UCT Department of Computer Science

Computer Science 1015F

Java Basics

Hussein Suleman
<hussein@cs.uct.ac.za>
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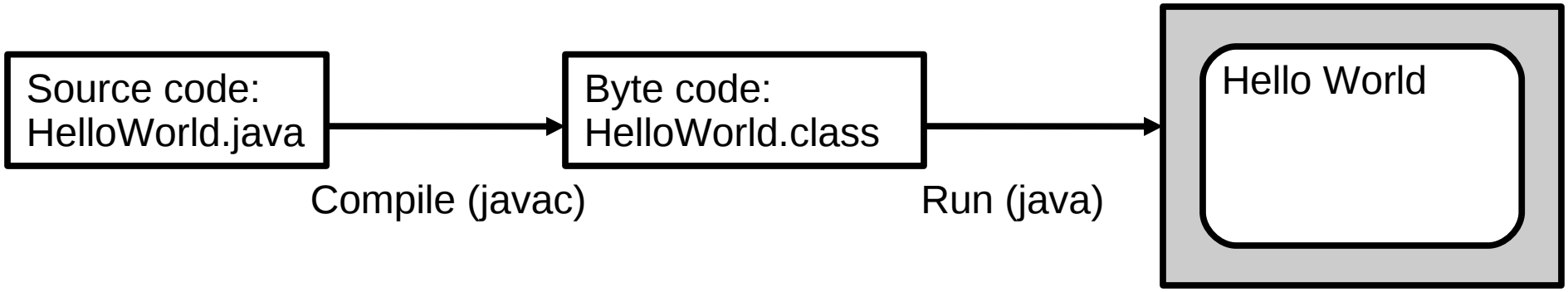
Java Programs and Byte-Code

- **Source cod**e is the program/instructions written in Java (high level language).
- The Java compiler converts source code into **byte-code** (low level language).
- The Java virtual machine (JVM) converts the byte-code into **machine code** and executes it.



Skeleton Java Program

```
// some comments at the top of program

public class ClassName
{
   public static void main ( String[] args )
   {
      // put sequence of instructions/statements here
   }
}
```


Example Program

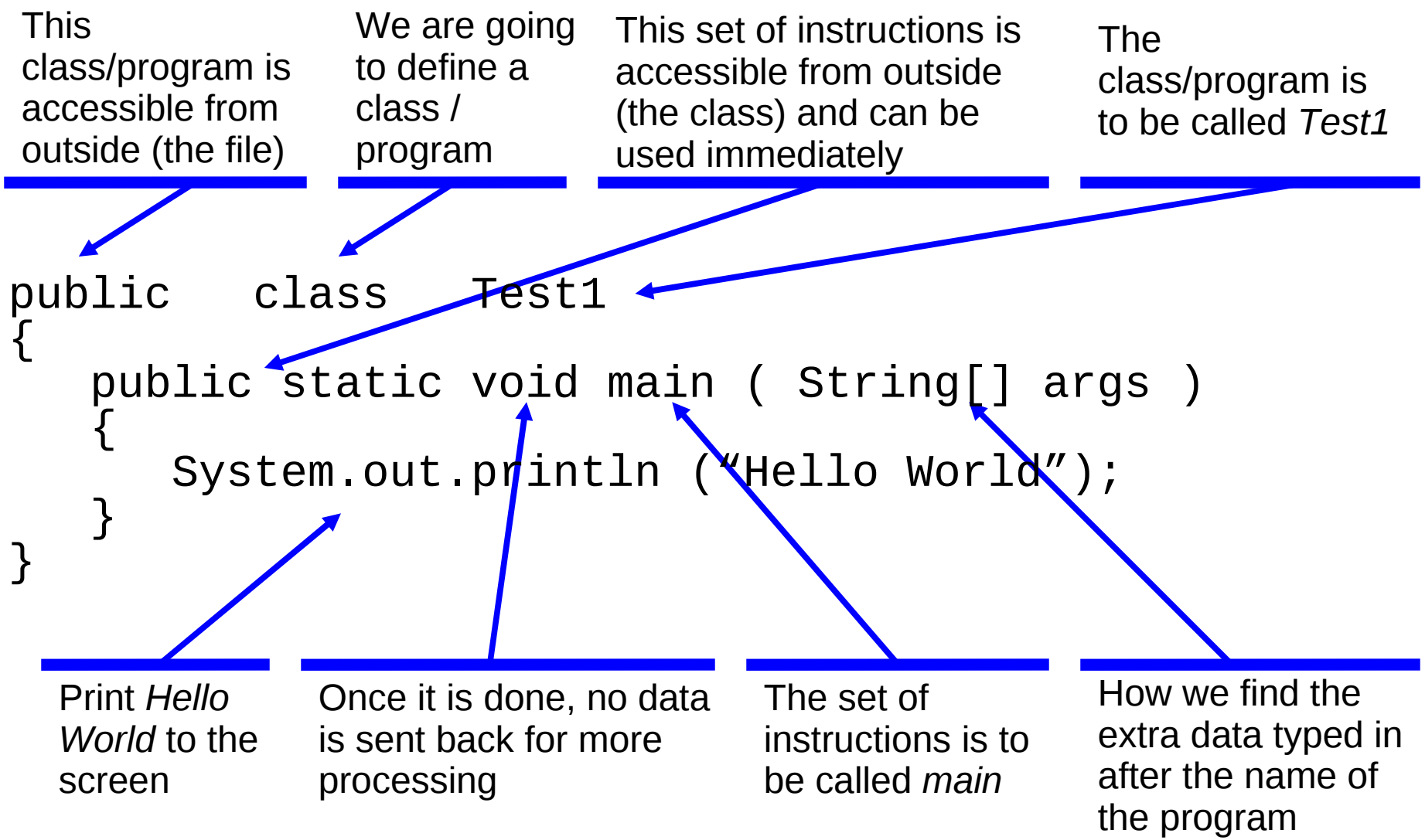
Test1.java:

```
public class Test1
{
   public static void main ( String[] args )
   {
      System.out.println (“Hello World”);
   }
}
```

