Java Basics

Object Orientated Programming in Java

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Outline

- Essential Java Concepts
  - Syntax, Grammar, Formatting, …
  - Encapsulation, Abstract Data, OO Languages,…
- Today's Practical
- Review/Discussion

Last Week

- Compile Java Programs
  - Javac.exe/Java.exe
- Setup IDE
- Basic Programs
  - Hello World
- Simple Debugging
  - e.g., Program entry point, hello worlds, print out (println..)
- Read Chapters 1 & 2

Question

- Java is case sensitive?

- A. True
- B. False

Answer

A. True

Question

- What will be output of x in following code? "class Test{ public static void main(String[] args) { int x = 1; if (x == 1) { x = x + 1} } }"

- A. 0
- B. 1
- C. 2
- D. 3
- E. Compile Error

Answer

- E. Compile Error

Missing semi-colon (;)

Question

- What will be output of x in following code? "class Test{ public static void main(String[] args) { int x = 1; if (x == 1) { x = x + 1;} } }"

- A. 0
- B. 1
- C. 2
- D. 3
- E. Compile Error

Answer

- C. 2

Today

- Exercises from Chapters 2, 4, 5 and 6
  - Data types (boolean, int, string, ..)
  - Loops (while, for, …)
  - Conditional Logic (if, else, switch, ..)
  - Math libraries
  - Arrays
  - Methods (calling and passing parameters)

Pure Object-Oriented Language

- ***Everything in an object***
- A program is a set of objects telling each other what to do by sending messages.
- Each object has its own memory (made up by other objects)
- Every object has a type
- All objects of a specific type can receive the same messages

Java breaks some of these rules in the name of efficiency

Object Concept

- An object is an *encapsulation* of data
- An object has
  - identity (a unique reference),
  - state, also called characteristics
  - behavior
- An object is an instance of an *abstract data type*
- An abstract data type is implemented via a *class*

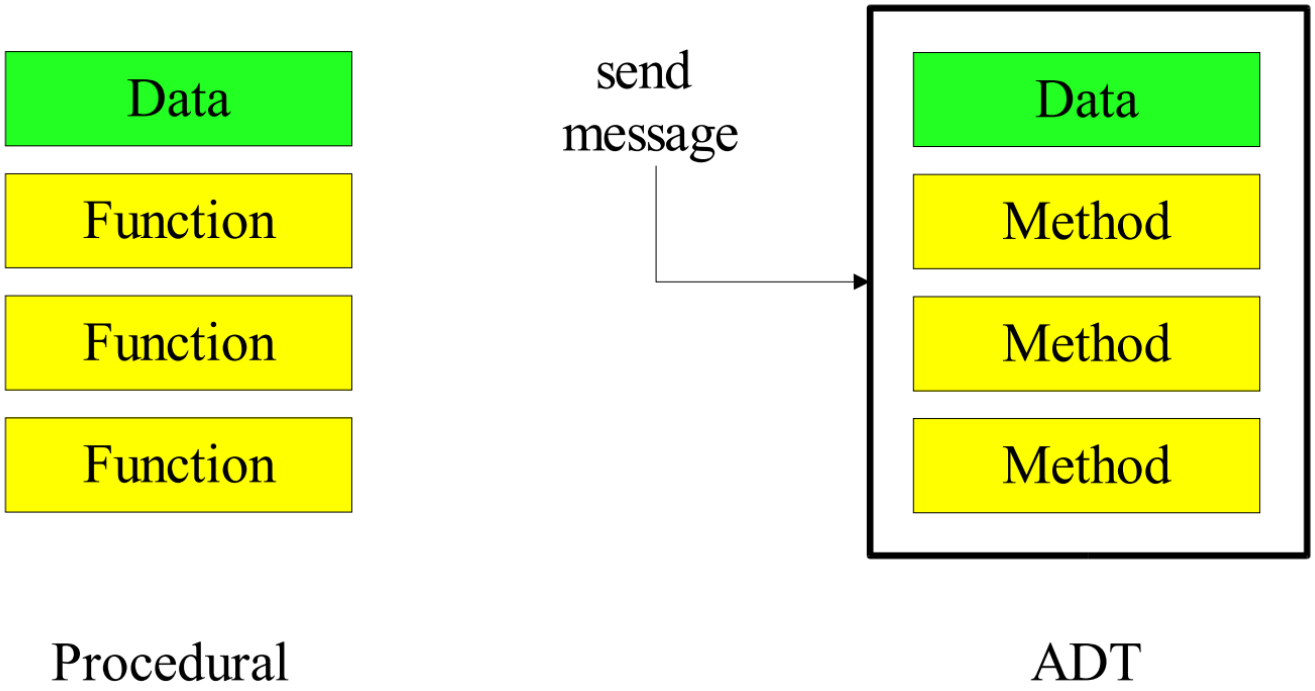
Abstract Data Type (ADT)

