

7A. Object-Oriented Design I

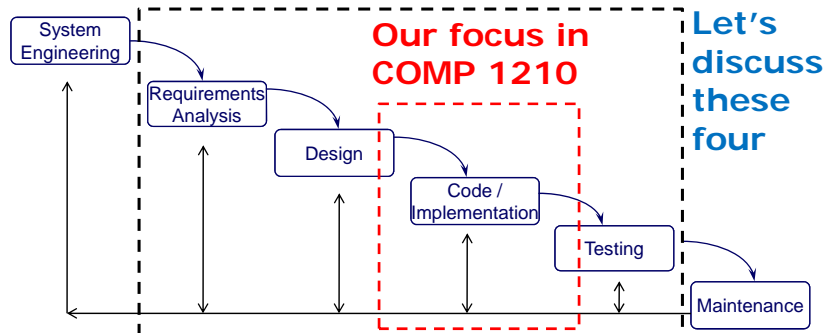
- Objectives - when we have completed this set of lecture notes, you should be familiar with:
 - Software development activities
 - determining the classes and objects that are needed for a program
 - the relationships that can exist among classes
 - the static modifier

Program Development

- The creation of software involves five basic activities plus maintenance:
 - Establishing **system** hardware/software boundaries and interfaces (especially for embedded systems)
 - Establishing/analyzing the **requirements**
 - creating a **design**
 - implementing the **code**
 - **testing** the implementation
 - **Maintaining** the software after delivery

Program Development

- The activities below can be linear, can overlap/interact, or can be naturally cyclical



- Many variants of the process model

Requirements

- Software requirements* specify the tasks that a program must accomplish
 - what to do (not how to do it)
- Translating what the customer wants into what the software should accomplish.
- Sample customer requirement: "I need a program that will provide interoperability between disparate C4ISR systems." (concept of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance)
 - It's not time to start coding yet.

Requirements

- A simple requirement: "I want something to check products against their barcodes."
 - Realistically, the customer would buy existing software.
- A partial requirements document:

The user must be allowed to specify each product by its primary characteristics, including its name and product number. If the bar code does not match the product, then an error should be generated to the message window and entered into the error log. The summary report of all transactions must be structured as specified in section 7.A.

Design

- *Software design*: how a program will accomplish its requirements.
- An object-oriented design:
 - Classes, methods, and data needed
 - Relationships between classes
 - How information will be stored (databases)
 - Etc.
- Your project descriptions in lab contain both the requirements and design details.

Implementation/Code

- *Implementation*: turning design into source code
- Novice programmers often think that writing code is the heart of software development, but actually it may be the **least creative step**
 - The important decisions were made during requirements and design stages
- Implementation focuses on coding and fine-grained design as well as style guidelines (Checkstyle) and documentation (Javadoc comments)

Testing

- *Testing* attempts to ensure that the program will solve the intended problem
 - A program should be thoroughly tested with the goal of finding errors/defects
- *Testing* discovers errors or defects; *debugging* locates and corrects/removes them
- We'll discuss the details of the testing process later in the lecture notes
- You will perform implementation and testing; Web-CAT decides how well your own testing was carried out as well run additional tests

Object-Oriented Design and Programming

- Objects and attributes are generally nouns, and methods are generally verbs

The **user** must be allowed to specify each **product** by its primary **characteristics**, including its **name** and **product number**. If the **bar code** does not match the **product**, then an **error** should be generated to the **message window** and entered into the **error log**. The **summary report** of all **transactions** must be structured as specified in section 7.A.

Identifying Classes and Objects

- Generally, classes that represent objects should be given names that are singular nouns
 - Class: Product
 - Attributes: name, product number, barcode
- We are free to instantiate as many of each objects as needed

Identifying Classes and Objects

- When a class becomes too complex, it often should be decomposed into multiple smaller classes to distribute the responsibilities

- **Class: Product**

- Attributes: name, product number, barcode



Might be complex enough to warrant a separate class

- **Class: Product**

- Attributes: name, product number, barcode

- **Class: Barcode**

- Attributes: version, format, data, visual representation, etc

Static Class Members

- Static methods are invoked using the class name

Example: `result = Math.sqrt(25)`

- Suppose that you name `getName` a static method in a `Person` class; what name would `Person.getName()` retrieve?
- **Static methods cannot access instance variables.**
 - An object of the class does not have to be instantiated to invoke static methods.

