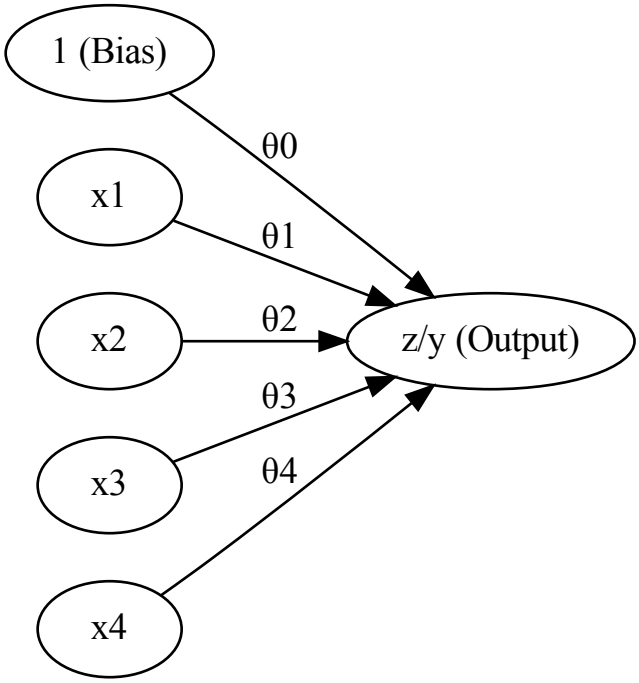
Module 13 Self Check

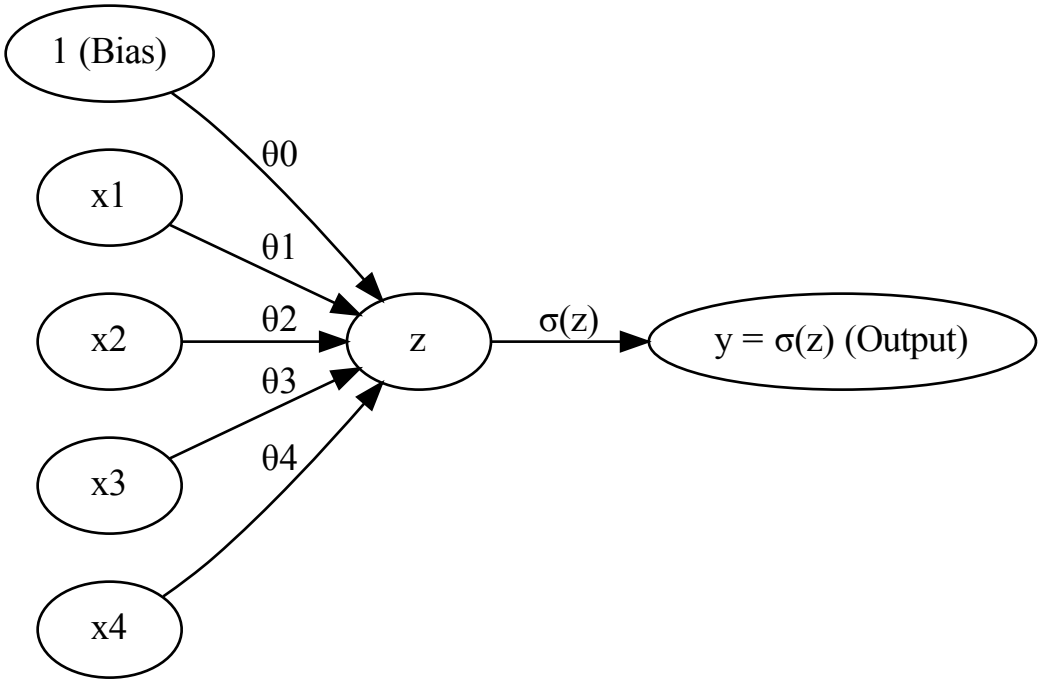
David Bishop

November 2024

1 Linear Regression Function

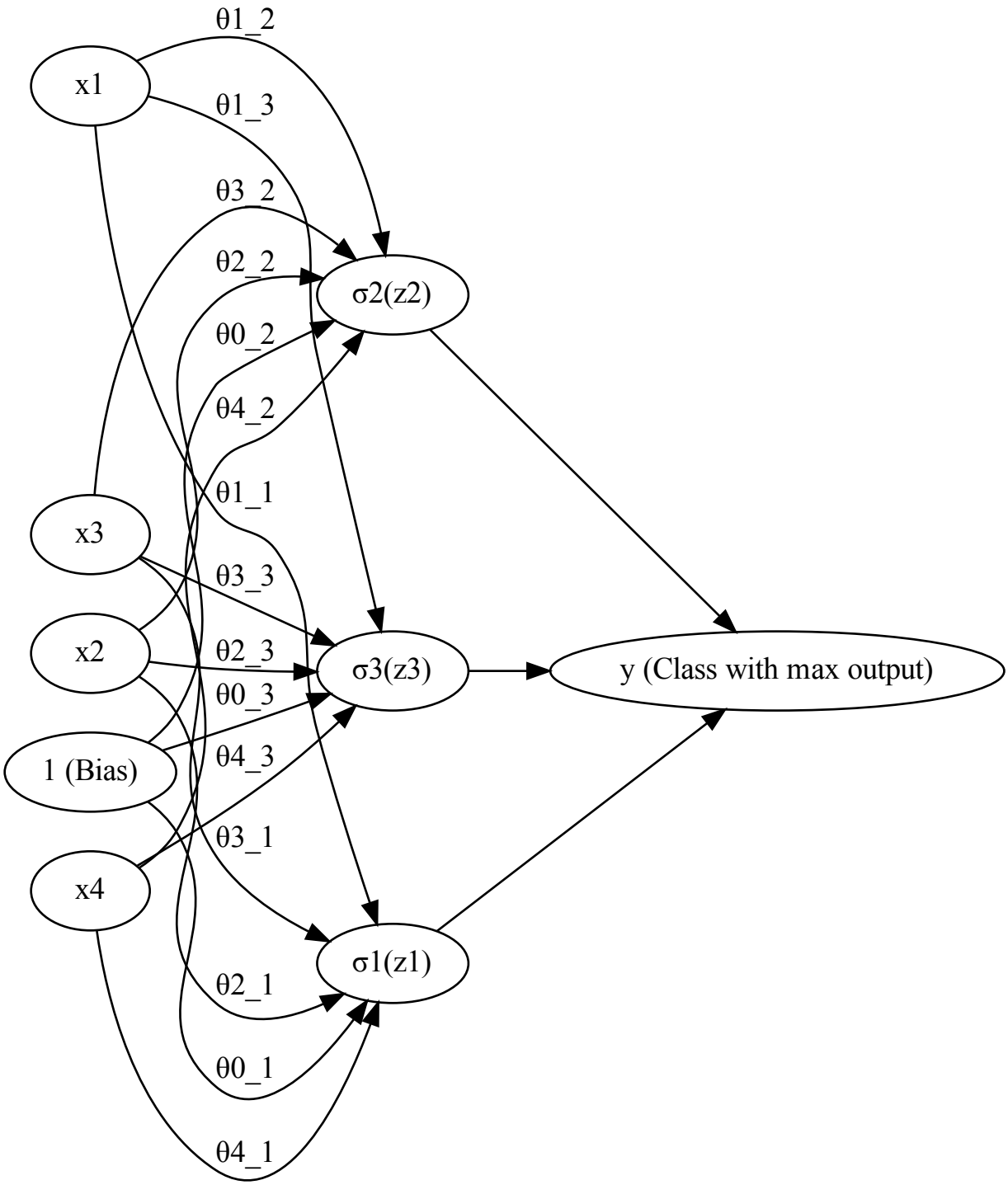


2 Logistic Function



The difference between these two functions is that the Linear Regression Function ingests all the inputs and outputs it directly to z/y, they are the same in this equation. Logistic Function on the other had ingests them all to z and then does a sigmoid function to get y.

3 N logistic regressions



This graph was hard to not be confusing to look at, the gist is that each x and the bias feeds into each z which is sigmoided to get the y value.

4 Calculate ?, Forward Pass

Going from top middle down and then to top right.

1. $?_1$
   $z = 1 * 0.01 + 0.52 * 0.26 + -0.97 * -0.42 = 0.5526$
   $\sigma(z) = \frac{1}{1+e^{-0.5526}} = 0.634$
2. $?_2$
   $z = 1 * -0.05 + 0.52 * 0.78 + -0.97 * 0.19 = 0.1713$
   $\sigma(z) = \frac{1}{1+e^{-0.1713}} = 0.543$
3. $?_3$
   $z = 1 * 0.42 + 0.52 * -0.23 + -0.97 * 0.37 = -0.0585$
   $\sigma(z) = \frac{1}{1+e^{0}.0585} = 0.485$
4. $?_4$
   $z = 1 * 0.2 + 0.634 * 0.61 + 0.543 * 0.12 + 0.485 * -0.9 = 0.2154$
   $\sigma(z) = \frac{1}{1+e^{0}.2154} = 0.554$
5. $?_5$
   $z = 1 * 0.3 + 0.634 * 0.28 + 0.543 * -0.34 + 0.485 * 0.1 = 0.341$
   $\sigma(z) = \frac{1}{1+e^{-0.5526}} = 0.584$

