Exercise Sheet 1
Parallel Computing 1 in WS 2022/23

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Exercise 1.1 (*Write operations to arrays in the ideal cache model*).

Consider a two-dimensional integer array x with m rows and n columns written in the language C. Suppose this array is assigned values in the following row-based variant

```c
for(int i=0; i<m; i++){
  for(int j=0; j<n; j++){
    x[i][j] = i+j;
  }
}
```

Consider also the column-based variant that switches the order of the nested loops such that j is the loop index of the outer loop and i is the index of the inner loop.

a) Analyze the two different variants in the ideal cache model with cache size M and cache line size B. (Suppose that the size of an integer is one word.) Give the cache complexity of the two variants for the cases $mn \ll M$ and $mn \gg M$.

b) Implement the row- and column-based variants on an architecture of your choice. Find out the values of M and B for your architecture. Measure the running times of your implementations and compare them with the predictions based on the ideal cache model.

c) Assume that the dimensions m and n are both multiples of a parameter s. Derive a blocked algorithm that uses blocks of size $s \times s$. Derive its cache complexity in the ideal cache model and compare the results with those of the row- and column-based variants.