Northeastern University

Lecture 6: Object Oriented Programming - 1

Prof. Chen-Hsiang (Jones) Yu, Ph.D.

College of Engineering

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

Outline

- Objects and Classes
- Thinking in Objects

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Objects and Classes

Objects

OO Programming Concepts

- Object-oriented programming (OOP) involves programming using objects.
- An *object* represents an entity in the real world that can be distinctly identified, such as a desk, a button, a car, etc.
- An object has a unique identity, state, and behaviors.

OO Programming Concepts

- The *state* of an object consists of a set of *data fields* (also known as *properties*) with their current values.
- The *behavior* of an object is defined by a set of methods.

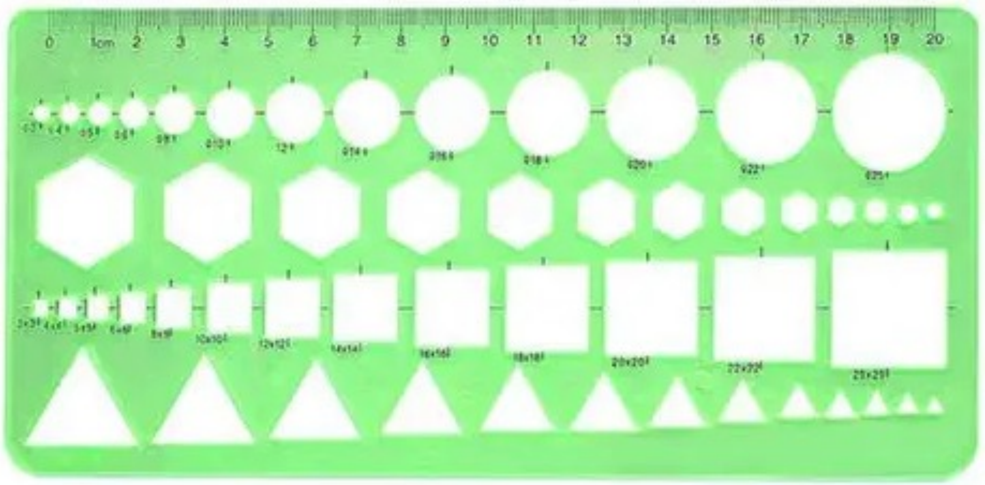
Objects

- An object has both a state and behavior.
- The state defines the object, and the behavior defines what the object does.

Classes

Classes

- *Classes* are constructs (structures, blueprints) that define objects of the same type.
- A Java class uses variables to define data fields and methods to define behaviors.
- Additionally, a class provides a special type of methods, known as constructors, which are called to construct objects from the class.



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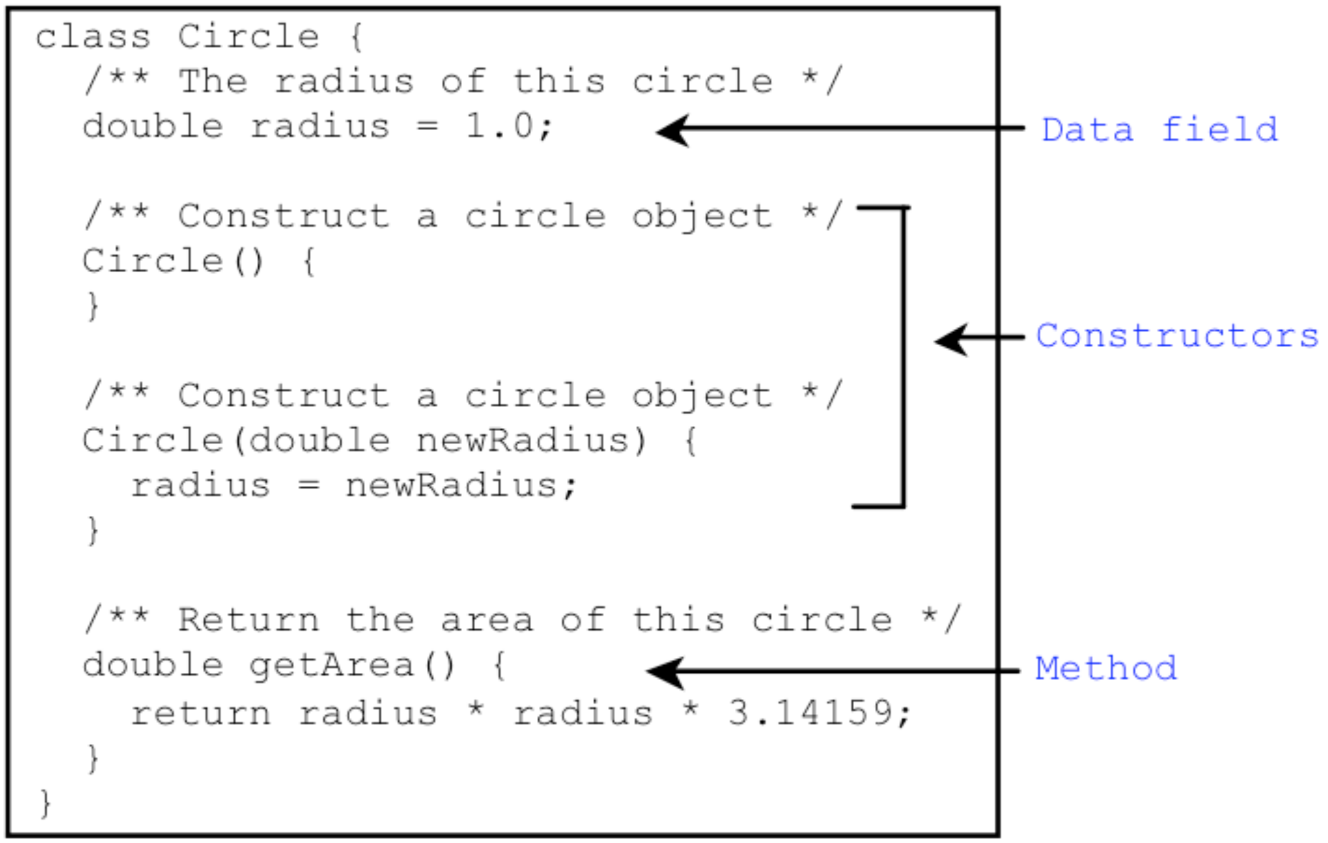
Classes