Static Methods

```
public class Helper
{
    public static int cube (int num)
    {
        return num * num * num;
    }
}
```

Because it is declared as static, the method can be invoked as

```
value = Helper.cube(5);
```

Static Variables

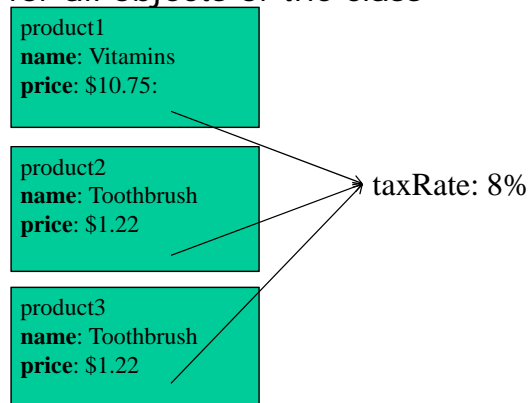
- If a variable is declared as static, it exists at the class level rather than for each instance

```
private static float taxRate;
```

- Space is reserved in memory when the class is first referenced
- A static variable is the same for all instances of the class (i.e., it is shared among the instances) and it is accessible from all instance methods in the class
- If the value of a variable needs to be unique for each object, then it should **not** be static.

Static Variables

- In this case the `taxRate` is the same for all objects; changing the static variable changes it for all objects of the class



The *static* Modifier

- Static methods are called *class methods* and static variables are also called *class variables*
- Instance methods can reference instance variables and static variables
- Static methods can only access static variables
- Before you declare any variable as static, consider the following:
 - Should the value of the variable be the same for all objects?
 - If I change the value of the variable, should it change for all other objects as well?



Static Class Members

- Static methods and static variables often work together
- The following example keeps track of how many **Magazine** objects have been created using a static variable, and makes that information available using a static method
- See [Magazine.java](#) and [MagazineExample.java](#)
- See [StaticExample.java](#)

Class Relationships

- Three of the most common relationships between two classes:
 - Dependency (**general**): A *uses* B
 - Aggregation: A *has-a* B
 - Inheritance: A *is-a* B (introduced in later in the course)
- General dependency: The ProductList class uses the DecimalFormat class for formatting
- Aggregation: The ProductList class **has a** set of Products (aggregation)

Dependency

- General dependency: one class relies on another in some way (usually by invoking methods)
- You don't want a lot of classes with complex dependencies, but you don't want very large, complex classes either
- Some dependencies occur between objects of the same class. Example, the `concat` method of the `String` class takes a `String` parameter

```
str3 = str1.concat(str2);
```

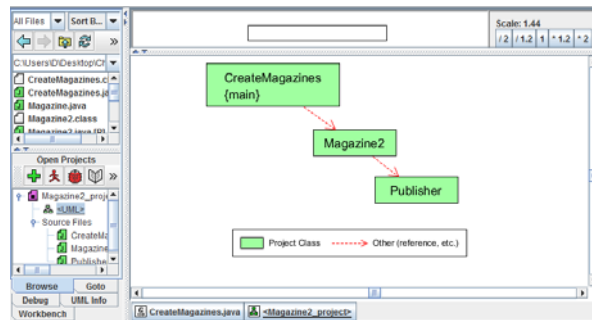
Aggregation

- An *aggregate* is an object that is made up of other objects
- Therefore aggregation is a *has-a* relationship
 - A car *has a* chassis
 - A product *has a* barcode
- An aggregate object contains references to other objects as instance data



Aggregation Dependencies in UML

- Open [Magazine2_project.gpj](#). What type of relationships exist among the three classes?
 - The general dependency and the aggregate relationship are both shown as red arrows.



The this reference

- The `this` reference allows an object to refer to itself
- The constructor of the `Magazine2` class could have been written as follows:

```
public Magazine2(String title, int pages,
                 String publisher, String city)
{
    this.title = title;
    this.pages = pages;
    this.publisher = new Publisher(publisher, city);
    count++;
}
```

Our coding standard requires unique names for parameters, so the `this` reference will generally be optional.