Object Oriented Programming with Java

CHAP 1: JAVA PROGRAMMING BASICS

Fundamentals, Programming Basics & Controls Structures: By Aphrodice Rwagaju

1.1. Java Language Fundamentals

Overview

- Java is a platform as well as a language
- The Java language was developed by James Gosling at Sun Microsystems (which is now a subsidiary of Oracle Corporation) and first released in 1995
- Java is an island in Indonesia where the first coffee was produced (called Java coffee). Java name was chosen by James Gosling while having a cup of coffee nearby his office
- The Java platform allows software to be developed and used across different architectures and operating systems

Overview

- The principles for creating Java programming language were "Simple, Robust, Portable, Platform-independent, Secured, High Performance, Multithreaded, Architecture Neutral, Object-Oriented, Interpreted, and Dynamic“
- Firstly, it was called "Greentalk" by James Gosling, and the file extension was .gt
- After that, it was called Oak and was developed as a part of the Green project that was started by small team of Sun Engineers (Called Green Team) in 1991.
- Oak is a symbol of strength and chosen as a national tree of many countries like the U.S.A., France, Germany, Romania, etc.

Java Versions

- Many java versions have been released till now. The current stable release of Java is Java SE 10

1. JDK Alpha and Beta (1995)
2. JDK 1.0 (23rd Jan 1996)
3. JDK 1.1 (19th Feb 1997)
4. J2SE 1.2 (8th Dec 1998)
5. J2SE 1.3 (8th May 2000)
6. J2SE 1.4 (6th Feb 2002)
7. J2SE 5.0 (30th Sep 2004)
8. Java SE 6 (11th Dec 2006)
9. Java SE 7 (28th July 2011)
10. Java SE 8 (18th Mar 2014)
11. Java SE 9 (21st Sep 2017)
12. Java SE 10 (20th Mar 2018)
13. Java SE 11 (September 2018)
14. Java SE 12 (March 2019)
15. Java SE 13 (September 2019)
16. Java SE 14 (Mar 2020)
17. Java SE 15 (September 2020)
18. Java SE 16 (Mar 2021)
19. Java SE 17 (September 2021)
20. Java SE 18 (March 2022)

- Since Java SE 8 release, the Oracle corporation follows a pattern in which every even version is release in March month and an odd version released in September month

Java editions

- **Java Micro Edition (ME)** - designed for running Java applications on mobile devices with limited resources.
- **Java Standard Edition (SE)** - the general purpose version for desktop PCs and servers
- **Java Enterprise Edition (EE)** - SE plus some additional APIs for large enterprise server applications

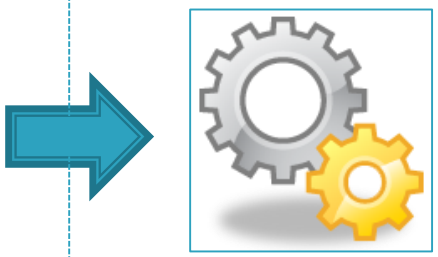
The platform

- **Java Runtime Environment (JRE)**
  - This a virtual machine which runs programs which have been compiled
  - Contains a large library of classes for lots of different purposes
- **Java Development Kit (JDK)**
  - Contains tools such the compiler
  - Has a copy of the JRE

A C program…

Source file(s) | Compiler | Machine code

```
int
main()
{
}
```



```
0101110
0010110
1101010
1010101
```