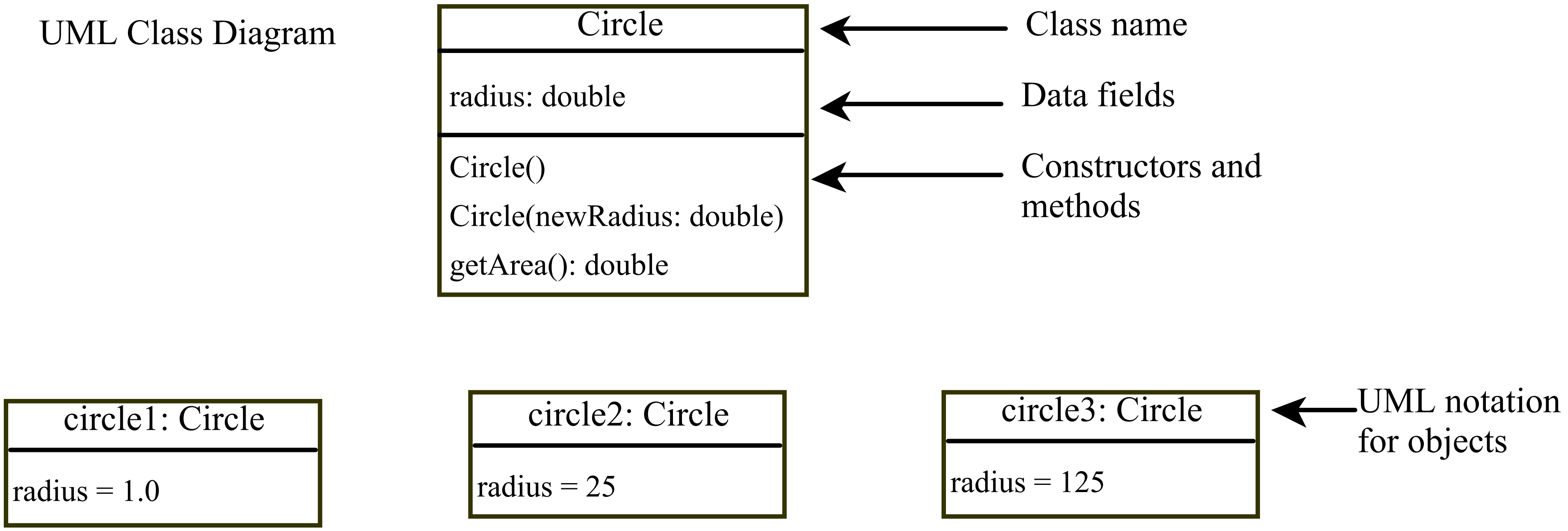
```
class Circle {
  /** The radius of this circle */
  double radius = 1.0;

  /** Construct a circle object */
  Circle() {
  }

  /** Construct a circle object */
  Circle(double newRadius) {
    radius = newRadius;
  }

  /** Return the area of this circle */
  double getArea() {
    return radius * radius * 3.14159;
  }
}
```

UML (Unified Modeling Language) Class Diagram



Exercise

- Create and define a `TV` class to have following data fields and methods:
  - data fields:

    `channel` (int)
    `volumeLevel` (int)
    `on` (boolean)

  - methods:

    `turnOn(): void`
    `turnOff(): void`

Answer

```java
public class TV {

    int channel;
    int volumeLevel;
    boolean on;

    TV() {
        channel = 1;
        volumeLevel = 1;
        on = false;
    }

    public void turnOn() {
        on = true;
    }

    public void turnOff() {
        on = false;
    }

}
```

```java
public class TV {

    int channel = 1;
    int volumeLevel = 1;
    boolean on = false;

    public void turnOn() {
       on = true;
    }
    public void turnOff() {
       on = false;
    }

}
```

TV.java (two possible solutions)

Constructing Objects Using Constructors

Constructors

- Constructors are a special kind of methods that are called to construct objects.

```
Circle() {
}

Circle(double newRadius) {
  radius = newRadius;
}
```

Constructors

- A constructor with no parameters is referred to as a *no-arg constructor*.
  - » Constructors must have the same name as the class itself.
  - » Constructors do not have a return type - not even void.
  - » Constructors are called using the **new** operator when an object is created. Constructors play the role of initializing objects.

Creating Objects Using Constructors

```
new ClassName();
```

Example:

```
new Circle();

new Circle(5.0);
```

Default Constructors

- A class may be defined without constructors.
- In this case, a no-arg constructor with an empty body is implicitly defined in the class.
- This constructor, called *a default constructor*, is provided automatically *only if no constructors are explicitly defined in the class*.

Accessing Objects via Reference Variables

Declaring object Reference Variables

- To reference an object, assign the object to a reference variable.
- To declare a reference variable, use the syntax:

```
ClassName objectRefVar;
```

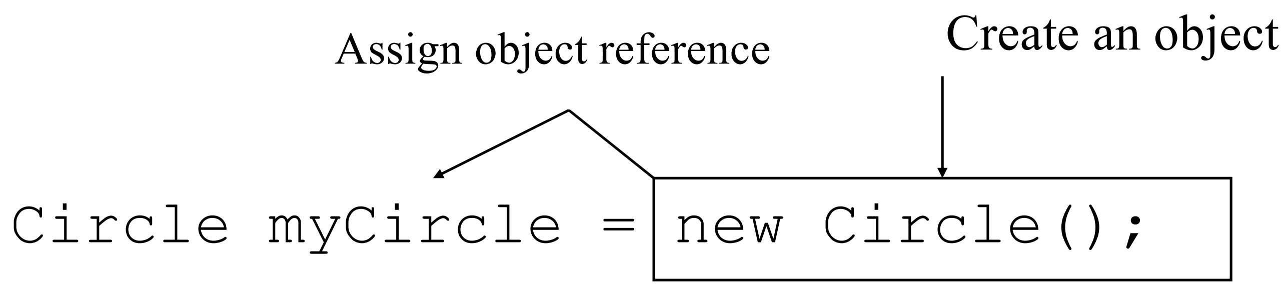
- Example:

```
Circle myCircle;
```

Declaring / Creating Objects in a Single Step

```
ClassName objectRefVar = new ClassName();
```

- Example:



```
Circle myCircle = new Circle();
```

Accessing Object's Members

- Referencing the object's data:

```
objectRefVar.data
```

e.g., `myCircle.radius`

- Invoking the object's method:

```
objectRefVar.methodName(arguments)
```

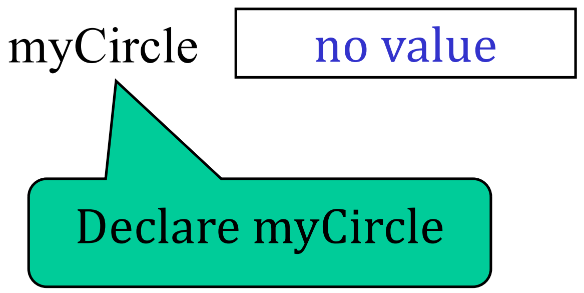
e.g., `myCircle.getArea()`

Trace Code

```
Circle myCircle = new Circle(5.0);

Circle yourCircle = new Circle();

yourCircle.radius = 100;
```