output:

```
Hello World
```


What It Means



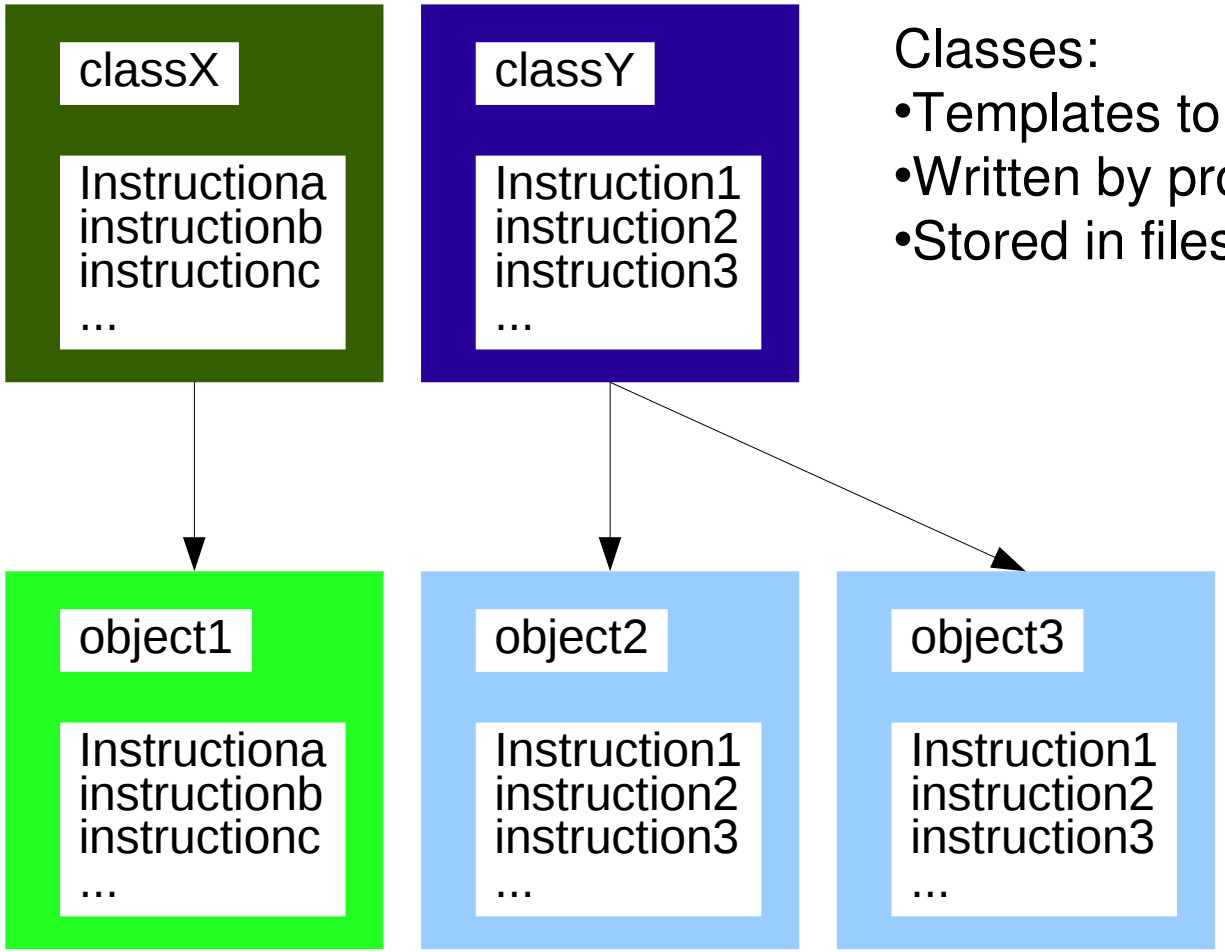
Simple Classes Simplified

- All instructions must appear within a class with the same name as the file (except for the .java extension).
- main is the name/identifier given to a set of instructions – this is called a method.
- Every program must have a main method.
- When the JVM is asked to run the program/class, it loads the byte-code and then tries to execute the instructions in the main method.

Problem

- Write a program to print out the lyrics of the chorus of Britney Spears' song “Gimme More”.

