National University of Computer & Emerging Sciences, Karachi
School of Computing
SPRING 2023

Assignment # 3

Artificial Intelligence

Max Points: ***100*** **Due Date: 12th May 2023**

Carefully read the following instructions!

a) Submit assignment in a softcopy only.
b) For any query related to the assignment contact at:
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Question no 1:

Assume that the signal sequence S is partitioned into some segments $x = [x_1, x_2 \ldots.]$ with equal length, and each segment can reveal the intrinsic modulation characteristic of signals. Denote $x_j = a_j + ib_j$ as the j[th] element in some segment of S, where a_j, b_j denote the In-phase (I) and Quadrature (Q) paths respectively. As shown in Fig.3, a convolution with one-dimensional kernel is performed on a signal segment, to filter out the signal feature, which is defined as a 1-D convolution. In the convolution, the kernel length is remarkably shorter than that of the signal segment. Fig.3 plots the 1-D convolution process for the I path of the modulation signal. In the convolution unit, assume there are ***N*** input neurons and ***K*** output neurons. Then we construct a group of connected weights $\{w_m^k\}$(m=1,2….M; k =1, 2,…..K), where ***M*** is the length of the filter; w_m^k is the connected weight between the m^{th} input neuron and k^{th} output neuron; w_b^k is the bias of the k[th] output neuron. Then the output layer can provide a group of features of the sequences, with the n^{th} feature being:

$$s_n^k = f\left(\sum_{i=1}^{M} w_i^k a_i + w_b^k\right)$$

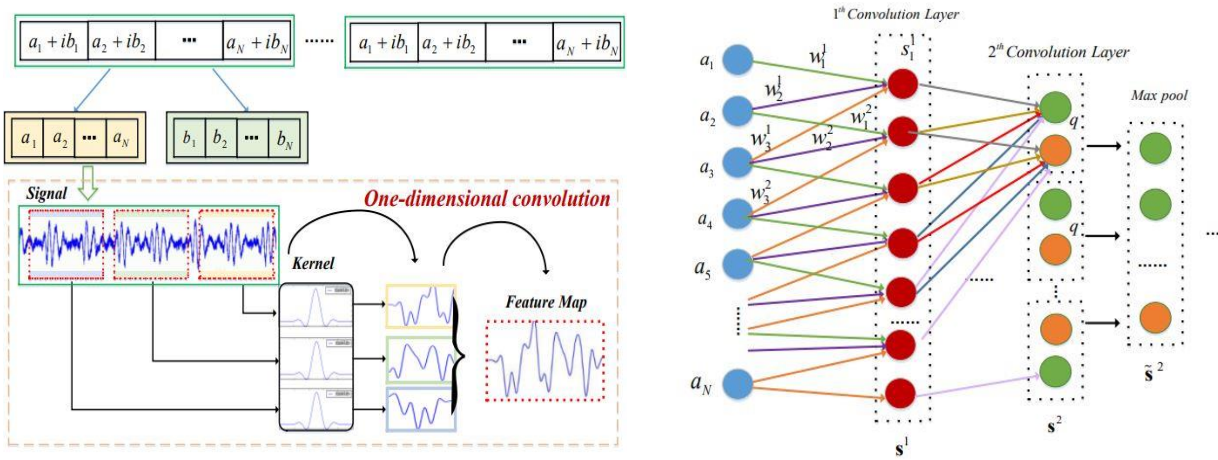


Figure 1 (Left Side) Schematic of One-dimensional Cooperative Convolution (OCC) of signals. (Right Side) NN architecture.

1. **Calculate** the ***S*** of the **first layer** of two nodes i-e s_1^1 and s_2^1. Where $a_1 + ib_1$ = 3+*i*4, $a_2 + ib_2$ = 5+*i*2 and $a_3 + ib_3$ = 2+*i*3.2, $w_1^1 = -2$ and , $w_2^1 = 2$, filter length M = 3 and W =[0.2, 0.4, 0.6] for first node and W= [0.1, 0.9, 0.7] for second node. Use Sigmoid function $f(x) = \frac{1}{1+e^{-x}}$ for all the activation functions.

2. Draw the Neural network structure of the following given equation.

$$Z_{pxm}^{[1]} = W_{pxn}^{[1]} X_{nxm} + B_{pxm}^{[1]}$$

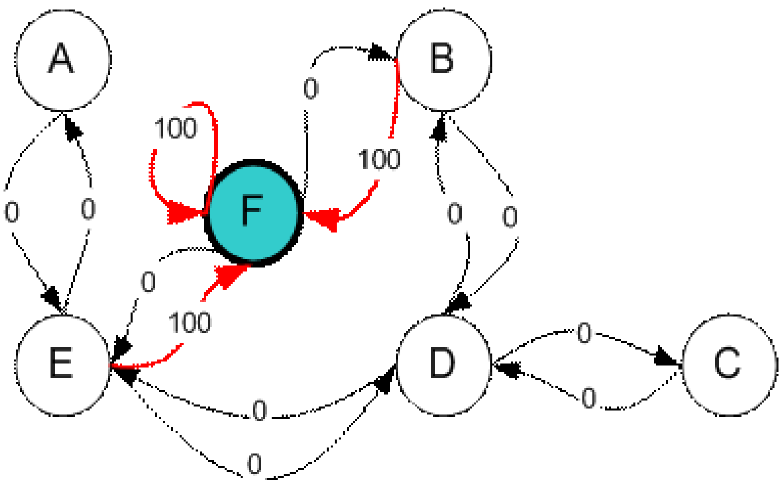
$$Z_{qxm}^{[2]} = W_{qxn}^{[2]} A_{pxm}^{[2]} + B_{qxm}^{[2]}$$

3. Calculate the loss $\partial L / \partial B^{[1]}$ using chain rule of the above drawn neural network. Also explain the importance of backpropagation in neural network in two point / statements just.

Question no 2:

Consider the following information and values:

1. Learning parameter ϒ = 0.8.
2. Initial Q matrix with all the values equal to zero, having states A, B,C,D,E,F.
3. Reward R in the form of state diagram as given below.



Assume that the current stater is B. There are two possible states from B to either F or D. We select F as a state after executing action. Compute the Q(B, F) and update the Q matrix.

Question no 3:

Explore the information given on the following link and write 2-page summary.

https://towardsdatascience.com/reinforcement-learning-made-simple-part-2-solution-approaches-7e37cbf2334e

The End