6. Hidden Layer Models

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

Models with Hidden Layer

Start of transcript. Skip to the end.

OK.

Let's look at these models in a little bit more detail now,

trying to understand them, how the computation is performed,

and how to visualize what they can and cannot do.

So here I have a simple three-layer

0:00 / 0:00 1.25x

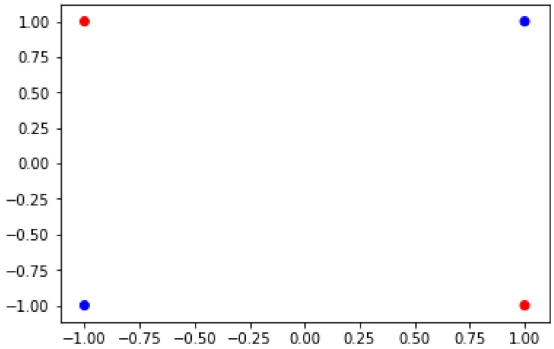
Video
Download video file

Transcripts
Download SubRip (.srt) file
Download Text (.txt) file

For the following set of problems, let's consider a simple 2-dimensional classification task. The training set is made up of 4 points listed below:

$$x^{(1)} = (-1, -1) \quad , \quad y^{(1)} = 1$$
$$x^{(2)} = (1, -1) \quad , \quad y^{(2)} = -1$$
$$x^{(3)} = (-1, 1) \quad , \quad y^{(3)} = -1$$
$$x^{(4)} = (1, 1) \quad , \quad y^{(4)} = 1$$

The dataset is illustrated below (blue - positive, red - negative)

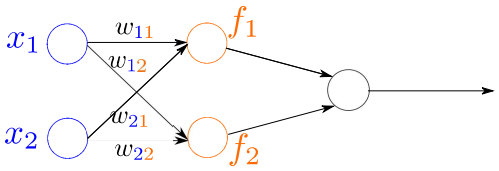


For simplicity, assume that we are only interested in binary classification problems for now. That is, $y^{(i)}$ can be either 1 or -1.

Linear Separability After First Layer

1/1 point (graded)

For this problem, let us focus on a network with one hidden layer and two units in that layer:



Let $f_1^{(i)}, f_2^{(i)}$ denote the output of the two units in the hidden layer corresponding to the input $x^{(i)}$ respectively, i.e.

$$f_1^{(i)} = f\left(w_{01} + \left(w_{11}x_1^{(i)} + w_{21}x_2^{(i)}\right)\right)$$
$$f_2^{(i)} = f\left(w_{02} + \left(w_{12}x_1^{(i)} + w_{22}x_2^{(i)}\right)\right)$$

Consider the set $D' = \left\{\left(\left[f_1^{(i)}, f_2^{(i)}\right], y^{(i)}\right), \quad i = 1, 2, 3, 4\right\}$.

Assume that f is the linear activation function given by $f(z) = 2z - 3$.

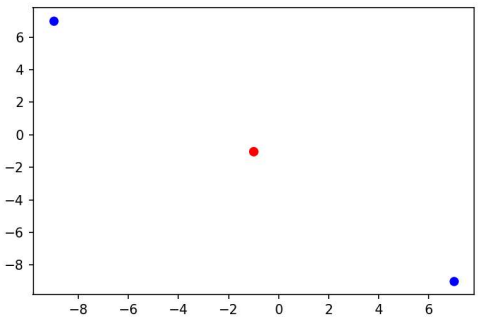
For which of the following values of weights would the set D' be linearly separable? (Select all that apply.)

- [ ] $w_{11} = w_{21} = 0, w_{12} = w_{22} = 0, w_{01} = w_{02} = 0$
- [ ] $w_{11} = w_{21} = 2, w_{12} = w_{22} = -2, w_{01} = w_{02} = 1$
- [ ] $w_{11} = w_{21} = -2, w_{12} = w_{22} = 2, w_{01} = w_{02} = 1$
- [x] None of the above

✔

Solution:

First of all note that from the figure in the text above that D is clearly not linearly separable.
Also, $f(z) = 2z - 3$ is a linear activation function.
Any linear transformation of the feature space of a linearly in-separable classification problem would still continue to remain linearly inseparable. For this question, one can compute the feature representations of all the data points and verify visually.
For example, the result of the second answer is plotted here:



Submit You have used 1 of 2 attempts

Answers are displayed within the problem

Non-linear Activation Functions

1/1 point (graded)

Again, let's focus on a network with one hidden layer with two units and use the same training set as above. The weights of the network are given as follows:

$$w_{11} = 1, w_{21} = -1, w_{01} = 1$$
$$w_{12} = -1, w_{22} = 1, w_{02} = 1$$

Let f_1, f_2 be the outputs of the first and second unit respectively.

Consider the set $D' = \{([f_1^{(i)}, f_2^{(i)}], y^{(i)}), \quad i = 1, 2, 3, 4\}$

For which of the following functions f, would the set D' be linearly separable? (Select one or more that apply.)

