SOMAIYA VIDYAVIHAR UNIVERSITY
K J Somaiya College of Engineering

Somaiya TRUST

Basic Concepts

Kaustubh Kulkarni
Assistant Professor,
Department of Computer Engineering,
KJSCE.

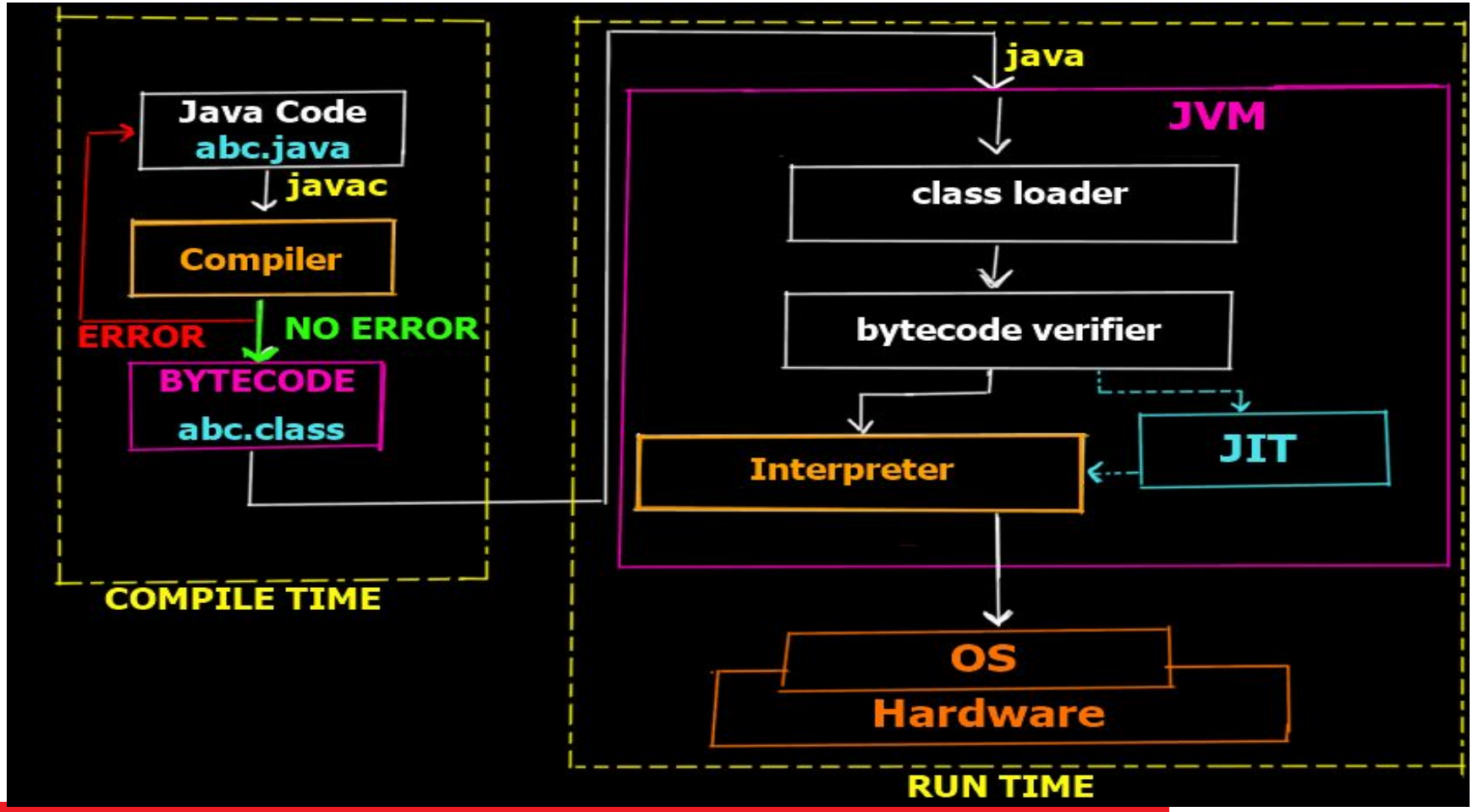
A Simple Program


```
/*
 This is a simple Java program.
 Call this file "Example.java".
*/
class Example {
 // Your program begins with a call to main().
      public static void main(String[] args) {
        System.out.println("This is a simple Java program.");
 }
}
```

