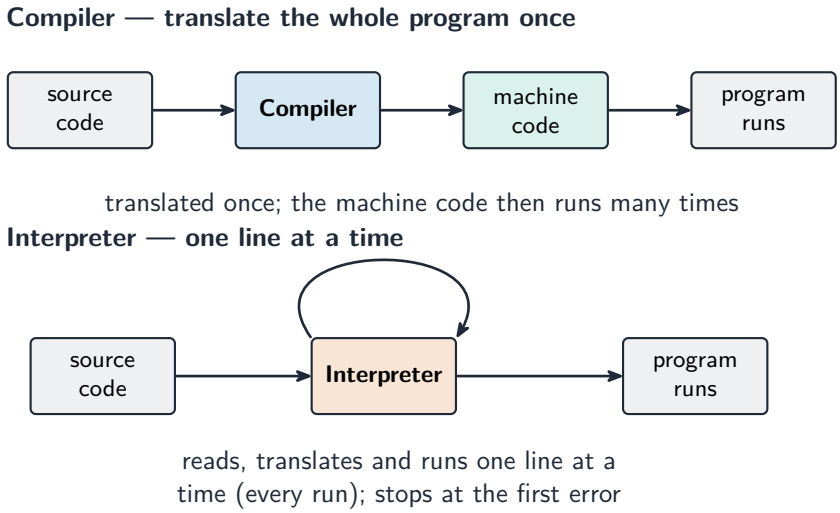
# Using Objects and Methods

AP Computer Science A

## Introduction to Algorithms, Programming, and Compilers

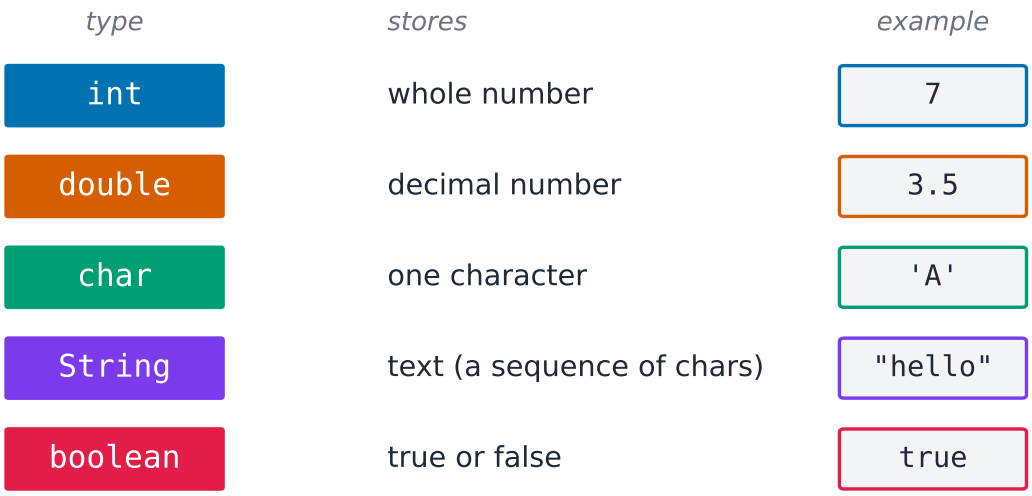
An **algorithm** 算法 is a finite, step-by-step procedure that solves a problem. A **program** 程序 expresses an algorithm in a language a computer can run. Java is **compiled** 编译: the **compiler** 编译器 translates your source code into **bytecode**, which the **Java Virtual Machine (JVM)** runs. A **syntax error** 语法错误 (breaking the grammar) is caught by the compiler; a **logic error** 逻辑错误 (wrong result) is not –the program runs but misbehaves.




*A compiler translates the whole program at once; an interpreter runs it line by line*

## Variables and Data Types

A **variable** 变量 is a named box that stores a value of a fixed **type** 类型. Java's main **primitive types** 基本类型 are `int` (whole numbers), `double` (decimals), and `boolean` (`true`/`false`). Declare with the type first:




*Java's basic data types, each storing a different kind of value*

```
int score = 90;
double price = 4.99;
boolean passed = true;
```

## Expressions and Output

An **expression** 表达式 combines values and **operators** to compute a result: `+ - * /` and `%` (**modulus** 取模, the remainder). **Integer division** truncates: `7 / 2` is `3`, while `7 % 2` is `1`. **Operator precedence** follows math (`*`,`/`,`%` before `+`,`-`). Print with:

```
System.out.print("no newline");
System.out.println("with newline");
```

## Assignment Statements and Input

An **assignment** 赋值 `x = expr;` evaluates the right side and stores it in the left variable. Read input with a `Scanner`:

```
Scanner in = new Scanner(System.in);
int age = in.nextInt();
String name = in.next();
```

## Casting and Range of Variables

Each type has a fixed range; an `int` overflows past about 2.1 billion. **Casting** 类型转换 converts between types. Widening (`int` to `double`) is automatic; narrowing needs an explicit cast, which **truncates** (does not round):

```
double avg = (double) total / count;   // force real division
int whole = (int) 3.9;                 // 3, truncated
```

**Exam skill:** watch for integer division producing a truncated result when a decimal was expected –cast one operand to `double` first.

