Neural Networks and Deep Learning with Business Applications

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Assignment L1

1. Given a neural network with a single neuron, calculate the output of this neuron using four different activation functions: sigmoid, ReLU (Rectified Linear Unit), threshold, and tanh (hyperbolic tangent). The input to the neuron (pre-activation) is $x = 0.5$, and the neuron's weight is $w = -1.5$, with no bias term. For the threshold function, use a threshold value of 0. (10 marks)

    (a) **Sigmoid Function:** The sigmoid function is defined as $\sigma(z) = \frac{1}{1+e^{-z}}$. Calculate the output of the neuron using the sigmoid activation function.

    (b) **ReLU Function:** The ReLU function is defined as $R(z) = \max(0, z)$. Calculate the output of the neuron using the ReLU activation function.

    (c) **Threshold Function:** The threshold function is defined as $T(z) = 1$ if $z \geq 0$ and $T(z) = 0$ if $z < 0$. Calculate the output of the neuron using the threshold activation function.

    (d) **Tanh Function:** The tanh function is defined as $\tanh(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}}$. Calculate the output of the neuron using the tanh activation function.

    For each activation function, provide your calculation and the final output value.

    Note: For this question, the pre-activation value z is calculated as $z = w \cdot x$.

2. Construct by hand a Perceptron which correctly classifies the following data; use your knowledge of plane geometry to choose appropriate values for the weights w_0, w_1, and w_2. (10 marks)

Training Example	x_1	x_2	Class
a.	0	1	-1
b.	2	0	-1
c.	1	1	+1

Table 1: Samples used