Trace Code

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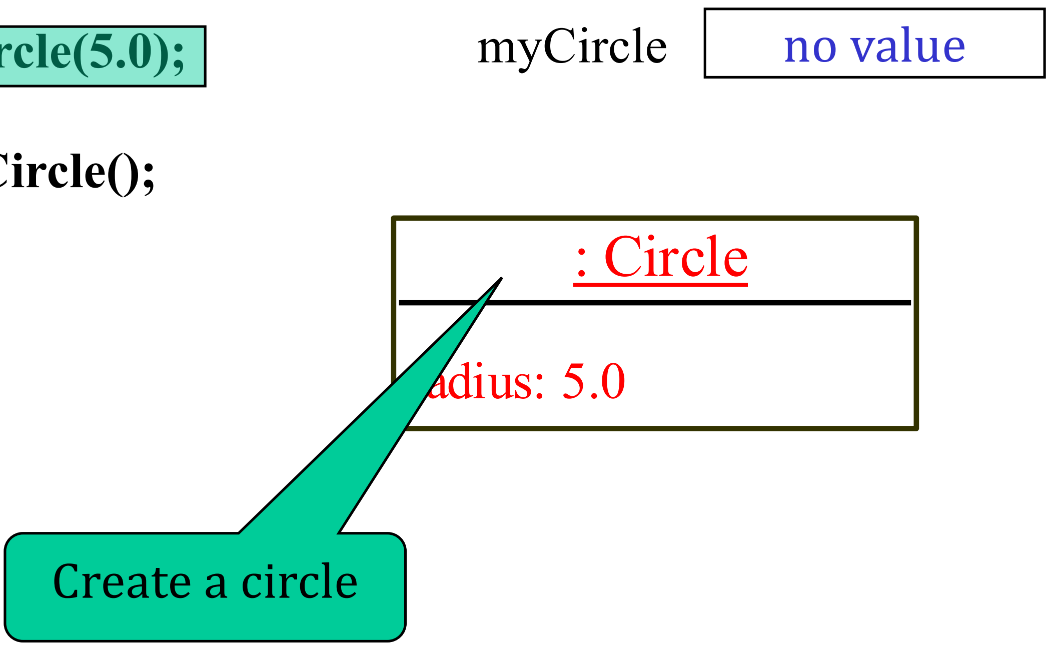
Circle yourCircle = new Circle();

