Object-Oriented Design And Software Testing

In this section of notes you will learn about principles of good design as well how testing is an important part of good design

Some Principles Of Good Design

1. Avoid going “method mad”
2. Keep an eye on your parameter lists
3. Minimize modifying immutable objects
4. Be cautious in the use of references
5. Be cautious when writing accessor and mutator methods
6. Consider where you declare local variables

This list was partially derived from “Effective Java” by Joshua Bloch and is by no means complete. It is meant only as a starting point to get students thinking more about why a practice may be regarded as “good” or “bad” style.

1. Avoid Going Method Mad

- There should be a reason for each method
- Creating too many methods makes a class difficult to understand, use and maintain
- A good approach is to check for redundancies that exist between different methods

2. Keep An Eye On Your Parameter Lists

- Avoid long parameter lists
  - Rule of thumb: Three parameters is the maximum
- Avoid distinguishing overloaded methods solely by the order of the parameters

3. Minimize Modifying Immutable Objects

- Immutable objects
- Once instantiated they cannot change (all or nothing)

```
e.g., String s = "hello";
      s = s + " there";
```


3. Minimize Modifying Immutable Objects (2)

- If you must make many changes consider substituting immutable objects with mutable ones

e.g.,

```
public class StringBuffer
{
  public StringBuffer (String str);
  public StringBuffer append (String str);
     :        :            :          :

}
```

For more information about this class

http://java.sun.com/j2se/1.5.0/docs/api/java/lang/StringBuffer.html

3. Minimize Modifying Immutable Objects (3)

```
public class StringExample
{
    public static void main (String [] args)
    {
        String s = "0";
        for (int i = 1; i < 10000; i++)
            s = s + i;
    }
}
```

```
public class StringBufferExample
{
    public static void main (String [] args)
    {
        StringBuffer s = new StringBuffer("0");
        for (int i = 1; i < 10000; i++)
            s = s.append(i);
    }
}
```


4. Be Cautious In The Use Of References

Similar pitfall to using global variables:

```
program globalExample (output);
var
  i : integer;

procedure proc;
begin
  for i:= 1 to 100 do;
end;

begin
  i := 10;
  proc;
end.
```

4. Be Cautious In The Use Of References (2)

```
public class Foo
{
   private int num;
   public int getNum () { return num; }
   public void setNum (int newValue) { num = newValue; }
}
```


4. Be Cautious In The Use Of References (3)

```
public class Driver
{
   public static void main (String [] argv)
   {
      Foo f1, f2;
      f1 = new Foo ();
      f1.setNum(1);

      f2 = f1;
      f2.setNum(2);

      System.out.println(f1.getNum());
      System.out.println(f2.getNum());

   }
}
```

5. Be Cautious When Writing Accessor And Mutator Methods: First Version

```
public class Driver
{
   public static void main (String [] args)
   {
      CreditInfo newAccount = new CreditInfo (10, "James Tam");
      newAccount.setRating(0);
      System.out.println(newAccount);
   }
}
```


5. Be Cautious When Writing Accessor And Mutator Methods: First Version (2)

```
public class CreditInfo
{
   public static final int MIN = 0;
   public static final int MAX = 10;
   private int rating;
   private StringBuffer name;
   public CreditInfo ()
   {
      rating = 5;
      name = new StringBuffer("No name");
   }
   public CreditInfo (int newRating, String newName)
   {
      rating = newRating;
      name = new StringBuffer(newName);
   }

   public int getRating () { return rating;}
```

5. Be Cautious When Writing Accessor And Mutator Methods: First Version (3)

```
public void setRating (int newRating)
{
   if ((newRating >=  MIN) && (newRating <= MAX))
      rating = newRating;
}

public StringBuffer getName ()
{
   return name;
}

public void setName (String newName)
{
   name = new StringBuffer(newName);
}
```


5. Be Cautious When Writing Accessor And Mutator Methods: First Version (4)

```
public String toString ()
{
   String s = new String ();
   s = s + "Name: ";
   if (name != null)
   {
      s = s + name.toString();
   }
   s = s + "\n";
   s = s + "Credit rating: " + rating + "\n";
   return s;
}
} // End of class CreditInfo
```

