Java Handout

English edition

Contents

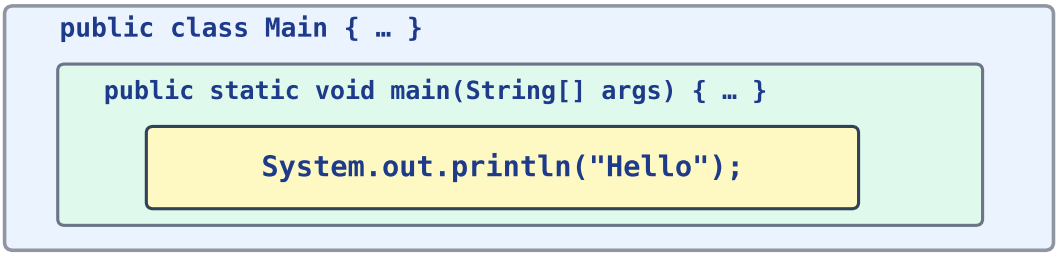
1 Java basics

1.1 Classes, main & output

Every Java program lives inside a class 类. It starts at a method 方法 named `main`. `System.out.println(...)` prints a line; `System.out.print(...)` prints with no new line.

```
public class Main {
    public static void main(String[] args) {
        System.out.println("Hello, world!");
        System.out.println("I am learning Java.");
    }
}
```

- Java is compiled 编译: the compiler 编译器 checks the whole program, then it runs.
- Every statement 语句 ends with a semicolon `;`.



Exam tip: every program lives in a class; execution starts at main; end each statement with ;

Java programs live in a class and start at main

1.2 Variables & primitive types

A variable 变量 must declare 声明 its type. Common primitive types 基本类型: `int` (whole number), `double` (decimal), `boolean` (`true`/`false`), `char` (one letter).

```
public class Main {
    public static void main(String[] args) {
        int age = 17;
        double price = 9.99;
```

```
        boolean passed = true;
        System.out.println(age + " " + price + " " + passed);
    }
}
```

1.3 Comments & style

A comment 注释 is `//` (one line) or `/* ... */` (a block). Indent the code inside braces `{ }`. Class names start Capitalised; variables and methods use camelCase 驼峰命名 (lowercase first).

```
public class Main {
    public static void main(String[] args) {
        // greet the user
        String firstName = "Mei";
        System.out.println("Hi, " + firstName);
    }
}
```

Common mistakes

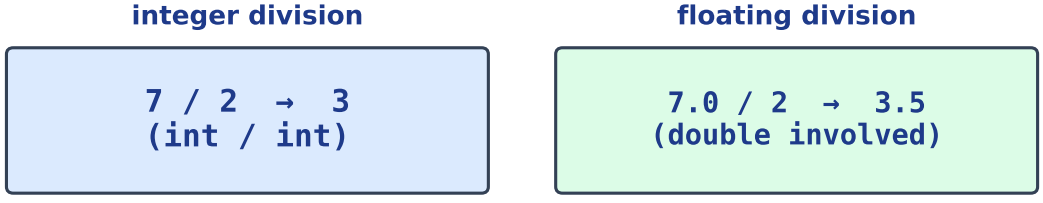
- Every statement ends with a semicolon `;`.
- `main` must be exactly `public static void main(String[] args)`.
- `println` adds a new line; `print` does not.

2 Operators & expressions

2.1 Arithmetic & assignment

Java arithmetic 算术 uses `+ - * /` and `%` (remainder). With two `int`s, `/` is integer division 整数除法 — it drops the decimal. `+=`, `-=`, and `++` are shortcuts.

```
public class Main {
    public static void main(String[] args) {
        int a = 7, b = 2;
        System.out.println(a / b);    // 3 (integer division)
        System.out.println(a % b);    // 1
        double x = 7.0 / 2;           // 3.5 (one side is double)
        System.out.println(x);
    }
}
```



Exam tip: int/int drops the decimal; make one side double for a real quotient; % is remainder

int/int truncates; involve a double for a real quotient

2.2 Using objects: String, Math, wrappers

Some values are objects 对象 with methods. `String` has `.length()`, `.substring()`, `.toUpperCase()`. `Math` has `Math.max`, `Math.sqrt`, `Math.pow`. Wrapper classes 包装类 (`Integer`, `Double`) wrap a primitive — e.g. `Integer.parseInt("42")`.

```
public class Main {
    public static void main(String[] args) {
        String s = "Hello";
        System.out.println(s.length());                    // 5
        System.out.println(s.toUpperCase());               // HELLO
        System.out.println(Math.max(3, 9));                // 9
```

```
        System.out.println(Integer.parseInt("42") + 1);  // 43
    }
}
```

`Math.random()` returns a random 随机 `double` from `0.0` up to (but not including) `1.0`. Scale it and cast to get whole numbers — this is the AP idiom:

```
public class Main {
    public static void main(String[] args) {
        // a random whole number from 1 to 6 (a dice roll)
        int roll = (int) (Math.random() * 6) + 1;
        System.out.println(roll >= 1 && roll <= 6);   // true
    }
}
```

- `Integer.MAX_VALUE` (2147483647) and `Integer.MIN_VALUE` are the limits of `int`; going past them wraps around (an overflow).
- An object variable that points at no object holds `null`; calling a method on it throws a NullPointerException.

