Faculty of Civil Engineering
Chair of Intelligent Technical Design

Weimar, 24th February 2022

Online exam WiSe 2021

Object-oriented modelling and programming in engineering

Name, First Name: (blockletters)			
Master Degree Programme		Student No.	

Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	**Σ**
max. points	5	9	8	5	12	12	4	4	14	6	14	8	12	12	1	126
achieved points																

Number of additional sheets	

Provide each extra sheet with your name, first name and student number.

Declaration

I have taken note of the examination regulations that apply to me.

Weimar, 24th February 2022 Signature: . . . . . .

Reference

- *Candidates may complete the front cover of this paper but must NOT write anything else until the start of the examination period is announced.*
- *The test will take place in the period from 10:00 to 12:00 (120 minutes).*
- *Answer ALL questions.*
- *No calculators are permitted in this examination.*
- *No electronic devices capable of storing and retrieving text, including electronic dictionaries, may be used.*
- *DO NOT turn examination paper over until instructed to do so.*

Introduction

1. List and explain the advantages of object-oriented programming compared to procedural programming

[5 points]

2. Name three future challenges for creators of engineering software and explain a method or concept, which addresses the named challenge.

[9 points]

3. Using a small diagram please explain the difference in executing a program from a compiled language (e.g. C++) and executing a Java program using the Java virtual machine.

[8 points]

Control structures

4. What kind of diagram can be used to model the algorithmic control flow in a program? Briefly draw and explain the core components of this kind of diagram.

[5 points]

5. A method shall calculate the sum of two arrays and store them in a new array to return it. The list below describes the necessary steps (I to VII). Draw a Nassi-Shneiderman diagram to visualize the steps for this algorithm, using the steps listed below.

I) The method is called 'vectorAdd' and returns an array of double values.

II) Two double arrays named 'array1' and 'array2' are the input parameters. These define the input vectors for the addition.

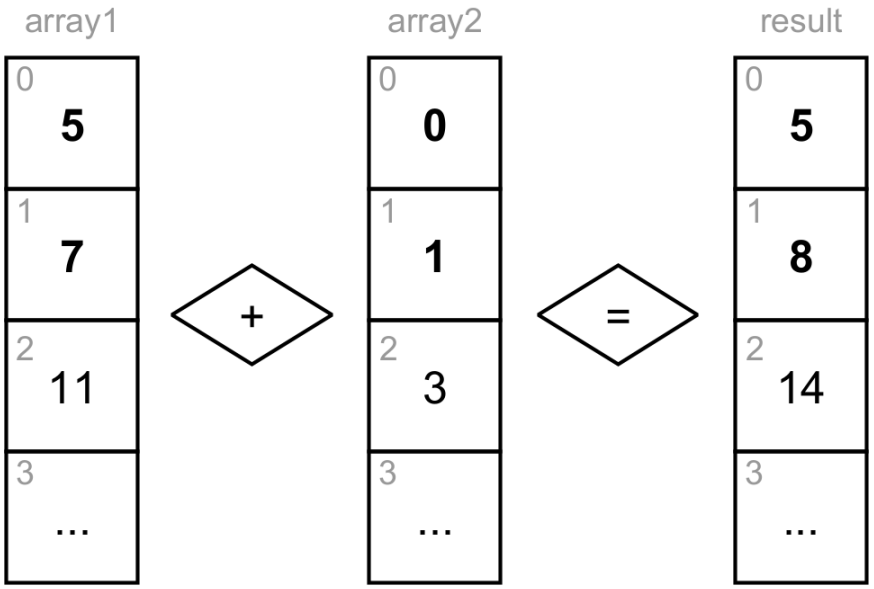
III) Both input arrays should have the same size with a minimum of 1. If one of these conditions is not fulfilled, the method should return null.

IV) Initialize a new array object named 'result' with the size of 'array1'.

V) Array element 0 of result is the sum of the elements with index zero in array1 and array2.

VI) Iterate over all elements in the two given arrays and calculate subsequent elements in the same way. The figure below illustrates the idea.

VII) Return the result array.



[12 points]

6. Draw a Nassi-Shneiderman diagram for the method plotted below, and name what this method is doing.

```
public void myMethod(int[] numbers)
{
    boolean ready;
    do
    {
        ready = true;
        for (int i = 0; i < numbers.length - 1; i++)
        {
            if (numbers[i] > numbers[i + 1])
            {
                int temp = numbers[i + 1];
                numbers[i + 1] = numbers[i];
                numbers[i] = temp;
                ready = false;
            }
        }
    } while (ready == false);
}
```

[12 points]

Various

7. Decide on a suitable datatype in Java for each of the following four scenarios and explain your decisions.

1) You want to store the fact if a book in library is lent.
2) You want to store the year of publishing of a book
3) You want to store the price of a book
4) You want to store the category of a book, whereby the category is represented by a single letter.

