PROGRAMMING III JAVA LANGUAGE

COURSE 3

PREVIOUS COURSE CONTENT

- **Classes**
- **Objects**
- **Object class**
- **Access control specifier**
  - fields
  - methods
  - classes
- **Organizing classes**

COUSE CONTENT

- ❑ **Inheritance**
  - ❑ Abstract classes
  - ❑ Interfaces
  - ❑ `instanceof` operator
- ❑ **Nested classes**
- ❑ **Enumerations**

RELATION BETWEEN CLASSES

- **What relations between classes exists?**
  - Associations
    - Dependency
    - Association
    - Aggregation
    - Composition
  - Inheritance

INHERITANCE

- **Inheritance is a mechanism which allows a class A to inherit members (data and functions) of a class B. We say “A inherits from B”. Objects of class A thus have access to members of class B without the need to redefine them.**
- **Terminology**
  - Base class
    - The class that is inherited
  - Derived class
    - A specialization of base class
  - Kind-of relation
    - Class level (Circle is a kind-of Shape)
  - Is-a relation
    - Object level (The object circle1 is-a shape.)
  - Types of inheritance
    - Simple
      - One base class
    - Multiple - NOT SUPPORTED IN JAVA
      - Multiple base classes

SIMPLE INHERITANCE

- **Syntax**
  - `[ClassSpecifier] class ClassName extends BaseClassName { ... }`

- **Example**

```
public class Figure {
      Color color;
      public Figure() {
           this.color = Color.RED;
      }
}
public class Circle extends Figure {
       int radius;
       int centerX, centerY;
       ...
}
```

- **A class inherits a single base class**

SIMPLE INHERITANCE. CONSTRUCTORS

- **super keyword**
  - Reference to the base class

- **Example**

```
public class Figure {
   Color color;

    public Figure() {
       this.color = Color.RED;
    }

    public Figure (Color c) {
       this.color = c
    }

    public String toString(){
       return "color: " +
this.color;
    }
}
```

```
public class Circle extends Figure {
   int radius;
   int centerX, centerY;

   public Circle(){
       super();
   }

   public Circle (int r, int x,
                   int y, Color c) {
        super(c);
        this. radius = r;
        this.centerX = x;
        this.centerY = y;
   }

   public String toString() {
        return "["+ this.radius + ",(" +
           this.centerX + "," +
           this.centerY + "), " +
           super.toString() + "]";
       }
}
```

ABSTRACT CLASSES

- **Abstract classes is a class declared abstract**
  - It may or not include abstract methods

- **Abstract method**
  - Method that is only declared without an implementation
  - Example
    - `public abstract void fooMethod(int par1);`

- **Properties**
  - Abstract classes cannot be instantiated
  - Can contain abstract and non abstract methods
  - Can contain fields that are not static or final

INTERFACES

- **Interfaces**
  - similar to class
  - API - Application Programming Interfaces
    - a "contract" that spells out software interactions
  - Can contain only
    - constants
    - method signature
    - default methods
    - static methods
    - nested types
  - Syntax

```
[interfaceModiefier] interface InterfaceName [implements
Inteface1 [, ..InterfaceN]]{ ... }
```

    - where
      - interfaceModiefier: package, public

INTEFACES

- ❑ **Inheritance**
  - ❑ a class can inherit multiple interfaces
  - ❑ An instance method in a subclass with the same signature (name, plus the number and the type of its parameters) and return type as an instance method in the superclass overrides the superclass's method
  - ❑ An overriding method can also return a subtype of the type returned by the overridden method. This subtype is called a covariant return type

- ❑ **Multiple inheritance**
  - ❑ Multiple inheritance is the ability to inherit method definitions from multiple base (super) classes
  - ❑ Java supports multiple inheritance of type, which is the ability of a class to implement more than one interface

INTERFACES CAN BE EXTENDED

- **Creation (definition) of interfaces can be done using inheritance**
  - one interface can extend another.

