

ECE421 - Winter 2022

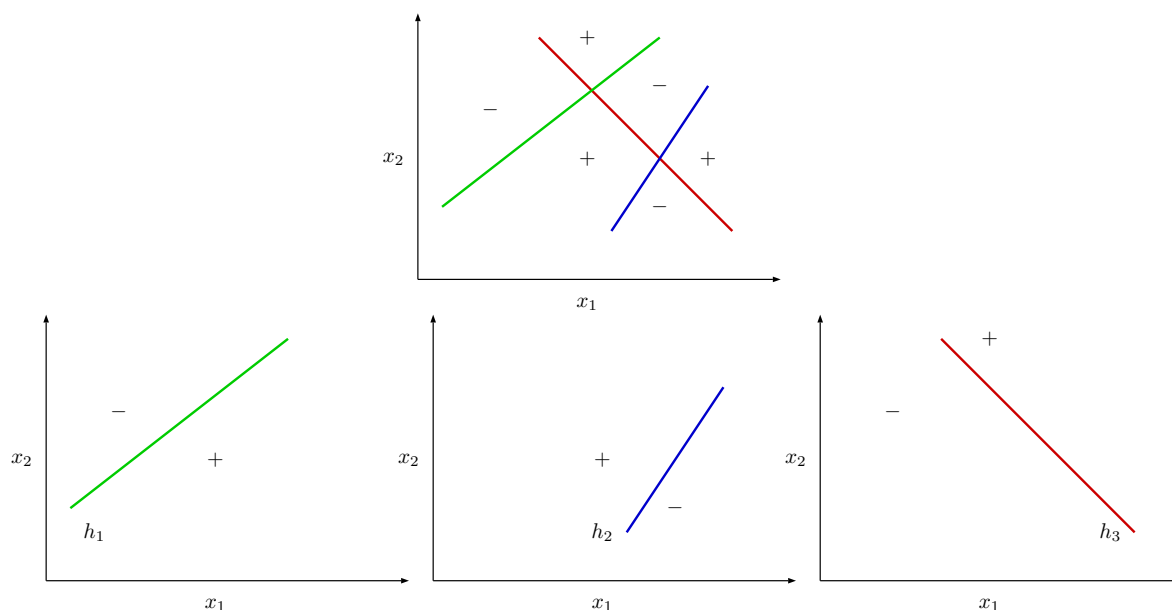
Homework Problems - Tutorial #5

Theme: Multi-Layer Perceptrons

Due: February 20, 2022 11:59 PM

Question 1 (Exercise 7.1 from LFD)

Consider a target function f (top row) composed of three perceptron components h_1, h_2 and h_3 . The $+$ and $-$ regions of h_1, h_2 and h_3 are illustrated (from left to right in bottom row).



(a) Show that

$$f = \overline{h_1}h_2h_3 + h_1\overline{h_2}h_3 + h_1h_2\overline{h_3}. \quad (1)$$

(b) Is there a systematic way of going from a target function composed of perceptrons to a Boolean formula like in the part (a)? [Hint: consider only the $+$ regions of the target function and use the disjunctive normal form (OR and ANDs).]

Question 2 (Exercise 7.2 from LFD)

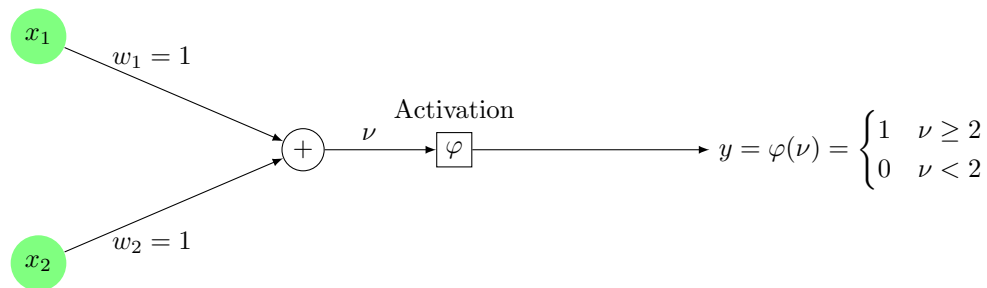
- Extend the boolean OR and AND to more than two inputs, i.e., $\text{OR}(x_1, \dots, x_M) = +1$ if any one of the M inputs is $+1$; and $\text{AND}(x_1, \dots, x_M) = +1$ only if all the inputs are $+1$. Give graph representations of $\text{OR}(x_1, \dots, x_M)$ and $\text{AND}(x_1, \dots, x_M)$.
- Give the graph representations of the perceptron $h(x) = \text{sign}(w^\top x)$.
- Give the graph representation of $\text{OR}(x_1, \overline{x_2}, x_3)$.

Question 3 (Problem 3, Midterm 2019)

Assume two logical inputs (that can either be 0 or 1)

x_1	0	1	0	1
x_2	0	0	1	1

and the following single-layer model.



- Given the 4 different sets of inputs of x_1 and x_2 , calculate the output y . What function can be represented by this model?
- How can the following function be implemented by changing only the threshold value (ν) (weights are same as before).

x_1	0	1	0	1
x_2	0	0	1	1
$g(x_1, x_2)$	0	1	1	1

- Can the following function be implemented with the given single-layer model (one set of inputs and an activation function)? If no explain why, if yes give an example.

x_1	0	1	0	1
x_2	0	0	1	1
$z(x_1, x_2)$	0	1	1	0