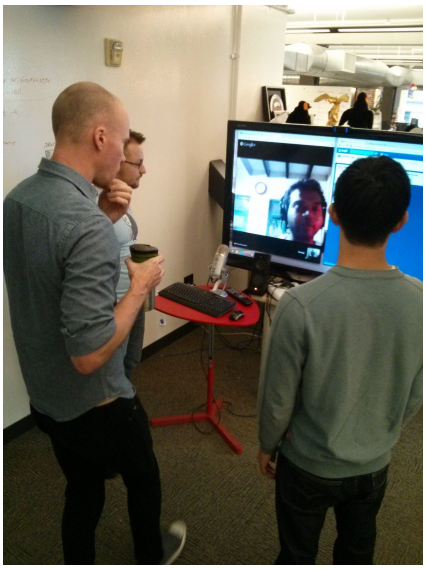
Software Development

A-Level Computer Science

Program development life cycle

A **development life cycle** 开发生命周期 is the set of stages from idea to finished, maintained software. It exists to **plan, manage and control** a project —to build the right product, on time, with good quality.



Software is built by teams who follow a development life cycle to stay coordinated

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Tabel Simbol-simbol *flowchart* program

No.	Simbol	Keterangan
1		**Kotak Terminal (*Terminal Symbol/Terminator*)** a. simbol dimulainya (Start/Begin) dan diakhirinya suatu program (Finish/End).
2		**Kotak Proses (*Processing Symbol*)** a. tempat untuk menuliskan perintah/operasi aritmatika.
3		**Kotak Input dan Output (*Input/Output Symbol*)** a. tempat untuk memberikan masukan (*input*) atau menampilkan keluaran (*output*) dari suatu operasi.
4		**Kotak Keputusan (*Decision Symbol*)** a. tempat pertanyaan/pengujian kondisi, berisikan operasi perbandingan logika, dengan dua nilai keluaran (YA/BENAR/*TRUE* dan TIDAK/SALAH/*FALSE*).
5		**Lingkaran Penyambung (*Connector Symbol*)** a. digunakan jika diagram alir belum selesai dan akan berlanjut ke sampingnya pada halaman yang sama.
6		***Off-page Connector Symbol*** a. digunakan jika diagram alir belum selesai dan akan berlanjut ke halaman yang berbeda.
7		***Looping Symbol/Preparation Symbol*** a. digunakan untuk memberikan nilai awal pada suatu variabel/*counter* dan menggambarkan proses yang perulangan.
8		**Arah Proses (*Direction*)** a. untuk menunjukkan arah aliran proses program.

A flowchart plans a program's logic during the design stage of the cycle

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Why a life cycle is needed

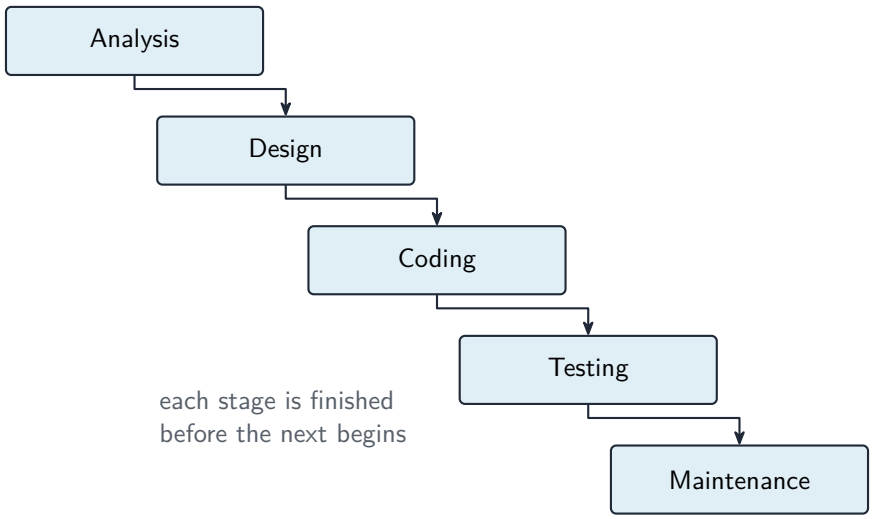
It manages complexity (break a big program into phases), coordinates teams, tracks progress with milestones, builds in testing, records design decisions for later, and manages risk.

