

# Numerical Analysis

## Homework 3. Cholesky Decomposition

**Due: March 24, 2015**

Given a linear system

$$\mathbf{Ax} = \mathbf{b}, \quad (3.1)$$

if the  $n \times n$  matrix  $\mathbf{A}$  is nonsingular and symmetric, the Cholesky decomposition can be employed to solve the linear system. Please add the following nonmember functions to the `MAT.h` header file.

```
MAT &cholesky(MAT &A);           // Cholesky decomposition
VEC choSolve(MAT &L,VEC b);       // forward and backward substitutions
```

As the names implies, the function `cholesky()` performs Cholesky decomposition and modifies the input matrix to a lower triangular matrix,  $\mathbf{L}$ , with  $\mathbf{LL}^T = \mathbf{A}$ . And the `choSolve()` function performs forward and backward substitutions, given the Cholesky factor  $\mathbf{L}$  and the right hand side vector  $\mathbf{b}$ .

Once those nonmember functions have been implemented, write a test program `hw03.cpp` that calls those functions to solve a linear system. Please use the 7 linear systems given in `hw02` to test your implementation. As in `hw02`, use the unix `time` command to measure the CPU time needed to solve each linear system. Compare that to the `hw02` results in your `hw03a.pdf` report.

### Notes.

1. For this homework you need to turn in a **C++** program that solves a linear system. Please name this program `hw03.cpp`. The header and definition files for `MAT` classes, `MAT.h` and `MAT.cpp`, also need to be turned in.
2. A **pdf** file is also needed. This file should include a plot that shows the CPU time as a function of the linear dimension of the system. Also, state your observations in this report. Please name this report `hw03a.pdf`.
3. It is a good idea to compare the linear system solution times using LU decomposition and Cholesky decomposition, especially the time complexities of these two approaches.
4. Submit your files on EE workstations. Please use the following command to submit your homework 3.

```
~ee407002/bin/submit hw03 hw03.cpp VEC.h VEC.cpp MAT.h MAT.cpp hw03a.pdf
```

where `hw03` indicates homework 3.

5. Your report should be clearly written such that I can understand it. The writing, including English grammar, is part of the grading criteria.