Java Basics

Object Orientated Programming in Java

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Outline

- Essential Java Concepts
  - Syntax, Grammar, Formatting, …
  - Introduce Object-Orientated Concepts
    - 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 is 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*

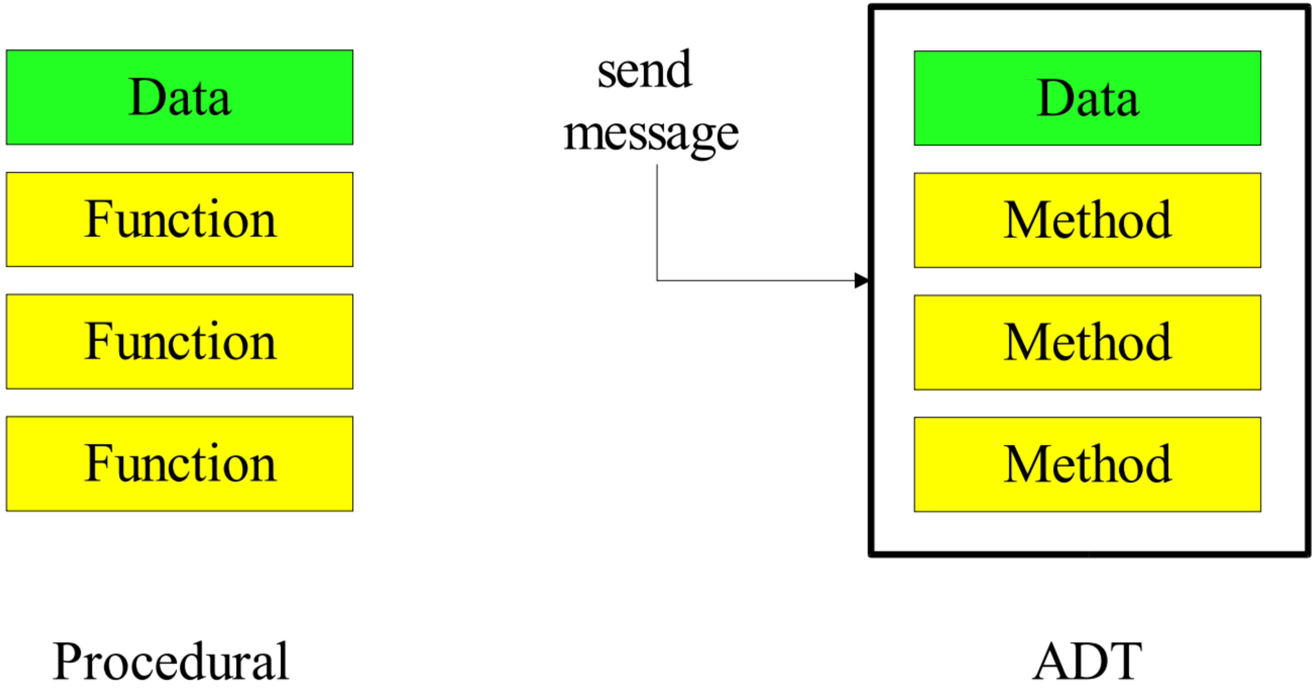
Abstract Data Type (ADT)

