation.

Features of fifth-generation computers

The main features of fifth-generation computers are listed below.

- **Ultra Large Scale Integration (ULSI)**: ULSI technology is the integrating or embedding of millions of transistors on one silicon microchip. Any integrated circuit (IC) or microchip that has more than a million transistors is thought of as being ULSI.
- **Development of true artificial intelligence (AI)**: Artificial intelligence is software that programs computers to think and behave more like humans do.



The motherboard of a fifth-generation computer with an AI chipset

- **Development of natural language processing (NLP)**: All the programming languages used in fifth-generation computers are known as high-level languages that simplify computer programming. Such a language is called 'high-level' because it needs additional steps to convert it to 'low-level' computer code that can be run on a computer. It is written using syntax (words) that a person finds easy to understand, and is then converted into a low-level program that can be run on a CPU (central processing unit). Some of the fifth-generation high-level languages are:
  - C#
  - C++
  - Fortran
  - Java
  - JavaScript
  - Python
  - PHP
  - Perl.

  Each program is different and uses different syntax. The code written in these languages has to be changed into machine code to be able to run. Code written in scripting languages, such as Perl or PHP, can be put through an interpreter to change the high-level code into low-level language.
- **Advancement in parallel processing**: Parallel processing can perform many tasks at the same time, thereby saving time. (See pages 6–7.)

- **Advancement in superconductor technology**: When the temperature of a superconductor is below a certain point, it can freeze the field of a permanent magnet and hold it in suspension. Superconducting magnets are used for any application where a strong magnetic field is needed, such as magnetic resonance imaging (MRI) scanners in hospitals. They are also used in industry, for example to separate minerals magnetically. Superconductors are used inside the Large Hadron Collider (LHC).
- **More user-friendly interfaces with multimedia features**: Graphic symbols, animation and sound help to make interfaces easier and more intuitive to use. These multimedia features also provide quick and easy access to features and options.
- **Availability of very powerful and compact computers at cheaper rates**: Laptops, mobile phones and tablets are now ultra slim and lightweight, so the components inside them have to be small and light. Some of those components are now also being used inside desktop computers, so computer towers are no longer needed. These ultra-small and lightweight components can be mounted on the back of a computer screen, thereby creating an all-in-one monitor and desktop computer. Because the technology has advanced so quickly, a laptop today can be 90% cheaper than it was in 1994, and approximately 1 000 times more powerful.

A doctor prepares a patient for an MRI scan

FACT BOX

The Large Hadron Collider is the largest and most powerful particle accelerator in the world. It contains a 27-kilometre ring of superconducting magnets.

A laptop (left) and an all-in-one desktop computer with all components mounted inside the back of the screen (right)

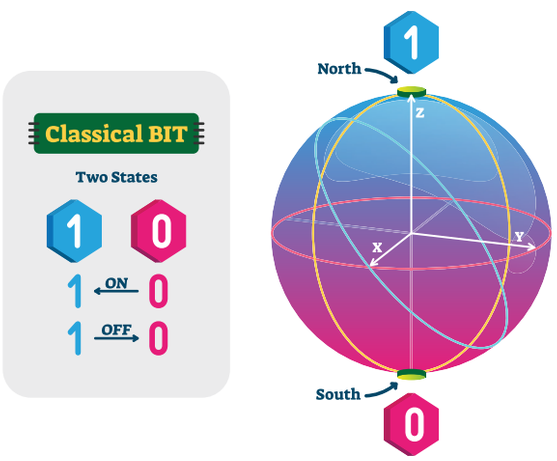
Quantum computing

Classic (or traditional) computers use **data** in units called bits, which is short for **binary digits**. Each bit has a value, either 0 or 1. Each bit can therefore handle only one of two states of data, for example, yes or no; on or off; true or false; low or high.

When you use a classic computer to solve a problem, the computer has to go through a series of steps, each with an either-or answer to get to the final solution.

Quantum computers use principles of quantum mechanics, specifically a principle called superpositioning, to perform certain functions. It uses **qubits** rather than bits as the basic unit of data. Unlike bits, qubits can be in two states or more at the same time. A qubit can therefore be a 1 and a 0 at the same time.

This superpositioning means that quantum computing is exceptionally powerful. Instead of going through a series of steps to get to an answer, a quantum computer can solve a problem in a single step.