- An ADT is a *collection* of objects (or values) and a corresponding set of methods
- An ADT *encapsulates the data* representation and makes data access possible at a higher level of abstraction

- Example 1: A set of vehicles with operations for starting, stopping, driving, get km/litre, etc
- Example 2: A time interval, start time, end time, duration, overlapping intervals, etc

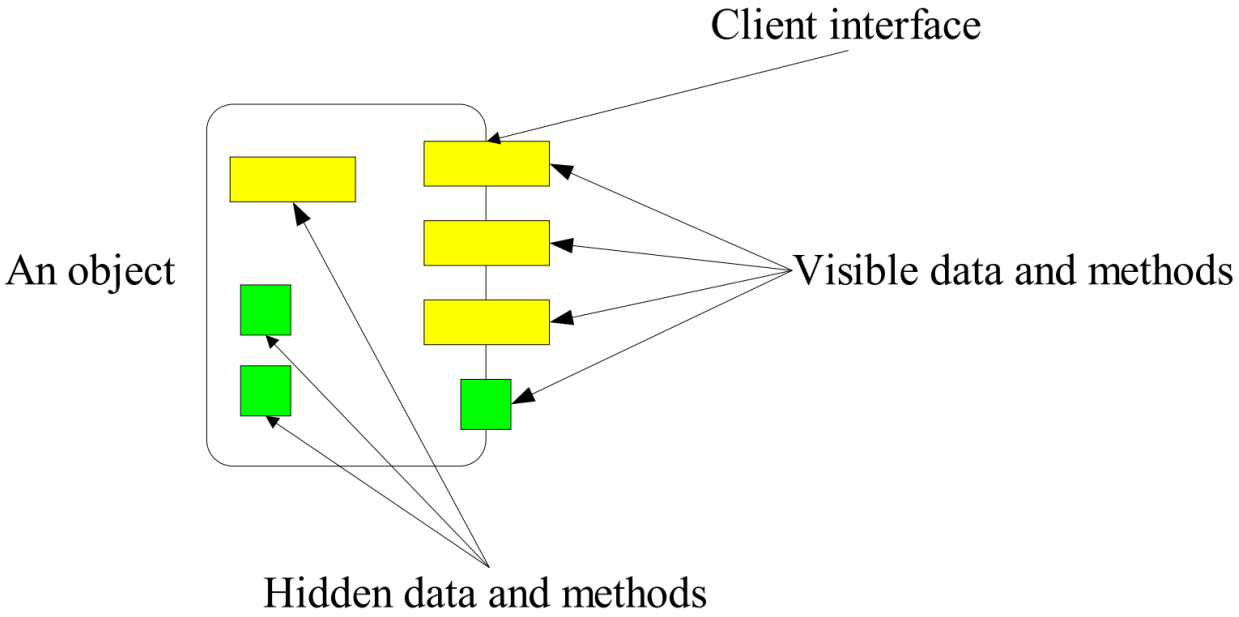
Encapsulation and Information Hiding

- Data can be encapsulated such that it is *invisible to the "outside world"*
- Data can only be *accessed via methods*



