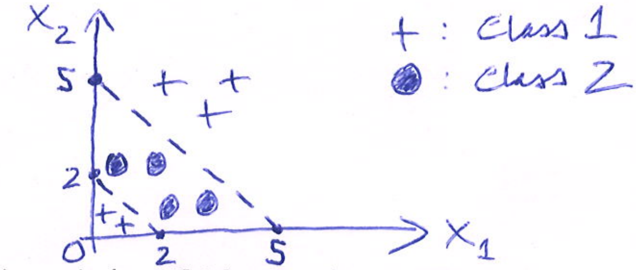
ELL788: Minor Test II

October 8, 2016

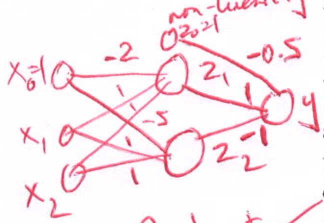
Maximum Marks: 25

1. What do you mean by fundamental frequency? What would be the perceptual effect of the missing fundamental frequency in a complex tone? **[2]**
2. Mention the importance of the cochlea in sound perception (with a diagram / graphical representation). If the auditory canal is damaged, what type of assistive technology can help the person to hear sound and how? **[2+2]**
3. What is mental imagery? How is imagery linked with intelligence? What would be the probable approaches to understand the circuitry of intelligence and its nature of function? (Explain with suitable logic.) **[1+1+2]**
4. Name the various mechanoreceptors present in our skin. How they are categorised based on their properties? Explain briefly about their properties with a diagram. **[1+1+2]**
5. Why can't we see colours at night (even with a full moon)? **[1]**
6. Consider the following two-class data set, which is similar to the XOR problem but for continuous inputs.

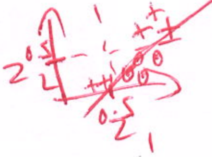


(a) Is it possible to design a single artificial neuron (perceptron or logistic regression unit) which can take x_1 and x_2 as inputs and entirely separate the two classes above? Why or why not? **[1]**

No, non-linearity



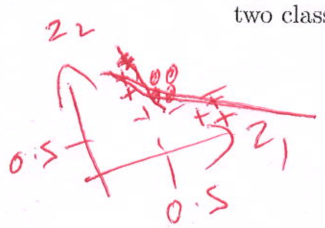
(b) Design two single artificial neurons (both using the logistic sigmoid activation function, $f(a) = 1/(1+e^{-a})$) which respectively give the decision boundaries $x_1+x_2 = 2$ and $x_1+x_2 = 5$ (the dashed lines in the above plot). Depict the inputs and the weights clearly. You may use a bias input, i.e., have an x_0 whose value is fixed to 1. (Note that you are not being asked to obtain the weights via backpropagation or learning of any kind. You just have to write down the weights that will give the desired boundaries.) **[3]**



(c) Let us call the outputs of the two neurons just designed z_1 and z_2. Draw a plot with z_1 on the x-axis and z_2 on the y-axis, showing all the data points from the above figure mapped (approximately) into this new feature space. **[1]**

(d) Now, using the two neurons from part (b), design a neural network with a hidden layer which (approximately) separates the above two classes. Clearly draw the entire network, showing all input, hidden, and output units, and all weights. You may use a bias unit in each layer, i.e., $x_0 = 1$ for the input layer as well as $z_0 = 1$ for the hidden layer. Assume a logistic sigmoid activation function for all neurons. Explain why your network separates the two classes, and draw the corresponding decision boundary in your plot for part (c). **[5]**

$z_1 = z_2 + 0.5$



$z_1 + z_2 = 1.1$?