For example…

Test.c

gcc.exe

Text.exe containing x86 instructions

Runs on an x86 processor

A Java program…

Source file(s)

```
class
Test {
   …
}
```

Compiler

Java byte code

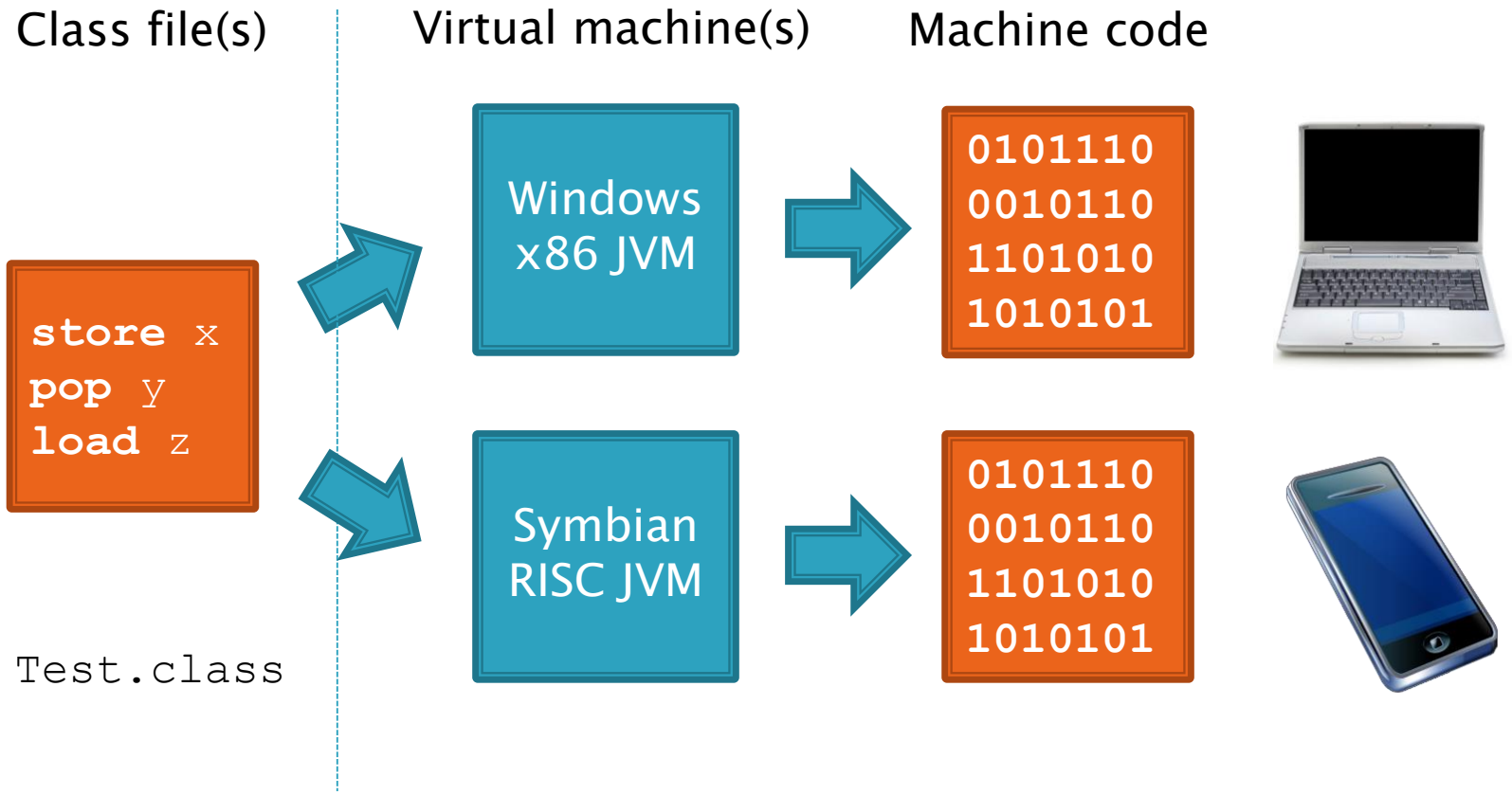
```
store x
pop y
load z
```

Virtual machine(s)

For example…

`Test.java` `javac.exe` `Test.class`

Virtual machines



Example

```
class Greeting {
  public static void main(String[] args){
    System.out.println("Hello RCA Student!");
  }
}
```

```
$ javac Greeting.java
```

```
Greeting.class
```

```
$ java Greeting
```

```
$ Hello RCA Student!
```