yourCircle.radius = 100;
```



Trace Code

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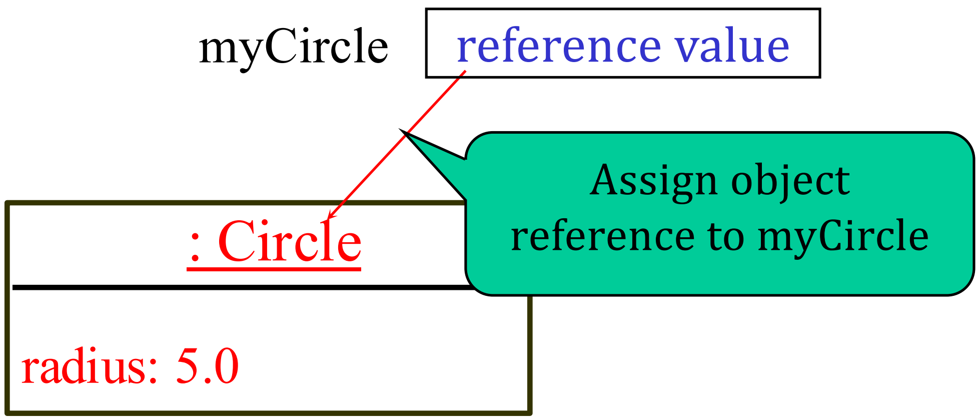

Trace Code

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yourCircle.radius = 100;
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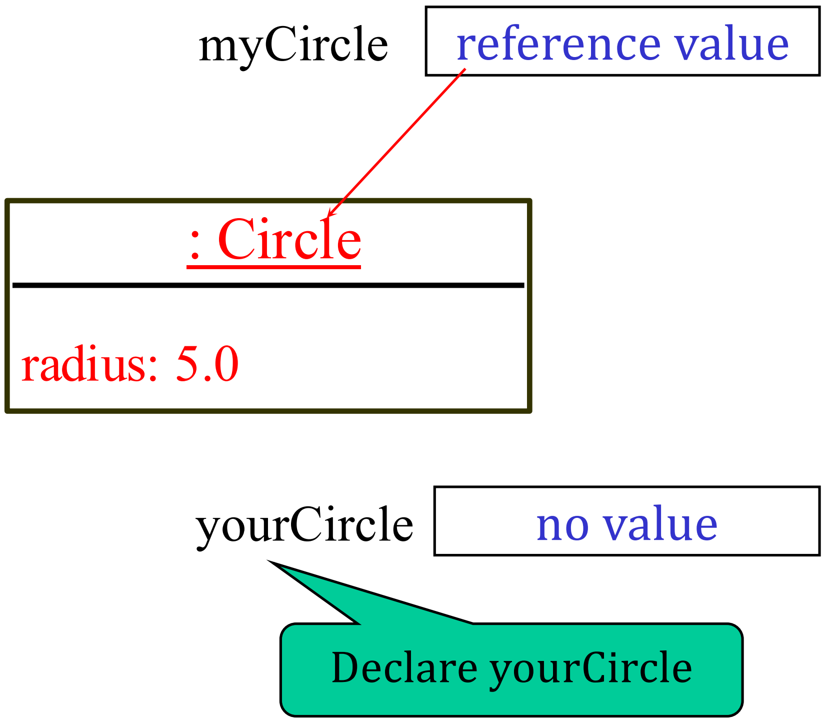

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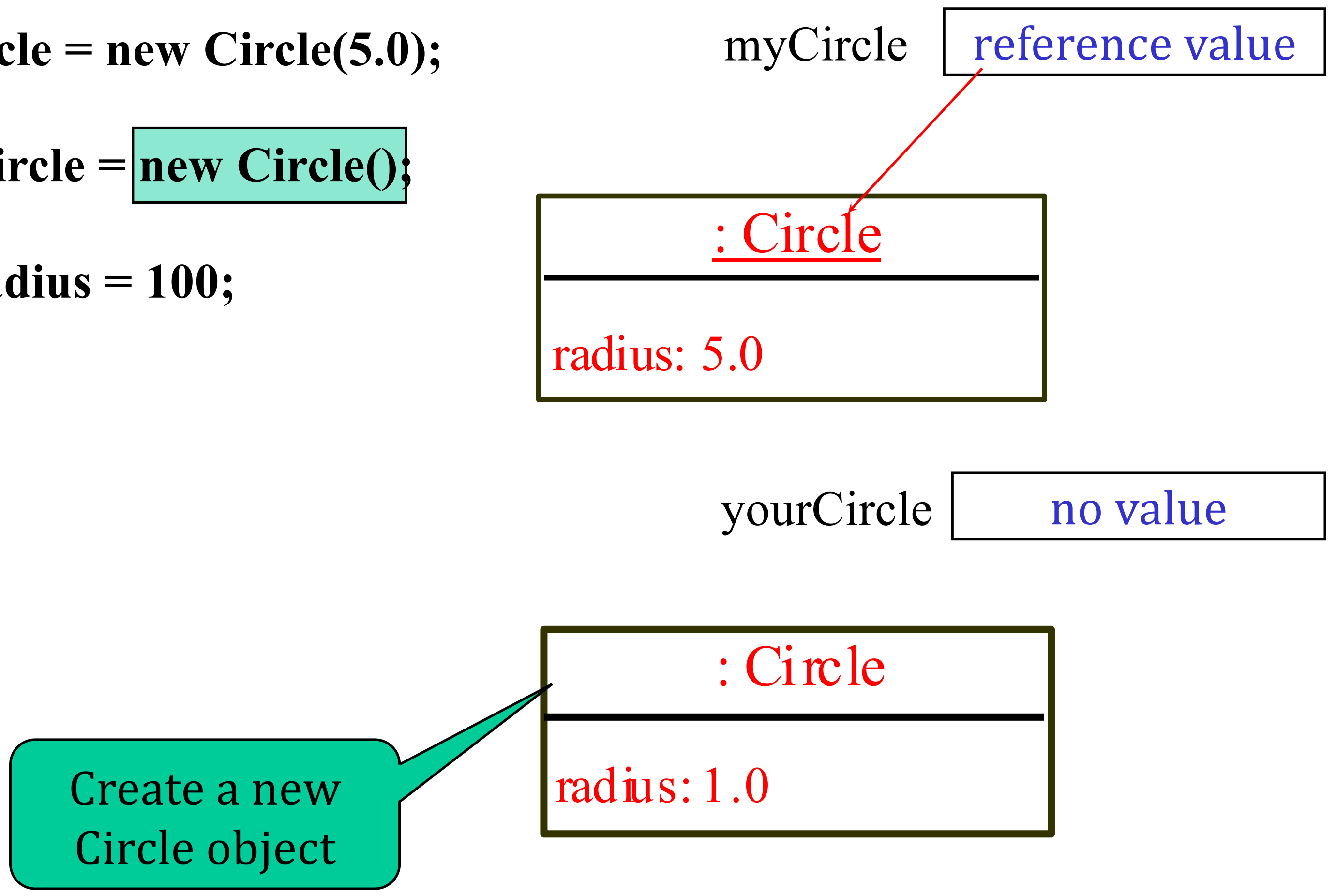

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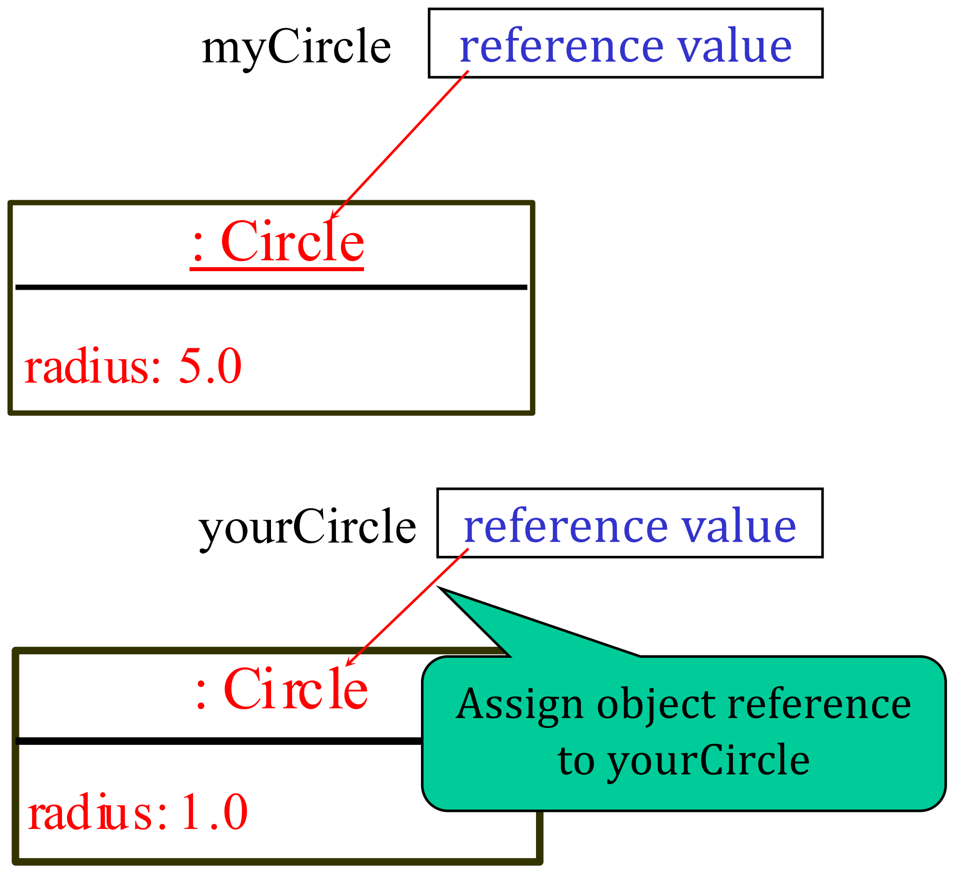

Trace Code

