

Topic 2 Java Basics

"To excel in Java, or any computer language, you want to build skill in both the "large" and "small". By "large" I mean the sweeping, strategic issues of algorithms, data structures, ... what we think of basically as a degree in Computer Science. You also need skill in the "small" -- 10 or 20 line methods built of loops, logic, strings, lists etc. to solve each piece of the larger problem. Working with students in my office hours, I see what an advantage it is for students who are practiced and quick with their method code. Skill with the method code allows you to concentrate on the larger parts of the problem. Or put another way, someone who struggles with the loops, logic, etc. does not have time for the larger issues."

- Nick Parlante
Stanford University, Google



What We Will Do Today

- ▶ What are computer languages?
- ▶ Writing Java Programs
 - text editor and command line
 - Eclipse
- ▶ First programming concepts
 - output with println statements
 - syntax and errors
- ▶ identifiers, keywords, and comments
- ▶ Strings

Computers and Computer Languages

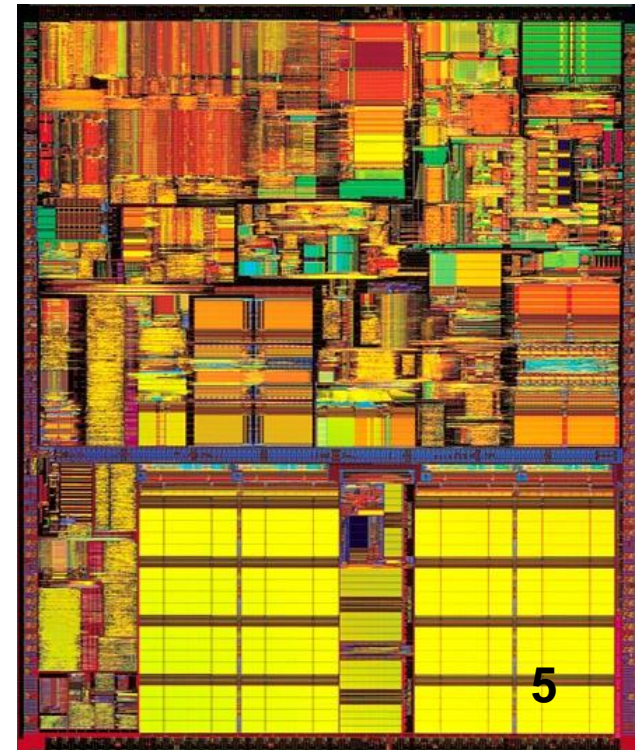
- ▶ Computers are everywhere
 - how many computers do you own?
- ▶ Computers are useful because they run programs
 - program is simply a set of instructions to complete some task
 - how many different programs do you use in a day?

Definitions

- ▶ **program:** A set of instructions that are to be carried out by a computer.
- ▶ **program execution:** The act of carrying out the instructions contained in a program.
 - this is done by feeding the instructions to the CPU
- ▶ **programming language:** A systematic set of rules used to describe computations, generally in a format that is readable and editable by humans.
 - in this class we use Java

High Level Languages

- ▶ Computers are fast
 - Intel® Core™ i7-8086K Processor on the order of 2 billion transistors (a switch that is on or off)
 - performs tens of billions of operations per second
- ▶ Computers are simple
 - They can only carry out a very limited set of instructions
 - on the order of 100 or so depending on the computer's processor
 - machine language instructions, aka instruction set architecture (ISA)
 - Add, Branch, Jump, Get Data, Get Instruction, Store, (CS429)



Machine Code

- ▶ John von Neumann - co-author of paper in 1946 with Arthur W. Burks and Hermann H. Goldstine,
 - "Preliminary Discussion of the Logical Design of an Electronic Computing Instrument"
- ▶ One of the key points
 - program commands and data stored as sequences of bits in the computer's memory

▶ A program:

```
1110001100000000
0101011011100000
0110100001000000
0000100000001000
0001011011000100
0001001001100001
0110100001000000
0000111000000011
```



Say What?

