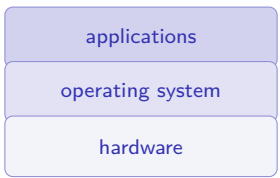
Software

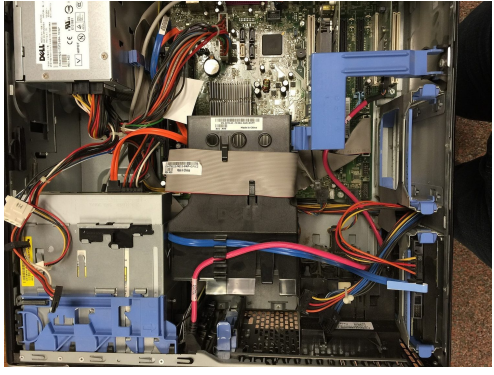
IGCSE Computer Science ▪ Topic 4

IGCSE Computer Science



What we will cover

1. Hardware & software
2. System vs application
3. The operating system
4. Interrupts
5. Languages & translators
6. Recap

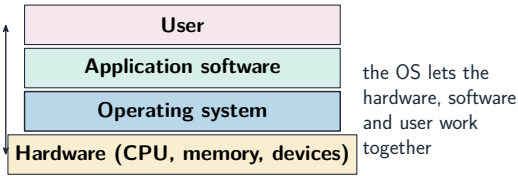


1 Software types

Hardware and software

- **hardware** 硬件: the physical parts you can touch
- **software** 软件: the programs that tell the hardware what to do

> Hardware alone does nothing useful; software needs hardware to run on. Both are needed.



Hardware is the physical parts; software is

hardware (physical parts)

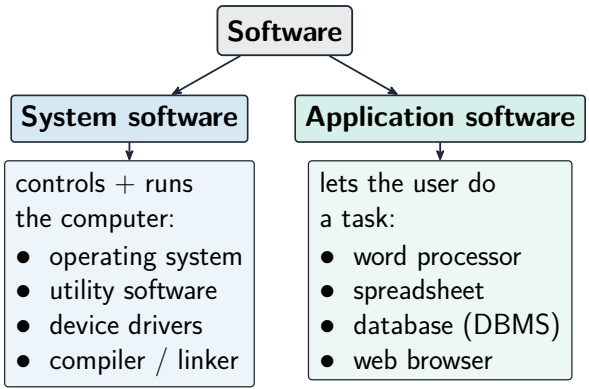
software (programs)

CPU, keyboard, RAM

apps, the OS

Hardware is the physical parts; software is the programs

System vs application software



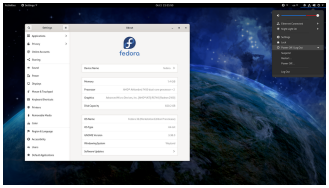
- **word processing** 文字处理 software (writing documents);
- **spreadsheet** 电子表格 software (working with numbers in a grid);
- **database management system** 数据库管理系统 (storing and searching data);
- **web browser** 网页浏览器 (viewing web pages).

The layers of software

application software	does a job for the user – word processor, browser, game
the operating system	manages the machine: memory, processes, input and output, security, and managing files – saving, opening, naming, moving and deleting
utility software 实用程序	small tools that look after the computer – anti-virus, backup, disk defragmenter, compression
device drivers 设备驱动程序	let the OS talk to a particular piece of hardware
firmware 固件	sits below the operating system – software stored permanently on ROM or flash that runs the hardware at start-up
the bootloader 引导程序	the first firmware to run; it loads the operating system into RAM

Sort by who it serves: the user, the machine, or one device. That is what separates application, system and utility software.

The operating system



The **operating system** 操作系统 runs the whole computer:

- manages files, memory, **peripherals** 外围设备
- handles interrupts & **multitasking** 多任务处理
- provides a **user interface** 用户界面 and a platform
- manages security – accounts, passwords

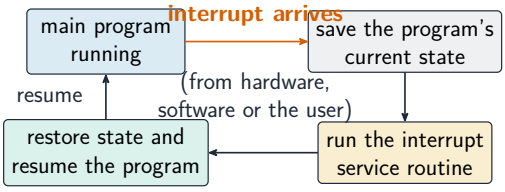
> It is the layer between the hardware and your programs – neither talks to the other directly.

What an operating system does

Providing a user interface	**Providing a user interface** 提供用户界面: the GUI or command line through which a person gives instructions.
Managing peripherals	**Managing peripherals** 管理外围设备: talking to printers, drives and screens through device drivers, so applications do not have to.
Managing multitasking	**Managing multitasking** 管理多任务: sharing processor time between programs so each appears to run at once.
Providing a platform	**Providing a platform** 提供平台: a common set of services every application can call – which is why a program is written for an OS, not for a machine.

Memory, files, security and users complete the list. Each one is a resource that would otherwise be fought over.

Interrupts



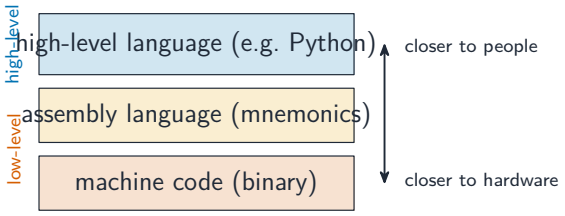
An **interrupt** 中断 is a signal that something needs attention now. It can come from:

- hardware – a key pressed, printer out of paper
- software – a divide-by-zero
- the user – a cancel key

> The processor saves its place, services the interrupt, then resumes exactly where it stopped.

