Neural Networks

Sean Theisen

June 2024

1 Introduction

The following will outline the mathematics behind nueral networks

2 Forward Propogation

1. Training Matrix

$$\{x \in R^{mxn} : m = samples, n = featues\}$$

2. Weights Matrix

$$\{w \in R^{nxp} : n = features, p = nodes\}$$

3. Biasis Vector

$$\{b \in R^{p} : n = features\}$$

4. Forward Propogation

$$f := R^{nxp} \mapsto R^{nxp}$$

$$z = ((x@w) + b) \tag{1}$$

$$a = f(z) \tag{2}$$

3 Back Propogation

Back propogation is done via gradient descent

$$\frac{dC}{dw} = (x^T@(a - y) * g'(z))/m \tag{3}$$

$$\frac{dC}{db} = (\sum(a - y))/m \tag{4}$$

4 Optimization

$$w_i = w_i - (\alpha x \frac{dC}{dw_i}) \tag{5}$$

$$b = b - (\alpha x \frac{dC}{db}) \tag{6}$$