CENG 1004
Introduction to Object Oriented Programming

Spring 2018

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Course Web Page:
piazza.com/mu.edu.tr/spring2018/ceng1004/home

Sign Up Link
piazza.com/mu.edu.tr/spring2018/ceng1004

Goal of the Course

- Object Oriented Programming Concepts
- Practice Object Oriented Programming using Java
- Be able to develop small scale applications using Java

Course Overview

- **Week 1** - Introduction & Basic Elements of Programming
- **Week 2** - Basic Elements of Programming
- **Week 3** - Algorithm and Recursion
- **Week 4** - Objects & Classes
- **Week 5** - Objects & Classes
- **Week 6** - Packages, Java API, Inheritance
- **Week 7** - Inheritance & Polymorphism

Course Overview

- **Week 8** - Midterm Exam
- **Week 9** - Interfaces and Generics
- **Week 10** - Collections
- **Week 11** - Collections
- **Week 12** - Exception Handling
- **Week 13** - Exception Handling
- **Week 14** - I/O Streams
- **Week 15** - Concurrency

Grading

- **In accordance with University policy, all students must be present for 70% of classroom instruction.**

• **Lab**	**7 %**
• **Quiz**	**8 %**
• **Homeworks**	**10 %**
• **Midterm**	**25 %**
• **Final exam**	**50 %**

Homeworks

- Write your **own** code

- Giving or receiving aid on exams or copying of homework will result in punishment

- Late submission policy:
  - 20 % penalty for each day late.

Logistics

- Course Web Page is located at Piazza
  - piazza.com/mu.edu.tr/spring2018/ceng1004/home
  - piazza.com/mu.edu.tr/spring2018/ceng1004 (Sign up)
  - your questions should be in **English**
- Office hours:
  - Mon 13:30-15:20
- email:
  - ozgur.kilic10@gmail.com
- Textbook:
  - No Text Book

Logistics

- Bitbucket will be used for code sharing and homework submision
  - https://bitbucket.org/
  - Only homeworks submitted via Bitbucket will be graded
  - Your Bitbucket user name should start with “U” followed by your id number such as
    - U123456789 given 123456789 is your id

Lab Information

- Class will be divided into two groups
  - Group A (goes first, 13:30 -14:20) and
  - Group B (goes second, 14:30 - 15:20)
  - on Tuesday in Linux Lab

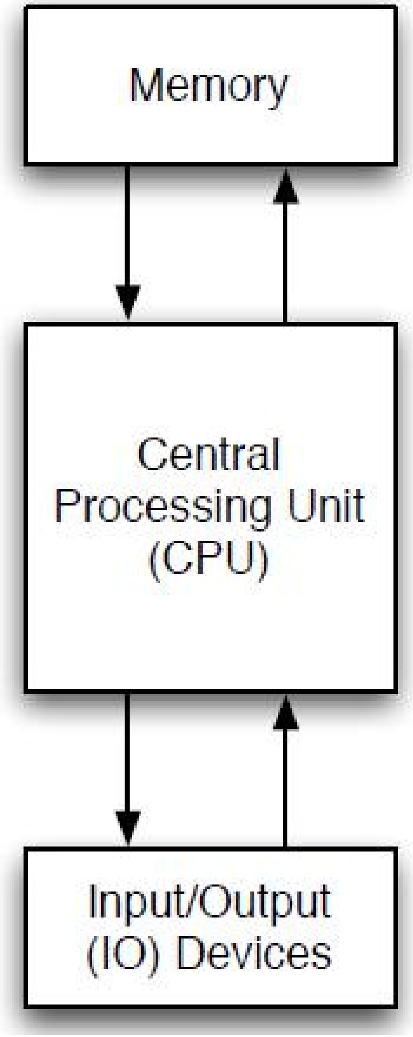
- Groups
  - Group A includes the first 43 students in the Attendance List (First Page)
  - Group B includes the others (Second Page)

Lab Grading

- You should commit the work you have completed to Bitbucket
- Every Wednesday at 12:00 noon, your code will be checked for the latest lab study
- If you complete the lab study and commit it to Bitbucket you will receive 100 otherwise 0 for that lab.

The Computer

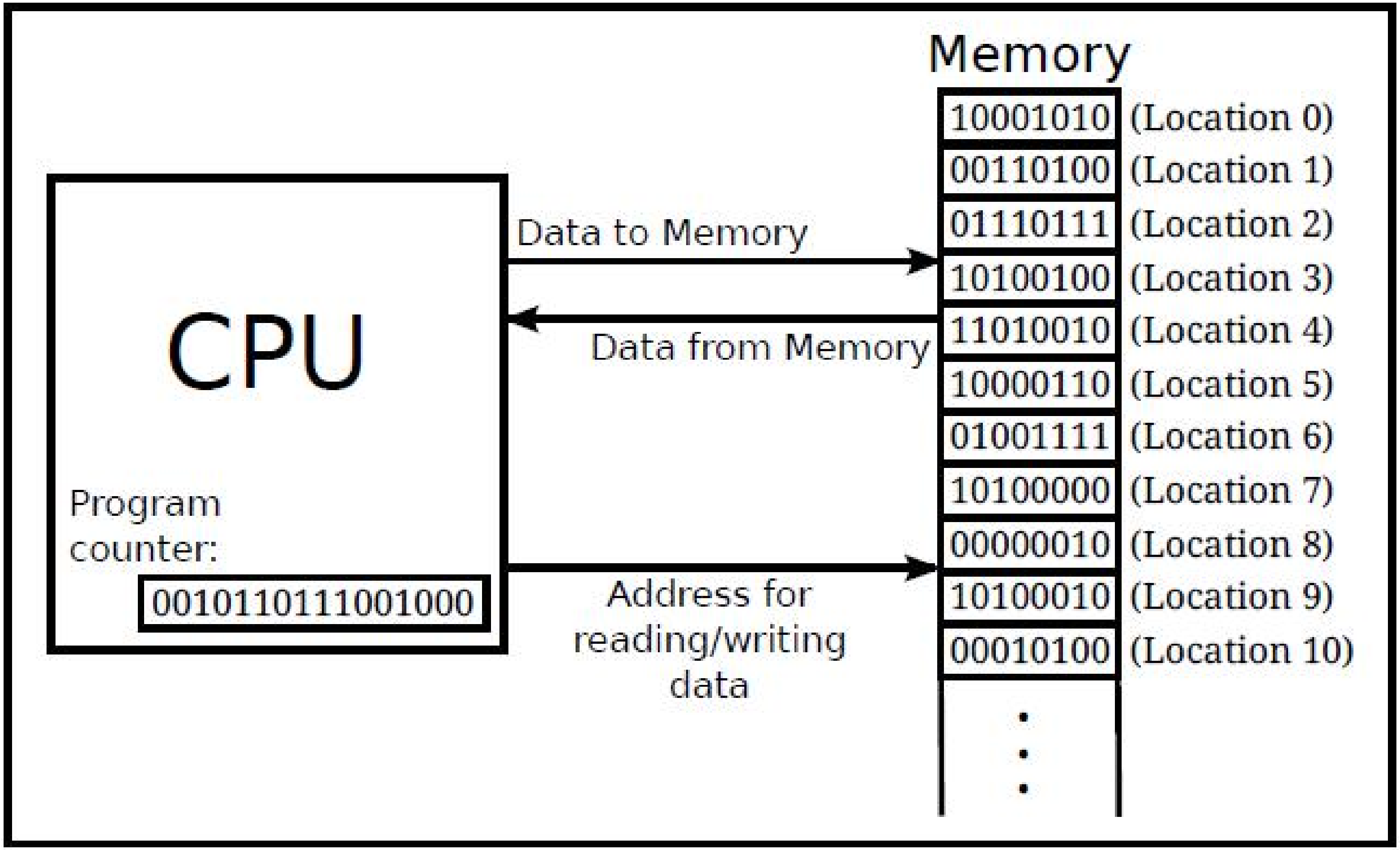
The Computer



The Computer

- CPU (Central Processing Unit)
  - execute programs
- Computer Program
  - a sequence of instructions that can be processed mechanically by a computer
- Machine Language
  - lowest-level representation of computer programs that can be executed by the computer

How Program is Executed



How Program is Executed

- Main memory holds
  - machine language programs and
  - data

- The CPU fetches
  - machine language instructions from memory one after another and executes them

The Software

What is Software (Application)?

