

CS615 Assignment 1

Willie Hood

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Part 1 - Theory

Given a single input observation $x = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ and a fully connected layer with weights of

$W = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}$ as biases $b = \begin{bmatrix} -1 & 2 \end{bmatrix}$, what are the output of the fully connected layer given x as its input (5pts)?

Answer:

$$Y = XW + b$$

$$XW(1,1) = 1(1) + 2(3) + 3(5) = 22$$

$$XW(1,2) = 1(2) + 2(4) + 3(6) = 28$$

$$x = \begin{bmatrix} 22 & 28 \end{bmatrix}$$

$$Y = \begin{bmatrix} 22 & 28 \end{bmatrix} + \begin{bmatrix} -1 & 2 \end{bmatrix} = \begin{bmatrix} 21 & 30 \end{bmatrix}$$

Given an input, $h = [10, -1]$, what would be the output(s) if this data was processed by the following activation functions/layers (10pts)?

Answer:

$$\text{Linear: } g(h) = \begin{bmatrix} 10 & -1 \end{bmatrix}$$

$$\text{ReLU: } g(h) = \begin{bmatrix} 10 & 0 \end{bmatrix}$$

$$\text{Sigmoid: } g(h) = \begin{bmatrix} 0.999 & 0.269 \end{bmatrix}$$

$$\text{Hyperbolic Tangent: } g(h) = \begin{bmatrix} 0.999 & -0.762 \end{bmatrix}$$

$$\text{Softmax: } g(h) = \begin{bmatrix} 0.999 & 1.67 \times 10^{-5} \end{bmatrix}$$

Part 5 - Testing the Layers

Input Layer:

```
[[ -1. -1. -1. -1.]
```

```
[ 1. 1. 1. 1.]]
```

Fully Connected Layer:

```
[[4.78632519e-05 4.38634319e-04]
```

```
[5.81183644e-05 1.07682605e-03]]
```

ReLu Activation Layer:

```
[[1 2 3 4]
```

```
[5 6 7 8]]
```

Sigmoid Activation Layer:

```
[[0.73105858 0.88079708 0.95257413 0.98201379]
```

```
[0.99330715 0.99752738 0.99908895 0.99966465]]
```

SoftMax Activation Layer:

```
[[0.00449655 0.00449655 0.00449655 0.00449655]
```

```
[0.24550345 0.24550345 0.24550345 0.24550345]]
```

Tanh Activation Layer:

```
[[0.76159416 0.96402758 0.99505475 0.9993293 ]
```

```
[0.9999092 0.99998771 0.99999834 0.99999977]]
```

Part 6 - Connecting Layers and Forward Propagate

Input Layer:

`[[-1. -1. -1. -1.]`

`[1. 1. 1. 1.]]`

Fully Connected Layer:

`[[9.01687740e-05 -1.82859629e-04]`

`[9.52963302e-05 1.36236236e-04]]`

Sigmoid Activation Layer:

`[[0.50002254 0.49995429]`

`[0.50002382 0.50003406]]`

Part 7 - Testing on full Dataset

Note: I was not sure what portion of the output you wanted. after confering with my classmates it looks like you just wanted the output from the sigmoid layer so that is what is below.

Sigmoid Activation Layer:

[[0.50006455 0.49997288]

[0.49999773 0.50001302]

[0.49999477 0.50005227]

...

[0.49998812 0.49999596]

[0.50000876 0.49998634]

[0.5000447 0.50000384]]