2.3 Casting & type conversion

A cast 强制转换 changes a value's type. `(int)` drops the decimal; `(double)` avoids integer division when you need an exact result.

```
public class Main {
    public static void main(String[] args) {
        double pi = 3.99;
        System.out.println((int) pi);            // 3
        int total = 7, n = 2;
        System.out.println((double) total / n);  // 3.5
    }
}
```

Common mistakes

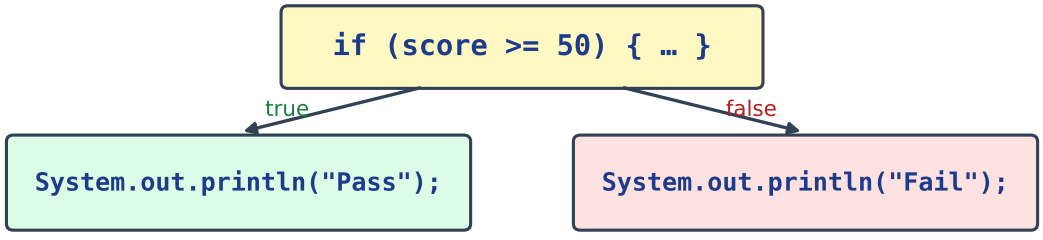
- Integer division: `5 / 2` is 2, not `2.5`. Cast first: `(double) 5 / 2`.
- Compare Strings (and other objects) with `.equals()`, not `==`.
- `==` on two objects tests whether they are the SAME object, not whether they look equal.

3 Booleans & selection

3.1 if / else

`if` runs a block when a condition 条件 is true; `else if` and `else` add more cases. The condition goes in `( )`, the block in `{ }`.

```
public class Main {
    public static void main(String[] args) {
        int score = 72;
        if (score >= 80) {
            System.out.println("A");
        } else if (score >= 60) {
            System.out.println("B");
        } else {
            System.out.println("fail");
        }
    }
}
```



Exam tip: always use braces; else if chains more cases; only one branch runs

if chooses the true branch; else the false branch

3.2 Logical operators & comparisons

Compare with `==`, `!=`, `<`, `>`, `<=`, `>=` — a comparison 比较 gives a `boolean`. Combine with `&&` (and), `||` (or), `!` (not) — the logical operators 逻辑运算符. For `String`s, use `.equals(...)`, **not** `==`.

```
public class Main {
    public static void main(String[] args) {
        int age = 16;
```

```
        boolean member = true;
        System.out.println(age >= 18 && member);   // false
        String a = "hi";
        System.out.println(a.equals("hi"));        // true
    }
}
```

3.3 switch

`switch` chooses among many fixed values. Each `case` ends with `break`; `default` is the fallback.

```
public class Main {
    public static void main(String[] args) {
        int day = 3;
        switch (day) {
            case 1: System.out.println("Mon"); break;
            case 3: System.out.println("Wed"); break;
            default: System.out.println("other");
        }
    }
}
```

Common mistakes

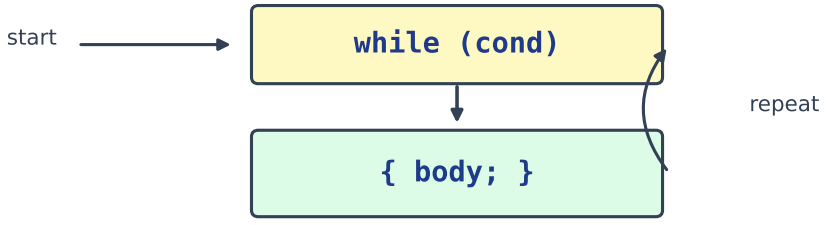
- A condition must be a `boolean`; `if (x = 5)` does not compile (use `==`).
- Each `switch` case needs a `break;`, or control falls through to the next case.
- `&&` and `||` are the logical operators; `&` and `|` are bitwise.

