Assignment II
COMP 5900 Advanced Machine Learning
Winter 2021

Solution

Q1

	Total # of parameters in RNN/LSTM layer(s)	Test accuracy %
2-level bi-LSTM	1,446,400	83.9
2-level bi-RNN	362,400	70.68
bi-RNN	120,800	61.2
RNN	60,400	63

Q2

$$\frac{\partial L^t}{\partial f_a} = \frac{\partial L^t}{\partial f_p} = \frac{\partial L^t}{\partial f_n} = 0$$

Q3

$$\frac{\partial L^t}{\partial f_a} = (f_a - f_p) - (f_a - f_n) = f_n - f_p$$

$$\frac{\partial L^t}{\partial f_p} = f_p - f_a$$

$$\frac{\partial L^t}{\partial f_n} = f_a - f_n$$

Q4

There are 6 options for selecting an anchor. This leaves 2 options for the positive sample. There are 3 options for the negative sample. Therefore, there are 6x2x3=36 triplets.

Q5

Q5.1 Determine $\frac{\partial L^1}{\partial f_1}, \frac{\partial L^1}{\partial f_2}, \frac{\partial L^1}{\partial f_3}, \frac{\partial L^1}{\partial f_4}, \frac{\partial L^1}{\partial f_5}$ and $\frac{\partial L^1}{\partial f_6}$.

$\frac{\partial L^1}{\partial f_1} = f_5 - f_2$, $\frac{\partial L^1}{\partial f_2} = f_2 - f_1$, $\frac{\partial L^1}{\partial f_5} = f_1 - f_5$. The rest of the derivatives are zero.

Q5.2 Determine $\frac{\partial L^2}{\partial f_1}, \frac{\partial L^2}{\partial f_2}, \frac{\partial L^2}{\partial f_3}, \frac{\partial L^2}{\partial f_4}, \frac{\partial L^2}{\partial f_5}$ and $\frac{\partial L^2}{\partial f_6}$.

$\frac{\partial L^2}{\partial f_1} = f_4 - f_3$, $\frac{\partial L^2}{\partial f_3} = f_3 - f_1$, $\frac{\partial L^2}{\partial f_4} = f_1 - f_4$. The rest of the derivatives are zero.

Q5.3 Determine $\frac{\partial L^3}{\partial f_1}, \frac{\partial L^3}{\partial f_2}, \frac{\partial L^3}{\partial f_3}, \frac{\partial L^3}{\partial f_4}, \frac{\partial L^3}{\partial f_5}$ and $\frac{\partial L^3}{\partial f_6}$.

$\frac{\partial L^3}{\partial f_2} = f_6 - f_1$, $\frac{\partial L^3}{\partial f_1} = f_1 - f_2$, $\frac{\partial L^3}{\partial f_6} = f_2 - f_6$. The rest of the derivatives are zero.

Q5.4 Determine $\frac{\partial L^4}{\partial f_1}, \frac{\partial L^4}{\partial f_2}, \frac{\partial L^4}{\partial f_3}, \frac{\partial L^4}{\partial f_4}, \frac{\partial L^4}{\partial f_5}$ and $\frac{\partial L^4}{\partial f_6}$.

$\frac{\partial L^4}{\partial x_2} = f_4 - f_3$, $\frac{\partial L^4}{\partial f_3} = f_3 - f_2$, $\frac{\partial L^4}{\partial f_4} = f_2 - f_4$. The rest of the derivatives are zero.

Q5.5 Determine $\frac{\partial L^5}{\partial f_1}, \frac{\partial L^5}{\partial f_2}, \frac{\partial L^5}{\partial f_3}, \frac{\partial L^5}{\partial f_4}, \frac{\partial L^5}{\partial f_5}$ and $\frac{\partial L^5}{\partial f_6}$.

$\frac{\partial L^5}{\partial f_3} = f_5 - f_1$, $\frac{\partial L^5}{\partial f_1} = f_1 - f_3$, $\frac{\partial L^5}{\partial f_5} = f_3 - f_5$. The rest of the derivatives are zero.

Q5.6 Determine $\frac{\partial L^8}{\partial f_1}, \frac{\partial L^8}{\partial f_2}, \frac{\partial L^8}{\partial f_3}, \frac{\partial L^8}{\partial f_4}, \frac{\partial L^8}{\partial f_5}$ and $\frac{\partial L^8}{\partial f_6}$.

$\frac{\partial L^6}{\partial f_5} = f_2 - f_6$, $\frac{\partial L^6}{\partial f_6} = f_6 - f_5$, $\frac{\partial L^6}{\partial f_2} = f_5 - f_2$. The rest of the derivatives are zero.

Q5.7 Determine $\frac{\partial L^9}{\partial f_1}, \frac{\partial L^9}{\partial f_2}, \frac{\partial L^9}{\partial f_3}, \frac{\partial L^9}{\partial f_4}, \frac{\partial L^9}{\partial f_5}$ and $\frac{\partial L^9}{\partial f_6}$.

$\frac{\partial L^7}{\partial f_6} = f_3 - f_4$, $\frac{\partial L^7}{\partial f_4} = f_4 - f_6$, $\frac{\partial L^7}{\partial f_3} = f_6 - f_3$. The rest of the derivatives are zero.

Q5.8 Determine $\frac{\partial L^{10}}{\partial f_1}, \frac{\partial L^{10}}{\partial f_2}, \frac{\partial L^{10}}{\partial f_3}, \frac{\partial L^{10}}{\partial f_4}, \frac{\partial L^{10}}{\partial f_5}$ and $\frac{\partial L^{10}}{\partial f_6}$.

$\frac{\partial L^8}{\partial f_6} = f_2 - f_4$, $\frac{\partial L^8}{\partial f_4} = f_4 - f_6$, $\frac{\partial L^8}{\partial f_2} = f_6 - f_2$. The rest of the derivatives are zero.

Q6:

$\frac{\partial L}{\partial f_1} = (f_5 - f_2) + (f_4 - f_3) + (f_1 - f_2) + 0 + (f_1 - f_3) + 0 + 0 + 0 = 2f_1 - 2f_2 - 2f_3 + f_4 + f_5$

$\frac{\partial L}{\partial f_2} = (f_2 - f_1) + 0 + (f_6 - f_1) + (f_4 - f_3) + 0 + (f_5 - f_2) + 0 + (f_6 - f_2) = -2f_1 - f_2 - f_3 + f_4 + f_5 + 2f_6$

$$\frac{\partial L}{\partial f_3} = 0 + (f_3 - f_1) + 0 + (f_3 - f_2) + (f_5 - f_1) + 0 + (f_6 - f_3) + 0 = -2f_1 - f_2 + f_3 + 0 + f_5 + f_6$$

$$\frac{\partial L}{\partial f_4} = 0 + (f_1 - f_4) + 0 + (f_2 - f_4) + 0 + 0 + (f_4 - f_6) + (f_4 - f_6) = f_1 + f_2 + 0 + 0 + 0 - 2f_6$$

$$\frac{\partial L}{\partial f_5} = (f_1 - f_5) + 0 + 0 + 0 + (f_3 - f_5) + (f_2 - f_6) + 0 + 0 = f_1 + f_2 + f_3 + 0 - 2f_5 - f_6$$

$$\frac{\partial L}{\partial f_6} = 0 + 0 + (f_2 - f_6) + 0 + 0 + (f_6 - f_5) + (f_3 - f_4) + (f_2 - f_4)$$

$$= 0 + 2f_2 + f_3 - 2f_4 - f_5 + 0$$