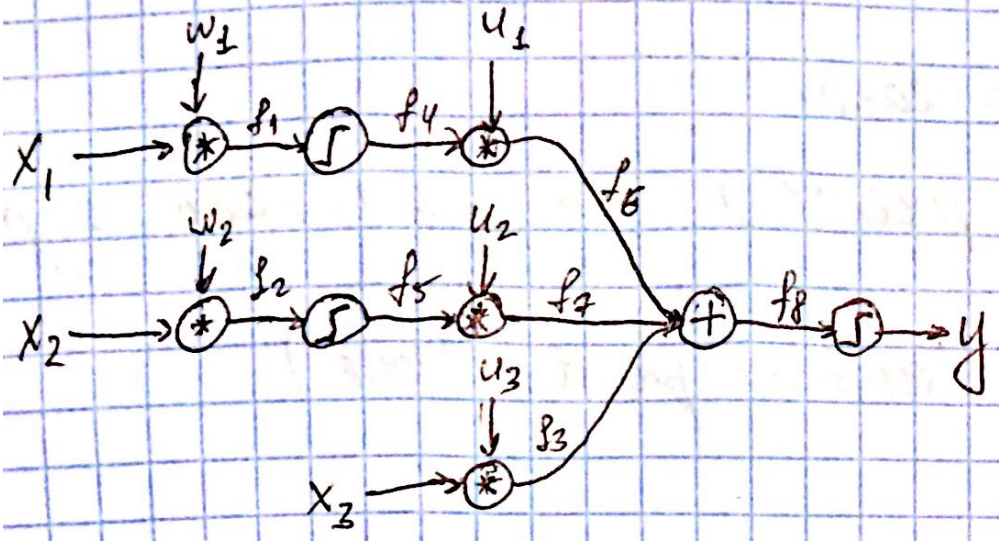

$f_1(x_1) = w_1 \cdot x_1 \Rightarrow \frac{df_1}{dx_1} = w_1, \quad \frac{df_1}{dw_1} = x_1$

$f_2(x_2) = w_2 x_2 \Rightarrow \frac{df_2}{dx_2} = w_2$

$f_3(x_3) = w_3 x_3 \Rightarrow \frac{df_3}{dx_3} = u_3, \quad \frac{df_3}{du_3} = x_3$

$f_4(f_1) = \text{sigmoid}(f_1) \Rightarrow \frac{df_4}{df_1} = s(f_1) \cdot (1 - s(f_1))$

$f_5(f_2) = s(f_2) \Rightarrow \frac{df_5}{df_2} = s(f_2) \cdot (1 - s(f_2))$

$f_6(f_4) = u_1 \cdot f_4 \Rightarrow \frac{df_6}{df_4} = u_1, \quad \frac{df_6}{du_1} = f_4$

$f_7(f_5) = u_2 \cdot f_5 \Rightarrow \frac{df_7}{df_5} = u_2, \quad \frac{df_7}{du_2} = f_5$

$f_8(f_6, f_7, f_3) = f_3 + f_6 + f_7 \Rightarrow \frac{df_8}{df_3} = 1, \quad \frac{df_8}{df_6} = 1, \quad \frac{df_8}{df_7} = 1$

$y(f_8) = s(f_8) \Rightarrow \frac{dy}{df_8} = s(f_8) \cdot (1 - s(f_8))$

$E = \frac{1}{2}\cdot(t-y)^2 \qquad \frac{dE}{dy} = (y-t)$ Chain Rules:

$$\frac{dE}{dw_1} = \frac{dE}{dy}\cdot\frac{dy}{dw_1} = \frac{dE}{dy}\cdot\frac{dy}{df_8}\cdot\frac{df_8}{df_6}\cdot\frac{df_6}{df_4}\cdot\frac{df_4}{df_1}\cdot\frac{df_1}{dw_1}$$

$$\frac{dE}{du_1} = \frac{dE}{dy}\cdot\frac{dy}{du_1} = \frac{dE}{dy}\cdot\frac{dy}{df_8}\cdot\frac{df_8}{df_6}\cdot\frac{df_6}{du_1}$$

$$\frac{dE}{du_2} = \frac{dE}{dy}\cdot\frac{dy}{du_2} = \frac{dE}{dy}\cdot\frac{dy}{df_8}\cdot\frac{df_8}{df_7}\cdot\frac{df_7}{du_2}$$

$$\frac{dy}{du_3} = \frac{dE}{dy}\cdot\frac{dy}{df_8}\cdot\frac{df_8}{df_3}\cdot\frac{df_3}{du_3}$$

Results:

$$\frac{dE}{dw_1} = (y-t)\cdot[s(f_8)\cdot(1-s(f_8))]\cdot 1\cdot u_1\cdot[s(f_1)\cdot(1-s(f_1))]\cdot x_1$$

$$\frac{dE}{du_1} = (y-t)\cdot[s(f_8)\cdot(1-s(f_8))]\cdot 1\cdot f_4$$

$$\frac{dE}{du_2} = (y-t)\cdot[s(f_8)\cdot(1-s(f_8))]\cdot 1\cdot f_5$$

$$\frac{dE}{du_3} = (y-t)\cdot[s(f_8)\cdot(1-s(f_8))]\cdot 1\cdot x_3$$

where:

$f_8 = u_1\cdot s(w_1\cdot x_1) + u_2\cdot s(w_2\cdot x_2) + u_3\cdot x_3$

$f_1 = w_1\cdot x_1$

$f_4 = s(w_1\cdot x_1)$

$f_5 = s(w_2\cdot x_2)$

$y = s(f_8)$

Finally: w_1', u_2', u_3' – new weights

$$w_1' = w_1 - \alpha \cdot \frac{dE}{dw_1}$$

$$u_2' = u_2 - \alpha \cdot \frac{dE}{du_2}$$

$$u_3' = u_3 - \alpha \cdot \frac{dE}{du_3}$$

where α – learning rate (e.g. 0.1, 0.05, 0.2)