- ▶ Programming with Strings of bits (1s or 0s) is not the easiest thing to do.
- ▶ Assembly language
 - mnemonics for machine language instructions

```
.ORIG      x3001
LD         R1, x3100
AND        R3, R3 #0
LD         R4, R1
BRn        x3008
ADD        R3, R3, R4
ADD        R1, R1, #1
LD         R4, R1
BRnzp     x3003
```

High Level Languages

- ▶ Assembly language, still not so easy, and lots of commands to accomplish things
- ▶ High Level Computer Languages provide the ability to accomplish a lot with fewer commands than machine or assembly language in a way that is hopefully easier to understand

```
int sum = 0;
int count = 0;
while (list[count] != -1) {
    sum += list[count];
    count = count + 1;
}
```


Binary Numbers - Base 2

▶ Base 10, 10 digits

$$\text{▶ } 5127_{10} = 5 * 1000 + 1 * 100 + 2 * 10 + 7 * 1$$

$$\text{▶ } 5127_{10} = 5 * 10^3 + 1 * 10^2 + 2 * 10^1 + 7 * 10^0$$

▶ Base 2, 2 digits

$$\text{▶ } 110101_2 = 1 * 32 + 1 * 16 + 0 * 8 + 1 * 4 + 0 * 2 + 1 * 1$$

$$\text{▶ } 110101_2 = 1 * 2^5 + 1 * 2^4 + 1 * 2^2 + 1 * 2^0$$

$$\text{▶ } 110101_2 = 53_{10}$$



There are
10 types
of people
in the world:

Those who
understand binary,
and those
who don't. |

Java

- ▶ There are thousands of high level computer languages. Java, C++, C, Basic, Fortran, Cobol, Lisp, Perl, Prolog, Eiffel, Python
- ▶ The capabilities of the languages vary widely, but they all need a way to do
 - declarative statements
 - conditional statements
 - iterative or repetitive statements
- ▶ A compiler is a program that converts commands in high level languages to machine language instructions

A Simple Java Program

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

This would be in a text file named Hello.java

DEMO of writing and running a program via notepad and the command line

Running a program

1. Write it.

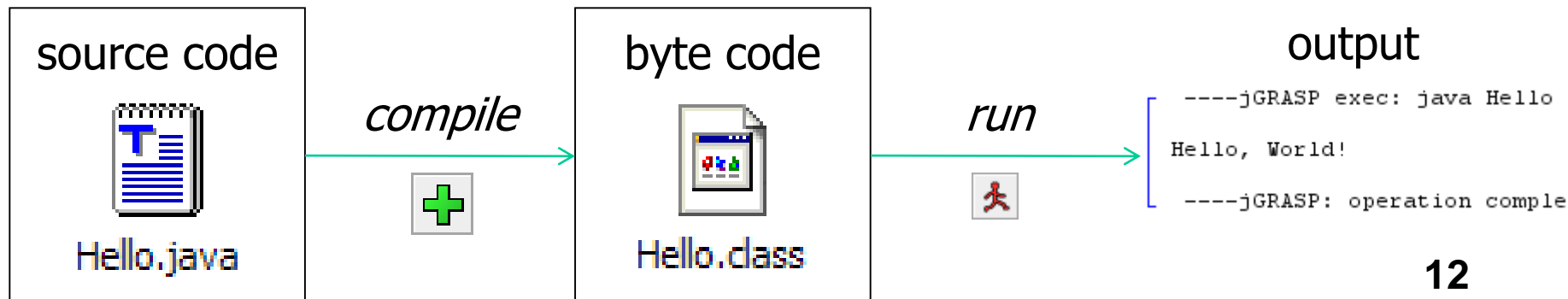
- **code** or **source code**: The set of instructions in a program.

2. Compile it.

- **compile**: Translate a program from one language to another.
- **byte code**: The Java compiler converts your code into a format named *byte code* that runs on many computer types.

3. Run (execute) it.

- **output**: The messages printed to the user by a program.



Bigger Java program!

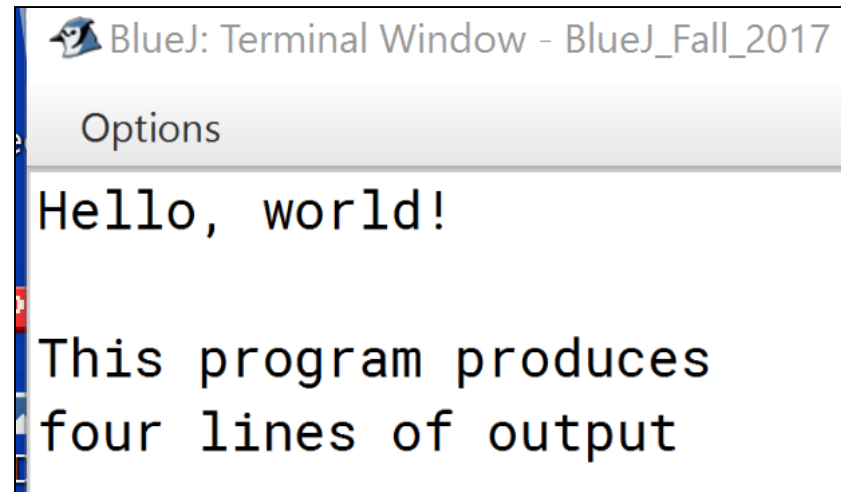
```
public class Hello {  
    public static void main(String[] args) {  
        System.out.println("Hello, world!");  
        System.out.println();  
        System.out.println("This program produces");  
        System.out.println("four lines of output");  
    }  
}
```

