

Inheritance

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Programmazione Avanzata

Corso di Laurea in Informatica (L31)

Scuola di Scienze e Tecnologie

Class Employee (1/2)

```
public class Employee {  
  
    private final String name;  
    private double salary;  
    private static int lastId = 0;  
    private int id;  
  
    public Employee( String name , double salary ) {  
        Employee.lastId++;  
        this.id = lastId;  
        this.name = name;  
        this.salary = salary;  
    }  
  
    public void raiseSalary( double byPercent ) {  
        double raise = salary*byPercent/100;  
        salary += raise;  
    }  
}
```

Class Employee (2/2)

```
public void setSalary( double salary ) {
    this.salary = salary;
}

public double getSalary( ) {
    return this.salary;
}

public String getName() {
    return this.name;
}

public int getId() {
    return id;
}
}
```

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A subclass have more functionalities than their superclasses!

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    ...  
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    }  
}
```

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    ...  
    public void setBonus(double bonus) {  
        this.bonus = bonus;  
    }  
}
```

On a Manager object we can invoke the `setBonus` but also all the methods defined in `Employee`:

```
Manager boss = new Manager( ... );  
boss.setBonus(10000);  
boss.raiseSalary(5);
```

Method Overriding

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```
public class Manager extends Employee {  
    ...  
    public double getSalary( ) {  
        return super.getSalary()+this.bonus;  
    }  
    ...  
}
```

Method Overriding

```
public class Employee {  
    public boolean worksFor( Employee supervisor ) {  
        ...  
    }  
}  
  
public class Manager extends Employee {  
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```

This is not overriding! A new method is defined!

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```

This is overriding!

The use of @Override is strongly recommended!

Subclass Construction

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```
public Manager( String name, double salary) {  
    super(name, salary);  
    this.bonus = 0;  
}
```

Subclass Construction

A subclass must invoke the appropriate constructor of its superclass to fill the `private` fields:

```
public Manager( String name, double salary) {  
    super(name, salary);  
    this.bonus = 0;  
}
```

If no `super` constructor is invoked, the superclass must have a `default` constructor that is called implicitly.

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Question: what happens when the following code is executed?

```
empl.getSalary();
```

The dynamic type of a receiver is used to select the method to invoke (dynamic method lookup)!

Example...

```
Employee [] staff = new Employee [...];  
staff[0] = new Employee (...);  
staff[1] = new Manager (...);  
staff[2] = new Employee (...);  
...  
double sum = 0;  
for (Employee e: staff) {  
    sum += e.getSalary();  
}
```

Example...

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Employee [] staff = new Employee [...];  
staff[0] = new Employee (...);  
staff[1] = new Manager (...);  
staff[2] = new Employee (...);  
...  
double sum = 0;  
for (Employee e: staff) {  
    sum += e.getSalary();  
}
```

Thanks to dynamic method lookup, the right version of `getSalary()` is selected!

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Employee empl = new Manager (...);  
empl.setBonus(10000);
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Employee empl = new Manager (...);  
empl.setBonus(10000);
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If **really needed**, we can use `instanceof` and explicit cast to access to methods of a subclass:

```
if (empl instanceof Manager) {  
    Manager mgr = (Manager) empl;  
    mgr.setBonus(10000);  
}
```

Final methods

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```
public class Employee {  
    ...  
    public final String getName() {  
        return this.name;  
    }  
}
```

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    ...  
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An example of `final` method is the `getClass` method of `Object`.

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Modifier `final` can be applied also to classes to prevent others from subclassing:

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```
public final class Executive extends Manager {  
    ...  
}
```

Abstract Methods and Classes

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```
public abstract class Person {  
    private final String name;  
  
    public Person( String name ) {  
        this.name = name;  
    }  
  
    public final String getName() {  
        return name;  
    }  
  
    public abstract int getId();  
}
```

Abstract Methods and Classes

```
public class Student extends Person {  
    private final int id;  
  
    public Student( int id , String name ) {  
        super( name );  
        this.id = id;  
    }  
  
    public final int getId() {  
        return id;  
    }  
  
}
```

Protected Access

```
public class Employee {  
    protected double salary;  
    ...  
}  
  
public class Manager {  
    ...  
  
    public double getSalary() {  
        return this.salary+this.bonus;  
    }  
    ...  
}
```

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    }  
    ...  
}
```

Protected fields must be used with caution! Protected methods and constructor are more standard!

Inheritance and Default Methods

```
public interface Named {  
    public String getName() { return ""; }  
}
```

```
public class Person implements Named {  
    ...  
    public String getName() { return this.name; }  
    ...  
}
```

```
public class Student extends Person implements Named {  
    ...  
}
```

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    public String getName() { return ""; }  
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}
```

In this case we have not a conflict! The class-win approach is used (to guarantee backward compatibility)!

Method Expressions



Method Expressions

```
public class Worker {  
    public void work() {  
        for( int i=0 ; i<100; i++ ) {  
            System.out.println("Working...");  
        }  
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}
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```

```
public class ConcurrentWorker {  
    public void work() {  
        Thread t = new Thread(super::work);  
        t.start();  
    }  
}
```

Object: The Cosmic Superclass!

