

# Machine Learning (IE406) Lab Assignment 1

(Linear Algebra)

January 25, 2022

## Note:

1. This exercise is to familiarize you with the working environment (Google Colab) and the Python packages.
2. to solidify your understanding of some Linear Algebra concepts. Please try to correlate the results of your code with your understanding of the concepts.

## Question 1.

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Consider the following matrix  $W$  and answer the questions below using the Python libraries.

$$W = \begin{bmatrix} 8 & 5 & 1 & 5 & 6 \\ 5 & 3 & 8 & 7 & 5 \\ 1 & 8 & 10 & 7 & 8 \\ 5 & 7 & 7 & 8 & 9 \\ 6 & 5 & 8 & 9 & 7 \end{bmatrix}$$

1. Is the matrix  $W$  symmetric?
2. What is the maximum eigenvalue of  $W$ ?
3. What is the square root of maximum eigenvalue of  $W^2$ ?
4. What is the Frobenius norm of the matrix
5. What is the determinant of the matrix? What is its rank?
6. Perform eigendecomposition of the symmetric matrix and print the eigenvector matrix  $Q$ , and the diagonal matrix  $\Lambda$  with eigenvalues. Verify that matrix  $W$  equals  $Q\Lambda Q^T$

## Question 2.

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Let  $y_0 = [0 \ 1 \ 0 \ 0 \ 0]^T$  and  $b = [1 \ 0 \ 0 \ 0 \ 0]^T$ . Let there be an iterative rule such that  $y_1 = Wy_0 + b$  and in general  $y_n = Wy_{(n-1)} + b$  where  $W$  is given in question 1. Then answer the questions below, round off answers to 4 decimal places.

1. What is the value of  $\|y_1\|_2$
2. What is the value of  $\|y_1\|_2/\|y_0\|_2$

**3. Orthogonal matrix**

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Consider the matrix

$$A = \frac{1}{3} \begin{bmatrix} 2 & -2 & 1 \\ 1 & 2 & 2 \\ 2 & 1 & -2 \end{bmatrix}$$

and vector

$$v^T = [ 1 \quad 0 \quad 1 ]$$

1. What is the norm of vectors  $v$  and  $Av$ ?
2. Is the matrix  $A$  orthogonal?