- 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

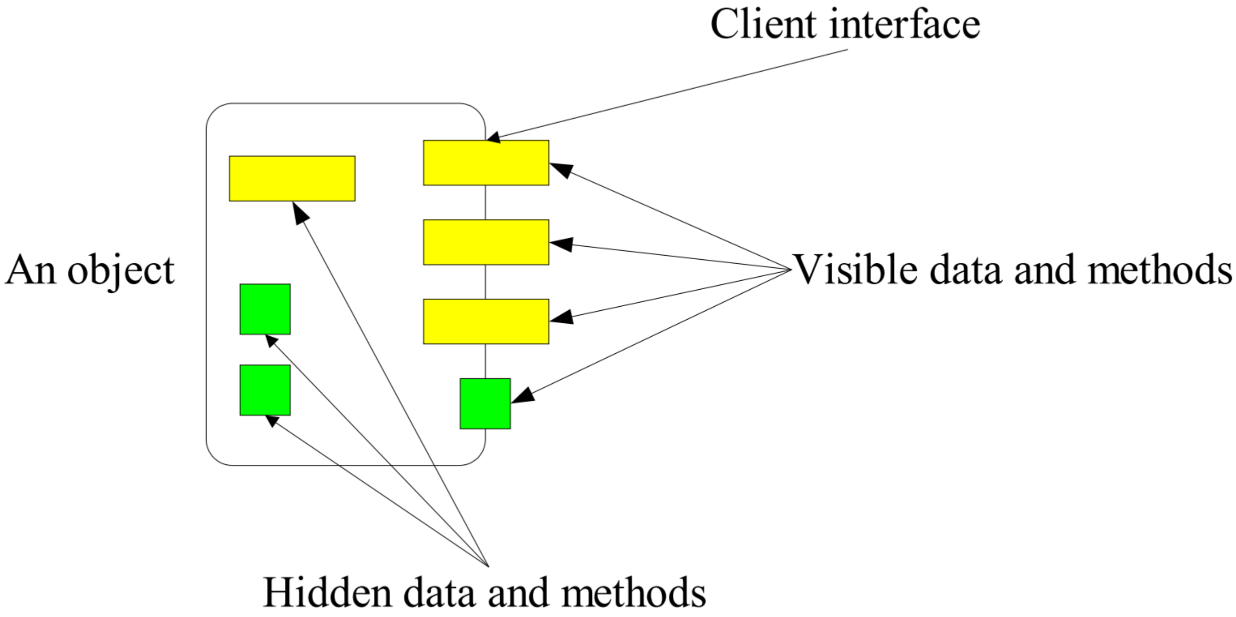
Encapsulation and Information Hiding

- 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!
- "*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

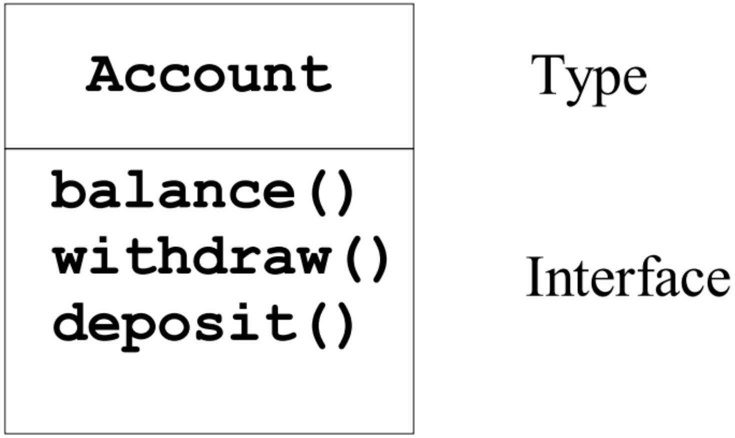
- A description of the *common properties* of a set of objects
- A concept
- A *class* is a part of a program
- Example 1: Person
- Example 2: Album

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



Account

balance()
withdraw()
deposit()

Type

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

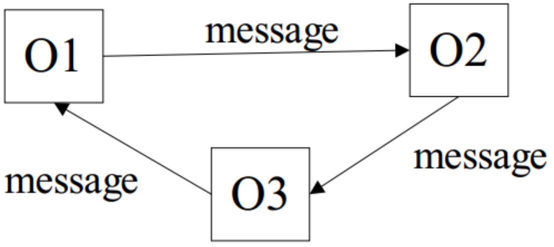
- In the declaration part of a program
- A static instance is *implicitly created*

Dynamic Instantiating

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

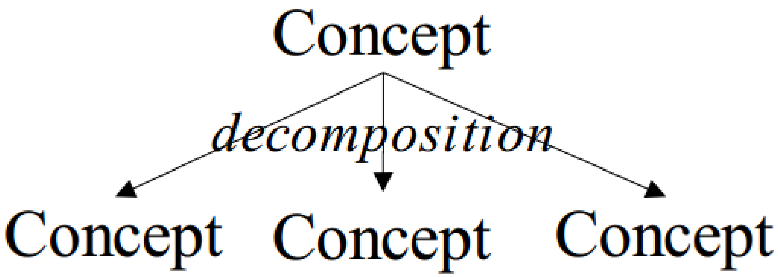
Interaction between Objects

- *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
  - ▷"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

