Department of Computer Engineering

Artificial Intelligence

Mini Project 4 Theory Questions

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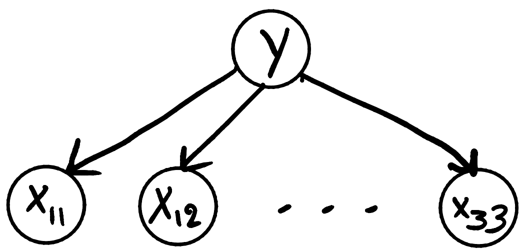
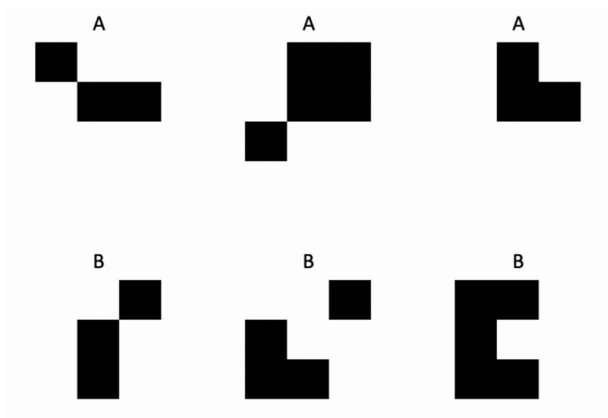
1.1

a) I used pixel values as features.

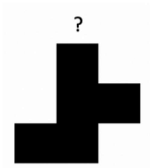
Consider every alphabet as an 3x3 square which pixels can have 2 possible values (black/white).





2/5	3/5	2/5
1/5	4/5	4/5
2/5	1/5	1/5

1/5	2/5	2/5
3/5	2/5	1/5
3/5	4/5	1/5



$$P(Y=y \mid X) \propto P(y=y) \times \underbrace{P(X \mid Y=y)}_{\prod_{ij} P(X_{ij} \mid Y=y)}$$

$$P(y=A \mid X) \propto \frac{3}{6} \times \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{2}{5} \times \frac{1}{5} \times \frac{4}{5}$$

$$= \frac{3^4 \times 4^4 \times 2}{6 \times 5^6}$$

$$P(y=B \mid X) \propto \frac{3}{6} \times \frac{4}{5} \times \frac{2}{5} \times \frac{3}{5} \times \frac{2}{5} \times \frac{2}{5} \times \frac{1}{5} \times \frac{3}{5} \times \frac{4}{5} \times \frac{4}{5}$$

$$= \frac{3^3 \times 4^3 \times 2^3}{6 \times 5^6}$$

$$P(y=A \mid X) > P(y=B \mid X) \Rightarrow \underline{X \text{ is } A}$$

As you can see I also used Laplace Smoothing because if I do not, X_{32} gets Zero and $P(y=A \mid X)$ gets Zero and prediction is wrong.

1.2

We can use introduced features as nodes of the decision tree, and values (black and white) as the edges of the decision tree. But this structure is extremely over fitted to the data. We can traverse resulting tree to classify the input image X but it is not accurate.

2

3

Since perceptron is a linear classifier, we can introduce an neural network consisting of multiple layer of perceptrons for the given shape. First we find the weights and biases of the first layer of perceptrons as shown in figure 1. Each w_i, b_i is weight and bias of the P_i perceptron in the first layer.

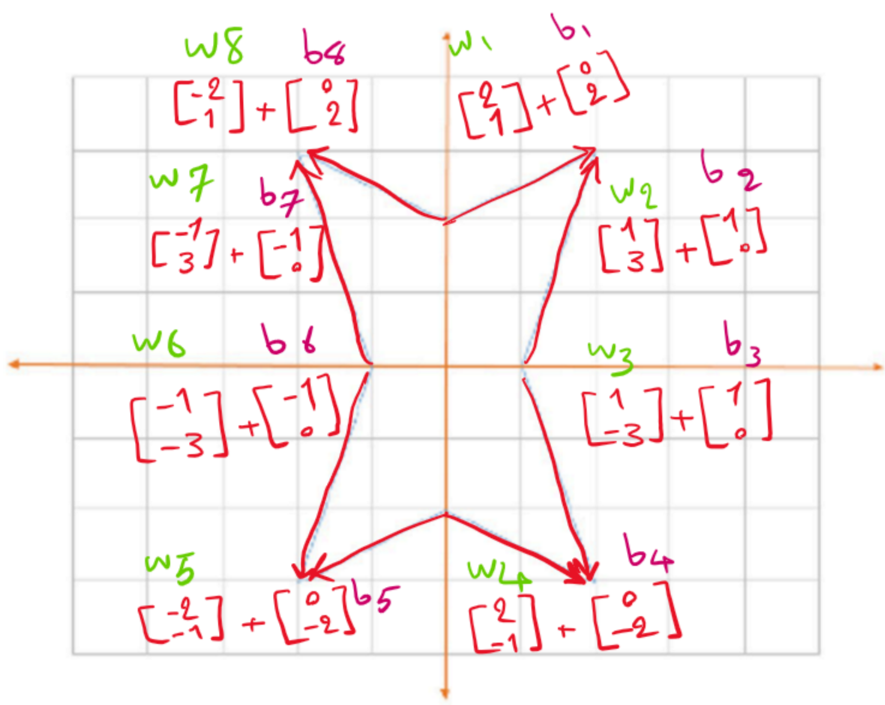


Figure 1: Weights and biases of the first layer of perceptrons

with the first layer, our classification become linear, so we use a single perceptron in the second layer. The whole neural network is shown in figure 2.

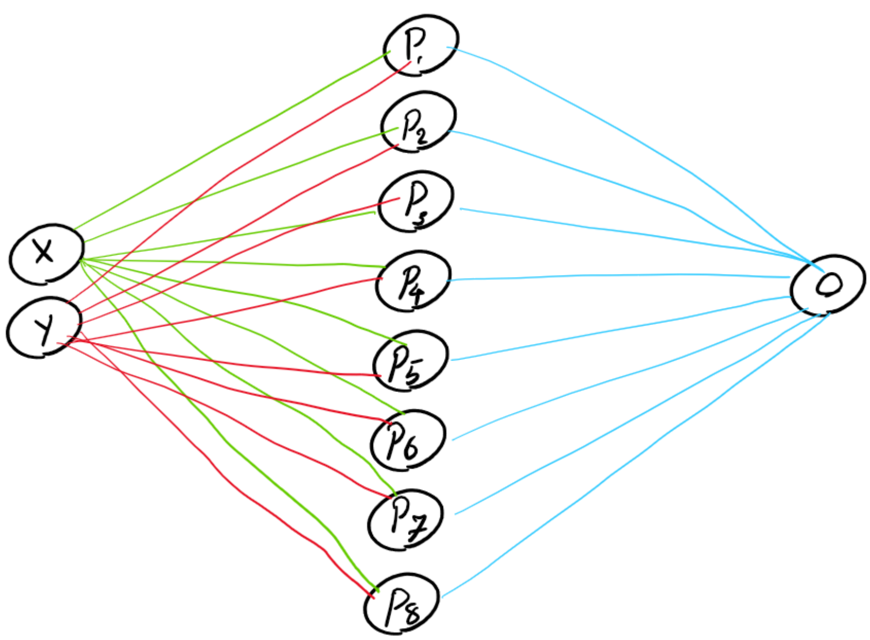


Figure 2: Neural network