4 Loops

4.1 while loops

A `while` loop repeats while a condition is true. Change something inside, or it loops forever.

```
public class Main {
    public static void main(String[] args) {
        int n = 1;
        while (n <= 3) {
            System.out.println(n);
            n++;
        }
    }
}
```



Exam tip: condition is checked before each pass; body must eventually make it false

while checks the condition before each pass of the body

4.2 for loops

A `for` loop packs the start, the condition, and the step into one line. Best when you know the count.

```
public class Main {
    public static void main(String[] args) {
        for (int i = 0; i < 5; i++) {
            System.out.print(i + " ");
        }
        System.out.println();   // 0 1 2 3 4
    }
```

```
}
```

4.3 Accumulation

The accumulator 累加器 pattern: start a variable before the loop, then update it each turn.

```
public class Main {
    public static void main(String[] args) {
        int total = 0;
        for (int i = 1; i <= 5; i++) {
            total += i;
        }
        System.out.println(total);   // 15
    }
}
```

4.4 Nested loops

A loop inside a loop is a nested loop 嵌套循环. The inner loop runs fully on each turn of the outer one.

```
public class Main {
    public static void main(String[] args) {
        for (int r = 0; r < 3; r++) {
            for (int c = 0; c < 3; c++) {
                System.out.print("*");
            }
            System.out.println();
        }
    }
}
```

Common mistakes

- `for (int i = 0; i < n; i++)` runs `n` times (`0` to `n - 1`); using `<=` runs one extra.
- Do not put a semicolon right after `for (...)` or `while (...)` — it makes an empty loop.
- Declare the counter in the `for` header so its scope ends with the loop.

5 Strings

5.1 String methods

A `String` 字符串 is text. Useful methods: `.length()`, `.charAt(i)`, `.substring(a, b)`, `.indexOf(x)`, `.toUpperCase()`, `.equals(...)`. Strings are immutable 不可变 — each method returns a **new** String.

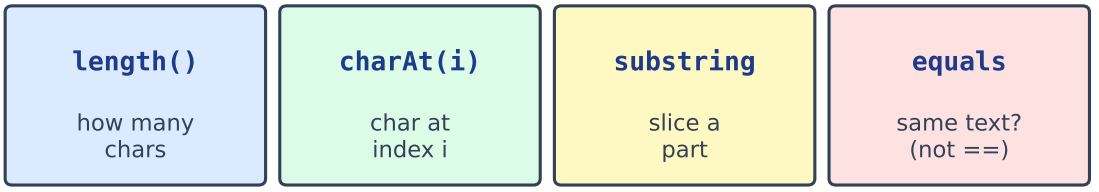
```
public class Main {
    public static void main(String[] args) {
        String s = "Python";
        System.out.println(s.length());          // 6
        System.out.println(s.charAt(0));         // P
        System.out.println(s.substring(0, 3));   // Pyt
        System.out.println(s.toUpperCase());     // PYTHON
    }
}
```

The methods you will use every day:

Method	Meaning	Example → result
`.length()`	how many characters	`"Hi".length()` → `2`
`.charAt(i)`	one character	`"Hi".charAt(0)` → `H`
`.substring(a, b)`	part, stops before `b`	`"Python".substring(0, 3)` → `Pyt`
`.substring(a)`	from `a` to the end	`"Python".substring(3)` → `hon`
`.indexOf(x)`	first position, `-1` if absent	`"banana".indexOf("na")` → `2`
`.equals(s)`	same text?	`"hi".equals("hi")` → `true`
`.compareTo(s)`	order: negative / 0 / positive	`"apple".compareTo("banana")` → negative

`compareTo` puts Strings in dictionary order — the AP exam uses it for sorting questions:

```
public class Main {
    public static void main(String[] args) {
        String a = "apple", b = "banana";
        System.out.println(a.compareTo(b) < 0);    // true (apple comes
↪   first)
        System.out.println(a.compareTo("apple"));  // 0 (equal)
    }
}
```



Exam tip: Strings are objects — use equals for text, not ==; indices start at 0

Key String methods: length, charAt, substring, equals

5.2 Building & traversing strings

Join strings with `+` (concatenation 拼接). Visit each character with a loop and `.charAt(i)`.

```
public class Main {
    public static void main(String[] args) {
        String word = "banana";
        int count = 0;
        for (int i = 0; i < word.length(); i++) {
            if (word.charAt(i) == 'a') count++;
        }
        System.out.println(count);   // 3
    }
}
```

When you build a long String in a loop, `StringBuilder` is much faster: append the pieces, then call `.toString()` once.

```
public class Main {
    public static void main(String[] args) {
        StringBuilder sb = new StringBuilder();
        for (int i = 1; i <= 5; i++) {
            sb.append(i).append(" ");
        }
        System.out.println(sb.toString().trim());   // 1 2 3 4 5
    }
}
```

