Objects and Classes (Part 1)

Introduction to Programming and Computational Problem Solving - 2

CSE 8B

Lecture 6

Announcements

- Assignment 2 is due today, 11:59 PM
- Quiz 2 is Oct 15
- Assignment 3 will be released today
  - Due Oct 20, 11:59 PM
- Educational research study
  - Oct 15, weekly survey
- Reading
  - Liang
    - Chapter 9

Object-oriented programming

- Object-oriented programming (OOP) involves programming using objects
- **This is the focus of CSE 8B**
  - The previous four lectures have been “double speed”
  - Beginning with this lecture, they will be “half speed”

Objects and classes

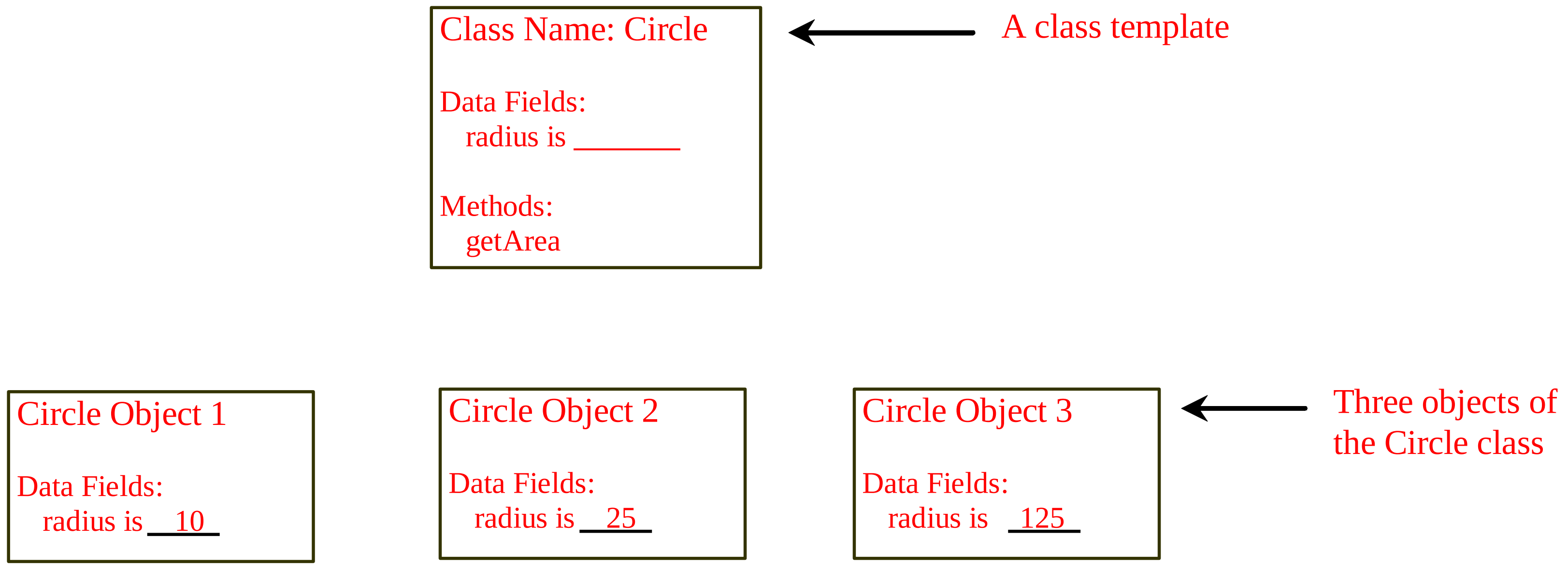
- An object represents an entity in the real world that can be distinctly identified
  - For example, a student, a desk, a circle, a button, and even a loan can all be viewed as objects
  - An object has a unique identity, state, and behaviors
- Classes are constructs that define objects of the same type

Objects

- An object has a unique identity, state, and behaviors
- 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