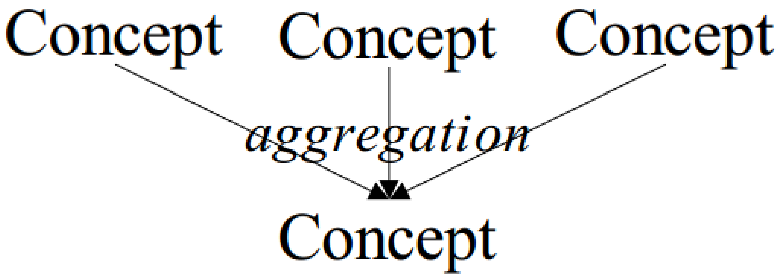
- A *decomposition* splits a single concept into a number of (sub-)concepts
- An *aggregation* consists of a number of (sub-)concepts which collectively is considered a new concept



Concept

decomposition

Concept Concept Concept



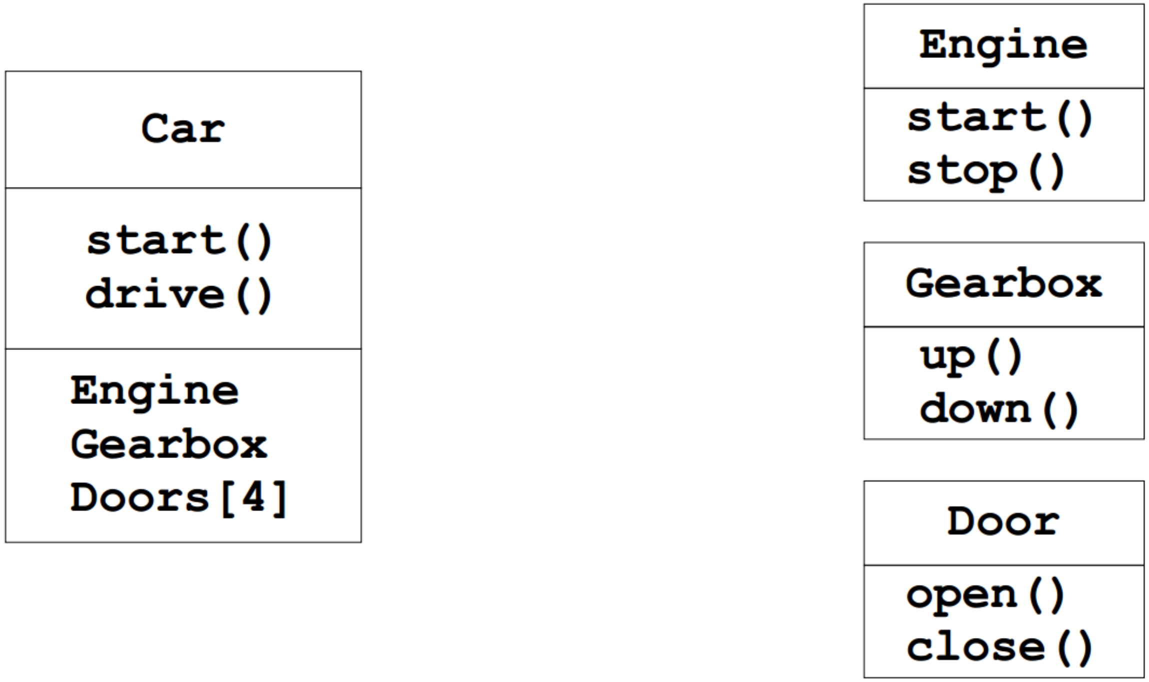
Concept Concept Concept

aggregation

Concept

Aggregation and Decomposition, Example

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



Car

start()
drive()

Engine
Gearbox
Doors[4]

Engine

start()
stop()

Gearbox

up()
down()