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Circle myCircle = new Circle(5.0);

Circle yourCircle = new Circle();

yourCircle.radius = 100;
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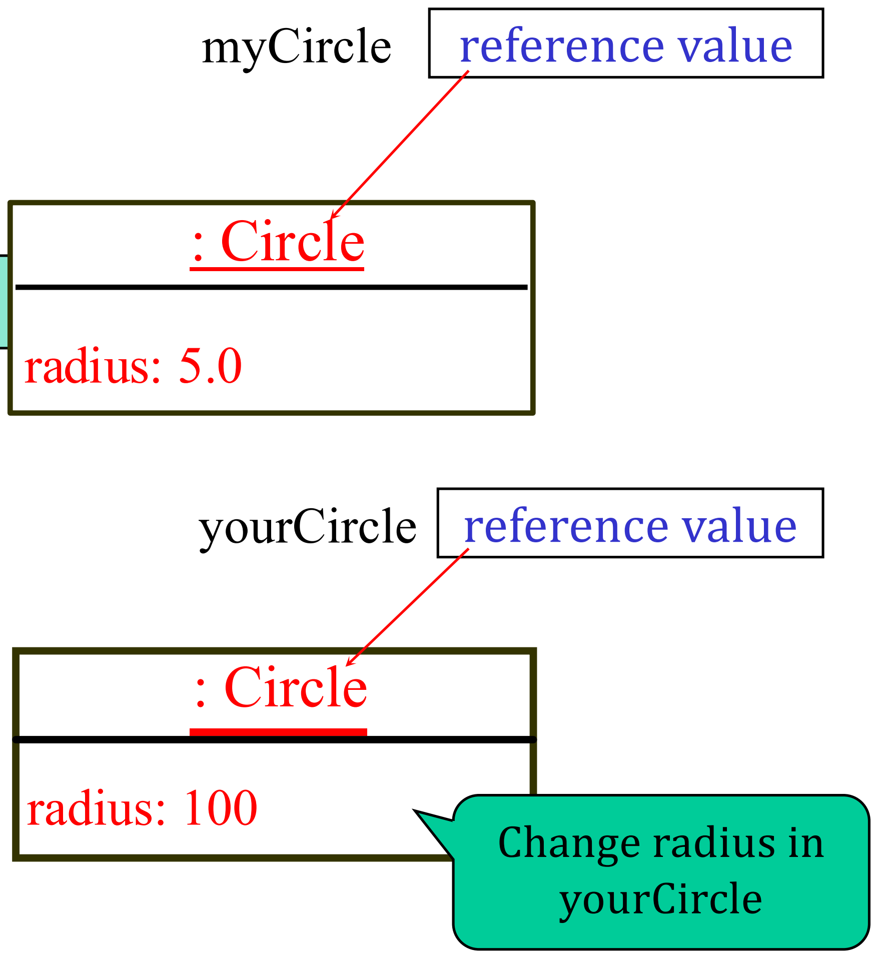


Default Value for a Data Field

- The default value of a data field:
  - » null for a reference type
  - » 0 for a numeric type
  - » false for a boolean type
  - » '\u0000' (null character) for a char type
- However, Java assigns no default value to a local variable inside a method.

Example

- Java assigns no default value to a local variable inside a method.