Hardware

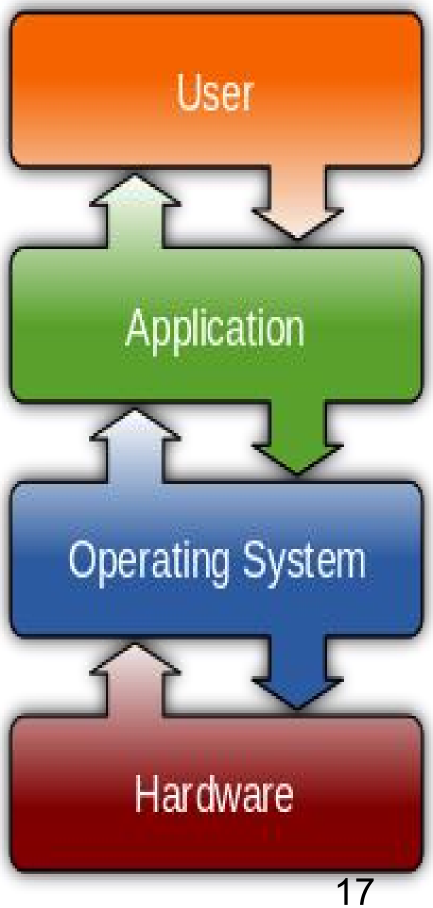
- physical and tangible
- provides necessary resources for computation and storage

Operating System

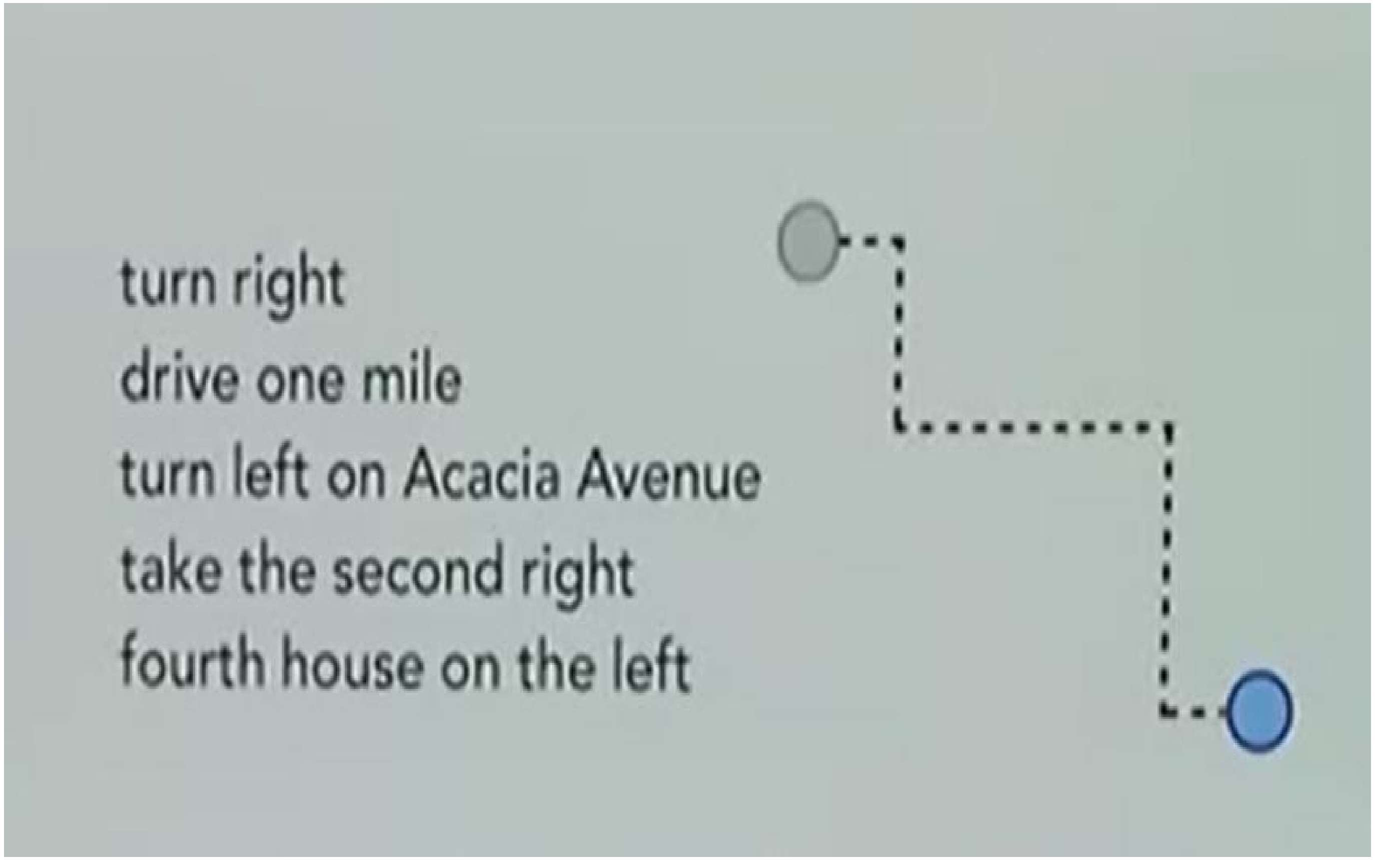
- manages computer hardware and software resources
- provides common services for sofware applications
- functions as a mediator between the HW and SW running within the operating system

Software Application (Computer Program)

- Aims to solve a specific problem
- A set of instructions/statements..



Machine Instructions



turn right
drive one mile
turn left on Acacia Avenue
take the second right
fourth house on the left

Machine Instructions

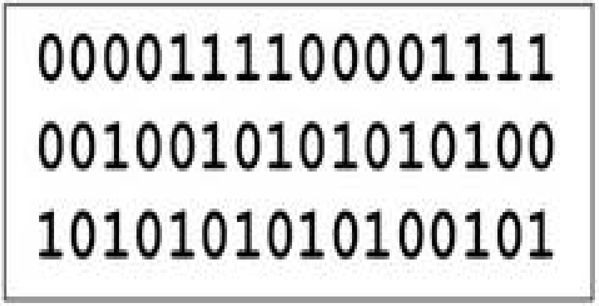
- Specific, Clear and Simple

- The sequence is vitally important
  - If you change the order of these instructions the person may end up at point C which is irrelevant.

- In programming
  - We are giving directions to the computer through machine instructions.

Machine Instructions

- Executed by Central Processing Unit (CPU) / Processor
- Performs a specific task
  - Computational Instructions
    - Add, subtract, increment, invert bits, etc.
  - Data Transfer Instructions
    - Load, store, move, etc.
  - Flow Control Instructions
    - Branch, jump, etc.
  - Input/output Instructions
    - In, Out
- Lowest level representation of Software Application/Program



```
0000111100001111
0010010101010100
1010101010100101
```

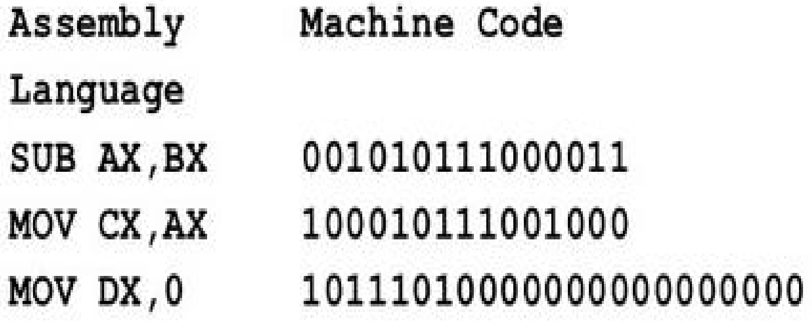
Assembly Language

Low-level programming language for a programmable device

Represent various instructions in symbolic code and a more understandable form.

