

Scientific Check Sheet

Family Name:

First Name:

Mailing Address
incl. country:

Date of Birth:

Email:

I apply for admission to the master programme Computer Simulation in Science. Following documents are attached so that you can check whether I comply with the scientific requirements for this master programme:

Bachelor transcript of records
(obligatory)

CV (not obligatory)

I am aware of the programming skills required for this M.Sc. I acknowledge that I have done the exercises provided as a self-assessment on page 2 of this document. Without acknowledgement your application will not be considered.

Note: Do not upload your solutions.

I would like to choose the following specialization:

(please indicate one choice per column „first choice“ and „second choice“:

First Choice:

Atmospheric Physics

Computational Electromagnetics

Computational Fluid Mechanics

Computational Finance

Experimental Particle Physics

Imaging in Medicine

Materials Science

Theoretical Chemistry

Theoretical Particle Physics

Second Choice:

Atmospheric Physics

Computational Electromagnetics

Computational Fluid Mechanics

Computational Finance

Experimental Particle Physics

Imaging in Medicine

Materials Science

Theoretical Chemistry

Theoretical Particle Physics

Reasons for the application, especially for the choice of specialization:

Self-assessment exercises: Basic programming

March 1, 2022

1. Write functions that take a matrix M of size $N \times N$ as an input and calculate the following quantities:

- The trace of the matrix.
- The sum, mean and maximum of the entries.
- The sum, mean and maximum of the absolute value of the entries.
- A vector of size $N \times 1$ containing the mean of each row.
- A vector of size $N \times 1$ containing the mean of each column.
- A matrix of size $N \times N$ containing the result of multiplying M with its transpose.

Note: Write the corresponding code in any language of your choice *without* using built-in functions that can directly give the result wanted in each function. For example, when using MATLAB the function `trace(M)` calculates the trace of the matrix M and therefore should not be used for this calculation.

2. Write a function that takes a matrix M of size $N \times N$ and a real number a as inputs and returns a matrix A of size $N \times N$ where the entry A_{ij} is 1 if $M_{ij} \geq a$ and -1 otherwise.
3. Test all the functions using the matrix M of size 20×20 with entries given as

$$M_{ij} = \frac{1}{2}(i - j), \quad i, j = 0, \dots, 19$$

4. Write a program which takes a vector of size $N \times 1$ whose entries are real numbers and sorts it in ascending order. For example, the vector $[3, 6, 4, 9]$ should become $[3, 4, 6, 9]$.
5. Write a program which computes prime numbers up to a given maximal number using the iterative algorithm called sieve of Eratosthenes. The iteration starts with the prime number 2 and marks the multiples of 2 as not prime. Then it proceeds to the next larger number, which is not marked and is therefore a prime number. The multiples of it are marked as not prime and so on.