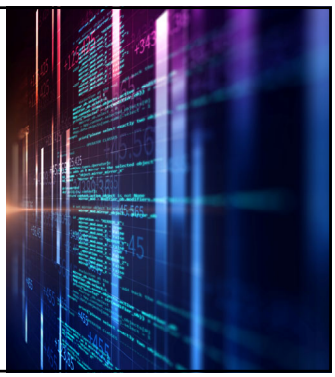
Polymorphism - Overloading

Brandon Krakowsky

Penn Engineering



1

Polymorphism

2

Signatures

In any programming language, a signature is what distinguishes one function or method from another

- In C, every function has to have a different name
- In Java, two methods have to differ in their *names* or in the *number* or *types* or *sequence* of their parameters
- For example:
  - foo(int i) and foo(int i, int j) are considered different
  - foo(int i) and foo(int k) are considered the same
  - foo(int i, double d) and foo(double d, int i) are considered different
- In Java, a method signature does not include the return type

3

Polymorphism

Polymorphism means *many* (poly) *shapes* (morph)

- In Java, polymorphism often refers to the fact that you can have multiple methods with the same *name* in the same *class*
- Polymorphism is divided into two types:
  - Overloading
    - Having two or more methods with the same *names* but different *signatures*
  - Overriding
    - Replacing an inherited method with another having the same *signature*

4

Overloading

5

Overloading

- Here's a class with 2 *myPrint* methods: they have different parameters

```
public class MyPrintingUtility {

    //prints given int i
    public void myPrint(int i) {
        System.out.println("int i = " + i);
    }

    //prints given double d
    public void myPrint(double d) { //same name, different parameter
        System.out.println("double d = " + d);
    }

    public static void main(String args[]) {
        MyPrintingUtility printingUtility = new MyPrintingUtility();
        printingUtility.myPrint(5);
        printingUtility.myPrint(5.0); //call same method name with different argument type
    }
}
```


6

Why Overload a Method?

- So you can use the same names for methods that do essentially the same thing
- These all take a single argument and print it
  - `System.out.println(int)`
  - `System.out.println(double)`
  - `System.out.println(boolean)`
  - `System.out.println(String)`
  - etc.
- These all take 2 arguments and compare them
  - `assertEquals(int expected, int actual)`
  - `assertEquals(String expected, String actual)`
  - `assertEquals(Object expected, Object actual)`
  - etc.

Why Overload a Method?

- So you can supply defaults for the parameters:

```
public class MyCountingUtility {

    int count = 0;

    //increments count by given amount
    //returns count
    public int increment(int amount) {
        this.count += amount;
        return this.count;
    }

    //increments by 1 and returns count
    public int increment() {
        return this.increment(1); //Note, one method can call another of the
same name
    }
}
```


Why Overload a Method?

- So you can supply additional information:

```
public class MyResults {

    double total = 0.0;
    double average = 0.0;

    //prints total and average
    public void printResults() {
        System.out.println("total = " + this.total + ", average = " +
this.average);
    }

    //prints given message and prints results
    public void printResults(String message) {
        System.out.println(message + ": ");
        this.printResults();
    }
}
```

DRY (Don't Repeat Yourself) Principle of Software Development

- When you overload a method with another, very similar method, only one of them should do most of the work:

```
public class MyInformation {
    int first;
    int last;
    String[] dictionary;
    //prints first, last, and dictionary info in between
    public void debug() {
        System.out.println("first = " + this.first + ", last = " + this.last);
        for (int i = this.first; i <= this.last; i++) {
            System.out.print(this.dictionary[i] + "  ");
        }
        System.out.println();
    }
    //prints given checkpoint s and debugs
    public void debug(String s) {
        System.out.println("At checkpoint " + s + ":");
        this.debug();
    }
}
```


Legal Variable Assignments

- In some cases, you can assign a different type of data to a predefined data type
- Widening (going to a "wider" data type) is legal
  `double d = 5; //legal`
- Narrowing (going to a more "narrow" data type) is illegal
  `int i = 3.5; //illegal`

  Unless you cast
  `int i = (int)(Math.round(3.5)); //legal`
- Rule: All ints are doubles but all doubles are not ints, so Java gets mad unless you do the cast!

