Exercises for Advanced Topics in High Performance Scientific Computing
WS 15/16, Nr.: 0000003213, 02.10.011, Rechnerraum
Exercise Sheet 2 (until October 28, 2015)

Exercise 2*
Write a library in C or C++ for the conjugate gradient algorithm for solving a sparse linear system.

$$Au = f$$

with $A \in \mathbb{R}^{n \times n}$ and $u, f \in \mathbb{R}^n$. Define the sparse matrix data structure in compressed row storage (CRS) data format as outlined in the lecture (CASE2.pdf). The CRS format is build from four vectors $cnt \in \mathbb{N}^n$, $dsp \in \mathbb{N}^n$, $col \in \mathbb{N}^m$, and $val \in \mathbb{R}^m$ with $m = \text{nnz}(A)$, the number of non-zero elements of the matrix A.

1. The *cnt* vector stores at position i the number of non-zero elements of the i-th row.
2. The *dsp* vector stores at position i the location of the first element of the i-th row within the vectors *col* and *val*.
3. The *col* vector stores all column indexes of the non-zero matrix entries in row-wise order.
4. The *val* vector stores all values of the non-zero matrix entries in row-wise order.

Implement a function for the sparse matrix-vector multiplication algorithm using the CRS data structure. Furthermore, implement functions for the scaled vector addition and the scalar product. Finally, build the CG algorithm from these components. Test the algorithm with a symmetric positive definite matrix A and a right hand side f of you choice.

* Place all source files of the exercises in a folder named `Exercise2` in your home directory on the `mephisto.uni-graz.at` cluster.