Why there are different ones

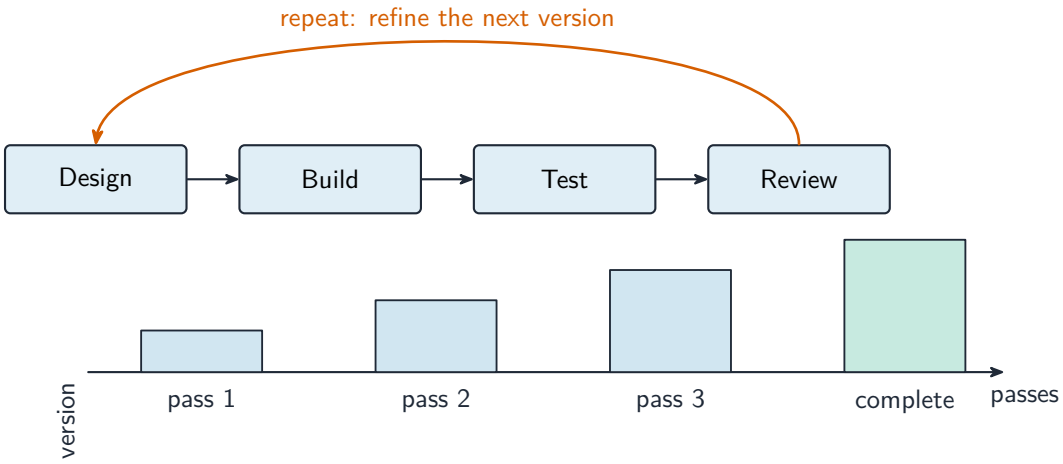
No single life cycle fits every project. The choice depends on the size and complexity, how clear the **requirements** 需求 are at the start, how much change is expected, the risk level, the team, and the deadline.

Common models

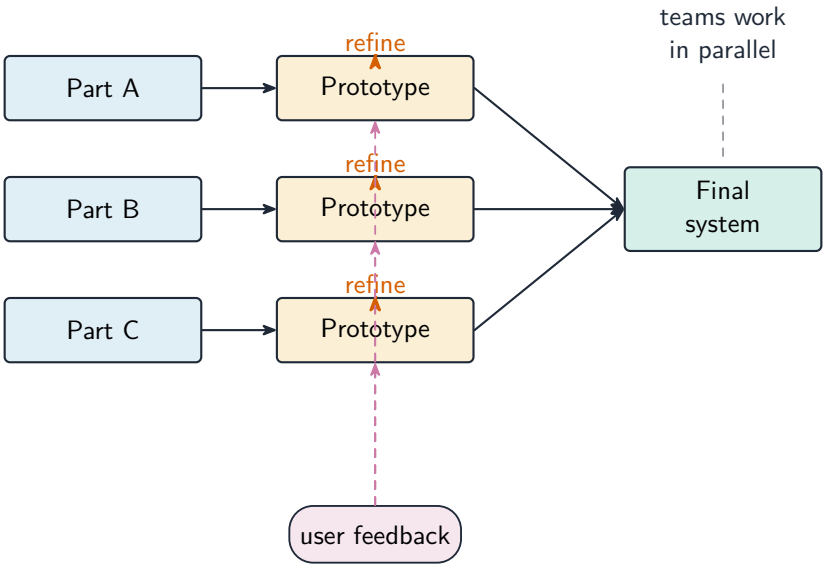
- **Waterfall** 瀑布模型—a linear sequence (Analysis → Design → Coding → Testing → Maintenance), each stage finished before the next. Clear and well-documented; good for **stable requirements**, but poor at coping with mid-project change, and the customer sees nothing working until the end.
- **Iterative model** 迭代模型—repeated passes, each producing a partial version that is reviewed and refined. Catches problems earlier; good when requirements are **discovered over time**, but harder to estimate.
- **Rapid Application Development** 快速应用开发 (RAD) —heavy use of a **prototype** 原型 and user feedback. Very fast first delivery; good for **changing requirements**, but depends on user availability and suits smaller systems.
- **Agile** 敏捷—short iterations ("sprints"), constant collaboration and testing. Flexible and adaptive, but needs a committed customer and a skilled team.