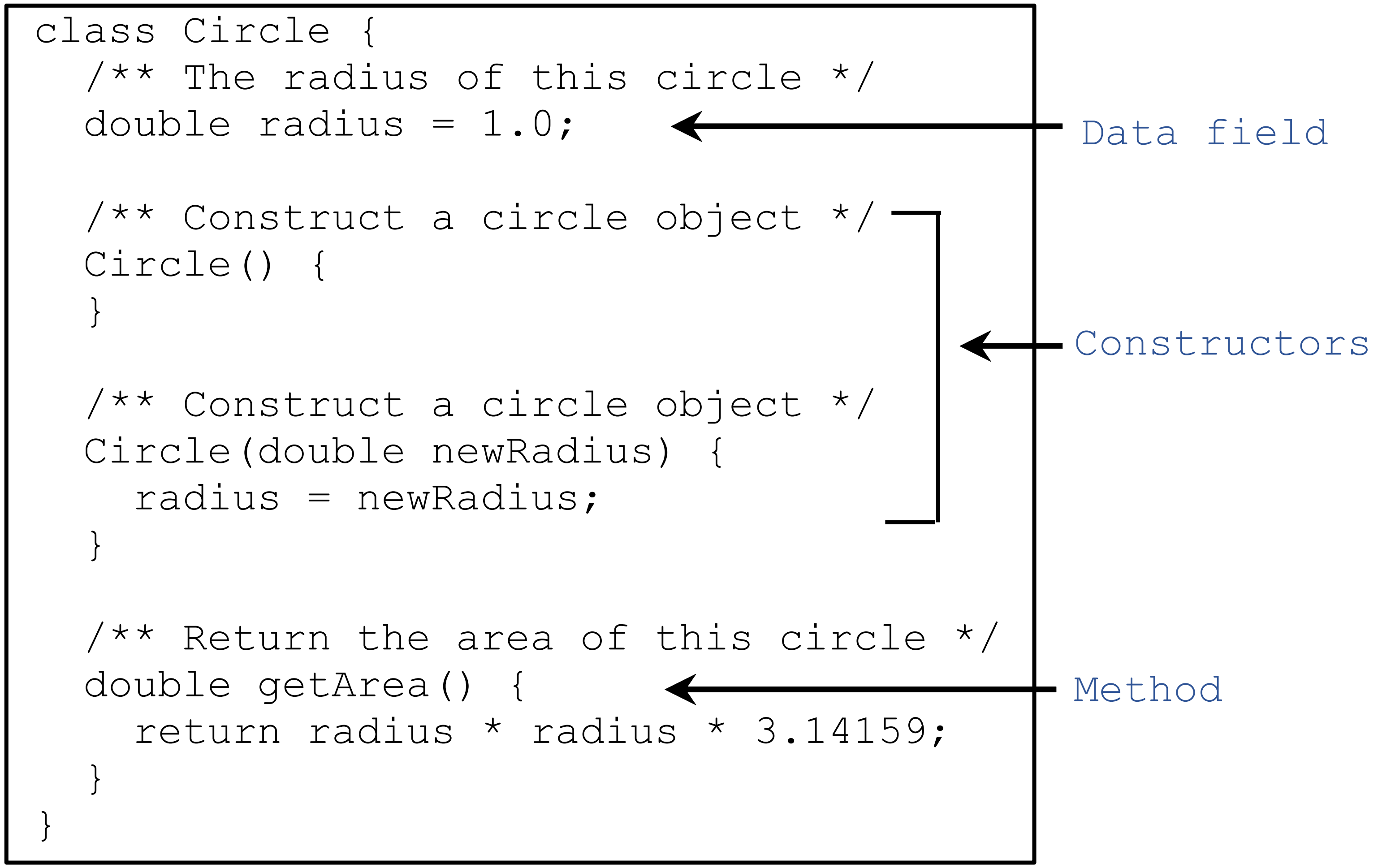
- An object has both a state and behavior
  - The state defines the object
  - The behavior defines what the object does



Classes

- 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 invoked to construct objects from the class

