CO-1: Home Assignment-1

1. Identify the combined embedding feature vector from vectors $\vec{e}_1 = (0,1,2)$, $\vec{e}_2 = (1,-1,2)$, $\vec{e}_3 = (-1,0,2)$.
2. In a neural network layer, if the input vector is $\mathbf{x} \in \mathbb{R}^3$and weight matrix is $W \in \mathbb{R}^{2\times 3}$, Identify the dimension of the output vector.
3. Determine the norms of u and v, and evaluate $u \cdot v$, if $u = (a, 2a, 3a, \dots, na)$ and $v = (b, b, b, \dots, b)$.
4. A geometric transformation is represented by the matrix $A = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$. If a planar region has an original area of 6 square units, compute the area of the region after the transformation.
5. An online streaming platform analyzes movie descriptions to improve its recommendation system by identifying similarities in plot content. Two movie plots are given:

   Movie A: A young wizard discovers his powers at a magic school.

   Movie B: A boy with magical abilities studies spells in a wizard school. Analyze the textual similarity between the two movie plots by applying the TF-IDF representation followed by cosine similarity computation also examine the resulting cosine similarity value and interpret what it reveals about the degree of thematic and contextual similarity between the two movie plots in the context of recommendation systems.
6. An AI-based real estate platform uses a single-layer neural network to estimate house price scores based on multiple input features: x_1: House size (in 100 sq. ft), x_2: Distance from the city center, x_3: Age of the house. The input vector, weight matrix, and bias vector for the hidden linear layer (2 neurons**)** are given by:

   $$X = [2 \quad 1 \quad 3], W = \begin{bmatrix} 0.3 & -0.2 & -0.1 \\ 0.4 & -0.3 & -0.2 \end{bmatrix}, b = \begin{bmatrix} 0.2 \\ 0.3 \end{bmatrix}$$

   The final output layer (1 neuron) is defined as:

   $$W_2 = [0.2 \quad 0.3], b_2 = 0.2$$

   Apply the linear transformation to compute the hidden layer output and also determine the final output of the neural network and illustrate the linear layer neural network model using a neat, labeled diagram from the above data.