

Lucerne University of Applied Sciences and Arts

# Programming and Algorithms

Personal Documentation

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# Preface

This is a personal documentation and notebook for the first course in programming at the Lucerne University of Applied Sciences and Arts. The goal of this document is to collect useful informations and nice snippets of code out of the course.

This document shall not be provided as a official or unofficial cheatsheet for the course exam or similar.

# 1 Objects and classes

## 1.1 Summary exercises

### Exercise 1.31

*What are the types of the following values?*

0	short, char, byte, int, long
"hello"	String
101	short, char, byte, int, long
-1	int, char, byte, int, long
true	boolean
"33"	String
3.1415	float, double

### Exercise 1.32

*What would you have to do to add a new filed, for example one called name, to a circle object?*

```
private String name;
```

### Exercise 1.33

*Write the signature of a method named send that has one parameter of type String, and does not return a value.*

```
public void send(String foo)
```

### Exercise 1.34

*Write a signature for a method named average that has two parameters, both of type int, and returns an int value.*

```
public int average(int foo, int bar)
```

### Exercise 1.35

*Look at the book you are reading right now. Is it an object or class? If it is a class, name some objects. If it is an object, name its class.*

The book is definitely an object, because it's a specific thing and in no way generic. The class could have a name like SchoolBook, CodingBook or just Book.

### Exercise 1.36

*Can an object have several different classes? Discuss.*

No it can't.

## 2 Understanding class definitions

### 2.1 Start with Eclipse

In the first chapter we've worked with the BlueJ IDE but now I want to check Java-Coding with a common and popular Java-IDE like Eclipse To get the BlueJ-Projects work with Eclipse there are some things that have to be done.

1. Create a new project in Eclipse.
2. Import the source (BlueJ example-code).
3. Add a package-name to the source.
4. Create a main (replaces all interaction which were invoked by hand).

Listing 1: TicketMachine

```
1
2 package foobar;
3
4 public class TicketMachine
5 {
6     // The price of a ticket from this machine.
7     private int price;
8     // The amount of money entered by a customer so far.
9     private int balance;
```

Listing 2: Main (TicketMachine)

```
1 package foobar;
2
3 public class Main
4 {
5     public static void main(String[] args)
6     {
7         TicketMachine tml;
8         tml = new TicketMachine(300);
9
10        tml.insertMoney(200);
11
12        System.out.println("Balance: "+tml.getBalance());
13
14        tml.insertMoney(100);
15
16        tml.printTicket();
17    }
18 }
```

### 2.2 Chapter Exercises

#### Exercise 2.21

*Suppose that the class `Pet` has a field called `name` that is of type `String`. Write an assignment statement in the body of the following constructor so that the `name` field will be initialized with the value of the constructor's parameter.*

```
1 public Pet(String petsName)
2 {
3     name = petsName;
4 }
```

#### Exercise 2.22 (challenge)

*The following object creation will result in the constructor of the `Date` class being called. Can you write the constructor's header?*

```
new Date("March", 23, 1861)
```

*Try to give meaningful names to the parameters.*

```
1 public Date(String month, int day, int year)
2 {
3     ...
4 }
```

### 2.3 Selfstudy-Questions OOP2

#### Exercise 4

*A class is build by three essential components. What are they?*

- Instance variables (member variables, attributes)
- constructor
- methods

#### Exercise 5

*What is the order of the three components?*

The order doesn't matter technically but there is a common convention:

1. instance variables
2. constructor
3. methods

#### Exercise 6

*What's their purpose?*

**instance variables** are holding data of an object. All of this data together builds the object's state.

**constructor** is a special method that initializes objects.

**methods** are sequences which are defining the object's behaviour and characteristics.

#### Exercise 8

*What is a variable?*

A variable (or field) is a data storage inside an object that can be used for persistent data storage (limited by the lifetime of the object).

#### Exercise 9

*What are the synonyms to instance variables?*

- member variable
- attribute
- filed
- variable

#### Exercise 10

*What do you think where the term instance variable comes from?*

An instance is a realisation of an class by an object. The expression variable is well defined an known in computer science and if a variable explicitly belongs to an object, so it's clear that this is a variable of an instance or instance variable.

### Exercise 11

*How can you put comments into a Java-Code?*

There are different ways to add comments in a Java source file without having trouble with the compiler.

- Use the single line comment by double slash.

```
1 // this method return the speed
2 private void getSpeed()
```

- Use the multiline comment by slash-dot

```
1 /**
2  * This is a method that will return the
3  * actual speed of the monstetruck that
4  * is driven by the crazy clown IT .
5  */
6 private void getSpeed()
```

### Exercise 12 (important)

*With which access-modification do you declare instance variables usually? Is it **private** or **public**? Do you have a reason for your answer?*

Usually we declare instance variables as private. The reason for this is a common pattern that is used to get or set these data form outside the objects by so called accessor and mutator methods (getSpeed, setSpeed, changeSpeed).

### Exercise 13

*Explain the relation between a constructor and the state of an onject.*

The constructor is creating (initializing) an object and has nothing to do with the state of the object once it's set up.

### Exercise 14

*How do we name constructors?*

Constructors are usually named after the class their used for.

### Exercise 15

*What's the lifetyme of instance variables, how long are they reachable/accessable?*

The lifetime of variables is coupled to the lifetime of their objects. As long as the object is alive the variables are also alive.



