

## ECE 3340 – Programming Assignment 2

### LU Factorization Using Partial Pivoting (LUP)

In this assignment, you will implement a stable algorithm for performing LU decomposition.

#### The problem

Your application will take a file name as a command-line argument: the name of a text file describing a linear system as an augmented matrix.

A text file containing:

1	0	1	3
2	3	-2	5
-4	1	1	8

represents the linear system:

$$\begin{bmatrix} 1 & 0 & 1 \\ 2 & 3 & -2 \\ -4 & 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 3 \\ 5 \\ 8 \end{bmatrix}$$

You will perform LU decomposition using two methods

- 1) Gaussian elimination (LU factorization) – this will not be graded but forms the basis for (2)
- 2) Gaussian elimination with partial pivoting (LUP factorization)

**Hint:** You can implement (1) by removing one line of code from (2). You only have to implement one algorithm with a conditional statement that switches between (1) and (2).

**Implement this algorithm using 64-bit precision for all floating point values!**

#### Input Format

The text file used as input has column values separated by tabs ('\t'). Rows are separated by a carriage return (13) and line feed (10). This is the equivalent of a '\n' character in Windows. The input and output files will be specified on the command line:

```
>> linsys infile.txt outfile.txt
```

#### Output Format

The three matrices for the LUP factorization will be saved to a file specified as the second argument to your program. Output these matrices in the following order: L, U, P. Output the values of each matrix  $A_{ij}$  such that each column component  $a_1 \cdots a_j \cdots a_j$  is separated by white space and each row is terminated by an end-line character '\n'.

In addition, solve the linear system  $Ax = b$  LUP factorization with  $b = [1, 2, \dots, n]^T$  and output both results to the console. Here is an example of a valid output format for 3 equations and 3 unknowns:

```
x0 = -.211    x1 = 3.95    x2 = 3.21
```

#### Turning in your code

Turn in your assignment as a single \*.c/\*.cpp file. Test your code on the department server (tuxedo.egr.uh.edu).

**Examples are available on the course website**

**ECE 2331 – Programming Assignment 2**  
**Solving Linear Systems Using Scaled Partial Pivoting**  
**Rubric**

Name \_\_\_\_\_

compiles on tuxedo.egr.uh.edu \_\_\_\_\_  
(the assignment will not be graded until it compiles – normal late penalties will apply)

**input format** \_\_\_\_\_ / 15

read correct data from the file \_\_\_\_\_ / 15

**output format** \_\_\_\_\_ / 10

**correct precision (64-bit floating point)** \_\_\_\_\_ / 5

**LU Factorization** \_\_\_\_\_ / 20  
**Correct result for simple matrices**

correct result \_\_\_\_\_ / 20  
(may fail for ill-conditioned matrices)

**Partial Pivoting** \_\_\_\_\_ / 30

**Stable LUP factorization (uses partial pivoting)**

correct result \_\_\_\_\_ / 10

correct implementation ( $\ell$  vector, etc) \_\_\_\_\_ / 10

code commented \_\_\_\_\_ / 10

**Forward and Back Substitution** \_\_\_\_\_ / 20

correct implementation \_\_\_\_\_ / 10

code commented \_\_\_\_\_ / 10

**Total** \_\_\_\_\_ / 100