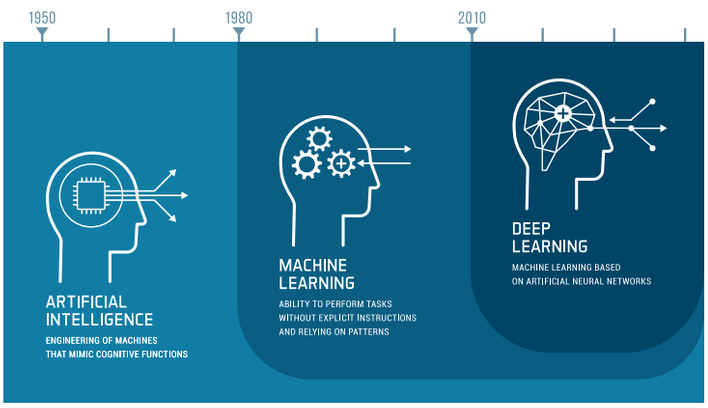
A graphical representation of a bit and a qubit

In theory, it means that a quantum computer with 30 qubits could perform 10 billion **floating-point operations per second (FLOPS)**. A floating point is a data type that includes all **integer** numbers (whole numbers). FLOPS are needed for dealing with software that uses an extremely large range of numbers.

In gaming, for example, floating point numbers are used to show shapes and create a 3D scene. The numbers must be processed extremely quickly to do that.

Quantum technology using Sycamore

Google has an AI division whose engineers and researchers have created a quantum computer; it is called **Sycamore**. When it became news in 2019, with information about how fast it could run, IBM disputed it and asked for proof, because if it were true, it would mean a huge leap in computing power. The Google® Sycamore team ran a test calculation and it took Sycamore 200 seconds to complete, hundreds of millions times faster than a regular machine would have taken. They claimed that it would have taken a supercomputer 10 000 years. IBM estimated that they could do this on their supercomputer in 2.5 days.



Quantum computing incorporates artificial intelligence, machine learning and deep learning.

Until it is actually done, it cannot be proven. The chip in Google's Sycamore computer has 53 qubits and each qubit has two amplitudes, because they can each be true and false at the same time. This is represented by 2^{53} (2 to the power of 53), which is 9 trillion or 9 000 000 000 000 calculations that the qubits can carry out. There is still a lot of research to be carried out on error rates.

Parallel processing hardware

Artificial intelligence (AI) can use a lot of processing power, which is why parallel processing is used in quantum computing. This holds a lot of promise for the future of computing.

There are two main types of parallel processing systems:

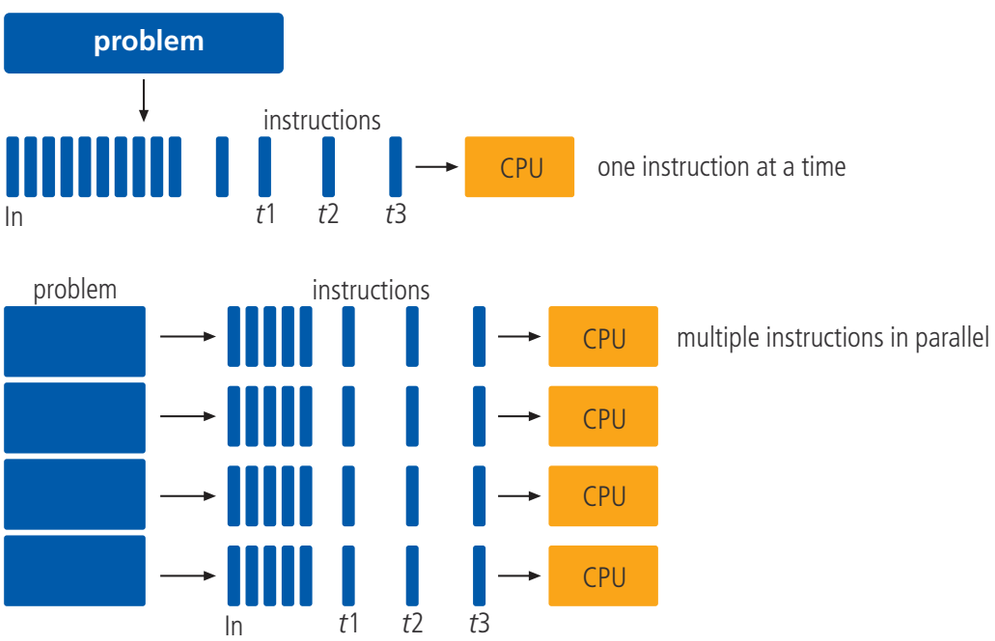
- A shared memory multiprocessor is a single computer with more than one internal processor. In some computer systems, the graphics cards can also be incorporated into parallel processing.
- A distributed memory multicomputer system consists of a number of separate computers connected through a network.

In this section, we focus on shared memory multiprocessors.

What is parallel processing?

Parallel processing, specifically multiprocessing, is when two or more processors (CPUs) are working together in a computer to handle separate parts of one task. A task is split into different parts and each part is processed by a separate processor, so the output is achieved much more quickly.