Common mistakes

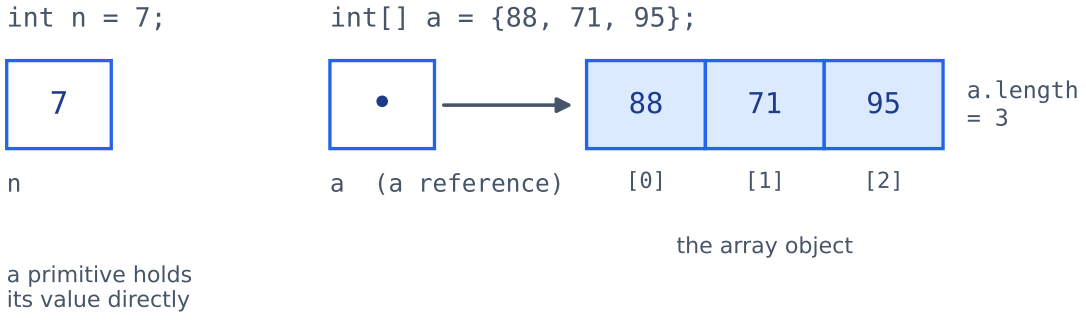
- Strings are immutable: `s.toUpperCase()` returns a new String, so store the result.
- Read a character with `s.charAt(i)`; the length is `s.length()` (a method, with `()`).
- Building a String with `+=` in a big loop is slow; use a `StringBuilder`.

6 Arrays

6.1 1-D arrays

An array 数组 holds a fixed number of values of one type. Index from `0`, and get the size with `.length`.

```
public class Main {
    public static void main(String[] args) {
        int[] scores = {88, 71, 95};
        System.out.println(scores[0]);        // 88
        System.out.println(scores.length);    // 3
        scores[1] = 100;
        System.out.println(scores[1]);        // 100
    }
}
```



06-array-memory

A primitive holds its value; an array variable holds a reference to the array object

6.2 Array algorithms

Walk the array with a loop to find a max, a total, a count, or to search 查找. A for-each loop (`for (int x : a)`) reads each value in turn.

```
public class Main {
    public static void main(String[] args) {
        int[] a = {3, 9, 2, 7};
        int max = a[0], total = 0;
        for (int x : a) {
            if (x > max) max = x;
```

```
            total += x;
        }
        System.out.println(max + " " + total);   // 9 21
    }
}
```

6.3 2-D arrays

A 2-D array 二维数组 is a grid 网格 of rows and columns: `grid[row][col]`.

```
public class Main {
    public static void main(String[] args) {
        int[][] grid = {{1, 2, 3}, {4, 5, 6}};
        System.out.println(grid[1][2]);   // 6
        for (int[] row : grid) {
            for (int v : row) System.out.print(v + " ");
        }
        System.out.println();             // 1 2 3 4 5 6
    }
}
```

Common mistakes

- An array's size is `a.length` (no brackets, no `()`), and it is fixed when created.
- Valid indexes are `0` to `a.length - 1`; `a[a.length]` throws ArrayIndexOutOfBoundsException.
- A new `int[5]` is filled with zeros, not left empty.

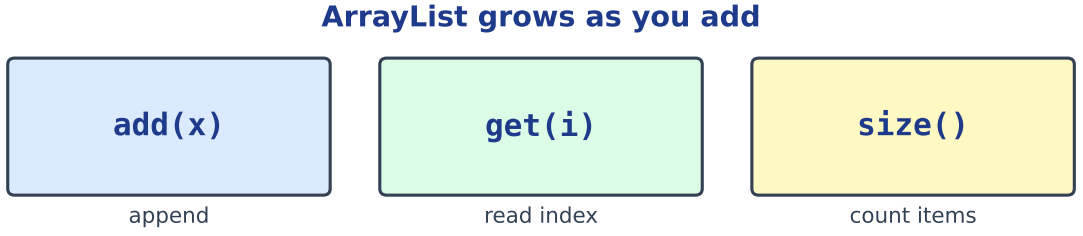
7 ArrayList

7.1 ArrayList basics

An `ArrayList` is a resizable 可变大小 list — it grows and shrinks as you add or remove items. It stores objects, so use a wrapper 包装类 type like `Integer` (not `int`). The `<Integer>` part is a generic 泛型 type. Key methods: `.add(x)`, `.get(i)`, `.set(i, x)`, `.size()`, `.remove(i)`.

```
import java.util.ArrayList;

public class Main {
    public static void main(String[] args) {
        ArrayList<Integer> nums = new ArrayList<Integer>();
        nums.add(10);
        nums.add(20);
        nums.add(30);
        System.out.println(nums.size());   // 3
        System.out.println(nums.get(1));   // 20
        nums.set(0, 99);
        System.out.println(nums);          // [99, 20, 30]
    }
}
```