Creating the Source Code File

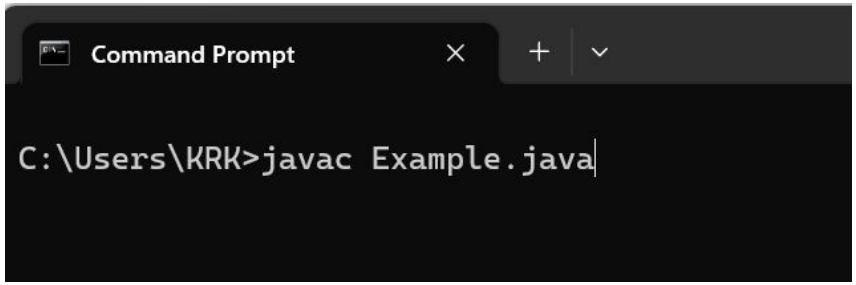
- For this example, the name of the source file should be **Example.java**.
- As you can see by looking at the program, the name of the class defined by the program is also **Example**.
- In Java, all code must reside inside a class.
- By convention, **the name of the main class should match the name of the file that holds the program**.

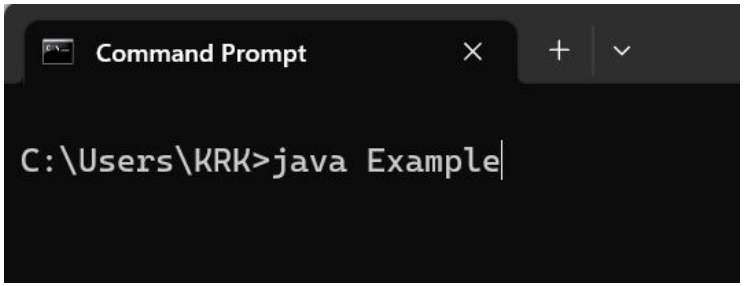
Compiling and Executing



Compiling and Executing

- To compile the program, execute the compiler, **javac**, specifying the name of the source file on the command line
- The javac compiler creates a file called Example.class that contains the bytecode version of the program.
- To run the program, you must use the Java application launcher called **java** and pass the class name, Example, as a command-line argument