### Exercise 16

*Why should you (if possible) initialise instance variables explicit?*

If we don't initialize variables explicit the compiler will use default values for the initialization. By explicit initialisation we don't have any disadvantage and it serves well to document what is actually happening.

### Exercise 17

*What's the default value which is given to a `int` variable by its initialisation?*

The default value for an `int` is zero.

### Exercise 19

*What's the use of parameters?*

Parameters provide additional information to a method or object. This is useful in many ways.

### Exercise 20

*What's the difference between a formal and a actual parameter?*

A formal parameter is a parameter that is defined as parameter but has no actual value corresponding. A actual parameter is a parameter with a specific value.

### Exercise 21

*Is the following statement correct; "formal parameters are special variables"?*

Parameters are temporary and restricted variables because their space is allocated by a call to the method or object and as soon as a value is transmitted to it. Once that call has completed its task, the formal parameter disappears and the values in it are lost.

### Exercise 22

*What's about the accessibility of formal parameters?*

The accessibility of parameters are limited to the lifetime of the task which is creating them (method). Also parameter are only reachable from inside the box that they are used in (like a local variable).

### Exercise 23

*In which way this differs from instance variables?*

Instance variables have a lifetime that is identical with the lifetime of their objects. Also parameters are only reachable from inside the block, instance variables are reachable from everywhere inside the class.

### Exercise 24

*How do the lifecycles of formal parameters and instance variables differ?*

Instance variables are persistent (limited by lifetime of the object) and the lifetime of formal parameters is not really defined in runtime.

### Exercise 26

*How would you translate the expressions "assignment" and "expression" in german?*

- assignment = Zuweisung
- expression = Ausdruck

### Exercise 27

*How does an assignment-instruction work exactly? What's about to be aware of in relation to data types?*

An assignment can be done with the operator "=". For example:

```
1 // create a instance variable for speed
2 private int speed;
3
4 // set the speed
5 public void setSpeed(int newSpeed)
6 {
7     speed = newSpeed;
8 }
```

By assigning data you have to be aware of data types. For example you can't assign a **int** to a **float** and so on. There are some strategies to "cast" or "parse" data between different data types but that's not our topic now.

## 2.4 Team Exercise 1-4

Create a Balloon-Class and create some objects and interact with them.

../workspace/balloon/src/flight/Balloon.java

```
1 package flight;
2
3 /**
4  * Balloon models a simple abstraction of a physical balloon.
5  */
6
7 public class Balloon
8 {
9     // size of the balloon. The balloon is abstracted a perfect
10    // bowl defined by its diameter.
11    private float diameter;
12
13    // horizontal position of the balloon
14    private int posHorizontal;
15
16    // altitude (vertical position) of the balloon
17    private int posVertical;
18
19    // color of the balloon
20    private String color;
21
22    // number of the ballon
23    private int number;
24
25    // simple constructor
26    public Balloon()
27    {
28        diameter = 300f;
29        posHorizontal = 300;
30        posVertical = 300;
31        color = "red";
32    }
33
34    // more detailed constructor
35    public Balloon(String newColor)
36    {
37        color = newColor;
38    }
39
40    public void setPosition(int newHorizontal, int newVertical)
41    {
42        posHorizontal = newHorizontal;
43        posVertical = newVertical;
44    }
45
46    public void setDiameter(float newDiameter)
47    {
48        diameter = newDiameter;
49    }
50
```

```

51     public void setColor(String newColor)
52     {
53         color = newColor;
54     }
55
56     public void setNumber(int newNumber)
57     {
58         number = newNumber;
59     }
60
61     public int getHorizontal()
62     {
63         return posHorizontal;
64     }
65
66     public int getVertical()
67     {
68         return posVertical;
69     }
70
71     public float getDiameter()
72     {
73         return diameter;
74     }
75
76     public String getColor()
77     {
78         return color;
79     }
80
81     public int getNumber()
82     {
83         return number;
84     }
85 }

```

../workspace/balloon/src/flight/Main.java

```

1 package flight;
2
3 public class Main
4 {
5     public static void main(String[] args)
6     {
7         // create a new balloon (with the simple constructor)
8         Balloon b1 = new Balloon();
9         // get the current horizontal position
10        System.out.println("Horizontal: " + b1.getHorizontal());
11        // set a new horizontal position
12        b1.setPosition(400, 400);
13        // get the current horizontal position
14        System.out.println("Horizontal: " + b1.getHorizontal());
15
16        // create a new balloon with the detailed constructor
17        Balloon b2 = new Balloon("yellow");

```

```
18      // get the color of the new ballon
19      System.out.println("Color: " + b2.getColor());
20
21
22  }
23 }
```

### 2.5 Team Exercise 5

You want to write records, so you have to write a class `Book` for this. This class shall have the following four attributes:

- Title (String)
- Author (String)
- Price (float)
- Year on buy (int)

The class shall also have two constructors.

- Title and author are parameters. The book is not bought yet and this is why the price is 0.0 and the "year of buy" is -1.
- All attributes are initialized by parameters.

The class shall have the following methods.

- Two methods to get the title and author.
- A method to get and to set the year of buy.
- A method to get and to set the price.