**Worked example.** Trace each expression:

- `7 / 2` → `3` (both `int`, so division **truncates**);
- `7.0 / 2` → `3.5` (one `double` forces real division);
- `7 % 2` → `1` (the remainder);
- `(double) 7 / 2` → `3.5` (the cast binds tighter than `/`, so it is `7.0 / 2`);
- `(double) (7 / 2)` → `3.0` (the parentheses compute `7 / 2 = 3` in `int` **first**, then widen).

The last two look alike but differ –the position of the cast decides whether the truncation happens.

## Compound Assignment Operators

Shorthands combine an operation with assignment: `x += 5` means `x = x + 5`; likewise `-=`, `*=`, `/=`, `%=`. The **increment** and **decrement** operators `x++` and `x--` add or subtract one.

## Application Program Interface (API) and Libraries

An **API** (Application Programming Interface) 应用程序接口 is the published list of classes and methods you may use. A **library** 库 is a collection of ready-made classes (like `Math`, `String`, `Scanner`). You read the API documentation to learn what a method needs (its parameters) and returns, without seeing its inner code –an example of **abstraction** 抽象.

## Documentation with Comments

**Comments** 注释 are ignored by the compiler but explain code to humans: `//` for a single line, `/* ... */` for a block, and `/** ... */` for a **Javadoc** comment that documents a method's purpose, parameters, and return value. Precise **preconditions** and **postconditions** are written here.

## Method Signatures

A **method signature** 方法签名 is a method's name plus its parameter types, e.g. `nextInt()` or `substring(int, int)`. To call a method you must supply **arguments** 实参 that match the parameters in number, type, and order. The signature also states the **return type** –the type of value the method gives back (`void` if none).

## Calling Class Methods

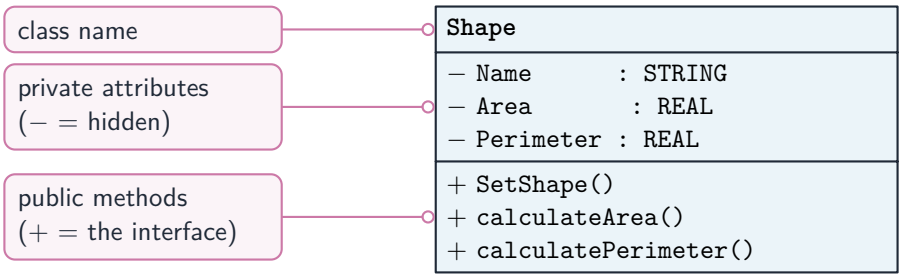
A **class (static) method** 类方法 belongs to the class itself, so you call it on the **class name**: `ClassName.method(args)`. No object is needed.

## Math Class

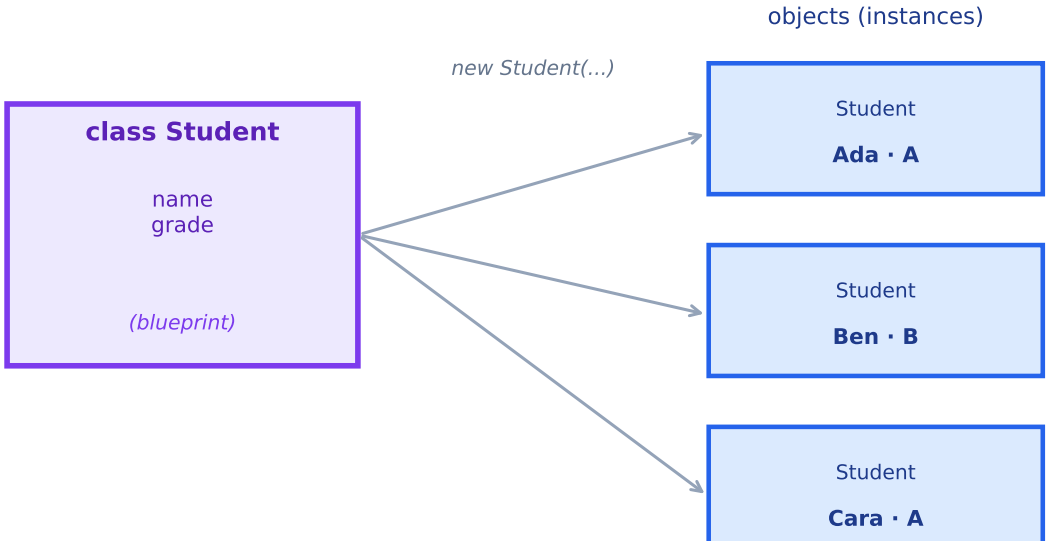
The `Math` class provides static math methods: `Math.abs(x)`, `Math.pow(base, exp)`, `Math.sqrt(x)`, and `Math.random()` (a `double` in $[0, 1)$). To get a random integer from `0` to `n-1`: `(int)(Math.random() * n)`.

