INDRAPRASTHA INSTITUTE of INFORMATION TECHNOLOGY DELHI

CSE643 – Artificial Intelligence

Monsoon 2021 session

Quiz-3

10-Nov-2021

Time: 1:30pm to 2:30pm (including time to upload your answers)

Max marks: 10 (will be scaled down to 5 marks)

Deadline to upload your answers: 10-Nov-21, 2:30 pm (no extensions)

INSTRUCTIONS: You will have to create a PDF file with your answers, name the file as AI-Q3-<Name>-<RollNo> and upload it on the classroom page. In the answer sheet write your name and roll number. In case you choose to have hand-written answers then those pages can be scanned and uploaded (make sure that it is clearly readable).

Q1: (4 marks)

An AI medical screening system is being designed using a single sigmoid unit neural network to take a series of pathological tests for patients and predict whether they have a disease or not. The cost of *c* is assigned for erroneous outputs where the neuron outputs a 1 instead of 0, and 0 instead of 1. Design an error function for this and show that it can be used for training the network using backpropagation.

Answers

We define the error function as L2 loss:

$E(h_w(x)) = c\ \Sigma_k\ (y_k - h_{wk}(x_k))^2$ where $h_{wk}(x) = g(\Sigma w_{ki}.x_{ki})$ for the kth training sample and x_{ki} are the input features for the kth training sample.

The gradient of the error function is $dE/dw = 2c\ \Sigma\ (h_{wk}(x_k) - y_k)\ (dh_{wk}(x_k)/dw)\ x_k$

Since $h_{wk}(x_k)$ is sigmoid$(w_k.x_{ki})$ then the derivative $dh_{wk}(x_k)/dw = h_{wk}(x_k)\ (1- h_{wk}(x_k))$

Thus we have $dE/dw = 2c\ \Sigma(y_k - h_{wk}(x_k))\ (h_{wk}(x_k)\ (1- h_{wk}(x_k)))\ x_k$ which is equivalent to

$dE/dw = 2c\ \Sigma(y_k - g(w_k.x_k))\ (g(w_k.x_k)\ (1- g(w_k.x_k)))\ x_k$

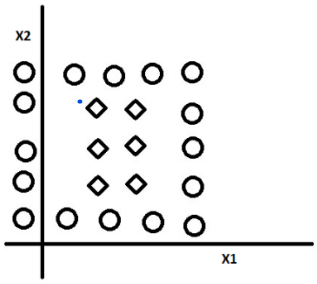
$\frac{1}{1+e^{-w_k}}$

Since we can take the derivative, we can backpropagate the error and train the network with the following weight update rule

$$w_k' = w_k + \alpha\,(2c\,\Sigma(y_k - g(w_k.x_k))\,(g(w_k.x_k)\;(1- g(w_k.x_k)))\,x_k\;)$$ where α is the step size

Q2: (3 marks)

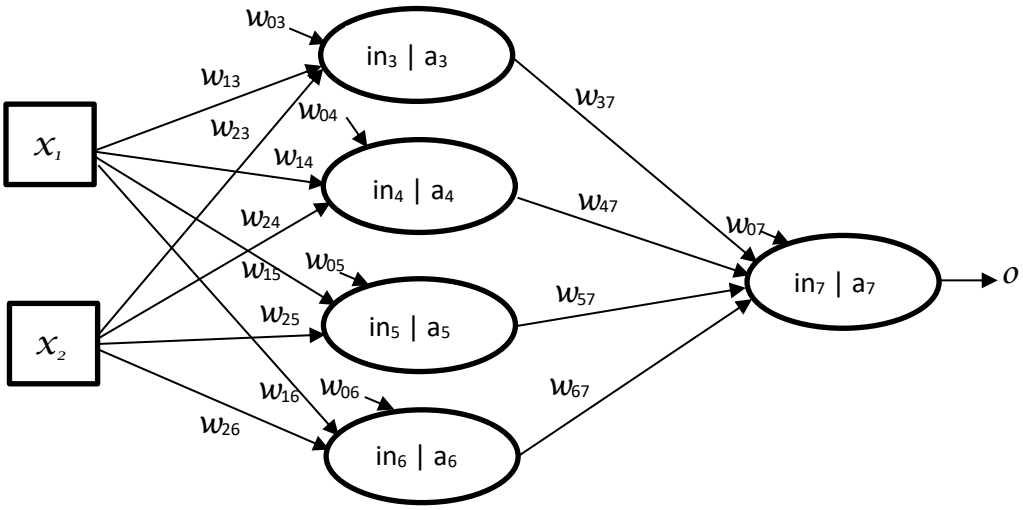
We want to design a neural network that classifies the below given two-dimensional data into two classes