- **Sometimes interfaces are used just as labeling mechanisms**
  - Look in the Java API documentation for interfaces like Cloneable or Serializable.
    - Optional
      - read about Marker design pattern and annotations

- **All interface methods are by default public so they do not need to be declared public**

INTERFACES

- **Java 1.8**
  - Methods with implementation
  - Types
    - `default` methods
    - `static` methods
- **Java 1.9**
  - Private methods
  - Private Static methods

INTERFACES. DEFAULT METHODS

- **Enable the add of new functionalities to interfaces without breaking the classes that implements that interface**

- **Example**

```
interface InterfaceA {
    public void saySomething();
    default public void sayHi() {
        System.out.println("Hi");
    }
}
```

```
public class MyClass implements InterfaceA {

    @Override
    public void saySomething() {
        System.out.println("Hello World");
    }
}
```

INTERFACES. DEFAULT METHODS

- ❑ **Conflicts with multiple interfaces**
  - ❑ Problem
    - ❑ One or more interfaces has a default method with the same signature
  - ❑ Solution
    - ❑ Provide implementation for the method in derived class
      - ❑ New implementation
      - ❑ Call one of the interfaces implementation

INTERFACES. STATIC METHODS

- Similar to default method except that can't be override in subclasses implementation
- Contain the complete definition of the function
- To use a static method, Interface name should be instantiated with it
- Example

```
public interface MyData {
   static boolean isNull(String str) {
       System.out.println("Interface Null Check");
       return str == null ? true : "".equals(str) ? true : false;
    }
}
public class MyDataImpl implements MyData {
    public boolean isNull(String str) {
      System.out.println("Impl Null Check");
      return str == null ? true : false;
    }
    public static void main(String args[]){
      MyDataImpl obj = new MyDataImpl();
      obj.isNull("abc");
    }
}
```

What is the result of the program?

a) Interface Null Check

b) Impl Null Check

Answer

a)

INTERFACES. PRIVATE METHODS

- **No need to write duplicate code, hence more code reusability.**
- **Expose only intended methods implementations to clients.**
- **Example**

```
public interface MyLogging{
   default void infoLog(String msg){
      log(“INFO”, msg);
   }
   default void infoErr(String msg){
      log(“Error”, msg);
   }
   private void log(String prefix, String msg){
      // write into a database or file
   }
    // other abstract methods
}
```

The class that uses the logging interface does not have to create an instance of the MyLogging object

FUNCTIONAL INTERFACES

- **An interface with exactly one abstract method is known as Functional Interface**
  - annotation `@FunctionalInterface` mark an interface as Functional Interface
  - lambda expressions

CASTING OBJECTS

- **A object of a derived class can be cast as an object of the base class**

- **When a method is called, the selection of which version of method is run is totally dynamic**
  - overridden methods are dynamic

POLYMORPHISM

- **A reference can be polymorphic, which can be defined as "having many forms"**
  - obj.doIt();
  - This line of code might execute different methods at different times if the object that obj points to changes
- **Polymorphic references are resolved at run time; this is called dynamic binding**
- **Careful use of polymorphic references can lead to elegant, robust software designs**
- **Polymorphism can be accomplished using inheritance or using interfaces**

INSTANCEOF

- **Knowing the type of an object during run time**

- **Usage**
  - object `instanceof` type

- **It can be very useful when writing generalized routines that operate on objects of a complex class hierarchy**

- **It will cause a compiler error if the comparison is done with objects which are not in the same class hierarchy.**

- **Returns true if the type could be cast to the reference type without causing a `ClassCastException`, otherwise it is false.**

NESTED CLASSES

- **Define a class within another class**

- **Why use nested classes?**
  - It is a way of logically grouping classes that are only used in one place
  - It increases encapsulation
  - It can lead to more readable and maintainable code

- **Types**
  - Static member classes
  - Member classes
  - Local classes
  - Anonymous classes

NESTED CLASSES

- **Types**
  - Static member classes
    - is a static member of a class
    - a static member class has access to all static methods of the parent, or top-level, class.
  - Member classes
    - is also defined as a member of a class
    - is instance specific and has access to any and all methods and members, even the parent's this reference
  - Local classes
    - are declared within a block of code and are visible only within that block
  - Anonymous classes
    - is a local class that has no name

NESTED CLASSES

- Example

```
public class Outer{
      private class Inner
      {
            // inner class instance variables
            // inner class methods

      } // end of inner class definition

      // outer class instance variables
      // outer class methods
}
```