Door

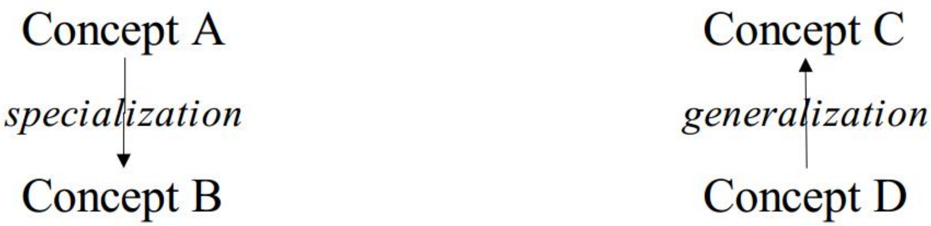
open()
close()

new class

existing classes

Generalization and Specialization

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



Concept A

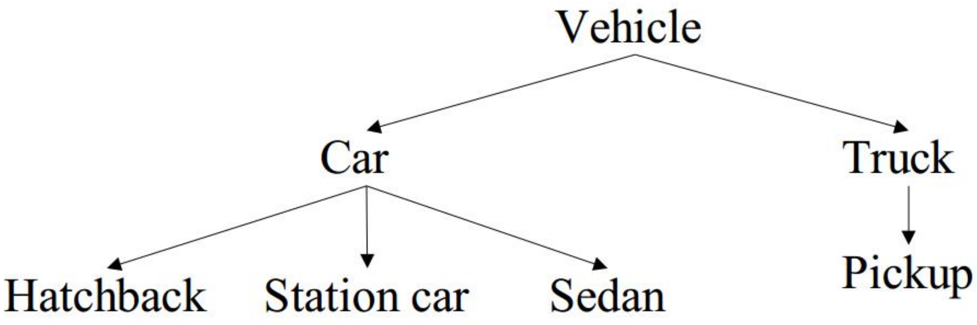
specialization

