

Object Oriented Programming

What is OOP?

We have a lot of objects around us

- They have a state and a behaviour
- All have a building plan

Classes → building plan

Objects → entity in real world build from building plan

How to build a class

```

1  public class MyClass {
2      //Constructor to create the Object
3      public MyClass(){
4          ...
5      }
6
7      //Attributes to describe state
8      private int myAttribute;
9      ...
10
11     //Methods to describe behaviour
12     public MyMethod(int myParameter, ...) {
13         this.myAttribute = myParameter;
14         ...
15     }
16 }
17

```

How to build a student?

Attributes describing a student?

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Attributes describing a student?

- Name
- Matriculation number
- Age

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Methods describing its behaviour?

How to build a student?

Attributes describing a student?

- Name
- Matriculation number
- Age

Methods describing its behaviour?

- Change name
- Increase age
- Calculate $1+1$

Class Student

```
1  public class Student {
2  //Constructor
3  public Student (String name, int matriculationNumber) {
4  this.name = name;
5  this.matriculationNumber = matriculationNumber;
6  }
7
8  // Attributes
9  private String name;
10 private int matriculationNumber;
11
12
13 // Methods
14 public void setName(String name) {
15 this.name = name;
16 }
17
18 public int getMatriculationNumber() {
19 return matriculationNumber;
20 }
21
22 }
23
```


Creation

We learned how to declare and assign a primitive datatype.

```
1 int a; // declare a
2 a = 273; // assign 273 to a
```

The creation of an object works similar.

```
1 Student example = new Student();
2 // create an instance of Student
```

The **object** derived from a **class** is also called **instance**. The variable is called the **reference**.

Calling a Method

```
1 public class Student {  
2  
3     private String name;  
4  
5     public String getName() {  
6         return name;  
7     }  
8     public void setName(String newName) {  
9         name = newName;  
10    }  
11    public void printName(){  
12        System.out.println(this.name);  
13    }  
14 }
```

The class *Student* has three methods: *void printName()*.

Calling a Method

```
1 public class Main {  
2  
3     public static void main(String[] args) {  
4         Student example = new Student(); // creation  
5         example.setName("Jane"); // method call  
6         String name = example.getName();  
7         System.out.println(name); // Prints "Jane"  
8  
9         example.printName();  
10    }  
11  
12 }
```

You can call a method of an object after its creation with **reference.methodName();**.

Calling a Method

```
1 public class Student {  
2  
3     private String name;  
4  
5     public void setName(String newName) {  
6         name = newName;  
7         printName();    // Call own method  
8         this.printName(); // Or this way  
9     }  
10  
11     public void printName() {  
12         System.out.println(name);  
13     }  
14  
15 }
```

You can call a method of the own object by simply writing **methodName()**; or **this.methodName()**;

Methods with Arguments

```
1 public class Calc {  
2  
3     public void add(int summand1, int summand2) {  
4         System.out.println(summand1 + summand2);  
5     }  
6  
7     public static void main(String[] args) {  
8         int summandA = 1;  
9         int summandB = 2;  
10        Calc calculator = new Calc();  
11        System.out.print("1 + 2 = ");  
12        calculator.add(summandA, summandB);  
13        // prints: 3  
14    }  
15  
16 }
```

Methods with Return Value

A method without a return value is indicated by **void**:

```
1 public void add(int summand1, int summand2) {  
2     System.out.println(summand1 + summand2);  
3 }
```

A method with an **int** as return value:

```
1 public int add(int summand1, int summand2) {  
2     return summand1 + summand2;  
3 }
```

Calling Methods with a return value

```

1 public class Calc {
2
3 public int add(int summand1, int summand2) {
4 return summand1 + summand2;
5 }
6
7 public static void main(String[] args) {
8 Calc calculator = new Calc();
9 int sum = calculator.add(3, 8);
10 System.out.print("3 + 8 = " + sum);
11 // prints: 3 + 8 = 11
12 }
13
14 }
    
```

Constructors

```

1 public class Calc {
2
3     private int summand1;
4     private int summand2;
5
6     public Calc() {
7         summand1 = 0;
8         summand2 = 0;
9     }
10
11 }
    
```

A constructor gets called upon creation of the object

Constructors with Arguments

```
1 public class Calc {  
2  
3     private int summand1;  
4     private int summand2;  
5  
6     public Calc(int x, int y) {  
7         summand1 = x;  
8         summand2 = y;  
9     }  
10  
11 }
```

```
1 [...]   
2 Calc myCalc = new Calc(7, 9);
```

A constructor can have arguments as well!