► **Its output:**

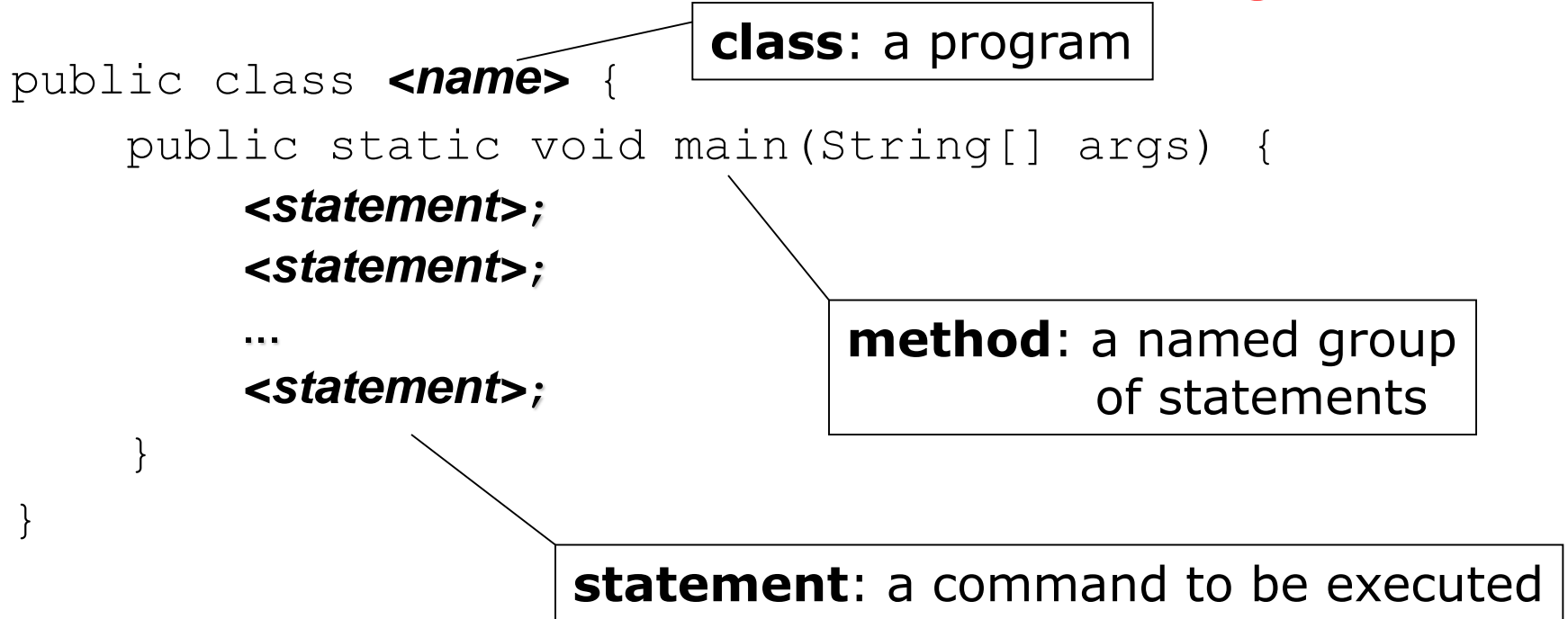
Hello, world!

This program produces
four lines of output

► **console:** Text box into which
the program's output is printed.



Structure of a Java program



▶ Every executable Java program consists of a **class**,

– that contains a **method** named `main`,

- that contains the **statements** (commands) to be executed.

System.out.println

- ▶ A statement that prints a line of output on the console.
 - pronounced "print-linn"
- ▶ **Two ways to use** `System.out.println` :
 - `System.out.println(" <text>");`
Prints the given message as output.
 - `System.out.println();`
Prints a blank line of output.

Syntax

- ▶ **syntax**: The set of legal structures and commands that can be used in a particular language.
 - Every basic Java statement ends with a semicolon ;
 - The contents of a class or method occur between { and }
- ▶ **syntax error (compiler error)**: A problem in the structure of a program that causes the compiler to fail.
 - Missing semicolon
 - Too many or too few { } braces, braces not matching
 - Class and file names do not match
 - ...

