Agenda

- instanceof
- Final Method & Class
- Object class
- Methods of object class
    - toString()
    - equals()
- Abstract class/method
- ~~Interfaces~~
- ~~Marker interfaces~~

instanceof operator

- Java's instanceof operator checks if given reference points to the object of given type (or its sub-class) or not. Its result is boolean.
- Typically "instanceof" operator is used for type-checking before down-casting.

```java
Person p = new SomeClass();
if(p instanceof Employee) {
    Employee e = (Employee)p;
    System.out.println("Salary: " + e.getSalary());
}
```

final Method

- If implementation of a super-class method is logically complete, then the method should be declared as final.
- Such final methods cannot be overridden in sub-class. Compiler raise error, if overridden.
- But final methods are inherited into sub-class i.e. The super-class final methods can be invoked in sub-class object (if accessible).

final Class

- If implementation of a super-class is logically complete, then the class should be declared as final.
- The final class cannot be extended into a sub-class. Compiler raise error, if inherited.
- Effectively all methods in final class are final methods.
- Examples of final classes
    - java.lang.Integer (and all wrapper classes)
    - java.lang.String
    - java.lang.System

Object class

- Non final and non-abstract class declared in java.lang package.

- In java, all the classes (not interfaces) are directly or indirectly extended from Object class.

- In other words, Object class is ultimate base class/super class hierarchy.

- Object class is not inherited from any class or implement any interface.

- It has a default constructor. Object o = new Object();

- Object class methods (read docs)

  - public Object();
  - public native int hashCode();
  - public boolean equals(Object);
  - protected native Object clone() throws CloneNotSupportedException;
  - public String toString();
  - protected void finalize() throws Throwable;
  - public final native Class<?> getClass();
  - public final native void notify();
  - public final native void notifyAll();
  - public final void wait() throws InterruptedException;
  - public final native void wait(long) throws InterruptedException;
  - public final void wait(long, int) throws InterruptedException;

toString() method

- it is a non final method of object class
- To return state of Java instance in String form, programmer should override toString() method.
- The result in toString() method should be a concise, informative, and human-readable.
- It is recommended that all subclasses override this method.

equals() method

- It is non final method of object class
- To compare the object contents/state, programmer should override equals() method.
- This equals() must have following properties:
  - Reflexive: for any non-null reference value x, x.equals(x) should return true.
  - Symmetric: for any non-null reference values x and y, x.equals(y) should return true if and only if y.equals(x) returns true.
  - Transitive: for any non-null reference values x, y, and z, if x.equals(y) returns true and y.equals(z) returns true, then x.equals(z) should return true.
  - Consistent: for any non-null reference values x and y, multiple invocations of x.equals(y) consistently return true or consistently return false, provided no information used in equals comparisons on the objects is modified.
- For any non-null reference value x, x.equals(null) should return false.
- It is recommended to override hashcode method along when equals method is overriden.

Abstract Methods

- If implementation of a method in super-class is not possible/incomplete, then method is declared as abstract.
- Abstract method does not have definition/implementation.

- If class contains one or more abstract methods, then class must be declared as abstract. Otherwise compiler raise an error.
- The super-class abstract methods must be overridden in sub-class; otherwise sub-class should also be marked abstract.
- The abstract methods are forced to be implemented in sub-class. It ensures that sub-class will have corresponding functionality.
- The abstract method cannot be private, final, or static.
- Example: abstract methods declared in Number class are:
  - abstract int intValue();
  - abstract float floatValue();

Abstract class

- If implementation of a class is logically incomplete, then the class should be declared abstract.
- If class contains one or more abstract methods, then class must be declared as abstract.
- An abstract class can have zero or more abstract methods.
- Abstract class object cannot be created; however its reference can be created.
- Abstract class can have fields, methods, and constructor.
- Its constructor is called when sub-class object is created and initializes its (abstract class) fields.
- Example:
- java.lang.Number
- java.lang.Enum

Fragile base class problem

- If changes are done in super-class methods (signatures), then it is necessary to modify and recompile all its sub-classes. This is called as "Fragile base class problem".
- This can be overcomed by using interfaces.