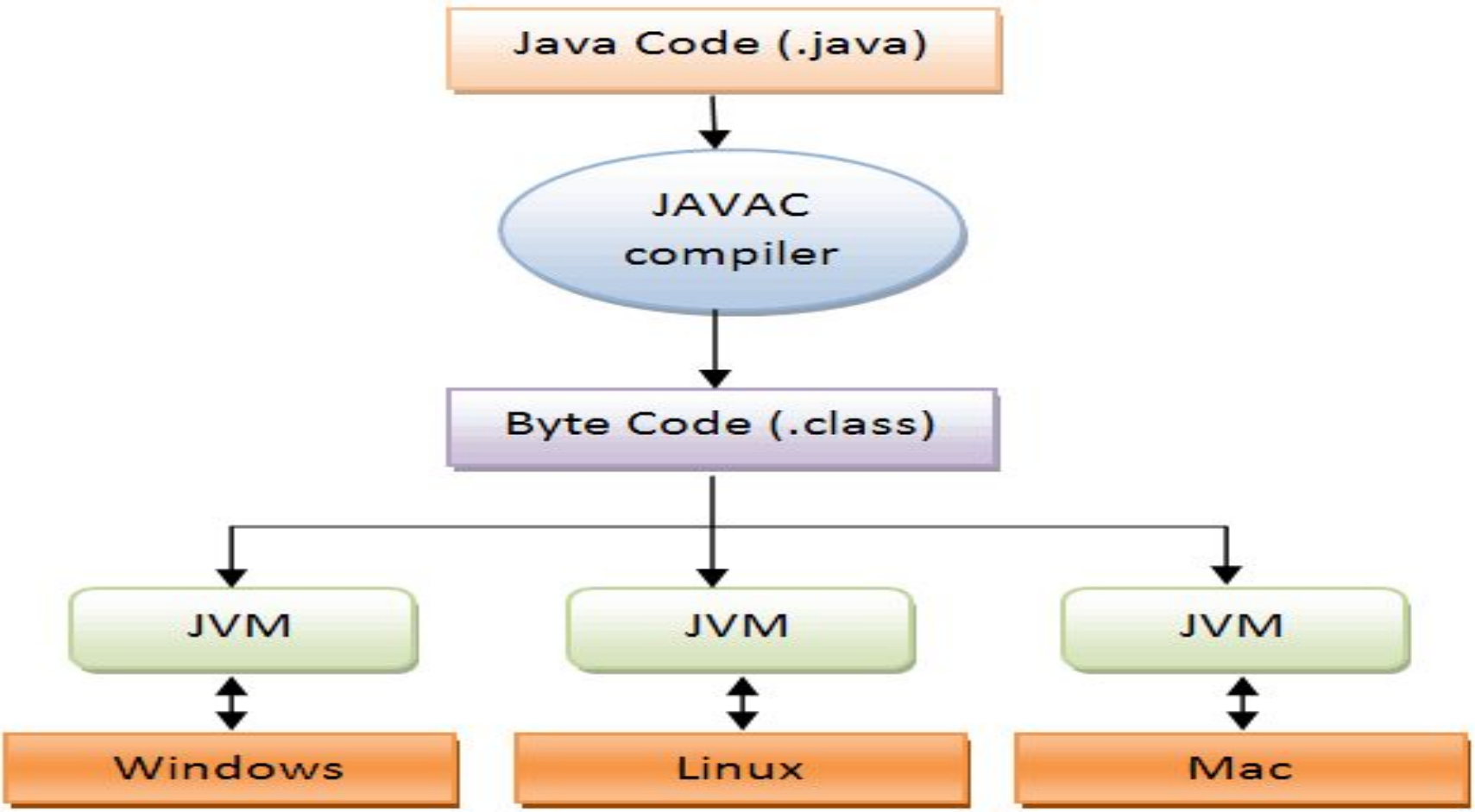




Bytecode

- The Java bytecode is the intermediate representation of your program that contains instructions the **Java Virtual Machine (JVM)** will execute.
- This **intermediate code is platform independent** (you can take this bytecode from a machine running windows and use it in any other machine running Linux or MacOS etc).
- Also this bytecode is only understandable by the **JVM** and not the user or even the hardware /OS layer.

