

Automated and emerging technologies

IGCSE Computer Science

Automated systems

An **automated system** 自动化系统 is a mix of software and hardware that senses and responds to data in its **environment** 环境, with no need for **human intervention** 人工干预. In other words, it works on its own.

Examples of automated systems:

- a central heating 中央供暖 system;
- a chemical process 化学过程 in a factory;
- a **greenhouse** 温室 (for growing plants);
- a **car park barrier** 停车场道闸.

Sensors, microprocessors and actuators

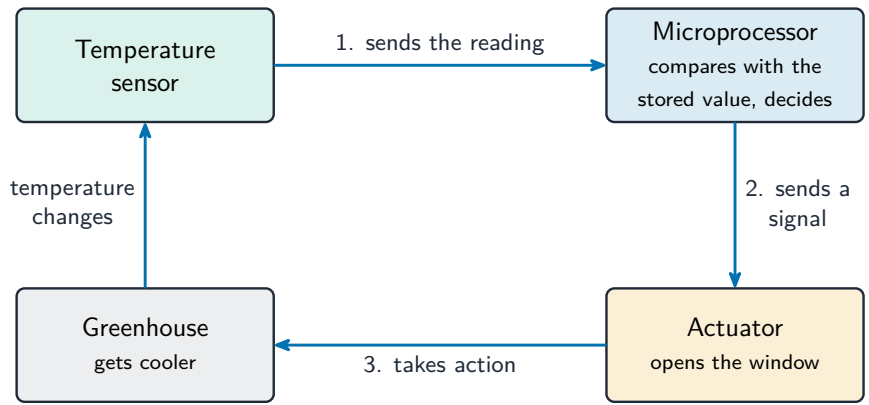
Three parts work together in an automated system.

Part	Job
sensor 传感器	measures a physical quantity (such as temperature or light) and sends the data
microprocessor 微处理器	compares the data with stored values and makes decisions
actuator 执行器	receives a signal and causes movement or action (such as opening a valve)

The cycle works like this:

1. The sensor sends data to the microprocessor.
2. The microprocessor compares this data with **stored values** 存储值 and makes a decision.
3. The microprocessor sends signals to the actuators to take action.

For example, in a greenhouse: a temperature sensor reads the heat; the microprocessor compares it with the wanted value; if it is too hot, the microprocessor signals an actuator to open a window.



A sensor feeds the microprocessor, which compares the reading with a stored value and signals an actuator; the loop then repeats

Advantages and disadvantages

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



A camera drone: it can fly itself along a set route to collect data

Image: Josh Sorenson, CC0 (commons.wikimedia.org)

Advantages	Disadvantages
work all day and night, without rest faster and more consistent 一致的 than people can work in places unsafe for people fewer human mistakes	cost a lot to buy and set up can break down and need expert repair may replace people's jobs cannot easily react to a situation they were not built for

Robotics

Robotics 机器人技术 is the branch of technology that deals with the design, building and operation of **robots** 机器人.

A robot has these characteristics:

- a **physical structure** 物理结构 (a mechanical 机械的 body, such as arms);
- **electrical components** 电子元件 (motors, sensors and wiring);
- **programmable instructions** 可编程指令—it follows a program that can be changed.

What robots do

Robots can perform many roles, for example:

- **factory equipment** 工厂设备—building cars, welding, moving heavy parts;
- **domestic appliances** 家用电器—such as a robotic **vacuum cleaner** 吸尘器.



An industrial robot arm. It follows a program and can be reprogrammed to do a new job.

Image: https://commons.wikimedia.org/wiki/File:ABB_robot_arm, CC BY-SA 4.0 (commons.wikimedia.org)



A robot vacuum cleaner: a home robot that drives itself around to clean the floor

Image: Popey900, Copyrighted free use (commons.wikimedia.org)

Advantages	Disadvantages
do dull or dangerous jobs	expensive to buy and maintain
work quickly and accurately	can replace human workers
do not get tired or bored	a robot has a lack of independent decision-making 缺乏独立决策—it only does what it is programmed to do

A key limit of a robot is that it cannot think for itself. It cannot make its own choices when something unexpected happens.

Artificial intelligence

Artificial intelligence 人工智能 (AI) is the **simulation** 模拟 of human intelligence by computer systems. This means a computer doing tasks that normally need human thinking.

Characteristics of AI

AI systems usually have these features:

- they **collect data** and the **rules** 规则 for using that data;
- they have the ability to **reason** 推理 (work things out using the rules);
- they have the ability to **draw conclusions** 得出结论, which may be **approximate** 近似的 (a best guess) or **definite** 确定的 (certain);
- they have the ability to **learn** 学习 from data;
- they have the ability to **adapt** 适应—to change their behaviour as they get new data.

Examples of AI

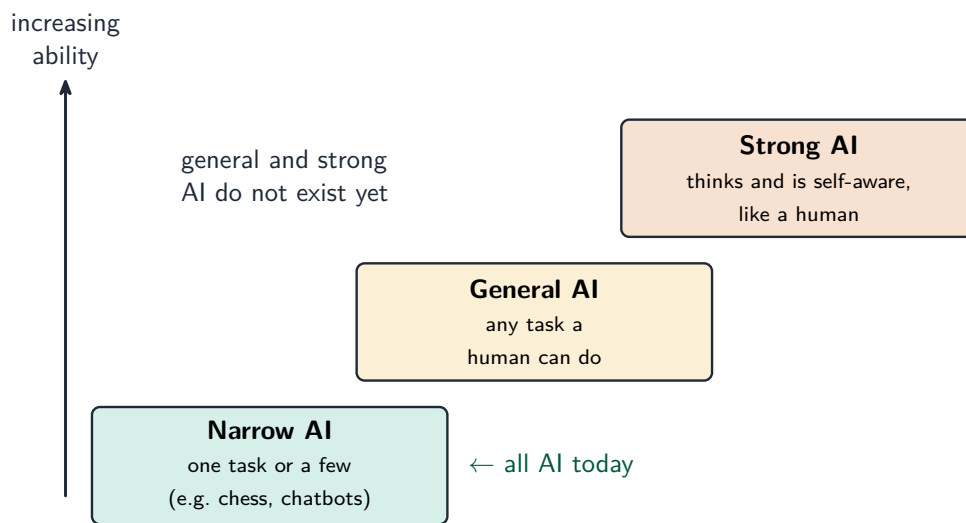
- **expert systems** 专家系统—software that gives advice like a human expert (for example, helping a doctor with a diagnosis);
- **natural language processing** 自然语言处理—understanding human speech or text;
- **self-driving cars** 自动驾驶汽车.



A self-driving car: sensors on the car let a computer steer it with no driver

Image: 9yz, CC BY 4.0 (commons.wikimedia.org)

Narrow, general and strong AI



Narrow AI does one task (all AI today); general AI could do any human task; strong AI would be self-aware —neither exists yet

Type	What it means
narrow AI 弱人工智能	can do only one task or a small set of tasks (for example, a chess program). All AI today is narrow AI.
general AI 通用人工智能	could do any task a human can do, switching between many different tasks.
strong AI 强人工智能	would think and be aware like a real human mind. This does not exist yet.