Northeastern University

Lecture 8: Object Oriented Programming - 3

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Liang, Y. Daniel. Introduction to Java Programming, Comprehensive Version, 12th edition, Pearson, 2019.

Outline

- Objects and Classes
- Thinking in Objects

Objects and Classes

Passing Objects to Methods

Passing Objects to Methods

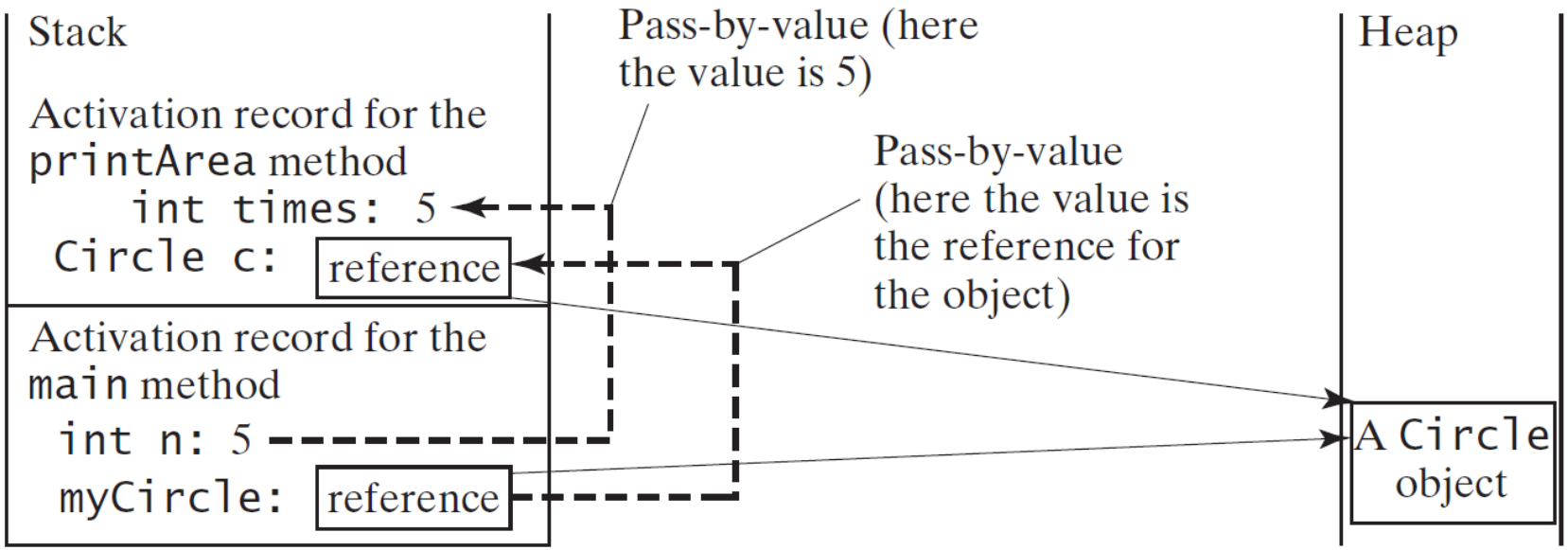
- Passing by value for primitive type value
  - » The value is passed to the parameter.
- Passing by value for reference type value
  - » The value is the reference to the object.

```java
public class CircleWithPrivateDataFields {
  /** The radius of the circle */
  private double radius = 1;

  /** The number of the objects created */
  private static int numberOfObjects = 0;

  /** Construct a circle with radius 1 */
  public CircleWithPrivateDataFields() {
    numberOfObjects++;
  }

  /** Construct a circle with a specified radius */
  public CircleWithPrivateDataFields(double newRadius)
  {
    radius = newRadius;
    numberOfObjects++;
  }

  /** Return radius */
  public double getRadius() {
    return radius;
  }

  /** Set a new radius */
  public void setRadius(double newRadius) {
    radius = (newRadius >= 0) ? newRadius : 0;
  }

  /** Return numberOfObjects */
  public static int getNumberOfObjects() {
    return numberOfObjects;
  }

  /** Return the area of this circle */
  public double getArea() {
    return radius * radius * Math.PI;
  }
}
```

```java
public class TestPassObject {
  public static void main(String[] args) {
    // Create a Circle object with radius 1
    CircleWithPrivateDataFields myCircle =
                        new CircleWithPrivateDataFields(1);

    // Print areas for radius 1, 2, 3, 4, and 5.
    int n = 5;
    printAreas(myCircle, n);

    // See myCircle.radius and times
    System.out.println("\n"+"Radius is ” +
                                  myCircle.getRadius());
    System.out.println("n is " + n);
  }

  /** Print a table of areas for radius */
  public static void
  printAreas(CircleWithPrivateDataFields c, int times) {
    System.out.println("Radius \t\tArea");
    while (times >= 1) {
      System.out.println(c.getRadius()+"\t\t”+c.getArea());
      c.setRadius(c.getRadius() + 1);
      times--;
    }
  }
}
```

```
Radius    Area
1.0       3.141592653589793
2.0       12.566370614359172
3.0       28.274333882308138
4.0       50.26548245743669
5.0       78.53981633974483

Radius is 6.0
n is 5
```

