

Introduction

- Objectives - when we have completed this introduction to computing, you should be able to:
 - Understand the basics of software and its relationship to hardware
 - Write simple Java programs
 - Edit, compile, and run Java programs using jGRASP
 - Set a breakpoint and step through your program in debug mode
 - Use Javadoc comments in your programs
 - Run Checkstyle to verify your comments and format
 - Generate documentation for your programs



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Background

- Computer System
 - Hardware and Software
- Hardware
 - "Physical" processor, memory, I/O devices, ...
- Software
 - "Abstract" instructions and data stored electronically
 - Program instructions are human readable as text and machine readable as executable binary
- Computing
 - "The Act of" - Software running (executing) on hardware, processing input and producing output to solve a problem, entertain, communicate, etc.
- Fields/Disciplines of Computing
 - CS + SwE (incl WRSwE) + CpE + IS + IT + ...



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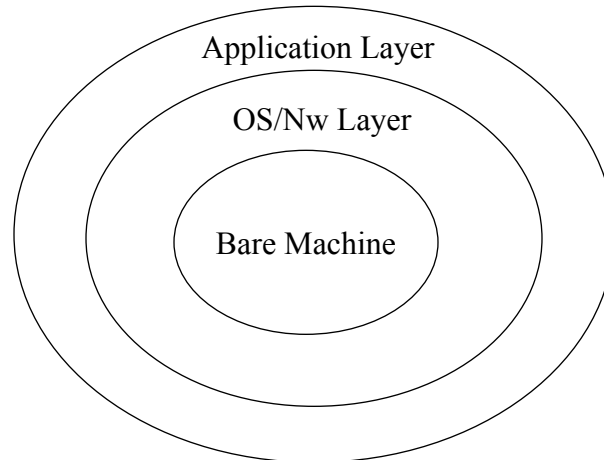
Sw and Hw Relationship

- Bare Machine
 - All physical components, devices, microcode
- OS/Network Layer
 - All system software: OS, Network, device drivers (Windows, Linux, MacOS, UNIX)
 - Management of all hardware: processor, memory, I/O devices
 - Management of all running software (multiple processes)
- Application Layer
 - All software applications: MS Office, Internet browsers, IDEs (Integrated Development Environments), compilers, ..., including **programs written in this course**



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Sw and Hw Relationship



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Software

- In this course
 - Hw is assumed; designed/implemented by CpE, EE, physicists, etc.
 - Sw is our focus; designed/implemented by CS, SwE, IS, etc.
- Developing Sw is about
 - Problem solving
 - Design, construction, testing, ...
 - Managing the inherent complexity
 - Organizing the algorithms (instructions) and data as classes and objects in object-oriented programming



Object-Oriented Concepts

- Classes
- Objects
- Encapsulation
- Inheritance
- Polymorphism
- Exception Handling

All of these OO concepts are directly supported in the Java programming language



Java

- A *programming language* specifies the words and symbols that we can use to write a program
 - Employs a set of rules (*syntax*) that dictate how the words and symbols can be put together to form valid *program statements*
 - Defines the meaning (semantics) of *program statements*
- Java was created by Sun Microsystems and introduced in 1995 (acquired by Oracle, 2010)
- Java continues to evolve and grow in importance to the software industry



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Java Program Structure

- In the Java programming language:
 - A **program** is made up of one or more *classes*
 - A **class** contains zero or more data and/or *methods*
 - A **method** contains zero or more local data and/or *program statements* that form an *algorithm*
- These terms will be explored in detail throughout the course
- A Java application has a class containing a method called **main**



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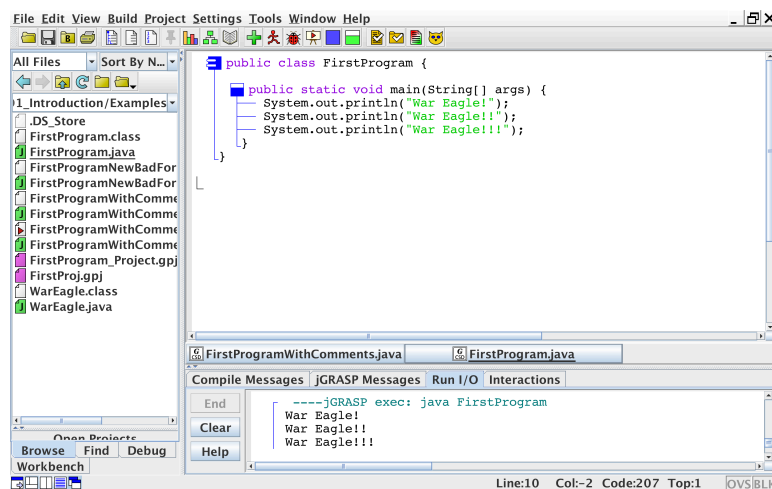
First Program with jGRASP