2 Languages

High- and low-level languages



- **high-level** 高级语言: English-like (Python); easy to read; runs on any computer
- **low-level** 低级语言: close to the machine; fast, but tied to one CPU

> High-level is portable and readable; low-level trades that away for speed and direct hardware control.

Compiler vs interpreter

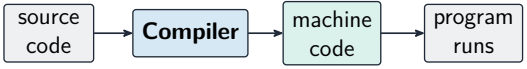
Both are **translators** 翻译程序 turning high-level code into machine code:

- **compiler** 编译器: translates all at once into a file you keep and re-run
- **interpreter** 解释器: translates & runs line by line, stopping at the first error

> A compiler makes a file you re-run; an interpreter stops at the first error – useful while writing. An **IDE** 集成开发环境 bundles editor, translator and debugger.

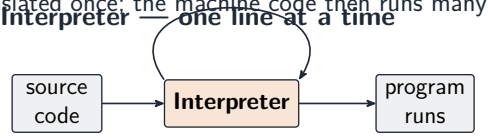
Compiler vs interpreter, in detail

Compiler — translate the whole program once



translated once; the machine code then runs many times

Interpreter — one line at a time



reads, translates and runs one line at a time (every run); stops at the first error

A **compiler** 编译器 makes a file you re-run; an **interpreter** 解释器 stops at the first error, which is useful while writing.

Assembler

An **assembler** 汇编器 translates a **low-level assembly-language** program (written in mnemonics such as `LDA`, `ADD`) into machine code.

> Each mnemonic becomes **one** machine instruction – a direct one-to-one translation, unlike a compiler or interpreter, which work on high-level code.

Choosing a translator, and what an IDE adds

a compiler	translates the whole program at once; the finished program runs fast and needs no translator
an interpreter	translates line by line, and stops at the first error it finds – which helps while testing
an assembler 汇编程序	translates **assembly language 汇编语言** into machine code, one line to one instruction
the CPU 中央处理器	all computers process data in it, and it executes machine code only
auto-completion 自动补全 and auto-correction 自动纠错	the IDE finishes or fixes code as you type
prettyprinting 美化打印	lays the code out neatly with colour and indentation, so it is easy to read

Use an interpreter while developing – errors surface one at a time – and a compiler for the released program, which then runs without one.

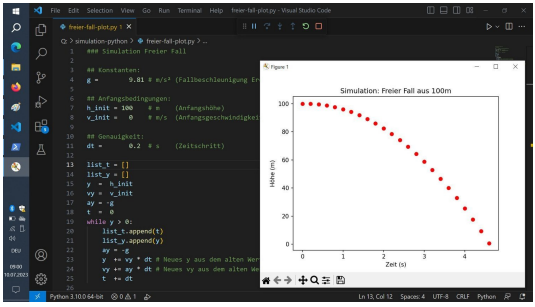
The translators, and where the linker fits

High-level language	A **high-level language** 高级语言 is close to English and portable; a low-level one is close to the **central processing unit** 中央处理器 and machine-**specific** 特定的.
Compiler	Translates the whole **programming language** 编程语言 source at once into an executable, reporting every error at the end. Fast to run afterwards.
Interpreter	Translates and runs line by line, stopping at the first error. Slower, and far easier to debug.
Linker	The **linker** 链接器 joins the compiled code to the library modules it calls, producing the single file that actually runs.

Development favours the interpreter; delivery favours the compiler. Most real toolchains use both at different stages.

Integrated development environment (IDE)

- a **code editor** 代码编辑器 – for typing in your program;
- a **run time environment** 运行时环境 – for running the program to test it;
- a **translator** – a compiler or interpreter to turn your code into machine code;
- **error diagnostics** 错误诊断 – messages that help you find and understand mistakes;



Worked example – which translator, at which stage?

A team wants errors found quickly while developing, and a fast program that hides its source when they ship.

- **While developing**: an **interpreter** 解释器 – it runs one line at a time and stops at the first error, so a mistake is easy to locate.
- **To ship**: a **compiler** 编译器 – it translates the whole program once into machine code, which runs fast with no translator present.
- The customer receives only the executable, so the source stays private.

Two different jobs, two different tools. Most real toolchains use both, at different stages of the same project.

Exam tips

- **Hardware** is the physical parts; **software** is the programs. **System software** runs the computer (OS, drivers, utilities); **application software** does a task for the user.
- A **compiler** translates the whole program at once (the finished program runs fast, and all errors are reported at the end); an **interpreter** translates line by line (it stops at the first error, runs slower, and is needed every time).
- **High-level** languages are close to English and run on any computer; **low-level** languages (assembly, machine code) are tied to one type of CPU.
- An **interrupt** is a signal that makes the CPU stop, save its place, service the event, then carry on where it left off.
- Learn the operating system's roles: managing files, memory, peripherals, multitasking, security and the user interface.

3 Recap

Topic 4 – key takeaways

1 Two types

system runs the computer; application serves the user

2 OS

the layer between hardware and applications

3 Interrupt

save place, service, resume

4 Translate

compiler all at once; interpreter line by line

Check yourself

1. Is a web browser system or application software?
2. What does the processor do first on an interrupt?
3. Which translator stops at the first error?
4. Which language type runs on any computer?

apps

OS

hardware

Answers **1.** application **2.** saves its place **3.** the interpreter **4.** high-level