

Automated & Emerging Technologies

IGCSE Computer Science ■ Topic 6

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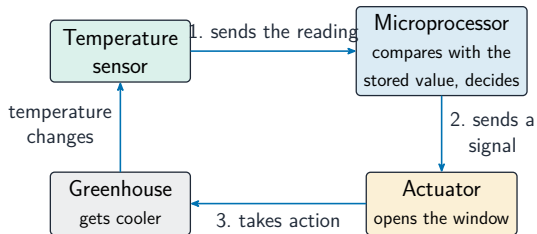


What we will cover

- 1 Automated systems
- 2 Sensor $\rightarrow$ micro $\rightarrow$ actuator
- 3 Pros & cons
- 4 Robotics
- 5 Artificial intelligence
- 6 Recap



The control loop



- 1 The **sensor** measures a quantity and sends the data.
- 2 The **microprocessor** compares it with a stored value and decides.
- 3 It signals an **actuator**, which acts – and the loop repeats.

Two marks nearly always sit on “compares with a stored value” and “the process repeats”.

Automated systems, and the sensor for the job

An **automated system** senses and responds to its **environment** with **no human intervention**.

Central heating, a chemical process, a **greenhouse** , a **car park barrier** .

Pick the sensor that reads the **right physical quantity**: a fish tank needs pH and temperature; an automatic door needs proximity.

Sensor	Measures	Used in
temperature	heat	ovens, greenhouses
light	brightness	automatic lights
pressure	force on a surface	alarm floor mats
infra-red / proximity	a nearby object	automatic doors
acoustic	sound level	noise monitors
humidity	water in air or soil	irrigation
gas	a gas being present	smoke alarms
pH	acidity	pools, fish tanks
accelerometer	movement or tilt	phones, airbags

Sensors, microprocessors and actuators

Three parts work together in an automated system.

The sensor sends data to the microprocessor.

Advantages and disadvantages

Automated systems are used in many situations, such as industry, transport, agriculture (farming), weather (gathering data), gaming and lighting.

Worked example. Describe how an automatic greenhouse holds the temperature at 25 °C.

Automation: what you gain, what you give up

advantages

- ✓ work 24/7, no breaks
- ✓ consistent, fewer mistakes
- ✓ safe in dangerous places
- ✓ lower running costs over time

disadvantages

- ✗ high setup cost
- ✗ jobs may be lost
- ✗ cannot handle the unexpected
- ✗ needs maintenance and power

- Works day and night, faster and more **consistent** than people, and can go where people cannot.
- Costs a lot to set up, breaks down, and **may replace jobs**.
- It cannot react to a situation it was **not built for**.



A camera drone flies a set route to collect data



Robotics

A robot has a **physical structure** (a mechanical body, such as arms), **electrical components** (motors, sensors, wiring), and **programmable instructions** it follows and that can be changed.

A robot **cannot think for itself**. Ask it to handle something it was not programmed for and it stops – a **lack of independent decision-making**.



A robot vacuum drives itself around to clean

What robots do



An industrial robot arm – reprogrammable for a new job

Robots can perform many roles, for example:

- **Factory equipment** : building cars, welding, moving heavy parts.
- **Domestic appliances** : a robotic vacuum cleaner.
- They do dull or dangerous jobs quickly and accurately, and never get tired.
- They are expensive to buy and maintain, and can replace human workers.

Where automated systems are used, and what a robot is

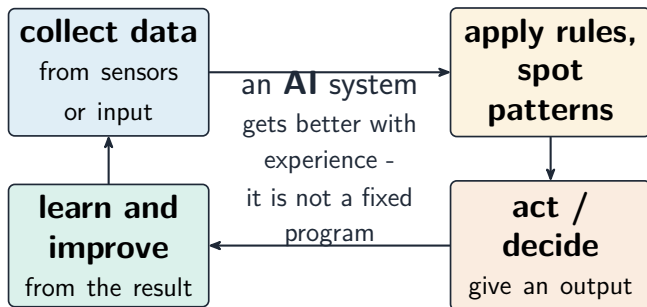
the applications	industry, transport, agriculture, weather monitoring, gas and oil, and a greenhouse for growing plants
the sensor types	temperature, pressure, light, moisture, pH, motion, magnetic field (door contacts, compasses), and flow or level (pipes, tanks)
the loop	sensor → microprocessor → actuator, repeating continuously
robotics	the branch of technology dealing with the design, building and operation of robots
what makes a robot	a mechanical structure, electrical components, and programmability
characteristics of AI	a collected data set , a set of rules for using it, the ability to reason , and the ability to learn and adapt

A robot follows a fixed program; an AI system **changes its own rules** from data. That difference is what the comparison question tests.

