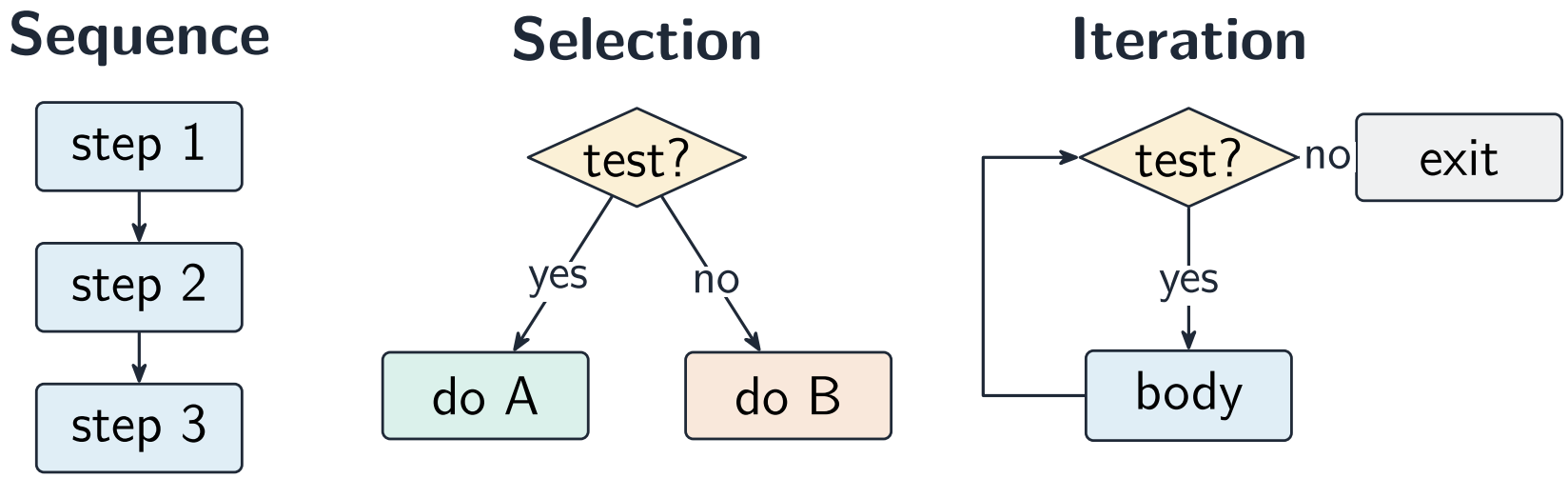
Exercise walk-through

3.16 Simulations

AP Computer Science Principles

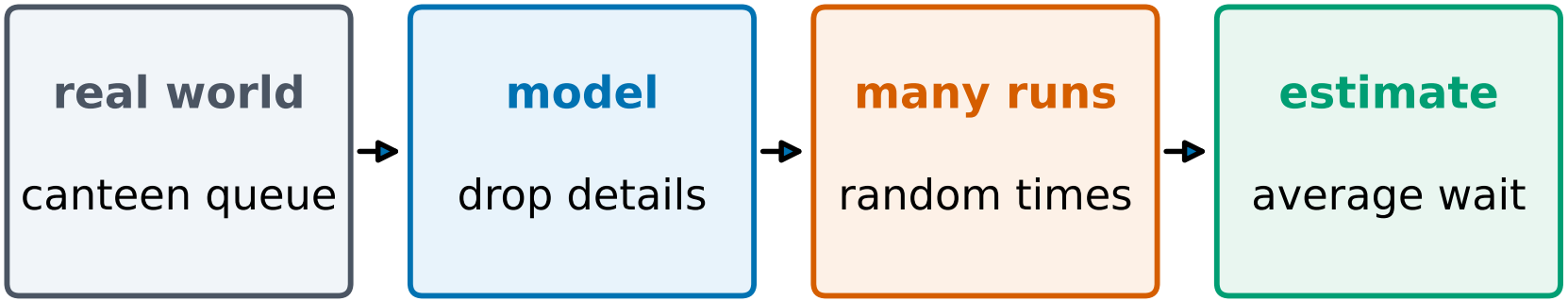
Selection chooses between paths based on a condition



`IF` runs its block when the condition is true; `ELSE` gives the other path. Exactly one of the two runs.

