# RNN Question

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**Work Integrated Learning Programmes Division**

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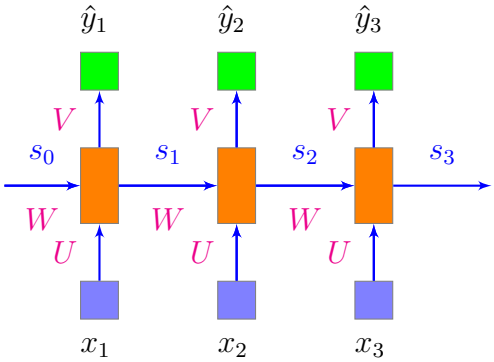
## Sample RNN Question

Compute the outputs in each timestep and the state after timestep=3 for the Vanilla RNN given below. Assume the biases as zeros. [5]



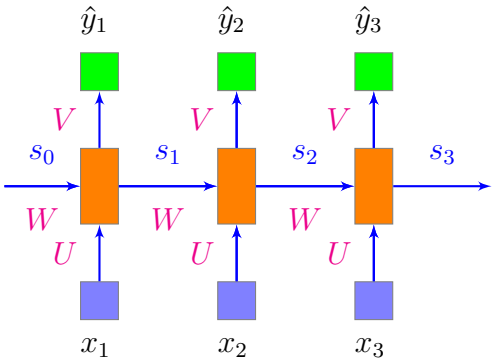

$$X = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix}^\top$$
$$W = \begin{bmatrix} 0.2 & 0.3 & 0.8 \end{bmatrix}^\top$$
$$U = \begin{bmatrix} 0.5 & 0.6 & 0.2 \end{bmatrix}^\top$$
$$V = \begin{bmatrix} 0.4 & 0.2 & 0.1 \end{bmatrix}^\top$$

Solution

$$X = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix}^\top$$
$$W = \begin{bmatrix} 0.2 & 0.3 & 0.8 \end{bmatrix}^\top$$
$$U = \begin{bmatrix} 0.5 & 0.6 & 0.2 \end{bmatrix}^\top$$
$$V = \begin{bmatrix} 0.4 & 0.2 & 0.1 \end{bmatrix}^\top$$
$$s_t = \sigma(Ux_t + Ws_{t-1} + b)$$
$$\hat{y}_t = Relu(Vs_t + c) \qquad \text{Relu is assumed}$$
$$s_0 = 0 \qquad b = 0 \qquad c = 0$$
$$s_1 = \sigma(0.5 * 1 + 0.2 * 0 + 0) = 0.6$$
$$\hat{y}_1 = \max(0, 0.4 * 0.6 + 0) = 0.24$$
$$s_2 = \sigma(0.6 * 1 + 0.3 * 0.6 + 0) = 0.68$$
$$\hat{y}_2 = \max(0, 0.2 * 0.68 + 0) = 0.136$$
$$s_3 = \sigma(0.2 * 0 + 0.8 * 0.68 + 0) = 0.63$$
$$\hat{y}_3 = \max(0, 0.1 * 0.63 + 0) = 0.063$$

# Sample LSTM Question

Compute the outputs in each timestep and the state after timestep=3 for the LSTM given below. Assume the biases as zeros. [5]




$$X = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix}^\top$$
$$W = \begin{bmatrix} 0.2 & 0.3 & 0.8 \end{bmatrix}^\top$$
$$U = \begin{bmatrix} 0.5 & 0.6 & 0.2 \end{bmatrix}^\top$$
$$V = \begin{bmatrix} 0.4 & 0.2 & 0.1 \end{bmatrix}^\top$$
$$W_o = \begin{bmatrix} 0.90.10.3 \end{bmatrix}^\top$$
$$U_o = \begin{bmatrix} 0.40.30.2 \end{bmatrix}^\top$$
$$W_i = \begin{bmatrix} 0.10.40.2 \end{bmatrix}^\top$$
$$U_i = \begin{bmatrix} 0.90.10.3 \end{bmatrix}^\top$$
$$W_f = \begin{bmatrix} 0.50.30.2 \end{bmatrix}^\top$$
$$U_f = \begin{bmatrix} 0.60.20.3 \end{bmatrix}^\top$$

Solution

$$s_t = \sigma(Ux_t + Ws_{t-1} + b)$$
$$\hat{y}_t = Relu(Vs_t + c) \qquad \text{Relu is assumed}$$
$$s_0 = 0 \qquad h_0 = 0 \qquad b = 0 \qquad c = 0$$
$$o_1 = \sigma(0.9 * 0 + 0.4 * 1 + 0) = 0.598$$
$$i_1 = \sigma(0.1 * 0 + 0.3 * 1 + 0) = 0.574$$
$$f_1 = \sigma(0.5 * 0 + 0.6 * 1 + 0) = 0.645$$
$$\hat{s}_t = \sigma(Wh_0 + Ux_1 + b)$$
$$\hat{s}_1 = \sigma(0.2 * 0 + 0.5 * 1 + 0) = 0.62$$
$$s_t = f_t \odot s_{t-1} + i_t \odot \hat{s}_t$$
$$s_1 = f_1 \odot s_0 + i_1 \hat{s}_1 = 0.645 * 0 + 0.574 * 0.62 = 0.355$$
$$h_1 = o_1 \odot \sigma(s_1)$$
$$= 0.598 * \sigma(0.355) = 0.351$$
$$\hat{y}_1 = \sigma(0.4 * 0.355 + 0)$$