Parallel processing is used for any task that uses a lot of processing power, such as artificial intelligence (AI) and multiple servers.



Serial vs. parallel processing

This table summarises the advantages and disadvantages of parallel processing.

Parallel processing	
Advantages	**Disadvantages**
• Solves large problems quickly. • Saves time. • Compared to serial computing where there is one processor, parallel computing can work better on such tasks as simulations and understanding complex, real-world phenomena for purposes of AI. • Because there are more resources working on a task, it is quicker to complete and can save costs. • Many problems are so large that it is difficult to solve them with a single-processor computer, especially when there is a limited amount of computer memory. • Stores huge amounts of data so data computations are achieved quickly.	• Programming for parallel architecture is difficult. • Extra costs can be high, and could possibly be greater than the advantages gained by parallel processing. • The program code has to be altered for different computer architectures to ensure successful execution of tasks. • Better cooling technologies are needed, as parallel processing creates more heat. • Power consumption is high.

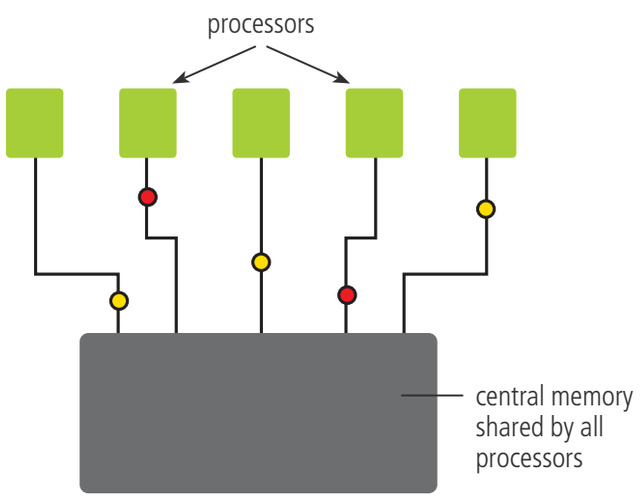
Hardware

The motherboard of a multiprocessor computer will have two or more sockets for processors and often many memory slots to allow large amounts of RAM to be installed in the computer.

A multiprocessing motherboard with two processor sockets

If there are two or more processors, they will all share the system memory and input/output (I/O) system of the computer.

As you can see in the diagram, each processor is allowed access to memory and the I/O system. All the resources are organised around a central memory bus. The bus is a communication system used to transfer data between components inside a computer, and from one computer device to another.



The computer system allows a processor to access a collection of memory modules.

Artificial Intelligence (AI) software

Artificial intelligence is the development of computer systems programmed to use abilities similar to those of humans, such as learning, planning and creativity, to understand, analyse and make sense of data.

To be able to perform these functions, computers need special AI software. Machine learning, speech and voice recognition are important features of AI software.

Below are some everyday examples of AI that you may have used.

Social media

AI plays an important role in managing posts on social media.

- AI can instantly detect hate posts by identifying keywords and phrases in different languages that have been fed into the system. AI can also help to control such problems as cybercrime and cyberbullying in a similar way.
- AI can recognise emoticons (emojis) like the ones we use to represent emotions in text, and can offer a suitable emoji for you to use as part of predictive text.
- Facial recognition and automatic suggestions are used in social media accounts to allow you to tag friends.

Possible fraud detection

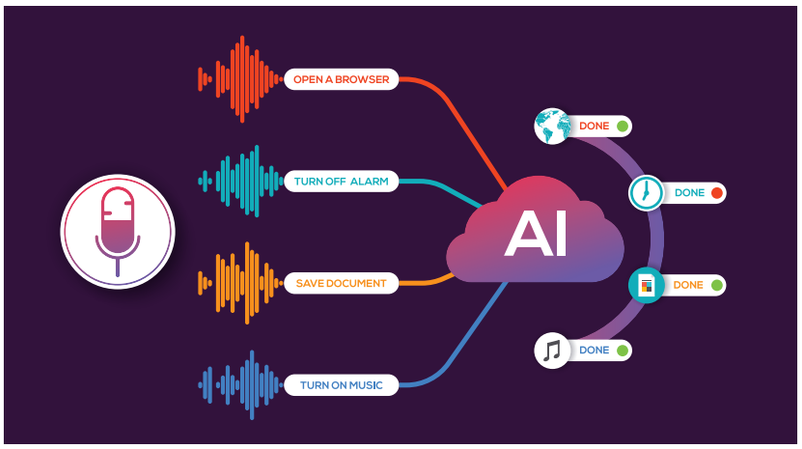
AI can learn the types of products that a person buys, how much they usually spend on items and where they buy them. If some unusual buying activity takes place on a credit card, the system automatically alerts the user.

