MIT AITI 2004
Lecture 10
Static and Final
public class MyMath {

    public double PI = 3.14159;

    public double square (double x) {
        return x * x;
    }

    public static void main(String[ ] args) {
        MyMath m = new MyMath();
        System.out.println("m: value of PI is " + m.PI);
        System.out.println("m: square of 5 is " + m.square(5));

        MyMath n = new MyMath();
        System.out.println("n: value of PI is " + n.PI);
        System.out.println("n: square of 5 is " + n.square(5));
    }
}
Objects Review

• In Example 1, to calculate the square of 5 we need to create an instance of MyMath class:

   ```java
   MyMath m = new MyMath();
   ```

• Then we invoke it’s square() method with the argument 5:

   ```java
   m.square(5);
   ```
MyMath Output

• The results of invoking square() method on instances m and n are the same:
  
  m: value of PI is 3.14159  
  m: square of 5 is 25  
  n: value of PI is 3.14159  
  n: square of 5 is 25  

• `square()` behaves the same no matter which instance it is called on.

• So... why not have one `square()` method for the entire class?
Also . . .

- The value of $\pi = 3.14159$ is the same for all instances of `MyMath` class.

- Why do we need to store a value of $\pi$ separately for each instance of `MyMath`?

- Instead, can we have only one common value of $\pi$ for the whole `MyMath` class?
public class MyMath {

    // add keyword "static" to field declaration
    public static double PI = 3.14159;

    // add keyword "static" to method declaration
    public static double square (double x) {
        return x * x;
    }

    // main method is always declared "static"
    public static void main( String[ ] args) {
        // MyMath m = new MyMath(); - No longer need this line!
        // MyMath n = new MyMath(); - No longer need this line!

        // Now invoke square() method on the MyMath class
        System.out.println("Value of PI is " + MyMath.PI);
        System.out.println("Square of 5 is" + MyMath.square(5));
    }
}
Static Pi Field

• We added word static to the declaration of the final variable PI:

```java
public static double PI = 3.14159;
```

• It means that now we have only one value of variable PI for all instances of MyMath class; PI is now a class data field
The **final** keyword

- We declared **PI** as
  ```java
  public static double PI = 3.14159;
  ```
  but this does not prevent changing its value:
  ```java
  MyMath.PI = 999999999;
  ```

- Use keyword **final** to denote a constant:
  ```java
  public static final double PI = 3.14159;
  ```

- Once we declare a variable to be **final**, it's value can no longer be changed!
Final References

• Consider this final reference to a Point:

```java
public static final Point ORIGIN =
    new Point(0,0);
```

• This prevents changing the reference `ORIGIN`:

```java
MyMath.ORIGIN = new Point(3, 4);
```

• **BUT**! You can still call methods on `ORIGIN` that change the state of `ORIGIN`.

```java
MyMath.ORIGIN.setX(4);
```
public class MyMath {

    // add keyword final to field declaration
    public static final double PI = 3.14159;

    public static double square (double x) {
        return x * x;
    }

    public static void main( String[ ] args) {
        System.out.println("Value of PI is " + MyMath.PI);
        System.out.println("Square of 5: " + MyMath.square(5));
    }
}
Static Fields

• Only one instance of a static field data for the entire class, not one per object.

• "static" is a historic keyword from C/C++

• "Class fields" is a better term
  – As opposed to "instance fields"
Static Square Method

• We also added the word "static" to the declaration of the method square():

```java
public static double square(double x) {
    return x * x;
}
```

• Now the method square() is shared by all instances of the class—only one square method for the class, not one for each instance.
Static Methods

• Static methods do not operate on a specific instance of their class

• Have access only to static fields and methods of the class
  – Cannot access non-static ones

• "Class methods" is a better term
  – As opposed to "instance methods"
Java's Math Class

• Let's take a look at Java's Math class in the API

• You cannot create an instance of the Math Class, it's just a place to store useful static methods

• All the methods and fields are static:
  
  ```java
  Math.sqrt(16)
  Math.PI
  Math.abs(-3)
  ```
Static Field Examples

• Constants used by a class
  (usually used with `final` keyword)

  – Have one per class; don’t need one in each object
    
    public static final double TEMP_CONVERT = 1.8;

  – If this is in class Temperature, it is invoked by
    double t = Temperature.TEMP_CONVERT * temp;

  – Constants are all capital letters by tradition (C, C++)
    For example: `PI`, `TEMP_CONVERT` etc.
Static Method Examples

• For methods that use only the arguments and therefore do not operate on an instance
  
  ```java
  public static double pow(double b, double p)
  // Math class, takes b to the p power
  ```

• For methods that only need static data fields

• Main method in the class that starts the program
  – No objects exist yet for it to operate on!
POP QUIZ

Should it be static or non-static?

• Speed of light field static
• `getName()` method in a Person class non
• A `sum` method that returns the resulting of adding both its arguments static
• Width data field in a Rectangle class non