CMPS 251

Please read Chapters 2, 4 and 5

Fundamentals

Dr. Abdelkarim Erradi

CSE @ QU

Outline

- Introduction to Java
- Data types (numeric data types and string)
- Conditional Statements (if-else and switch)
- Loops (for, while, do)
- String
- Arrays
- Input/output

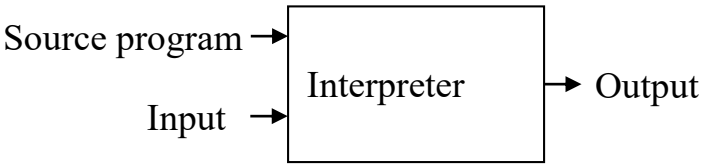
Introduction to Java

Families of Languages

Compiled translates to machine code

- **Fast**
- Example: C++

Interpreted executes source code "directly"

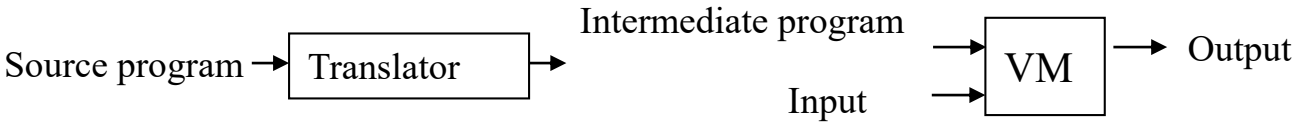


- **Flexible**
- But Slower execution

Example: JavaScript

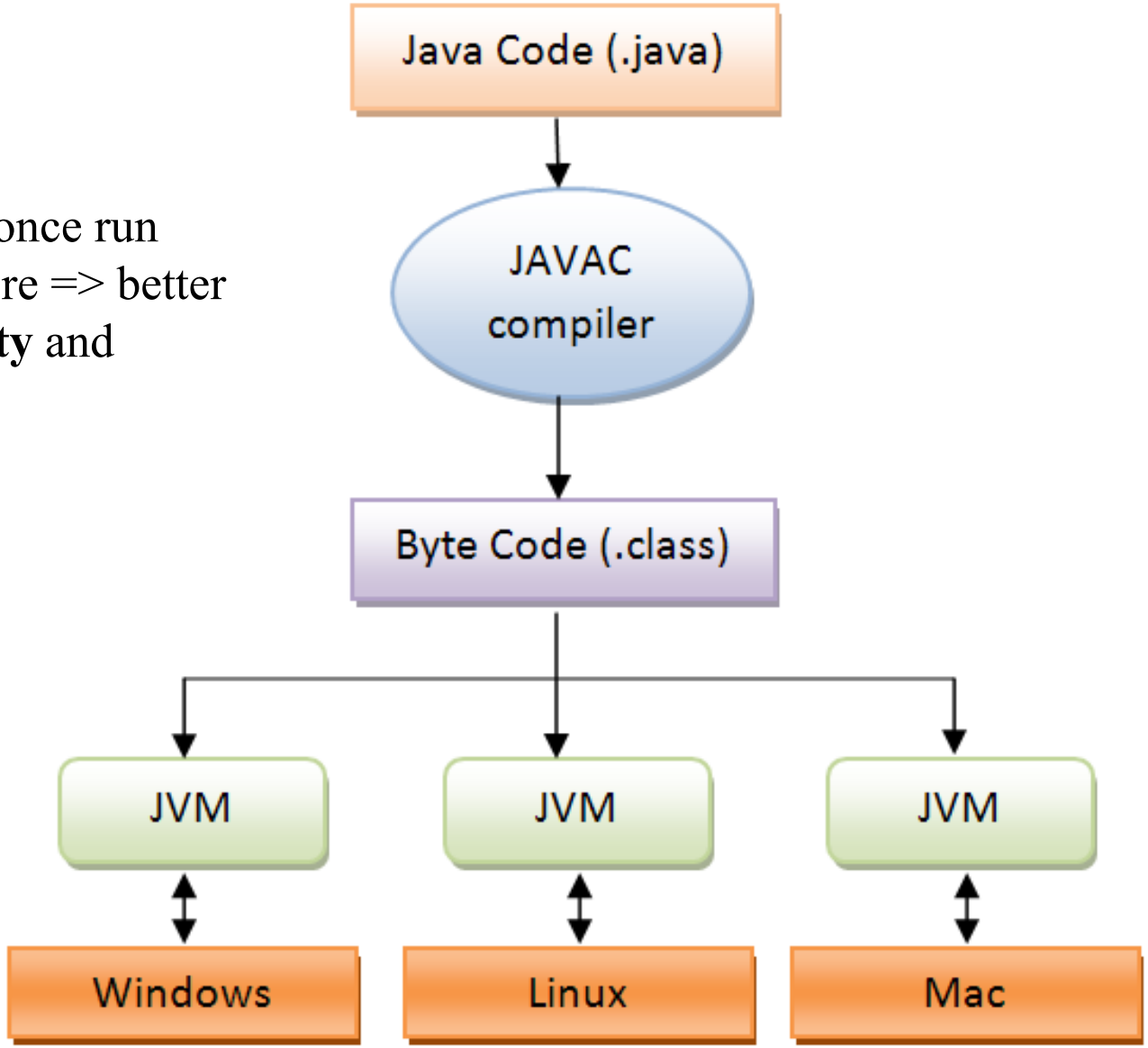
Hybrid interpretation of intermediate code

