MAT202E – Numerical Methods in CE

Spring 2017

Homework 2

Assignment Date: 27.03.2017
Due Date: 09.04.2017 - 23:59
Duration 2 weeks

- You should prepare an e-report and submit a .zip archive that contains your matlab or octave codes, e-report and other requested materials. You will submit your assignment through Ninova.
- Late submissions will not be accepted.
- This is an individual assignment, you should do it on your own. Plagiarism will not be tolerated.

1. Gaussian Elimination and Backward Substitution (20 points)

Consider the problem

$$\begin{aligned} x_1 - x_2 + 3x_3 &= 2 \\ x_1 + x_2 &= 4 \\ 3x_1 - 2x_2 + x_3 &= 1 \end{aligned}$$

Carry out Gaussian elimination in its simplest form for this problem. What is the resulting upper triangular matrix? Proceed to find the solution by backward substitution. Implement Gaussian elimination and backward substitution in matlab or octave. Compare the results.

2. LU Decomposition (30 points)

$$\begin{aligned} Ax &= b \\ LUx &= b \end{aligned}$$

$$A = \begin{bmatrix} 1 & 2 & 4 \\ 3 & 8 & 14 \\ 2 & 6 & 13 \end{bmatrix}$$

a) Find the LU decomposition of the matrix A. What is the difference between LU decomposition and Gaussian elimination? Implement LU decomposition in matlab or octave.

b) With using LU decomposition calculate the x vector with given b below using matlab or octave.

$$b = \begin{bmatrix} 3 \\ 13 \\ 4 \end{bmatrix} \qquad b = \begin{bmatrix} 6 \\ 24 \\ 15 \end{bmatrix} \qquad b = \begin{bmatrix} -1 \\ -5 \\ -4 \end{bmatrix}$$

3. Pivoting (20 points)

$$A=\begin{bmatrix}5 & 6 & 7 & 8\\ 0 & 4 & 3 & 2\\ 0 & 0 & 0 & 1\\ 0 & 0 & -1 & -2\end{bmatrix}$$

a) The matrix A can be decomposed using partial pivoting as P A = LU, where U is upper triangular, L is unit lower triangular, and P is a permutation matrix. Find the 4×4 matrices U, L, and P.
b) Given the right-hand-side vector

$$b=\begin{bmatrix}26\\ 9\\ 1\\ -3\end{bmatrix}$$ find x that satisfies Ax = b.

4) Data Compression and Truncated SVD (30 points)

In this question we will play with a cute picture(cute.jpg). Using matlab or octave, convert the image into gray scale. Then, compute truncated SVD of the image with various ranks. Determine the rank where the cuteness disappears(where the loss effects the content of the picture). Add pictures as output when r = 10,15,20,30.

Use may use a svd function built in matlab or octave.

Hint: Use imread to read image and imshow to plot the image. To convert a image to gray scale, you can get the mean of the all channels.

For questions you can contact:
Abdullah Cihan AK
akab@itu.edu.tr