M.Sc. in High-Performance Computing
5613 - C programming
Assignment 4

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Rules

To submit, make a single tar-ball with all your code and a pdf of any written part you want to include. Submit this via `msc.tchpc.tcd.ie` by the end of **Tuesday November 15th**. Attempt all parts. Marks will be given for the efficiency of your implementation. Late submissions without prior arrangement or a valid explanation will result in reduced marks.

Question

1. (a) (5p) Write a C structure `typedef struct Tridiag_s {...} Tridiag;` that will store a square tridiagonal $N \times N$ matrix, T efficiently. A tridiagonal matrix has non-zero entries T_{ij} only when i and j differ by at most one. The matrix element T_{ij} should be referenced by the syntax `t.entry[i][j]` (assuming `i` and `j` differ by only one).

   (b) (5p) Write a function

   ```
   void tridiag_mul(Tridiag* t, double* a, double *b)
   ```

   that applies the tridiagonal matrix stored in `t` to a vector whose elements are stored in array `a`, writing the answer in array `b`. Test it by evaluating the matrix-vector product

$$\begin{pmatrix} 4.0 & -1.7 & 0 & 0 & 0 \\ 1.4 & 5.6 & -1.3 & 0 & 0 \\ 0 & -0.8 & 3.2 & 1.8 & 0 \\ 0 & 0 & 0.4 & 2.3 & -1.2 \\ 0 & 0 & 0 & 1.8 & 4.6 \end{pmatrix} \begin{pmatrix} 2.3 \\ -4.4 \\ 7.9 \\ -0.1 \\ 5.9 \end{pmatrix}$$

   (c) (10p) Write a C-code that computes an inverse of a non-singular tridiagonal matrix. The tridiagonal matrix is read from a text file `tridiag_matrix.txt` containing in the first line a size of the matrix `N` and in the next line only (3N-2) relevant elements of the tridiagonal matrix. For the previous example, the input file would contain the following entries:

   ```
   5
   4.0  -1.7  1.4 5.6  -1.3 -0.8 3.2  1.8  0.4  2.3 -1.2  1.8  4.6
   ```

Write the output matrix to the output file `inverse.txt`. If the resulting inverse matrix $N \times N$ is denoted with $M_{n \times n} = T^{-1}_{n \times n}$, than the output file should have N+1 lines, and a format:

$$
\begin{array}{l}
N \\
m_{0,0} \quad m_{0,1} \quad \dots \quad m_{0,n-1} \\
\dots \\
m_{n-1,0} \quad m_{n-1,1} \quad \dots \quad m_{n-1,n-1}
\end{array}
$$