The waterfall model: each stage is finished before the next begins



The iterative model: repeated passes refine the program



Rapid application development: teams work on parts in parallel

The standard stages

- **analysis** —find **what** the program must do; gather and document requirements.
- **design** —decide **how**: data structures, algorithms, modules, interface, file layouts.
- **coding (implementation** 实现 **)** —write the source code following the design.
- **testing** —run against test data and fix bugs.
- **maintenance** 维护—after release, keep it working and useful.

Program design tools

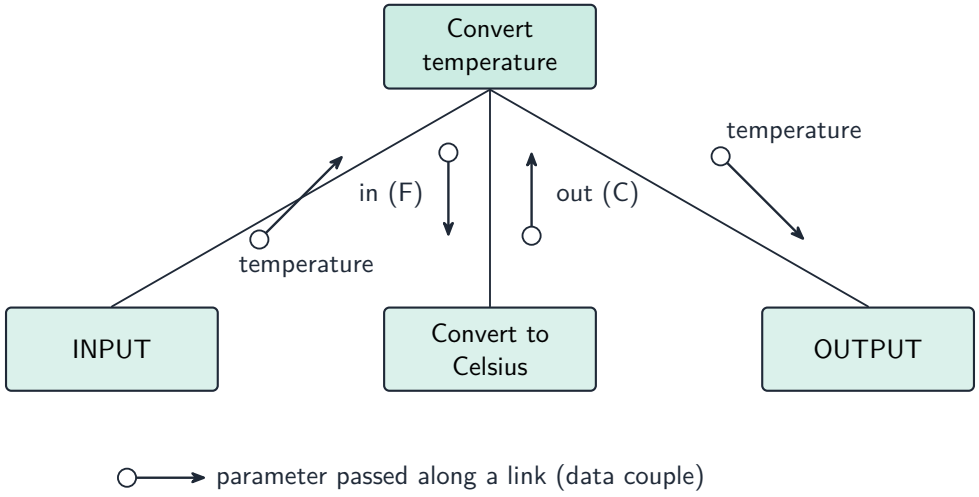
Structure chart

A **structure chart** 结构图 shows the **hierarchical decomposition** 分解 of a program into modules (**subroutines** 子程序) and the **parameters** 参数 passed between them.

Each module is a rectangle; lines link caller (above) to callee (below); small arrows show data going down and results coming back up.

```
                CalculatePay
             /        |        \
      GetEmployee  CalculateBonus  CalculateTax
      Returns:     Takes: sales    Takes: gross
      employeeID   Returns: bonus  Returns: tax
```

It is a design-stage tool, and you can read the procedure signatures off it.



