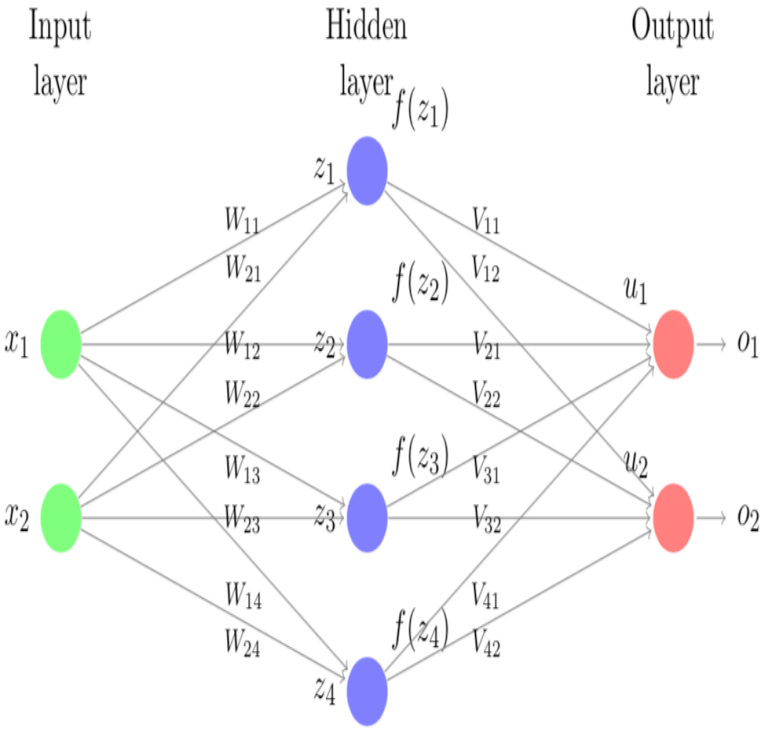
# 1. Neural Networks

Homework due Mar 29, 2023 08:59 -03 Past due

In this problem we will analyze a simple neural network to understand its classification neural network given in the figure below, with **ReLU activation functions (denoted by $f$) softmax activation function in the output layer**:




Given an input $\boldsymbol{x} = [x_1, x_2]^T$, the hidden units in the network are activated in stages a following equations:

$$
\begin{aligned}
z_1 &= x_1 W_{11} + x_2 W_{21} + W_{01} \quad & f(z_1) &= \max\{z_1, 0\} \\
z_2 &= x_1 W_{12} + x_2 W_{22} + W_{02} \quad & f(z_2) &= \max\{z_2, 0\} \\
z_3 &= x_1 W_{13} + x_2 W_{23} + W_{03} \quad & f(z_3) &= \max\{z_3, 0\} \\
z_4 &= x_1 W_{14} + x_2 W_{24} + W_{04} \quad & f(z_4) &= \max\{z_4, 0\}
\end{aligned}
$$

$$
\begin{aligned}
u_1 &= f(z_1) V_{11} + f(z_2) V_{21} + f(z_3) V_{31} + f(z_4) V_{41} + V_{01} \quad & f(u_1) &= \mathrm{ma} \\
u_2 &= f(z_1) V_{12} + f(z_2) V_{22} + f(z_3) V_{32} + f(z_4) V_{42} + V_{02} \quad & f(u_2) &= \mathrm{ma}
\end{aligned}
$$

The final output of the network is obtained by applying the **softmax** function to the las

$$
o_1 = \frac{e^{f(u_1)}}{e^{f(u_1)} + e^{f(u_2)}}
$$

$$
o_2 = \frac{e^{f(u_2)}}{}
$$

## Feed Forward Step

2/2 points (graded)

Consider the input , . What is the final output of the network?

**Important:** Numerical outputs from the softmax function are sometimes extremely clos recommend you enter you answer as a mathematical expression, such as **e^2+1**. If yo answers as a decimal, you must enter the decimal accurate to at least **9 decimal place**

0.999999694 ✔ 0.000000306

? STANDARD NOTATION

Submit You have used 2 of 4 attempts

## Decision Boundaries

1 point possible (graded)

In this problem we visualize the “decision boundaries" in -space, corresponding to the These are the lines in -space where the values of are exactly zero. Plot of the four hidden units using the parameters of provided above.

Enter below the **area of the region** of your plot that corresponds to a negative ( ) va hidden units.

Submit You have used 0 of 3 attempts

## Output of Neural Network

3/3 points (graded)

Using the same matrix as above, what is the value of (accurate to at least three d responding numerically) in the following three cases?

- Assuming that :

0.500 ✔

3/3 points (graded)

Now, suppose we modify the network's softmax function as follows:

where is a parameter. Note that our previous setting corresponded to the specia

In the following, please write a numerical solution with an accuracy of at least 3 places.

For , in order to satisfy , the value of should be smal

6.907 ✔

If we increase the value to , in order to satisfy , the value of smaller or equal than:

2.302 ✔

In general, in order to satisfy , increasing the value of can result in

- larger
- smaller ✔

Submit You have used 3 of 4 attempts

## Discussion

**Topic:** Unit 3. Neural networks (2.5 weeks):Homework 3 / 1. Neural Networks

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Terminology Discussion: log vs ln

I just understood now that in stats, ML, and programming it is standard to use "log" when you are taking the

I'm banned, and may need a hint. I got the second part of the question correct, which makes me assume that

? Question about the format for the decision boundaries answer

Hi, Could you please tell me what kind of description of the area is authorized ? plain english, one inequality,

? Output of Neural Network

Since matrix V is same, I think the given expressions f(z_1) + ...+ f(z_4) represent u_1, where u_2 is same as b

? Make NN image wider

Can you make the first NN image wider, it is too narrow.

Calculating derivatives

Practical Example

The exercise is great and help us solidify several concepts of NN. Could I ask someone from course staffing