5. Be Cautious When Writing Accessor And Mutator Methods: Second Version

- (All mutator methods now have private access).

```
public class Driver
{
   public static void main (String [] args)
   {
      CreditInfo newAccount = new CreditInfo (10, "James Tam");

      StringBuffer badGuyName;
      badGuyName = newAccount.getName();

      badGuyName.delete(0, badGuyName.length());
      badGuyName.append("Bad guy on the Internet");

      System.out.println(newAccount);
   }
}
```


5. Be Cautious When Writing Accessor And Mutator Methods: Second Version (2)

```
public class CreditInfo
{
   private int rating;
   private StringBuffer name;

   public CreditInfo ()
   {
      rating = 5;
      name = new StringBuffer("No name");
   }

   public CreditInfo (int newRating, String newName)
   {
      rating = newRating;
      name = new StringBuffer(newName);
   }
```

5. Be Cautious When Writing Accessor And Mutator Methods: Second Version (3)

```
public int getRating ()
{
   return rating;
}
private void setRating (int newRating)
{
   if ((newRating >= 0) && (newRating <= 10))
      rating = newRating;
}
public StringBuffer getName ()
{
   return name;
}
private void setName (String newName)
{
   name = new StringBuffer(newName);
}
```


5. Be Cautious When Writing Accessor And Mutator Methods: Second Version (4)

```
public String toString ()
{
   String s = new String ();
   s = s + "Name: ";
   if (name != null)
   {
      s = s + name.toString();
   }
   s = s + "\n";
   s = s + "Credit rating: " + rating + "\n";
   return s;
}
}
```

5. Be Cautious When Writing Accessor And Mutator Methods: Third Version

```
public class Driver
{
   public static void main (String [] args)
   {
      CreditInfo newAccount = new CreditInfo (10, "James Tam");
      String badGuyName;
      badGuyName = newAccount.getName();

      badGuyName = badGuyName.replaceAll("James Tam", "Bad guy on
          the Internet");
      System.out.println(badGuyName + "\n");
      System.out.println(newAccount);
   }
}
```


5. Be Cautious When Writing Accessor And Mutator Methods: Third Version (2)

```
public class CreditInfo
{
   private int rating;
   private String name;
   public CreditInfo ()
   {
      rating = 5;
      name = "No name";
   }
   public CreditInfo (int newRating, String newName)
   {
      rating = newRating;
      name = newName;
   }
   public int getRating ()
   {
      return rating;
   }
```

5. Be Cautious When Writing Accessor And Mutator Methods: Third Version (3)

```
 private void setRating (int newRating)
{
    if ((newRating >= 0) && (newRating <= 10))
        rating = newRating;
}

public String getName ()
{
    return name;
}

private void setName (String newName)
{
    name = newName;
}
```


5. Be Cautious When Writing Accessor And Mutator Methods: Third Version (4)

```
 public String toString ()
 {
    String s = new String ();
    s = s + "Name: ";
    if (name != null)
    {
        s = s + name;
    }
    s = s + "\n";
    s = s + "Credit rating: " + rating + "\n";
    return s;
 }
}
```

5. Be Cautious When Writing Accessor And Mutator Methods

- When choosing a type for an attribute it comes down to tradeoffs, what are the advantages and disadvantages of using a particular type.
- In the previous examples:
  - Using mutable types (e.g., StringBuffer) provides a speed advantage.
  - Using immutable types (e.g., String) provides additional security

6. Consider Where You Declare Local Variables

- First Approach: Declare all local variables at the beginning of a method:

```
void methodName (..)
{
   // Local variable declarations
   int num;
   char ch;

   // Statements in the method
      :

}
```

Advantage:

- Putting all variable declarations in one place makes them easy to find

6. Consider Where You Declare Local Variables (2)

- Second Approach: declare local variables only as they are needed

```
void methodName (..)
{
  int num;
  num = 10;
     :
  for (int i = 0; i < 10; i++)

}
```

Advantage:

- For long methods it can be hard to remember the declaration if all variables are declared at the beginning
- Reducing the scope of a variable may reduce logic errors

Object-Oriented Design And Testing

- Start by employing a top-down approach to design
  - Start by determining the candidate classes in the system
  - Outline a skeleton for candidate classes (methods are stubs)
- Implement each method one-at-a-time.
- Create test drivers for methods.
- Fix any bugs in these methods
- Add the working methods to the code for the class.

