

# 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  
9     public void setName(String newName) {  
10        name = newName;  
11    }  
12  
13 }
```

The class *Student* has two methods: *void printTimetable()* and *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  
10 }
```

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

...

# 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 getFavouritePorn() {
7         return "...";
8     }
9 }
10
11 // [...]
12 exampleStudent.getName(); // Works!
13 exampleStudent.getFavouritePorn(); // 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
```