1. Start up jGRASP
2. Open a new file
3. Enter the program (incrementally: steps 3-6)
 - The program should print "War Eagle" three times
4. Save program
5. Compile program
6. Run program (check for correct output)
7. Set a breakpoint and Debug (step through each statement)
8. Generate the control structure diagram (CSD) and Documentation; turn on/off line numbers



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jGRASP

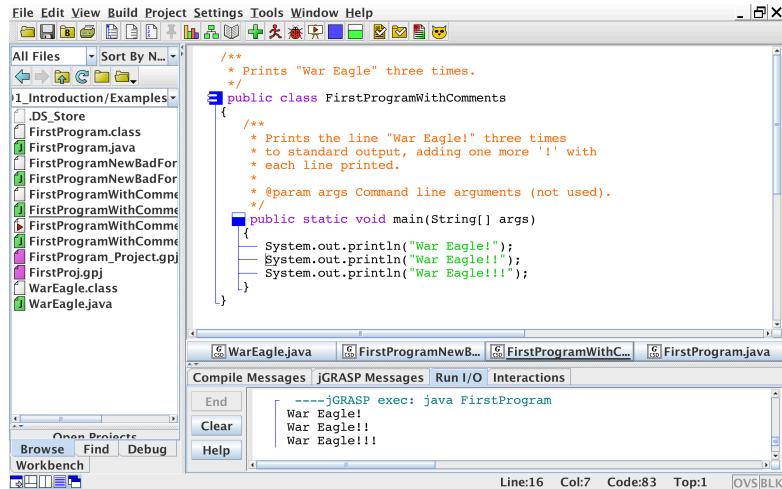


[FirstProgram.java](#)



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jGRASP



The screenshot shows the jGRASP IDE interface. On the left is a project explorer with a tree view containing files like `DS_Store`, `FirstProgram.class`, `FirstProgram.java`, `FirstProgramNewBadFor`, `FirstProgramNewBadFor`, `FirstProgramWithComme`, `FirstProgramWithComme`, `FirstProgramWithComme`, `FirstProgram_Project.gpj`, `FirstProj.gpj`, `WarEagle.class`, and `WarEagle.java`. The main editor window displays the source code for `FirstProgramWithComments.java`. The code includes comments and a `main` method that prints "War Eagle!" three times with increasing exclamation marks. Below the editor, the "Run I/O" tab shows the execution output: `War Eagle!`, `War Eagle!!`, and `War Eagle!!!`. The status bar at the bottom indicates "Line:16 Col:7 Code:83 Top:1 OVS|BLK".

```
File Edit View Build Project Settings Tools Window Help
All Files Sort By N...
1 Introduction/Examples
  DS_Store
  FirstProgram.class
  FirstProgram.java
  FirstProgramNewBadFor
  FirstProgramNewBadFor
  FirstProgramWithComme
  FirstProgramWithComme
  FirstProgramWithComme
  FirstProgram_Project.gpj
  FirstProj.gpj
  WarEagle.class
  WarEagle.java

/**
 * Prints "War Eagle" three times.
 */
public class FirstProgramWithComments
{
    /**
     * Prints the line "War Eagle!" three times
     * to standard output, adding one more '!' with
     * each line printed.
     * @param args Command line arguments (not used).
     */
    public static void main(String[] args)
    {
        System.out.println("War Eagle!");
        System.out.println("War Eagle!!");
        System.out.println("War Eagle!!!");
    }
}

WarEagle.java FirstProgramNewB... FirstProgramWithC... FirstProgram.java
Compile Messages jGRASP Messages Run I/O Interactions
End
Clear
Help
----jGRASP exec: java FirstProgram
War Eagle!
War Eagle!!
War Eagle!!!
Line:16 Col:7 Code:83 Top:1 OVS|BLK
```

[FirstProgramWithComments.java](#)



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Software Concepts

Algorithms and Data
Dissecting a Java Program
Program Development, Translation, and Execution
Syntax, Semantics, and Errors
Overview of Programming Languages
Object-Oriented Programming