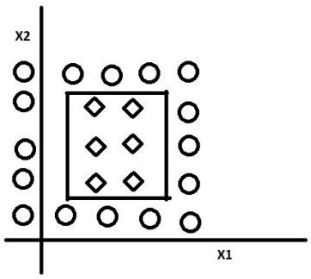
Describe / Draw a neural network that can model this classification. How many input neurons do you require, how many hidden layers and neurons do you require, and how many output neurons do you require?

Answers

We require to build a feed-forward neural network with two inputs since the input is two dimensional (X1 and X2), with one hidden layer comprising of four neurons since we want to model a single boxed region that separates the diamonds inside the region and the circles outside that region using four classifying hyperplanes, and one output layer with one neuron since we just need a classification between two classes – diamond and circles.



This will achieve the classification as follows:



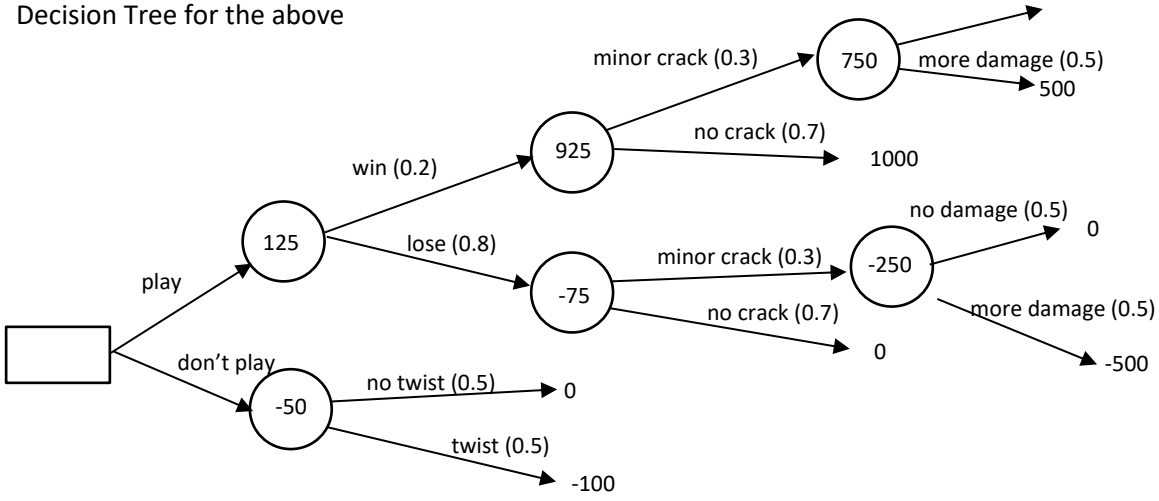
Q3: (3 marks)

You are a football player and represent your institute team. During a practice match you sprained your ankle. Your doctor suspects that there could be a minor crack in your ankle and predicts it with a probability of 0.3 (i.e. the doctor is 30% sure that there is a crack) and advises you complete rest. - However, there is an important game tomorrow and you feel that you should play for the team to win (with a win probability of 0.2). If actually you have a minor crack in the ankle and you play then you will risk further damage that can ground you for a long time. Hence, the utility values are as follows: If your team wins and you have not damaged your ankle further then you get Rs.1000/-. If your team wins but your ankle becomes more painful and damaged you gain a total of Rs.500/- (Rs 1000/- minus Rs 500/- you spend on the medical advice). If your team loses and your ankle is not damaged further then you gain Rs 0/-. But if your team loses and your ankle is damaged further then you lose Rs 500/- for medical advice. If you do not play and your ankle is as before then you gain Rs 0/-. But if you don't play but twist your ankle at home then you lose Rs 100/- for pain-management ointment.

a. Draw the decision tree for the above situation showing the probabilities and values.
b. Evaluate the tree and determine the best choice and its expected utility.

Answers

a. Decision Tree for the above



b. Utility of play = 125 and Utility of don't play = -50. So the best choice is that you play the game the next day.