ANN (summer project), assignment 1

Vivek Kumar Singh

1 Theory Assignments:-

1. **Solution:**
   Forward Propagation : In this step we pass the inputs to the model, multiply with weights and add bias at every layer of NN and find the calculated output of the model.
   Backward Propagation: After calculating the loss using the calculated output and the expected output, we update the weights at every layer using gradient descent.

2. **Solution:**

$$z^{[1]} = w^{[1]T}x + b^{[1]}$$
$$a^{[1]} = g^{[1]}(z^{[1]})$$
$$z^{[2]} = w^{[2]T}a^{[1]} + b^{[2]}$$
$$a^{[2]} = g^{[2]}(z^{[2]})$$

   Where X is a vector with entries $x[i]$ where i is from 0 to 3. $g^{[1]}$ and $g^{[2]}$ are activation function for first and second layer respectively. $w^{[1]}$ and $b^{[1]}$ are weights and biases for first layer and $w^{[2]}$ and $b^{[2]}$ are weights and biases for second layer.

   In general

$$z^{[i]} = w^{[i]T}a^{[i-1]} + b^{[i]}$$
$$a^{[i]} = g^{[i]}(z^{[i]})$$

3. **Solution:**
   a. Sigmoid

$$f(x) = \frac{1}{1 + e^{-x}}$$
$$f'(x) = f(x)(1 - f(x))$$

b. ReLU

$$f(x) = \begin{cases} x, & \text{if } x > 0 \\ 0, & \text{if } x \leq 0 \end{cases}$$

$$f'(x) = \begin{cases} 1, & \text{if } x > 0 \\ 0, & \text{if } x \leq 0 \end{cases}$$

c. Leaky ReLU

$$f(x) = \begin{cases} x, & \text{if } x > 0 \\ 0.01x, & \text{if } x \leq 0 \end{cases}$$

$$f'(x) = \begin{cases} 1, & \text{if } x > 0 \\ 0.01, & \text{if } x \leq 0 \end{cases}$$

d. tanh

$$f(x) = 1 - \frac{2}{e^{2x} + 1}$$

$$f'(x) = \frac{4}{(e^x + e^{-x})^2}$$

e. Softmax

$$\sigma(x_i) = \frac{e^{x_i}}{\sum_{i=1}^{n} e^{x_i}}$$

$$\frac{\partial}{\partial x_i}\sigma(x_i) = \sigma(x_i)(1 - \sigma(x_i))$$