../workspace/Book/src/library/Book.java

```

1 package library;
2
3 public class Book
4 {
5     // title of the book
6     private String title;
7
8     // author of the book
9     private String author;
10
11    // price of the book
12    private float price;
13
14    // year of buy
15    private int year;
16
17    /**
18     * Create a new book with all attributes.
19     */
20    public Book(String newTitle, String newAuthor, float newPrice, int
        newYear)
21    {
22        title = newTitle;
23        author = newAuthor;
24        price = newPrice;
25        year = newYear;
26    }
27
28    public Book(String newTitle, String newAuthor)

```

```
29     {
30         title = newTitle;
31         author = newAuthor;
32         price = 0.0f;
33         year = -1;
34     }
35
36     public String getTitle()
37     {
38         System.out.println("Title: " + title);
39         return title;
40     }
41
42     public String getAuthor()
43     {
44         System.out.println("Author: " + author);
45         return author;
46     }
47
48     public void setYear(int newYear)
49     {
50         year = newYear;
51     }
52
53     public void setPrice(float newPrice)
54     {
55         price = newPrice;
56     }
57
58     public int getYear()
59     {
60         System.out.println("Year: " + year);
61         return year;
62     }
63
64     public float getPrice()
65     {
66         System.out.println("Price: " + price + " USD");
67         return price;
68     }
69
70 }
```

../workspace/Book/src/library/Main.java

```
1 package library;
2
3 public class Main
4 {
5     public static void main(String[] args)
6     {
7         Book b1 = new Book("Objects First with Java", "David Barnes",
8                             70.0f, 2013);
9         b1.getTitle();
10        b1.getAuthor();
```

```
10         b1.getYear();  
11         b1.getPrice();  
12     }  
13 }
```



## 2.6 Team Exercise 5 - Optional

Think about bank accounts, their behaviour and attributes. Implement a class `Account`. To avoid round sum problems work with integer values. Play around with your class and get you some money!

../workspace/Account/src/money/Account.java

```

1 package money;
2
3 public class Account
4 {
5     private String ownerFirstName;
6     private String ownerLastName;
7     private String ownerAddress;
8     private String ownerEMail;
9     private int yearOfBirth;
10    private int yearOfAccount;
11    private int accountNumber;
12    private long accountBalance;
13    private long accountDebit;
14    private long accountCredit;
15    private boolean accountActive;
16
17    /**
18     * Create a new inactive account with default values.
19     */
20    public Account ()
21    {
22        ownerFirstName = "Default";
23        ownerLastName = "Default";
24        ownerAddress = "Default";
25        ownerEMail = "Deafult";
26        yearOfBirth = -1;
27        yearOfAccount = -1;
28        accountNumber = -1;
29        accountBalance = 0;
30        accountDebit = 0;
31        accountCredit = 0;
32        accountActive = false;
33    }
34
35    /**
36     * Create a new active account.
37     */
38
39    public Account ( String newFirstName,
40                    String newLastName,
41                    String newAddress,
42                    String newEMail,
43                    int newYearOfBirth,
44                    int newYearOfAccount,
45                    int newAccountNumber,
46                    long newAccountBalance)
47    {
48        ownerFirstName = newFirstName;
49        ownerLastName = newLastName;

```

```
50     ownerAddress = newAddress;
51     ownerEMail = newEMail;
52     yearOfBirth = newYearOfBirth;
53     yearOfAccount = newYearOfAccount;
54     accountNumber = newAccountNumber;
55     accountBalance = newAccountBalance;
56     accountDebit = 0;
57     accountCredit = 0;
58     accountActive = true;
59 }
60
61 public String getOwnerFirstName()
62 {
63     System.out.println("First name: " + ownerFirstName);
64     return ownerFirstName;
65 }
66
67 public void setOwnerFirstName(String newOwnerFirstName)
68 {
69     ownerFirstName = newOwnerFirstName;
70 }
71 }
```

../workspace/Account/src/money/Main.java

```
1 package money;
2
3 public class Main
4 {
5     public static void main(String[] args)
6     {
7         Account acc1 = new Account();
8         acc1.getOwnerFirstName();
9         acc1.setOwnerFirstName("David Barnes");
10        acc1.getOwnerFirstName();
11    }
12 }
```

## 2.7 Selfstudy-Questions OOP3

### Exercise 1

*What is a header? What is a body?*

A header is a part of a method. For example `public int getSpeed()` is the header of the method

```
1 public int getSpeed()
2 {
3     return speed;
4 }
```

### Exercise 2

Write down the signatures of the methods from class *TicketMachine*.

- `getPrice( ... )`
- `getBalance( ... )`
- `insertMoney(int ...)`
- `printTicket( ... )`

### Exercise 3

Where can you place expressions and definitions?

I don't understand that question.

### Exercise 4

What is a block?

A block is the part of a method which is between the curly braces.

### Exercise 5

How many **return** expressions do you find in Code 2.1?

### Exercise 7

What's the meaning of the return-type **void**?

The return type **void** indicates that the method has no return value.

### Exercise 8

Fill out the table.

compound assignment	assignment
<code>a += b</code>	<code>a = a + b</code>
<code>a -= b</code>	<code>a = a - b</code>
<code>a *= b</code>	<code>a = a * b</code>
<code>a /= b</code>	<code>a = a / b</code>

### Exercise 9

In the code of the *TicketMachine*, there are two places where you can place a compound assignment operator. Find those two places.