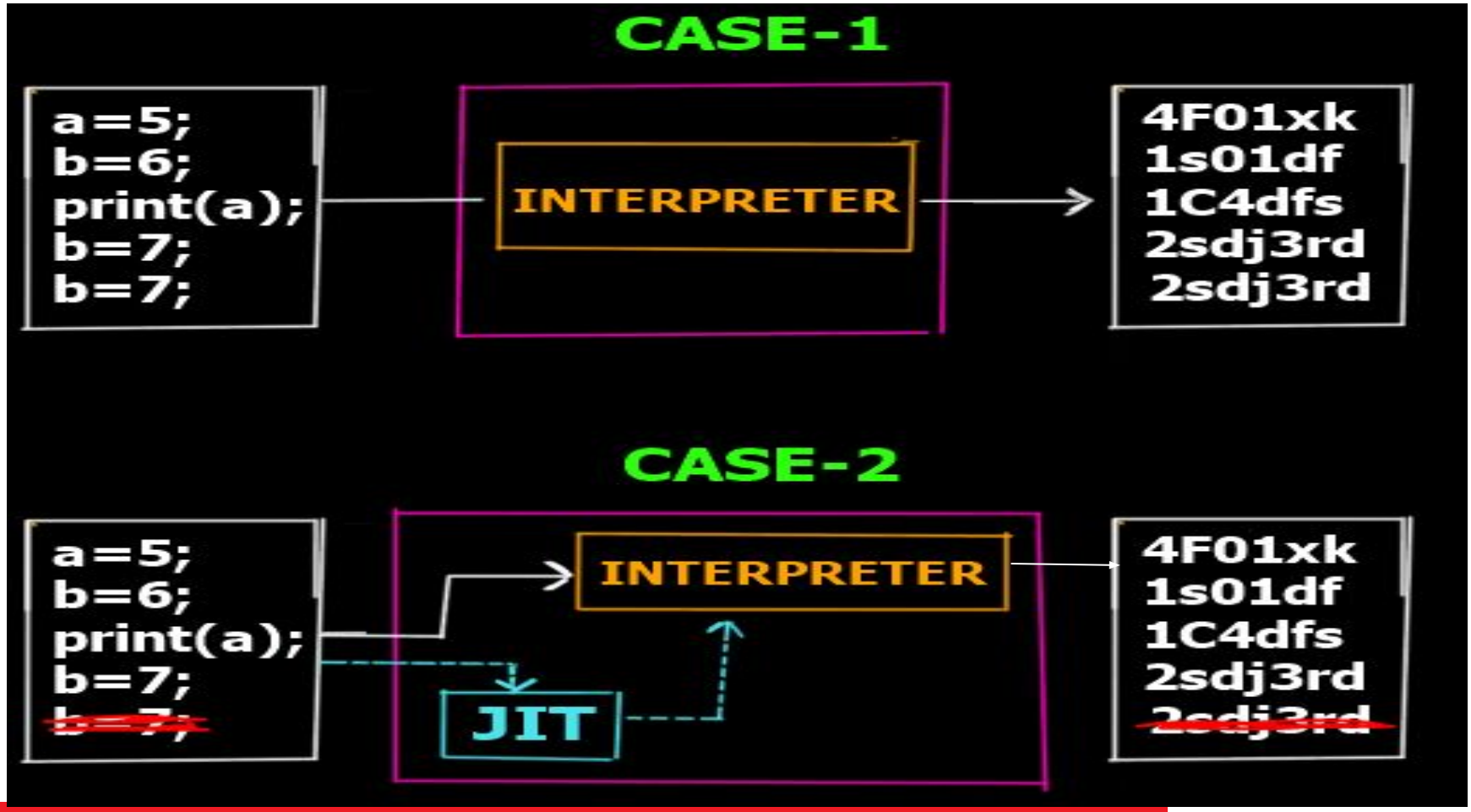
Java is Platform Independent



Run Time

- Run Time phase starts when the bytecode is loaded into the JVM by the **class loader** (another inbuilt program inside the JVM).
- Now the **bytecode verifier** (an inbuilt program inside the JVM) checks the bytecode for its integrity and if no issues are found, passes it to the interpreter.
- The **interpreter** inside the JVM converts each line of the bytecode into executable machine code and passes it to the the CPU to execute.

JIT (Just-In-Time) Compiler



JIT Compiler

- The last 2 lines (both b = 7) are the same (redundant).
- Clearly the second line does not have any effect on the actual output.
- Since the interpreter works line by line it still creates 5 lines of machine code for 5 lines of the bytecode in Case 1.
- This is inefficient.

JIT Compiler

- In case 2 we have the JIT compiler.
- Now before the bytecode is passed onto the interpreter for conversion to machine code, the **JIT compiler scans** the full code to see if it can be **optimized**.
- As it finds the last line is redundant it removes it from the bytecode and passes only 4 lines to the interpreter thus making it more **efficient** and **faster** as the interpreter now has 1 line less to interpret.
- JIT compiler optimizations can include inlining functions, constant folding, dead code elimination, and more. The goal is to produce highly efficient machine code tailored for the specific execution environment.

A Closer Look at the Program

Multiline comment

The program begins with the following lines:

```
/*
 This is a simple Java program.
 Call this file "Example.java".
*/
This is a multiline comment.
```

Class Definition

- The next line of code in the program is :

  class Example {

- This line uses the keyword **class** to declare that a new class is being defined.
- **Example** is an identifier that is the name of the class.
- The entire class definition, including all of its members, will be between the opening curly brace ({) and the closing curly brace (}).

Single-Line Comment

The next line in the program is the single-line comment, shown here:

```
// Your program begins with a call to main().
```

A single-line comment begins with a // and ends at the end of the line.

main()

- The next line of code is shown here:

```
public static void main(String[] args) {
```

- This line begins the main( ) method.
- This is the line at which the program will begin executing.
- As a general rule, a Java program begins execution by calling main( ).
- main( ) is simply a starting place for your program.
- A complex program will have dozens of classes, only one of which will need to have a main( ) method to get things started.

Printing output on screen

- The next line of code is shown here. Notice that it occurs inside main( ).

  System.out.println("This is a simple Java program.");

- This line outputs the string **"This is a simple Java program."** followed by a new line on the screen.
- This is accomplished by the built-in **println( )** method.
- The line begins with **System.out.**
- **System** is a predefined class that provides access to the system, and **out** is the output stream that is connected to the console (screen).

Signature of main()

- The **public** keyword is an access modifier.
- When a class member is preceded by public, then that member may be accessed by code outside the class in which it is declared.
- **main( )** must be declared as **public**, since it must be called by code outside of its class when the program is started. (JVM)
- The keyword **static** allows **main( )** to be called without having to instantiate a particular instance of the class.
- This is necessary since main( ) is called by the JVM before any objects are made.
- The keyword **void** simply tells the compiler that main( ) does not return a value.

Signature of main()

- **main( )** has only one parameter **String[ ] args**
- **String[ ] args** declares a parameter named **args**, which is an array of instances / objects of the class **String**.
- Objects of type String store character strings.
- In this case, **args** receives any command-line arguments present when the program is executed.