Very strong (generally one-to-one) correspondence between the language and the machine code instructions.

Specific to a particular computer architecture

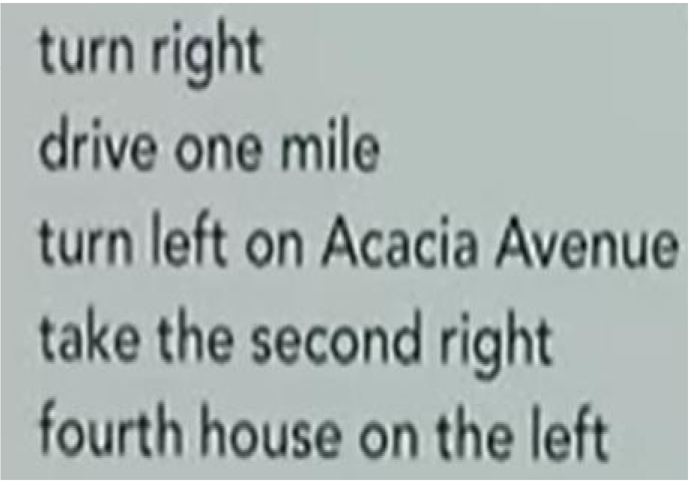


Assembly Language	Machine Code
SUB AX,BX	001010111000011
MOV CX,AX	100010111001000
MOV DX,0	10111010000000000000000

High Level Programming Languages

<u>High Level Language</u> <u>Machine Instructio</u>

Go to the Bank
Withdraw Money
Go to the Market
Buy some Vegetables



turn right
drive one mile
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take the second right
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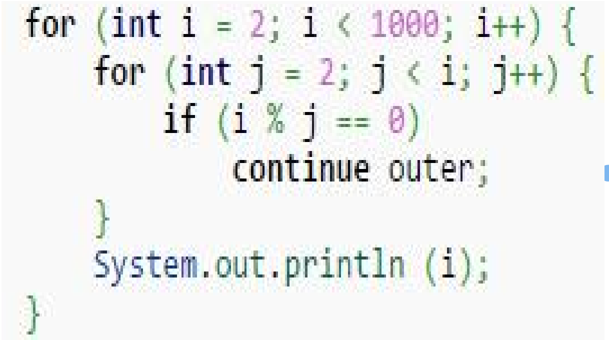
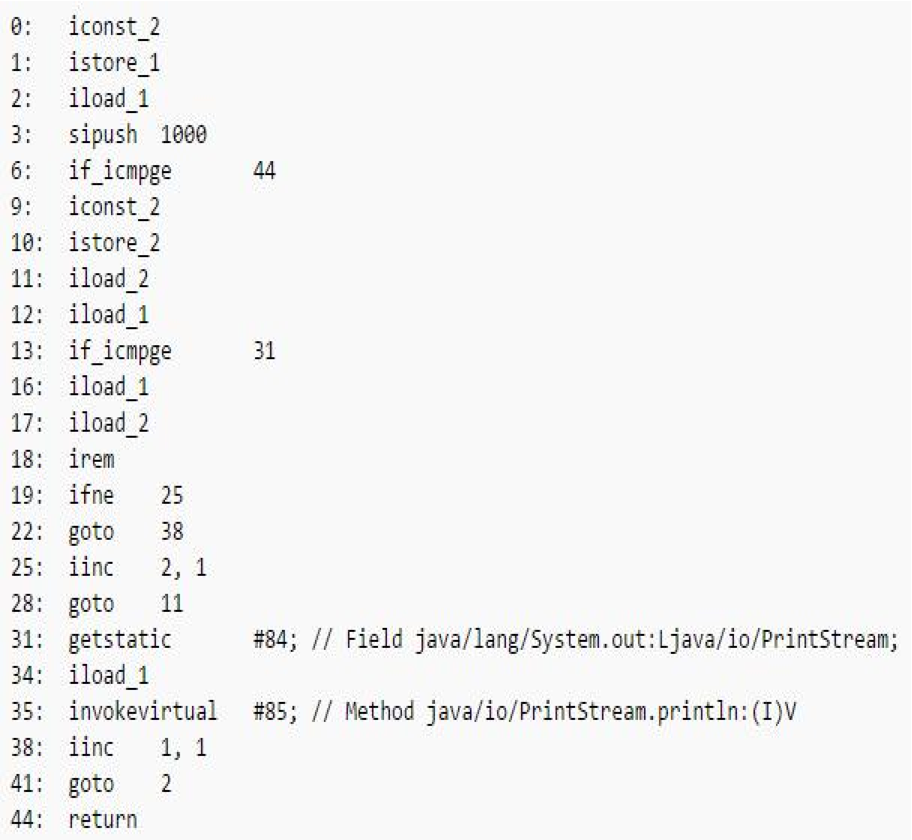
High Level Programming Languages



```
for (int i = 2; i < 1000; i++) {
    for (int j = 2; j < i; j++) {
        if (i % j == 0)
            continue outer;
    }
    System.out.println (i);
}
```



```
0:   iconst_2
1:   istore_1
2:   iload_1
3:   sipush  1000
6:   if_icmpge       44
9:   iconst_2
10:  istore_2
11:  iload_2
12:  iload_1
13:  if_icmpge       31
16:  iload_1
17:  iload_2
18:  irem
19:  ifne    25
22:  goto    38
25:  iinc    2, 1
28:  goto    11
31:  getstatic       #84; // Field java/lang/System.out:Ljava/io/PrintStream;
34:  iload_1
35:  invokevirtual   #85; // Method java/io/PrintStream.println:(I)V
38:  iinc    1, 1
41:  goto    2
44:  return
```