Encapsulation and Information Hiding

- What the "outside world" cannot see it cannot depend on!
- The object is a "fire-wall" between the object and the "outside world"
- The *hidden data and methods can be changed without affecting the "outside world"*



Class vs. Object

Class

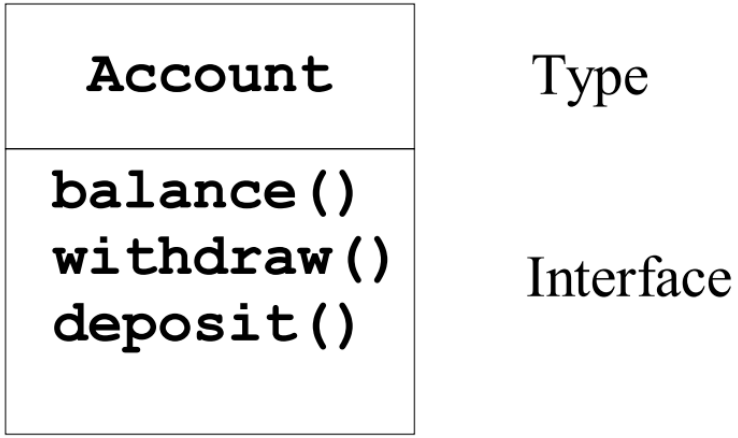
- A description of the *common properties* of a set of objects
- A concept
- A class is a part of a program
- Example 1: Person
- Example 2: Album

Object

- A representation of the *properties* of a single *instance*
- A phenomenon
- An object is part of data and a program execution
- Example 1: Bill Clinton, Bono, Viggo Jensen
- Example 2: A Hard Day's Night, Joshua Tree

Type and Interface

- An object has type and an interface



- To get an object: *Account a = new Account()*
- To send a message: *a.withdraw()*

Instantiating Classes

- An instantiation is a mechanism where objects are created from a class
- Always involves storage allocation for the object
- A mechanism where objects are given an initial state

Static Instantiating

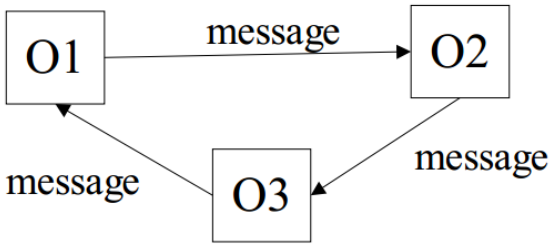
- In the declaration part of a program
- A static instance is *implicitly created*

Dynamic Instantiating

- In the method part of a program
- A dynamic instance is *created explicitly* with a special command

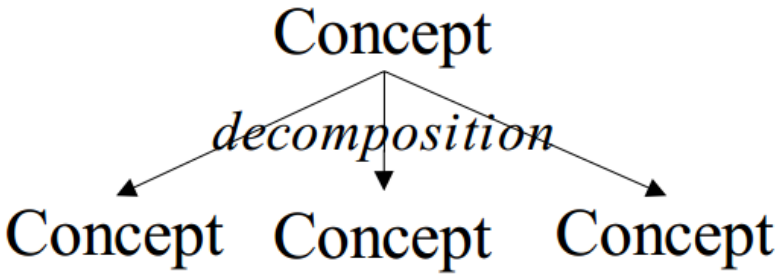
Interaction between Objects

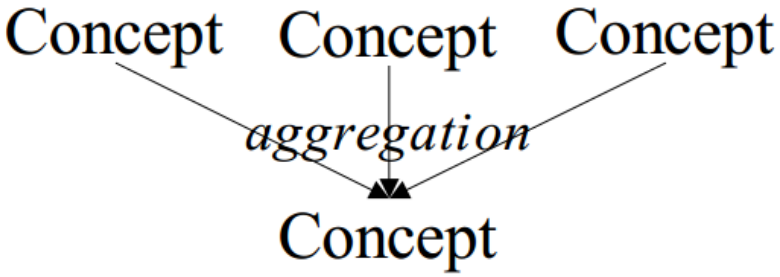
- *Interaction between objects* happens by *messages* being send
  - A message activates a method on the calling object
- An object O1 interacts with another object O2 by calling a method on O2 (must be part of the client interface).
  - "O1 sends O2 a message"
- The call of a method corresponds to a procedure call in a non object-oriented language such as C or Pascal