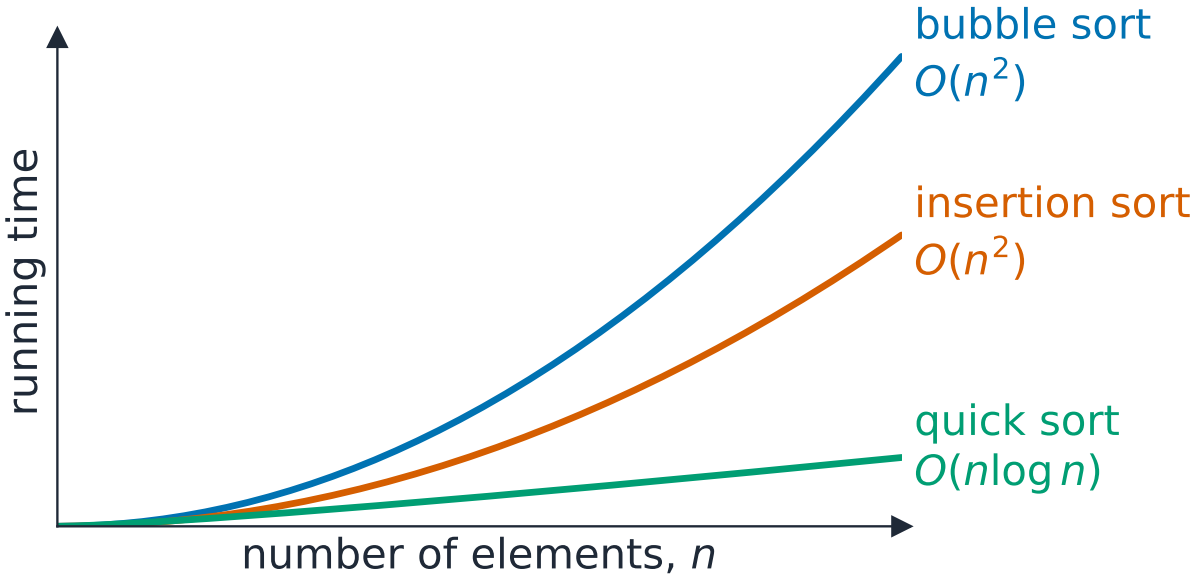
Simulations

A **simulation** is a program that models a real-world process to study it **safely and cheaply**.



> Simulations **simplify** reality (they leave out detail) and often use **randomness** to imitate chance events.

Check yourself, in detail



for large n: $O(n \log n)$ (quick/merge) beats $O(n^2)$ (bubble/insertion)

How the running time of an algorithm grows with the input size n

exercises.lol exercises.com.cn

Exercises 2.1·2.2

2.1 State **two** benefits of using a simulation instead of a real experiment. [2]

2.2 Explain why a simulation is an **abstraction**. [1]

Exercises 2.1·2.2

2.1 State **two** benefits of using a simulation instead of a real experiment. [2]

2.1 any two:

- **cheaper**
- **safer**, e.g. no one can be hurt
- **faster**: years can be simulated in seconds
- can be **repeated** many times with different settings

2.2 Explain why a simulation is an **abstraction**. [1]

2.2

- it **leaves out** details of the real situation and keeps only those that matter

