CS 335: Introduction to Large Language Models

Habib University

Activity Sheet 03

Name: _____ ID: _____

Question 01: Neural Network

Consider the following single layer neural network:

i. The network consists of 2 input neurons, 2 hidden neurons, and 1 output neuron.

ii. The inputs x_1 and x_2 are

$$x_1 = 0.5, \;\; x_2 = 0.7$$

iii. The weight matrix $\mathbf{W}_1$ (2×2) between the input layer and the hidden layer is:

$$\begin{pmatrix} 0.1 & -0.4 \\ 0.6 & 0.9 \end{pmatrix}$$

iv. The activation function for the hidden layer is the ReLU function.

v. The weight matrix $\mathbf{W}_2$ (1×2) between the hidden layer and the output neuron is:

$$(0.4 \quad -0.6)$$

vi. The final output y is computed as a weighted sum of the hidden layer activations (output of the hidden layer). No activation function is applied at the output layer.

(a) Draw the network architecture with 2 input neurons, 2 hidden neurons, and 1 output neuron. Label the layers and connections, including weights $\mathbf{W}_1$ and $\mathbf{W}_2$.

(b) Given the inputs to the neural network, perform a forward pass to compute the final output y.

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Question 02: Next word prediction

A neural language model was given the following context to predict the next word:

"Habib University is"

The tokens in the sequence are represented as vectors:

$$x_1 = embedding(\text{"Habib"}),\ \ x_2 = embedding(\text{"University"}),\ \ x_3 = embedding(\text{"is"})$$

Assume these embeddings are column vectors in $\mathbb{R}^3$:

$$x_1 = \begin{pmatrix} 3.0 \\ -6.5 \\ 0.2 \end{pmatrix},\ \ x_2 = \begin{pmatrix} -2.0 \\ 4.0 \\ 0.1 \end{pmatrix},\ \ x_3 = \begin{pmatrix} 0.0 \\ 3.0 \\ 0.1 \end{pmatrix}$$

(a) Compose these embeddings into a single vector by computing the sum to represent the sequence "Habib University is".

(b) Given a vocabulary of three words: "brilliant," "amazing," and "incredible," and the weight matrix $\mathbf{W}$, determine which word the model predicts next. The weight matrix $\mathbf{W}$ is as follows:

$$\begin{pmatrix} 2.0 & 0.5 & 0.1 \\ 0.3 & 1.5 & 0.2 \\ 0.4 & 0.2 & 1.8 \end{pmatrix}$$