4. Neural Network Units

Exercises due Oct 28, 2020 05:29 IST *Completed*

Neural Network Units

Start of transcript. Skip to the end.

Our feed forward neural networks don't actually

look very much like real neural networks in the brain.

To that end, let's take a very brief look

at what real neural networks look like

and then abstract them away towards

our artificial neural networks.

0:00 / 0:00 1.25x

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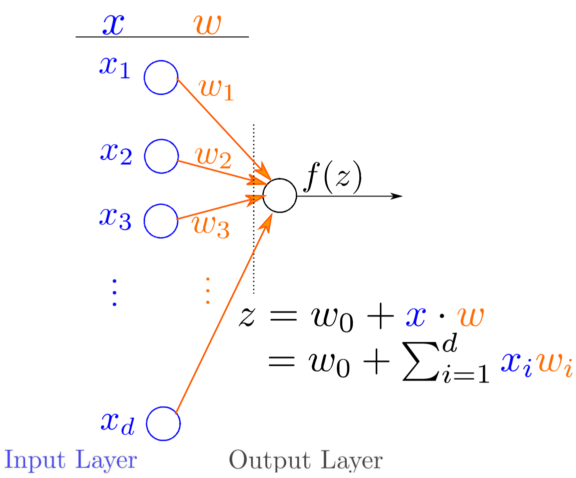
A **neural network unit** is a primitive neural network that consists of only the “input layer", and an output layer with only one output. It is represented pictorially as follows:



A neural network unit computes a non-linear weighted combination of its input:

$$\hat{y} \quad = \quad f(z) \quad \text{where } z = w_0 + \sum_{i=1}^{d} x_i w_i$$

where w_i are numbers called **weights** , z is a number and is the weighted sum of the inputs x_i , and f is generally a non-linear function called the **activation function** .

The above equation in vector form is:

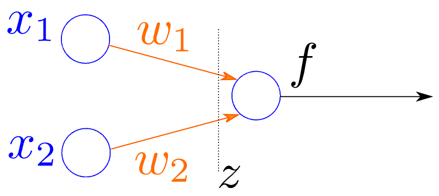
$$\hat{y} \quad = \quad f(z) \quad \text{where } z = w_0 + x \cdot w,$$

where $x = [x_1, \ldots, x_d]$ and $w = [w_1, \ldots, w_d]$.

Numerical Example - Neural Network Unit

2/2 points (graded)

In this problem, you will compute the output $\hat{y} = f(z)$ in the following neural network unit with 2 inputs x_1 and x_2.



Let

$$\begin{aligned} x &= [1, 0] \\ w_0 &= -3 \\ w &= \begin{bmatrix} 1 \\ -1 \end{bmatrix} \end{aligned}$$

First, compute z.

$z =$ -2 ✔ **Answer:** -2

The **rectified linear function (ReLU)** is defined as:

$$f(z) = \max\{0, z\}.$$

Using the ReLU function as the activiation function $f(z)$, compute $\hat{y}$:

$\hat{y} =$ 0 ✔ **Answer:** 0

Solution:

$$\begin{aligned} x &= [1, 0] \\ w_0 &= [-3] \\ w &= \begin{bmatrix} 1 \\ -1 \end{bmatrix} \\ x \cdot w &= [1, 0] \cdot \begin{bmatrix} 1 \\ -1 \end{bmatrix} \\ x \cdot w &= 1 \\ x \cdot w + w_0 &= 1 - 3 \\ x \cdot w + w_0 &= -2 \\ \mathrm{ReLU}(x \cdot w + w_0) &= \mathrm{ReLU}(-2) \\ \mathrm{ReLU}(x \cdot w + w_0) &= max(0, -2) \\ \mathrm{ReLU}(x \cdot w + w_0) &= 0 \end{aligned}$$

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You have used 1 of 2 attempts

Answers are displayed within the problem

Hyperbolic Tangent Activation Function

2.0/2.0 points (graded)

In this problem, we will recall and refamiliarize ourselves with hyperbolic tangent function, which is commonly used as an activation function in a neural network.

Recall the **hyperbolic tangent function** is defined as

$$\tanh(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}} = 1 - \frac{2}{e^{2z}+1}.$$

What is the domain of $\tanh(z)$, i.e. for what values of z is $\tanh(z)$ defined?

- ( ) The set of two numbers $\{-1, 1\}$
- ( ) the interval $(-1, 1)$
- (●) All real numbers

✔

Find $\tanh(0)$. (Enter `e` for e.)

$\tanh(0) =$ 0 ✔ **Answer:** 0

Is $\tanh$ odd, even, or neither?

- (●) odd
- ( ) even
- ( ) neither

✔

What is the range of $\tanh$? Answer by giving the tightest lower bound, and a tightest upper bound of the set of all possible values of $\tanh(z)$.

Lower bound: -1 ✔ **Answer:** -1

Upper bound: 1 ✔ **Answer:** 1

Solution:

Observe that $\tanh$ is an odd function since $\tanh(-z) = -\tanh(z)$. Hence $\tanh(0) = 0$. Since $\tanh$ is a strictly increasing function:

$$\frac{d\tanh(z)}{dz} = \frac{d}{dz}\left(1 - \frac{2}{e^{2z}+1}\right) = \frac{4e^{2z}}{(e^{2z}+1)^2} > 0,$$

the greatest lower bound (or infimum), and the lower upper bound (or supremum) are given by the limits

$$\lim_{z\to-\infty} \tanh(z) = 1 - \frac{2}{(\lim_{z\to-\infty} e^{2z}) + 1} = -1$$

$$\lim_{z\to+\infty} \tanh(z) = 1 - 0 = 1$$

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Range
Plotting the graph really helps
1

Helpful links
Here are some helpful links if anyone is struggling. Basics of Neural networks and a simple implementation in Python. (Part 2 explains it ...
1

Grab some basics here
Here we go for odd, even or neither. https://portal.tpu.ru/SHARED/k/KONVAL/Sites/English_sites/Site3_M/6/6_04.htm
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