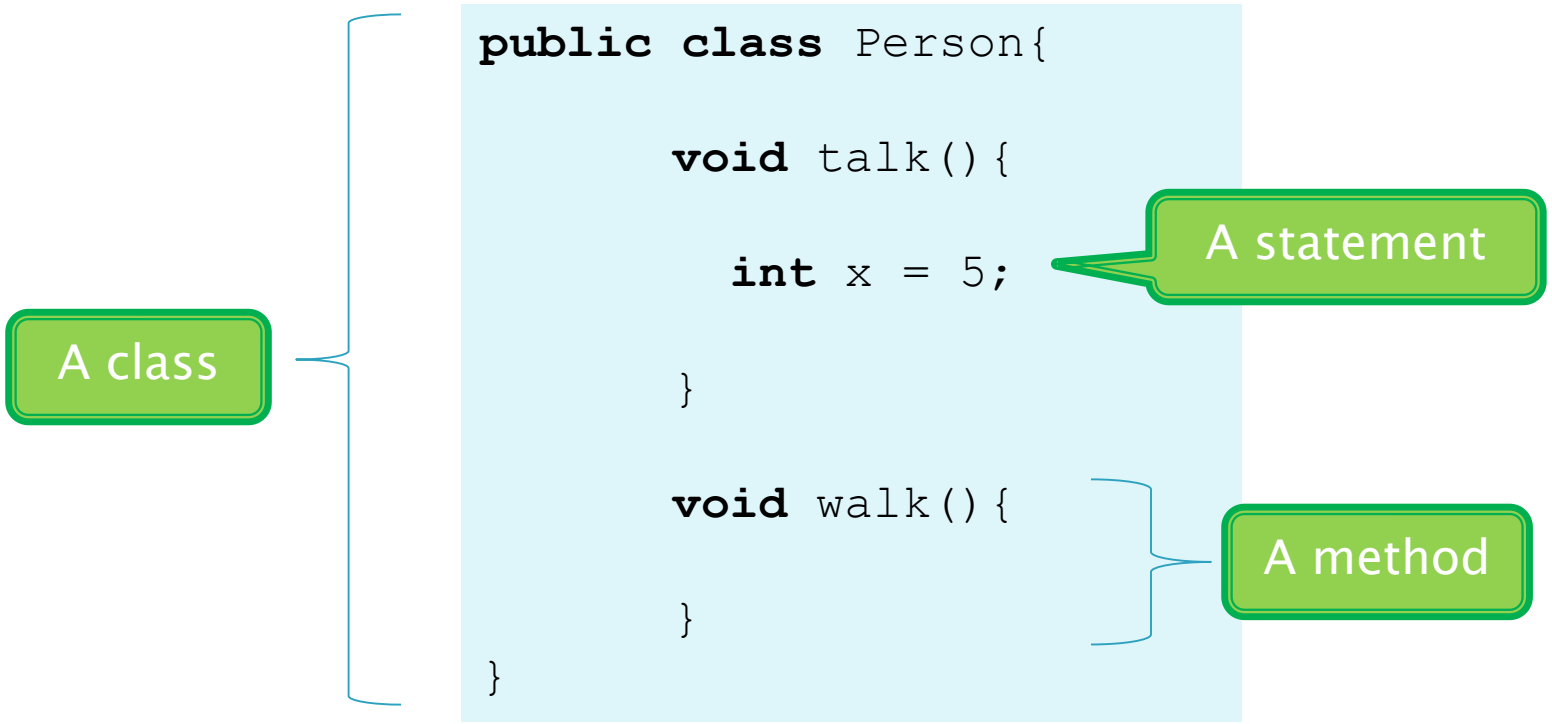
Write the **source** file

Compile the class file

Run the class file in the virtual machine

View the ouput

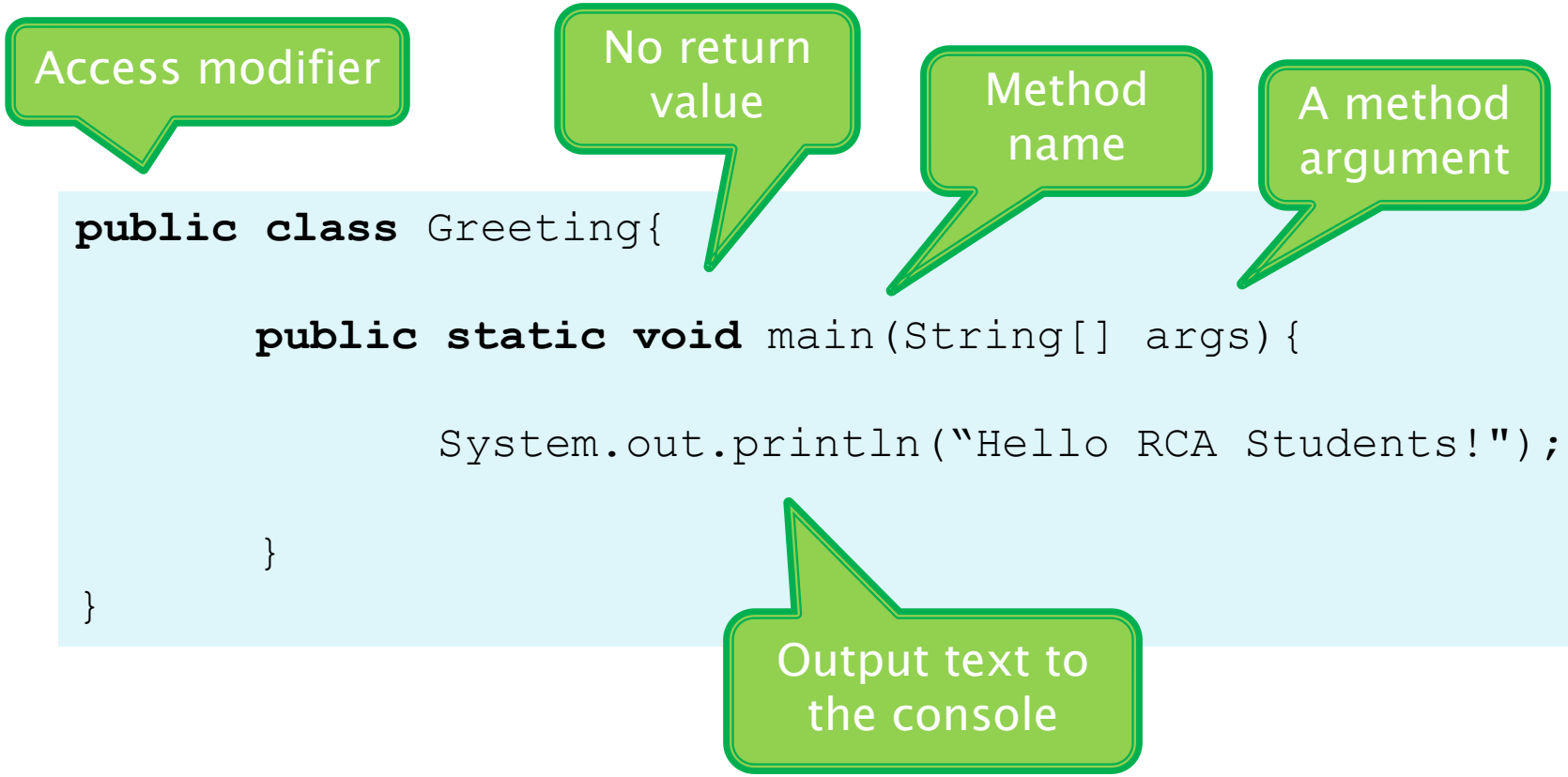
A Java source file



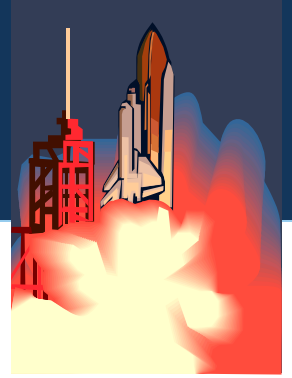
Class:
Method:
Statement:

`public`, `class`, `void` and `int` are all Java keywords

More detail…


Access modifier
No return value
Method name
A method argument
public class Greeting{
public static void main(String[] args){
System.out.println("Hello RCA Students!");
}
}
Output text to the console

Launch time



- Calling the `java` program launches the JVM
- You specify the name of the class and any arguments to send it, e.g.

```
$ java Greeting "Hello" 4
```

- The JVM searches the class for a method called `main`, and then calls that method
- It sends the arguments (e.g. `"Hello"` and `"4"`) as items in the array called `args`

Write your first class!