Let's build a car

Create a car with doors, wheels, gas, seats,...

Focus on:

ID unique id for each car

Car gas, speed

Doors can open/close

Wheels air pressure, size,...

Seats free, quality

...

Also implement refueling, open/close doors, decrease/increase air pressure,...

Class Student

```
1 public static void main(String[] args) {  
2     Student peter = new Student();  
3     peter.changeName("Peter");  
4 }
```

Java

Introduction to OOP and inheritance

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Overview

1. OOP in Java
 - General information
 - Methods
 - Return Value
 - Constructor
2. Conclusion
 - An Example
3. Visibilities
4. Arrays
 - Multi-Dimensional Array
5. Inheritance
 - Inheritance
 - Constructor
 - Implicit Inheritance

Visibilities

- public
- private
- protected

Visibilities

```
1  public class Student {
2      public String getName() {
3          return "Peter";
4      }
5
6      private String getFavouriteFilm() {
7          return "...";
8      }
9  }
10
11  // [...]
12  exampleStudent.getName(); // Works!
13  exampleStudent.getFavouriteFilm(); // Error
14
15
16
```

Array

An array is a data-type that can hold a **fixed number** of elements. An Element can be any simple data-type or object.

```
1 public static void main(String[] args) {  
2  
3     int[] intArray = new int[10];  
4     intArray[8] = 7; // assign 7 to the 9th element  
5     intArray[9] = 8; // assign 8 to the last element  
6  
7     System.out.println(intArray[8]); // prints: 7  
8 }  
9
```

You can access every element via an index. A n-element array has indexes from 0 to (n-1).

Array Initialization

You can initialize an array with a set of elements.

```
1 public static void main(String[] args) {  
2  
3     int[] intArray = {3, 2, 7};  
4  
5     System.out.println(intArray[0]); // prints: 3  
6     System.out.println(intArray[1]); // prints: 2  
7     System.out.println(intArray[2]); // prints: 7  
8 }  
9
```

Alternative Declaration

There two possible positions for the square brackets.

```
1 public static void main(String[] args) {  
2  
3     // version 1  
4     int[] intArray1 = new int[10];  
5  
6     // version 2  
7     int intArray2[] = new int[10];  
8 }  
9
```

2-Dimensional Array

Arrays work with more than one dimension. An m-dimensional array has m indexes for one element.

```
1 public static void main(String[] args) {  
2  
3     // an array with 100 elements  
4     int[][] intArray = new int[10][10];  
5  
6     intArray[0][0] = 0;  
7     intArray[0][9] = 9;  
8     intArray[9][9] = 99;  
9 }  
10
```

Assignment with Loops

Loops are often used to assign elements in arrays.

```
1 public static void main(String[] args) {  
2  
3     int[][] intArray = new int[10][10];  
4  
5     for(int i = 0; i < 10; i++) {  
6         for(int j = 0; j < 10; j++) {  
7             intArray[i][j] = i*10 + j;  
8         }  
9     }  
10 }  
11
```

Arrays with objects

Loops are often used to assign elements in arrays.

```
1 public static void main(String[] args) {  
2  
3     Student[][] studentArray = new Student[10][10];  
4  
5     for(int i = 0; i < 10; i++) {  
6         for(int j = 0; j < 10; j++) {  
7             intArray[i][j] = new Student();  
8         }  
9     }  
10 }  
11
```

A special Delivery

Our class *Letter* is a kind of *Delivery* denoted by the keyword **extends**.

- *Letter* is a **subclass** of the class *Delivery*
- *Delivery* is the **superclass** of the class *Letter*

```
1 public class Letter extends Delivery {  
2  
3 }  
4
```

As mentioned implicitly above a class can have multiple subclasses. But a class can only inherit directly from one superclass.