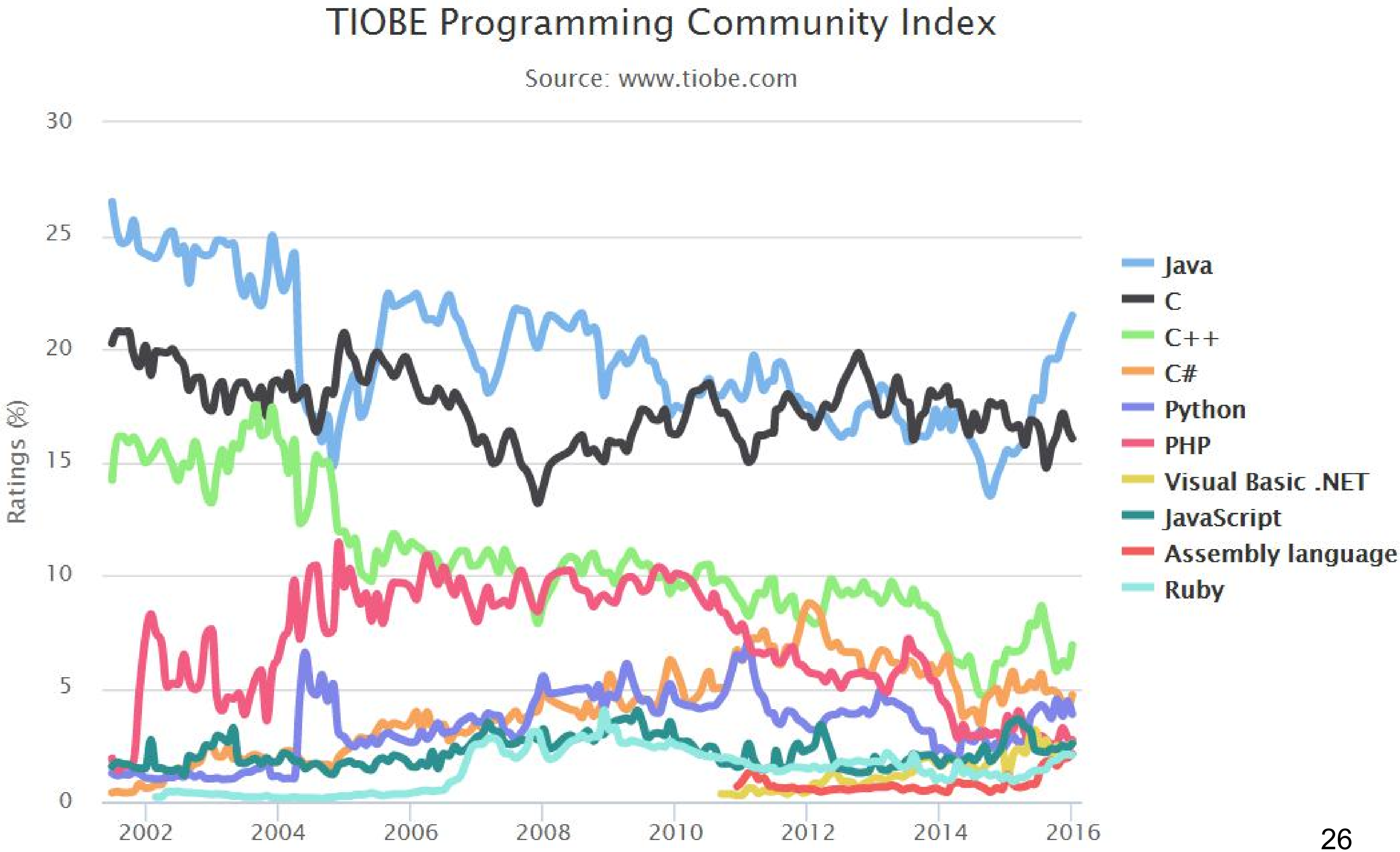
High Level Programming Languages

- Easier to understand than machine instructions

- Needs to be translated for the CPU to understand it

Java

Java is popular

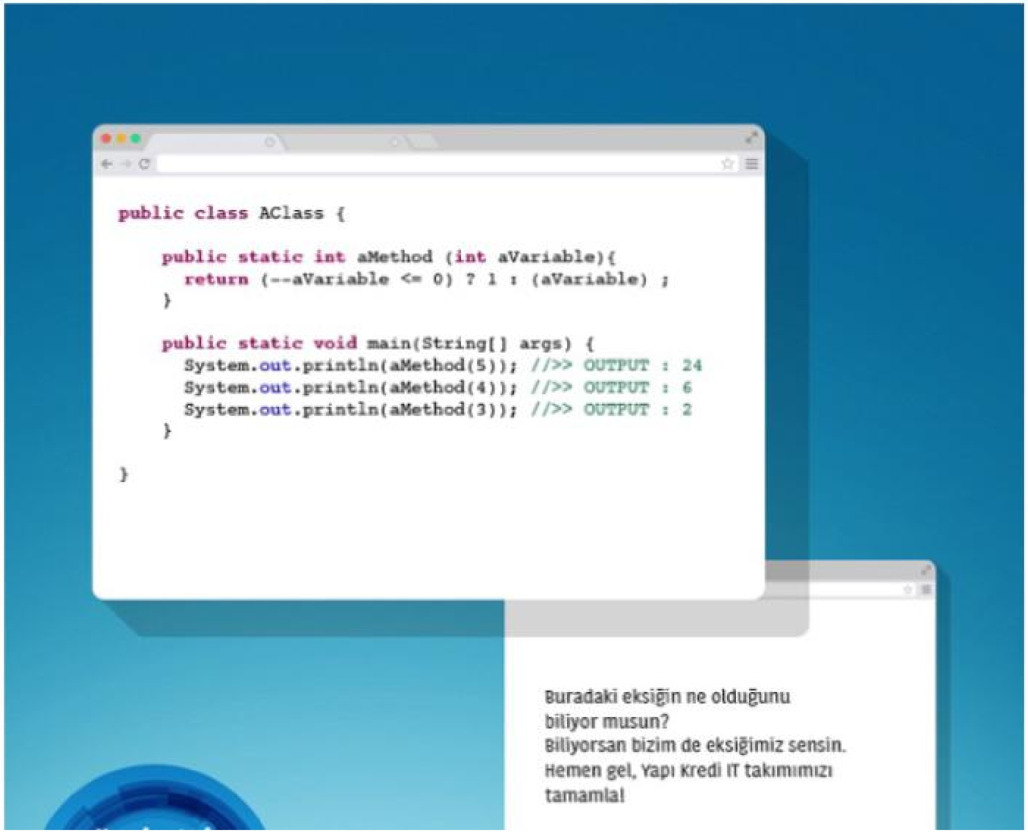


YAPI KREDİ

İstanbul(Avr.), Kocaeli, İstanbul(Asya)

30.01.2017

☆ İlanı Kaydet



```
public class AClass {

    public static int aMethod (int aVariable){
      return (--aVariable <= 0) ? 1 : (aVariable) ;
    }

    public static void main(String[] args) {
      System.out.println(aMethod(5)); //>> OUTPUT : 24
      System.out.println(aMethod(4)); //>> OUTPUT : 6
      System.out.println(aMethod(3)); //>> OUTPUT : 2
    }

}
```

Buradaki eksiğin ne olduğunu
biliyor musun?
Biliyorsan bizim de eksiğimiz sensin.
Hemen gel, Yapı Kredi IT takımımızı
tamamla!

Why Java?

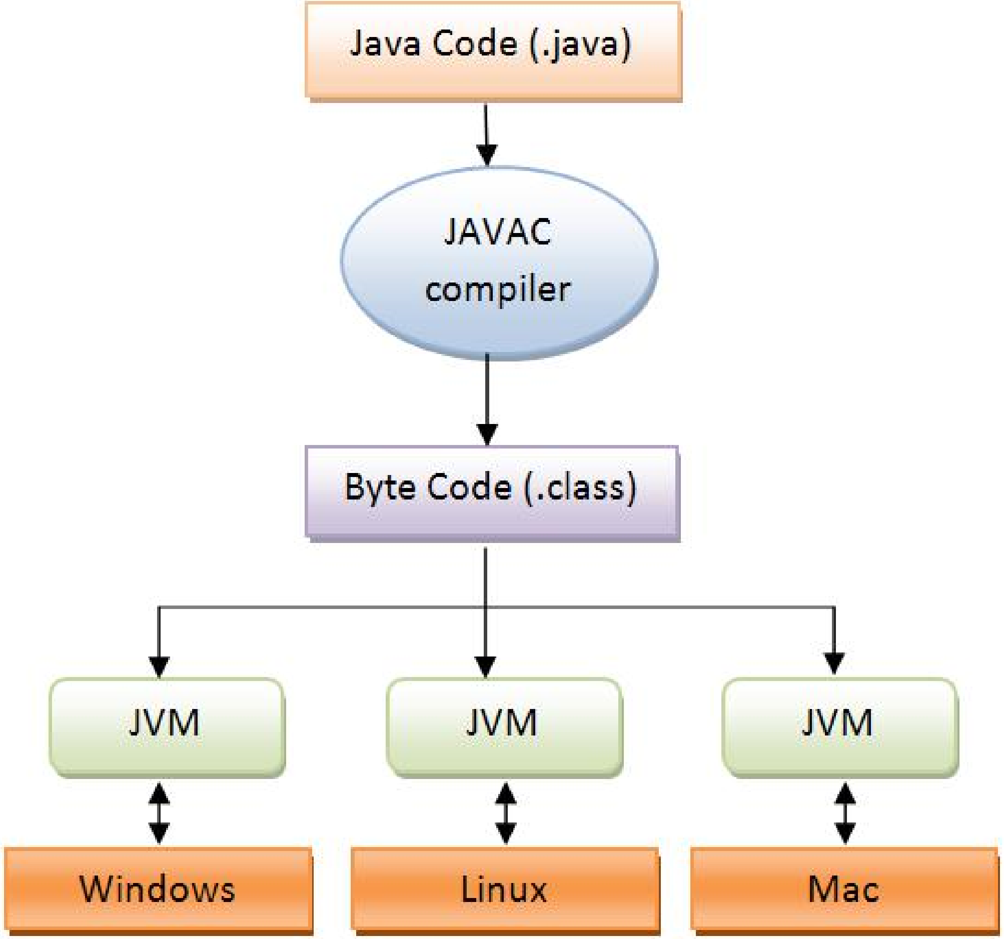
- Object Oriented Programming Language
- Portable
  - offers a write-once-run-anywhere with the help of virtual machine
- Backward compatibility
  - Old programs survive while the language evolves
- Scalability and Performance
  - is used in large enterptise applications and big data projects

Why Java?