Determine The Candidate Classes

Example:

A utility company provides three types of utilities:

1. Electricity:

   Bill = No. of kilowatt hours used * $0.01

2. Gas:

   Bill = No. of gigajoules used * $7.50

3. Water

   a) Flat rate: $10.00 + (square footage of dwelling * $0.01)

   b) Metered rate: $1.00 * No. cubic of meters used

Determine The Candidate Classes (2)

Some candidate classes

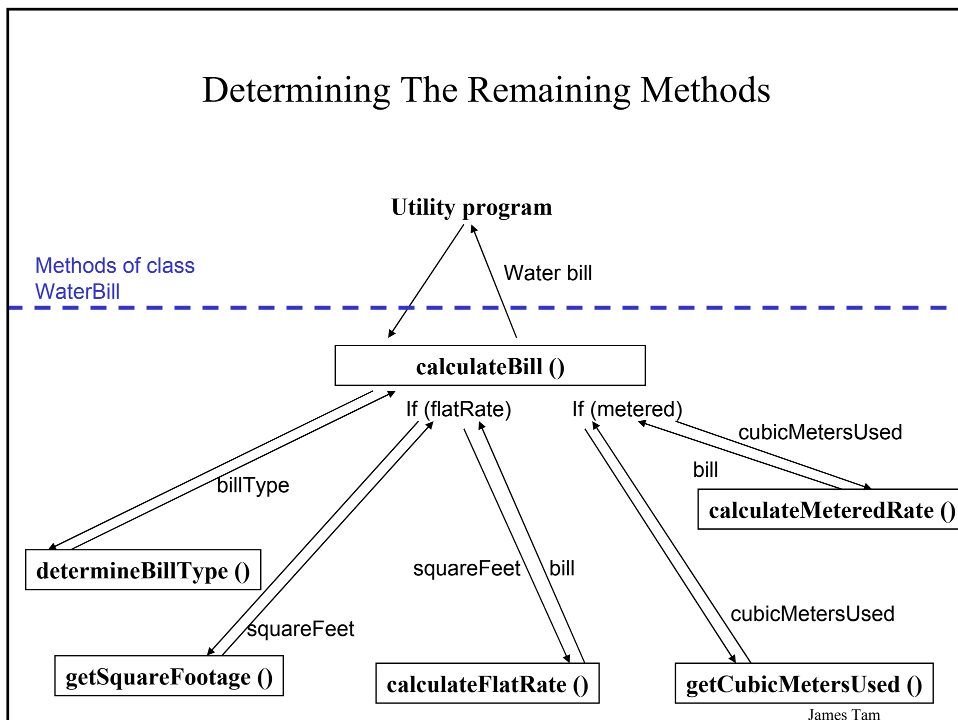
- ElectricityBill
- WaterBill
- GasBill

Skeleton For Class WaterBill

```
public class WaterBill
{
    private char billType;
    private double bill;
    public static final double RATE_PER_SQUARE_FOOT = 0.01;
    public static final double BASE_FLAT_RATE_VALUE = 10.0;
    public static final double RATE_PER_CUBIC_METER = 1.0;

    public WaterBill ()
    {
    }
      :          :          :
```


Determining The Remaining Methods



Remaining Skeleton For Class WaterBill (2)

```
public double calculateBill () { return 1.0;}
public void determineBillType () { }
public int getSquareFootage () { return 1; }
public double calculateFlatRate (int squareFootage) { return 1.0; }
public double getCubicMetersUsed () { return 1.0; }
public double calculateMeteredRate (double cubicMetersUsed) { return 1.0; }
public char getBillType () { return billType; }
```


Implementing The Bodies For The Methods

1. calculateBill
2. getBillType
3. getSquareFootage
4. calculateFlatRate
5. getCubicMetersUsed
6. calculateMeteredRate

Body For Method CalculateBill

```
public double calculateBill ()
{
   int squareFootage;
   double cubicMetersUsed;
   determineBillType();
   if (billType == 'f')
   {
      squareFootage = getSquareFootage ();
      bill = calculateFlatRate (squareFootage);
   }
   else if (billType == 'm')
   {
      cubicMetersUsed = getCubicMetersUsed();
      bill = calculateMeteredRate (cubicMetersUsed);
   }
   else
       System.out.println("Bill must be either based on a flat rate or metered.");
   return bill;
}
```