Passing Objects to Methods



Array of Objects

Array of Objects

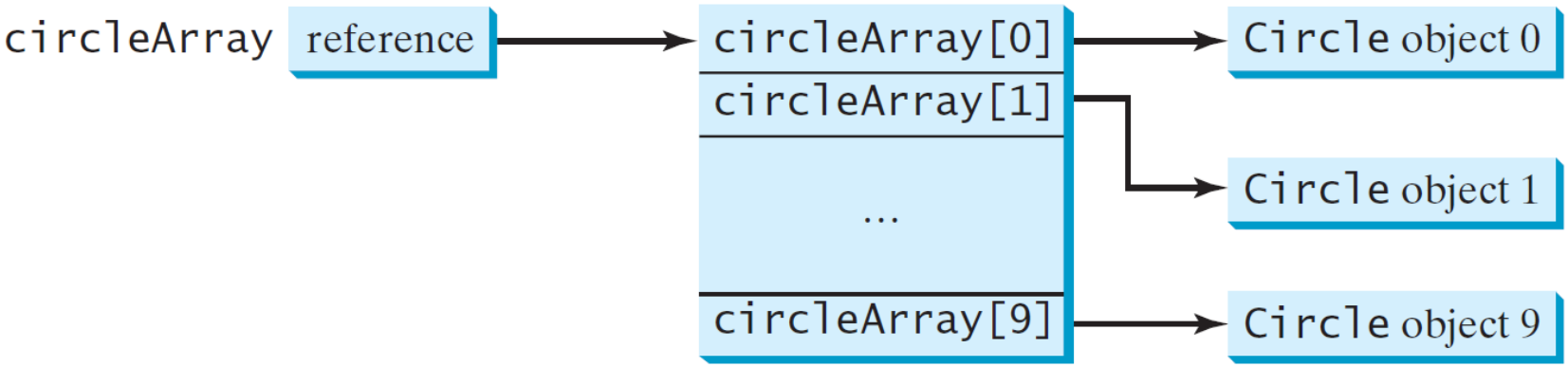
- An array of objects is actually an *array of reference variables*.

```
Circle[] circleArray = new Circle[10];
```

- So invoking circleArray[1].getArea() involves two levels of referencing as shown in the next figure.
  - » circleArray references to the entire array.
  - » circleArray[1] references to a Circle object.

Array of Objects

```
Circle[] circleArray = new Circle[10];
```



Exercise

- What is wrong in the following code? Please type it into your Eclipse Java project.
- Please fix it and print out the value for current time.

```
import java.util.Date;

public class ClassExamples {
   public static void main(String[] args){
      Date[] dates = new Date[10];

      System.out.println(dates[0]);
      System.out.println(dates[0].toString());
   }
}
```

Answer

```java
import java.util.Date;

public class Objects_and_Classes_Lecture3 {
    public static void main(String[] args){
        Date[] dates = new Date[10];
        for(int i = 0;i<10;i++){
            dates[i] = new Date();
        }
        System.out.println(dates[0]);
        System.out.println(dates[0].toString());
    }
}
```

The `this` Reference

This `this` Keyword

- The `this` keyword is the name of a reference that refers to an object itself.
- Common uses:
  - » It can also be used inside a constructor to invoke another constructor of the same class.
  - » `this` keyword is a reference to a class's *hidden data fields*.

Reference the Hidden Data Fields

```java
public class F {
  private int i = 5;
  private static double k = 0;

  void setI(int i) {
    this.i = i;
  }

  static void setK(double k) {
    F.k = k;
  }
}
```

```
Suppose that f1 and f2 are two objects of F.
   F f1 = new F(); F f2 = new F();

Invoking f1.setI(10) is to execute
   this.i = 10, where this refers f1

Invoking f2.setI(45) is to execute
   this.i = 45, where this refers f2
```

Calling Overloaded Constructor

```
public class Circle {
  private double radius;

  public Circle(double radius) {
    this.radius = radius;
  }

  public Circle() {
    this(1.0);
  }

  public double getArea() {
    return this.radius * this.radius * Math.PI;
  }
}
```

this must be explicitly used to reference the data field radius of the object being constructed

this is used to invoke another constructor

Every instance variable belongs to an instance represented by this, which is normally omitted

Exercise

- Write a class named `Account` which has two (`private`) data fields: the `balance` of the account and the `name` of the account
- Include a constructor that allows you to set the name and the initial balance of the account
- Also include a `toString()` method that puts both the name and balance in the String
- Write a `main()` method to test the class

Answer

Account.java:

```
public class Account {
	private String name;
	private double balance;

	public Account(String accountName, double initialBalance) {
		this.name = accountName;
		this.balance = initialBalance;
	}

	public String toString() {
		String output = name;
		output += String.format(": $%.2f", balance);
		return output;
	}
}
```

MyTest.java:

```
public class MyTest {
	public static void main(String[] args) {
		Account checking = new Account("Checking", 0.93);
		System.out.println(checking);
	}
}
```

Exercise (Continued) - Offline

- Modify your `Account` class to include a default constructor that sets the `balance` to $0.00 and the `name` to "Account".
- Also add a method named `adjust()` that allows you to adjust the balance by a positive or negative amount.
- Test the new methods in `main()`.