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Algorithms and Data

- Sw ::= algorithms (“instructions”) and data
- Algorithms ::= Sequence, Selection, Iteration of instructions
- Pseudo-code (initial prog. design) becomes “formal” program (i.e., code in a programming language like Java)
 - Pseudo-code can become comments in the program
- Many pieces of code for algorithms and data
- Organized into classes which define objects (Object-Oriented Programming)



Dissecting a Java Program

```
/**
 * Prints the line "War Eagle!" three times
 * to standard output.
 *
 * @author James Cross
 * @version e.g., date written
 */
public class FirstProgram
{
    /**
     * Prints "War Eagle!" three times.
     *
     * @param args Command line arguments (not used).
     */
    public static void main(String[] args)
    {
        System.out.println("War Eagle!");
        System.out.println("War Eagle!!");
        System.out.println("War Eagle!!!");
    }
}
```



Parts of this Program

- Comments
- Class
- `main` Method
- Identifiers
 - Reserved Words
 - Other (e.g., method and variable names)
- Java API
- Literals
- White space

Identifiers can be any combination of letters, digits, dollar sign (\$) and underscore (_) characters; cannot begin with a digit. Java is “case sensitive”.

```
/**
 * Prints the line "War Eagle!" three times
 * to standard output.
 *
 * @author James Cross
 * @version e.g., date written
 */
public class FirstProgram
{
    /**
     * Prints "War Eagle!" three times.
     *
     * @param args Command line arguments (not used).
     */
    public static void main(String[] args)
    {
        System.out.println("War Eagle!");
        System.out.println("War Eagle!!");
        System.out.println("War Eagle!!!");
    }
}
```

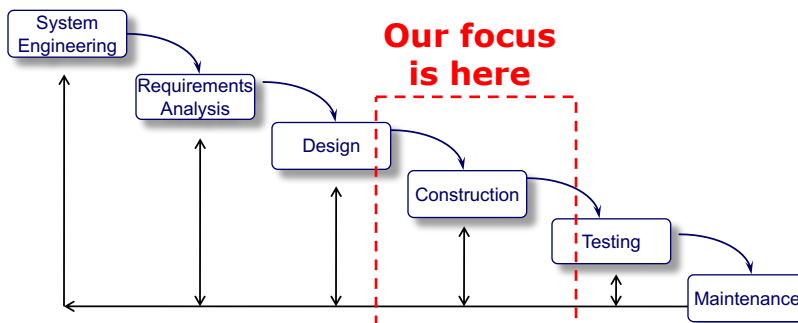
[Q1](#) [Q2](#) [Q3](#)



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Program Development

- There's more to developing software than coding (a.k.a. construction or implementation)



- Many variants of the process model



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Program Development (cont.)

Construction – includes Code and Unit Test

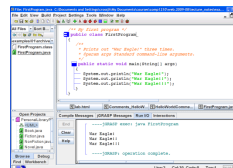
- Code
 - Writing source code that will be compiled into an executable program.
 - **Coding standard:** Rules as to how source code should be formatted and documented - makes code easier to read and debug.
- Test (Unit Test)
 - Once you write your program, make sure that the **actual output** of your program matches the **expected output** as specified in the requirements document.



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Program Development (cont.)

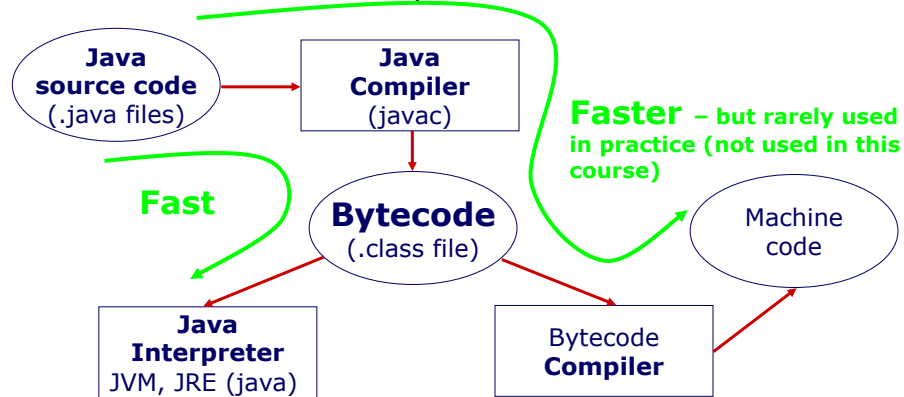
- Program development tools are valuable aids during the process.
 - A good IDE (integrated development environment) with program editor, debugger, interactions, etc. will should become one of your best sw tools.
 - *jGRASP* (jgrasp.org) with Java, Checkstyle, JUnit, Web-CAT
 - *Checkstyle* is used with jGRASP to support the coding standard we'll use in this course.