PUBLIC INNER CLASSES

- ❑ If an inner class is marked public, then it can be used outside of the outer class

- ❑ In the case of a nonstatic inner class, it must be created using an object of the outer class

```
BankAccount account = new BankAccount();
BankAccount.Money amount = account.new Money("41.99");
```

- ❑ Note that the prefix account. must come before new

- ❑ The new object amount can now invoke methods from the inner class, but only from the inner class

PUBLIC INNER CLASSES

- **In the case of a static inner class, the procedure is similar to, but simpler than, that for nonstatic inner classes**

```
OuterClass.InnerClass innerObject =
                new OuterClass.InnerClass();
```

- **Note that all of the following are acceptable**

```
innerObject.nonstaticMethod();
innerObject.staticMethod();
OuterClass.InnerClass.staticMethod();
```

INNER CLASS AND INHERITANCE

- ❑ **Given an OuterClass that has an InnerClass**
  - ❑ Any DerivedClass of OuterClass will automatically have InnerClass as an inner class
  - ❑ In this case, the DerivedClass cannot override the InnerClass

- ❑ **An outer class can be a derived class**

- ❑ **An inner class can be a derived class**

ANONYMOUS CLASSES

- **If an object is to be created, but there is no need to name the object's class, then an anonymous class definition can be used**
  - The class definition is embedded inside the expression with the new operator
  - An anonymous class is an abbreviated notation for creating a simple local object "in-line" within any expression, simply by wrapping the desired code in a "new" expression.

- **Anonymous classes are sometimes used when they are to be assigned to a variable of another type**
  - The other type must be such that an object of the anonymous class is also an object of the other type
  - The other type is usually a Java interface

ANONYMOUS CLASSES

- **Example**

```
interface Foo {
    void doSomething();
}
public class Test {
    public static void main (String args[]) {
          Foo obj = new Foo(){
                 void doSomething(){
                        System.out.println(“test”);
                 }
          };
          obj.doSomething();
    }
}
```

Anonymous Class

ENUMERATIONS

- Enumerated values are used to represent a set of named values

- These were often stored as constants.

- For example

```
public static final int SUIT_CLUBS = 0;
public static final int SUIT_DIAMONDS = 1;
public static final int SUIT_HEARTS = 2;
public static final int SUIT_SPADES = 3;
```

ENUMERATIONS

- **Issues with previous approach**
  - Acceptable values are not obvious
    - Since the values are just integers, it's hard at a glance to tell what the possible values are.
  - No type safety
    - Since the values are just integers, the compiler will let you substitute any valid integer
  - No name-spacing
    - With our card example, we prefixed each of the suits with "SUIT_" .
    - We chose to prefix all of those constants with this prefix to potentially disambiguate from other numerated values of the same class.
  - Not printable
    - Since they are just integers, if we were to print out the values, they'd simply display their numerical value.

ENUMERATIONS

- **Java 5 added an** `enum` **type to the language**

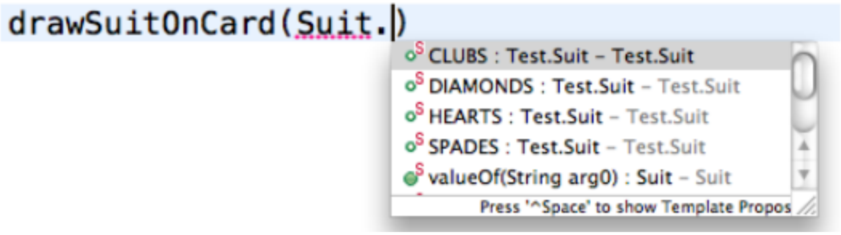
- **Declared using the** `enum` **keyword instead of** `class`

- **Simplest form, contains a comma separated list of names representing each of the possible options.**

```
public enum Suit { CLUBS, DIAMONDS, HEARTS,
SPADES }
```