- Create a **`.java`** file
  - Define a class (should have the same name as the Java file)
  - Add a the main method

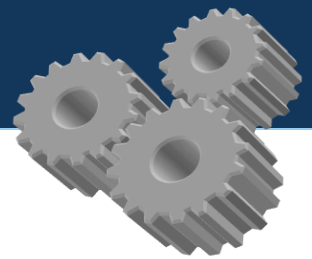
```
public static void main(String[] args) { ... }
```

  - Call `System.out.println(…)` to print something

- Compile with **`javac`**

- Run the file with **`java`**

The compiler



- Converts the .java files to Java **bytecode**
- Reports any errors that prevented it from completing, or warnings that the developer should consider
  - Tells the developer what is wrong
  - Gives the source file and line number

Statements

- A statement does something, e.g.
  - Declaring a variable, `int x;`
  - Assigning a value to a variable, `x = 10;`
  - Incrementing a variable, `x++;`
  - Calling a method, `System.out.println("X");`
- Statements are separated by semi-colons, e.g
  - `x = 10; y = x;`

Expressions

- An expression evaluates to a value, e.g.
  - `10 + 2 * 3 / 4` ⇒ 11
  - `"Hello" + " world"` ⇒ "Hello world"
  - `3` ⇒ 3
  - `"kind of.."` ⇒ "kind of.."

- A statement can be an expression if it evaluates to a value, e.g.
  - `x = 10` ⇒ 10 e.g. `y = (x = 10);`
  - `Math.sin(5)` ⇒ -0.9589...

Variables

- A value is stored in a variable so that it can be used elsewhere in a program, e.g.

```
int x = 10;
```

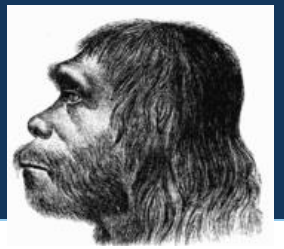
Variable type

Variable name

Initial value (optional)

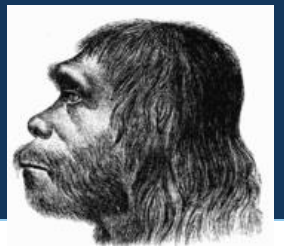
- Variables can be **primitive types** or **object references**

Primitive types



- These are the types which are part of the Java language
  - `boolean` true or false (1bit)
  - `byte` a 8bit signed number
  - `char` a 16bit Unicode character
  - `short` a 16bit signed number
  - `int` a 32bit signed number
  - `long` a 64bit signed number
  - `float` a 32bit floating-point number
  - `double` a 64bit floating-point number

Primitive types



- You can generally assign the value of a smaller primitive type to a larger one, e.g.

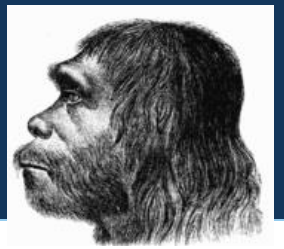
```
short big = 5646;
int bigger = big;
long biggest = bigger;
```

- But not the other way around

```
long big = 3453434623426;
int notSoBig = big;
short evenSmaller = notSoBig;
```

Compiler error!

Casting primitives



- To assign a value to a smaller type, you have to use the cast operator, e.g.

```
long big = 3453;

int notSoBig1 = big;


int notSoBig2 = (int)big;
short smaller = (short)big;
```

Compiler error!

Works

Objects

- These are complex types which are defined in the JDK or in your code, e.g.
  - `String` - a sequence of characters
  - `Date` - a date and time value

- An object is created in memory using the **new** keyword, e.g.

```
String s1 = new String("Hello");
```

The object's class

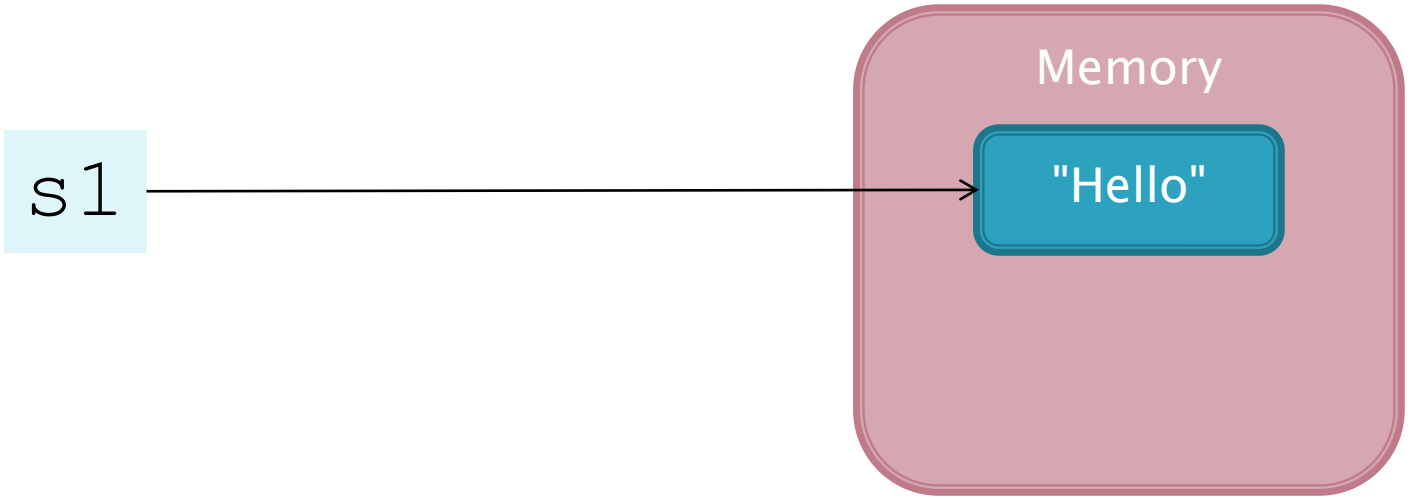
Reference variable

The object itself

Objects

- Variable references aren't objects themselves
- They reference an object in memory

```
String s1 = new String("Hello");
```