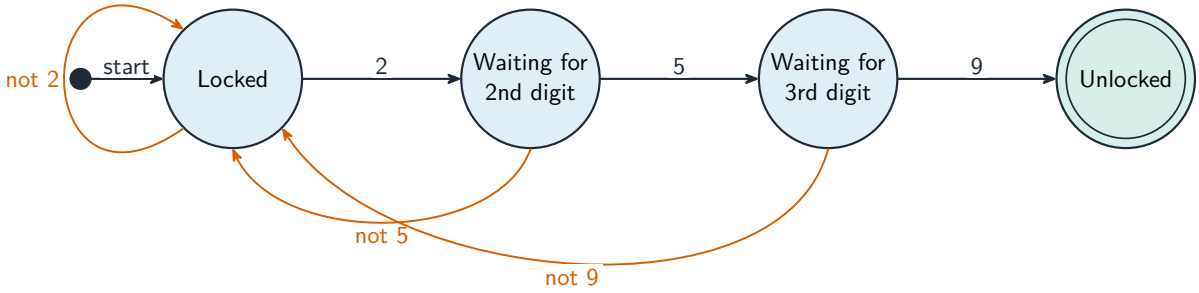
A structure chart: modules with the parameters passed between them

State-transition diagram

A **state-transition diagram** 状态转换图 shows the **states** 状态 a system can be in and the **events** that move it between them —good for vending machines, traffic lights, user interfaces. Each state is a circle; each transition is an arrow labelled with the event.

```
   coin inserted               item selected
[Idle]        → [Awaiting selection]      → [Dispensing]
```

It makes missing transitions easy to spot (”what if a second coin is inserted while awaiting selection?”).



A state-transition diagram for a door lock with code 259

Errors

- **syntax error** 语法错误—breaks the language's grammar (missing bracket, misspelled keyword). Caught at translation time; the program won't run until fixed.
- **run-time error** 运行时错误—happens while running (divide by zero, file not found, array index out of range). The program crashes or raises an exception; fix by adding checks.
- **logic error** 逻辑错误—the program runs but gives **wrong results** (using `+` for `-`, an off-by-one loop, conditions in the wrong order). The hardest to find; the only sign is wrong output, so use careful testing and tracing.

Testing methods

- **dry run** 手工跟踪—trace the code on paper, writing each variable's value in a table.
- **walkthrough** 走查—a team review of the code.
- **white-box testing** 白盒测试—designed from the code's internal structure, covering every statement, branch and loop.
- **black-box testing** 黑盒测试—designed from the specification only: feed inputs, check outputs.
- **integration testing** 集成测试—combine modules and test the interfaces between them.
- **alpha testing** 测试—by the developers/in-house before release; **beta testing** 测试—by a limited group of real users in their own environment.
- **acceptance testing** 验收测试—by the customer, to decide if the product is fit for purpose.
- **stub** 桩—a placeholder for a module that does not exist yet, so the structure can be tested top-down.

Test strategy and test plan

A **test strategy** 测试策略 is the **high-level approach** —which kinds of testing, who does them, when, and the criteria to move on. A **test plan** 测试计划 is the **detailed list of tests** —each with input data, expected output, and a column for the actual output.

Choosing test data

For each field or condition, include three kinds:

- **normal data** 正常数据—typical values inside the valid range (for marks 0–100: `50`, `75`).
- **abnormal data** 异常数据—values that should be rejected (`-10`, `200`, `"abc"`).
- **boundary data** 边界数据—values at the edges, where off-by-one errors hide (`0`, `100`, and just outside `-1`, `101`).

Maintenance

Most of a program's lifetime cost is in maintenance. Three kinds:

- **perfective maintenance** 完善性维护—improving performance or features even though it works (a faster query, a new option).
- **adaptive maintenance** 适应性维护—keeping it working in a changing environment (a new OS, a new API, a legal change).
- **corrective maintenance** 纠正性维护—fixing bugs found in use.

A program may need all three throughout its life.

Amending an existing program

When asked to add a feature or fix a bug:

1. **read the existing code** until you understand the algorithm and data flow.
2. **find where the change goes** —which subroutine, which lines.
3. **make the change as small as possible** —don't rewrite working code.
4. **update related parts** —every caller of a changed parameter list, every routine using a changed data structure.
5. **test** the new behaviour **and** the old (**regression testing** 回归测试—check you broke nothing).
6. **document** the change.

Clear comments, meaningful names, decomposed subroutines and a structure chart make a program much easier to amend —which is why the design tools matter even after the first release.