Concept B

Concept C

generalization

Concept D



Vehicle

Car

Truck

Hatchback

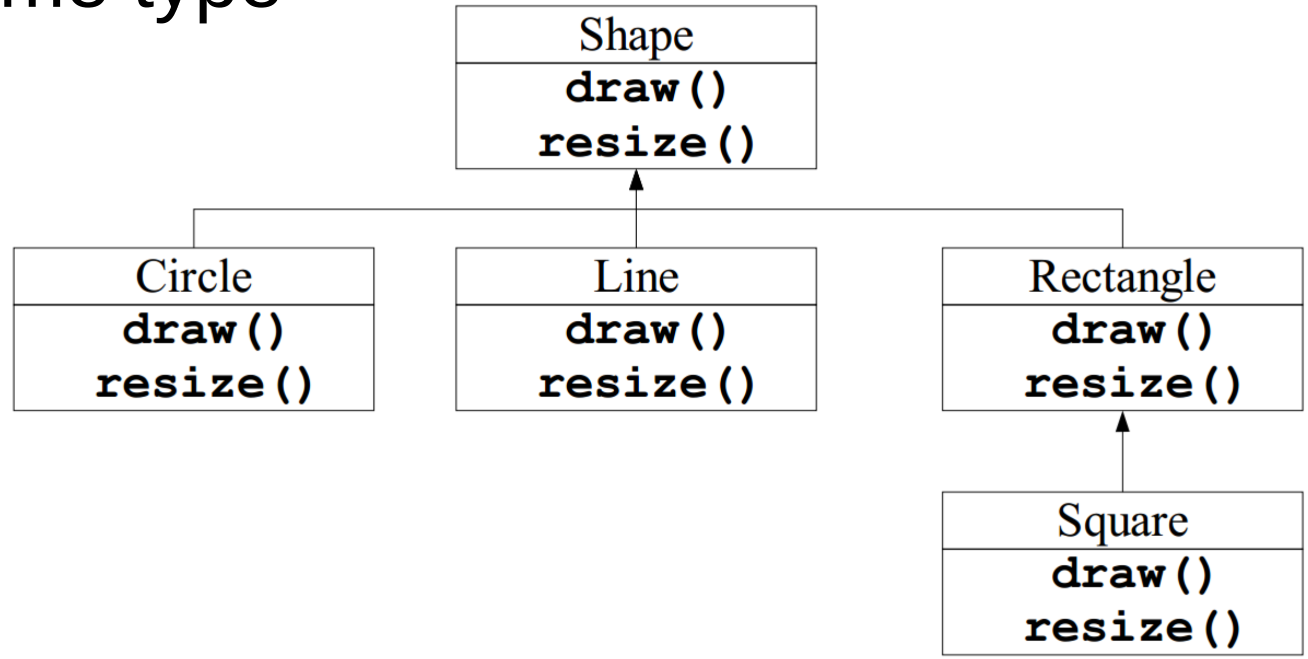
Station car

Sedan

Pickup

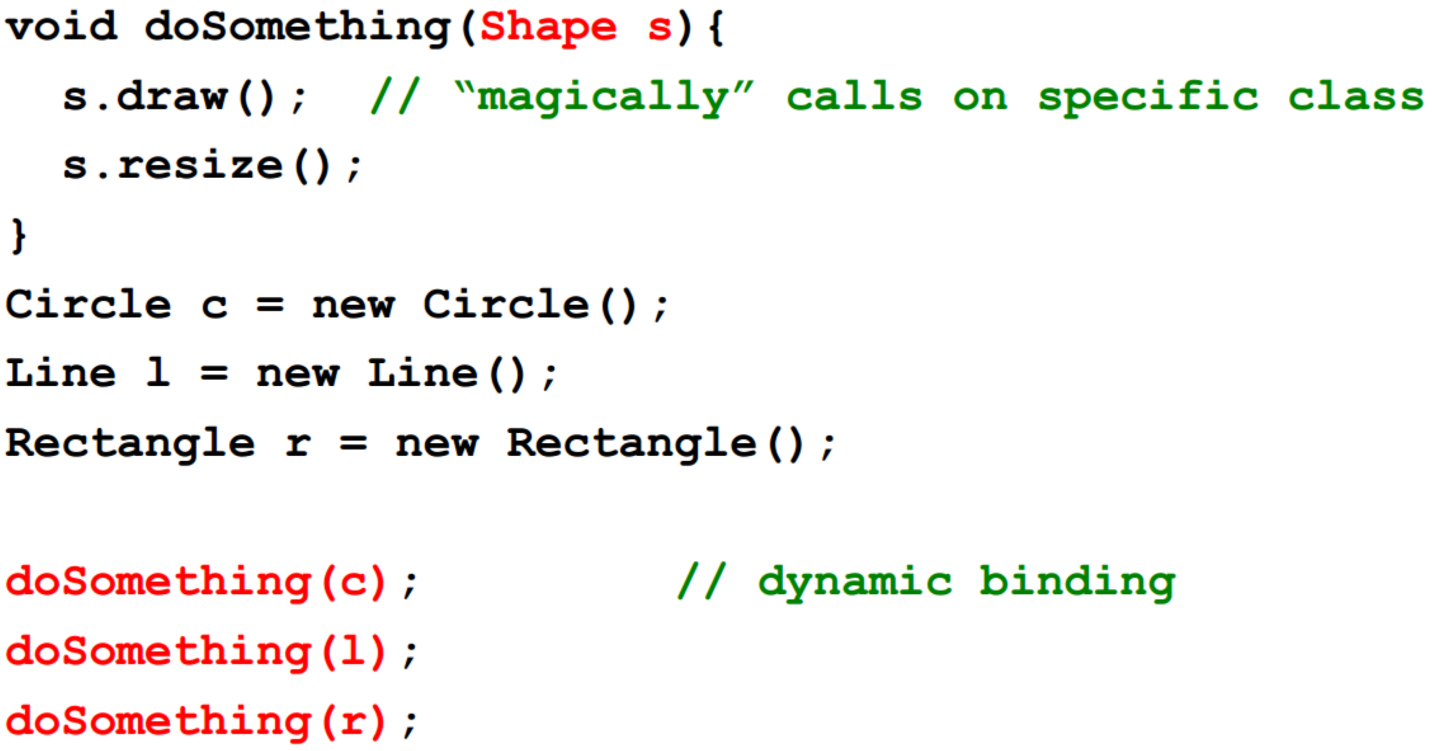
Generalization and Specialization, Example

