# Exercise 1

*360.252 - Computational Science on Many-Core Architectures*
WS 2022

October 5, 2022

The following tasks are due by 23:59pm on Tuesday, October 11, 2022. Please document your answers in a PDF document and email the PDF (including your student ID in the file name to get due credit) to karl.rupp@tuwien.ac.at.

You are free to discuss ideas with your peers. Keep in mind that you learn most if you come up with your own solutions. In any case, each student needs to write and hand in their own report. Please refrain from plagiarism!

> "I've been imitated so well I've heard people copy my mistakes." — Jimi Hendrix

## About Yourself (1 Point)

Do you have any prior experience with many-core (esp. GPU) computing? If so, please describe briefly.

## Expectations (1 Point)

What do you expect and hope to learn in this lecture? Are there any topics that you are particularly interested in?

## Recap: 2D-Arrays in C (1 Point)

Please describe and sketch in code how two-dimensional arrays in C are allocated. In particular, how does one allocate the necessary memory for an $N \times M$ matrix $A$ using `malloc()` calls? How is this different to using a one-dimensional array of length $N \cdot M$?

## Summing Random Numbers in a Lecture Hall (4 Points)

Assume that there are 32 students in the lecture room, aligned in 4 rows with 8 students each (structured 4x8 grid). Because the students are early and lecturer has not arrived yet, they decide to play a game.

Initially, each student secretly picks a random number. Then, turn by turn, students can exchange their numbers (either the random integer, or a computed value) with one of their neighbors (left, right, front, back - if available). Multiple pairs of students can exchange their numbers simultaneously within a turn; but each student can only communicate with one other student in each turn[1].

Determine the minimum number of turns such that

1. at least one student knows the sum of all the random integers (2 points)
2. each student knows the sum of all the random integers (1 point)
3. How many turns are needed for the general case of $S$ students arranged in $R$ rows? (1 point)

## Bonus Point: Arbitrary Communication

How does the game above change if in each turn students can communicate with any other student instead of just with their direct neighbors?

[1] If student A communicates with student B, student B cannot simultaneously communicate with student C