Classes



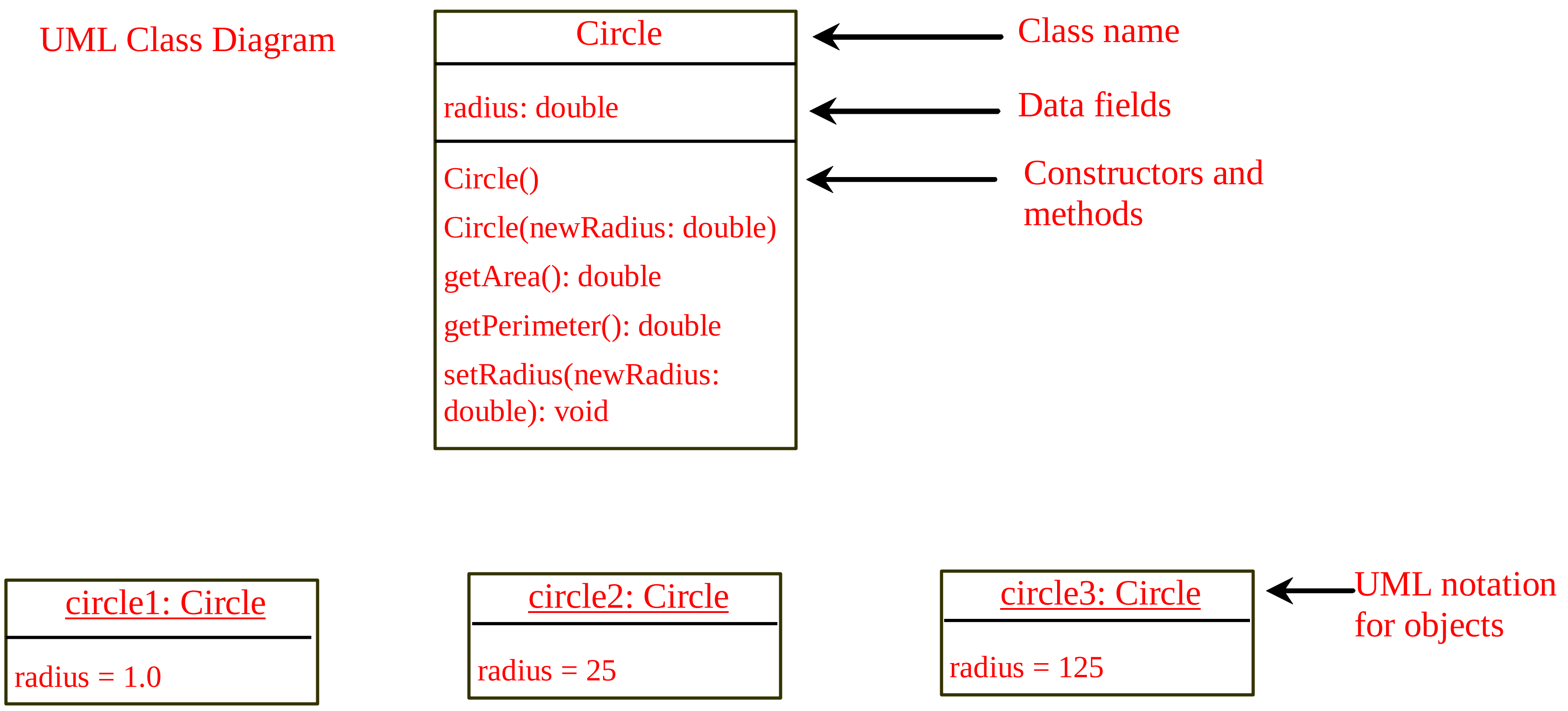
```java
class Circle {
  /** The radius of this circle */
  double radius = 1.0;

  /** 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;
  }
}
```

Unified Modeling Language (UML)



Constructors

- Constructors must have the same name as the class itself
- A constructor with no parameters is referred to as a *no-arg constructor*
  - It is a best practice to provide (if possible) a no-arg constructor for every class (we'll cover why in two weeks)
- Constructors do not have a return type
  - Not even `void`
- Constructors are invoked using the new operator when an object is created
- Constructors play the role of initializing objects

Creating objects using constructors

```
new ClassName();
```

- For example

```
new Circle();
new Circle(5.0);
```

Default constructor

- 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*
  - It is a best practice to provide (if possible) a no-arg constructor for every class (we'll cover why in two weeks)

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;
```

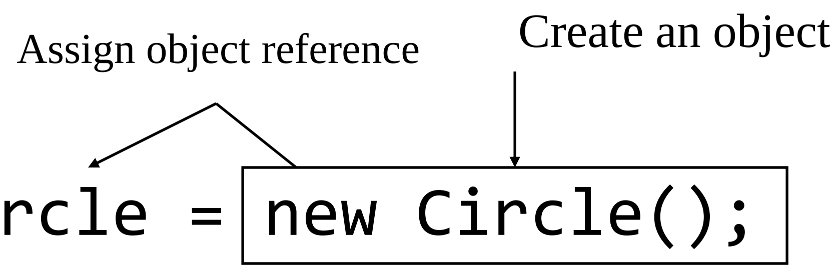
- For example