Example

We have the classes: *PostOffice*, *Delivery* and *Letter*. They will be used for every example in this section and they will grow over time.

```
1  public class Delivery {  
2  
3      private String address;  
4      private String sender;  
5  
6      public void setAddress(String addr) {  
7          address = addr;  
8      }  
9  
10     public void setSender(String snd) {  
11         sender = snd;  
12     }  
13  
14     public void printAddress() {  
15         System.out.println(this.address);  
16     }  
17 }  
18
```

Inherited Methods

The class *Letter* also inherits all methods from the superclass *Delivery*.

```
1 public class PostOffice {  
2  
3     public static void main(String[] args) {  
4  
5         Letter letter = new Letter();  
6  
7         letter.setAddress("cafe ascii, Dresden");  
8  
9         letter.printAddress();  
10        // prints: cafe ascii, Dresden  
11    }  
12 }  
13
```


Override Methods

The method `printAddress()` is now additionally defined in *Letter*.

```
1 public class Letter extends Delivery {  
2  
3     @Override  
4     public void printAddress() {  
5         System.out.println("a letter for " + this.address);  
6     }  
7 }  
8
```

`@Override` is an annotation. It helps the programmer to identify overwritten methods. It is not necessary for running the code but improves readability. What annotations else can do we discuss in a future lesson.

Override Methods

Now the method `printAddress()` defined in *Letter* will be used instead of the method defined in the superclass *Delivery*.

```
1 public class PostOffice {  
2  
3     public static void main(String[] args) {  
4  
5         Letter letter = new Letter();  
6  
7         letter.setAddress("cafe ascii, Dresden");  
8  
9         letter.printAddress();  
10        // prints: a letter for cafe ascii, Dresden  
11    }  
12 }  
13
```

Super()

If we define a **constructor with arguments** in *Delivery* we have to define a constructor with the same list of arguments in every subclass.

```
1 public class Delivery {  
2  
3     private String address;  
4     private String sender;  
5  
6     public Delivery(String address, String sender) {  
7         this.address = address;  
8         this.sender = sender;  
9     }  
10  
11     public void printAddress() {  
12         System.out.println(address);  
13     }  
14 }  
15
```

Super()

For the constructor in the subclass *Letter* we can use `super()` to call the constructor from the superclass.

```
1 public class Letter extends Delivery {  
2  
3     public Letter(String address, String sender) {  
4         super(address, sender);  
5     }  
6  
7     @Override  
8     public void printAddress() {  
9         System.out.println("a letter for " + this.address);  
10    }  
11 }  
12
```

Super() - Test

```
1 public class PostOffice {  
2  
3     public static void main(String[] args) {  
4         Letter letter =  
5             new Letter("cafe ascii, Dresden", "");  
6  
7         letter.printAddress();  
8         // prints: a letter for cafe ascii, Dresden  
9     }  
10 }  
11
```

Object

Every class is a subclass from the class *Object*. Therefore every class inherits methods from *Object*.

See <http://docs.oracle.com/javase/7/docs/api/java/lang/Object.html> for a full reference of the class *Object*.

toString()

Letter is a subclass of *Object*. Therefore *Letter* inherits the method `toString()` from *Object*.

`System.out.println(argument)` will call `argument.toString()` to receive a printable String.

```
1 public class PostOffice {
2
3     public static void main(String[] args) {
4         Letter letter =
5             new Letter("cafe ascii, Dresden", "");
6
7         System.out.println(letter);
8         // prints: Letter@_some_HEX-value_
9         // for example: Letter@4536ad4d
10    }
11 }
12
```

Override toString()

```
1 public class Letter extends Delivery {  
2  
3     public Letter(String address, String sender) {  
4         super(address, sender);  
5     }  
6  
7     @Override  
8     public String toString() {  
9         return "a letter for " + this.address;  
10    }  
11 }  
12
```


Override toString() - Test

```
1 public class PostOffice {  
2  
3     public static void main(String[] args) {  
4         Letter letter =  
5             new Letter("cafe ascii, Dresden", "");  
6  
7         System.out.println(letter);  
8         // a letter for cafe ascii, Dresden  
9     }  
10 }  
11
```