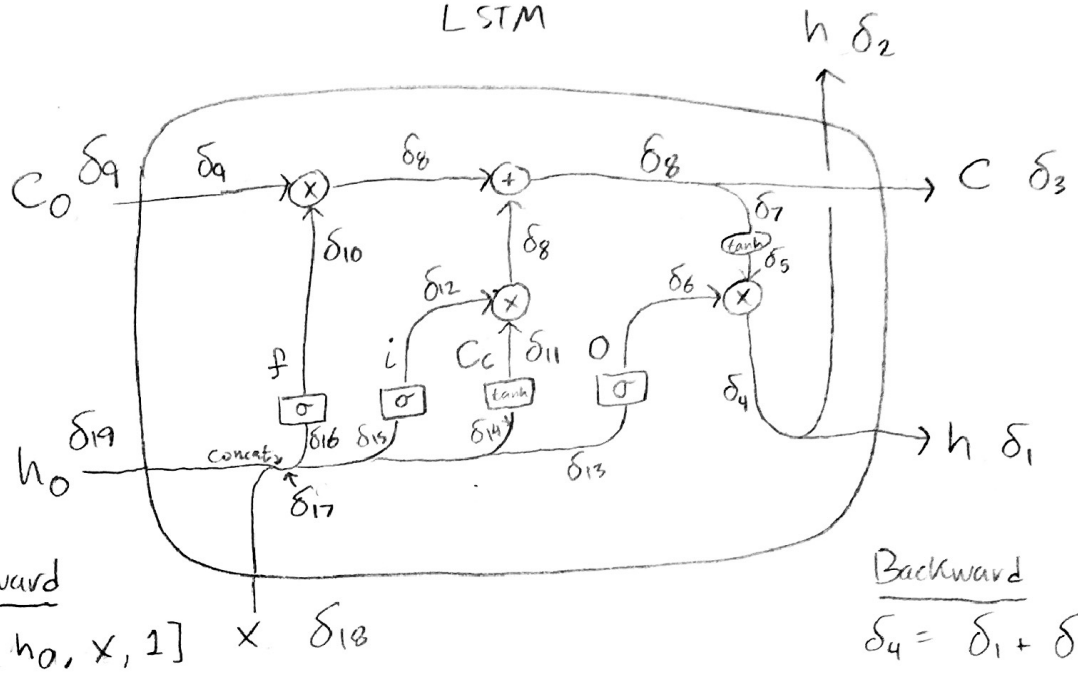
LSTM



forward

$hxb = [h_0, x, 1]$

$f = \sigma(hxb \cdot W_f)$

$i = \sigma(hxb \cdot W_i)$

$C_c = \tanh(hxb \cdot W_c)$

$O = \sigma(hxb \cdot W_o)$

$C = f \otimes C_0 + i \otimes C_c$

$h = O \otimes \tanh(C)$

Backward

$\delta_4 = \delta_1 + \delta_2$

$\delta_5 = \delta_4 \otimes O$

$\delta_6 = \delta_4 \otimes \tanh(C)$

$\delta_7 = \delta_5 \otimes \tanh'(C)$

$\delta_8 = \delta_3 + \delta_7$

$\delta_9 = \delta_8 \otimes f$

$\delta_{10} = \delta_8 \otimes C_0$

$\delta_{11} = \delta_8 \otimes i$

$\delta_{12} = \delta_8 \otimes C_c$

$\delta_{13} = O'(\delta_6)$

$\delta_{14} = C_c'(\delta_{11})$

$\delta_{15} = i'(\delta_{12})$

$\delta_{16} = f'(\delta_{10})$

remove last 1 from bias add

$\delta_{17} = \delta_{13} + \delta_{14} + \delta_{15} + \delta_{16}$

$\delta_{18} = \delta_{17}$ [x region]

$\delta_{19} = \delta_{17}$ [h region]