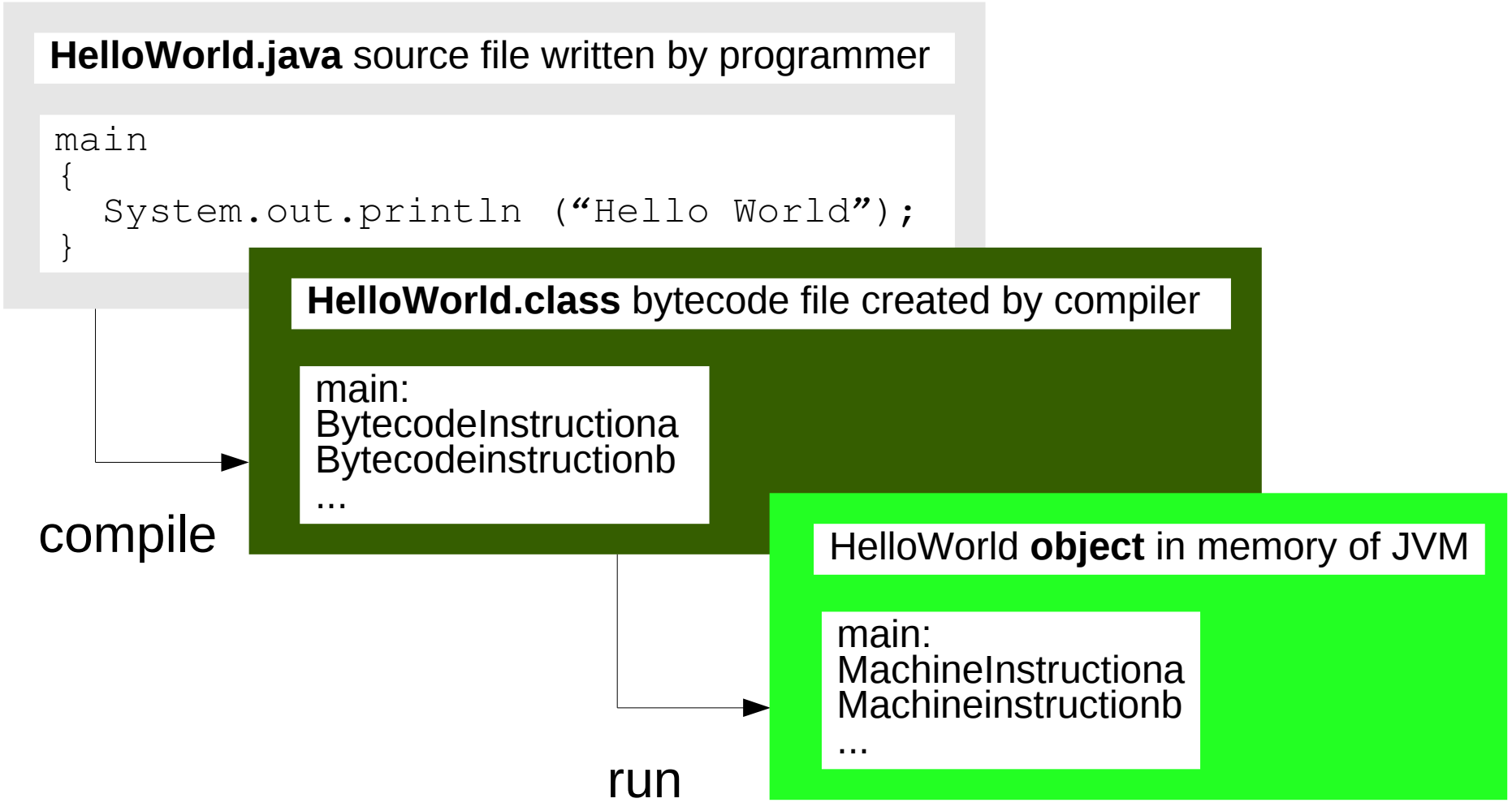
Classes and Objects



Classes:
- Templates to create objects.
- Written by programmers and compiled.
- Stored in files.

Objects:
- Correspond to classes.
- Created by JVM.
- Stored in memory.

HelloWorld Class and Object



Program Syntax and Style

- Semicolon needed after every statement.
- Case-sensitivity
  - STUFF vs stuff vs STuff vs stUFF
- Indented programs are easier to read.
- Everything after // is a comment

```
// a sample method
public void test
{
    System.out.println (“Hi”); // write Hi on screen
}
```


Comments

- Brief description, author, date at top of class.
- Brief description of purpose of each method (if more than one).
- Short explanation of non-obvious parts of code within methods.

```
// test program to print to screen
// hussein suleman
// 16 february 2009

public class HelloWorld
...
```


Syntax and Logic Errors

- Syntax errors are when your program does not conform to the structure required.
  - e.g., class spelt incorrectly
  - The program will not compile successfully.

- Logic errors are when your program compiles but does not work as expected.
  - You MUST test your program.

Identifiers

- In source file, *HelloWorld* is an **identifier**.