Exam tip: ArrayList<Type> needs a type; indices start at 0 like arrays

ArrayList: add, get, size on a resizable list

7.2 ArrayList algorithms & the remove bug

`.remove(i)` shifts 移动 every later element one place left. If you remove while counting `i` **up**, you skip the next element. Fix: loop **backwards**, or don't increment `i` after a remove.

```java
import java.util.ArrayList;

public class Main {
    public static void main(String[] args) {
        ArrayList<Integer> nums = new ArrayList<Integer>();
        for (int n : new int[]{4, 7, 4, 9, 4}) nums.add(n);
        // Remove every 4 - loop backwards so removals don't skip items.
        for (int i = nums.size() - 1; i >= 0; i--) {
            if (nums.get(i) == 4) nums.remove(i);
        }
        System.out.println(nums);   // [7, 9]
    }
}
```

Common mistakes

- `ArrayList` uses `.size()`, `.get(i)` and `.add(...)` — not the `[]` you use on arrays.
- Removing items while looping forward by index skips the next item (the remove bug). Loop backwards, or use an iterator.
- Store objects, not primitives: use `ArrayList<Integer>`, and Java auto-boxes `int` values.

8 Writing classes

8.1 Fields, constructor & methods

A class 类 is a blueprint for objects. Its fields 字段 store data, its constructor 构造方法 sets up a new object, and its methods 方法 are the actions. `this.name` means "this object's `name`". Create an object with `new`.

```
public class Main {
    public static void main(String[] args) {
        Dog d = new Dog("Rex", 3);
        System.out.println(d.describe());   // Rex is 3 years old
        d.haveBirthday();
        System.out.println(d.describe());   // Rex is 4 years old
    }
}

class Dog {
    private String name;
    private int age;

    public Dog(String name, int age) {   // constructor
        this.name = name;
        this.age = age;
    }

    public String describe() {
        return name + " is " + age + " years old";
    }

    public void haveBirthday() {
        age++;
    }
}
```

A `static` member belongs to the class itself, not to any one object. Call a static method on the class name — like `Math.max` — and a static field is shared by every object:

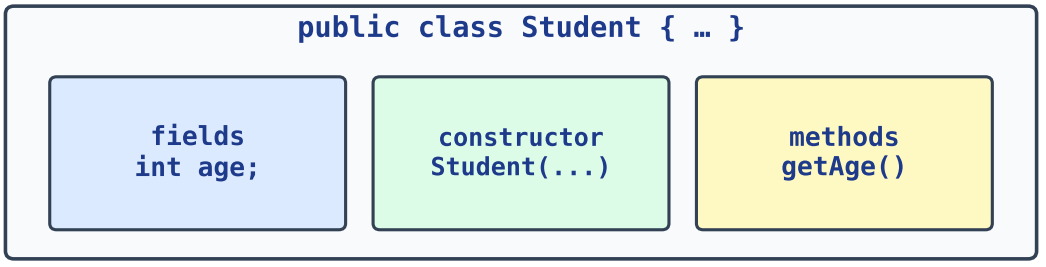
```
public class Main {
    public static void main(String[] args) {
        System.out.println(Counter.made());   // 0
        new Counter();
        new Counter();
        System.out.println(Counter.made());   // 2
```

```
    }
}

class Counter {
    private static int count = 0;      // shared by ALL Counter objects

    public Counter() { count++; }

    public static int made() {         // called on the class:
↪   Counter.made()
        return count;
    }
}
```



Exam tip: constructor name matches the class; fields store state; methods do work

Fields store state; constructor builds; methods act

8.2 Encapsulation

Encapsulation 封装 means hiding data behind methods. Mark fields `private` so outside code can't touch them directly; expose an accessor 访问方法 (getter) to read, and a method to change them safely. The method can **guard** the data — here a deposit must be positive.

```
public class Main {
    public static void main(String[] args) {
        Account a = new Account(100);
        a.deposit(50);
        a.deposit(-999);                        // rejected by the guard
        System.out.println(a.getBalance());     // 150
    }
}
```

```
class Account {
    private int balance;                          // hidden from outside

    public Account(int start) {
        balance = start;
    }

    public void deposit(int amount) {
        if (amount > 0) balance += amount;        // guard keeps balance
↪   valid
    }

    public int getBalance() {                     // accessor (getter)
        return balance;
    }
}
```

Common mistakes

- A constructor has the class name and no return type (not even `void`).
- Use `this.field` to tell a field apart from a parameter with the same name.
- Make fields `private` and reach them through getter/setter methods (encapsulation).

