Computer science is no more about computers than astronomy is about telescopes.

- Edward Dijkstra , UT Austin

This lecture is primarily slides developed by Mike Scott

https://www.cs.utexas.edu/~scottm/cs312/handouts/slides/topic2JavaBasics.pdf

Used with permission

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

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.

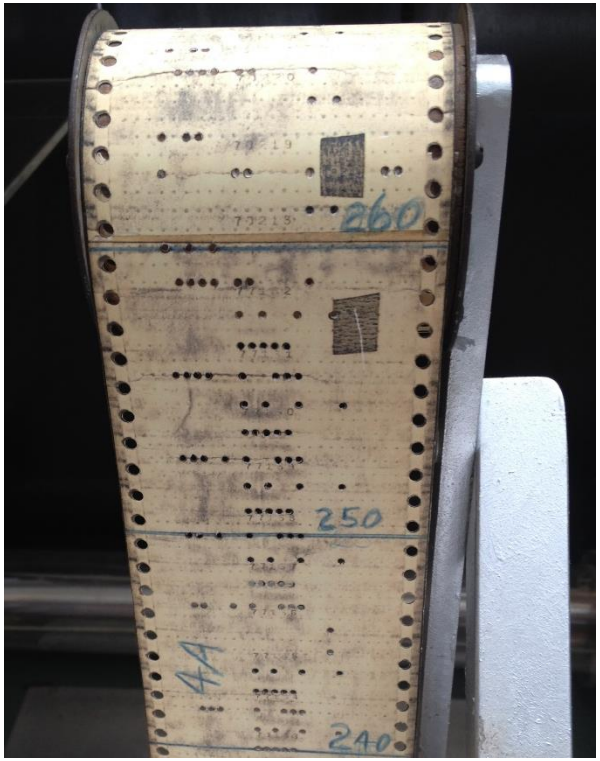
- **program execution**: The act of carrying out the instructions contained in a program.
  - this is done by feeding the instructions to the CPU