### Exercise 12

Describe the conditional operator of the pseudo-code on page 42 in german. Try to translate the code in german (except for the keywords **if** and **else**).

### Exercise 16

*At pitfall on page 48 is a very important information. Translate the first sentence in german.*

### Exercise 17

*Fill out the following table.*

	Field	formal parameter	local variable
can store values?	Yes	No	limited
Where is/are they defined?	class	class	method
How long do they exist?	permanent	imaginary	limited
From where can you access them?	global	nowhere	localy

## 2.8 Team Exercise 1

```
1 2.5 * (2+3) = 12.5
2 (int) 2.5 * 2 + 3 = 7
3 (int) 2.5 * (2+3) = 10
4 (int) (2.5 * 2 + 3) = 8
5 (int) (2.5 * (2+3)) = 12
6 (int) 2.5 * 2 + (float) 3 = 7.0
```

## 2.9 Team Exercises 2

- *What are konventions?*  
Konventions are rules that are not strict.
- *For whatr are they good for?*  
They give the programmer a good orientation if every coder used the same conventions or if a coder used a convention consistantly. This improves the portability and make the code easy to maintain.
- *Give the signatures for the following attributes by konventions:*
  - String secondName
  - float hours
  - int personalNumber
  - Object myObject

### Answer

```
– public String getSecondName ()
– public float getHours ()
– public int getPersonalNumber ()
– public Object getMyObject ()
```

- *Can you define a konvention for mutator-methods?*  
Of course you can, just as for getter-methods.

### 2.10 Team Exercise 3

At the exercises 2.27 and 2.59 you had to note error messages.

- *Compare your Notes*  
"Missing return statement" and "unreachable statment".
- *Try to define rules out of these error messages.*  
If you use a return declaration in the header you have to use a return expression and the return expression has to be at the end of the block.

### 2.11 Team Exercise 4

Now you'll get into the **switch** expression on your own. You can use the appendix D of your book and the file `Selection.jar` from ILIAS

#### 2.11.1 Team Exercise 4.1

Look at the following snippet.

```
1 public void output(int value)
2 {
3     System.out.println();
4     System.out.println("actual parameter: " + value);
5     switch(value)
6     {
7         case 1:
8             System.out.println("one");
9             break;
10        case 2:
11            System.out.println("two");
12            break;
13        case 3:
14            System.out.println("three");
15            break;
16        default:
17            System.out.println("other value");
18            break;
19    }
20 }
```

#### 2.11.2 Team Exercise 4.2

../workspace/Selection/src/choose/Selection.java

```
1 /* Copyright 2012 Hochschule Luzern - Technik & Architektur */
2
3 package choose;
4
5 /**
6  * Klasse Selection für die Lernaufgabe zu switch.
7  * @author Peter Sollberger
8  */
9 public class Selection
```

```
10 {
11
12     /**
13      * Der Konstruktor von Selection ist "leer".
14      */
15     public Selection()
16     {
17     }
18
19     /**
20      * In Abhängigkeit des übergebenen Wertes erfolgt die
21      * Ausgabe eines Textes.
22      */
23     public void output(int value)
24     {
25         System.out.println("aktueller Parameter: " + value);
26
27         switch (value)
28         {
29             case 1:
30                 System.out.println("eins");
31             case 2:
32                 System.out.println("zwei");
33             case 3:
34                 System.out.println("drei");
35             default:
36                 System.out.println("anderer Wert");
37         }
38     }
39 }
```

../workspace/Selection/src/choose/Main.java

```
1 package choose;
2
3 public class Main
4 {
5     public static void main(String[] args)
6     {
7         Selection mySel = new Selection();
8         mySel.output(5);
9         System.out.println("END OF PROGRAM");
10    }
11 }
```

### 2.12 Summary exercises

## 3 Object interaction

### 3.1 Selfstudy-Questions OOP4

#### 3.1.1 Chapter 3.6 - Class diagrams vs. object diagrams

##### Exercise 1

*How do you declare a referencevariable?*

A referencevariable is a variable that points to an object. For example `Account myAccount = new Account ();` defines a referencevariable `myAccount`. This variable doesn't contain a value but a reference to the storage-space where the object lays (like a pointer in C).

##### Exercise 2

*Draw the object diagram to the BlueJ project "house" from chapter 1.*

##### Exercise 3

*Draw the class diagram to the BlueJ project "house" from chapter 1.*

##### Exercise 4

*Solve the exercises 3.1 to 3.4*

#### 3.1.2 Chapter 3.8 - The ClockDisplay source code

##### Exercise 1

*Solve the exercise 3.5*

##### Exercise 2

*What is the result of the following expressions?*

Question		Result
<code>(3&gt;2)</code>	<code>^</code>	<code>(4&gt;5)</code> <b>true</b>
<code>(3&lt;2)</code>	<code>^</code>	<code>(4&gt;5)</code> fasle
<code>(3&lt;2)</code>	<code>&amp;&amp;</code>	<code>(4&gt;5)</code> <b>false</b>
<code>(3&gt;2)</code>	<code>  </code>	<code>(4&gt;5)</code> <b>true</b>
<code>!(3&gt;2)</code>		<b>false</b>

##### Exercise 3

*Solve the exercises 3.6 to 3.8*

**3.6** Nothing happens. This implemetation is not a good idea. To improve it we could use a error-message that is returned.

