Selection & Iteration

AP Computer Science A ▪ Unit 2

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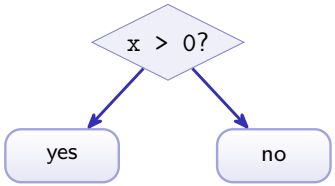
What we will cover

1. Boolean expressions
2. The if statement
3. Compound & nested conditions
4. while & for loops
5. Nested iteration & run-time



1 Selection

Boolean expressions & the if statement

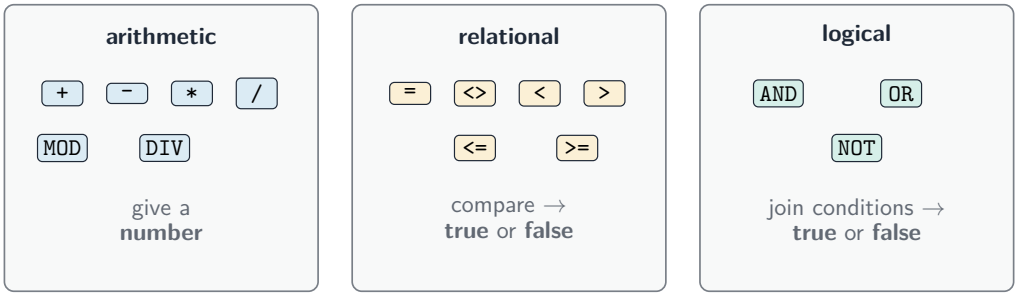
A **Boolean expression** 布尔表达式 evaluates to `true` or `false` using **relational operators** 关系运算符 (`>`, `<`, `==`, `!=`).

`if (cond)`	`if / else`	`else if`
run a block	pick one of two	three or more paths

This ability to choose a path is **selection** 选择. Trace which **branch** 分支 runs for a given input.

Assembly loop

The three families of operators



The three families of operators: arithmetic, relational, and logical

Compound & nested conditions

`&&` (AND)	`||` (OR)	`!` (NOT)
both true	at least one	reverse

Short-circuit 短路 evaluation stops early: `a && b` skips `b` if `a` is false. Compare **objects** with `.equals()`, not `==` (which compares references).

Traffic light if

Nested and chained conditions: only the first match runs

nesting	an `if` inside another – the inner one is reached only when the outer condition was true
chaining	`else if` tests several cases in order
the rule	only the first matching branch runs; the rest are skipped even if they also match
so order matters	put the most specific test first – `score >= 50` before `score >= 80` gives everyone the lower grade
`else`	catches everything no earlier branch matched – it needs no condition of its own

Tracing a chain means reading top to bottom and stopping at the first true. That is the whole semantics, and most multiple-choice items test only this.

2 Iteration

while & for loops

`while` loop

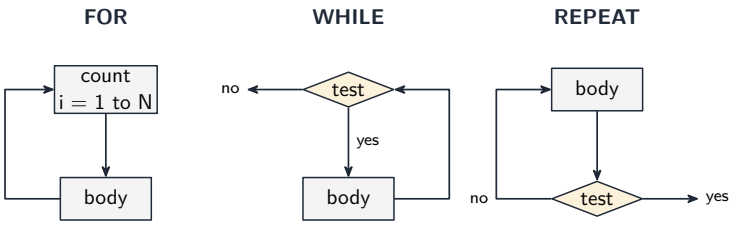
repeat while a condition holds – count of repeats not known in advance

`for` loop

`for (int i=0; i<n; i++)` – a known number of times

Every **loop** 循环 needs progress toward its stop condition, or it becomes an **infinite loop** 无限循环. Trace variables pass by pass.

while & for loops, in detail



a set number of passes

test **before** may run 0 times

test **after** runs at least once

The three loop types differ in where the condition is tested

Every `for` loop is a `while` loop

These two do identical work. Be able to convert either way.

```
// for: init, condition, update
for (int i = 0; i < n; i++) {
    sum += i;
}

// the same, written as a while
int i = 0;
while (i < n) {
    sum += i;
    i++;
}
```

Use `for` when you know the count in advance, `while` when you do not. Notice where the three parts of the `for` header land in the `while` version – and that omitting `i++` is exactly what makes an **infinite loop** 无限循环.

Nested iteration & run-time

```
for (int i=0; i<n; i++)
  for (int j=0; j<n; j++)
    // runs n x n times
```

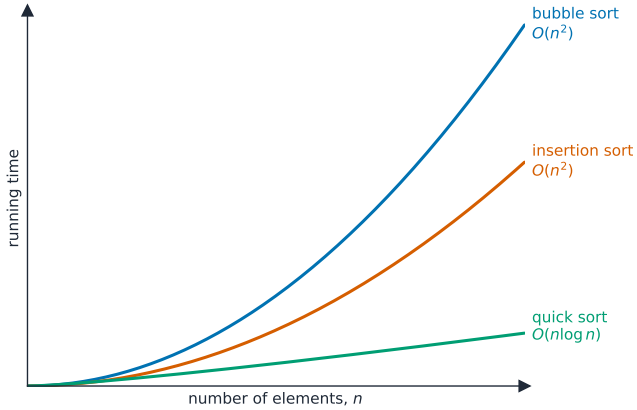
A **nested loop** 嵌套循环 puts one loop inside another. **Informal run-time analysis** 运行时分析: count how many times the inner statement runs – here $n \times n = n^2$, so it grows fast.