ENUMERATIONS

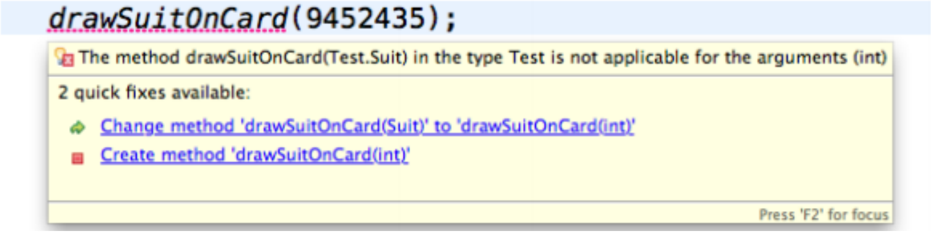
- ❑ **Acceptable values are now obvious — must choose one of the Suit enumerated values…**



```
drawSuitOnCard(Suit.)
```

CLUBS : Test.Suit – Test.Suit
DIAMONDS : Test.Suit – Test.Suit
HEARTS : Test.Suit – Test.Suit
SPADES : Test.Suit – Test.Suit
valueOf(String arg0) : Suit – Suit
Press '^Space' to show Template Propos

Type safety — possible values are enforced by the compiler



```
drawSuitOnCard(9452435);
```

The method drawSuitOnCard(Test.Suit) in the type Test is not applicable for the arguments (int)

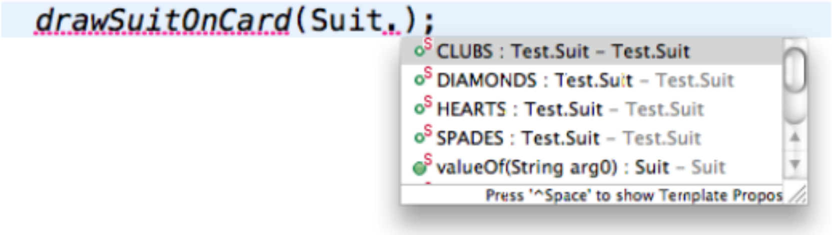
2 quick fixes available:

Change method 'drawSuitOnCard(Suit)' to 'drawSuitOnCard(int)'
Create method 'drawSuitOnCard(int)'

Press 'F2' for focus

ENUMERATIONS

- **Every value is name-spaced off of the enum type itself.**



```
drawSuitOnCard(Suit.);
```

CLUBS : Test.Suit – Test.Suit
DIAMONDS : Test.Suit – Test.Suit
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Press '^Space' to show Template Propos

- **Printing the enum value is actually readable.**

```
System.out.print("Card is a Queen of " + Suit.HEARTS);
```

ENUMERATIONS

- **Additional Benefits**
  - Storage of additional information
  - Retrieval of all enumerated values of a type
  - Comparison of enumerated values

ENUMERATIONS. ADDITIONAL BENEFITS

- **Enums are objects**
  - So they can have…
    - Member variables
    - Methods
- **For example…**
  - Embed the color of the suit within the Suit.
  - Read the value using a getter, etc.

```
public enum Suit {
            CLUBS(Color.BLACK),
            DIAMONDS(Color.RED),
            HEARTS(Color.RED),
            SPADES(Color.BLACK);
            private Color color;

            Suit(Color c) {
                        this.color = c;
            }
            public Color getColor() {
                        return this.color;
            }
}
```

Constructor, add supplementary information

Method to access supplementary information

How to use?

```
public static void main(String[] args) {
  Suit s = Suit.CLUBS;
  System.out.println("Card color: " + s.getColor());
}
```

ENUMERATIONS. ADDITIONAL BENEFITS

RETRIEVAL OF ALL ENUMERATED VALUES

- **All enum types will automatically have a `values()` method that returns an array of all enumerated values for that type.**

```
Suit[ ] suits =
Suit.values();
for(Suit s : suits) {
      System.out.println(s
);
}
```

COMPARISON OF ENUMERATED VALUES

- **It is possible to compare enums using the == operator.**

```
if(suit == Suit.CLUBS) {
// do something
}
```

- **can also be used with the switch control structure**

```
Suit suit = /* ... */;
switch (suit) {
      case CLUBS:
      case SPADES:
          // do something
          break;
      case HEARTS:
      case DIAMONDS:
          // do something else
          break;
    default:
      // yet another thing
      break;
}
```