CISC 3115 TY2
Visibility Modifiers and Data Encapsulation

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Outline

- Concept of Java packages

- Visibility modifiers

  - public, private, and no modifiers

- Data encapsulation

Java Packages

- Problem. Programmers need to organize Java classes

  - Imagine that your program consists of more than 1,000 classes …

- Solution. Bundle classes into **packages**

- Any benefits?

  - To make classes easier to find and use

    - Recall that you have created 1,000 classes …

  - To avoid naming conflicts

    - You may want to have two "Student" classes, each with different purposes, thus different methods

  - To control access to the classes (control where we can use the classes in our programs)

Creating Package

- Use the "package" statement as the first non-comment and non-blank statement in the program

- Syntax

    package packagename

- Examples

  - package project1

  - package cisc3115.project1

  - package edu.cuny.brooklyn.cis.cisc3115.project1

Package Naming Convention

- Best Practice

  - Package names should be written in all lower case to avoid conflicting with the names of classes and other data types that you define.

Every Java class belongs in a package

Unnamed Package

- If you do not use a package statement, your class is in an unnamed package.

- Best practice
  - Generally speaking, an unnamed package is only for small or temporary applications or when you are just beginning the development process.

Package: Example

Unnamed package

(the default package)

class Circle {

  double radius;

}

Named package

package cisc3115

class Circle {

  double radius;

}

Package layout corresponds to directory layout

- Where (what directory) should we save the Circle.java file?

  <u>package cisc3115.shape</u>

  class Circle {

     double radius;

  }

Using Package Members

- To use a class in a package, we have three methods that are equal to the Java compiler

  1. Refer to the member by its fully qualified name

  2. Import the package member

  3. Import the member's entire package

Fully Qualified Name

- Fully qualified name

  - Syntax

    packagename.typename

- Example

  - Circle.java

  - TestCircle.java

package cisc3115

class Circle {

  double radius;

}

```
class TestCircle {
    public static void main(String[] args) {
        cisc3115.Circle c1 = new Circle();
        // …
    }
}
```

Import Package Member

- To import a specific member into the current file, Use an <u>import</u> statement at the beginning of the file before any type (e.g., class) definitions but after the package statement, if there is one.

- Syntax

  import packagename.PackageMember

- Example

```
import cisc3115.shape.Circle;
import cisc3115.shape.Square;
class TestShapes {
   public static void main(String[] args) {
      Circle c1 = new Circle();
      Square s1 = new Square();
   }
}
```

```
package cisc3115.shape

class Circle {

   double radius;

}

class Square {

   double length;

}
```

Import Entire Package

- To import a specific member into the current file, Use an <u>import</u> statement at the beginning of the file before any type (e.g., class) definitions but after the package statement, if there is one.

  - Don't use this method

- Syntax

    import packagename.*

- Example
  import cisc3115.shapes.*;

  ```
  class TestShape {
      public static void main(String[] args) {
          Circle c1 = new Circle();
          Square s1 = new Square();
      }
  }
  ```

```
package cisc3115.shape

class Circle {

    double radius;

}

class Square {

    double length;

}
```

Apparent Hierarchies of Packages

- Packages appear to be hierarchical from the naming perspective, but they are not from "importing" perspective

- Example
  - cisc3115 and cisc3115.shape are two packages when you import them.

```
package cisc3115
class Student {
    String name;
}
```

```
package cisc3115.shape
class Circle {
    double radius;
}
```

Apparent Hierarchies of Packages: Exercise

- cisc3115 and cisc3115.shape are two packages when you import them.

- Question: right or wrong?

```
import cisc3115.*;

class TestShapes {
    public static void main(String[] args) {
        Circle c1 = new Circle();
    }
}
```

```
package cisc3115
class Student {
    String name;
}
```

```
package cisc3115.shape
class Circle {
    double radius;
}
```

Apparent Hierarchies of Packages: Exercise: Answer

- cisc3115 and cisc3115.shape are two packages when you import them.