Primitive Data Types

- **byte**:
  - The `byte` data type is an 8-bit signed two's complement integer.
  - It has a minimum value of -128 and a maximum value of 127 (inclusive).
- **short**:
  - The `short` data type is a 16-bit signed two's complement integer.
  - It has a minimum value of -32,768 and a maximum value of 32,767 (inclusive).
- **int**:
  - By default, the `int` data type is a 32-bit signed two's complement integer.
  - It has a minimum value of -2^{31} and a maximum value of $2^{31}-1$ (from -2147483648 to 2147483647, inclusive)
- **long**:
  - The `long` data type is a 64-bit two's complement integer.
  - The signed long has a minimum value of -2^{63} and a maximum value of $2^{63}-1$ (from -9223372036854775808 to 9223372036854775807, inclusive)

Primitive Data Types (continued)

- **float**:
  - The float data type is a single-precision 32-bit IEEE 754 floating point.
  - The maximum absolute value of a float in Java is 3.4028235 E 38 and the minimum absolute value is 1.4E-45.
- **double**:
  - The double data type is a double-precision 64-bit IEEE 754 floating point.
  - The maximum absolute value of a double in Java is 1.7976931348623157 E 308 and the minimum absolute value is 4.9E-324.
- **Scientific notation:**
  - **5 E 2 means 5 * 10^2**

Primitive Data Types (continued)

- boolean:
  - The boolean data type has only two possible values: true and false.
  - Use this data type for simple flags that track true/false conditions.
  - This data type represents one bit of information, but its "size" isn't something that's precisely defined.
- char:
  - The char data type is a single 16-a Unicode character.
  - It has a minimum value of '\uOOOO' (or O) and a maximum value of '\uffff' (or 65,535 inclusive).
- In addition to the eight primitive data types listed till now, the Java programming language also provides special support for character strings via the java.lang.String class.
- Enclosing your character string within double quotes will automatically create a new String object.
- For example, String s = "this is a string";

Default Values

Data Type	Default Value (for fields)
byte	0
short	0
int	0
long	0L
float	0.0f
double	0.0d
char	'\u0000'
String (or any object)	null
boolean	false

Program to demonstrate variables

```
class Example2 {
    public static void main(String[] args) {
        int num; // this declares a variable called num
        num = 100; // this assigns num the value 100
        System.out.println("You entered: " + num);
        num = num *1.25 ;
        System.out.print("Increased by 25 % :");
        System.out.println(num);
 }
}
```

Explanation

- **int num; // this declares a variable called num**
- This line declares an integer variable called num.
- Java requires that variables be declared before they are used.
- Following is the general form of a variable declaration:

  type var-name;
- Here, ***type*** specifies the type of variable being declared, and var-name is the name of the variable.

- **System.out.println("You entered: " + num);**
- In this statement, the plus sign causes the value of **num** to be appended to the string that precedes it, and then the resulting string is output.
- Actually, **num** is first converted from an integer into its string equivalent and then concatenated with the string that precedes it.

Input

- In Java, you can take input from the user using the **Scanner** class, which is part of the **java.util** package.

- **Step 1 : Import the `Scanner` class**:
  - import java.util.Scanner;

- **Step 2 : Create a `Scanner` object**:
  - Scanner scanner = new Scanner(System.in);
  - `System.in` represents the standard input stream, which is typically the keyboard.

- **Step 3 : Prompt the user for input**:
  - Although not strictly necessary, it's a good practice to provide a prompt to the user so they know what kind of input is expected. For example:
  - System.out.print("Enter your name: ");

Input (continued)

- **Step 4 : Read input**:
  - The `Scanner` class provides various methods to read different data types.
  - String nextLine()
    - Reads and returns the next line of input as a string. (Specifically, it reads and returns all the remaining characters on the line as a character string, and then moves to the next line.)
  - String next()
    - Reads and returns the next input token as a character string.
  - double nextDouble()
    - Reads and returns a double value. If the next token cannot be translated to a double, throws InputMismatchException.
  - int nextInt()
    - Reads and returns an int value. If the next token cannot be translated to an int, throws InputMismatchException.
  - In general, *type nextType()*
  - For example:
    - String name = scanner.nextLine();
  - Also refer the source code **ConsoleIO_Scanner.java**

Procedural Vs OOP

- All computer programs consist of two elements: code and data.
- Furthermore, a program can be conceptually organized around its code or around its data.
- That is, some programs are written around “what is happening” and others are written around “who is being affected.”
- Former, Procedural programming, latter, Object Oriented Programming.

