Tutorial of Enum

> Based on the tutorial of "2020S-Java-A" designed by teaching group in SUSTech
>
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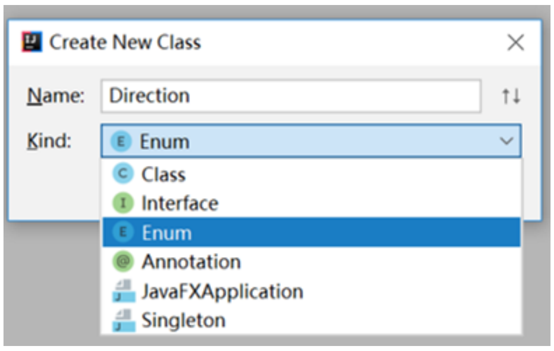
Objective

- Learn to use `enum` types.

Part 1: Enumerations

An `enum` type is a special data type that enables a variable to be a set of predefined constants. The variable must be equal to one of the values that have been predefined for it. For example, a week has seven days (MONDAY to SUNDAY).

A `enum` type is declared using the `enum` keyword, not class. Let's create a new `enum` type Direction with four constants named "NORTH", "SOUTH", "EAST", and "WEST", respectively. In IDEA, creating a new `enum` type is similar to creating a new class. The only difference is to select `Enum` in the dropdown list.



```java
package sustech.cs109.lab10;

public enum Direction {
    NORTH, SOUTH, EAST, WEST // semicolon unnecessary
}
```

Variables of this `enum` type Direction can only receive the values of the four `enum` constants. For example, the following code creates an object of this `enum` type.

```java
package sustech.cs109.lab10;

public class DirectionTest {
    public static void main(String[] args) {
        Direction d = Direction.EAST;
        System.out.println(d);
    }
}
```

The above code prints `EAST`. The last statement in the main method is equivalent to `System.out.println(d.toString())`. The `toString()` method returns the name of the `enum` constant EAST.

In the code, we cannot create an object of the `enum` type using the "new" operator with a constructor call. If you compile the following code, you will receive the error message "Enum types cannot be instantiated".

```
public Direction d = new Direction();
```

This is because under the hood, every `enum` type is internally implemented using class (the compiler will create a private constructor that cannot be called outside the `enum` type).

```
public final class Direction extends Enum {
public static final Direction NORTH = new Direction();
public static final Direction SOUTH = new Direction();
public static final Direction EAST = new Direction();
public static final Direction WEST = new Direction();
} // simplified for illustration
```

From this internal view, we can see that NORTH, SOUTH, EAST, WEST are no more than four class variables pointing to four Direction objects. The final modifier makes them constants.

An `enum` type variable can be passed as an argument to a `switch` statement.

```
package sustech.cs109.lab10;

public class DirectionTest {

  private Direction d;

  public DirectionTest(Direction d) {
    this.d = d;
  }

  public Direction getDirection() {
    return d;
  }

  public static void main(String[] args) {
    DirectionTest test = new DirectionTest(Direction.EAST);
    switch(test.getDirection()) {
      case EAST: // must be unqualified name of the enum constant
        System.out.println("Countries in the east: Japan, Korea");
        break;
      case WEST:
        System.out.println("Countries in the west: US, Germany");
        break;
      case SOUTH:
        System.out.println("Countries in the south: Australia, New Zealand");
        break;
      case NORTH:
        System.out.println("Countries in the north: Russia, Mongolia");
        break;
    }
  }
}
```

When declaring an `enum` type, besides the `enum` constants, we can also declare other members such as constructors, fields and methods. A `enum` type constructor can specify any number of parameters and can be overloaded, but it cannot have the access modifier public (must be private or no-modifier, meaning package private).

```java
package sustech.cs109.lab10;

public enum Book {
    JHTP("Java: How to Program", "2012"),
    CHTP("C: How to Program"),
    CPPHTP("C++: How to Program", "2012"),
    VBHTP("Visual Basic: How to Program", "2011"),
    CSHARPHTP("Visual C#: How to Program");

    private final String title;
    private final String year;

    private Book(String title, String year) {
        this.title = title;
        this.year = year;
    }

    private Book(String title) {
        this.title = title;
        this.year = "no info";
    }

    public String getTitle() {
        return title;
    }

    public String getYear() {
        return year;
    }
}
```

In the `enum` type Book, there are two fields: title and year. They are declared to be constants since `enum` type objects only receive predefined constant values (`enum` constants). There are two getter methods. There are two overloaded constructors. The two constructors are used in the declarations of the `enum` constants. For example, when declaring the `enum` constant CHTP, the one-argument constructor is used.