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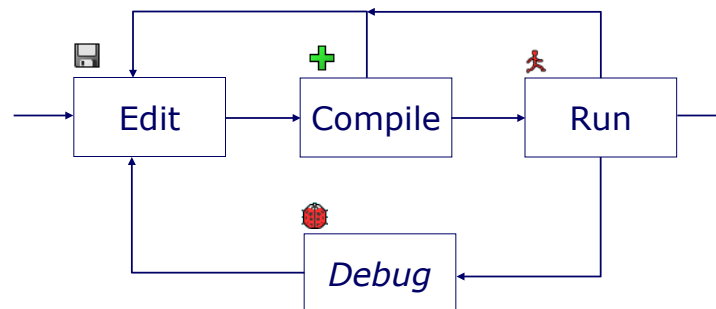
Program Translation

- **Compiler v. Interpreter (Java Virtual Machine)**
- The Java translation process:



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The Implementation Cycle...



- This cycle implies incremental program construction.
- Plan to repeat this cycle early and often.



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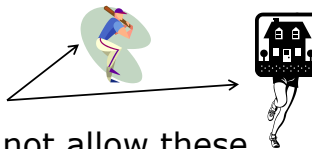
Syntax and Semantics

- Syntax: “grammar”
 - Rules of how the vocabulary can be used to compose legal structures in the language.
 - In the context of programs, the language syntax describes how to form legal statements and other constructs in the language.
- Semantics: “meaning”
 - What a given legal structure in the language means.
 - In the context of programs, the language semantics describes what will happen when a legal statement in the language is executed.



Syntax and Semantics (cont.)

- In natural languages, some things can be syntactically correct but have no meaning...
 - Blue ideas sleep furiously.
- ... or be syntactically correct but have many (possible) meanings.
 - Time flies like an arrow.
 - The house flies like a saucer.
 - Did you ever see a home run?
- Programming languages do not allow these situations - - there is no ambiguity!
 - A program will have the same behavior each time it is run - - assuming input, if any, is the same.



Program Errors [Q4](#) [Q5](#) [Q6](#)

- **Compile-time errors**
 - Compilation cannot be completed
 - Syntax errors
 - Static semantic errors
 - The Java compiler will not produce bytecode.
- **Logical errors (logic errors)**
 - Execution proceeds and halts normally, but incorrect behavior or incorrect results are observed.
- **Run-time errors**
 - Execution is halted abnormally.
 - Deep-end, crash, blow up, crash and burn, hosed
 - Illegal operations, exceptions.
- Find errors by **testing** and remove them by **debugging**



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Overview of Programming Languages

- A programming language is an artificial language designed for humans to express programs and have these programs translated into machine-executable form.
- Programming languages can be categorized in different ways, for example:
 - Machine languages
 - Assembly languages
 - **High-level languages (e.g., Java, C++, Python)**
- Languages in different categories are obviously going to be very different from each other, but even languages within the same category can vary widely.



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Same Program, Different Languages

Java

```
/** Prints a quote from the Plains */
public class War_Eagle
{
    public static void main(String[] args)
    {
        System.out.println ("War Eagle!\n");
    }
}
```

C

```
/* Prints a quote from the Plains */
main()
{
    printf ("War Eagle!\n");
}
```

Ada

```
-- Prints a quote from the Plains
with Ada.Text_IO;
use  Ada.Text_IO;
procedure War_Eagle is
begin
    Put ("War Eagle!");
    New_Line;
end War_Eagle;
```

Perl

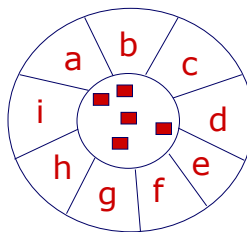
```
# Prints a quote from the Plains
print "War Eagle!", "\n";
```



