Deep Learning CS583 Fall 2021

Quiz 2

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• Read these instructions carefully

• Fill-in your personal info, as indicated above.

• You have 24 hours.

• There are two questions. Each question is worth the same (1 point). • Both computer-typed and hand-writing in the very clear form are accepted. • This is an open-book test.

• You should work on the exam only by yourself.

• Submit your PDF/Doc/Pages by 12:30 Dec 1st on Canvas under Final exam.

good luck!

Tell the difference between supervised and unsupervised learning.

Supervised learning:
In supervised learning we have prior knowledge of what the output values for our samples should be i.e. we are aware of the ground truth values.
The goal of supervised learning is to learn a function that, given a simple of data and desired output, best approximates the relationship between the input and output in the data.
It is typically used for classification and regression tasks.
Supervised learning algorithms: logistic regression, naive bayes, support vector machine, artificial neural networks and random forests.

Unsupervised learning:
In unsupervised learning, we do not have labeled outputs
Goal of unsupervised learning is to learn the inherent structure of the data without using labels.
It is typically used for clustering, representation learning and density estimation.
Unsupervised learning is useful in exploratory data analysis and dimensionality reduction
Most common unsupervised learning algorithms are k-means clustering, hierarchical clustering

Give the formula for the loss function used in multiclass classification problems (categorical cross-entropy).

$$Loss = -\sum_{i=1}^{n} y_i \log \hat{y}_i$$

where.

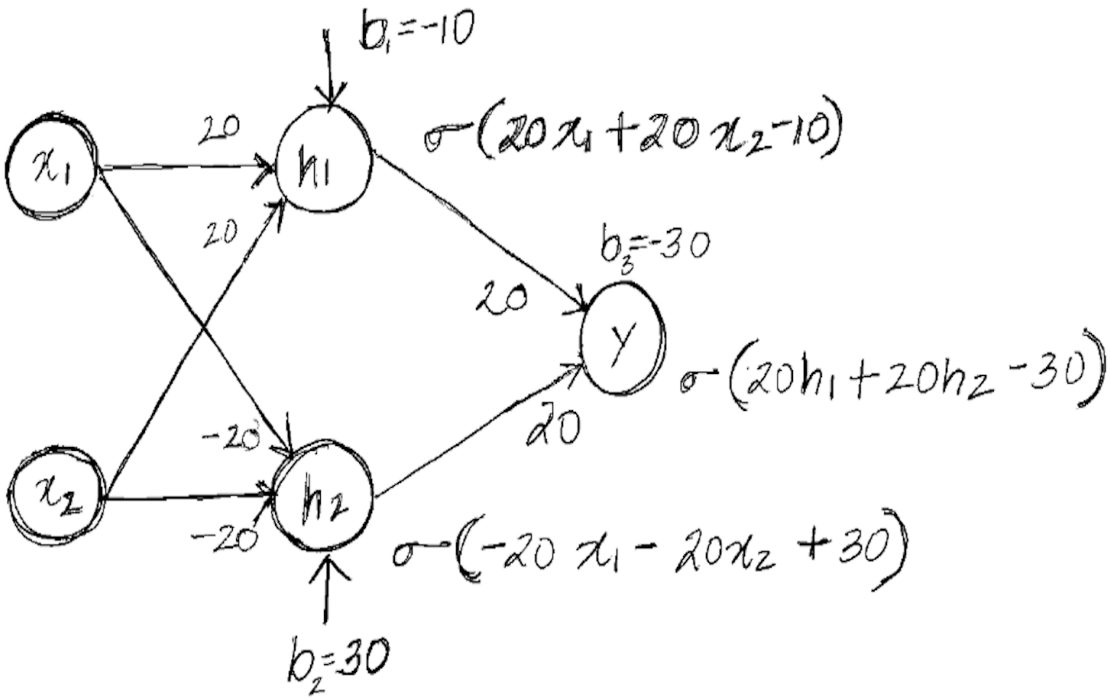
n : Output Size - Scalar values in model o/p

$\hat{y}_i$: i-th scalar value in the model o/p

y_i : Corresponding target value

Is it possible to construct a single layer neural network with threshold activation function implementing XOR of two bits? Construct a neural network implementing XOR.

It is possible to construct a single layer neural network with threshold activation function implementing XOR of two bits. Following is the structure of the neural network.



