Program Submission Instructions:

- You must submit your source code file
- The source code file must be submitted in Webcourses from the assignment page
- All source code must be in exactly one file of type .c, .cpp, or .java

COT 4500 – Numerical Calculus
Spring 2014
Program #2 LU Factorization (100 points)

In this assignment you will write a program that will open a file, read in the elements of a real-valued matrix, and then determine the LU Factorization for that matrix using the algorithm presented in Section 6.5 of the textbook. The program must generate output to the console (terminal) screen as specified below.

Command Line Parameter

1. Your program compile and run from the command line.
2. The program executable must be named "factor" (all lower case, no spaces or file extension).
3. The program must retrieve the following command line parameter. There is only one parameter. Your program may NOT prompt the user to enter the parameter value, nor may the program require that the parameter be entered after pressing the "enter" key following the program name.

   Parameter 1: fname the name of the file that contains the matrix elements. The file name may or may not contain a file name extension. The file must be located in the same directory as the program.

Input File Format

The input file will be a text file containing one row for each row of the matrix. Each row of the file will contain the matrix elements for one row of the matrix. The first row of the file will contain the matrix elements for row 1, and so on. The matrix elements may be positive or negative decimal values, for example, “23.12”, “14”, and “-6.7”. The matrix elements in a row will be separated by one or more spaces (blanks), not tabs.

All matrices that will be used for test will be square matrices. Therefore, the number of rows and columns in the matrix may be determined easily by reading in the first row of the file and observing how many matrix elements are specified for that row.

Your program must be able to process matrices from 2 x 2 through 10 x 10, both values inclusive.

Running the Program

To run the program, simply launch the program from a command prompt or terminal window by typing the program name and the file name parameter, followed by pressing the “enter” key.

For a Java program in Windows, Mac OS, or Linux, an example would be:

```
java factor matrix1.txt
```

For a C/C++ version of the program in Mac OS or Linux, the run command would look like

```
./factor matrix1.txt
```

And the C/C++ version in Windows would be simply:

```
factor matrix1.txt
```

Program Output

The program must send all output to the console (terminal) screen. The output must contain the following sections and must be formatted in substantially the same form as the sample output in the next section:

(a) Echo input matrix values: The program must output the values of the input matrix row-by-row, separated by spaces.
(b) Report Values of the “L” Matrix: The program must output the values of the “L” matrix row-by-row, separated by spaces.
(c) Report Values of the “U” Matrix: The program must output the values of the “U” matrix row-by-row, separated by spaces.
(d) Report Error Messages: If the input matrix is not factorable for any reason, or if the input file cannot be parsed successfully, the program must output an appropriate error message and exit gracefully. The program should not not crash or report an exception.

Sample Output

The following is the the sample input file for the matrix: $\begin{bmatrix} 1 & 1 & 0 & 3 \\ 2 & 1 & -1 & 1 \\ 3 & -1 & -1 & 2 \\ -1 & 2 & 3 & -1 \end{bmatrix}$

```
 1  1  0  3
 2  1 -1  1
 3 -1 -1  2
-1  2  3 -1
```

Sample Output

The following is the desired output from running the program on the matrix above:

```
Input Matrix:

 1  1  0  3
 2  1 -1  1
 3 -1 -1  2
-1  2  3 -1

“L” Matrix:

 1  0  0  0
 2  1  0  0
 3  4  1  0
-1 -3  0  1

“U” Matrix:

 1  1  0   3
 0 -1 -1  -5
 0  0  3  13
 0  0  0 -13
```

Grading Rubric

The total possible score for this program is 100 points. Your program will be tested using a script that runs a number of test cases. The following point values will be deducted for the reasons stated. Partial credit may be given if performance fails for only some of the test cases.

[-100 points] Your program does not successfully compile from the command line with one of these commands:

```
C program:      prompt>     gcc –lm –o factor [your_file_name].c
C++ program:    prompt>     g++ -lm –o factor [your_file_name].cpp
Java program:   prompt>     javac factor.java
```

Note: If you are submitting a Java program, the class file must be named “factor.java” and the class name must be “factor”. Also, you should not include a package specification so that the program can be run from the command line without the need to include a package specifier.

[-90 points] Your program does not run from the command line without error or produces no output.

[-70 points] The program compiles, runs, and outputs the input matrix values correctly, but crashes thereafter or does not produce any correct output thereafter.

[-40 points] The program compiles, runs, echoes the input matrix values correctly, and also reports the correct values for the “U” matrix.

[-10 points] The program compiles, runs, echoes the input matrix values correctly, and also reports the correct values for both the “U” and “L” matrices.

[no deductions] The program compiles, runs, echoes the input matrix values correctly, reports the correct values for both the “U” and “L” matrices for valid input matrices, and also issues an appropriate message and exits gracefully if an input matrix cannot be factored.