```
public class Test {
  public static void main(String[] args) {
    int x; // x has no default value
    String y; // y has no default value
    System.out.println("x is " + x);
    System.out.println("y is " + y);
  }
}
```

Compile error: variable not initialized

Exercise

- Define a `Student` class to have following data fields: `name` (String), `age` (int), `isScienceMajor` (boolean) and `gender` (char)
- Create an object of `Student` class type and print out the default values of its data fields

Answer

Student.java

```
public class Student {
  String name;
  int age;
  boolean isScienceMajor;
  char gender;
}
```

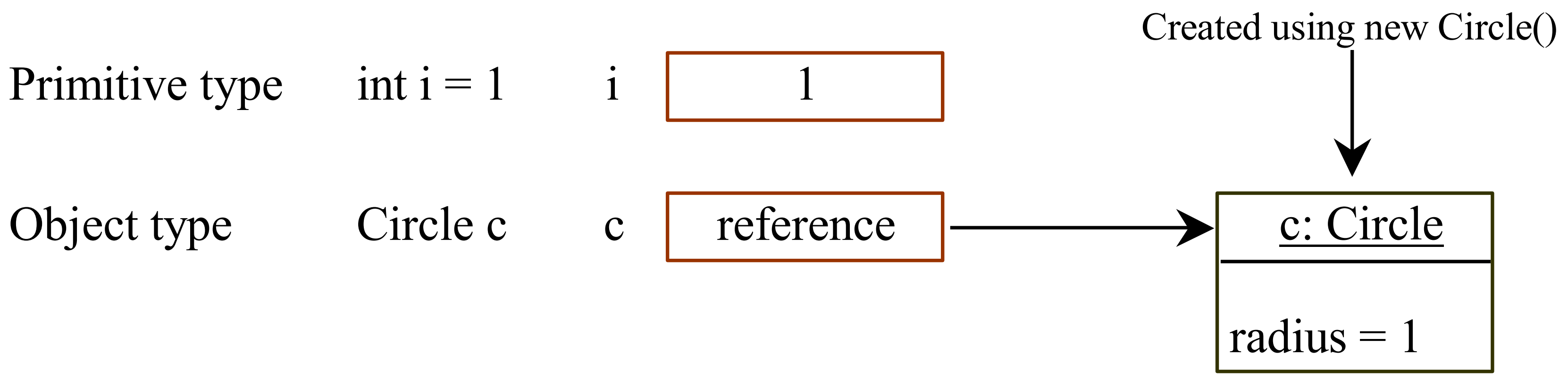
ClassExamples.java

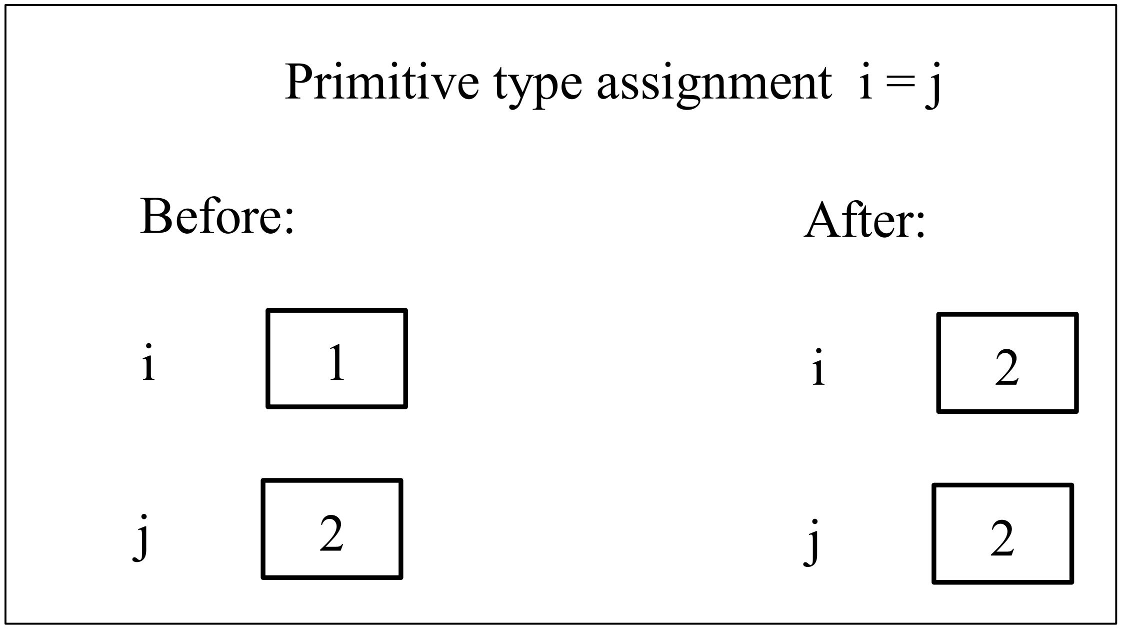
```
public class ClassExamples {
  public static void main(String[] args) {
    Student student = new Student();
    System.out.println("name? " + student.name);
    System.out.println("age? " + student.age);
    System.out.println("isScienceMajor? " + student.isScienceMajor);