Basic Terminology

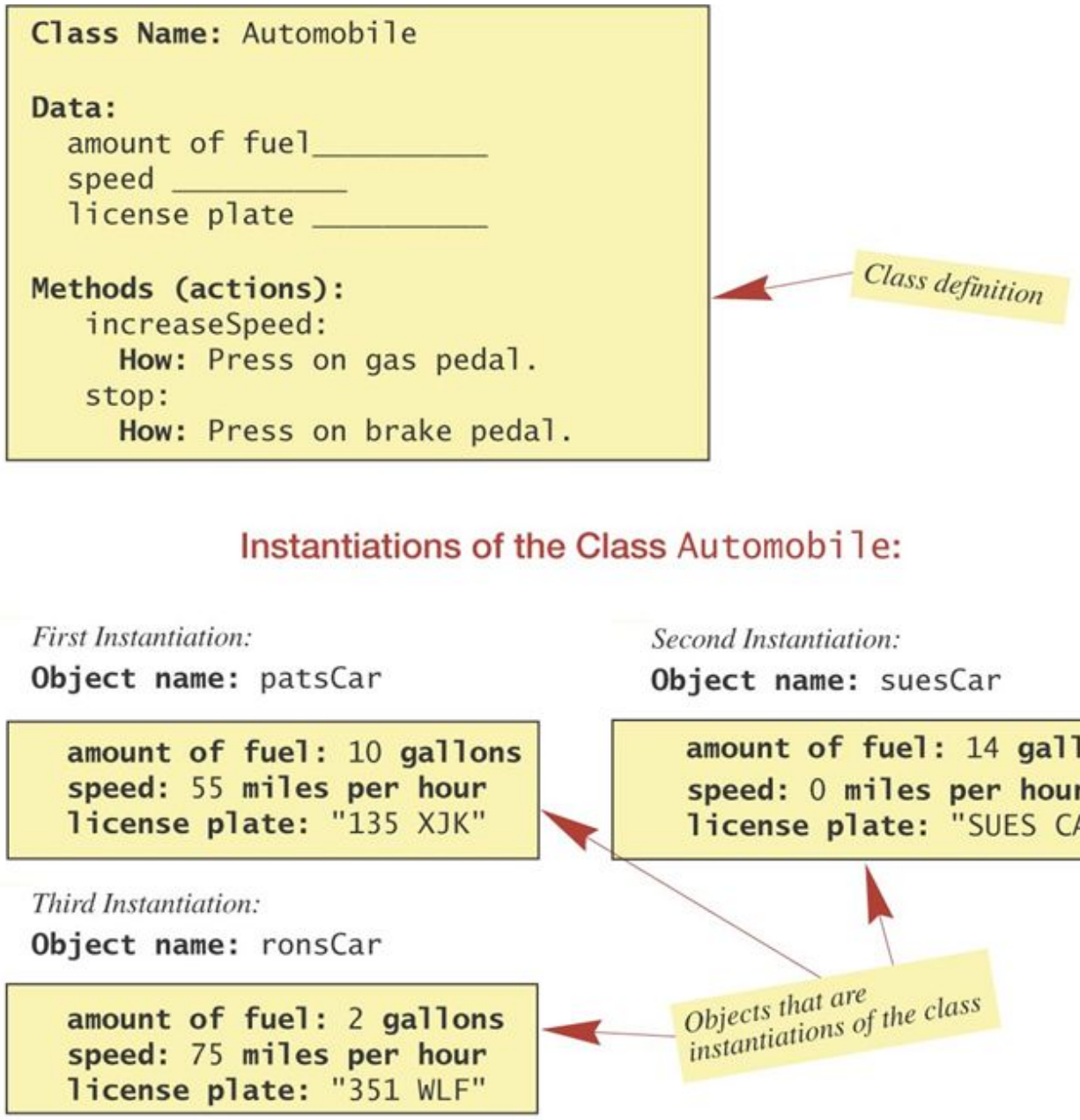
- A *class* defines a blueprint for objects:
  - specifies the *attributes* (*data*) an object of the class can have.
  - provides *methods* specifying the *actions* an object of the class can take.
- An object is an *instance* of the class.
- Example: Person is a class. Alice and Bob are objects of the Person class.