- Huge Open Source Community and Many Libraries
  - http://apache.org/

- Various Nice Integrated Development Environments
  - NetBeans,
  - Eclipse
  - IntelliJ IDEA

Java Virtual Machine (JVM)



Programming Environment

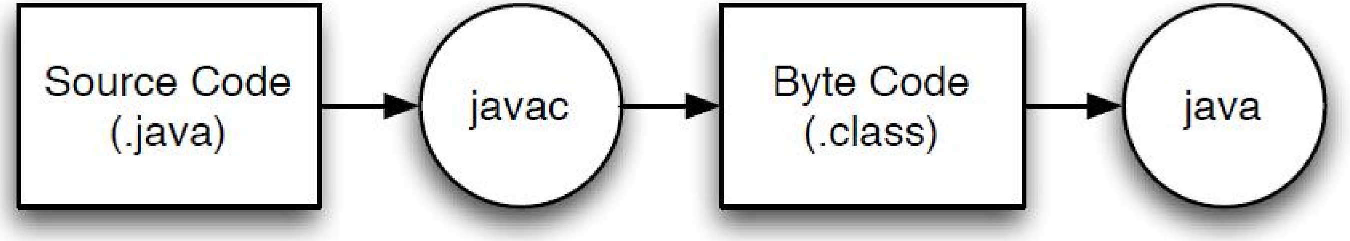
- Java “Standard Edition”
  - Java Runtime Environment (JRE)
    - does not allow you to compile your Java sources
  - Java Development Kit (JDK)
    - You need to install JDK for use in this course
- There are two alternatives
  - Command line environment and a Text Editor
  - Integrated Development Environment (IDE)

Checking Installed JDK

- Type the following commands
  - java -version
  - javac -version

- If you get a message such as “Command not found,” then there is a problem in your installation

Compiling Java



Compiling and Running

- javac HelloWorld.java
  - this command will produce a file "HelloWorld.class" unless you do not have an error in the source file

- java HelloWorld
  - This command will execute "HelloWorld.class"
  - Note that the extension (.class) is not specified in the command

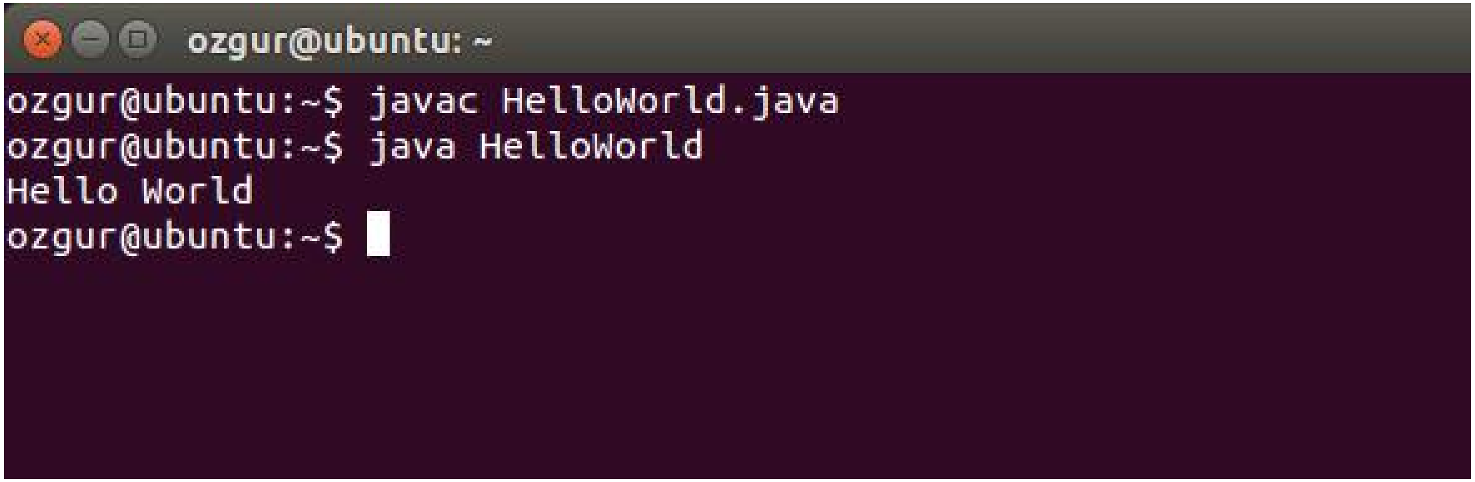
HelloWorld.java

```
/** A program to display the message
* "Hello World!" on standard output.
*/
public class HelloWorld {

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

} // end of class HelloWorld
```

HelloWorld.java



```
ozgur@ubuntu:~$ javac HelloWorld.java
ozgur@ubuntu:~$ java HelloWorld
Hello World
ozgur@ubuntu:~$ 
```

Program Structure

```
public class CLASSNAME {

  public static void main(String[] arguments){
       STATEMENTS
  }

}
```

Program Structure

```
public class CLASSNAME {
  variable-declarations-and-methods
  public static void main(String[] arguments){
      STATEMENTS
  }
  variable-declarations-and-methods
}
```

HelloWorld.java

```java
/** A program to display the message
* "Hello World!" on standard output.
*/
public class HelloWorld {

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

} // end of class HelloWorld
```

Basic Language Elements

Variables

- Programs manipulate data that are stored in memory.
- In machine language, data can only be referred to by giving the numerical address of the location in memory where the data is stored.
- In a high-level language such as Java, names are used instead of numbers to refer to data.

```
rate = 0.07;
interest = rate * principal;
```

Types

- Kinds of values that can be stored and manipulated.
  - **boolean:** Truth value (true or false).
  - **int:** Integer (0, 1, -47).
  - **double:** Real number (3.14, 1.0, -2.1).
  - **String:** Text (“hello”, “example”).

Primitive Types

- There are eight so-called primitive types
  - **boolean:** Truth value (true or false).
  - **short:** corresponds to two bytes (16 bits). range -32768 to 32767.
  - **int:** corresponds to four bytes (32 bits). range -2147483648 to 2147483647.
  - **long** corresponds to eight bytes (64 bits). range -9223372036854775808 to 9223372036854775807.

Primitive Types

- There are eight so-called primitive types
  - The **float** and **double** types hold real numbers (such as 3.6 and -145.99). Again, the two real types are distinguished by their range and accuracy.
  - A variable of type **byte** holds a string of eight bits, which can represent any of the integers between -128 and 127, inclusive.
  - A variable of type **char** holds a single character.

Variables

- Named location that stores a value of one particular type.
  - TYPE NAME;

- Example:
  - int age;
  - String name;

Assignment

- Use "=" to give variables a value.

- Example:
  - String foo;
  - foo = “IAP 6.092”;

Assignment

- Can be combined with a variable declaration.

