HW01 Preliminary and LU Decomposition

The goal of this homework it to reinforce the first part of our unit on numerical linear algebra, and to begin to get you acclimated with writing up your homework in a Jupyter notebook. This means that you will need to begin to learn how to write regular text using Markdown, mathematics using LaTeX, and entering simple commands in Julia.

NB01 has links to some resources to help with writing your homework solutions in a Jupyter notebook.

One of the easiest ways to learn some the syntax for Markdown, LaTeX and Julia is to double-click on a cell in the lecture notebooks and see how I did it.

Problem 1

Generate a random 4×4 matrix A and a random 4×1 right-hand-side b.

1. (5 points) **Use Julia** to do an LU decomposition on your matrix A. Solve $Ax = b$ by using the backslash operator on L and U with appropriate right-hand-sides. Show the work done by Julia in the output cells (this should be automatic).

Solution

In [1]:
```
using Random
rng = MersenneTwister(4441)
A = rand(rng, Int8, 4, 4)
```

Out[1]:
```
4×4 Matrix{Int8}:
  64  -77    12  -74
  -6   30    74   71
 -85  124  -106  -97
  34  -37    -2   86
```

In [2]:
```
b = rand(rng, Int8, 4, 1)
```

Out[2]:
```
4×1 Matrix{Int8}:
  32
 109
 -43
 -92
```

In [3]:
```
using LinearAlgebra
L,U,p = lu(A)
```

Out[3]:
```
LU{Float64, Matrix{Float64}, Vector{Int64}}
L factor:
4×4 Matrix{Float64}:
  1.0        0.0       0.0       0.0
  0.0705882  1.0       0.0       0.0
 -0.752941   0.77021   1.0       0.0
 -0.4        0.593023  0.710123  1.0
U factor:
4×4 Matrix{Float64}:
 -85.0  124.0     -106.0      -97.0
   0.0   21.2471    81.4824    77.8471
   0.0    0.0     -130.57    -206.994
   0.0    0.0        0.0      148.026
```

In [4]:
```
x = U\(L\b[p])
```

Out[4]:
```
4-element Vector{Float64}:
  0.29648615650366505
  0.8654656847760872
  1.8856785456388951
 -0.7707783941061814
```

2. (5 points) Take the Julia output, truncate entries to 4 significant digits, and typeset it using LaTeX in Markdown cells.

Solution

$$x = \begin{bmatrix} 0.2964 \\ 0.8654 \\ 1.8856 \\ -0.7707 \end{bmatrix}$$

To turn in your homework as a pdf file, you will probably get the best result by doing the following in Jupyter:

1. Go to `File -> Save and Export Notebook As` in the menu to generate an html file.
2. "Print" the html file to a pdf file instead of a printer in the printer options.

This often gives a nicer result than using the built-in Jupyter print to pdf option.