- [ ] $f(z) = 5z - 2$
- [x] $f(z) = \text{ReLU}(z)$
- [x] $f(z) = \tanh(z)$
- [ ] $f(z) = z$

✔

Solution:

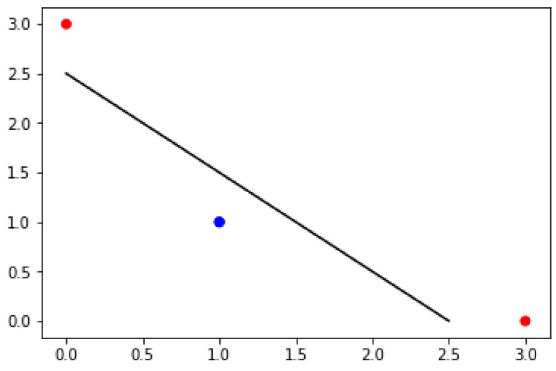
From the above problem, we note that any linear transformation of the feature space of a linearly in-separable classification problem would still continue to remain linearly inseparable. Hence we rule out the two linear functions. For all of the parts below, note that

$$f_1^{(i)} = f(w_{01} + (w_{11}x_1^{(i)} + w_{21}x_2^{(i)}))$$
$$f_2^{(i)} = f(w_{02} + (w_{12}x_1^{(i)} + w_{22}x_2^{(i)}))$$

- $f(z) = \text{ReLU}(z)$: Substituting for ReLU into f in the above equation gives the following results:

$$(1, 1), (3, 0), (0, 3), (1, 1)$$

The following figure plots these points and a potential linear classifier:

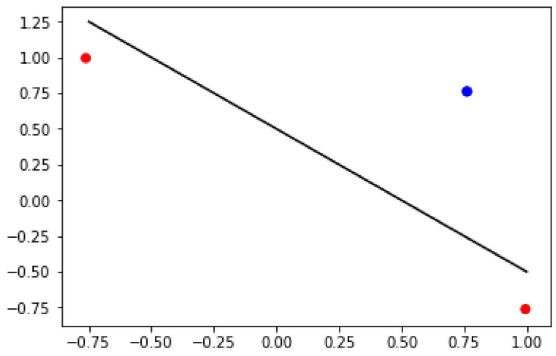


- $f(x) = \tanh(x)$: Substituting for $tanh$ into f in the above equation gives the following results:

$$(0.76, 0.76), (0.99, -0.76), (-0.76, 0.99), (0.76, 0.76)$$

/

The following figure plots these points and a potential linear classifier:



Submit You have used 1 of 2 attempts

Answers are displayed within the problem

Neural Network Learned parameters

1/1 point (graded)

Given a neural network with one hidden layer for classification, we can view the hidden layer as a feature representation, and the output layer as a classifier using the learned feature representation.

There're also other parameters that will affect the learning process and the performance of the model, such as the learning rate and parameters that control the network architecture (e.g. number of hidden units/layers) etc. These are often called hyper-parameters.

Which of the following is/are optimized during a single training pass? (Note that cross-validation is tuned before this point.) Check all that apply.

- [ ] The dimension of the feature representation
- [x] The weights that control the feature representation
- [ ] The hyper-parameters
- [x] The weights for the classifier

✔

Submit You have used 1 of 2 attempts

Discussion

Hide Discussion

Topic: Unit 3 Neural networks (2.5 weeks):Lecture 8. Introduction to Feedforward Neural Networks / 6. Hidden Layer Models

Add a Post

Show all posts by recent activity

Use this tool to play around with neural networks. 2

https://playground.tensorflow.org/#activation=tanh&batchSize=10&dataset=circle&regDataset=reg-plane&learningRate=0.03&regul...

Pinned

?	Question 3 In Question 3 what is meant with " a single training pass"? Is it a full training unit from raw initial values such as (w1=w2=...=0) to a w...	11
?	[STAFF] - Non-linear Activation Functions By applying the linear transformation 5z-2, i got the following points: (3,3) - label+ (13,-7) - label - (-7,13) - label - (3,3) - label + I dont u...	8
	PCA? Hiii, I'm wondering how does our teacher find the 2d representation of the 10-dimensional coordinates? did he use PCA?	4
	Spaghetti code to visualize changes Might be helpful for some :) import numpy as np import matplotlib.pyplot as plt X = np.array([[-1, -1], [1, -1], [-1, 1], [1, 1]]) Y = np.arra...	1
	Link to plot points You can use Desmos to plot the points. It helped me visually. https://www.desmos.com/calculator/mhq4hsncnh?lang=nl	3
?	Norm Of W and tanh Hi everyone 5:39 prof. mention that $Andthequickeritmakest\hat{t}ransition, thelar \geq rthe\|\|o\|\|ftheparameter \vec{\to} rw1is.$ Can ...	4
?	First question. From D its clear ? Hello. In the first question, the answer says, [edit], is it because of linear combinations?, That part I do not get. if could help me pleas...	2
☑	Any hints for first 2 questions? Hello, I am unable to get my head around figuring out how to attempt the first 2 questions (got one attempt wrong too). Any hints or...	13
☑	[STAFF] Is the grader on Non-linear Activation functions? ReLU is supposed to take the value zero at zero, right?	2
	Excellent video!!! Units as linear classifier is a beautiful perspective!!	1
?	What the lines represent on the hidden units graph? Hi, on the lecture (from minute 8 onwards) there is a graph with title "Hidden Layer units" with the data points on it and two decissio...	7
?	Meaning of term "activation"	2

‹ Previous | Next ›

Connect