- Example:
  - double pi = 3.14;
  - boolean isJanuary = false;

HelloWorld.java

```
/** A program to display the message
* "Hello World!" on standard output.
*/
public class HelloWorld {

  public static void main(String[] args) {
     String message = "Hello World!";
     System.out.println(message);
     message = "Hello Again!";
     System.out.println(message);
  }
} // end of class HelloWorld
```

Operators

- Symbols that perform simple computations
  - Assignment: =
  - Addition: +
  - Subtraction: -
  - Multiplication: *
  - Division: /

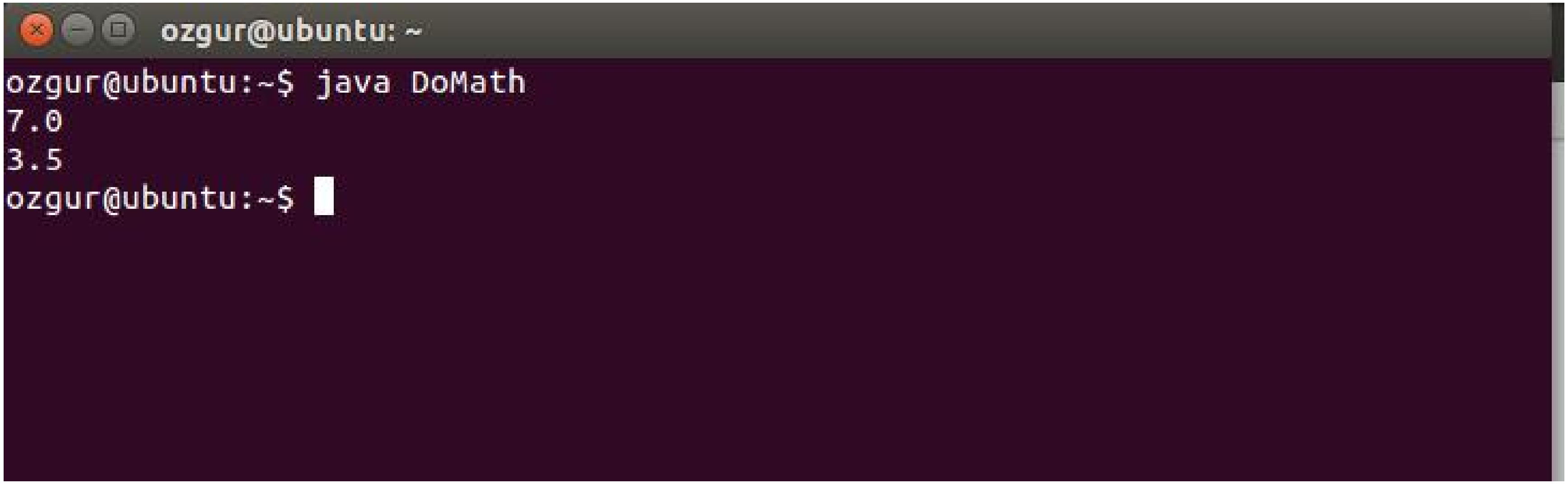
Order of Operations

- Follows standard math rules:
  1. Parentheses
  2. Multiplication and division
  3. Addition and subtraction

DoMath.java

```
public class DoMath {
   public static void main(String[] args){
        double score = 1.0 + 2.0 * 3.0;
        System.out.println(score);
        score = score / 2.0;
        System.out.println(score);
   }
}
```

DoMath.java

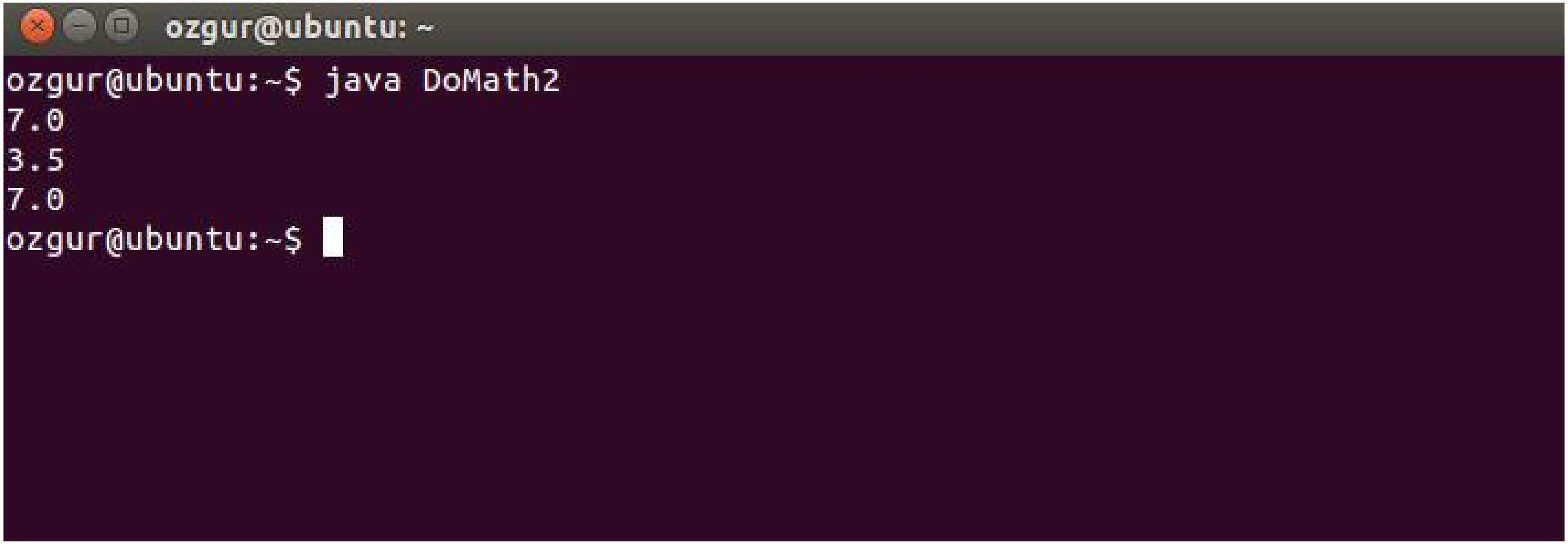


```
ozgur@ubuntu:~$ java DoMath
7.0
3.5
ozgur@ubuntu:~$ 
```

DoMath2.java

```
public class DoMath2 {
   public static void main(String[] args){
         double score = 1.0 + 2.0 * 3.0;
         System.out.println(score);
         double copy = score;
         copy = copy / 2.0;
         System.out.println(copy);
         System.out.println(score);
   }
}
```

DoMath2.java



```
ozgur@ubuntu:~$ java DoMath2
7.0
3.5
7.0
ozgur@ubuntu:~$ 
```

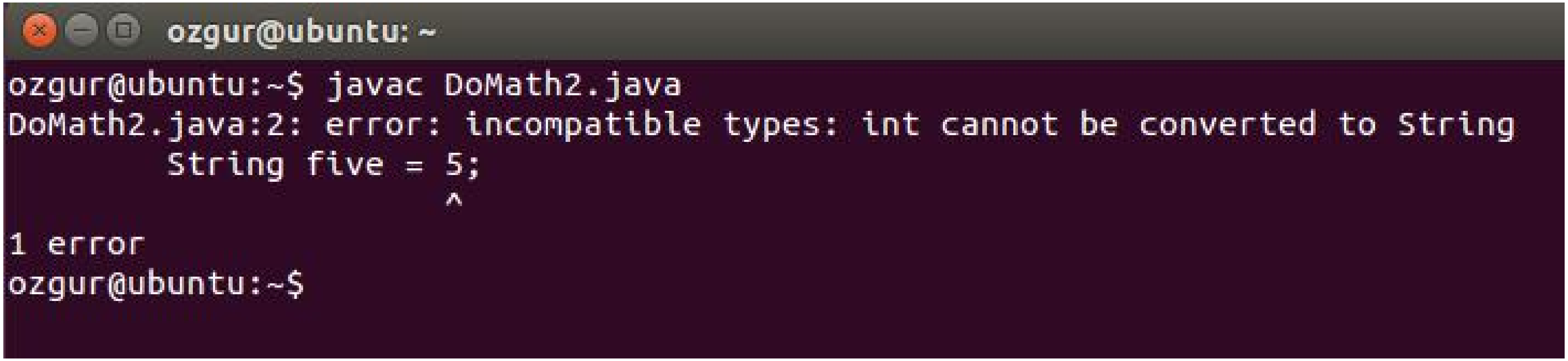
Division

- Division (“/”) operates differently on integers and on doubles!
  - double a = 5.0/2.0;   // a = 2.5
  - int b = 4/2;   // b = 2
  - int c = 5/2;   // c = 2
  - double d = 5/2;   // d = 2.0