- ## Question: right or wrong?

```
import cisc3115.*;  ✗

class TestShapes {
  public static void main(String[] args) {
    Circle c1 = new Circle();
  }
}
```

```
package cisc3115
class Student {
    String name;
}
```

```
package cisc3115.shape
class Circle {
    double radius;
}
```

Apparent Hierarchies of Packages: Example

- cisc3115 and cisc3115.shape are two packages when you import them.

```
import cisc3115.*;
import cisc3115.shape.*;

class TestShapes {
    public static void main(String[] args) {
        Circle c1 = new Circle();
        Student s1 = new Student();
    }
}
```

```
package cisc3115
class Student {
    String name;
}
```

```
package cisc3115.shape
class Circle {
    double radius;
}
```

Apparent Hierarchies of Packages: Example

- cisc3115 and cisc3115.shape are two packages when you import them.

  - But do not use the method importing entire package

```
import cisc3115.*;
import cisc3115.shape.*;

class TestShapes {
  public static void main(String[] args) {
    Circle c1 = new Circle();
    Student s1 = new Student();
  }
}
```

```
package cisc3115

class Student {

    String name;

}
```

```
package cisc3115.shape

class Circle {

    double radius;

}
```

Questions?

- Concept of package

- How to name a package?

- How to import a package?

- Why do we talk about this?

  - To make types (e.g., classes) easier to find and use

    - What if you created 1,000 classes?

  - To avoid naming conflicts

    - You may want to have two "Student" classes

  - <u>To control access</u>

Visibility Modifier

- No modifier: By default, the <u>class</u>, <u>data field</u>, or <u>method</u> can be accessed by any class in <u>the same package</u>.

  - If you don't explicitly declare which package your class belongs to, the class is in the default package, an unnamed package

  - You may change this using three modifiers, public, private, and protected ("protected" to be discussed in the future) to the class, data field, or method

Public and Private Visibility Modifiers

- public

  - The class, data field, or method is visible to any class in any package.

- private

  - The data field or methods can be accessed only by the declaring class.

Visibility Modifier: Example 1

- Public and private modifiers

```
package p1;

public class C1 {
    public int x;
    int y;
    private int z;

    public void m1() {
    }
    void m2() {
    }
    private void m3() {
    }
}
```

```
package p1;

public class C2 {
    void aMethod() {
        C1 o = new C1();
        can access o.x;
        can access o.y;
        cannot access o.z;

        can invoke o.m1();
        can invoke o.m2();
        cannot invoke o.m3();
    }
}
```

```
package p2;

public class C3 {
    void aMethod() {
        C1 o = new C1();
        can access o.x;
        cannot access o.y;
        cannot access o.z;

        can invoke o.m1();
        cannot invoke o.m2();
        cannot invoke o.m3();
    }
}
```

Visibility Modifier: Example 2

- No modifiers

```
package p1;

class C1 {
    ...
}
```

```
package p1;

public class C2 {
    can access C1
}
```

```
package p2;

public class C3 {
    cannot access C1;
    can access C2;
}
```

Visibility Modifier: Example 3

- Private

```java
public class C {
  private boolean x;

  public static void main(String[] args) {
    C c = new C();
    System.out.println(c.x);
    System.out.println(c.convert());
  }

  private int convert() {
    return x ? 1 : -1;
  }
}
```

(a) This is okay because object **c** is used inside the class **C**.

```java
public class Test {
  public static void main(String[] args) {
    C c = new C();
    System.out.println(c.x);
    System.out.println(c.convert());
  }
}
```