Syntax error example

```
1 public class Hello {
2     pooblic static void main(String[] args) {
3         System.owt.println("Hello, world!")_
4     }
5 }
```

► Compiler output:

```
Hello.java:2: <identifier> expected
      pooblic static void main(String[] args) {
          ^
Hello.java:3: ';' expected
      }
      ^
2 errors
```

- The compiler shows the line number where it found the error.
- The error messages sometimes can be tough to understand:
 - Why can't the computer just say “*You misspelled ‘public’?*”?

An Important Realization

- ▶ Computers are stupid.
- ▶ Computers can't read minds.
- ▶ Computers *seldom* make mistakes.
- ▶ If the computer is not doing what we want, it's because **WE** made a mistake.

More on syntax errors

▶ Java is case-sensitive

- Hello and hello are not the same

```
1 Public class Hello {
2     public static void main(String[] args) {
3         System.out.println("Hello, world!");
4     }
5 }
```

compiler output:

```
Hello.java:1: class, interface, or enum expected
Public class Hello {
^
1 error
```

Names

- ▶ You must give your program a name.

```
public class
```

```
SubstitutionCipherDecoder {
```

- Naming convention: capitalize each word (e.g. `MyClassName`)
- Your program's file must match exactly (`SubstitutionCipherDecoder.java`)
 - includes capitalization (remember, Java is "case-sensitive")

Identifiers

▶ **identifier:** A name given to an item in your program.

- must start with a letter, underscore, or \$
- subsequent characters can be any of those or digits 0 through 9

• **legal:** `_myName` `TheCure`
 `ANSWER_IS_42` `$bling$`

• **illegal:** `me+u` `49ers` `side-swipe`
 `Ph.D's`

Keywords

- ▶ **keyword:** An identifier that you cannot use because it already has a reserved (special) meaning in Java.

abstract	default	if	private	this
boolean	do	implements	protected	throw
break	double	import	public	throws
byte	else	instanceof	return	transient
case	extends	int	short	try
catch	final	interface	static	void
char	finally	long	strictfp	volatile
class	float	native	super	while
const	for	new	switch	
continue	goto	package	synchronized	

- Because Java is case-sensitive, you could technically use `Class` or `cLaSs` as identifiers, but this is very confusing and thus **strongly discouraged**.

Clicker 1

- ▶ Which of the following is not a syntactically correct Java identifier for the name of a program?
 - A. static
 - B. Void
 - C. FirstProgram
 - D. _My_program
 - E. More than one of A - D is not a syntactically correct Java identifier.

Strings

- ▶ **string**: A sequence of text characters.
 - Starts and ends with a " (quotation mark character).
 - The quotes do not appear in the output.
 - Examples:
 - `"hello"`
 - `"This is a string. It's very long!"`
- ▶ **Restrictions**:
 - May not span multiple lines.
 - `"This is not
a legal String."`
 - May not contain a " character.
 - `"This is not a "legal" String either."`
- ▶ This begs the question...

Escape sequences

- ▶ **escape sequence**: A special sequence of characters used to represent certain special characters in a string.

\t tab character
\n new line character
\ " quotation mark character
\ \ backslash character

– **Example:**

```
System.out.println("\\hello\nhow\tare \"you\"?\\");
```

– **Output:**

```
\hello  
how     are "you"?\\
```

Clicker 2

- ▶ How many visible characters does the following println statement produce when run?

```
System.out.println("\t\nn\\t\"tt");
```

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

Practice Program 1

- ▶ What sequence of println statements will generate the following output?

This program prints the first lines of the song "slots".

```
"She lives in a trailer"
```

```
"On the outskirts 'a Reno"
```

```
"She plays quarter slots in the local's casino."
```

Practice Program 2

- ▶ What sequence of `println` statements will generate the following output?

```
A "quoted" String is  
'much' better if you learn  
the rules of "escape sequences."
```

```
Also, "" represents an empty String.  
Don't forget to use \" instead of " !  
' is not the same as "
```

Practice Program 3

- ▶ What is the output of the following `println` statements?

```
System.out.println("\ta\tb\tc");  
System.out.println("\\\\");  
System.out.println("'");  
System.out.println("\\""\\"");  
System.out.println("C:\nin\the downward spiral");
```

Answer to Practice Program 3

Output of each println statement:

```
    a    b    c
\\
'
""
C:
i
the downward spiral
```

Practice Program 4

- ▶ Write a `println` statement to produce this output:

```
/ \ // \\ /// \\\
```

Answer to Practice Program 4

println statement to produce the line of output:

```
System.out.println("/ \ \ // \\\ \\\ \\\ \\\ \\\ \\\");
```