9 Inheritance & polymorphism

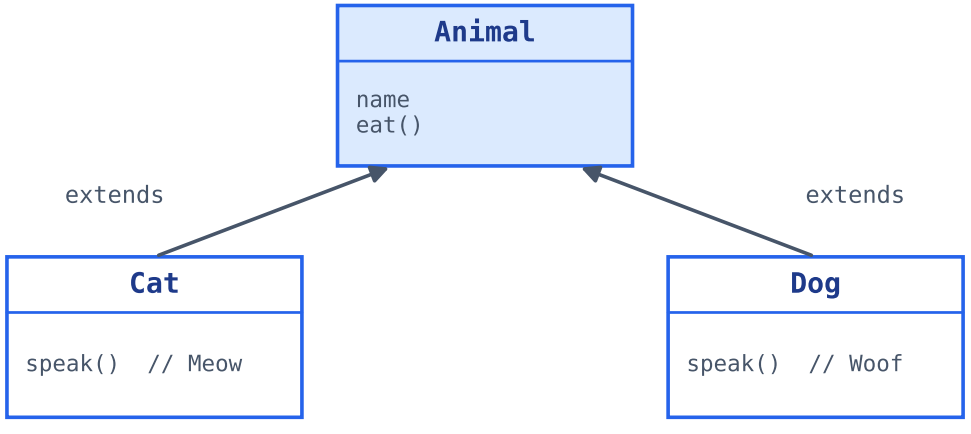
9.1 Inheritance

Inheritance 继承 lets a subclass 子类 reuse a superclass 父类. Write `class Cat extends Animal` and `Cat` gets `Animal`'s fields and methods for free. Call the parent constructor with `super(...)`.

```
public class Main {
    public static void main(String[] args) {
        Cat c = new Cat("Milo");
        c.eat();      // Milo is eating  (inherited from Animal)
        c.speak();    // Meow            (Cat's own method)
    }
}

class Animal {
    protected String name;
    public Animal(String name) { this.name = name; }
    public void eat() { System.out.println(name + " is eating"); }
}

class Cat extends Animal {
    public Cat(String name) { super(name); }     // call Animal's
↪   constructor
    public void speak() { System.out.println("Meow"); }
}
```



Cat and Dog inherit name and eat(), and add their own speak()
09-inheritance

Cat and Dog extend Animal: they inherit its members and add their own

9.2 Polymorphism & toString

A subclass can override 重写 a method to replace the parent's version. Polymorphism 多态 means a `Shape` variable can hold any subtype, and Java picks the right `toString` at run time. `System.out.println(obj)` automatically calls `obj.toString()`.

```
public class Main {
    public static void main(String[] args) {
        Shape[] shapes = { new Circle(2), new Square(3) };
        for (Shape s : shapes) {
            System.out.println(s);          // each calls its own
↪   toString
        }
    }
}

class Shape {
    public String toString() { return "a shape"; }
}

class Circle extends Shape {
    private int r;
    public Circle(int r) { this.r = r; }
    public String toString() { return "Circle r=" + r; }     // override
}

class Square extends Shape {
    private int side;
    public Square(int side) { this.side = side; }
    public String toString() { return "Square side=" + side; }   //
↪   override
}
```

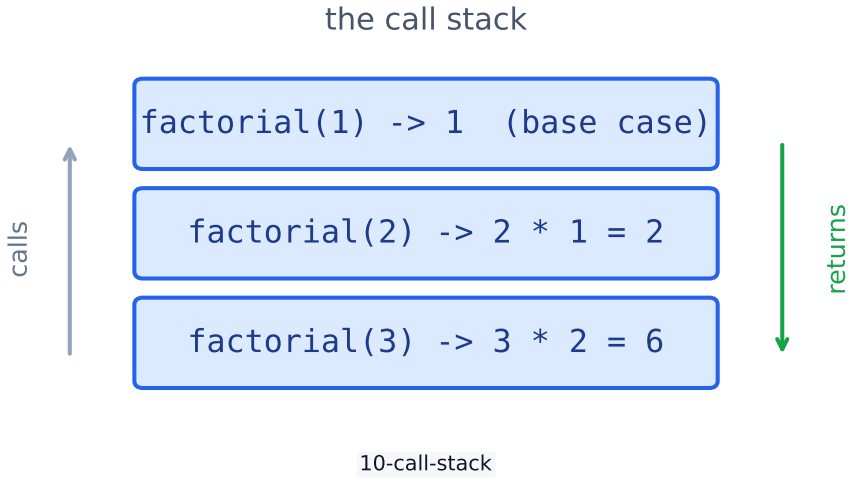
Common mistakes

- An overriding method must match the signature exactly; add `@Override` so the compiler catches slips.
- `super(...)` must be the first line of a subclass constructor.
- A subclass object IS-A superclass object, but not the other way round.

10 Recursion

10.1 Recursion

Recursion 递归 is a method that calls itself. Every recursion needs a base case 基准情形 (when to stop) and a recursive call 递归调用 that moves toward it. Without a base case it never stops and crashes with a *stack overflow*.



The call stack for factorial(3): each call waits, then returns in reverse order

```java
public class Main {
    public static void main(String[] args) {
        System.out.println(factorial(5));   // 120
    }

    public static int factorial(int n) {
        if (n <= 1) return 1;            // base case
        return n * factorial(n - 1);     // recursive call: n * (n-1)!
    }
}
```

Trace it: `factorial(5)` waits for `factorial(4)`, which waits for `factorial(3)`… down to `factorial(1)` returning `1`. Then the answers multiply back up: `1 → 2 → 6 → 24 → 120`.