Exercises 2.3·2.4

2.3 State the value the coin-flip simulation displays on average, and how to make its result more reliable. [2]

2.4 Give **one** reason the results of a simulation may be **inaccurate**. [1]

Exercises 2.3·2.4

2.3 State the value the coin-flip simulation displays on average, and how to make its result more reliable. [2]

2.3

- about **0.5**
- run **more** flips

2.4 Give **one** reason the results of a simulation may be **inaccurate**. [1]

2.4 any one:

- a **simplifying assumption** leaves out something that matters
- the data or probabilities used are not accurate

Exercise 3.1

3.1 Which is the **best** reason to use a simulation to study how a fire spreads through a building? [1]

- [ ] **A** A simulation always gives the exact result.
- [ ] **B** Setting a real building on fire is dangerous and costly.
- [ ] **C** A simulation does not need any data.
- [ ] **D** A simulation never uses random values.

Exercise 3.1

3.1 Which is the **best** reason to use a simulation to study how a fire spreads through a building? [1]

- ☐ **A** A simulation always gives the exact result.
- **B** Setting a real building on fire is dangerous and costly.
- **C** A simulation does not need any data.
- **D** A simulation never uses random values.

3.1 B

- the real experiment is dangerous and expensive; simulations are estimates, not exact

Exercises 3.2·3.3

3.2 A simulation of a shop queue assumes every customer takes **exactly 2 minutes** to serve. What is the most likely effect? [1]

- [ ] **A** The simulation will not run.
- [ ] **B** Long waits caused by slow customers may be underestimated.
- [ ] **C** The simulation becomes more accurate.
- [ ] **D** The number of customers doubles.

3.3 Which change is most likely to make a simulation's results **more reliable**? [1]

- [ ] **A** run it many more times and average the results
- [ ] **B** remove the random values
- [ ] **C** run it once with fewer customers
- [ ] **D** display the results with more decimal places

Exercises 3.2·3.3

3.2 A simulation of a shop queue assumes every customer takes **exactly 2 minutes** to serve. What is the most likely effect? [1]

- [ ] **A** The simulation will not run.
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3.2 B

- real customers vary; ignoring slow ones makes long waits look rarer

---

3.3 Which change is most likely to make a simulation's results **more reliable**? [1]

- [ ] **A** run it many more times and average the results
- [ ] **B** remove the random values
- [ ] **C** run it once with fewer customers
- [ ] **D** display the results with more decimal places

3.3 A

- more trials make the average closer to the true value

Setup for exercise 3.4

3.4 A biologist simulates a population of rabbits. Each year, each rabbit has a 1-in-4 chance of having young, which adds **2** rabbits.

```
rabbits ← 20
REPEAT 5 TIMES
{
    born ← 0
    REPEAT rabbits TIMES
    {
        IF(RANDOM(1, 4) = 1)
        {
            born ← born + 2
        }
    }
    rabbits ← rabbits + born
}
DISPLAY(rabbits)
```

Exercise 3.4 (a)

(a) State the **expected** number of rabbits born in the **first** year. Show your working. [2]

Exercise 3.4 (a)

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(a)

- expected number having young: $20 \times \frac{1}{4} = 5$
- each adds 2: $5 \times 2 = \mathbf{10}$ born

Exercise 3.4 (b)

(b) Identify **two** simplifying assumptions in this simulation that could make its results inaccurate. [2]

Exercise 3.4 (b)

(b) Identify **two** simplifying assumptions in this simulation that could make its results inaccurate. [2]

(b) any two:

- no rabbits **die**
- every rabbit can have young, whatever its **age** or sex
- the chance of having young is the **same** every year; there is no limit on **food** or space
- every litter is exactly 2 young

Exercise 3.4 (c)

(c) The program displays a different number each time it runs. Explain why, and state how the biologist should use the results. [2]

Exercise 3.4 (c)

(c) The program displays a different number each time it runs. Explain why, and state how the biologist should use the results. [2]

(c)

- the code uses `RANDOM`, so the number born **varies** from run to run
- run the simulation **many** times and use the **average** (or range) of the results