Answer

Account.java:

```java
public class Account {
	private String name;
	private double balance;

	public Account() {
		this.name = "Account";
		this.balance = 0;
	}

	public Account(String accountName, double initialBalance) {
		this.name = accountName;
		this.balance = initialBalance;
	}

	public void adjust(double amount) {
		balance = balance + amount;
	}

	public String toString() {
		String output = name;
		output += String.format(": $%.2f", balance);
		return output;
	}
}
```

MyTest.java:

```java
public class MyTest {
	public static void main(String[] args) {
		Account checking = new Account("Checking", 0.93);
		System.out.println(checking);
		Account account = new Account();
		account.adjust(1000);
		account.adjust(-250);
		System.out.println(account);
	}
}
```

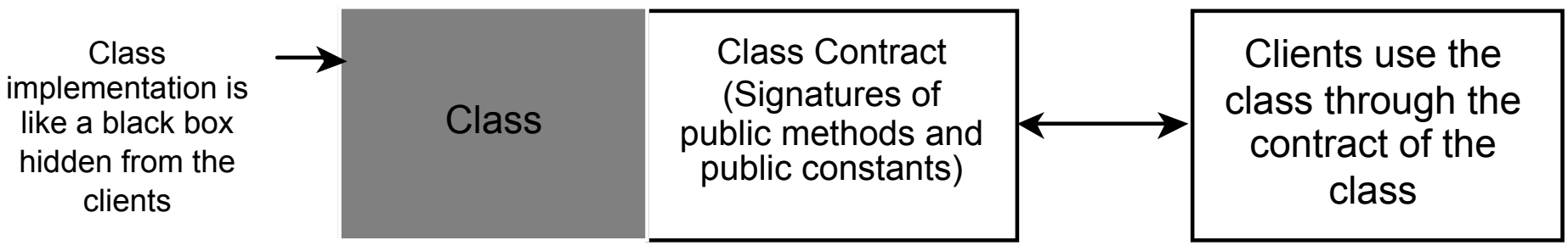
Thinking in Objects

Class Abstraction and Encapsulation

Class Abstraction and Encapsulation

- Class abstraction means to separate class implementation from the use of the class.
- The creator of the class provides a description of the class and let the user know how the class can be used.
- The user of the class does not need to know how the class is implemented. The detail of implementation is encapsulated and hidden from the user.

Class Abstraction and Encapsulation



Case Study: The BMI Class

The get methods for these data fields are provided in the class, but omitted in the UML diagram for brevity.

BMI	
-name: String	The name of the person.
-age: int	The age of the person.
-weight: double	The weight of the person in pounds.
-height: double	The height of the person in inches.
+BMI(name: String, age: int, weight: double, height: double)	Creates a BMI object with the specified name, age, weight, and height.
+BMI(name: String, weight: double, height: double)	Creates a BMI object with the specified name, weight, height, and a default age 20.
+getBMI(): double	Returns the BMI
+getStatus(): String	Returns the BMI status (e.g., normal, overweight, etc.)

BMI.java

```java
public class BMI {
	private String name;
	private int age;
	private double weight; // in pounds
	private double height; // in inches

	public static final double KILOGRAMS_PER_POUND = 0.45359237;
	public static final double METERS_PER_INCH = 0.0254;

	public BMI(String name, int age, double weight, double height) {
		this.name = name;
		this.age = age;
		this.weight = weight;
		this.height = height;
	}

	public BMI(String name, double weight, double height) {
		this(name, 20, weight, height);
	}

	public double getBMI() {
		double bmi = weight * KILOGRAMS_PER_POUND / ((height * METERS_PER_INCH) * (height * METERS_PER_INCH));
		return Math.round(bmi * 100) / 100.0;
	}

	public String getStatus() {
		double bmi = getBMI();
		if (bmi < 18.5)
			return "Underweight";
		else if (bmi < 25)
			return "Normal";
		else if (bmi < 30)
			return "Overweight";
		else
			return "Obese";
	}

	public String getName() { return name; }
	public int getAge() { return age; }
	public double getWeight() { return weight; }
	public double getHeight() { return height; }
}
```

UseBMIClass.java

```java
public class UseBMIClass {
  public static void main(String[] args) {
    BMI bmi1 = new BMI("John Doe", 18, 145, 70);
    System.out.println("The BMI for " + bmi1.getName() + " is "
      + bmi1.getBMI() + " " + bmi1.getStatus());

    BMI bmi2 = new BMI("Peter King", 215, 70);
    System.out.println("The BMI for " + bmi2.getName() + " is "
      + bmi2.getBMI() + " " + bmi2.getStatus());
  }
}
```

```
The BMI for John Doe is 20.81 Normal
The BMI for Peter King is 30.85 Obese
```