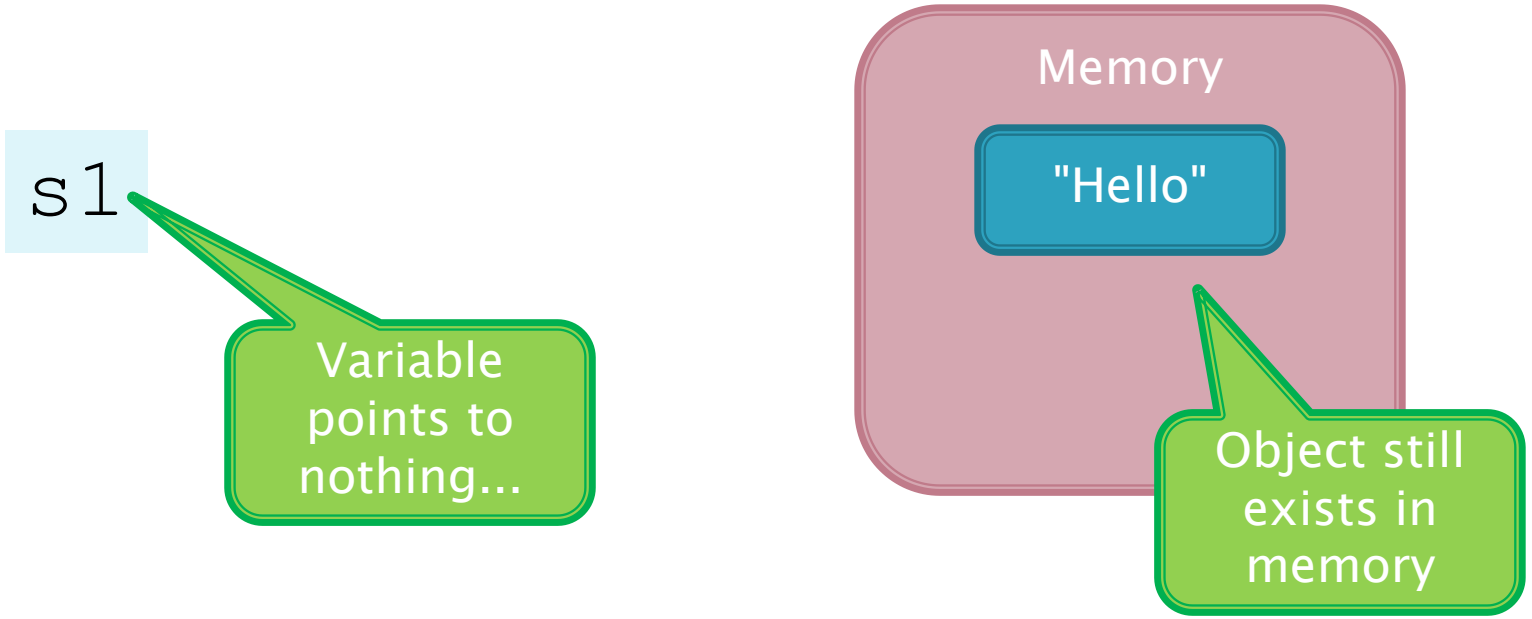


Objects

- Reference variables can be null which means they don't reference an object anymore,

e.g.

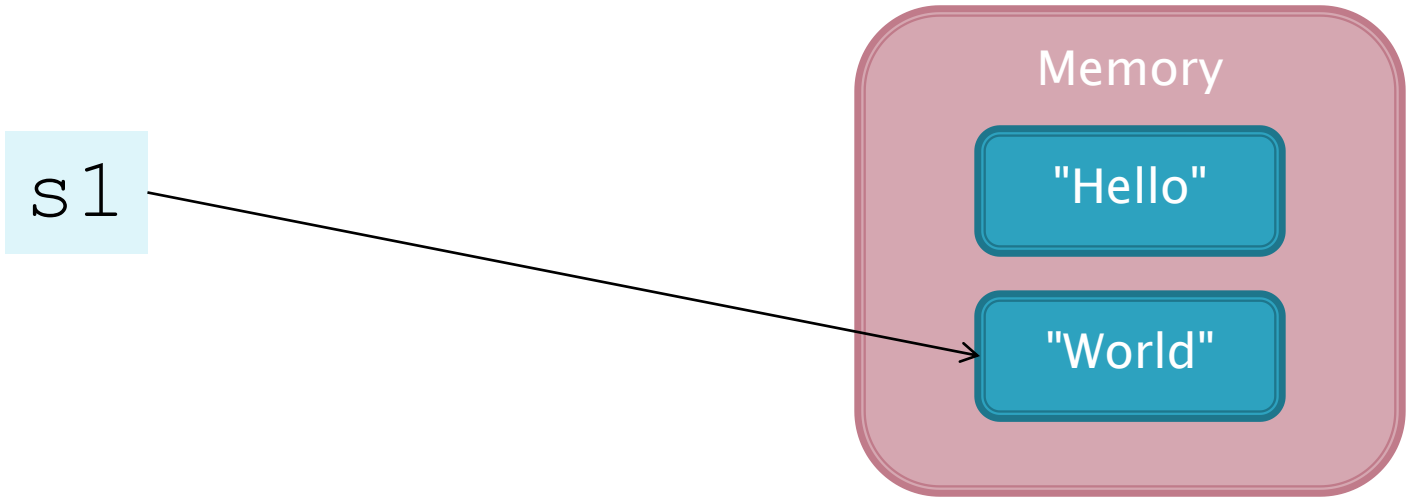
```
s1 = null;
```



Objects

- A variable can be changed to reference a different object, e.g.