- Identifiers are used to name parts of the program.
  - start with _ or letter, and followed by zero or more of _, letter or digit
  - preferred style: ClassName, everythingElseLikeThis
- **Reserved words**:
  - class, public, void, …
- Not reserved but has special meaning:
  - main, String, ...

Identifiers: Quick Quiz

- Which are valid identifiers:
  - 12345
  - JanetandJustin
  - _lots_of_money_
  - “Hello world”
  - J456
  - cc:123
- Which are good identifiers?

Primitive Data Types

- byte, short, int, long (Integers)
- float, double (Real numbers)
- char
- boolean
- String (not really, but almost)

Integers: Literals

- Literals are actual data values written into a program.
- Numerical literals can be output just like text, but after sensible conversions:
  - `System.out.println (12);`
    - `12`
  - `System.out.println (“No:” + 12);`
    - `No:12`
  - `System.out.println (12 + 13);`
    - `25`
  - `System.out.println (“No:” + (12 + 13));`
    - `No:25`

Integers: Expressions

- Common operations
  - + (plus), - (minus), / (divide), * (times), % (mod)
- 11 + 11 / 2 = 16 … how ?
  - precedence of operators:
    - high: ( )
    - middle: * / %
    - low: + -
  - left associative if equal precedence.
  - integer operations when both “operands” are integers.