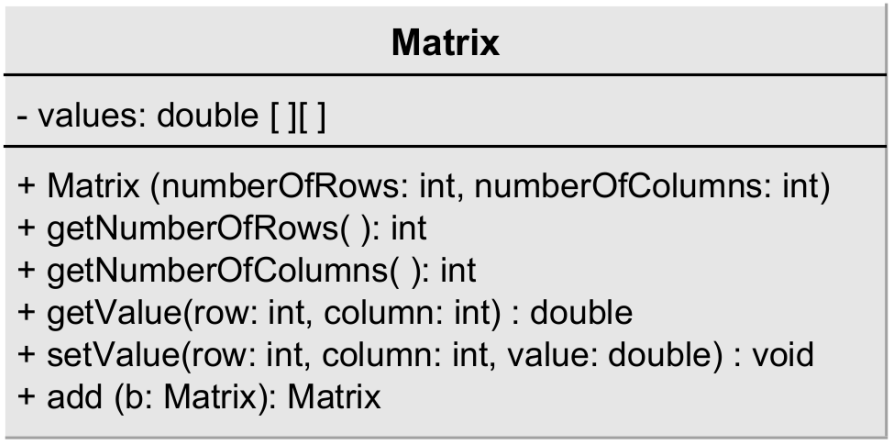
[4 points]

8. Name what is the output of the following lines of code? Using a sketch, briefly explain how the pointers (handles) of the object variables a, b and c are being redirected.

```
19        char[] a = {'I', 'T', 'D'};
20        char[] b = {'R', 'O', 'C', 'K', 's'};
21
22        char[] c = a;
23        a = b;
24        a[2] = 'O';
25        b[4] = 'Y';
26
27        System.out.println(c);
28        System.out.println(a);
29        System.out.println(b);
```

[4 points]

9. Java does not provide 2-dimensional arrays, which are required to model matrices. However, Java provides the concept of arrays of objects. Using the UML diagram below please explain how the concept arrays of objects may be used to model 2-dimensional matrices. Additionally, implement a Java method called 'add' to multiply two matrices. The first matrix is the object itself and the second matrix is given by the input parameter 'b' in the diagram below.



[14 points]

UML

10. Describe which aspects of software systems can be represented by a UML class diagram. Furthermore, explain the terms Class, Association, and Cardinality by the means of a self-chosen UML class diagram.

[6 points]

11. Have a look at the source code below. Draw the UML class diagram for the two classes. Describe how inheritance can be used to improve the depicted implementation. Draw the new UML class diagram, with appropriate symbols for inheritances.

```
public class Mouse
{
    private int connectionType;
    private Color mouseColor;
    private Vector position;

    public Mouse(int connectionType)
    {
        this.connectionType = connectionType;
    }

    public int getConnectionType()
    {
        return this.connectionType;
    }

    public void setColor (Color newColor)
    {
        this.mouseColor = newColor;
    }

    public Color getColor ()
    {
        return this.mouseColor;
    }

    public Vector getPosition()
    {
        return this.position;
    }
}
```

```
public class Keyboard
{
    private int connectionType;
    private Color keyboardColor;
    private int numberOfKeys;

    public Keyboard(int connectionType)
    {
        this.connectionType = connectionType;
    }

    public int getConnectionType()
    {
        return this.connectionType;
    }

    public void setColor (Color newColor)
    {
        this.keyboardColor = newColor;
    }

    public Color getColor ()
    {
        return this.mouseColor;
    }

    public int getNumberOfKeys()
    {
        return this.numberOfKeys;
    }
}
```

[14 points]

12. Draw a UML class diagram with associations and cardinalities for the class structure described below.

I) The name of one of the classes is 'Network'

II) ‘Network’ has n related 'nodes' of type 'Node'

III) ‘Network’ has m related 'edges' of type 'Edge'