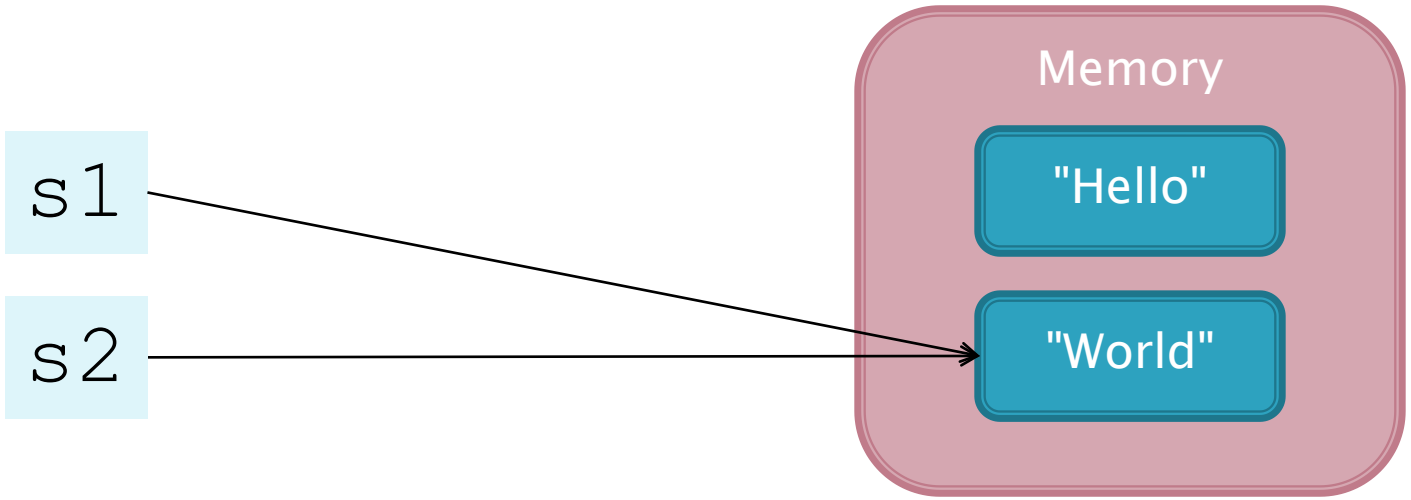
```
s1 = new String("World");
```



Objects

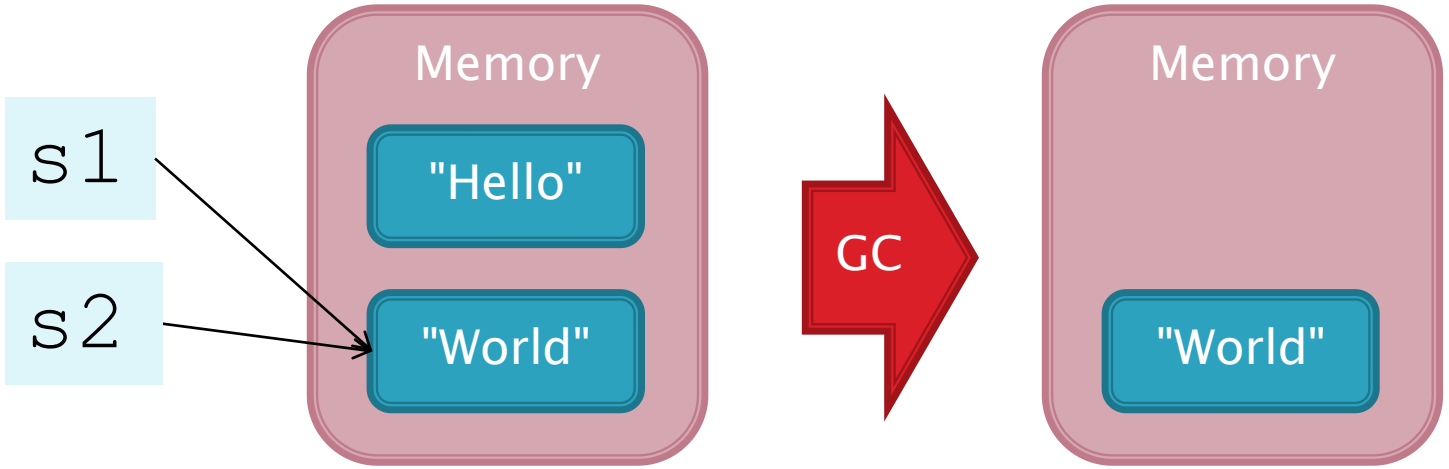
- And more than one variable can reference the same object, e.g.

```
String s2 = s1;
```



Garbage collection

- This is process which runs in the background looking for objects with no references
- It deletes such objects from memory to free space for new objects



Equality

- Two types of equality...

