CS 1678/2078 Homework 3 (Back prop)

Alaa Alghwiri

Question 1

1.

What is the partial derivative of the loss function with respect to the weight $W_{1,1}^3$ in the output layer?

$$\frac{\partial l(\theta)}{\partial W_{1,1}^3} = \frac{\partial h^3}{\partial W_{1,1}^3} \frac{\partial l(\theta)}{\partial h^3}$$

$$\frac{\partial h^3}{\partial W_{1,1}^3} = h_1^2$$

$$\frac{\partial l(\theta)}{\partial h^3} = \sigma$$

Accordingly:

$$\frac{\partial l(\theta)}{\partial W_{1,1}^3} = h_1^2 \times \sigma$$

2.

$$\frac{\partial l(\theta)}{\partial W_{1,2}^3} = h_2^2 \times \sigma$$

3.

$$\frac{\partial l(\theta)}{\partial W^3} = \begin{bmatrix} h_1^2 \times \sigma & h_2^2 \times \sigma \end{bmatrix}$$

4.

$$\frac{\partial l(\theta)}{\partial h_{1,1}^2} = \frac{\partial h^3}{\partial h_{1,1}^2} \frac{\partial l(\theta)}{\partial h^3}$$

$$\frac{\partial l(\theta)}{\partial h_{1,1}^2} = W_{1,1}^3 \times \sigma$$

5.

$$\frac{\partial l(\theta)}{\partial h^2} = \begin{bmatrix} W_{1,1}^3 \times \sigma & W_{1,2}^3 \times \sigma \end{bmatrix}$$

6.

$$\frac{\partial \sigma(x)}{\partial x} =$$

$$\frac{d\sigma(x)}{dx} = \begin{cases} 1 & \text{if } x > 0 \\ 0 & \text{if } x \leq 0 \end{cases}$$

7.

$$\frac{\partial h_{1,1}^2}{\partial W_{1,j}^2} = \begin{bmatrix} \sigma(z_1^1) & \sigma(z_2^1) & \sigma(z_3^1) \end{bmatrix}$$

8.

$$\frac{\partial h_{1,1}^2}{\partial W_{2,j}^2} = \begin{bmatrix} \sigma(z_1^1) & \sigma(z_2^1) & \sigma(z_3^1) \end{bmatrix}$$

9.

$$\frac{\partial h_{1,1}^2}{\partial W^2} = \begin{bmatrix} \sigma(z_1^1) & \sigma(z_2^1) & \sigma(z_3^1) \\ \sigma(z_1^1) & \sigma(z_2^1) & \sigma(z_3^1) \end{bmatrix}$$