- *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

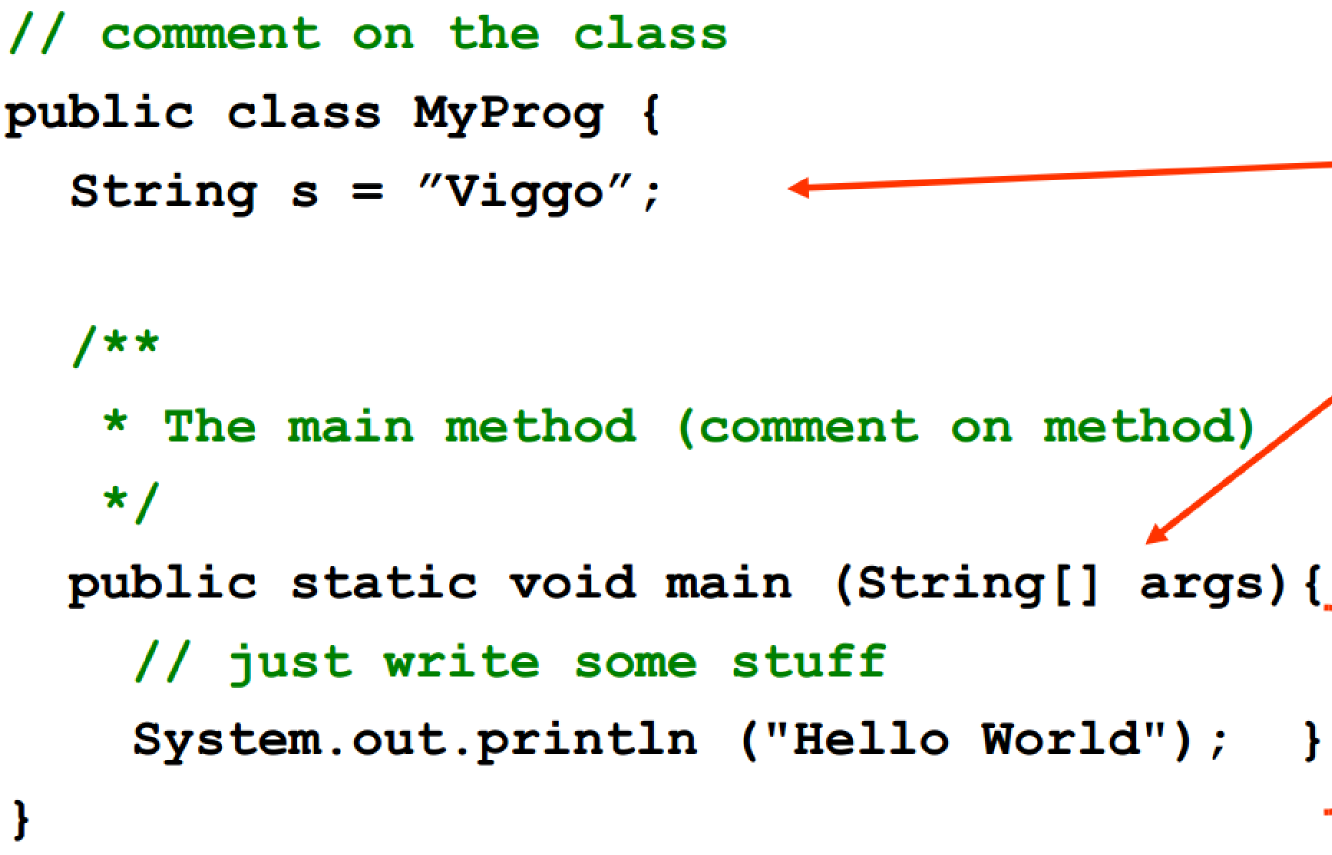


```
void doSomething(Shape s){
  s.draw();  // “magically” calls on specific class
  s.resize();
}
Circle c = new Circle();