Aggregation and Decomposition

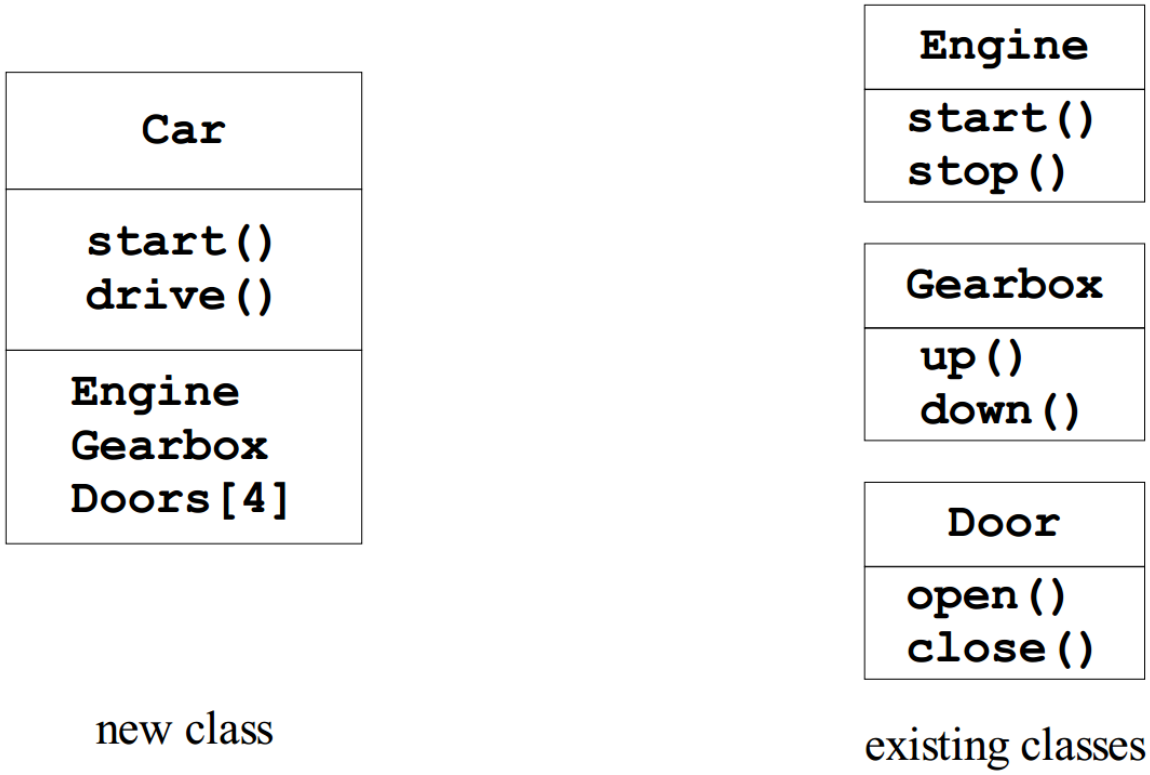
- An aggregation consists of a number of (sub-)concepts which collectively is considered a new concept
- A decomposition splits a single concept into a number of (sub-)concepts





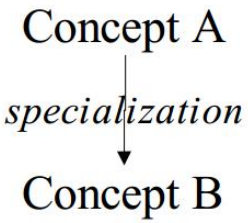
Aggregation and Decomposition, Example

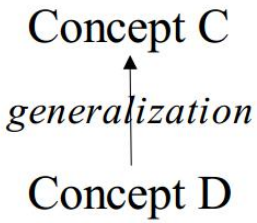
- Idea: make new objects by combining existing objects.
- Reusing the implementation