- **Reference equality** `x == y`
  - Checks if the variables reference the same object in memory

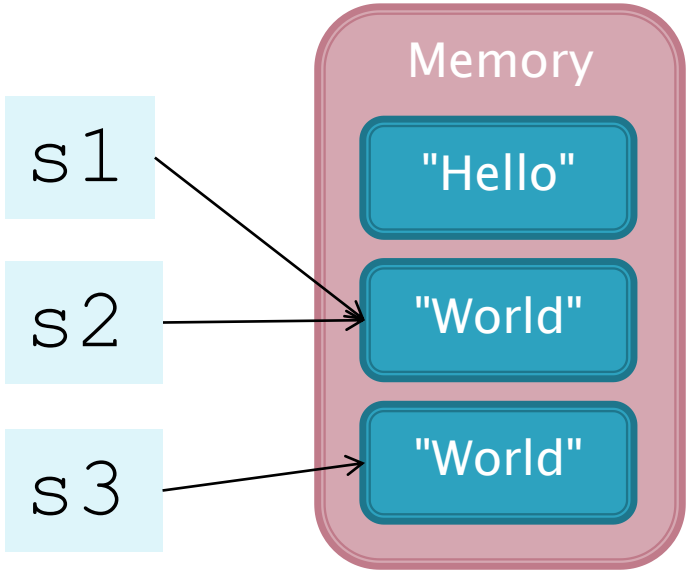
- **Object equality** `x.equals(y)`
  - Checks if the objects which the variables reference are equal, i.e. have the same meaning or content
    - E.g. for Strings - do they have the same characters?

Equality example

```
String s3 = new String("World");
```

- `s1` and `s2` reference the same object so
  `s1 == s2` is **TRUE**

- `s1` and `s3` reference different objects so
  `s1 == s3` is **FALSE**
  even though the strings are the same

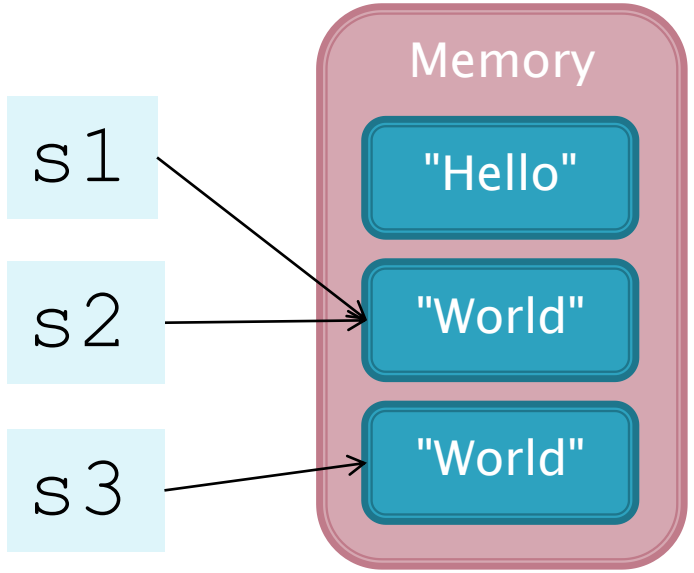


Equality example

- `s1` and `s3` reference `String` objects with the **same content** so `s1.equals(s3)` is TRUE

- Summary...

`s1 == s2`	TRUE
`s1 == s3`	FALSE
`s1.equals(s2)`	TRUE
`s1.equals(s3)`	TRUE



Strings are an exception...

- Strings can be created in two ways...

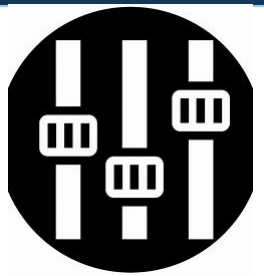
```
String s1 = new String("Hello");

String s2 = "Hello";
String s3 = "Hello";
String s4 = "World";
```

As a normal object in memory

As literals which go into the "String pool"

- `s1` and `s2` will reference different objects so `s1 != s2`
- But `s2` and `s3` will point to the same object so `s2 == s3`
- `s2` and `s4` will not so `s2 != s4`

Variable terminology



```
public class SuperApp {

  int count = 0;

  void setCount(int c) {
    count = c;
  }

  void print() {
    String s = "Val = " + count;

    System.out.println(s);
  }
}
```

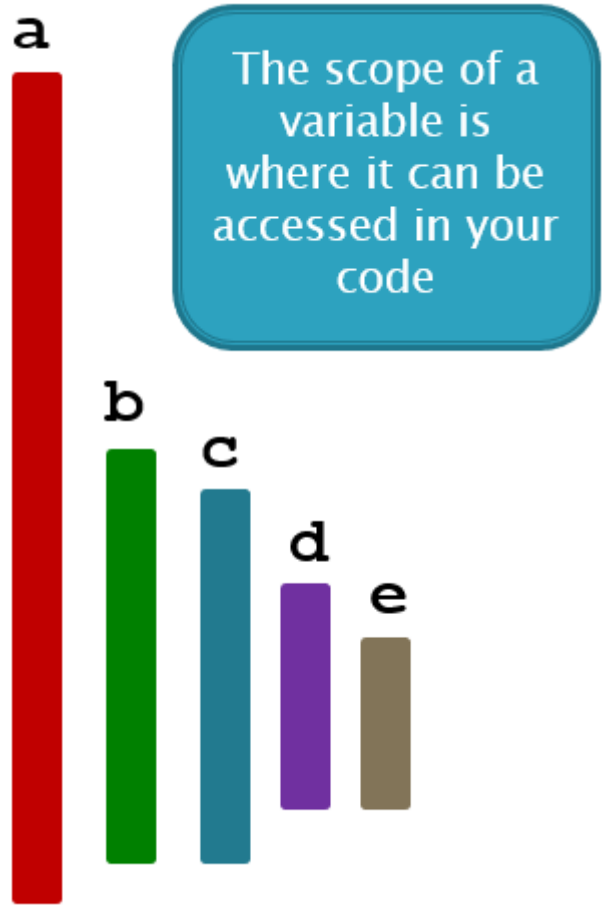
Instance variable
- it's available anywhere in the class instance

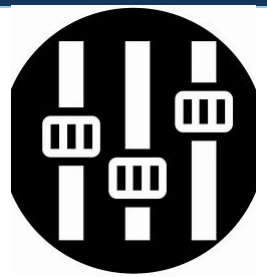
Method parameter
- it's available only in the method

Local variable
- it's available only in the method

Variable scope

```
public class SuperApp {

  int a = 10;

  SuperApp {
    foo(a);
  }

  void foo(int b) {
    int c = b;

    for (int d = 0; d < c; d++) {
      int e = d;

      System.out.println(e);
    }
  }
}
```





Naming conventions

- The compiler won't complain if you don't stick to these, but we will!