Recursion also works on Strings — peel off one character each call:

```java
public class Main {
    public static void main(String[] args) {
        System.out.println(reverse("PYTHON"));   // NOHTYP
    }

    static String reverse(String s) {
        if (s.length() <= 1) return s;               // base case
        return reverse(s.substring(1)) + s.charAt(0);
    }
}
```

Merge sort 归并排序 is the recursive sort on the AP exam: split the array in half, sort each half recursively, then merge 合并 the two sorted halves. It runs in O(n log n) — far faster than the $O(n^2)$ sorts on big arrays.

```java
import java.util.Arrays;

public class Main {
    public static void main(String[] args) {
        int[] a = {5, 2, 9, 1, 7, 3};
        mergeSort(a, 0, a.length - 1);
        System.out.println(Arrays.toString(a));   // [1, 2, 3, 5, 7, 9]
    }

    static void mergeSort(int[] a, int lo, int hi) {
        if (lo >= hi) return;                 // base case: one element
        int mid = (lo + hi) / 2;
        mergeSort(a, lo, mid);                // sort the left half
        mergeSort(a, mid + 1, hi);            // sort the right half
        merge(a, lo, mid, hi);                // merge the two halves
    }

    static void merge(int[] a, int lo, int mid, int hi) {
        int[] tmp = new int[hi - lo + 1];
        int i = lo, j = mid + 1, k = 0;
        while (i <= mid && j <= hi) {
            if (a[i] <= a[j]) tmp[k++] = a[i++];
            else              tmp[k++] = a[j++];
        }
        while (i <= mid) tmp[k++] = a[i++];
        while (j <= hi)  tmp[k++] = a[j++];
        for (k = 0; k < tmp.length; k++) a[lo + k] = tmp[k];
    }
}
```

Common mistakes

- Recursion needs a base case, or it throws StackOverflowError.
- Each recursive call must move CLOSER to the base case.
- Trace a small example by hand to check the recursion returns the right value.
- In merge sort, the merge step does the real work; the recursion only splits the array.

11 Searching & sorting

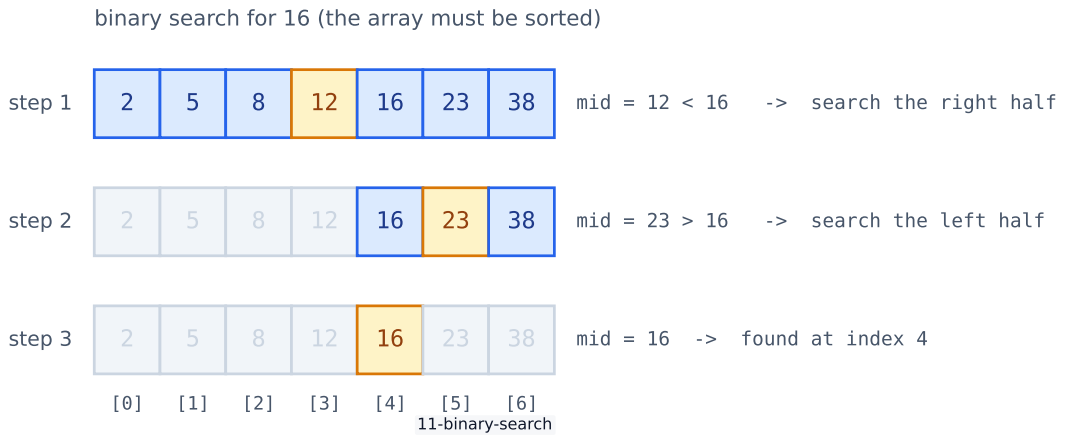
11.1 Linear & binary search

Linear search 线性查找 checks every element — works on any array. Binary search 二分查找 is much faster but needs a **sorted** 已排序 array: it looks at the middle, then throws away half each step. Both return the index, or `-1` if not found.

```
public class Main {
    public static void main(String[] args) {
        int[] a = {2, 5, 8, 12, 16, 23};      // sorted, so binary search
↪   works
        System.out.println(linear(a, 12));    // 3
        System.out.println(binary(a, 12));    // 3
        System.out.println(binary(a, 9));     // -1 (not found)
    }

    static int linear(int[] a, int target) {
        for (int i = 0; i < a.length; i++)
            if (a[i] == target) return i;
        return -1;
    }

    static int binary(int[] a, int target) {
        int lo = 0, hi = a.length - 1;
        while (lo <= hi) {
            int mid = (lo + hi) / 2;
            if (a[mid] == target) return mid;
            else if (a[mid] < target) lo = mid + 1;
            else hi = mid - 1;
        }
        return -1;
    }
}
```