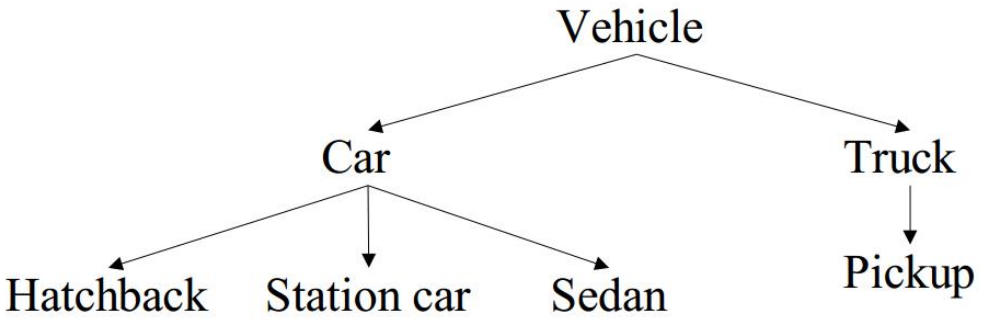


Generalization and Specialization

- Generalization creates a concept with a broader scope.
- Specialization creates a concept with a narrower scope.
- Reusing the interface

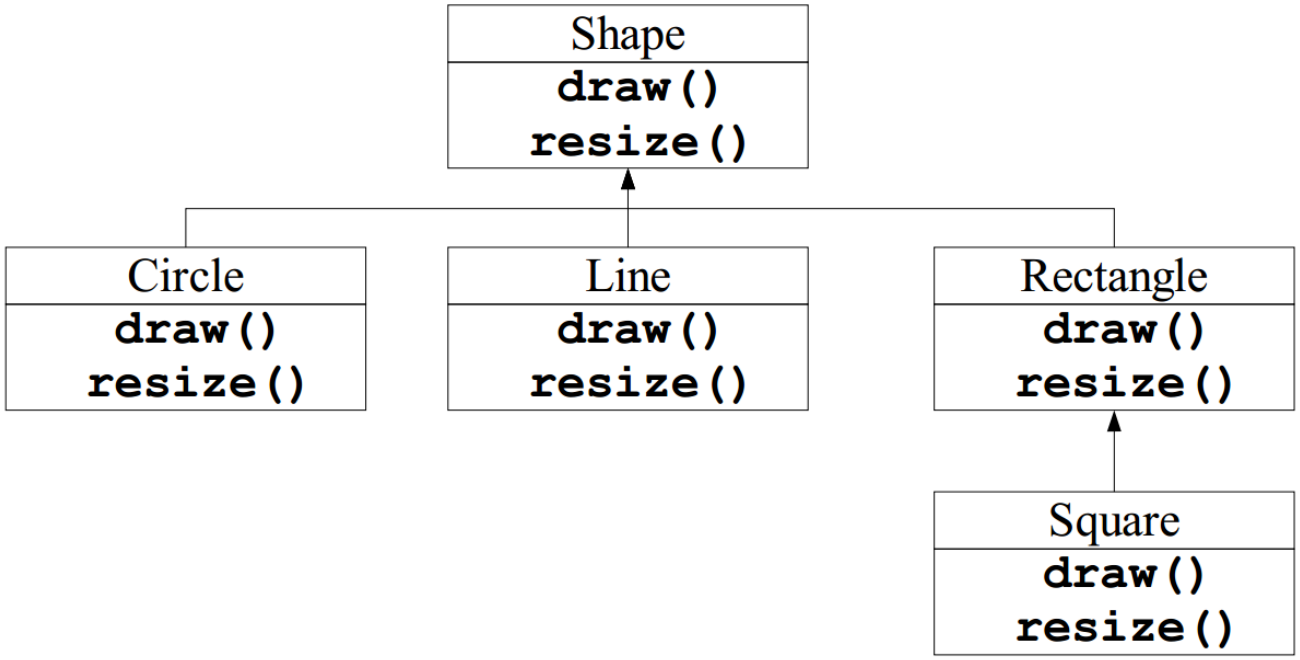






Generalization and Specialization, Example

- Inheritance: get the interface from the general class
- Objects related by inheritance are all of the same type