Legal Method Calls

- Method calls have the same rules
- The following call to *myPrint* is legal due to widening

```
public class MyPrintingUtility {

    public void myPrint(double d) {
        System.out.println(d);
    }

    public static void main(String args[]) {
        MyPrintingUtility printingUtility = new MyPrintingUtility();
        printingUtility.myPrint(5); //widening is legal: will print 5.0
    }
}
```

Illegal Method Calls

- Method calls have the same rules
- The following call to *myPrint* is illegal due to narrowing

```
public class MyPrintingUtility {

    public void myPrint(int i) {
        System.out.println(i);
    }

    public static void main(String args[]) {
        MyPrintingUtility printingUtility = new MyPrintingUtility();
        printingUtility.myPrint(5.0); //narrowing is illegal
    }
}
```


Java Uses the Most Specific Method

- If your methods are legally overloaded, Java will figure out which one you want to use

```
public class MyPrintingUtility {

    public static void myPrint(double d) {
        System.out.println("double: " + d);
    }

    public static void myPrint(int i) {
        System.out.println("int: " + i);
    }

    public static void main(String args[]) {
        MyPrintingUtility.myPrint(5); //prints “int: 5” using myPrint(int i)
        MyPrintingUtility.myPrint(5.0); //prints “double: 5.0” using
myPrint(double d)
    }
}
```


Multiple Constructors I

- You can overload constructors as well as methods

```
public class Counter {

    int count;

    //creates counter and starts count at 0
    public Counter() {
        this.count = 0;
    }

    //creates counter and starts count at given start
    public Counter(int start) {
        this.count = start;
    }
}
```

Multiple Constructors II

- One constructor can call another constructor in the same class, but there are rules
  - You call the other constructor with the keyword this
  - The call must be the *very first thing* the constructor does

```
public class Point {

        int x;
        int y;
        int sum;

        //creates a point at given x and y
        public Point(int x, int y) {
            this.x = x;
            this.y = y;
            this.sum = x + y;
        }

        //creates a point at 0, 0
        public Point() {
            this(0, 0);
        }
    }
```


16

Summary

- Rule: You should *overload* a method when you want to do essentially the same thing, but with different parameters

17

Dog Project

18

Dog Class

```
Dogjava ⊠
package poly;

/**
 * Represents a Dog.
 * @author Skrandon
 *
 */
public class Dog {

    //static variables

    /**
     * Default name for a dog.
     */
    static String DEFAULT_NAME = "Generic dog";

    /**
     * Default age for a dog.
     */
    static double DEFAULT_AGE = .5;

    /**
     * Default weight for a dog.
     */
    static double DEFAULT_WEIGHT = 1.75;

    /**
     * Default food for dog.
     */
    static String DEFAULT_FOOD = "Generic dog food";

    /**
     * Default dog bark sound.
     */
    static String DEFAULT_BARK = "Bark!";

    /**
     * Default number of times for dog to bark.
     */
    static int DEFAULT_NUM_TIMES_BARK = 1;

    /**
     * Constant weight gain value.
     */
    static final double WEIGHT_GAIN_INCREASE = 0.01;
```


Dog Class

```
    //instance variables

    /**
     * Name of dog.
     */
    String name;

    /**
     * Age of dog.
     */
    double age;

    /**
     * Owner of dog.
     */
    String owner;

    /**
     * Weight of dog.
     */
    double weight;
```


Dog Class

```
    //constructors

    /**
     * Creates a Dog with given name, age, owner, and weight.
     * @param name of dog
     * @param age of dog
     * @param owner for dog
     * @param weight for dog
     */
    public Dog(String name, double age, String owner, double weight) {
        this.name = name;
        this.age = age;
        this.owner = owner;
        this.weight = weight;
    }

    /**
     * Creates a Dog with given name and age.
     * @param name of dog
     * @param age of dog
     */
    public Dog(String name, double age) {
        //call first constructor with 2 given values
        //and 2 default values
        this(name, age, null, Dog.DEFAULT_WEIGHT);
    }

    /**
     * Creates a dog that barks immediately.
     */
    public Dog() {
        //call second constructor with 2 default values
        this(Dog.DEFAULT_NAME, Dog.DEFAULT_AGE);

        //dog barks after creation
        this.bark();
    }
```