**3.7** We could not set the value to zero.

**3.8** If would be true for all inputs, because their either `>0` or `<limit`.

### Exercise 4

*Solve the exercises 3.15 to 3.17 and 3.19*

**3.15** The modulo operator returns the remainder of an division.

**3.16**  $8\%3$  returns 2

**3.17**  $-10\%3$  returns -1,  $10\%-3$  returns +1.

**3.18**  $5-1$

**3.19**  $m-1$

### Exercise 5

*Solve the exercise 3.21*

**3.21**

```
1 if((value+1) < limit){
2     value++;
3 }
4 else{
5     value = 0;
6 }
```

### 3.1.3 Chapter 3.9 - Objects creating objects

#### Exercise 1

*Solve the exercise 3.23*

**3.23** The time is "00:00". The constructor is responsible for this value.

### 3.1.4 Chapter 3.10 - Multiple constructors

#### Exercise 1

*Create the singatures for all possible constructors which accord with the following object-creation.*

**new** Student("Peter", 34);

```
1 // simple creator with no parameters
2 public Student()
3 {
4     name = "No-Name";
5     age = -1;
6 }
7
8 // creator with single-parameter name
9 public Student(String newName)
10 {
11     name = newName;
12     age = -1
13 }
14
15 // creator with single-parameter age
```



```
16 public Student (int newAge)
17 {
18     name = "No-Name";
19     age = newAge;
20 }
21
22 // creator with full parameter list name, age
23 public Student (String newName, int newAge)
24 {
25     name = newName;
26     age = newAge;
27 }
```

### Exercise 2

*Solve the exercises 3.28 and 3.29*

**3.28** It creates two NumberDisplay objects with the overroll limits 24 and 60.

**3.29** Because it is set by the parameters given to the constructor.

### 3.1.5 Chapter 3.11 - Method calls

#### Exercise 1

*Solve the exercise 3.30*

#### 3.30

```
1 // print the Payroll-Summary on Printer p1, two-sided
2 p1.print("Payroll-Summary.txt", true)
3
4 // print the Phone-List on Printer p1, single-sided
5 p1.print("Phone-List.txt", false)
6
7 // show the status of Printer p1 on the console
8 System.out.println(p1.getStatus(20))
9
10 // return the status of Printer p1
11 p1.getStatus(10)
```

### 3.1.6 Chapter 3.12 - Another example of object interaction

#### Exercise 1

*Solve the exercises 3.33 and 3.34*

#### 3.33

../workspace/Mail-System/src/emails/Main.java

```
1 package emails;
2
3 public class Main
```

```

4 {
5     public static void main(String[] args)
6     {
7         // create a MailServer
8         MailServer MS1 = new MailServer();
9
10        // create two MailClients
11        MailClient MC1 = new MailClient(MS1, "Homer");
12        MailClient MC2 = new MailClient(MS1, "Fry");
13
14        // send a message from MC1 to MC2
15        MC1.sendMailItem("Fry", "Hello Fry! How are you?");
16
17        // show the mail at MC2
18        MC2.printNextMailItem();
19
20        // give an answer
21        MC2.sendMailItem("Homer", "Hi Homer! I'm fine, thanks.");
22
23        // show the mail at MC1
24        MC1.printNextMailItem();
25    }
26 }

```

../workspace/Mail-System/src/mails/MailServer.java

```

1 package mails;
2
3 import java.util.ArrayList;
4 import java.util.List;
5 import java.util.Iterator;
6
7 /**
8  * A simple model of a mail server. The server is able to receive
9  * mail items for storage, and deliver them to clients on demand.
10  *
11  * @author David J. Barnes and Michael Kölling
12  * @version 2011.07.31
13  */
14 public class MailServer
15 {
16     // Storage for the arbitrary number of mail items to be stored
17     // on the server.
18     private List<MailItem> items;
19
20     /**
21      * Construct a mail server.
22      */
23     public MailServer()
24     {
25         items = new ArrayList<MailItem>();
26     }
27
28     /**
29      * Return how many mail items are waiting for a user.

```

```

30     * @param who The user to check for.
31     * @return How many items are waiting.
32     */
33     public int howManyMailItems(String who)
34     {
35         int count = 0;
36         for(MailItem item : items) {
37             if(item.getTo().equals(who)) {
38                 count++;
39             }
40         }
41         return count;
42     }
43
44     /**
45     * Return the next mail item for a user or null if there
46     * are none.
47     * @param who The user requesting their next item.
48     * @return The user's next item.
49     */
50     public MailItem getNextMailItem(String who)
51     {
52         Iterator<MailItem> it = items.iterator();
53         while(it.hasNext()) {
54             MailItem item = it.next();
55             if(item.getTo().equals(who)) {
56                 it.remove();
57                 return item;
58             }
59         }
60         return null;
61     }
62
63     /**
64     * Add the given mail item to the message list.
65     * @param item The mail item to be stored on the server.
66     */
67     public void post(MailItem item)
68     {
69         items.add(item);
70     }
71 }

```

../workspace/Mail-System/src/mails/MailClient.java

```

1  /**
2  * A class to model a simple email client. The client is run by a
3  * particular user, and sends and retrieves mail via a particular server.
4  *
5  * @author David J. Barnes and Michael Kölling
6  * @version 2011.07.31
7  */
8
9  package mails;
10