Code Example

- Polymorphism: One piece of code works with all shape objects.
- Dynamic binding: How polymorphism is implemented

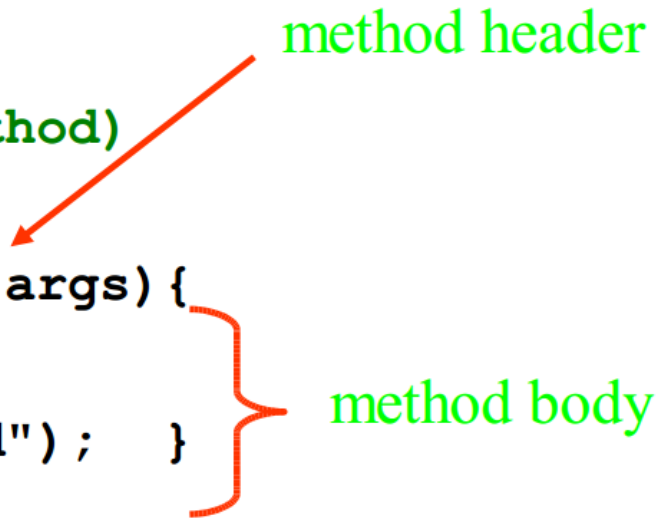
```
void doSomething(Shape s){
  s.draw();  // "magically" calls on specific class
  s.resize();
}
Circle c = new Circle();
Line l = new Line();
Rectangle r = new Rectangle();

doSomething(c);          // dynamic binding
doSomething(l);
doSomething(r);
```

Structuring by Program or Data?

- What are the actions of the program vs. which data does the program act on
  - Top-down: Stepwise program refinement
  - Bottom-up: Focus on the stable data parts then add methods
- Object-oriented programming is bottom-up. Programs are structure with outset in the data
- C and Pascal programs are typically implemented in a more top-down fashion