    System.out.println("gender? " + student.gender);
  }
}
```

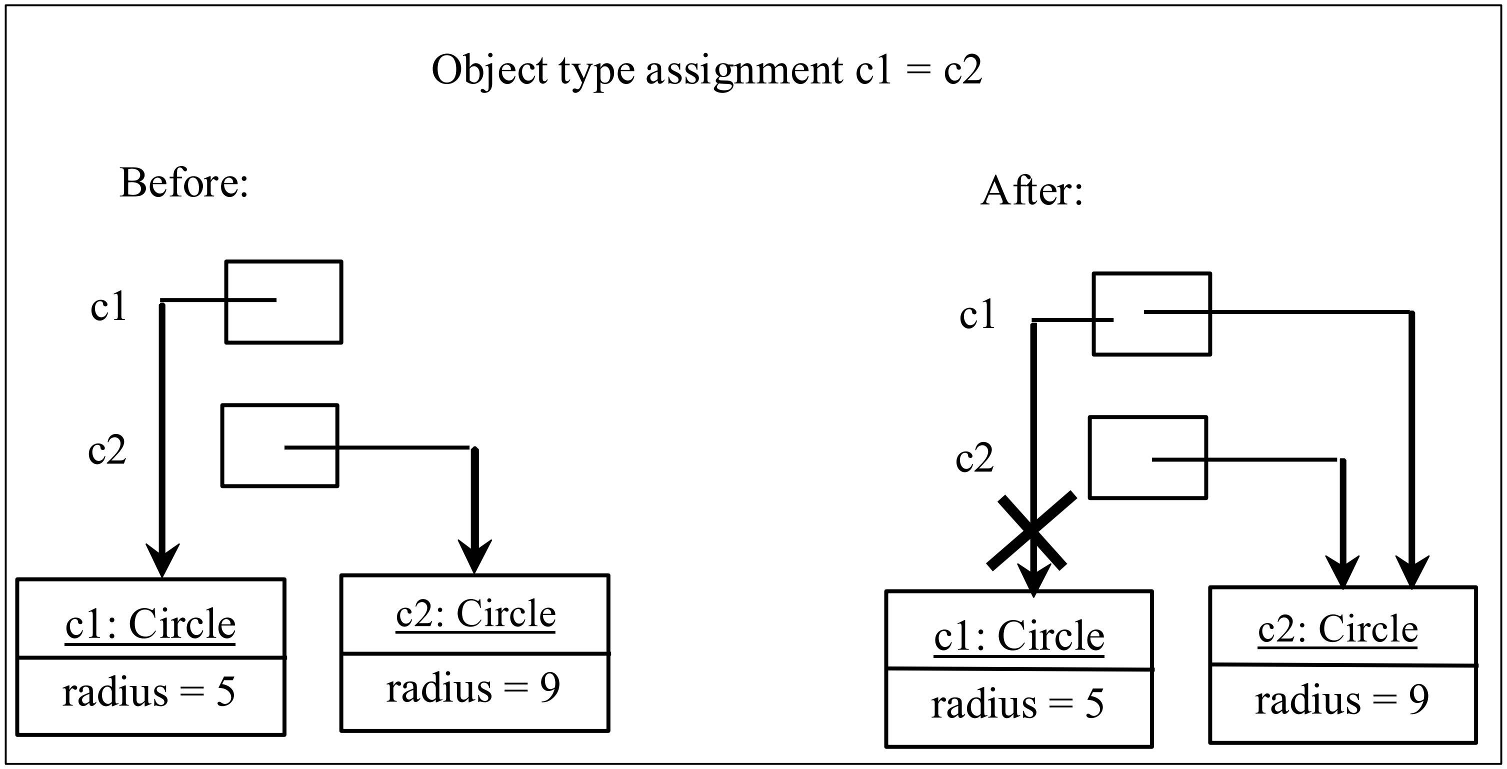
Output

```
name? null
age? 0
isScienceMajor? false
gender?
```

Primitive Data Type vs. Object Types




Primitive type assignment i = j
Before:
After:
i
1
j
2
i
2
j
2


Object type assignment c1 = c2
Before:
After:
c1
c2
c1: Circle
radius = 5
c2: Circle
radius = 9
c1
c2
c1: Circle
radius = 5
c2: Circle
radius = 9

Garbage Collections

- As shown in the previous figure, after the assignment statement c1 = c2, c1 points to the same object referenced by c2.
- The object previously referenced by c1 is no longer referenced. This object is known as garbage. Garbage is automatically collected by JVM.

Garbage Collections

- TIP: If you know that an object is no longer needed, you can explicitly assign null to a reference variable for the object.
- The JVM will automatically collect the space if the object is not referenced by any variable.