5 Calculate ?, Backpropogation

1. Calculate Error
   $?_4 = 0.544 - 1 = -0.446$
   $?_5 = 0.584 - 0 = 0.584$
2. Calculate output gradients
   $\sigma'(z) = \sigma(z) * (1 - \sigma(z))$
   $\delta = error * \sigma'(z)$
   $\sigma'(z_4) = 0.554 * (1 - 0.554) = 0.554 * 0.446 = 0.247$
   $\delta_4 = -0.446 * 0.247 = -0.110$
   $\sigma'(z_5) = 0.584 * (1 - 0.584) = 0.584 * 0.416 = 0.243$
   $\delta_5 = 0.584 * 0.243 = 0.142$
3. Backprop to hidden layer
   $\sigma'(z_1) = 0.634 * (1 - 0.634) = 0.232$
   $\delta_1 = 0.232 * (-0.110 * 0.61 + 0.142 * 0.28) = -0.006$
   $\sigma'(z_2) = 0.543 * (1 - 0.543) = 0.248$
   $\delta_2 = 0.248 * (-0.110 * 0.12 + 0.142 * -0.34) = -0.015$
   $\sigma'(z_3) = 0.485 * (1 - 0.485) = 0.249$
   $\delta_3 = 0.249 * (-0.110 * -0.9 + 0.142 * 0.1) = 0.028$
4. Update Weights from input to hidden
   $w_{1\to1}^{\text{new}} = w_{1\to1} - \alpha \cdot \delta_1 \cdot x_1 = 0.01 - 0.01 \cdot (-0.006) \cdot 1 = 0.0101$
   $w_{2\to1}^{\text{new}} = w_{2\to1} - \alpha \cdot \delta_1 \cdot x_2 = 0.26 - 0.01 \cdot (-0.006) \cdot 0.52 = 0.2603$
   $w_{3\to1}^{\text{new}} = w_{3\to1} - \alpha \cdot \delta_1 \cdot x_3 = -0.42 - 0.01 \cdot (-0.006) \cdot -0.97 = -0.4206$

$$w_{1\to2}^{\text{new}} = w_{1\to2} - \alpha \cdot \delta_2 \cdot x_1 = -0.05 - 0.01 \cdot (-0.015) \cdot 1 = -0.0498$$
$$w_{2\to2}^{\text{new}} = w_{2\to2} - \alpha \cdot \delta_2 \cdot x_2 = 0.78 - 0.01 \cdot (-0.015) \cdot 0.52 = 0.7808$$
$$w_{3\to2}^{\text{new}} = w_{3\to2} - \alpha \cdot \delta_2 \cdot x_3 = 0.19 - 0.01 \cdot (-0.015) \cdot -0.97 = 0.1899$$
$$w_{1\to3}^{\text{new}} = w_{1\to3} - \alpha \cdot \delta_3 \cdot x_1 = 0.42 - 0.01 \cdot 0.028 \cdot 1 = 0.4197$$
$$w_{2\to3}^{\text{new}} = w_{2\to3} - \alpha \cdot \delta_3 \cdot x_2 = -0.23 - 0.01 \cdot 0.028 \cdot 0.52 = -0.2301$$
$$w_{3\to3}^{\text{new}} = w_{3\to3} - \alpha \cdot \delta_3 \cdot x_3 = 0.37 - 0.01 \cdot 0.028 \cdot -0.97 = 0.3703$$

5. Update weights from hidden to output

$$w_{1\to4}^{\text{new}} = w_{1\to4} - \alpha \cdot \delta_4 \cdot h_1 = 0.61 - 0.01 \cdot (-0.110) \cdot 0.634 = 0.6107$$
$$w_{2\to4}^{\text{new}} = w_{2\to4} - \alpha \cdot \delta_4 \cdot h_2 = 0.12 - 0.01 \cdot (-0.110) \cdot 0.543 = 0.1206$$
$$w_{3\to4}^{\text{new}} = w_{3\to4} - \alpha \cdot \delta_4 \cdot h_3 = -0.9 - 0.01 \cdot (-0.110) \cdot 0.485 = -0.8995$$
$$w_{1\to5}^{\text{new}} = w_{1\to5} - \alpha \cdot \delta_5 \cdot h_1 = 0.28 - 0.01 \cdot 0.142 \cdot 0.634 = 0.2791$$
$$w_{2\to5}^{\text{new}} = w_{2\to5} - \alpha \cdot \delta_5 \cdot h_2 = -0.34 - 0.01 \cdot 0.142 \cdot 0.543 = -0.3408$$
$$w_{3\to5}^{\text{new}} = w_{3\to5} - \alpha \cdot \delta_5 \cdot h_3 = 0.10 - 0.01 \cdot 0.142 \cdot 0.485 = 0.0993$$