```
Circle myCircle;
```

Declaring and creating in one step

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

For example



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

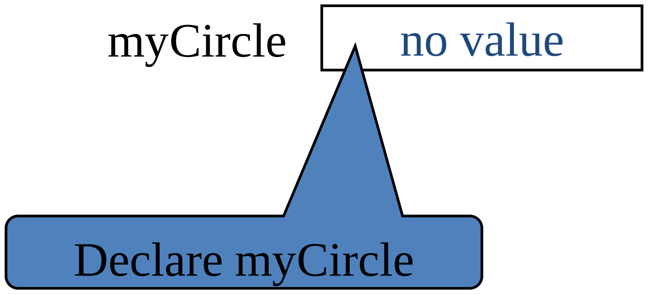
Accessing an object’s members

- Use the *object member access operator*
  - Also called the *dot operator* (`.`)
- Reference the object’s data using
  `objectRefVar.data`
  - For example
    `myCircle.radius`
- Invoke the object’s method using
  `objectRefVar.methodName(arguments)`
  - For example
    `myCircle.getArea()`

Member variables and methods do not use the dot operator to access other member variables and methods within the same class (but, when method formal parameters have the same name as a member, then member variables and methods must be accessed a special way; covered next lecture).

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;
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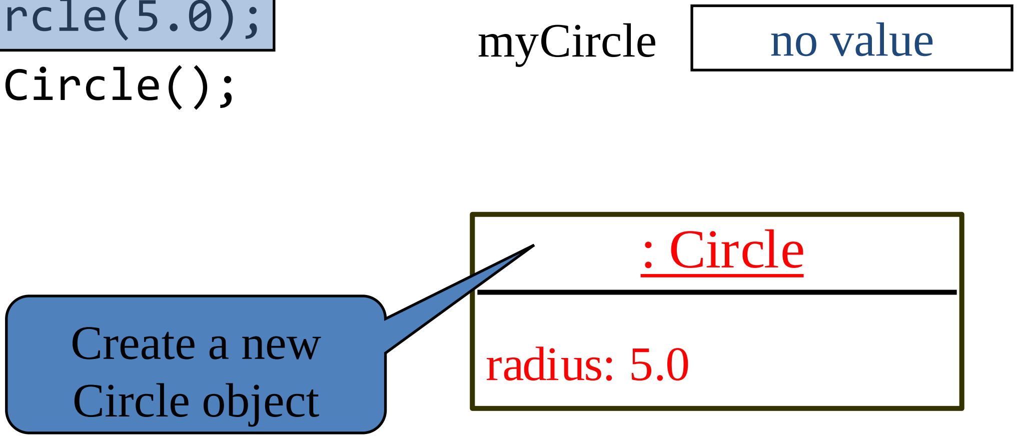

Trace code

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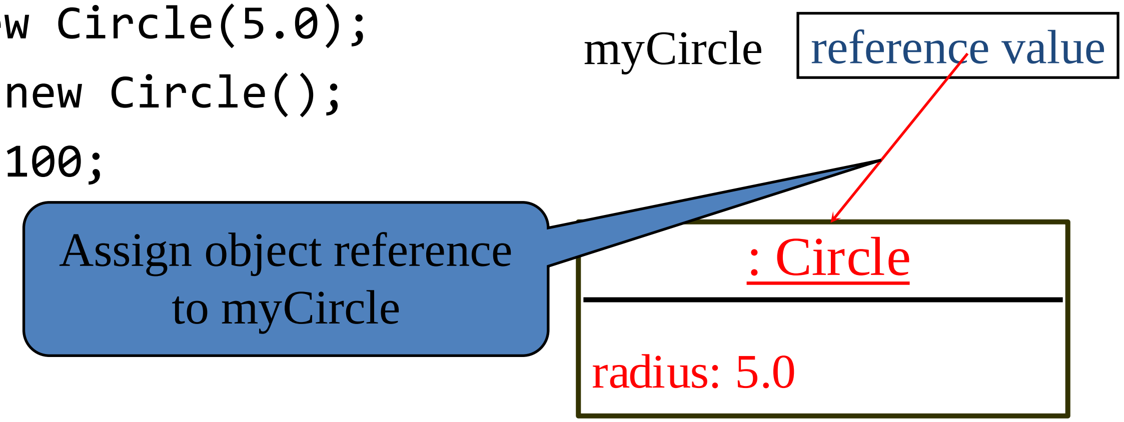

Trace code

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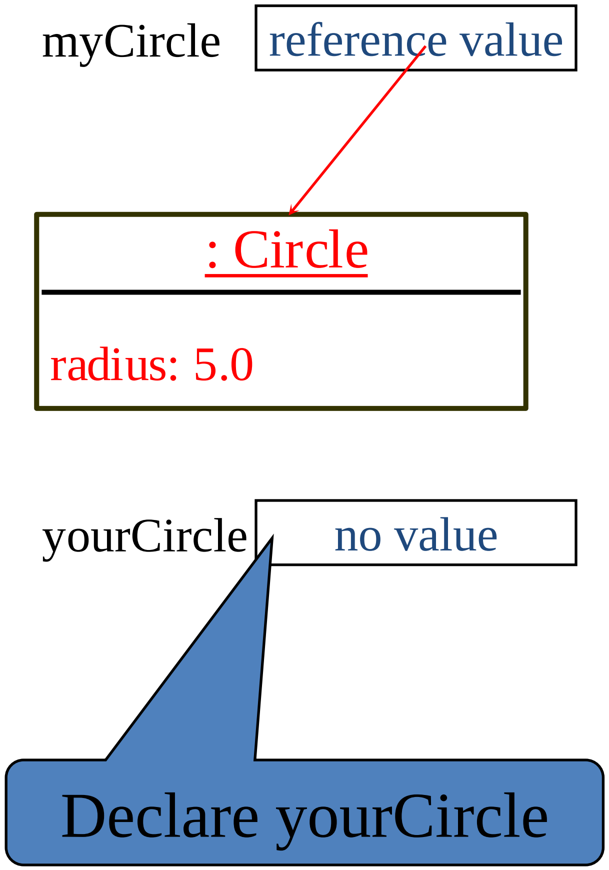
Circle yourCircle = new Circle();
yourCircle.radius = 100;
```