Line l = new Line();
Rectangle r = new Rectangle();

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



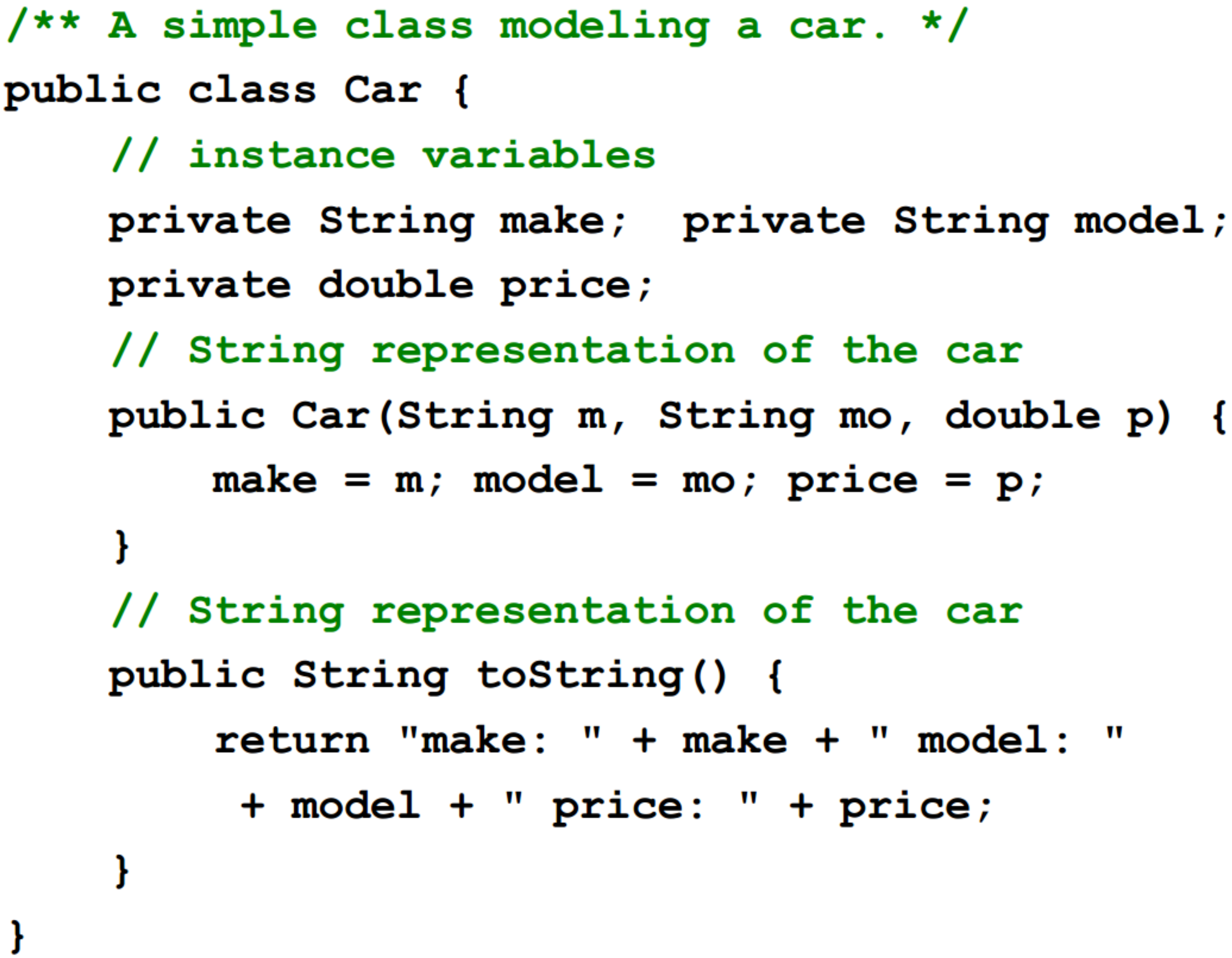
```
// comment on the class
public class MyProg {
  String s = ”Viggo”;