We can further write the following program to test the `enum` type.

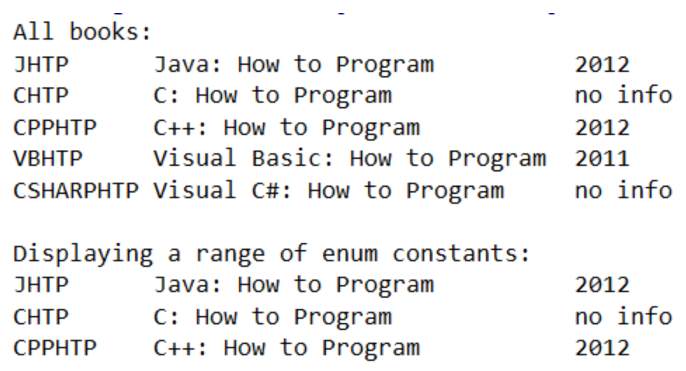
```java
package sustech.cs109.lab10;
import java.util.EnumSet;

public class BookTest {
    public static void main(String[] args) {
        System.out.println("All books:");

        for (Book book : Book.values()) {
            System.out.printf("%-10s", book);
            System.out.printf("%-30s", book.getTitle());
            System.out.printf("%s\n", book.getYear());
        }
        System.out.println("\nDisplaying a range of enum constants:");

        for(Book book : EnumSet.range(Book.JHTP, Book.CPPHTP)) {
            System.out.printf("%-10s", book);
            System.out.printf("%-30s", book.getTitle());
            System.out.printf("%s\n", book.getYear());
        }
    }
}
```

The code prints:



```
All books:
JHTP      Java: How to Program          2012
CHTP      C: How to Program             no info
CPPHTP    C++: How to Program           2012
VBHTP     Visual Basic: How to Program  2011
CSHARPHTP Visual C#: How to Program     no info

Displaying a range of enum constants:
JHTP      Java: How to Program          2012
CHTP      C: How to Program             no info
CPPHTP    C++: How to Program           2012
```

In the above example, only five Book objects will be created. The constants such as `Book.JHTP` stores the references to the objects.

The values() method is a static method that is automatically generated by the compiler to return an array of the `enum` constants (an array of references to the objects of the `enum` type).

The static method range() of generic class `EnumSet` returns a collection of the `enum` constants in the range specified by two endpoints. In the above code, range() takes two `enum` constants as arguments. The first constant should be declared before the second (the ordinal() method of a `enum` constant can return the position of the constant in all declared constants). If this constraint is violated (for example, when `EnumSet.range(Book.CPPHTP, Book.JHTP)` is used in the code), an `java.lang.IllegalArgumentException` will be thrown.

Exercise

1. Create an `enum` type `PhoneModel`, which contains the following constants: `IPHONE, HUAWEI, PIXEL, SAMSUNG, LG`.
2. Create a field named `price (int type)`. Write a getter method for this field.
3. Create a one-argument constructor `PhoneModel(int price)` that can be used to create the `enum` constants. The prices for the five models are: 9999, 8888, 6666, 9399, 5588.
4. Write a test program. It contains a main method that recommends possible phones for a user based on the user’s budget.

   Three sample runs:

   ```
   Enter your budget: 4000
   You do not have sufficient money.
   ```

```
Enter your budget: 8888
---Recommended Phone List---
HUAWEI          price: 8888
PIXEL           price: 6666
LG              price: 5588
```

```
Enter your budget: 10000
---Recommended Phone List---
IPHONE          price: 9999
HUAWEI          price: 8888
PIXEL           price: 6666
SAMSUNG         price: 9399
LG              price: 5588
```