Class Members

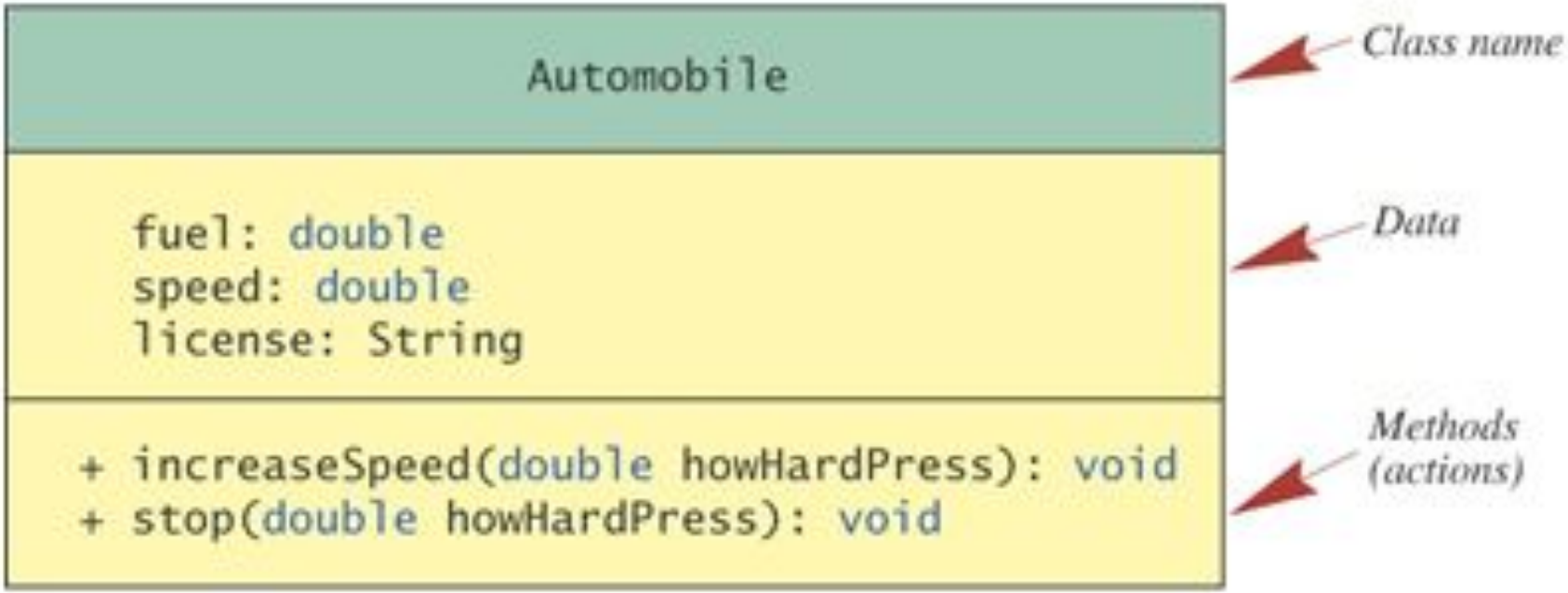
- *Members* of a class*:*
  - *Attributes (instance variables, data)*
    - For each instance of the class (object), values of attributes can vary, hence instance variables
  - *Methods*
- Example: class Person
  - Attributes: name, address, phone number
  - Methods: change_address(), change_phone_number()
- object Arthur
  - Name is Arthur, address is “221B Baker Street, London, England”, phone number is 123-4567
- object Bart
  - Name is Bart, address is “742 Evergreen Terrace, Springfield, USA”, phone number is 555-1212

State and Behavior

- An object's **state** refers to the current values of its attributes (also known as fields or instance variables).
- It represents the data associated with an instance of a class at a specific point in time.
- Each object of a class has its own unique set of attribute values, which collectively define its state.
- **Behavior** refers to the actions or operations that an object can perform.
- It defines what an object does and how it responds to various requests or stimuli.
- An object's behavior is defined by its methods.


Class Name: Automobile
Data:
amount of fuel_____
speed _____
license plate _____
Methods (actions):
increaseSpeed:
How: Press on gas pedal.
stop:
How: Press on brake pedal.
Class definition
Instantiations of the Class Automobile:
First Instantiation:
Object name: patsCar
amount of fuel: 10 gallons
speed: 55 miles per hour
license plate: "135 XJK"
Second Instantiation:
Object name: suesCar
amount of fuel: 14 gallons
speed: 0 miles per hour
license plate: "SUES CAR"
Third Instantiation:
Object name: ronsCar
amount of fuel: 2 gallons
speed: 75 miles per hour
license plate: "351 WLF"
Objects that are instantiations of the class

A UML Class Diagram



Local Variables

- Declared within a method
  - "local to" (confined to) the method definition
  - can't be accessed outside the method
- Not attributes (instance variables)