Trace code

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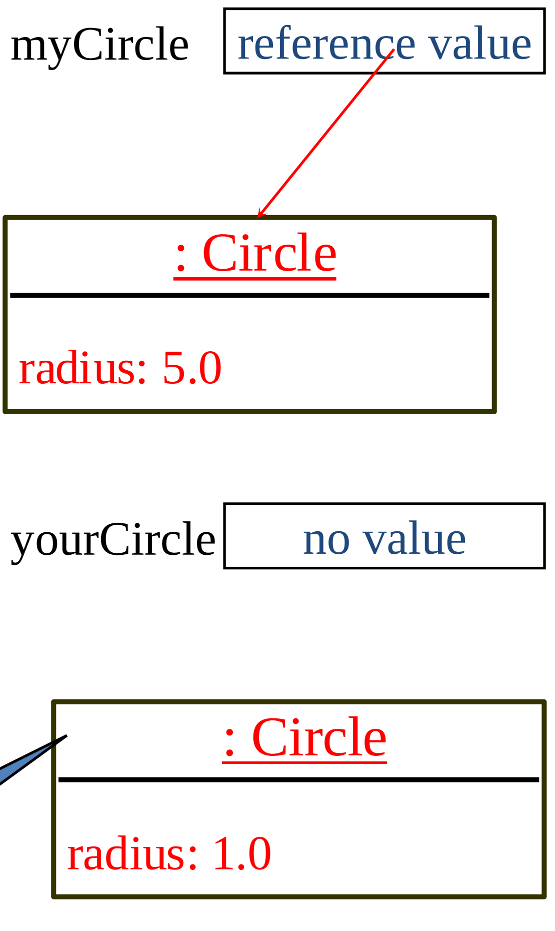