## Objects: Instances of Classes

A **class** 类 is a blueprint; an **object** 对象 is a concrete **instance** 实例 built from it. A class bundles **data** (fields) with **behavior** (methods) –the heart of **object-oriented programming** 面向对象编程. `String`, `Scanner`, and `ArrayList` are all classes you instantiate.




*A class diagram: private attributes and public methods*



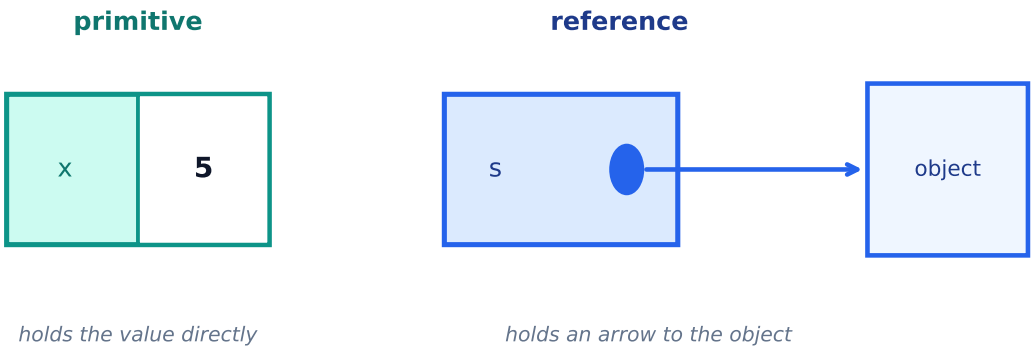

*A class is a blueprint; each object is one instance built from it*

# Object Creation and Storage (Instantiation)

**Instantiation** 实例化 creates an object with the `new` keyword, which calls a **constructor** 构造函数:

```
Scanner in = new Scanner(System.in);
String s = new String("hi");   // or just "hi"
```

The variable holds a **reference** 引用 (the object's address), not the object itself. Two references can point to the **same** object; comparing them with `==` compares addresses, not contents.




*A primitive variable holds its value directly, a reference holds an arrow to the object*

# Calling Instance Methods

An **instance method** 实例方法 acts on a specific object, so you call it on the **object reference**: `object.method(args)`. Example: `in.nextInt()`, `word.length()`.

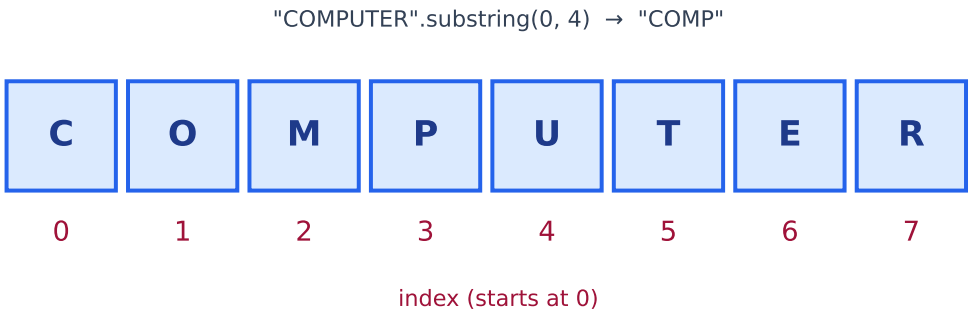
# String Manipulation

`String` objects are **immutable** 不可变–methods return a **new** string rather than changing the original. Key methods (all indices start at `0`):

```
s.length();            // number of characters
s.substring(2, 5);     // chars at index 2,3,4 (5 excluded)
s.indexOf("ab");       // first position, or -1
s.equals(other);       // content comparison (never use == for Strings)
s.compareTo(other);    // <0, 0, >0 by dictionary order
```

**Exam skill:** `substring(a, b)` includes index `a` but **excludes** `b`, and String comparison must use `.equals`, not `==` –two of the most-tested String pitfalls.

**Worked example.** Let `String s = "COMPUTER";` (indices 0–7). Then `s.length()` is 8; `s.substring(0, 4)` is `"COMP"` (indices 0,1,2,3 –index 4 excluded); `s.substring(4)` is `"UTER"` (from index 4 to the end); `s.indexOf("PU")` is 3; and `s.indexOf("X")` is `-1` (not found). Counting the excluded endpoint of `substring` is the single most common slip.




*String indices start at 0*

# Exam tips

- Trace code by hand line by line, tracking each variable's value in a table —the exam rewards careful tracing over guessing.
- Know Java's primitive types and that integer division truncates (7/2 gives 3); use a cast or a double for real division.
- Distinguish **compile-time** errors (syntax, types) from **run-time** errors (divide by zero, null) and **logic** errors (wrong output).
- Follow operator precedence and initialise every variable before you use it.
- On the free-response, write **complete, compilable** Java —return the right type and match the method header exactly.