



Computational Foundations I (Winter Term 2021/22) Sample Exam

Here will be rules including (1) how multiple choice is counted, (2) how you can decide what to do (3) what is allowed and what is not. Expect it to be the default. The first page will be visible to you while we are distributing the paper and before we start, you put your name, your matrikel number, and your place number and you sign the declaration.

Evaluation (leave this space empty!)

Aufgabe 1: MATLAB Multiple Choice

(4 points.)

Are the following statements true or false?		True	False
a	MATLAB has been designed for working with matrices		
b	In MATLAB, subsets of data can be created with slicing.		
c	In MATLAB, one needs to allocate memory for an object before creating or using it using malloc and free.		
d	Discrete time simulation is not suitable for simulating movement.		

Listing 1: 'A simple program'

```
for (size_t i=0; i < input.size(); i++)
{
    work_on(input[i]);
}
```

Aufgabe 2: Algorithms

(4 points.)

Are the following statements true or false?		True	False
a	A linear time algorithm is expected to run faster as opposed to a quadratic time algorithm on the same input.		
b	The program in Listing 1 is $O(N^2)$ for an input of size N (assuming <code>work_on</code> is constant time).		

Aufgabe 3: Algorithm Complexity

(2 points.)

Consider Listing 1 and assume that the implementation of `work_on` implies a time complexity for `work_on` of $O(n^2 \log n \log \log n)$.

What is the time complexity of Listing 1 in this case?

Aufgabe 4: Addition

(8 points.)

Assume you are given two numbers as vectors of digits in C++ as in the following snippet. Implement (sketch an implementation of) a function that computes the sum. Therefore

a. Perform the written addition on paper here:

b. Complete the following program

```
void add(std::vector<int> A, std::vector<int> B)
{
    std::vector<int> ret;
    std::vector<int> carry;
    // what you write below shall be inserted right here...
    return ret;
}
```

Write your program snippet below this line:

Aufgabe 5: MIU

(8 points.)

Consider the MIU text replacement system

- Rule 1: If a sequence ends with a I, we are allowed to add a U to the end
- Rule 2: a sequence of the form Mx , where x is any sequence of available character, can be transformed into a sequence Mxx , that is, the part after the M is doubled. *Note that x always refers to the complete sequence after M and could contain M 's as well.*
- Rule 3: A subsequence III can be replaced by U
- Rule 4: A subsequence UU can be removed.

With this system:

- a. Compute all derivations to depth 2 of the word “MI”.

- b. Give a reason why “MU” is not part of the language.