```

```

11 public class MailClient
12 {
13     // The server used for sending and receiving.
14     private MailServer server;
15     // The user running this client.
16     private String user;
17
18     /**
19      * Create a mail client run by user and attached to the given server.
20      */
21     public MailClient(MailServer server, String user)
22     {
23         this.server = server;
24         this.user = user;
25     }
26
27     /**
28      * Return the next mail item (if any) for this user.
29      */
30     public MailItem getNextMailItem()
31     {
32         return server.getNextMailItem(user);
33     }
34
35     /**
36      * Print the next mail item (if any) for this user to the text
37      * terminal.
38      */
39     public void printNextMailItem()
40     {
41         MailItem item = server.getNextMailItem(user);
42         if(item == null) {
43             System.out.println("No new mail.");
44         }
45         else {
46             item.print();
47         }
48     }
49
50     /**
51      * Send the given message to the given recipient via
52      * the attached mail server.
53      * @param to The intended recipient.
54      * @param message The text of the message to be sent.
55      */
56     public void sendMailItem(String to, String message)
57     {
58         MailItem item = new MailItem(user, to, message);
59         server.post(item);
60     }
61 }

```

../workspace/Mail-System/src/emails/MailItem.java

---

```

1  /**
2   * A class to model a simple mail item. The item has sender and recipient
3   * addresses and a message string.
4   *
5   * @author David J. Barnes and Michael Kölling
6   * @version 2011.07.31
7   */
8
9  package mails;
10
11 public class MailItem
12 {
13     // The sender of the item.
14     private String from;
15     // The intended recipient.
16     private String to;
17     // The text of the message.
18     private String message;
19
20     /**
21      * Create a mail item from sender to the given recipient,
22      * containing the given message.
23      * @param from The sender of this item.
24      * @param to The intended recipient of this item.
25      * @param message The text of the message to be sent.
26      */
27     public MailItem(String from, String to, String message)
28     {
29         this.from = from;
30         this.to = to;
31         this.message = message;
32     }
33
34     /**
35      * @return The sender of this message.
36      */
37     public String getFrom()
38     {
39         return from;
40     }
41
42     /**
43      * @return The intended recipient of this message.
44      */
45     public String getTo()
46     {
47         return to;
48     }
49
50     /**
51      * @return The text of the message.
52      */
53     public String getMessage()
54     {

```

```
55     return message;
56 }
57
58 /**
59  * Print this mail message to the text terminal.
60  */
61 public void print()
62 {
63     System.out.println("From: " + from);
64     System.out.println("To: " + to);
65     System.out.println("Message: " + message);
66 }
67 }
```

### 3.34

#### 3.1.7 Chapter 3.13 - Using a debugger

##### Exercise 1

*Solve the exercises 3.35 to 3.42*

### 3.35 to 3.42

../workspace/Mail-System/src/emails/Sophie.java

```
1 package mails;
2
3 public class Sophie
4 {
5     public static void main(String[] args)
6     {
7         // create a MailServer
8         MailServer MS1 = new MailServer();
9
10        // create two clients
11        MailClient sophie = new MailClient(MS1, "Sophie");
12        MailClient juan = new MailClient(MS1, "Juan");
13
14        // send a message from sophie to juan
15        sophie.sendMailItem("Juan", "Hello Juan. How are you?");
16
17        // print the message at juans client
18        juan.printNextMailItem();
19
20        // check for new messages
21        juan.printNextMailItem();
22    }
23 }
```

## 3.2 Team-Exercises

### 3.2.1 Exercise 1 - Using a debugger

Exercise 3.43, page 90

Exercise 3.44, page 90

### 3.2.2 Exercise 2 - Some random exercises

Exercise 3.9, page 71

*Which of the following expressions return true?*

Expression	Result
<code>! (4&lt;5)</code>	<b>true</b>
<code>! false</code>	<b>true</b>
<code>(2&gt;2)    ((4==4) &amp;&amp; (1&lt;0))</code>	<b>false</b>
<code>(2&gt;2)    (4==4) &amp;&amp; (1&lt;0)</code>	<b>false</b>
<code>(34 != 33) &amp;&amp; ! false</code>	<b>true</b>

Exercise 3.10, page 71

*Write an expression using boolean variables  $a$  and  $b$  that evaluates to true when  $a$  and  $b$  are either true or both false.*

`! (a^b)`

Exercise 3.11, page 71

*Write an expression using boolean variables  $a$  and  $b$  that evaluates to true when only one of  $a$  and  $b$  is true, and that is false if  $a$  and  $b$  are both false or both true.*

`(a^b)`

Exercise 3.12, page 71

*Consider the following expression. Write an equivalent expression (one that evaluates true at exactly the same values for  $a$  and  $b$ ) without using the AND Operator.*

`(a&&b)`

### 3.2.3 Exercise 3 - Challenges

### 3.2.4 Exercise 4 - Programming (optional)

Exercise 3.45, page 91

*Add a subject line for an e-mail to mail items in the mail-system project. Make sure printing messages also prints the subject line. Modify the mail client accordingly.*

