PROGRAMMING III
OOP. JAVA LANGUAGE

COURSE 3

PREVIOUS COURSE CONTENT

- **Classes**
- **Objects**
- **Object class**
- **Acess control specifier**
  - fields
  - methods
  - classes

COUSE CONTENT

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

RELATION BETWEEN CLASSES

- What relation between classes exists?

RELATION BETWEEN CLASSES

- **What relations between classes exists?**
  - Associations
    - Dependence
    - Association
    - Agregation
    - 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 BaseClass { ... }
- **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**
- **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 abstrat**
  - It may or not include abstract methods
- **Abstract method**
  - Method that is only declared without an implementation
  - Example: public static 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
  - All interface methods are by default public so they do not need to be declared public

INTERFACES

- **Interfaces**
  - simlar 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
      - reade about Marker design pattern and annotations

INTERFACES

- **default methods**
  - from java 8
  - 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 interface
    - problem
      - 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 intefaces implementation
- **static methods**
  - from java 8
  - similar to default method except that can’t be override in subclasses implementation

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 also**

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();
        }
}
```

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

- **number of 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.

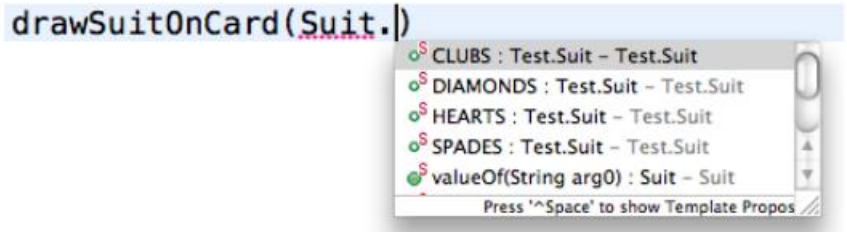
ENUMERATIONS

- **Java 5 added an enum type to the language**
- **Declared using the enum keyword instead of class**
- **In its simplest form, it contains a commaseparatedl ist of names representing each of the possible options.**

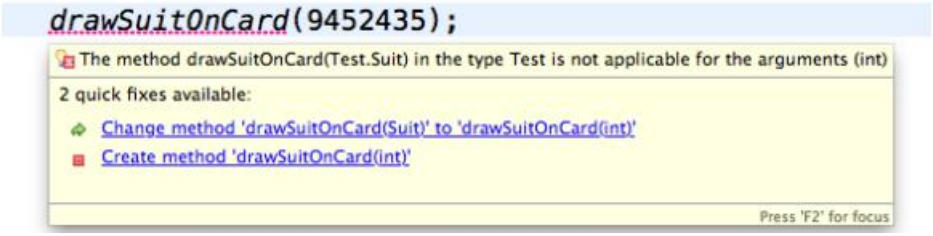
  public enum Suit { CLUBS, DIAMONDS, HEARTS, SPADES }

ENUMERATIONS

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

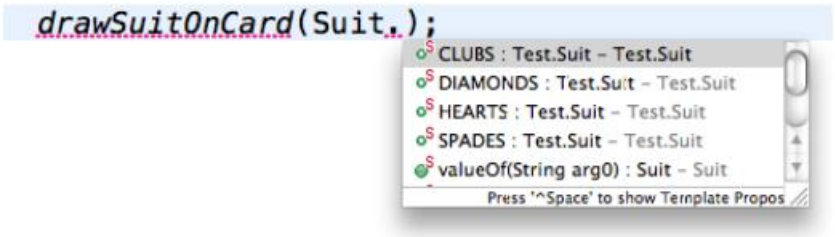


Type safety — possible values are enforced by the compiler



ENUMERATIONS

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



- 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…**
  - We could embed the color of the suit within the Suit.
  - We can then 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;
        }
}
```

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;
}
```

COURSE TEST

- **True or False**

  1. Java allows multiple inheritance
  2. Abstract classes can be instantieted
  3. It is imposible to declare a class inside other class
  4. Inheritance is a type of polymorfis
  5. From java 8 interfaces ca contain metods that are implemented in an inteface

- **What is the usage of equals() and hashCode() methods? In which situation you need to provide a custom behaviour? (homework from previous course)**