Integers: Quick Quiz

- What is the value of each expression:
  - `(12 + 34)`
  - `(1 + 2) / (3 - 4)`
  - `5 % 2 + 2 % 5`
  - `1/1/2/3`
  - `4/(3/(2/1))`

Integers: Types

name	*size*	*smallest*	*largest*
byte	1 byte	-128	127
short	2 bytes	-32768	32767
int	4 bytes	-2147483648	2147483647
long	8 bytes	approx. $-9*10^{18}$	approx. $9*10^{18}$

Floating-point numbers

- 10.0, 0.386, 1.2345, 3.141, 2.6e12, 5.34e-79
- Two types:
  - float 4 bytes 1.4e-45 … 3.4e+38
  - double 8 bytes 4.9e-324 … 1.7e+308
- Same precedence and meaning of operations, except for mixed type expressions
  - `(10 / 4.0f) * 4`
  - Must use suffix to force calculations to be floating point!

Problem

- Write a program to calculate the number of precious seconds you spend at lectures in a semester, assuming you have 5 lectures a day, lectures on 4 days a week, and there are 12 weeks in a semester.

Variables

- Variables are sections of memory where data can be stored.
- Most variables have names (identifiers) by which they can be referred.
  - e.g., `aValue, theTotal`
- Variables are defined by specifying the **type** of data and the name (or list of names).
  - `int aValue;`
  - `float a, b, c;`
  - `String aName;`

Assignment and Output (I/O)

- Putting a value into a variable:

```
int a, b;
a = 1;
b = a + 5;
int c = 1; // initialization
a = c = 2; // assignment with right associativity
```

  - LHS is usually a variable, RHS is an expression

- Output values of variables just like literals
  - e.g., `System.out.println (“The value is ” + a);`

Problem

- Write a program to calculate your subminima and final mark for CSC1015F. Initialize variables for each component mark at the top of the main method so the marks can be changed relatively easily.

Problem

- Write a program to calculate the minimum of 4 integer values using the Math.min method, which returns the minimum of 2 numbers. Initialize variables for these 4 values at the top of the main method so the values can be changed relatively easily.

char and boolean

- **char** represents characters – single letters, numbers, symbols, etc.
  - e.g., `'A', '1', '#'`
  - Characters are from the Unicode set.

- **boolean** represents true or false.
  - This is used for comparisons and decision-making.
  - e.g., `false`

Objects

- Objects are computer representations of real-world objects in memory.
  - e.g., System.out
  - Also called an **instance.**

- Objects contain data and methods (instructions that can operate on the data).
  - *println* is a method.
  - Methods often require extra data (parameters) to specify what is to be done.

Strings

- Basically sequences of characters (letters, digits, symbols).
  - e.g., `“howzit gaz’lum”`
- Strings can be concatenated (joined) with +
  - e.g., `“Cape” + “Town”`
- The data type of Strings is **String**.
- All Strings are objects so have methods for various useful functions.

String methods

- *length* returns the number of characters in the string
  - e.g., "`CapeTown`"`.length()`
  - Calling this method is just like an expression – it has a value than can be used further.
- *equals (anotherString)* indicates if anotherString has the same value
- *substring (start,end)* returns part of a string from start to just before end
- *indexOf (aString)* returns position of aString

(see textbook or Java API for more methods)

Problem

- Suppose we have a variable:
- “the quick brown fox jumped over the lazy dog”.
- Write a program to extract the colour of the quick fox from the sentence using only String manipulations. Make sure your program will work even if the String is different, as long as there is a quick something fox in it!

The Output Statement

- To output text to the screen (console):
  - `System.out.print (“Hello world”);`
  - `System.out.println (“ abc”+”def”);`
  - `System.out.print (“hey \”dude\” \\ wheres my car\n”);`
  - `System.out.flush (); // outputs incomplete lines`
- *print* outputs text without going to the next line.
- *println* outputs text and goes to the next line.
- + joins together 2 pieces of text.

What is System.out?

- *System.out* is an **object**.
- An object is a computer model of some real world phenomenon.
  - In this case *System.out* represents your screen.
- *System.out* contains a number of actions – things that can be done to it. These are defined as sets of instructions with names, called **methods**.
- *println* is a method.

The System.out.println method

- The stuff within (parentheses) tells *println* what to print.
- The dots between identifiers are used to indicate containment.
  - *println* is contained in *out.*
  - *out* is contained in *System*.
- This is known as **dot-notation**.
- Just like *main* is a method of *Test1*,
  - *println* is a method of *System.out* (or *out*).
  - But someone else already wrote this - we just use it!