Characteristics of AI

- they **collect data** and the **rules** for using that data;
- they have the ability to **reason** (work things out using the rules);
- they have the ability to **draw conclusions** , which may be **approximate** (a best guess) or **definite** (certain);
- they have the ability to **learn** from data;

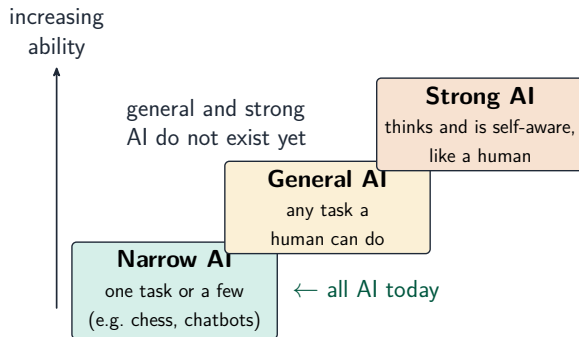
What makes a system “AI”



Artificial intelligence is the **simulation** of human intelligence by a computer. Such a system:

- collects **data** and the **rules** for using it;
- can **reason** and **draw conclusions** – **approximate** or **definite** ;
- can **learn** from data and **adapt** its behaviour.

Narrow, general and strong AI



- **narrow AI** – one task or a small set (a chess program). All AI today is narrow AI.
- **general AI** – any task a human can do.
- **strong AI** – would think and be self-aware.

General and strong AI do not exist yet.

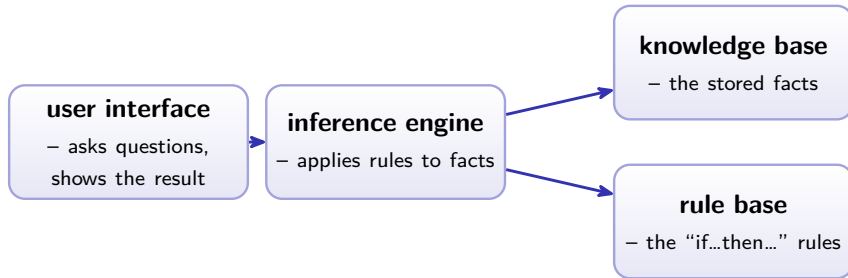
Examples of AI

- **expert systems** – advice like a human expert, e.g. helping a doctor with a diagnosis;
- **natural language processing** – understanding speech or text;
- **self-driving cars** .



Sensors on the car let a computer steer it with no driver

Inside an expert system



The interface collects facts, the engine runs the rules against the knowledge, and the system outputs a diagnosis or a probability.

Machine learning

Machine learning is a program that improves its own performance **from experience**, without being reprogrammed. It finds patterns in data and adapts.

“Without being explicitly reprogrammed” is the phrase the mark scheme wants.

- a search engine ranks results better;
- a voice assistant recognises commands more accurately;
- a robot vacuum learns the layout of a room.

Worked example – how a greenhouse holds 25 °C

Describe how an automatic greenhouse keeps the temperature at 25 °C.

- A **temperature sensor** measures continuously and sends the reading, converted to digital by an ADC, to the **microprocessor**.
- The microprocessor **compares** the reading with the stored value of 25 °C.
- Above it, it signals an **actuator** to open a window or run a fan; below it, it switches on a heater.
- The loop then **repeats continuously**.

Two marks nearly always sit on *compares with a stored value* and *repeats continuously*. Both are easy to leave out.

Exam tips

- Learn the control loop: a **sensor** measures a quantity → the **microprocessor** compares it with a stored value → an **actuator** takes action; then the loop repeats.
- Do not confuse the parts: a **sensor** sends data *in*; an **actuator** causes movement *out*.
- A robot follows **programmable instructions** and cannot make its own decisions when something unexpected happens.
- **AI** simulates human thinking: it collects data and rules, reasons, draws conclusions, and can learn and adapt.
- Know the AI levels: **narrow** (one task; all AI today), **general** (any human task), **strong** (self-aware; does not exist yet).



Topic 6 – key takeaways

1 Loop

sensor → microprocessor → actuator, repeated

2 Decide

the micro compares data with stored values

3 Robot

no independent decision-making

4 AI

data + rules; learns and adapts

Check yourself

- 1 Which part makes the decision?
- 2 Which part causes movement?
- 3 What is a robot's key limitation?
- 4 What can AI do that a fixed system cannot?



Answers 1. the microprocessor 2. the actuator 3. no independent decisions
4. learn and adapt