Review Java Program Structure

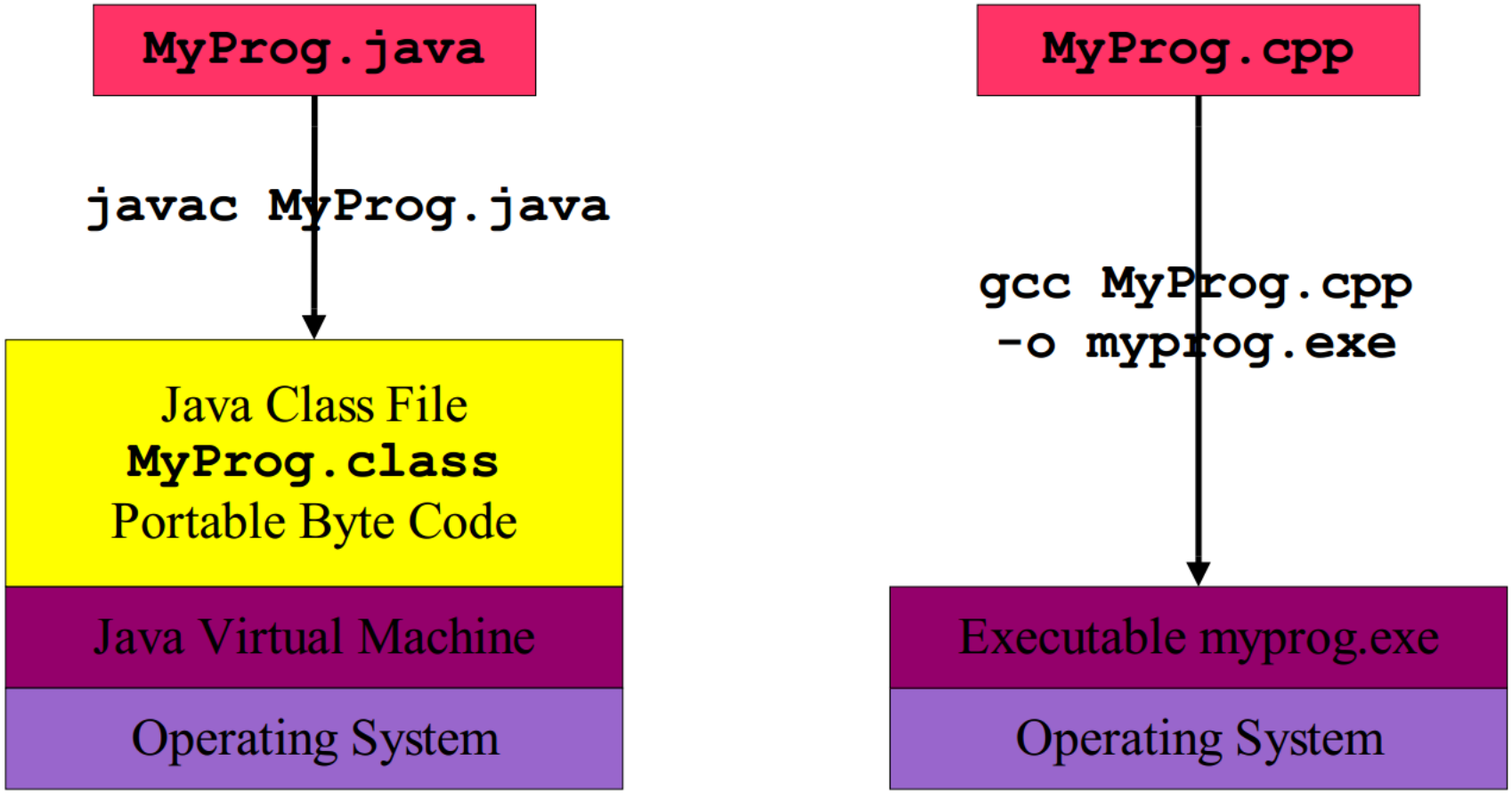
```
// comment on the class
public class MyProg {
   String s = ”Viggo”;

   /**
    * The main method (comment on method)
    */
   public static void main (String[] args){
     // just write some stuff
     System.out.println ("Hello World");   }
}
```



Java Class Example Car

```
/** A simple class modeling a car. */
public class Car {
    // instance variables
    private String make;  private String model;
    private double price;
    // String representation of the car
    public Car(String m, String mo, double p) {
        make = m; model = mo; price = p;
    }
    // String representation of the car
    public String toString() {
        return "make: " + make + " model: "
         + model + " price: " + price;
    }
}
```

Byte Code vs. Executable



Difference from **C**/C++

- Everything resides in a class
  - ▷variables and methods
- Garbage collection
- Error and exception handling
- No global variables or methods
- No local static variables
- No separation of declaration and implementation (no header files).
- No explicit pointer operations (uses references)
- No pre-processor (but something similar)
- Has fewer "dark corners"
- Has a much larger standard library

Review Concepts

- Classes are "recipes" for creating objects
- All objects are instances of classes
- An ADT is implemented in a class
- Aggregation and decomposition
  - “has-a” relationship
- Generalization and specialization
  - “is-a” or “is-like-a” relationship
- Encapsulation
  - Key feature of object-oriented programming
  - Separation of interface from implementation
  - It is not possible to access the private parts of an object

This Week

- Read Chapters 3, 4, 5, 6
- Review Slides
- Complete Java Chapter Exercises
  - Practical Exercises
- Review `Quizzes'

Summary

- Overview Essential Java Principles
- Hands-On/Practical
- Today is about becoming comfortable/familiar with Java and the Programming Syntax/Concepts

Questions/Discussion