$$J_{MSE}(\theta) = \frac{1}{2m} \sum_{i=1}^{m} \left(y^{(i)} - \left(\sum_{k=1}^{n} w_{2,k} \cdot \sigma(w_{1,k} \cdot x^{(i)} + b_{1,k}) + b_2 \right) \right)^2$$

$$\frac{\partial}{\partial w_{1,k}} = -\frac{1}{m} \sum_{i=1}^{m} \left(y^{(i)} - \left(\sum_{k=1}^{n} w_{2,k} \cdot z + b_2 \right) \right) \cdot z \cdot (1-z) \cdot x^{(i)} \cdot w_{2,k} \, ,$$

$$z = \sigma(w_{1,k} \cdot x^{(i)} + b_{1,k})$$

$$\frac{\partial}{\partial w_{2,k}} = -\frac{1}{m} \sum_{i=1}^{m} \left(y^{(i)} - \left(\sum_{k=1}^{n} w_{2,k} \cdot z + b_2 \right) \right) \cdot z \, ,$$

$$z = \sigma(w_{1,k} \cdot x^{(i)} + b_{1,k})$$

$$\frac{\partial}{\partial b_{1,k}} = -\frac{1}{m} \sum_{i=1}^{m} \left(y^{(i)} - \left(\sum_{k=1}^{n} w_{2,k} \cdot z + b_2 \right) \right) \cdot z \cdot (1-z) \cdot w_{2,k} \, ,$$

$$z = \sigma(w_{1,k} \cdot x^{(i)} + b_{1,k})$$

$$\frac{\partial}{\partial b_2} = -\frac{1}{m} \sum_{i=1}^{m} \left(y^{(i)} - \left(\sum_{k=1}^{n} w_{2,k} \cdot z + b_2 \right) \right) \cdot 1 \, ,$$

$$z = \sigma(w_{2,k} \cdot x^{(i)} + b_2)$$