The integer patterns the exam tests directly

reading digits	repeatedly take `n % 10` for the last digit, then `n /= 10` to drop it – loop while `n > 0`
why it works	`%` gives the remainder and integer `/` truncates, so together they peel one digit per pass
a running total	declare the accumulator outside the loop, add inside it
a counter	the same shape, but incrementing on a condition rather than adding a value
a flag 标志	a `boolean` recording whether something happened – set inside the loop, tested after it

Total, count, max/min and flag cover most free-response loop questions. Decide which the wording is asking for before writing anything.

Nested iteration & run-time, in detail



How the running time grows with the number of elements n

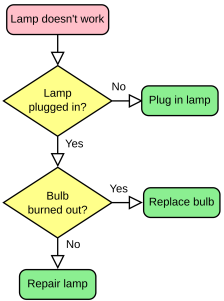
String algorithms

Loop over a String's indices to process each character.

Traverse a String

```
for (int i = 0; i < s.length();
i++)
char c = s.charAt(i);
```

Count vowels, reverse text, or find a substring – all by visiting each index in turn.



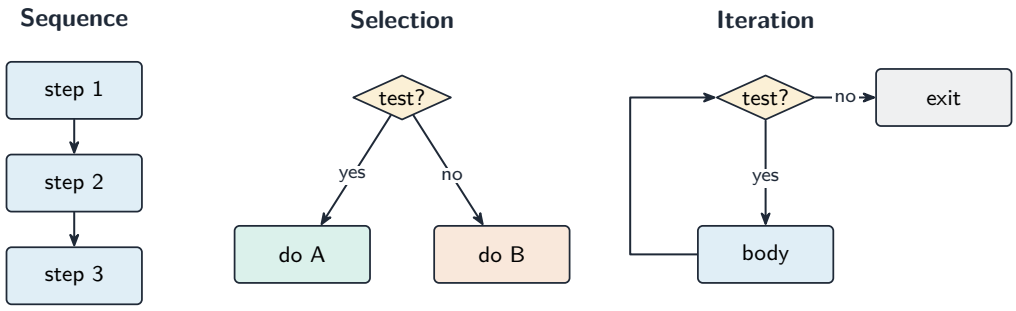
A flowchart with a decision diamond: selection chooses which path the algorithm takes

The standard String tasks

count occurrences	loop the indices, compare `s.substring(i, i+1)` to the target, increment a counter
build a copy	start from an empty String and concatenate the characters you want, in the order you want them
reverse	the same build, walking the index downward
filter	the same build, concatenating only characters that pass a test
contains	`s.indexOf(t) >= 0` — remembering that `-1` means absent

All five are one loop with a different body. Because a String is immutable, each builds a *new* String rather than editing the old one.

The three control structures



The three control structures: sequence, selection, and iteration

Every algorithm is built from three structures

sequence 顺序	steps executed in order, one after another
selection 选择	choosing a path – `if`, `if/else`, `else if`
iteration 迭代	repeating – `while` and `for`
logical operators 逻辑运算符	`&&`, `||`, `!` combine conditions; the first two short-circuit, so the right side may never be evaluated
the claim	any algorithm can be written with just these three – a theorem, not a style rule

> Name the structure before you write code. Most "I don't know where to start" moments are really "I have not decided whether this repeats".

Key points

`if` / `else if` / `else` choose a **branch** (selection)

`&&`, `||`, `!` build compound conditions

`while` & `for` loops **iterate**; avoid infinite loops

A **nested loop** runs n^2 times – growth matters

Exam tips

- Get boundary conditions right: use < vs <= deliberately, and watch the first and last iteration of every loop (off-by-one is the classic bug).
- Build compound conditions with `&&`, `||`, `!` and remember **short-circuit** evaluation (put the null check first).
- Trace nested loops by counting how many times the **inner** body runs in total.
- Choose the right structure – `if/else if` for ranges, a loop for repetition – and avoid an infinite loop by updating the loop variable.
- Apply **De Morgan's laws** when you simplify or negate a boolean condition.

3 Recap

Unit 2 – key takeaways

1 Bounds

$<$ vs $\leq$; first and last iteration

2 Short-circuit

null check first in $\&\&$

3 Nested

count how many times the inner body runs

4 De Morgan

use it to simplify or negate

Check yourself

1. A loop runs n times inside a loop that runs n times. How many iterations?
2. `while` or `for`: which suits a known count?
3. What does `&&` do when the left side is false?
4. Name the two structures that control program flow.

Answers **1.** n^2 **2.** `for` **3.** short-circuits – the right side never runs **4.** selection and iteration