Dog Class

```java
    /**
     * Dog eats given amount of given food.
     * @param amount to eat
     * @param food to eat
     * @return new weight
     */
    public double eat(double amount, String food) {
        System.out.println(this.name + " is eating " + amount + " of " + food);

        double weightGained = Dog.WEIGHT_GAIN_INCREASE * amount;

        this.weight += weightGained;

        return this.weight;
    }

    /**
     * Dog eats given amount of generic dog food.
     * @param amount to eat
     * @return new weight
     */
    public double eat(double amount) {
        //calls first eat method with given amount
        //and default dog food
        return this.eat(amount, Dog.DEFAULT_FOOD);
    }
```


Dog Class

```java
    /**
     * Dog eats given amount.
     * Parses given amount as a double.
     * @param amount to eat
     * @return new weight
     */
    public double eat(String amount) {

        double returnVal = 0.0;

        //try some code in try block
        try {
            //cast given amount to double with static parseDouble method
            double amountAsDouble = Double.parseDouble(amount);

            //calls second eat method with given amount
            //and gets return value
            returnVal = this.eat(amountAsDouble);

        //code may fail, in which case we end up in catch block
        } catch (NumberFormatException e) {
            //print friendly message
            System.out.println(amount + ": can't be casted to double");
        }

        return returnVal;
    }
```


Dog Class

```java
    /**
     * Dog makes given bark sound given number of times.
     * @param numTimes to make sound
     * @param barkSound to make
     */
    public void bark(int numTimes, String barkSound) {
        //prints dog's name
        System.out.println(this.name + " says:");

        //iterate using numTimes to print barkSound
        for (int i = 0; i < numTimes; i++) {
            System.out.println(barkSound);
        }

        System.out.println();
    }

    /**
     * Dog makes given bark sound given number of times.
     * @param numTimes to make sound
     * @param barkSound to make
     */
    public void bark(String barkSound, int numTimes) {
        //calls first bark method with given bark sound
        //and number times
        this.bark(numTimes, barkSound);
    }

    /**
     * Dog makes generic bark sound once.
     */
    public void bark() {
        //calls first bark method with default values
        this.bark(Dog.DEFAULT_NUM_TIMES_BARK, Dog.DEFAULT_BARK);
    }
```

Dog Class

```java
    /**
     * Returns dog's weight.
     * @return weight
     */
    public double getWeight() {
        return this.weight;
    }

    /**
     * Set new name for dog.
     * @param name of dog
     */
    public void setName(String name) {
        this.name = name;
    }

    /**
     * Sets dog's owner.
     * @param owner for dog
     */
    public void setOwner(String owner) {
        this.owner = owner;
    }
```


Dog Class

```java
    /**
     * Returns String representing this dog.
     */
    @Override
    public String toString() {
        return this.name + ", " + this.weight + ", " + this.age + ", " + this.owner;
    }
```


Dog Class

```java
    public static void main(String[] args) {

        //create dog using first constructor
        Dog dog1 = new Dog("Princess", 12.7, "Brandon", 9.3);

        //create dog using second constructor
        Dog dog2 = new Dog("Fido", 5.5);

        //create dog using third constructor
        Dog dog3 = new Dog();

        //print dogs
        System.out.println(dog1);
        System.out.println(dog2);
        System.out.println(dog3);

        System.out.println("\n");
```

Dog Class

```
        //set name for dog3
        dog3.setName("Samantha");

        //re-print dog3
        System.out.println(dog3);

        System.out.println("\n");
```


Dog Class

```
        //calls first eat method
        //prints new weight
        System.out.println(dog1.eat(2.1, "Beneful"));
        System.out.println("\n");

        //calls second eat method
        System.out.println(dog2.eat(1.1));
        System.out.println("\n");

        //calls second eat method with int (widening)
        System.out.println(dog3.eat(1));
        System.out.println("\n");

        //calls third eat method with string which can be parsed as a double
        System.out.println(dog3.eat("12.1"));
        System.out.println("\n");

        //calls third eat method with string which cannot be parsed as a double
        //should print friendly error
        dog3.eat("twelve");

        //print weight for dog3 -- it should be the same
        System.out.println(dog3.getWeight());
        System.out.println("\n");
```


Dog Class

```
        //calls first bark method
        dog1.bark(2, "Woof!");

        //calls second bark method
        dog3.bark("Help me!", 1);

        //calls third default bark method
        dog2.bark();
    }
```