Entity	Convention	Examples
Class name	Camelcase, starts uppercase	`HelloWorldProgram` `UserRole`
Method name	Camelcase, starts lowercase	`getAllStudents` `main`
Variable	Camelcase, starts lowercase	`numStudents` `listOfUsers`
Constant	Uppercase with underscores	`MAX_STUDENT_AGE` `DEFAULT_USER`

1.2. Programming basics & Control Structures

Flow control: if-else

```
if (condition) {

}
else if (another condition) {

}
else {

}
```

```
if (a == b) {
  doMethod();
}
else if (isJava()) {
  a = 10;
}
else {
  out.println("X");
}
```

```
if (a < x) {
  a = 5;
}
```

```
if (a < x)
  a = 5;
```

If only one statement follows the if or else if, then the braces aren't needed

Flow control: while / do-while

```
while (condition) {
   // loop these statements
}
```

```
while (a < 10) {
   out.println(a);
   a++;
}
```

```
do {
   // loop these statements
}
while (condition);
```

do while means that the statements will always been executed at least once

Flow control: for

```
for (statement; condition; statement) {
  // loop these statements
}
```

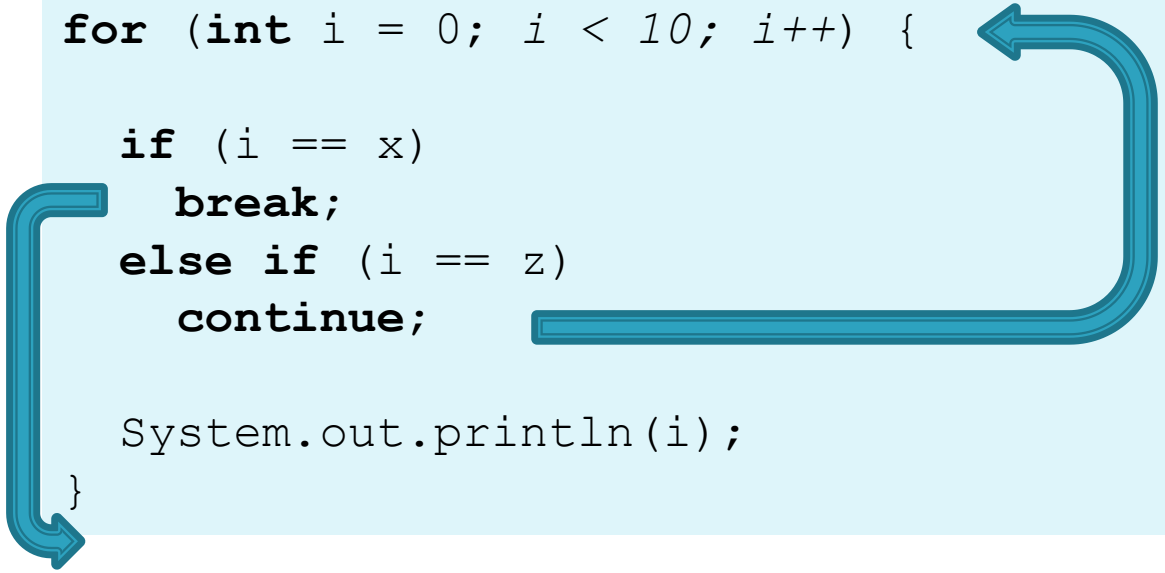
```
for (int i = 0; i < 10; i++) {
  System.out.println(i);
}
```

```
int i = 0 ;
while (i < 10) {
  System.out.println(i);

  i++;
}
```

for is a alternative way to write a while loop

Flow control: continue/break

```
for (int i = 0; i < 10; i++) {

  if (i == x)
    break;
  else if (i == z)
    continue;

  System.out.println(i);
}
```



break causes the **for** loop to finish immediately

continue goes to the next iteration if there will be one

Flow control: switch

```
switch (variable) {
case <value1>:
   statements
   break;
case <value2>:
   statements
   break;
default:
   statements
}
```

e.g

```
switch (choice) {
case 'Y':
   doThing();
   break;
case 'N':
   exitProgram();
   break;
default:
   showHelp();
}
```

switch can work with **byte**, **char**, **short** and **int** values

Flow control: switch

```
switch (choice) {
case 'Y':
  doThing();
  break;
case 'N':
  exitProgram();
  break;
default:
  showHelp();
}
```

```
if (choice == 'Y')
  doThing();
else if (choice == 'N')
  exitProgram();
else
  showHelp();
```

switch is often a better way of writing an **if-else** statement

Flow control: switch

```
switch (choice)
{
case 'Y':
   doThing();
case 'N';
case 'X';

exitProgram();
   break;
default:
   showHelp();
}
```

What happens now when choice equals 'Y'?

What about 'X'?

Further reading

- http://java.sun.com/docs/books/tutorial/java/nutsandbolts/index.html
- https://docs.oracle.com/en/java/javase/19/language/java-language-changes.html
- History of Java – Javatpoint

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