Body For DetermineBillType

```
public class WaterBill
{
    :      :      :      :
   public void getBillType ()
   {
      System.out.println("Please indicate the method of billing.");
      System.out.println("(f)lat rate");
      System.out.println("(m)etered billing");
      billType = (char) Console.in.readChar();
      Console.in.readLine();
   }
}
```

Creating A Driver To Test DetermineBillType

```
public class Driver
{
    public static void main (String [] args)
    {
        WaterBill test = new WaterBill ();
        char bill;
        test.determineBillType ();
        bill = test.getBillType();
        System.out.println(bill);
    }
}
```


Body For GetSquareFootage

```
public class WaterBill
{
    :      :      :      :
    public int getSquareFootage ()
    {
        int squareFootage;
        System.out.print("Enter square footage of dwelling: ");
        squareFootage = Console.in.readInt();
        Console.in.readLine();
        return squareFootage;
    }
}
```

Creating A Driver To Test GetSquareFootage

```
public class Driver
{
    public static void main (String [] args)
    {
            WaterBill test = new WaterBill ();
            int squareFootage = test.getSquareFootage ();
            System.out.println(squareFootage);
     }
}
```


Body For CalculateFlatRate

```
public class WaterBill
{
      :      :      :      :
    public double calculateFlatRate (int squareFootage)
    {
      double total;
      total = BASE_FLAT_RATE_VALUE + (squareFootage *
              RATE_PER_SQUARE_FOOT);
      return total;
    }
}
```

Creating A Driver For CalculateFlatRate

```
public class DriverCalculateFlatRate
{
   public static void main (String [] args)
   {
      WaterBill test = new WaterBill ();
      double bill;
      int squareFootage;

      squareFootage = 0;
      bill = test.calculateFlatRate(squareFootage);
      if (bill != 10)
         System.out.println("Incorrect flat rate for 0 square feet");
      else
         System.out.println("Flat rate okay for 0 square feet");
```


Creating A Driver For CalculateFlatRate (2)

```
      squareFootage = 1000;
      bill = test.calculateFlatRate(squareFootage);
      if (bill != 20)
         System.out.println("Incorrect flat rate for 1000 square feet");
      else
         System.out.println("Flat rate okay for 1000 square feet");
   }
} // End of Driver
```

Body For GetCubicMetersUsed

```
public class WaterBill
{
      :      :      :      :
    public double getCubicMetersUsed ()
    {
        double cubicMetersUsed;
        System.out.print("Enter the number of cubic meters used: ");
        cubicMetersUsed = Console.in.readDouble();
        Console.in.readChar();
        return cubicMetersUsed;
    }
```


Creating A Driver To Test GetCubicMetersUsed

```
public class Driver
{
    public static void main (String [] args)
    {
            WaterBill test = new WaterBill ();
            double cubicMeters = test.getCubicMetersUsed ();
            System.out.println(cubicMeters);
    }
}
```

Body For CalculateMeteredRate

```
public double calculateMeteredRate (double cubicMetersUsed)
{
   double total;
   total = cubicMetersUsed * RATE_PER_CUBIC_METER;
   return total;
}
```


Driver For CalculateMeteredRate

```
public class DriverCalculateMeteredRate
{
   public static void main (String [] args)
   {
      WaterBill water = new WaterBill ();
      double bill;
      double cubicMetersUsed;

      cubicMetersUsed = 0;
      bill = water.calculateMeteredRate(cubicMetersUsed);
      if (bill != 0 )
         System.out.println("Incorrect metered rate for 0 cubic meters consumed.");
      else
         System.out.println("Metered rate for 0 cubic meters consumed is okay.");
```

Driver For CalculateMeteredRate (2)

```
        cubicMetersUsed = 100;
        bill = water.calculateMeteredRate(cubicMetersUsed);
        if (bill != 100 )
          System.out.println("Incorrect metered rate for 100 cubic meters
             consumed.");
        else
          System.out.println("Metered rate for 100 cubic meters consumed is
             okay.");
    }
}
```


General Rule Of Thumb: Test Drivers

- Write a test driver class if you need to verify that a method does what it is supposed to do (determining if it is correct).
  - e.g., When a method performs a calculation, if a method is getting input
- Benefits of writing test drivers:
  1. Ensuring that you know precisely what your code is supposed to do.
  2. Making code more robust (test it before adding it a code library).

You Should Now Know

- Some general design principles
  - What constitutes a good or a bad design.
- How to write test drives and what are the benefits of using test drivers in your programs