$w_1 = [20, 20]$ $\quad w_2 = [-20, -20]$

$b_1 = -10$. $\quad b_2 = 30$. $\quad b_3 = -30$

let $x_1 = 0$, $x_2 = 0$ $\qquad (0,0) \rightarrow 0$

$h_1 = 20 \times 0 + 20 \times 0 - 10 = -10$

$z_0 = \sigma(-10) = 0$

$h_2 = -20 \times 0 - 20 \times 0 + 30 = 30$

$z_1 = \sigma(30) = 1$

$y = \sigma(20 \times z_1 + 20 \times z_2 - 30) = \sigma(-10) = 0$

for $x_1 = 1$, $x_2 = 1$ $\qquad (1,1) \rightarrow 0$

$z_1 = \sigma(20 \times 1 + 20 \times 1 - 10) = 1$

$z_2 = \sigma(-20 \times 1 - 20 \times 1 - 30) = 0$

$y = \sigma(20 \times 1 + 20 \times 0 - 30) = 0$

for $x_1 = 0$ & $x_2 = 1$ $(0,1) \rightarrow 1$

$z_0 = \sigma(20 \times 0 + 20 \times 1 - 10) = 1$

$z_1 = \sigma(-20 \times 0 - 20 \times 1 + 30) = 1$

$y = \sigma(20 \times 1 + 20 \times 1 - 30) = 1$

for $x_1 = 1$ & $x_2 = 0$ $(1,0) \rightarrow 1$

$z_0 = \sigma(20 \times 1 + 20 \times 0 - 10) = 0$

$z_1 = \sigma(-20 \times 1 - 20 \times 0 + 30) = 1$

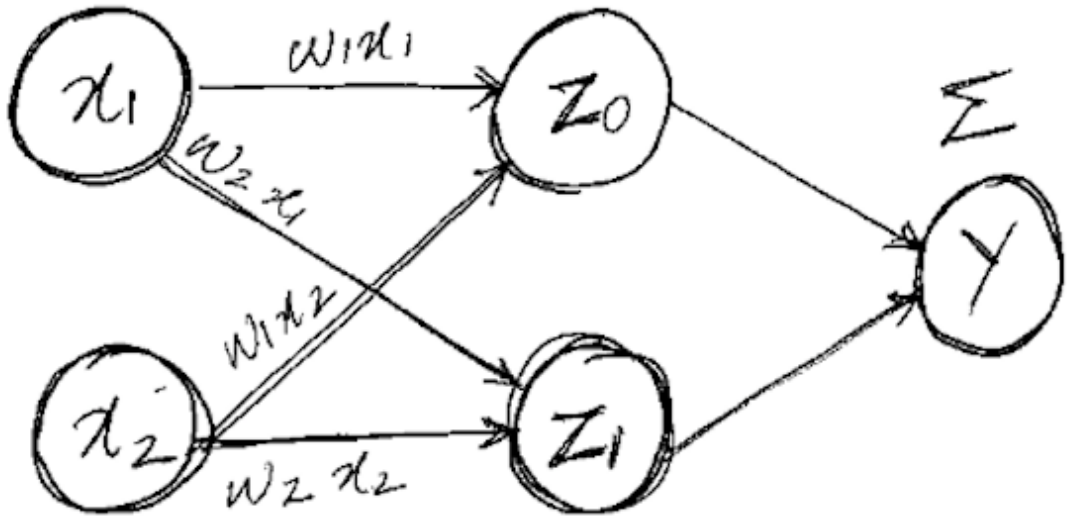
$y = \sigma(20 \times 1 + 20 \times 1 - 30) = 1$

Is it possible to construct a single layer neural network with threshold activation function implementing addition of two bits?

Yes it is possible to construct a neural network with a threshold activation function implementing addition of two bits. The truth table for XOR and addition operation is the same, if we ignore the carry over we can successfully construct the neural network.

Construct a single layer neural network (define architecture, activation function and give a vector of weights) with a single output implementing conjunction of n bits.

Neural network architecture



Number of hidden layers: 1
Number of hidden units: 2

Weights
W1 = 1
W2 = 1
Bias b = -1

For $x_1 = 0$ & $x_2 = 0$ $\quad (0,0) \rightarrow 0$

$z_0 = x_1 w_1 + x_2 w_1 + b = 0 + 0 - 1 = -1$

$z_0 = x_1 w_2 + x_2 w_2 + b = 0 + 0 - 1 = -1$

$y = \sigma((-1) + (-1)) = \sigma(-2) = 0$

For $x_1 = 1$ & $x_2 = 0$ $\quad (1,0) \rightarrow 0$

$z_0 = x_1 w_1 + x_2 w_1 + b = 1 + 0 - 1 = 0$

$z_1 = x_1 w_2 + x_2 w_2 + b = 1 + 0 - 1 = 0$

$y = \sigma(0 + 0) = \sigma(0) = 0$

For $x_1 = 0$ & $x_2 = 1$ $\quad (0,1) \rightarrow 0$

$z_0 = x_1 w_1 + x_2 w_1 + b = 0 + 1 - 1 = 0$

$z_0 = x_1 w_2 + x_2 w_2 + b = 0 + 1 - 1 = 0$

$y = \sigma(0 + 0) = \sigma(0) = 0$

For $x_1 = 1$ & $x_2 = 1$ $\quad (1,1) \rightarrow 1$

$z_0 = x_1 w_1 + x_2 w_1 + b = 1 + 1 - 1 = 1$

$z_1 = x_1 w_2 + x_2 w_2 + b = 1 + 1 - 1 = 1$

$Y = \sigma(1+1) = \sigma(2) = 1$