- **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

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;
}
```

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

Software Applications

- Large business systems
- Databases
- Internet, e-mail, etc.
- Military
- Embedded systems
- Scientific research
- AI

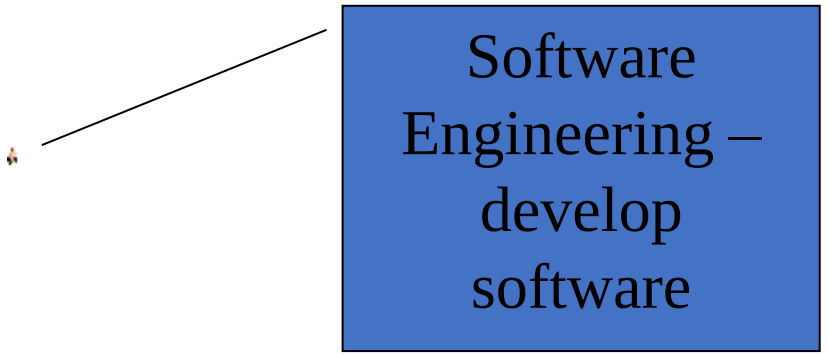
- Word processing and other small business and personal productivity tools
- Graphics / arts / digital photography
- Games

The next 4 slides are adapted from slides by Larry Baker for IB Computer Science

Software Development

1950-1960's:

- Emphasis on efficiency
  - fast algorithms
  - small program size
  - limited memory use
- Often cryptic code
- Not user-friendly



Now:

- Emphasis on
  - programmer's productivity
  - team development
  - reusability of code
  - easier maintenance
  - Portability
  - QA
    - Not done by programmers
- Better documented
- User-friendly
  - High priority

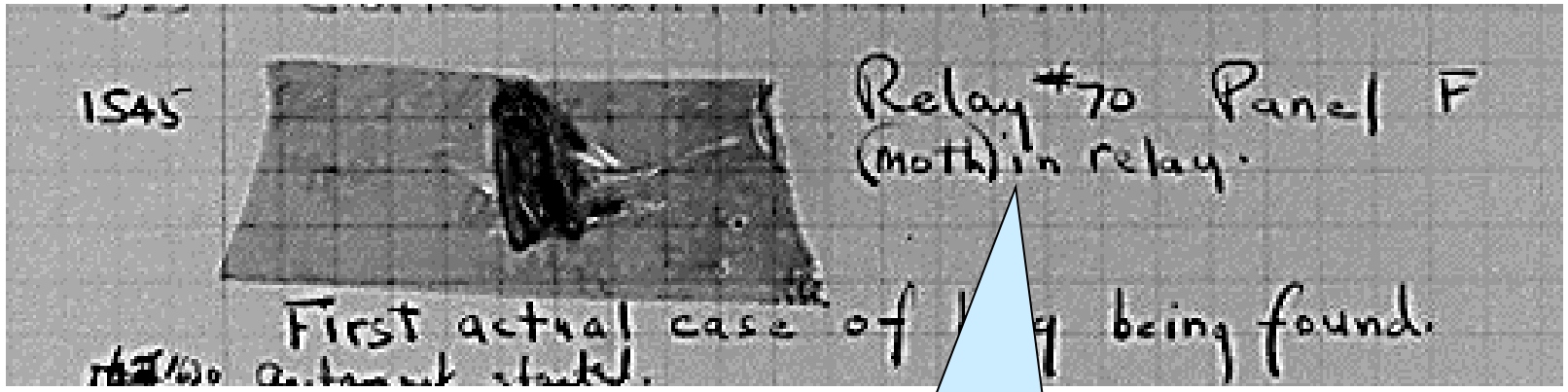
Large software programs

- Task is usually considered a part of a large software development project:
  - Assessing customer needs and formalizing specifications
  - General and detailed design
  - Prototyping
  - Designing user interface
  - Coding
  - Testing
  - Packaging
  - Creating online help
  - Technical support

- Important but not really software development
  - Training customers
  - Assessing customer satisfaction

The First "Bug"

Software error → "bug"
Why?



"(moth) in relay"

Mark II Aiken Relay Calculator (Harvard University, 1945)

A Simple Java Program

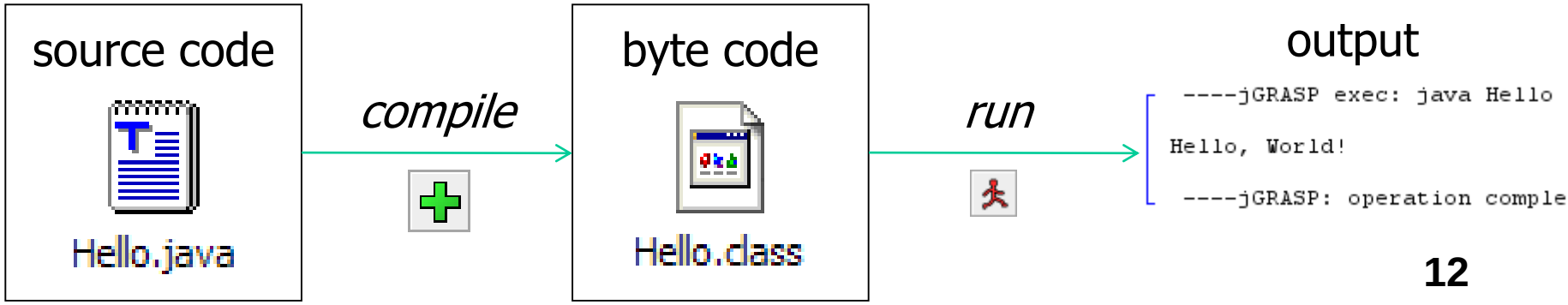
```
public class Hello {
    public static void main(String[] args) {
        System.out.println("Hello World!");
    }
}
```

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.



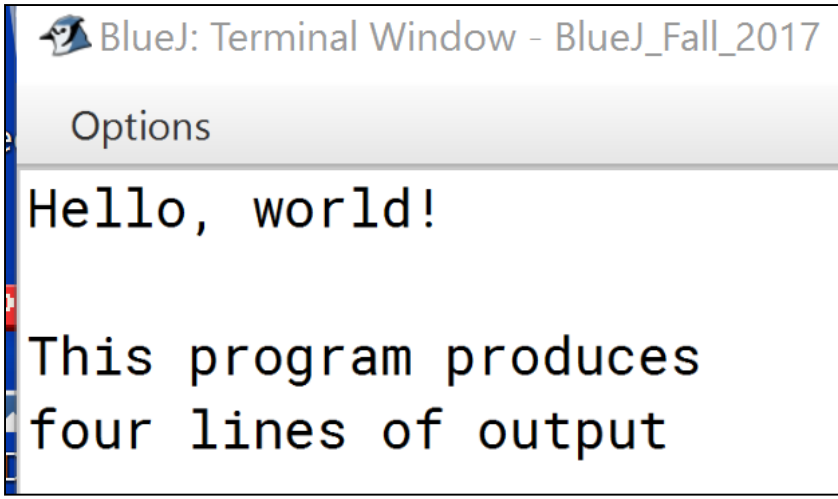
Bigger Java program!