Naming Conventions

- **Class** names should be nouns, in mixed case, with the first letter of each internal word capitalized.
- Try to keep your class names simple and descriptive.
- Use whole words-avoid acronyms and abbreviations (unless the abbreviation is much more widely used than the long form, such as URL or HTML).
- **Method** names should contain a verb, as they are used to make an object take action.
- They should be mixed case, beginning with a lowercase letter, and the first letter of each subsequent word should be capitalized.
- Adjectives and nouns may be included in method names:
  - public void locate() {...} // verb
  - public String getBalance() {...} // verb and noun
- **Instance and static variable** names should be nouns and should follow the same capitalization convention as method names:
  - private String wayPoint;

Naming Conventions

- **Parameter and local variable** names should be descriptive lowercase single words, acronyms, or abbreviations. If multiple words are necessary, they should follow the same capitalization convention as method names:

```
public void printHotSpots(ArrayList spotList) {
  int counter = 0;
  for (String hotSpot : spotList) {
    System.out.println("Hot Spot #"
      + ++counter + ": " + hotSpot);
  }
}
```

- **Temporary variable** names may be single letters such as i, j, k, m, and n for integers and c, d, and e for characters.
- **Constant** names should be all uppercase letters, and multiple words should be separated by underscores:

```
public static final int MAX_DEPTH = 200;
```

Creating Objects

- Creating objects of a class is a two-step process.
- ***First***, you must declare a variable of the class type.
  - This variable does not define an object. Instead, it is simply a variable that can refer to (contain the address of) an object.
- ***Second***, you must acquire an actual, physical copy of the object and assign it to that variable.
  - You can do this using the **new** operator.
  - The **new** operator dynamically allocates (that is, allocates at run time) memory for an object and returns a reference to it.
  - This reference is, essentially, the address in memory of the object allocated by **new**.
- This reference is then stored in the variable.
- Thus, in Java, all the objects must be dynamically allocated.

Example : class Box

```
class Box {

        double width;
        double height;
        double depth;

}
```

```
class BoxDemo2 {
 public static void main(String[] args) {
 Box mybox1 = new Box();
 Box mybox2 = new Box();
 double vol;
 // assign values to mybox1's instance variables
 mybox1.width = 10;
 mybox1.height = 20;
 mybox1.depth = 15;
 /* assign different values to mybox2's
 instance variables */
 mybox2.width = 3;
 mybox2.height = 6;
 mybox2.depth = 9;
 // compute volume of first box
 vol = mybox1.width * mybox1.height * mybox1.depth;
 System.out.println("Volume is " + vol);
 // compute volume of second box
 vol = mybox2.width * mybox2.height * mybox2.depth;
 System.out.println("Volume is " + vol);
 }
}
```

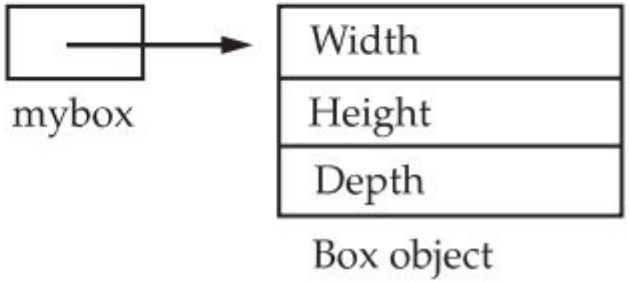
Explanation

- In the preceding sample programs, a line similar to the following is used to declare an object of type Box:
  - Box mybox = new Box();
- It can be rewritten like this to show each step more clearly:
  - Box mybox; // declare reference to object
  - mybox = new Box(); // allocate a Box object
- The first line declares mybox as a reference to an object of type Box.
  - At this point, mybox does not yet refer to an actual object.
- The next line allocates an object and assigns its memory address to mybox.
- After the second line executes, you can use mybox as if it were a Box object.

Explanation (continued)

- Each time you create an instance of a class, you are creating an object that contains its own copy of each instance variable defined by the class.
- Thus, every Box object will contain its own copies of the instance variables **width**, **height**, and **depth**.
- To access these variables, you will use the **dot (.) operator**.
- The dot operator links the name of the object with the name of an instance variable.
- mybox1.width = 10;
- This statement tells the compiler to assign the value of 10 to the copy of width that is contained within the mybox1 object.
- In general, you use the dot operator to access both the instance variables and the methods within an object.

Illustration: Creating an object of type Box

Statement	Effect
Box mybox;	
mybox = new Box();	

Questions?