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:		**Second Choice:**	
Atmospheric Physics	☐	Atmospheric Physics	☐
Computational Electromagnetics	☐	Computational Electromagnetics	☐
Computational Fluid Mechanics	☐	Computational Fluid Mechanics	☐
Computational Finance	☐	Computational Finance	☐
Detector Physics	☐	Detector Physics	☐
Imaging in Medicine	☐	Imaging in Medicine	☐
Molecular and Materials Modelling	☐	Molecular and Materials Modelling	☐
Theoretical Particle Physics	☐	Theoretical Particle Physics	☐

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

Self-assesment 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
$$M_{ij} = \frac{1}{2}(i - j),\ i, j = 0, \ldots, 19$$
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.