Binary search halves the range each step, so a sorted array is searched in O(log n)

11.2 Selection & insertion sort

Selection sort 选择排序 repeatedly finds the smallest remaining value and swaps it to the front. Insertion sort 插入排序 takes each value and slides it back into its place among the already-sorted values.

```java
import java.util.Arrays;

public class Main {
    public static void main(String[] args) {
        int[] a = {5, 2, 9, 1, 7};
        for (int i = 0; i < a.length - 1; i++) {
            int min = i;
            for (int j = i + 1; j < a.length; j++)
                if (a[j] < a[min]) min = j;
            int t = a[min]; a[min] = a[i]; a[i] = t;   // swap into place
        }
        System.out.println(Arrays.toString(a));   // [1, 2, 5, 7, 9]
    }
}
```

```java
import java.util.Arrays;

public class Main {
    public static void main(String[] args) {
        int[] a = {5, 2, 9, 1, 7};
        for (int i = 1; i < a.length; i++) {
            int key = a[i], j = i - 1;
```

```
            while (j >= 0 && a[j] > key) {    // shift bigger values
↪  right
                a[j + 1] = a[j];
                j--;
            }
            a[j + 1] = key;                   // drop key into the gap
        }
        System.out.println(Arrays.toString(a));   // [1, 2, 5, 7, 9]
    }
}
```

How the speeds compare:

Algorithm	Time
linear search	O(n)
binary search	O(log n), sorted arrays only
selection / insertion sort	$O(n^2)$
merge sort (topic 10)	O(n log n)

Common mistakes

- Binary search only works on a **sorted** array.
- Linear search is O(n); binary search is O(log n) but needs the sort first.
- Selection and insertion sort are $O(n^2)$ — clear to learn, slow on big data.

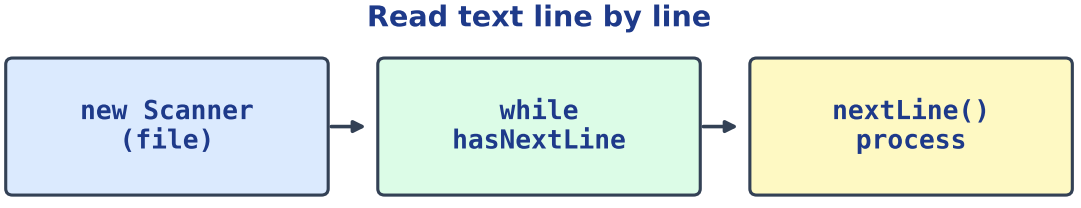
12 Files & the FRQ

12.1 Text files with Scanner

A `Scanner` reads text one line at a time. For a real file you write `new Scanner(new File("scores.txt"))`; here we wrap a `String` so the example runs anywhere. Use `.split(" ")` to split 拆分 a line into parts and `Integer.parseInt(...)` to parse 解析 a number from text.

```
import java.util.Scanner;

public class Main {
    public static void main(String[] args) {
        // Real file:  Scanner in = new Scanner(new File("scores.txt"));
        String data = "Alice 80\nBob 95\nCara 72";
        Scanner in = new Scanner(data);
        int total = 0, count = 0;
        while (in.hasNextLine()) {
            String line = in.nextLine();
            String[] parts = line.split(" ");      // break the line on
↪   the space
            total += Integer.parseInt(parts[1]);
            count++;
        }
        System.out.println("average = " + (total / count));   // average
↪   = 82
    }
}
```



Exam tip: hasNextLine guards the loop; split + parseInt turn a line into data

Scanner reads lines while hasNextLine is true

12.2 The AP FRQ question types

The AP CS A exam has four free-response 自由作答 questions, each a fixed shape:

- **Q1 — Methods & control:** write methods to a given spec; loops, `if`, `String`/`Math`.
- **Q2 — Class design:** write a full class (fields, constructor, methods) from a description.
- **Q3 — Array / ArrayList:** process a 1-D array or `ArrayList` (search, count, build a new list).
- **Q4 — 2-D array:** traverse a grid by row and column.

The skill is always the same: read the spec, write the method exactly as described, return the right type.

```
public class Main {
    public static void main(String[] args) {
        // Q1 style: implement a method to a spec, then it is tested.
        System.out.println(countEven(new int[]{4, 7, 10, 3, 6}));   // 3
    }

    /** Returns how many values in arr are even. */
    public static int countEven(int[] arr) {
        int count = 0;
        for (int x : arr)
            if (x % 2 == 0) count++;
        return count;
    }
}
```

Common mistakes

- `nextInt()` leaves the newline behind, so a following `nextLine()` reads an empty line — read it away first.
- Check `hasNext()` before reading, to avoid running off the end of the file.
- In the FRQ, read the method header carefully: match the return type and parameters exactly.