Output: Quick Quiz

- What is output by:

```
System.out.println (“The ”);
System.out.print (“ quick ”);
System.out.println (“ brown ”);
System.out.print (“ fox ”
                 +“ jumped “);
System.out.print (“ over the lazy”);
System.out.println (“ dog.”);
```


Problem

- Write a program to print out the source code for a Hello World Java program.

Increment / Decrement

- c++
  - increment c by 1
  - same as: c = c + 1
- c--
  - decrement c by 1
  - same as: c = c - 1
- Pre/Postfix
  - ++x prefix operator, increment before evaluation
  - x++ postfix operator, increment after evaluation
- What does x+=2 do ? And y*=3 ? z+=w++ ?

Variables: Quick Quiz

- What is the output of this code:

```
int countA = 1, countB=2, countC=3;
countA++;
countB = ++countA + 2 + countC;
countA = countC-- + countB / 4;
countC = --countC - 1;
System.out.print (countA+“:”+countB+“:”+countC);
```


Implicit Conversions

- If there is a type mismatch, the narrower range value is promoted up
  - `int i=1; float f=2.0f;`
  - `System.out.print (i+f);`
- Cannot automatically convert down
  - `e.g., int a = 2.345;`

Explicit Conversions

- Use pseudo methods to “cast” a value to another type

```
int a = (int) 1.234;
2.0f + (float)7/3
```

- Use Math.ceil, Math.floor, Math.round methods for greater control on floating-point numbers
- `String.valueof (123)`
  - converts 123 to a String

Constants

- Like variables, but values cannot be changed after initialisation.
- Prefix the data type with **static final**
  - e.g., `static final double Pi = 3.14159;`
- Useful for fixed values used in many places in the program - one future change will affect all uses.

Input

- Use Scanner to get values from users entered at the keyboard during program execution

```
// tell the compiler we will use the Scanner class which is part
// of Java's built-in code (libraries)
import java.util.Scanner;

public class Test {
   public static void main ( String[] args )
   {
      // create an object conforming to the Scanner class
      Scanner input = new Scanner (System.in);

      String aWord = input.next(); // get a word
   }
}
```


Scanner methods

- `next`
  - Reads in the next word.
- `nextInt`
  - Reads in the next integer.
- `nextFloat`
  - Reads in the next float.
- `nextLine`
  - Reads in complete line until ENTER is pressed.

(see textbook or Java API for more)

Problem

- Write a program to convert your age into dog years. Your program must ask for a human years number and then output the dog years equivalent.
  - The formula is: 10.5 dog years per human year for the first 2 years, then 4 dog years per human year for each year after.
    - [source: http://www.onlineconversion.com/dogyears.htm]
  - Now do it the other way around … dog->human

Problem

- Write a program to simulate Eliza, the artificial conversationalist. For example:
  - `What is your name?`
  - `Hussein`
  - `Tell me, Hussein, what is your problem today?`
  - `My students are bored.`
  - `You said your students are bored. Why do you say that?`
  - `They have that bored look.`
  - `Are you sure they have that bored look?`
  - `Yes`
  - `...`

Output Formatting

- System.out.printf (format_string, expressions) is a method to format output.
  - format_string indicates the format of the output.
    - e.g., “%2d” is a decimal with width 2
  - Expressions are used in place of the placeholders that begin with % in the format_string.
- Examples:
  - `printf (“%03d”, 5);`
    - `005`
  - `printf (“%-6s-%6s%n”, “left”, “right”);`
    - `left  - right`

Format Strings

- General format: %-0w.dt
  - - = optional to left-justify, otherwise right-justify
  - 0 = optional to left-pad with zeroes instead of spaces
  - w = width
  - d = optional decimal places
  - t = format specifier (data type)
- Some Format Specifiers
  - d (decimal/integer)
  - f (floating point number)
  - e (E-notation floating point)
  - s (String)
  - c (character)

Problem

- Write a program to calculate compound interest, according to the formula:

$$A(t) = A_0\left(1 + \frac{r}{n}\right)^{n \cdot t}$$

  - A0 = Initial sum, R = Annual interest rate, N = Number of periods per year, T = Number of years
- Use floating point numbers and use output formatting for output.
- Hint: Math.pow calculates the power with a double result.