Exercise 3.46, page 91

*Given the following class write some lines of java code that create a Screen object. Then call its clear method if (and only if) its number of pixels is greater than two million. (Don't worry about things being logical here; the goal is only to write something that is syntactically correct - i.e., that would compile if we typed it in.)*

## 4 Grouping objects

### 4.1 Selfstudy-Questions OOP5

#### 4.1.1 Chapter 4.1 to 4.3 - An organizer for music files

##### Exercise 1

*Solve the exercises 4.1 to 4.3*

##### 4.1

../workspace/Music-Organiser-V1/src/music/MusicOrganizer.java

```
1 package music;
2
3 import java.util.ArrayList;
4
5 /**
6  * A class to hold details of audio files.
7  *
8  * @author David J. Barnes and Michael Kölling
9  * @version 2011.07.31
10 */
11 public class MusicOrganizer
12 {
13     // An ArrayList for storing the file names of music files.
14     private ArrayList<String> files;
15
16     /**
17      * Create a MusicOrganizer
18      */
19     public MusicOrganizer()
20     {
21         files = new ArrayList<String>();
22     }
23
24     /**
25      * Add a file to the collection.
26      * @param filename The file to be added.
27      */
28     public void addFile(String filename)
29     {
30         files.add(filename);
31     }
32
33     /**
34      * Return the number of files in the collection.
35      * @return The number of files in the collection.
36      */
37     public int getNumberOfFiles()
38     {
39         return files.size();
40     }
41
42     /**
43      * List a file from the collection.
```



```

44     * @param index The index of the file to be listed.
45     */
46     public void listFile(int index)
47     {
48         if(index >= 0 && index < files.size()) {
49             String filename = files.get(index);
50             System.out.println(filename);
51         }
52     }
53
54     /**
55     * Remove a file from the collection.
56     * @param index The index of the file to be removed.
57     */
58     public void removeFile(int index)
59     {
60         if(index >= 0 && index < files.size()) {
61             files.remove(index);
62         }
63     }
64 }

```

../workspace/Music-Organiser-V1/src/music/Main.java

```

1 package music;
2
3 public class Main
4 {
5     public static void main(String[] args)
6     {
7         // create a MusicOrganiser object
8         MusicOrganizer myOrg = new MusicOrganizer();
9
10        // store some tracks to it
11        myOrg.addFile("Free Software Song");
12        myOrg.addFile("Hacker after all");
13        myOrg.addFile("CRE197 - IPV6");
14
15        // check the number of tracks that are stored
16        System.out.println("Number of Files: " +
17                           myOrg.getNumberOfFiles());
18
19        // show the name of the first, second and third track
20        myOrg.listFiles(0);
21        myOrg.listFiles(1);
22        myOrg.listFiles(2);
23
24        // remove the first track and ask for the first track
25        myOrg.removeFile(0);
26        myOrg.listFiles(0);
27    }
28 }

```

**4.2** We don't get an error. As we look at the code of the method we'll see, that the method is examining if the index is "valid". If not it does not perform a remove action.

../workspace/Music-Organiser-V1/src/music/MusicOrganizer.java

```
1 public void removeFile(int index)
2 {
3     if(index >= 0 && index < files.size()) {
4         files.remove(index);
5     }
6 }
```

**4.3** The list is shifted, so that the previously second track is the first track after removing the first track.

### Exercise 2

*What do you understand by "Java-Package"?*

A Java-Package is just a collection of classes. It is a namespace to organize classes.

### Exercise 3

*You want to use the library-class ArrayList. What expression makes it possible to use that library-class in your source code?*

If we want to use a library-class, we have to import it to our source with

```
import java.nameOfTheLibraryClass;
```

So to use the ArrayList we just have to write in our source

```
import java.util.ArrayList;
```

#### 4.1.2 Chapter 4.4 to 4.7 - Numbering within collections

### Exercise 4

*Solve the exercises 4.4 to 4.7*

### Exercise 5

*Solve the exercises 4.8 to 4.11*

### Exercise 6

*Solve the exercises 4.12 to 4.13*

### Exercise 7

*Explain the following declaration:*

```
private ArrayList<Balloon> list = new ArrayList<>();
```

### Exercise 8

*What is the connection between abstraction and ArrayLists?*

### Exercise 9

*What is the difference of the methods `remove()` and `get()` on `ArrayLists`?*

### 4.1.3 Chapter 4.8 to 4.12 - The Iterator type

#### Exercise 10

*Solve the exercises 4.18 to 4.19*

#### Exercise 11

*Solve the exercise 4.22*

#### Exercise 12

*Explain as detailed as possible the source code on page 108.*

#### Exercise 13

*Is it possible, that the body of an while-loop is never executed?*

#### Exercise 14

*Show two alternative expressions for `no++`*

#### Exercise 15

*An `ArrayList` can be traversed by an foreach-loop. Do you know other ways to do the same?*

#### Exercise 16

*Is `hasNext()` a method of `ArrayList` or `Iterator`? How do you have to understand/interpret the return-value of `hasNext()`?*

### 4.1.4 Chapter 4.14 - Summary of the music-organizer project

#### Exercise 17

*DO NOT READ THIS CHAPTER, JUST READ THE CONCEPT-BOX AT PAGE 130.*

#### Exercise 18

*A variable that is declared for a classtype (or so called reference-variable) can store the special value `null`. Explain the situation with a drwing/sektch. What does it look like, if it's storing an object?*