E-payments

You can deposit cheques into your bank account without leaving home because AI can read handwriting.

Digital assistants

We can instruct digital assistants to do things for us, such as call a friend. The assistant looks at your contacts, recognises your friend's name and rings the number.



AI allows a digital assistant to respond to user commands.

Searches

AI helps computer users to find relevant information quickly.

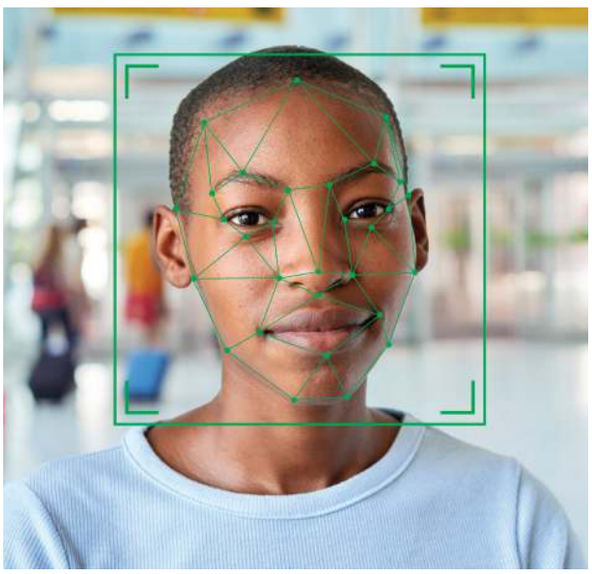
- AI can predict your preferences and recommend, for example, music and movies so that you do not have to keep searching.
- Natural language processing (NLP) technology helps AI to understand humans.
- AI can be used to recognise and identify music, images and video. For example, if you have the software installed on your phone, you can hold your smartphone up to the sound of a song that is playing. The AI will look through an enormous database of music and then tell you the name of the song, as well as other details about it.
- When you want to identify a plant, you can take a photo of a leaf with your smartphone. An app installed on the phone will analyse the photo and supply the name of the plant.

Text editors and autocorrect

Autocorrect is a feature that checks your text for mistakes in spelling, grammar and punctuation. It then suggests corrections. AI can do this because data about a language has been fed in and organised so that machines can understand it. When you make a spelling mistake, for instance, a wavy red line appears under the word.

Facial recognition

This feature is used for security at airports and train stations. Some airports use cameras for facial recognition at airport exits, and also before boarding a plane.



Facial recognition markings on the face of passenger at an airport

ACTIVITY 1.1 **PAIRS AND CLASS**

Features of fifth-generation computers and parallel processing

1. Discuss fifth-generation computers.
   a. Make notes about fifth-generation computers in readiness for a discussion.
   b. Do research online to find out one extra fact about fifth-generation computers. Add the fact to your notes.
   c. Take part in a class discussion.
2. Discuss parallel processing hardware and AI software.
   a. Write your own definition of parallel processing hardware.
   b. Write your own definition of AI software.
   c. Take part in a class discussion.

ACTIVITY 1.2 **CLASS, INDIVIDUAL AND GROUPS**

Artificial intelligence

Watch two videos about artificial intelligence and take a fun online test about AI.

1. Watch the following two short videos:
   https://www.youtube.com/watch?v=zjeBGkS4LAA
   https://www.youtube.com/watch?v=ad79nYk2keg
2. Read the information on this website about AI:
   https://kids.kiddle.co/Artificial_intelligence
3. Work on your own and take the test on the following website:
   https://kubra.com/artificial-intelligence-trivia/
   If you get it wrong, try again.
4. Divide into small groups and discuss everything you have found out about AI.

Direct data entry devices

Direct data entry devices are **input devices**. They read data and transfer it directly into the computer system.

Graphics tablets

A graphics tablet is a computer input device, similar to a mouse or keyboard. It is a touch-sensitive pad that the user can draw on to guide a pointer on the computer screen.

The tablet is connected to your computer using a USB cable or via Bluetooth. You use a **stylus** to write or draw on the tablet. Whatever you draw on the graphics pad appears on your computer screen. The drawing will not appear on the screen of the tablet. The stylus can be separate from the tablet and powered by a battery, which will need regular re-charging, or it can be attached to the tablet.

A graphics tablet and stylus

How the stylus works

The tablet surface has embedded horizontal and vertical wires that transmit electromagnetic signals. The signals are received by a circuit inside the stylus. When you draw on the tablet with the stylus, the electromagnetic signals are transferred to the computer and displayed on the screen.

- The amount of pressure you exert on the stylus determines the thinness or thickness of a line.