Mismatched Types

- Java verifies that types always match:

String five = 5; // ERROR!



```
ozgur@ubuntu:~$ javac DoMath2.java
DoMath2.java:2: error: incompatible types: int cannot be converted to String
        String five = 5;
                      ^
1 error
ozgur@ubuntu:~$
```

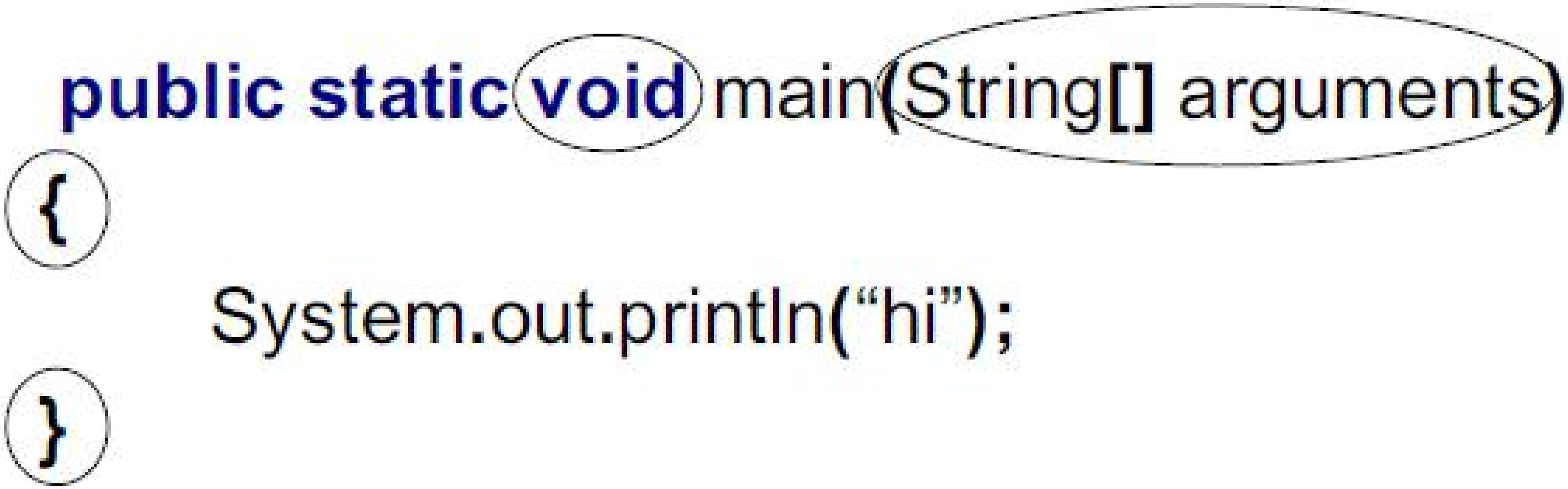
Conversion by casting

```
int a = 2;                    // a = 2
double a = 2;                 // a = 2.0 (Implicit)
int a = 18.7;                 // ERROR
int a = (int)18.7;            // a = 18
double a = 2/3;               // a = 0.0
double a = (double)2/3;       // a = 0.6666…
```

String Concatenation (+)

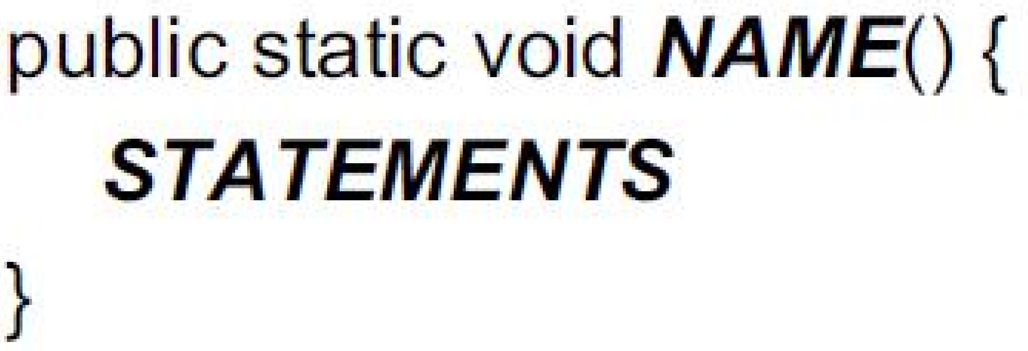
```
String text = "hello" + " world";
text = text + " number " + 5;
// text = "hello world number 5"
```

Methods

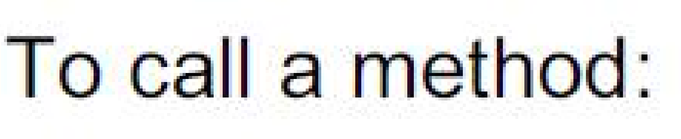


```
public static void main(String[] arguments)
{
      System.out.println(“hi”);
}
```

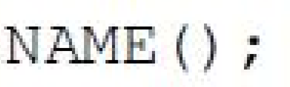
Adding Methods



```
public static void NAME() {
    STATEMENTS
}
```



To call a method:

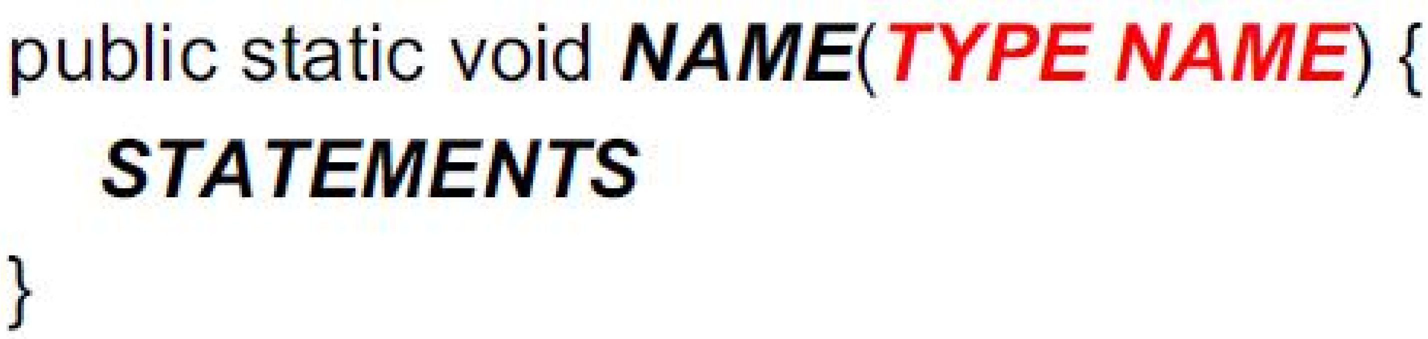


```
NAME();
```

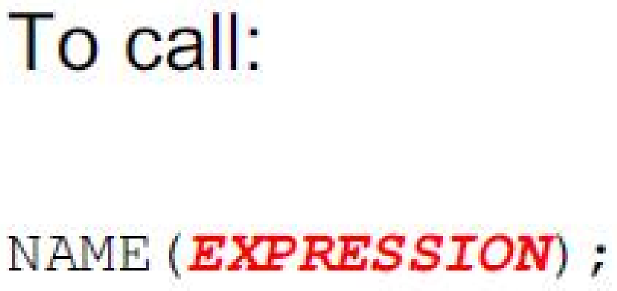
Calling Methods

```
public class NewLine {
    public static void newLine() {
        System.out.println("");
    }
    public static void threeLines() {
        newLine();
        newLine();
        newLine();
    }
    public static void main(String[] args){
        System.out.println("Line 1");
        threeLines();
        System.out.println("Line 2");
    }
}
```

Parameters



```
public static void NAME(TYPE NAME) {
    STATEMENTS
}
```



To call:

```
NAME (EXPRESSION);
```

Parameters

```
public class Square {
    public static void printSquare(int x) {
            System.out.println(x*x);
    }
    public static void main(String[] args){
            int value = 2;
            printSquare(value);
            printSquare(3);
            printSquare(value*2);
    }
}
```

