BS Computer and Software Engineering

Linear Algebra

Quiz# 5 (BSSE23-A), Fall 2024

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Maximum Time Allowed: 10 minutes Maximum Marks: 10

1. For the matrix A and vector b as shown

$$A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, b = \begin{bmatrix} 2 \\ 3 \\ 4 \end{bmatrix}$$

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(a) Project b onto the column space of A by solving $A^T A\hat{x} = A^T b$ and $p = Ax$.

(b) Find $e = b - p$. Show that it is perpendicular to the columns of A.

(a)

$A^T A\hat{x} = A^T b$.

$$\begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 4 \end{bmatrix}.$$

→ from where you extract it?

$$\begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 2 \\ 5 \end{pmatrix}.$$

$x_1 + x_2 = 2.$

$-(x_1 + 2x_2 = 5.)$

$x_2 - 2x_2 = 2 - 5$

$-x_2 = -3$

$x_2 = 3.$

$x_1 + 3 = 2$

$x_1 = 2 - 3$

$x_1 = -1$

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -1 \\ 3 \end{bmatrix}$$

$p = Ax.$

$$= \begin{bmatrix} 1 & 1 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} -1 \\ 3 \end{bmatrix} = \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix}.$$

-1 +3

$$= -1 \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} + 3 \begin{bmatrix} \\ \\ \end{bmatrix}$$

$$p = \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix}.$$