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

variable

method header

method body

Java Class Example Car



```java
/** 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;
    }
}
```

Question

- Is Java a `top-down’ or `bottom-up’ programming language?

- A. `top-down’
- B. `bottom-up’

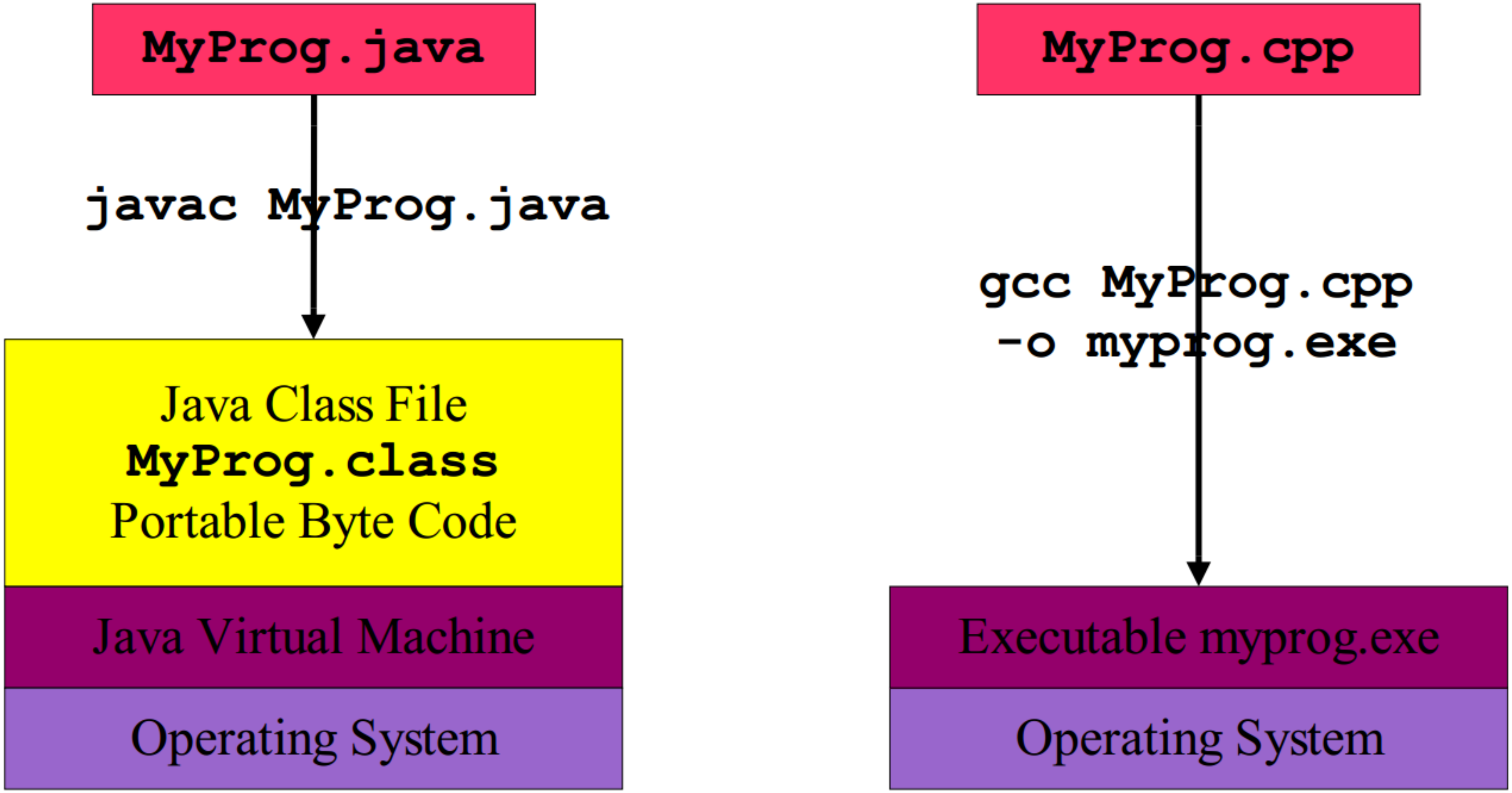
Answer

- B. `bottom-up’

Object-oriented programming is bottom-up. Programs are structure with outset in the data

In OOP, you first write a base class, and constantly derive new child classes from the existing base one (like a Car class will probably derive from a class called Vehicle). So, you start from the basic blocks and go on making it a more complex design.

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

Question

- What displays from the following statements? String word = "abcde"; for (int i = 0; i <4; i+=2) System.out.print(word.charAt(i));

A. ab

B. ac

C. ace

D. bd

// access characters in a String using charAt(i)
similar to word[i] in C language

Answer

- B. ac

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
  - Submit Exercises
- Review `Quizzes’

Summary

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

Questions/Discussion

- Submit Exercise Questions

- 2.1 to 2.12

- Single .zip file with your student number
- Remember to comment your code, name/student number at the top of files, separate file for each exercise
- ch2_1.java, ch2_2.java, …