Homework 5: Due 10/25/17 (This may seem a lot, but you just use my + scipy functions, so it is actually very quick and easy).

In **Jupyter Notebook**, use ALL **1) manual method** and **2) automatic function** from scipy to solve system of linear equation of Ax = B where A is 15 x 15 matrix.

You will need to generate your own matrix A and B and solve for x. You are expected to use the provided user function in Jupyter Notebook taught in class and scipy function taught in class. If you COPY/MODIFY the function from lecture, show where you are copying from in function comment. If you copy/modify from the internet (it is fine, I allow you to do it this time, but use my function will be easier), describe the URL (link address) in the function comment.

Specifically you will
Task A: Use all manual method (learnt in class) to solve system of linear equation Ax = B
Task B: One case where your manual method (learnt in class) need **partial pivoting** (have at least one zero in the diagonal terms)
Task C: Use all automatic function from scipy (learn in class) to solve system of linear equation Ax = B
Task D: Calculate your matrix A condition number (if you have several matrix A, calculate the condition number for all matrix A that you created)
Task E: Compare the speed of scipy versus user method for LU decomposition and Cholesky method.
Task F: For each answer, you show that your answer is correct (show the value of left-hand-side minus right-hand-side).
Task G: For each method that can be done with both without and with partial pivoting, compare the accuracy from each method.
Task H: Compare the speed of user define Gaussian elimination and LU decomposition method
Task I: Count the number of floating point operation in Gaussian elimination (elimination + backward substitution) and count the number of floating point operation in LU decomposition (decomposition step + forward substitution + backward substitution)
For task A, you may create your own function or you may also use the function given in the lecture.
For task A, the method that you must create and use (user define function created from **def** statement) to solve your Ax = B are
1) Gaussian Elimination without partial pivoting
2) Gaussian Elimination with partial pivoting
3) LU decomposition without partial pivoting
4) LU decomposition with partial pivoting
5) Cholesky decomposition
6) Gauss-Jordan method
7) Jacobi iterative method
8) Gauss-Seidel
9) Successive Over-Relaxation (SOR)
10) Thomas Algorithm
Please note that your matrix A and B may need to change when you use method 1 – 10 to solve your system of linear equation Ax = B. This is because some method need more requirement of matrix A in order to work properly.

Do all calculation in Jupyter notebook. Make the summary at the end of each question in Jupyter Notebook by using Markdown (‘
’ is for newline, ‘<p>’ is for new paragraph). Submit just one **.ipynb** file