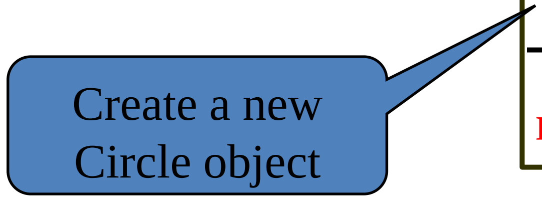

Trace code

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```

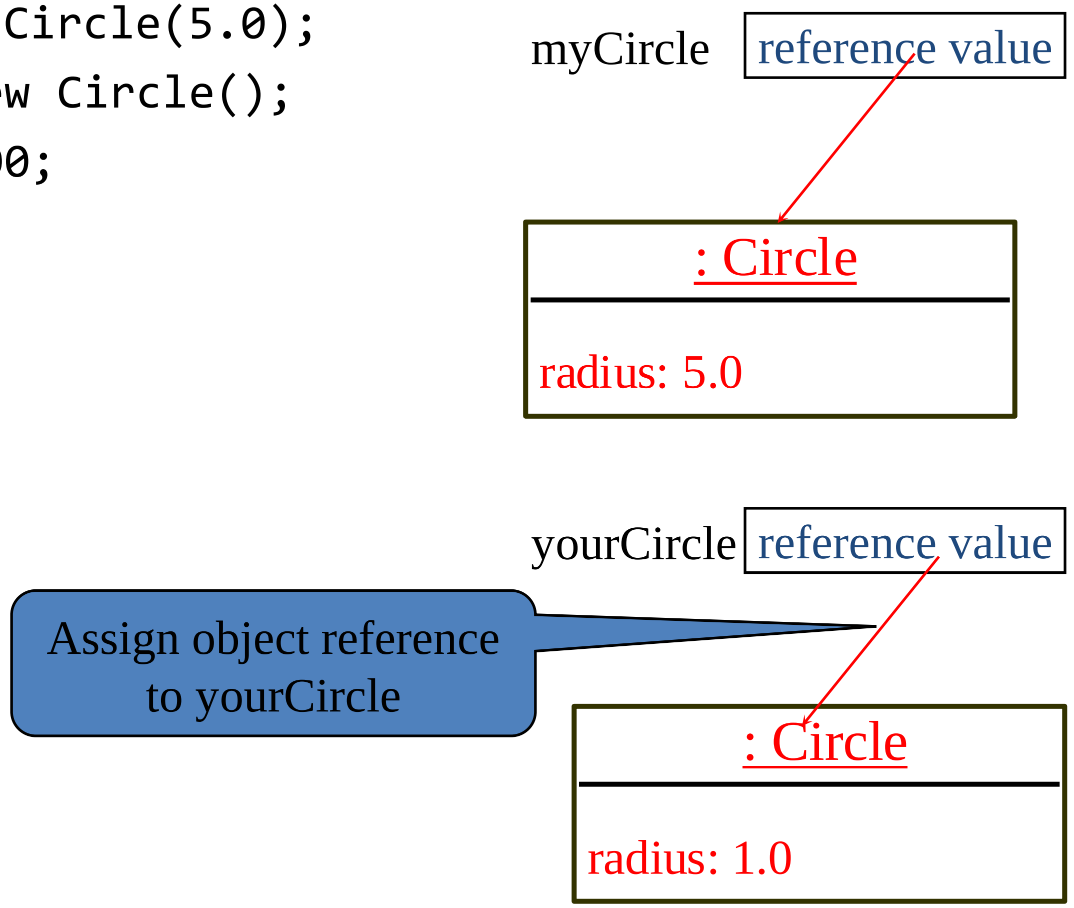

Trace code

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yourCircle.radius = 100;
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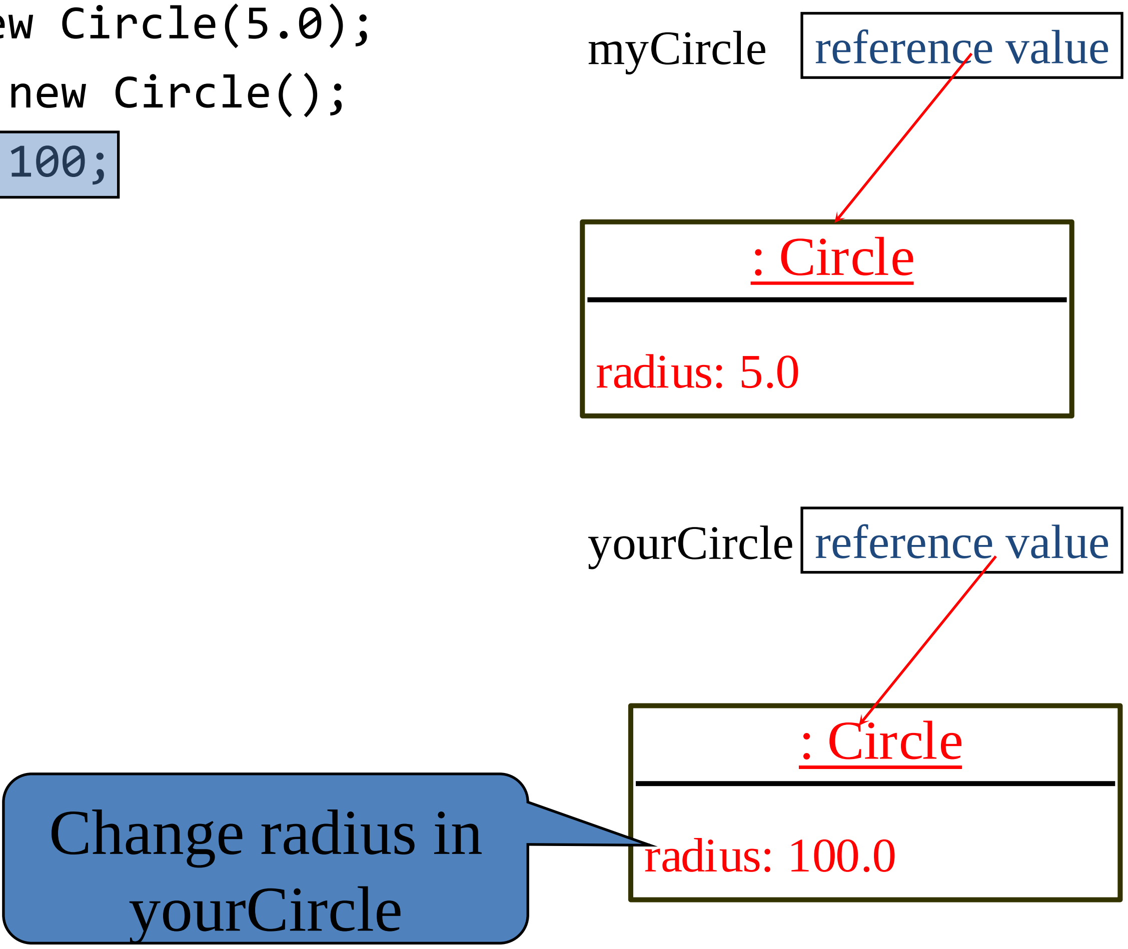