- **Portable**
- Example: Java

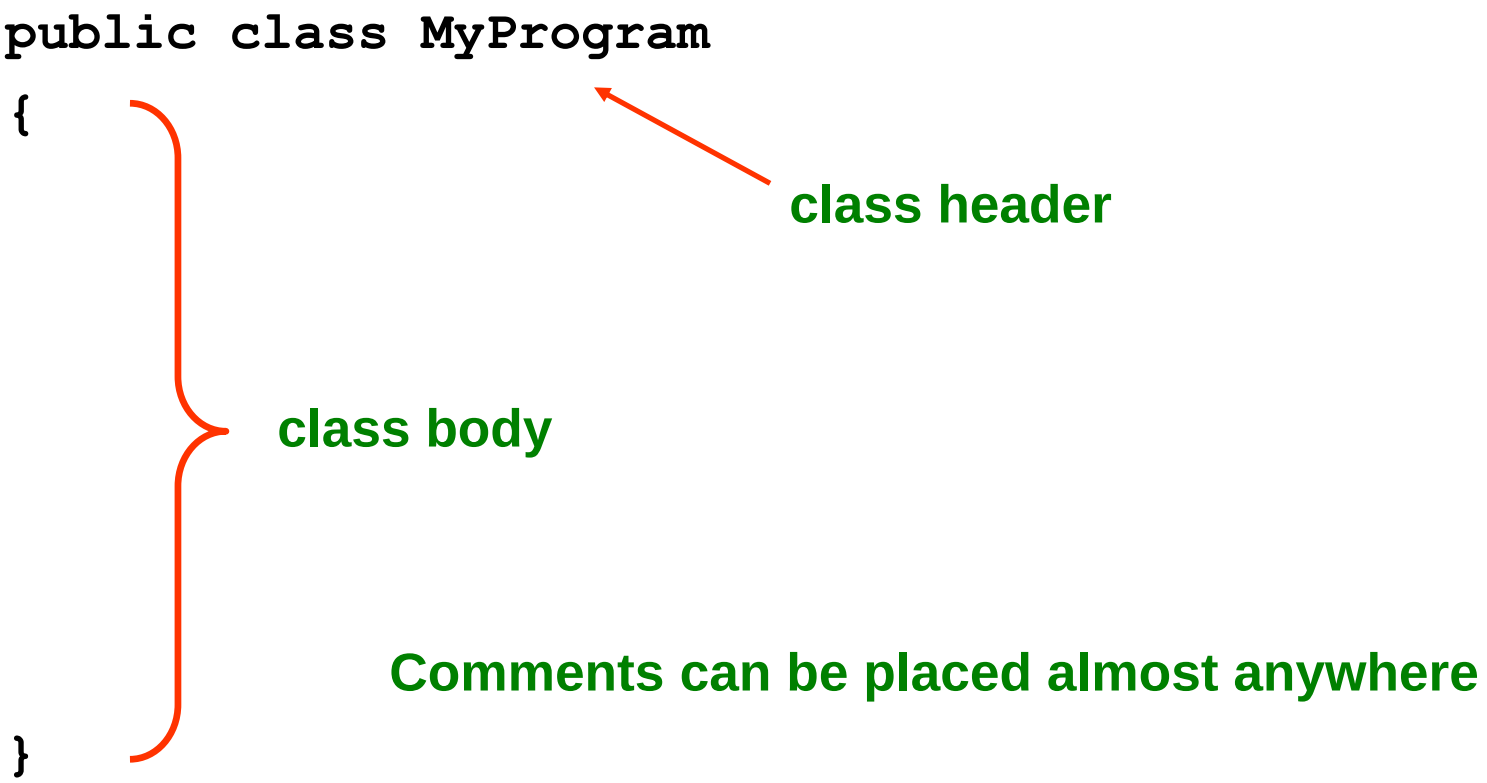


Java Compilation

Compile once run everywhere => better **portability** and **security**



A Java Program



A Java Program

```
//  comments about the class
public class MyProgram
{
   //  comments about the method
   public static void main(String[] args)
   {
   }

}
```

method body

method header

Comments

- Comments should be included to explain the purpose of the program and describe the processing
- They do not affect how a program works
- Java comments can take two forms:

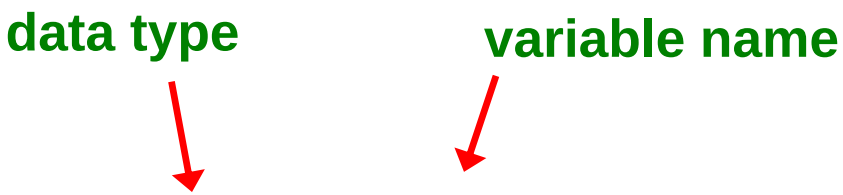
```
// this comment runs to the end of the line


/*  this comment runs to the terminating
    symbol, even across line breaks       */
```

Data Types

Variables

- A *variable* is a name for a location in memory
- A variable must be *declared* by specifying its name and the type of data that it will hold




```
int total;
int count, temp, result;
```

Multiple variables can be created in one declaration

Numeric Types

- The difference between the various numeric primitive types is their **size**, and therefore the **values they can store**:

Type	Storage	Min Value	Max Value
`byte`	8 bits	–128	127
`short`	16 bits	–32,768	32,767
`int`	32 bits	–2,147,483,648	2,147,483,647
`long`	64 bits	–9,223,372,036,854,775,808	9,223,372,036,854,775,807
`float`	32 bits	Approximately –3.4E+38 with 7 significant digits	Approximately 3.4E+38 with 7 significant digits
`double`	64 bits	Approximately –1.7E+308 with 15 significant digits	Approximately 1.7E+308 with 15 significant digits

Characters

- A `char` variable stores a single character
- Character literals are delimited by single quotes:

```
'a'   'X'   '7'   '$'   ','   '\n'
```

- Example declarations

```
char topGrade = 'A';

char terminator = ';', separator = ' ';
```

- Note the distinction between a primitive character variable, which holds only one character, and a `String` object, which can hold multiple characters

Booleans

- A `boolean` value represents a true or false condition
- The reserved words `true` and `false` are the only valid values for a boolean type

```
boolean done = false;
```

Implicit type using var

NEW

- Java 10 and above has **var** keyword to declare a variable without explicit type

e.g. instead of doing

```
String str = "Java" ;
```

You can just say

```
var str = "Java" ;
```

- Java will **implicitly** recognize the variable data type based on the initial value assigned to it
- This will be heavily used in this course!