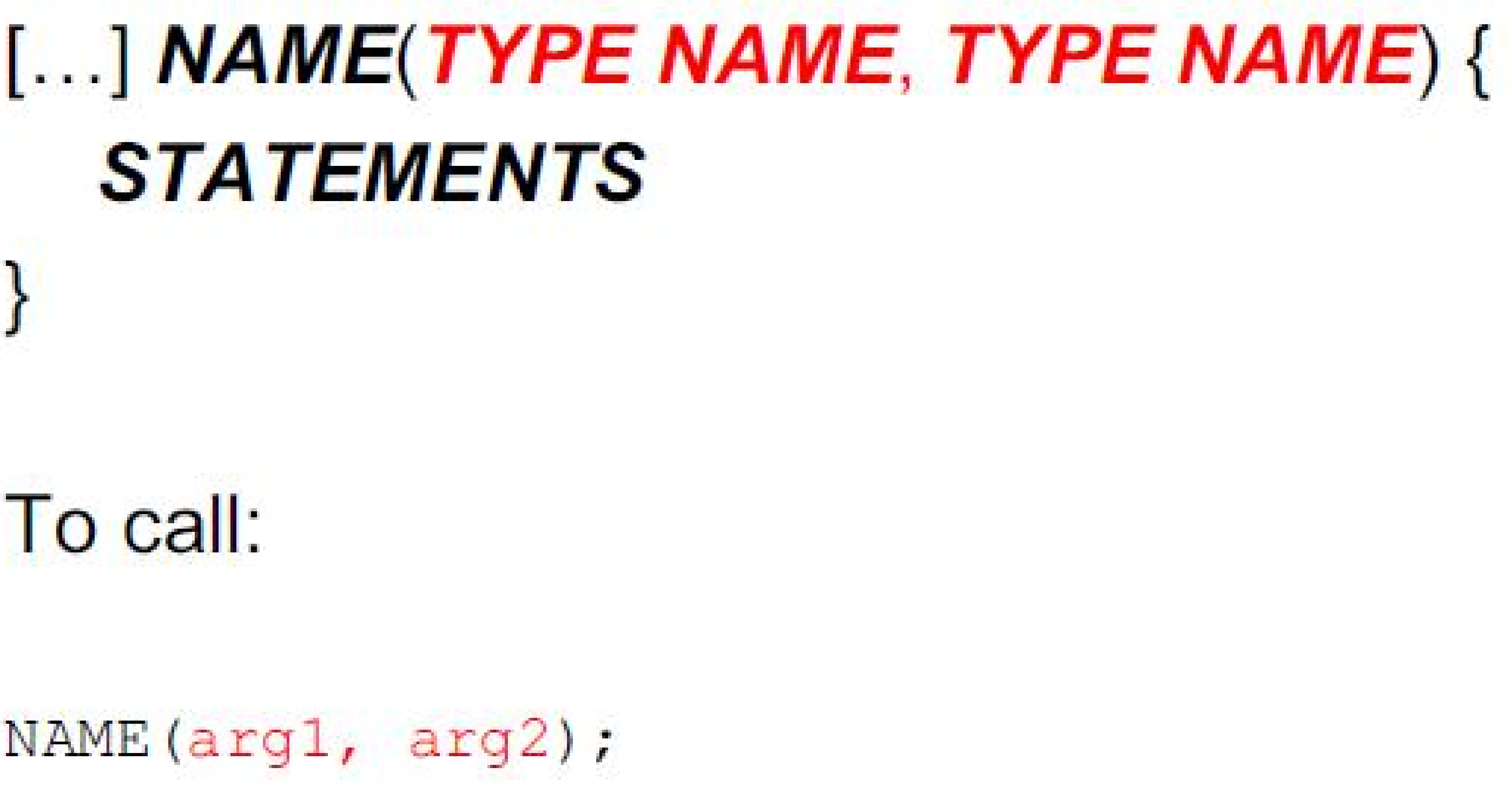
What’s wrong here?

```
public class Square2 {
   public static void printSquare(int x) {
      System.out.println(x*x);
   }
   public static void main(String[] args) {
      printSquare("hello");
      printSquare(5.5);
   }
}
```

What’s wrong here?

```
public class Square3 {
  public static void printSquare(double x) {
      System.out.println(x*x);
  }
  public static void main(String[] args) {
      printSquare(5);
  }
}
```

Multiple Parameters



```
[...] NAME(TYPE NAME, TYPE NAME) {
    STATEMENTS
}
```

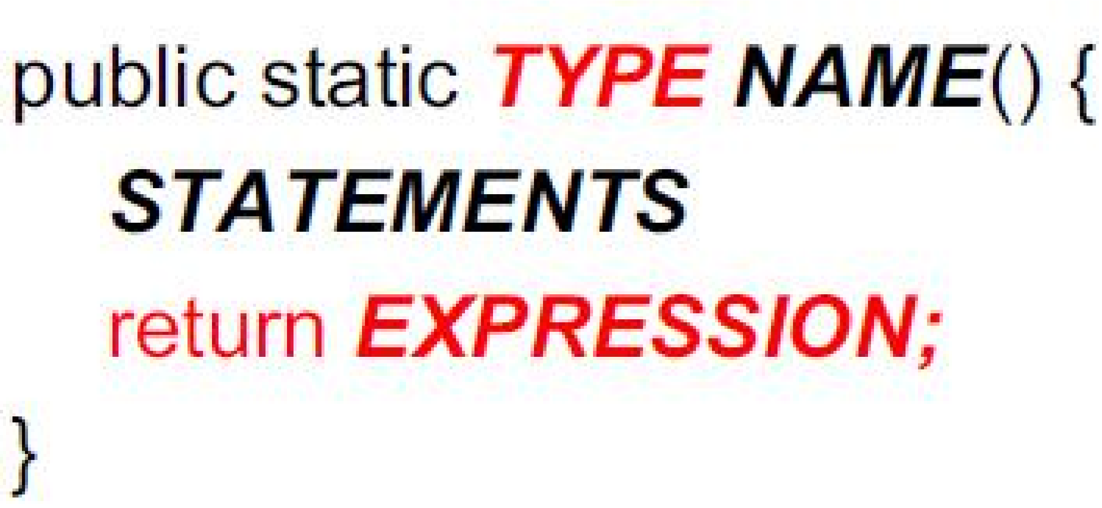
To call:

```
NAME(arg1, arg2);
```

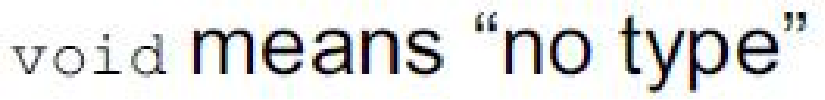
Multiple Parameters

```
public class Multiply {
   public static void times (double a, double b){
         System.out.println(a * b);
   }
   public static void main(String[] args){
         times (2, 2);
         times(3, 4);
   }
}
```

Return Values



```
public static TYPE NAME() {
    STATEMENTS
    return EXPRESSION;
}
```



`void` means “no type”

Return Values

```
public class Square3 {
  public static void printSquare(double x) {
      System.out.println(x*x);
  }
  public static void main(String[] args) {
      printSquare(5);
  }
}
```

Return Values

```
public class Square4 {
    public static double square(double x) {
        return x*x;
    }
    public static void main(String[] args) {
        System.out.println(square(5));
    }
}
```

Before Lab

- If you use laptop in lab hours
  - install JDK 8
    - http://www.oracle.com/technetwork/java/javase/downloads/index.html
- Otherwise make sure you have an account to use PCs in the Linux Lab

Before Lab

- Register Piazza
- Create bitbucket account as described in lab1.pdf
  - Your user name shoud have the following format
  - U123456789

References

- http://math.hws.edu/javanotes/
- http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-introduction-to-programming-in-java-january-iap-2010/lecture-notes/
- http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html