Every Java class directly or indirectly extends the class Object:

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is equivalent to

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- `int hashCode()`
- `Class<?> getClass()`
- `protected Object clone()`
- `protected void finalize ()`
- `wait, notify, notifyAll`

Method toString

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public class Employee {  
    ...  
    public String toString() {  
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            ",salary="+this.salary+"]";  
    }  
    ...  
}
```

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            ",salary="+this.salary+"]";  
    }  
    ...  
}  
  
public class Manager extends Employee {  
    ...  
    public String toString() {  
        return super.toString()+" [bonus="+this.bonus+"]";  
    }  
    ...  
}
```

Method equals

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Example:

```
public class Item {
    private String description;
    private double price;
    ...
    public boolean equals( Object other ) {
        if (this == other) return true;
        if (other == null) return false;
        if (getClass() != other.getClass()) return false;
        Item otherItem = (Item) other;
        return
            Objects.equals(this.description , otherItem.description)
            &&(this.price == other.price);
    }
}
```

Method equals (2)

```
public class DiscountedItem extends Item {  
    private double discount;  
    ...  
    public boolean equals( Object other ) {  
        if (!super.equals(other)) return false;  
        DiscountedItem otherItem = (DiscountedItem) other;  
        return this.discount == otherItem.discount;  
    }  
}
```

Method hashCode

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Hash code algorithm for String:

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int hash = 0;
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}
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    hash = 31*hash + charAt(i);
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Util method in class Objects:

```
public int hashCode() {
    return Objects.hash(description, price);
}
```

hashCode contract



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- Whenever it is invoked on the same object more than once during an execution of a Java application, the hashCode method must consistently return the same integer.
- If two objects are equal according to the equals(Object) method, then calling the hashCode method on each of the two objects must produce the same integer result.

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- It is 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`.

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- It is 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 , $x.equals(\text{null})$ should return `false`.

Cloning Objects



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The default implementation performs a **shallow copy**.

Cloning Objects

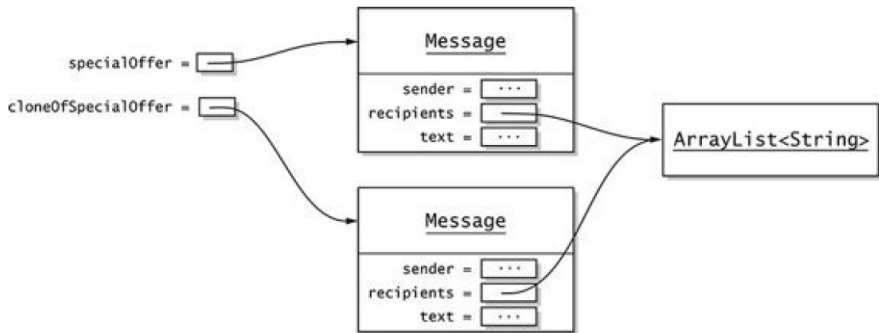
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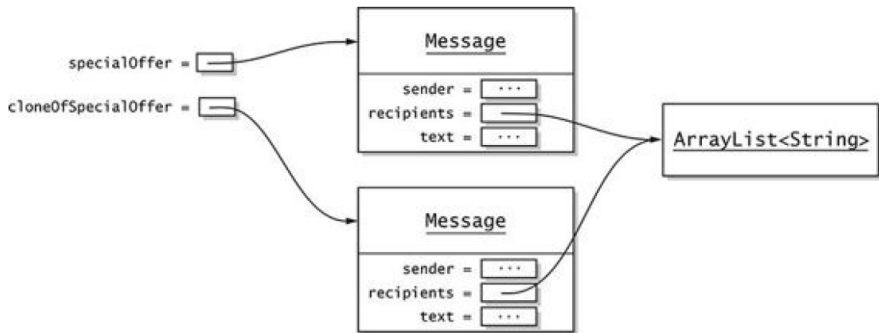
It only works for basic types:

```
public final class Message {
    private String sender;
    private ArrayList<String> recipients;
    private String text;
    ...
    public void addRecipient( String recipient ) { ... }
}
```

Cloning Objects



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A deep copy is needed!

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1. We do not want to provide a clone method

do nothing!

2. The inherited clone method is acceptable

Implement interface Cloneable!

3. The clone method should make a deep copy

Override method clone!

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```

Elements of an enumeration can be compared with the `==` operator (there is only one instance of each case).

Method `toString` by default provides the name of the enumerated object (e.g. `"SMALL"`).

Enumerations

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Size [] allValues = Size.values();
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Method `ordinal` can be used to get the position of an instance in the enum declaration.

Any enumerated type `E` implements `Comparable<E>`, the comparison is performed via `ordinal` values.

Constructors, Methods, and Fields



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```
public enum Size {  
    SMALL("S"), MEDIUM("M"), LARGE("L"), EXTRA_LARGE("XL");  
  
    private String abbreviation;  
  
    Size(String abbreviation) {  
        this.abbreviation = abbreviation;  
    }  
  
    public String getAbbreviation() { return abbreviation; }  
}
```

Bodies of Instances



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```
public enum Operation {  
    ADD {public int eval(int arg1, int arg2) {return arg1+arg2;}}  
    SUB {public int eval(int arg1, int arg2) {return arg1-arg2;}}  
    MUL {public int eval(int arg1, int arg2) {return arg1*arg2;}}  
    DIV {public int eval(int arg1, int arg2) {return arg1/arg2;}}  
    public abstract int eval(int arg1, int arg2);  
}
```

To be continued...