Expressions

- An *expression* is a combination of one or more operators and operands
- *Arithmetic expressions* compute numeric results and make use of the arithmetic operators
  - Addition +
  - Subtraction -
  - Multiplication *
  - Division /
  - Remainder %
- If either or both operands used by an arithmetic operator are floating point, then the result is a floating point

Arithmetic expressions shortcut form

- Handy tip: Use

  a <operator>= b

  instead of

  a = a <operator> b

  Example:

  a *= 4 is the same as **a = a * 4**

- Another handy tip:

  ++ increments by 1

  -- decrements by 1

  Example:

  b++ is the same as **b = b + 1**

Conditional Statements

If Statements

- Single option

```
if (boolean-expression) {
  statement1;
  ...
  statementN;
}
```

- Two options

```
if (boolean-expression) {
  ...
} else {
  ...
}
```

- Multiple options

```
if (boolean-expression) {
  ...
} else if (boolean-expression) {
  ...
} else if (boolean-expression) {
  ...
} else {
  ...
}
```

- The value inside the parenthesis must strictly be boolean
- A widely accepted best practice is to use the braces even if there is only a single statement inside the if or else.

Switch Statements

- Example

```
int month = ...;
String monthString;
switch(month) {
  case 1: monthString = "January";  break;
  case 2: monthString = "February"; break;
  case 3: monthString = "March";    break;
  ...
  default: monthString = "Invalid month"; break;
}
```

  - Types can be primitives, enums, and Strings

Boolean Operators

- ==, !=

  Equality, inequality

- <, <=, >, >=

  Numeric less than, less than or equal to, greater than, greater than or equal to.

- &&, ||

  Logical AND, OR. Both use short-circuit evaluation to more efficiently compute the results of complicated expressions

- !

  Logical negation.

Example: If Statements

```
public static int max(int n1, int n2) {
   if (n1 >= n2) {
      return n1;
   } else {
      return n2;
   }
}
```

Loops

Looping Constructs

- **for**

```
for(init; continueTest; updateOp) {
  body;
}
```

- **for/each**

```
for(variable: collection) {
  body;
}
```

- **while**

```
while (continueTest) {
  body;
}
```

- **do**

```
do {
  body;
} while (continueTest);
```

For Loops

```
public static void listNums1(int max) {
   for(int i=0; i<max; i++) {
     System.out.println("Number: " + i);
   }
}
```

- Result

```
listNums1(4);

Number: 0
Number: 1
Number: 2
Number: 3
```

For/Each Loops

```
public static void listEntries(String[] entries) {
  for(String entry: entries) {
    System.out.println(entry);
  }
}
```

- Result

```
String[] test = {"This", "is", "a", "test"};
listEntries(test);

This
is
a
test
```

While Loops

```
public static void listNums2(int max) {
  int i = 0;
  while (i < max) {
    System.out.println("Number: " + i);
    i++; // "++" means "add one"
  }
}
```

- Result

```
listNums2(5);

Number: 0
Number: 1
Number: 2
Number: 3
Number: 4
```

Do Loops

```
public static void listNums3(int max) {
  int i = 0;
  do {
    System.out.println("Number: " + i);
    i++;
  } while (i < max);
                  // ^ Don't forget semicolon
}
```

- Result

```
listNums3(3);
Number: 0
Number: 1
Number: 2
```

Deciding Which Loop to Use

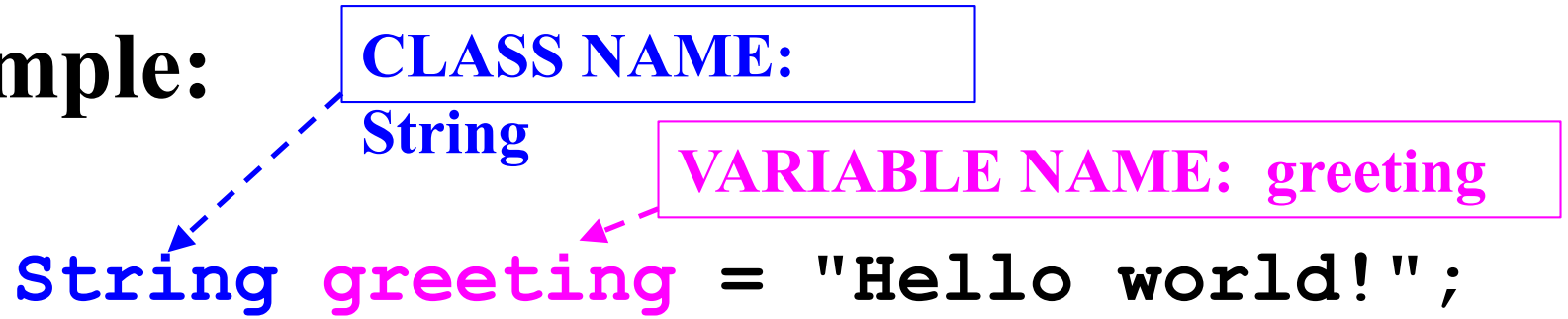
- **`while`**: pretest loop (loop body may not be executed at all)
- **`do-while`**: post test loop (loop body will always be executed at least once)
- **`for`**: pretest loop (loop body may not be executed at all); has initialization and update code; is useful with counters when precise number of repetitions is known
- **for/each**: used to iterate through a list / array