IV) ‘Network’ has a constructor without parameters

V) ‘Network’ has a public method draw, which takes a PApplet ‘app’ as parameter

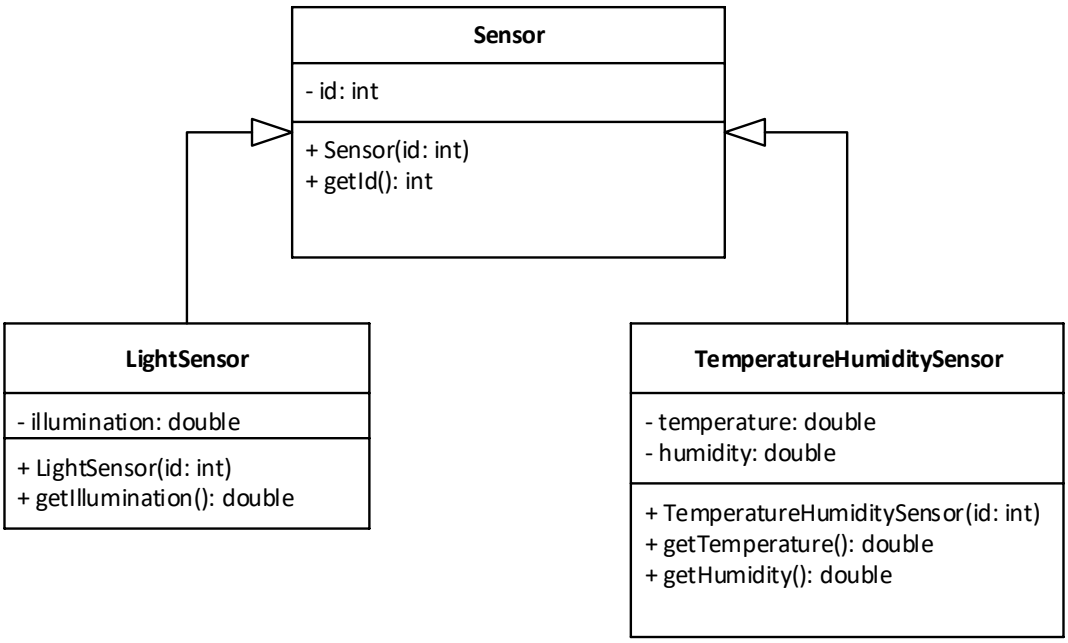
VI) The other class ‘Node’ has an 'id' of type integer

VII) For the initialization of a ‘Node’ at least the 'id' is needed

[8 points]

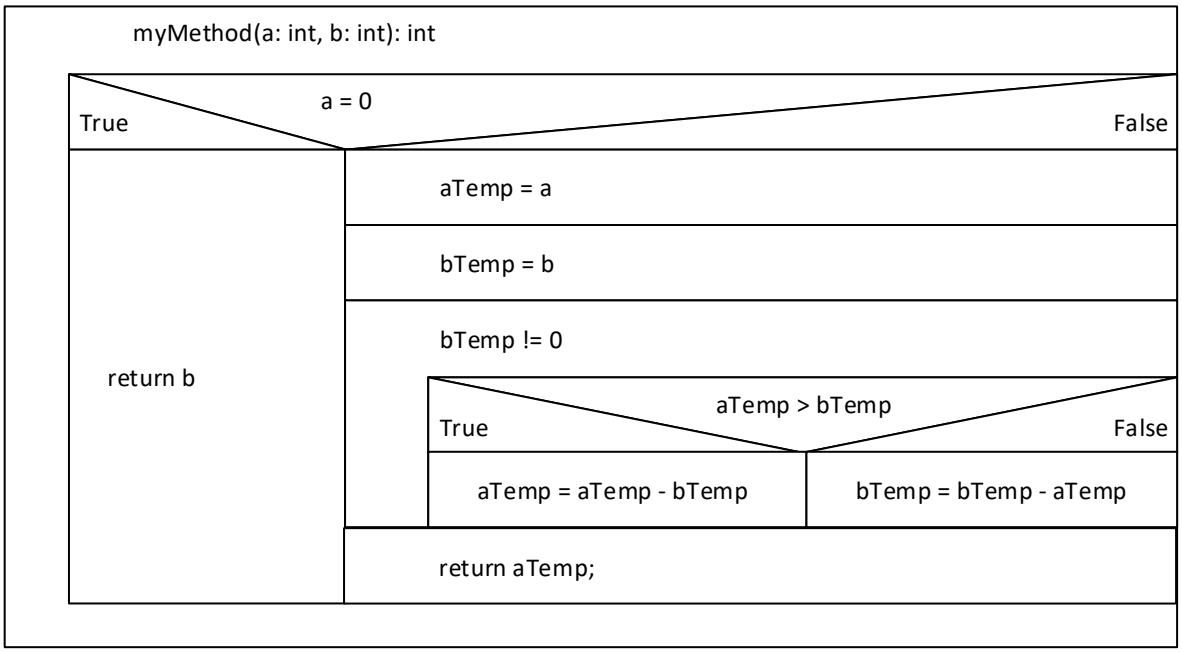
Writing Source Code

13. Write the source code in Java based on the UML diagram depicted below. Note, that the implementation code for the methods' bodies is not needed.



[12 points]

14. Implement a method in Java that is described in the Nassi-Shneiderman diagram below.



[12 points]

15. What does the method in question 14 calculate? Name it.

[1 point]