(b) This is wrong because **x** and **convert** are private in class **C**.
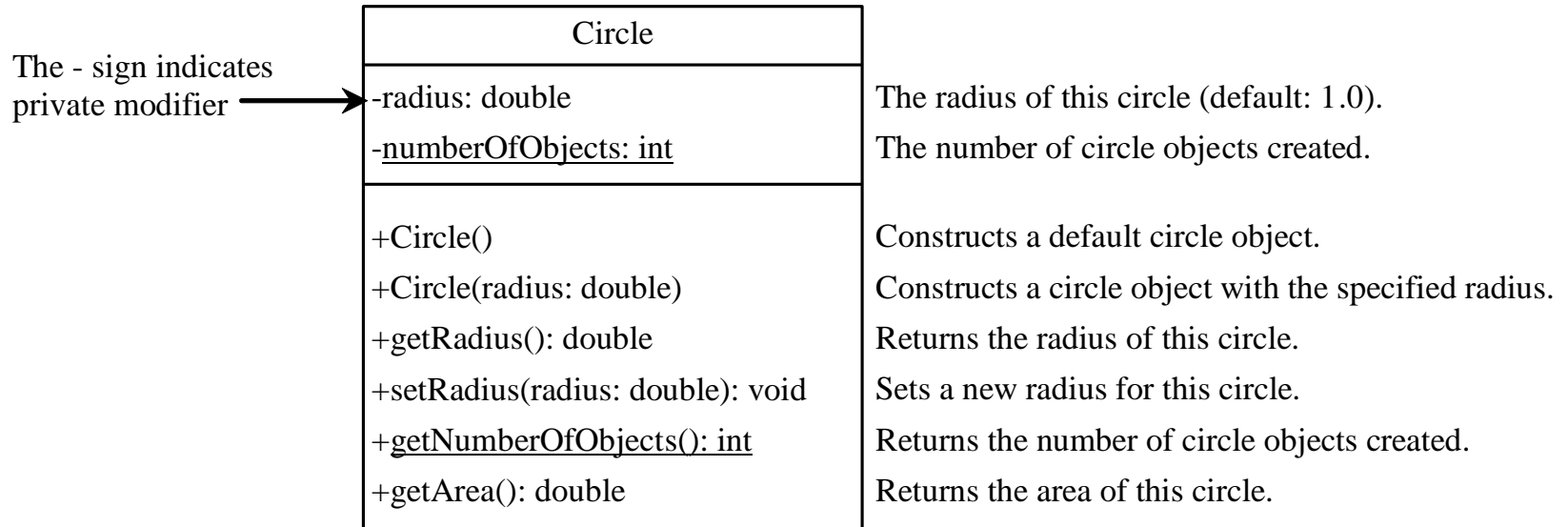
Visibility Modifiers: How to Choose?

- Consider most/more restrictive visibility modifier first, unless you have a good reason not to

  - Generally, make data fields private

  - which make code easy to maintain (why?)

Data Field Encapsulation

- <u>Making data fields private</u> protects data and makes the class easy to maintain

- Why?

  - Data may be tampered with

    - e.g., Circle.numberOfObjects = 3

  - The class becomes difficult to maintain and vulnerable to bugs

    - e.g., statement like c1.radius = -5 can be written in many places

  - Implementation also depends on the data structure

Data Field Encapsulation: Example

The - sign indicates
private modifier →

Circle
-radius: double
-<u>numberOfObjects: int</u>
+Circle()
+Circle(radius: double)
+getRadius(): double
+setRadius(radius: double): void
+<u>getNumberOfObjects(): int</u>
+getArea(): double

The radius of this circle (default: 1.0).

The number of circle objects created.

Constructs a default circle object.

Constructs a circle object with the specified radius.

Returns the radius of this circle.

Sets a new radius for this circle.

Returns the number of circle objects created.

Returns the area of this circle.

Questions

- Visibility modifiers

  - No visibility modifiers

  - Public and private visibility modifiers

- Data field encapsulation

Exercise

- Complete this after the discussion on Java API class Date

- Create a subdirectory (e.g., ex01 or TV) in today's journal entry, and work from the directory

- Take two classes, TV and TestTV as illustrated in Listings 9.3 and 9.4 in the textbook

  - Add a private static data field to the TV class and the data field is to count the number of objects of the TV class that has been created.

  - Add an instance data field to the TV class, called manufacturingDate that references a Date object represent the manufacturing date and time of a TV object.

  - Following the principle of data encapsulation, make data fields private, and make methods public

  - Test the revised program