Classes/Objects/Interfaces (Savitch, Various Chapters)

TOPICS

- Classes
- Public versus Private
- Static Data
- Static Methods
- Interfaces

Classes

- Classes are the basis of object-oriented (OO) programming.
- They *encapsulate* functionality to form powerful *abstractions* of real world objects.
- What can classes be used for? Classes have many different uses, for example:
  - Data Structures
  - Code Libraries
  - Java Programs
  - Complex Objects

Classes as Data Structures

- Just like a *struct* in C and C++ (no code), for example:

```
public class Student {
    public String firstName;
    public String lastName;
    public Date birthDate;
    public Address homeAddress;
    public double gradePointAverage;
}
```


Classes as Code Libraries

- Just like a *library* in a procedural language (no data) like C or C++, for example:

```
public class Math {
    public static final double PI = 3.14159;
    public static double sin(double a) {…}
    public static double exp(double a) {…}
    public static double log(double a) {…}
    public static double sqrt(double a) {…}
}
```

Classes as Small Programs

- Just like a *program* in a procedural language like C or C++, for example:

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


Classes as Large Programs

- Just like a *program* in a procedural language like C or C++, for example:

```
public class MyLargeProgram{
    // lots of data
    public static void main(String args[]) {
        // lots of code
    }
    // lots of methods
}
```


Classes as Complex Objects

- No comparable example in a procedural language like C or Pascal!

```
public class MyClass {
    // class variables (static)
    // instance variables (non-static)
    // no main method
    // class methods (static)
    // instance methods (non-static)
}
```


Using Different Class Types

```
// Data Structure
Student students[] = new Student[100];
students[0].firstName = "Christopher";
// Code Library
System.out.println(Math.sin(1.0));
// Java Programs
$ java MySmallProgram
// Complex Objects
MyClass myClass = new MyClass();
myClass.initialize();
```

Public versus Private

- `public`
  - Can access the class, method, or data by name outside defining class
- `private`
  - Can access the class, method, or data by name only inside defining class
- Classes generally specified as `public`
- Instance variables usually are `private`
- Methods can be `public` or `private`

Static (versus non-Static)

- Local data resides in a method, class and instance data resides in the class.
- Data defined in the class can be of two types:
  - Data may belong to the class (only one copy that has the same value for all objects of that class)
  - Data may belong to the object (separate storage and different values for each instance)
- Class data is identified by `static`
- Instance data is not be `static`

Class versus Instance: Data

```
public class MyClass {
   static int int0;
   double real0;
}
```

•*int0* resides in the class (1 copy), use class name to access: `MyClass.int0 = 123;`

•*real0* resides in an instance (many copies):

```
MyClass m = new MyClass;
m.real0 = 1.234;
```


Class Methods

- Notation: class.method()
- Does not require instantiation, should be called using the class name.
- Class name is not necessary if within the class itself.
- Marked as static, and cannot access instance data, since no instance is used to call them.
- Useful for library methods that do not need any associated data: for example `Math.sin();`

Instance Methods

- Notation: objectname.method()
- Must be called on an object instantiated from a class.
- Most objects are instantiated with the new keyword: String word = new String("Whatever");
- For example, calling word.length() requires an object of type String called word.
- The length() method uses the data for the specific instance it is called on.

Constructors

- Q: How to initialize instance data when creating an object? A: Use a constructor.
- Constructors are used to create objects and send them data.
- Always named after the class, arbitrary parameters, but no return value!
- Example:

```
Scanner s = new Scanner(System.in);
```


Methods inside a class

- Order of writing methods is arbitrary
  - Generally constructors are written first.
- What if two methods need to share data?
  - Can pass data around as parameters and return values.
  - Alternative: specifying class or instance data allows access from multiple methods.

Encapsulation

- Consider example of driving a car
  - We see and use break pedal, accelerator pedal, steering wheel – we know <u>what</u> they do.
  - We do <u>not</u> see mechanical details of <u>how</u> they do their jobs.
- We can divide class definition into different parts to support <u>encapsulation</u>:
  - Class interface
  - Class implementation

Interface/Implementation

- A *class interface*
  - Tells the user or programmer <u>what</u> the class does
  - Gives headings for public methods and comments about them
- A *class implementation*
  - Contains private variables
  - Includes definitions of public and private methods, i.e. <u>how</u> the class does what it does

Interfaces

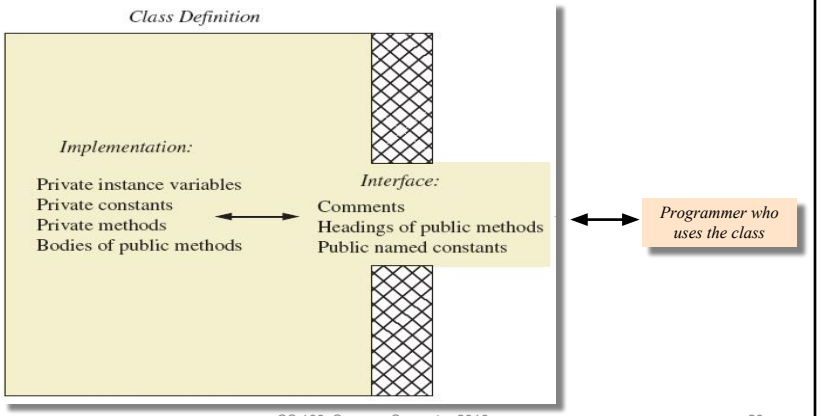
- Interface definition is pure functionality, a set of methods and a description of what they do (Javadoc).
- Instance variables in the class usually are declared as private to prevent direct access.
- Provide public accessor (getter) methods to read data.
- Provide public mutator (setter) methods to write data.
- Add comments before each public method heading that fully specifies how to use method.
- Hide everything else: data structures, helper methods, algorithms - all implementation details.

Interface Example

```
public interface Trigonometry {
    public double sin(double angle);
    public double cos(double angle);
    public double tan(double angle);
}
public class Math implements Trigonometry {
    public double sin(double angle) { … code … }
    public double cos(double angle) { … code … }
    public double tan(double angle) { … code … }
}
Trigonometry trig = new Math();
```


Encapsulation/Interfaces

A well encapsulated class definition:



Why Interfaces?

- Interfaces are pure functionality, a designer can specify <u>what</u> the software does without worrying about <u>how</u>.
- Provides a methodology for partitioning large systems without having to consider all of the details.
- Interfaces can (and should) be designed based on user requirements and the intended functionality.
- Interfaces hide implementation details, user of class does not need to see internal code or data structures.
- Allows shipment of class files to protect intellectual property while still communicating functionality.