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Object-Oriented Programming

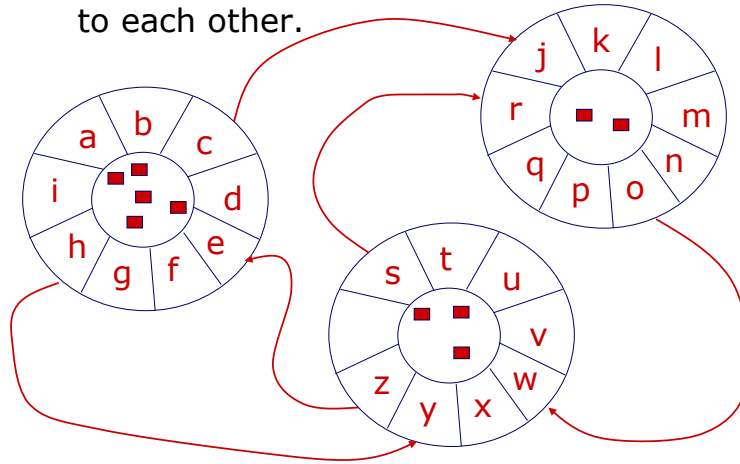
- OOP is a programming world-view in which things in the real world are modeled as software **objects**.
 - An object is really just an **abstraction** of a real-world thing, implemented as an **encapsulation** of private **data** and **methods** (operations on that data).



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Object-Oriented Programming (cont.)

- Objects communicate by sending **messages** to each other.



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Object-Oriented Programming (cont.)

- **Class** = a description of an entire category or group of objects
 - Classes model categories of real world things by describing their "data" and their "operations."

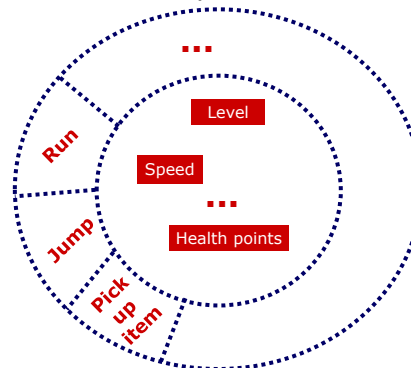
Class Name: GamePlayer

Data:

Level
Speed
Health points

Operations:

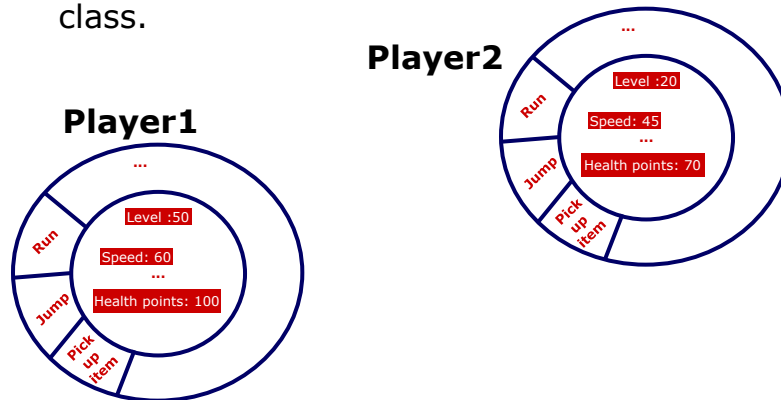
Run
Jump
Pick up item
...



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Object-Oriented Programming (cont.)

- An object is an **instance** of some particular class.

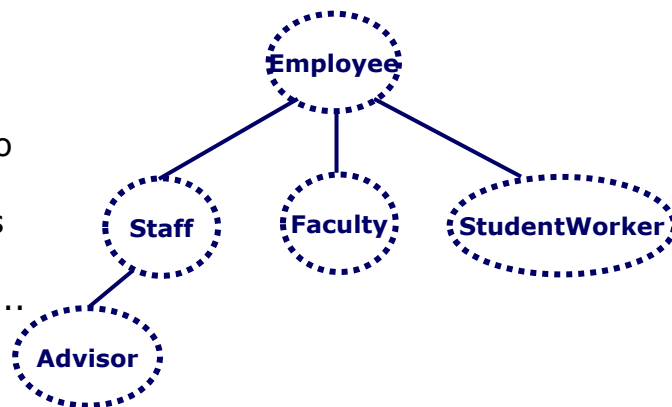


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Object-Oriented Programming (cont.)

- New classes are derived from existing ones through **inheritance**.

Suppose you were creating a program to track employees at Auburn University...



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Object-Oriented Programming (cont.)

- OOP is intended to support software **reuse**.
- **Class libraries** are an important element of this support.
 - Class libraries are sets of classes designed to be reusable components whose services can be used by many programs.
- The Java Application Programming Interface (**API**) is a set of class libraries that comes with the **JDK**.
 - The Java API is organized into **packages** such as `java.awt`, `java.io`, `java.lang`, and `java.net`
 - Example: The `System` class that you use in your output statements is in the `java.lang` package