**4.1.5 Chapter 4.15 to 4.17 - Summary**

**Exercise 19**

*Solve the exercises 4.62 to 4.65*

**Exercise 20**

*Solve the exercises 4.66 to 4.68*

**Exercise 21**

*What are the pros and cons of Arrays?*

**Exercise 22**

*How do you get the length of an Array?*

**Exercise 23**

*Solve the exercises 4.69, 4.71, 4.73 and 4.74*

## Glossary

### A

#### abstraction

Abstraction describes the ability to ignore details and focus attention on a higher level of a problem. As an example think about an car as a Parking-Boy. You would ignore how many seats the car has, but not how big it is, because it's relevant for your task.. 36

#### accessor

A accessor or accessor method is a method that provides access to information about an object's state (get-methods). 36

#### array

An array is a special type of collection that can store a fixed number of items. These items have to be of the same data type. 36

#### assignment

An assignment (statement) is a directive to assign a value into a variable, for example `speed = newSpeed;` is an assignment.. 36

### B

#### body

A body is a part of an method. It is the part that is bordered by the curly braces. The whole content between these braces is called body (see header for contrast). 36

#### boolean expressions

A boolean expression is an expression that has only two possible values: **true** or **false**. They are often controlling conditional statements. For example an **if**(a<b) can only return a **true** or **false**. 36

### C

#### class

A class describes the kind of an object. This is done by giving instance variables and methods. The objects represents individual instantiations of the class. 36

#### collection

A collection can store an arbitrary number of other objects. Common variants for collections in Java are the ArrayList-Objects and arrays. 36

#### conditional statement

A conditional statement takes one of two possible actions based upon the result of a test. For example **if**(a<b) ... **else** ... is a typical conditional statement. 36

#### constructor

A constructor is a special method in a class which is responsible to initialize objects properly. In difference to usual methods it has no return value and is only used once. 36

### F

#### field

Fields store data for an object to use. Fields are also known as instance variables.. 36

### H

#### header

A header is a part of a method. It is the part that is not only including the signature but the whole definition. Example: **public int** getAge(String name) is the header whereas getAge(String ) is the signature. 36

### I

#### instance

An instance is a realisation of a class to a real object, so instance is a synonym to object. 36

#### iterator

An iterator is an object that provides functionality to iterate over all elements of a collection. 36

### L

#### lifetime

The lifetime of a variable describes how long the variable continues to exist before it is destroyed. 36

#### local variable

A local variable is a variable declared and used within a single method. Its scope and lifetime are limited to that specific method they're defined in. A special variant of local variables are actual parameters. 36

### loop

A loop is a functionality that is given by the elementary functions of a programming language, like in Java. They are used to repeat a sequence of expressions (a body) for a number of times, coupled to one or more conditions. In Java there are three essential types of loops: The **while**, **do while** and **for** loop. There are also other types of loops like the "foreach" loop. 36

## M

### method

A method is a action (function) of a specific class that can be invoked on an object of the given class. Objects usually do something when a method is invoked, so a good keyword to it would be *what*, as most methods are named by a verb. The methods give the objects their own particular and characteristic behavior. 36

### modularization

Modularization is the process of dividing a whole into well-defined parts that can be build and examined separately and that interact in well defined ways. For example a car as a whole entity can be divided into modules such as the engine, seats, radio, wheels and so on. 36

### mutator

A mutator or mutator method is a method that provides the ability to change fields of an object. For example `changeSize(int newSize)` is a typical mutator method. 36

## N

### non-primitive types

Java has eight primitive types ( **boolean**, **char**, **byte**, **short**, **int**, **long**, **float**, **double**) and gives the programmer the ability to define own types of a more complex manner. For example a class defines a new type with the name of the class. Variables that have a class as their type can store objects of that class. A popular example of such a type is `String` which in fact is a class. 36

### null

**null** is a reserved word in Java (and many other programming languages) that indicates

that a reference is not referencing to something, that it is showing to **null**. In Java it's used to mean "no object" because a reference variable should point to a object, if it's not so it's containing the reference **null**. Also a field that has not been explicitly set will contain **null** if it's not defined by an other default value (like 0 for variables of type **int**). 36

## O

### object

An object is a instance of a class. 36

### object reference

Variables of an object type (non-primitive type) always store references to objects. 36

### overloading

In Java sources, classes may contain multiple constructors, methods and variables (variable vs. parameter) with the same name. This is called overloading. In Java there is a keyword **this** to specify the variables so that the compiler can differ them plural. 36

## P

### parameter

Addition information (data) given to a method or object is called parameter. 36

### primitive types

The primitive types in Java are the non-object types **boolean**, **char**, **byte**, **short**, **int**, **long**, **float**, **double**. An important characteristic to primitive-types is, that they don't have methods. 36

## S

### scope

The scope of a variable defines the section of source code from which the variable can be accessed. 36

### signature

The signature of a method is the part that identifies it to the compiler. For example the signature of **public** `setSpeed(int newSpeed, int newTolerance)` is not the whole head of the method but the name `setSpeed` and the list of parameter-types **int** ..., **int** .... 36

### state

A object or its status is represented by his state. The state is represented by the values in the fields (instance variables). 36

### T

### type

The type defines the kind of data or value (for example to a parameter, return value (see data types) or a variable. 36