Reference data fields and `null`

- The data fields can be of reference types
- For example, the following `Student` class contains a data field name of the `String` type

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

- If a data field of a reference type does not reference any object, then the data field holds the special Java literal value `null`

Default value for a data field

- The default value of a data field is

  `null` for a reference type

  `0` for a numeric type

  `false` for a `boolean` type

  `'\u0000'` for a `char` type

```
public class Student {
  String name; // name has default value null
  int age; // age has default value 0
  boolean isScienceMajor; // isScienceMajor has default value false
  char gender; // c has default value '\u0000'
}
```

Default values

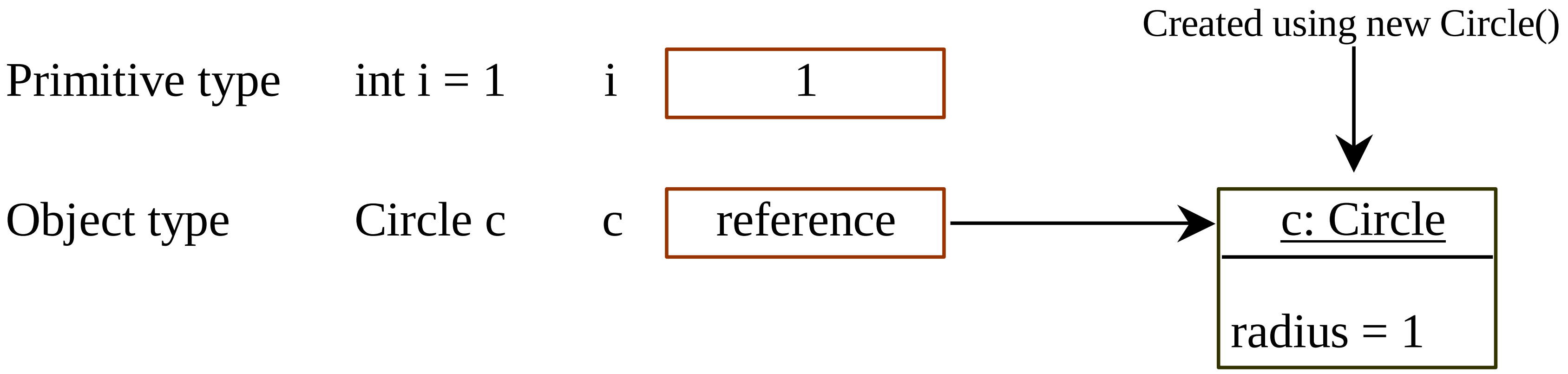
- *Note: Java assigns no default value to a local variable inside a method*

```
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

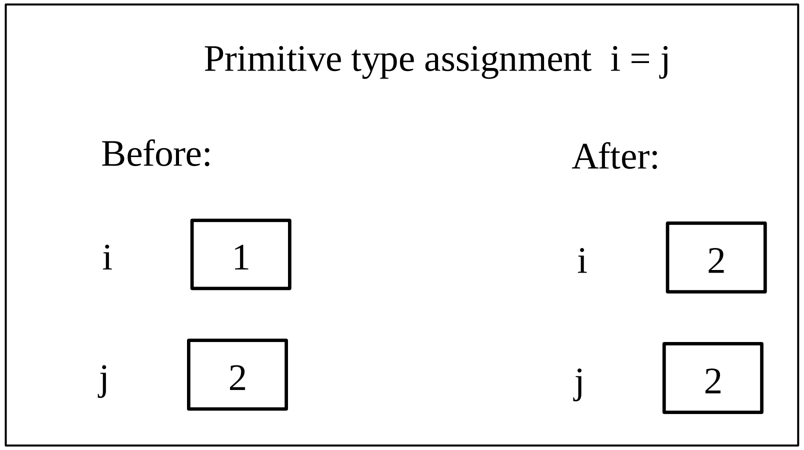
Differences between variables of primitive data types and object types

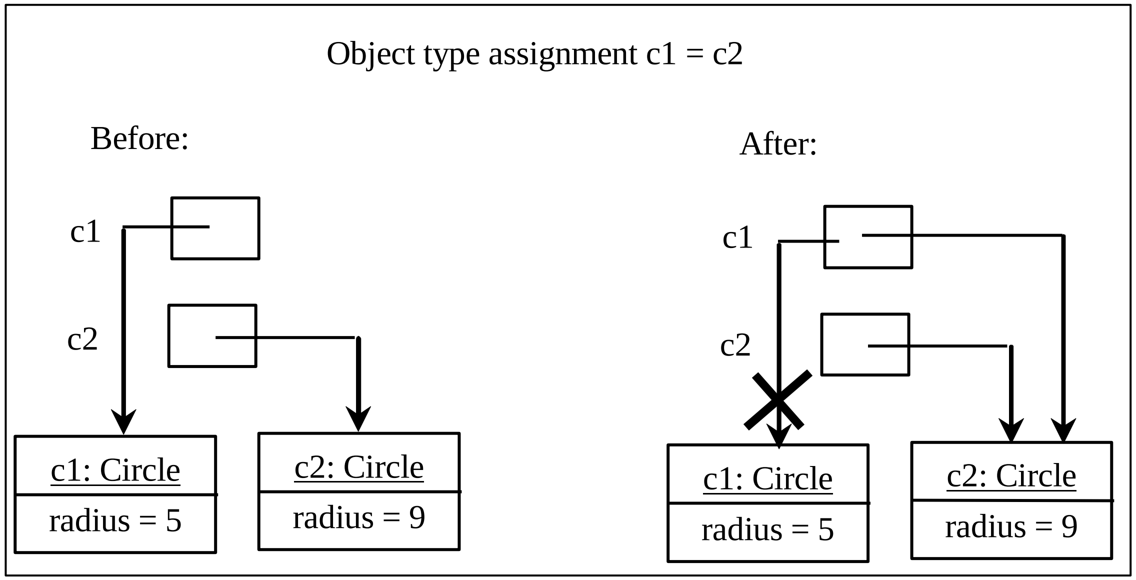
- A variable of a primitive type holds a value of the primitive type
- A variable of a reference type holds a reference to where an object is stored in memory



Differences between variables of primitive data types and object types

- Variable assignment





Garbage and its collection

- If an object is no longer referenced, then it is considered *garbage*
- Garbage occupies memory space
- Garbage collection
  - The JVM will automatically detects garbage and reclaims the space it occupies
- If you know an object is no longer needed, then you can explicitly assign `null` to the object reference variable

Using classes from the Java library

- The Java API contains a rich set of classes for developing Java programs
- Some commonly used ones
  - The `String` class
  - The `java.util.Date` class
  - The `Math` class
  - The `java.util.Random` class
    - More capable than `Math.random` method

Instance methods vs static methods

- An instance method can only be invoked from a specific instance of an object
  - The syntax to invoke an instance method is

    ```
    referenceVariable.methodName(arguments)
    ```
- A static method (i.e., a non-instance method) can be invoked without using an object (i.e., they are not tied to a specific object instance)
  - The syntax to invoke a static method is

    ```
    ClassName.methodName(arguments)
    ```

Next Lecture

- Objects and classes
- Reading
  - Liang
    - Chapter 9