ITU Computer and Informatics Faculty
BLG 202E Numerical Methods in CE
2018 - 2019 Spring
Homework 3

Due 23.04.2019 23:00

- Please submit your report through Ninova e-Learning System. Another way of submission will not be accepted.
- No late submissions will be accepted.
- In Case of Cheating and Plagiarism Strong **disciplinary action will be taken**.
- For any questions about the Homework 3, contact Beyza EKEN (beyzaeken@itu.edu.tr).

Questions:

1. Making use of the relationship between the singular values of A and the eigenvalues of $AA^T$and A^TA, show the proof of the Singular Value Decomposition (SVD) of A with eigenvalue decomposition.

2. In this question you will play with two pictures (see Figure 1) that can be found in MATLAB's repository of images and can be retrieved by entering `load mandrill` and `load durer`. After loading these files, enter for each the command `colormap(gray)` and then `image(X)`. As you can see, these pictures feature the handsome mandrill and a drawing by the artist Albrecht Dürer, who lived in the 1500s.

    a. Write a short MATLAB script for computing the truncated SVD of these images. For both pictures, start with rank $r = 2$ and go up by powers of 2, to $r = 64$. For a compact presentation of your figures, use the command `subplot` for each of the pictures, with 3 and 2 as the first two arguments.
    b. Comment on the performance of the truncated SVD for each of the pictures. State how much storage is required as a function of *r* and how much storage is required for the original pictures. Explain the difference in the effectiveness of the technique for the two images for small *r* .
    [The mandrill picture file is in fact in color, and you may see it at its full glory by avoiding entering `colormap(gray)` , or simply by entering `colormap(map)` at any time. However, for your calculations please use grayscale.]

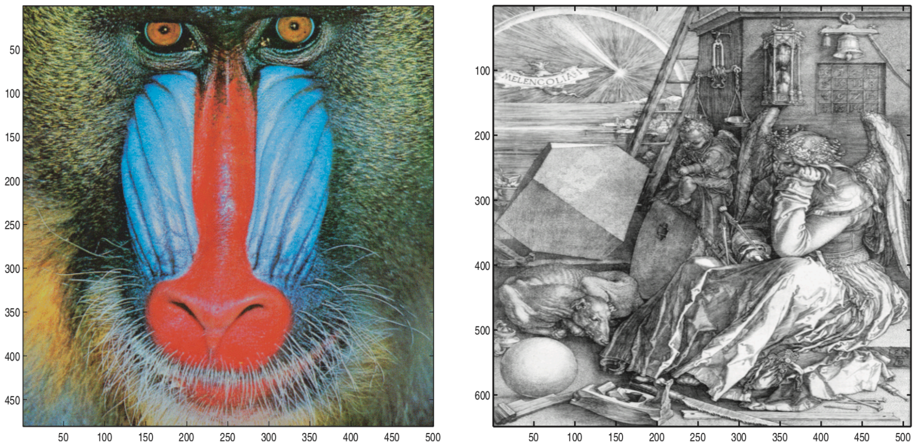

Figure 1: *Mandrill image and a drawing by Albrecht Dürer*

3. Implement the Power Method in Matlab by writing a program that inputs a matrix $A \in R^{nxn}$ and an initial guess vector $v_0 \in R^n$. Use your code to find an eigenvector of matrix given below, starting with the initial guess vectors $v_0 = (1,2,-1)^T$ and $v_0 = (1,2,1)^T$

$$A = \begin{pmatrix} -2 & 1 & 4 \\ 1 & 1 & 1 \\ 4 & 1 & -2 \end{pmatrix}$$

Report the first 5 iterates for each of the two initial vectors. Then use MATLAB's eig(A) to examine the eigenvalues and eigenvectors of A. Where do the sequences converge to? Why do the limits not seem to be the same?

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