String

String

- **Strings Are**
  - Sequences of Characters
  - Object (instance of class **String**) in Java
  - Variables that can be manipulated

Example:



- Many useful builtin methods
  - contains, startsWith, endsWith, indexOf, substring, split, replace, replaceAll
  - toUpperCase, toLowerCase, equalsIgnoreCase

Use `equals` to compare strings

Never use == to test if two Strings have same characters!

```
public static void main(String[] args) {
  String match = "Test";
  if (args.length == 0) {
    System.out.println("No args");
  } else if (args[0] == match) {
    System.out.println("Match");
  } else {
    System.out.println("No match");
  }
}
```

- Prints "No match" for *all* inputs
  - Fix:

```
if (args[0].equals(match))
```

String Concatenation

Use + for string concatenation

```
String hellostr = "Hello," + " world!";
System.out.println( hellostr );
//The output will be     Hello world!
```

Arrays

Arrays

- Declare and initialize an array

```
type[] var = { val1, val2, ... , valN };
```

- Examples:

```
int[] values = { 10, 100, 1000 };
String[] names = {"Joe", "Jane", "Juan"};
```

Declare then populate arrays

- **Step 1: Declare the array:**

```
const int size = 10;
type[] var = new type[size];

E.g.:
   int[] primes = new int[size];
   String[] names = new String[size];
```

- **Step 2: populate the array**

```
primes[0] = 2;
primes[1] = 3;
primes[2] = 5;
primes[9] = 7;
```

etc.

```
names[0] = "Ali";
names[1] = "Ahmed";
names[2] = "Mariam";
names[3] = "Sarah";
```

Input / Output

Using System.out for Output

- Commonly used methods:
  - **print(String *line*)** will send *line* to output
  - **println(String line)** will send line to output, followed by a line break **println()** will send just the line break to output
  - `printf(`formatstring, argumentlist`)`

```
double price = 19.8;
String name = "magic apple";
System.out.printf("$%.2f for each %s.", price, name);
```

will output

```
$ 19.80 for each magic apple
```

  - The first argument containing 2 format specifiers (`%.2f` and `%s`) that match the two arguments (`price` and `name`)
  - The format specifier`"%.2f"` indicates display 2 digits after the decimal point

Reading Input from the Keyboard

- Read input from the keyboard using **Scanner** class

```
Scanner inputScanner = new
 Scanner(System.in);
int i = inputScanner.nextInt();
double d = inputScanner.nextDouble();
```

- In real applications, use a Graphical User Interface (GUI)

Example: Printing Random Numbers

```
import java.util.*;
public class RandomNums {
  public static void main(String[] args) {
    System.out.print("How many random nums? ");
    Scanner inputScanner = new Scanner(System.in);
    int n = inputScanner.nextInt();
    for(int i=0; i<n; i++) {
      System.out.println("Random num " + i +
                         " is " + Math.random());
    }
  }
}
```

```
How many random nums? 3
Random num 0 is 0.22686369670835704
Random num 1 is 0.0783768527137797
Random num 2 is 0.17918121951887145
```

Summary

- Conditional statements, loops, and array are similar to C/C++
  - Java has a special for loop to iterate trough a list

    for(String s: stringArray) { … }
- `String` is a class in Java
  - Use **`equals`**, not ==, to compare strings
- Use **Scanner** to read values from the keyboard
- Use **System.out.println** for output to the screen
- More info @ https://www.w3schools.com/java/default.asp