```
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:

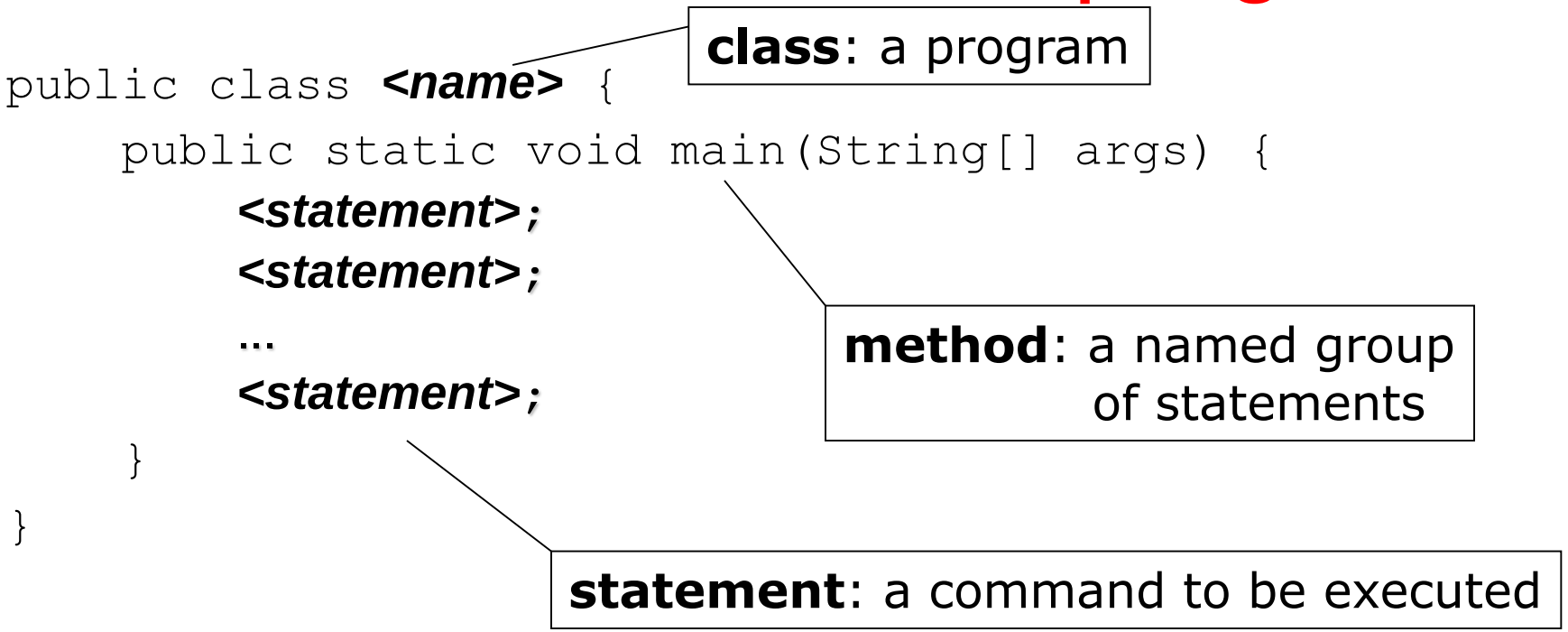
```
Hello, world!

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 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");
```


29

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("/ \\ // \\\\ /// \\\\\\");
```