CS 520 : Assignment 4

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1. A) The provided tree correctly classifies the examples. The classification as per tree is listed below.

No.	GPA	Univerity	Published	Reco	Given Class	Class using Tree
1	4	1	yes	good	P	p
2	4	1	no	good	P	p
3	4	2	no	normal	P	p
4	3.6	1	yes	good	P	P
5	3.6	2	no	good	P	p
6	3.6	3	yes	good	P	p
7	3.6	3	no	good	N	n
8	3.6	1	no	good	N	n
9	3.3	2	yes	normal	N	n
10	3.3	1	no	normal	N	n
11	3.3	3	yes	normal	N	n
12	3.3	3	no	good	N	n

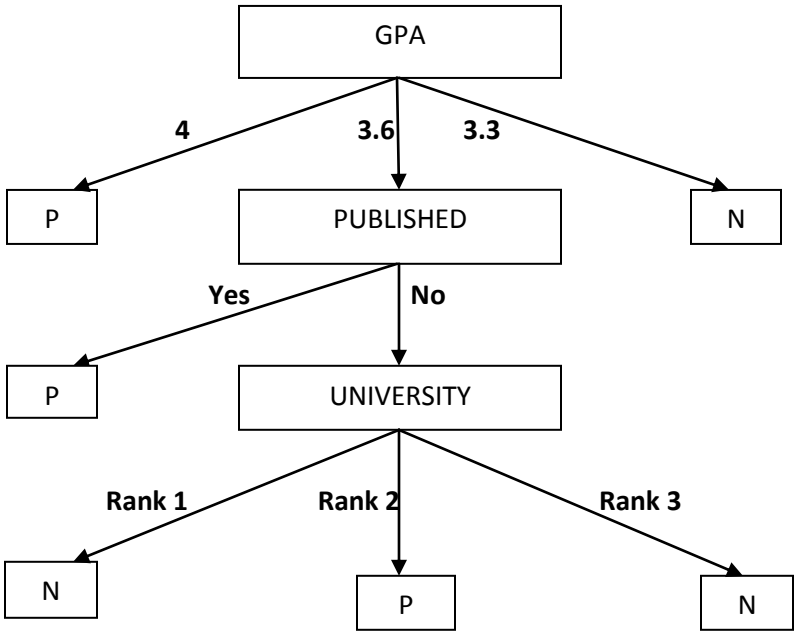
1. B) The information gain from different attributes are listed below:
   Step 1:
   Reco = 1 – [8/12 * I(5/8,3/8) + 4/12 * I(1/4,3/4)] = 0.09
   Published = 1 – [5/12 * I(3/5, 2/5) + 7/12 * I(3/7,4/7)] = 0.024
   Rank = 1 - [5/12 * I(3/5,2/5) + 3/12 * I(2/3, 1/3) + 4/12 * I(1/4, 3/4)] = .095
   GPA = 1 – [3/12 * I(1,0) + 5/12 * I(3/5, 2/5)+ 4/12 * I(0,1)] = 0.595

Step 2:

University = I(3/5,2/5) – [2/5 * I(1/2,1/2) + 1/5 * I(1,0) + 2/5 * I(1/2,1/2)] = 0.972 – 0.8 =0.172

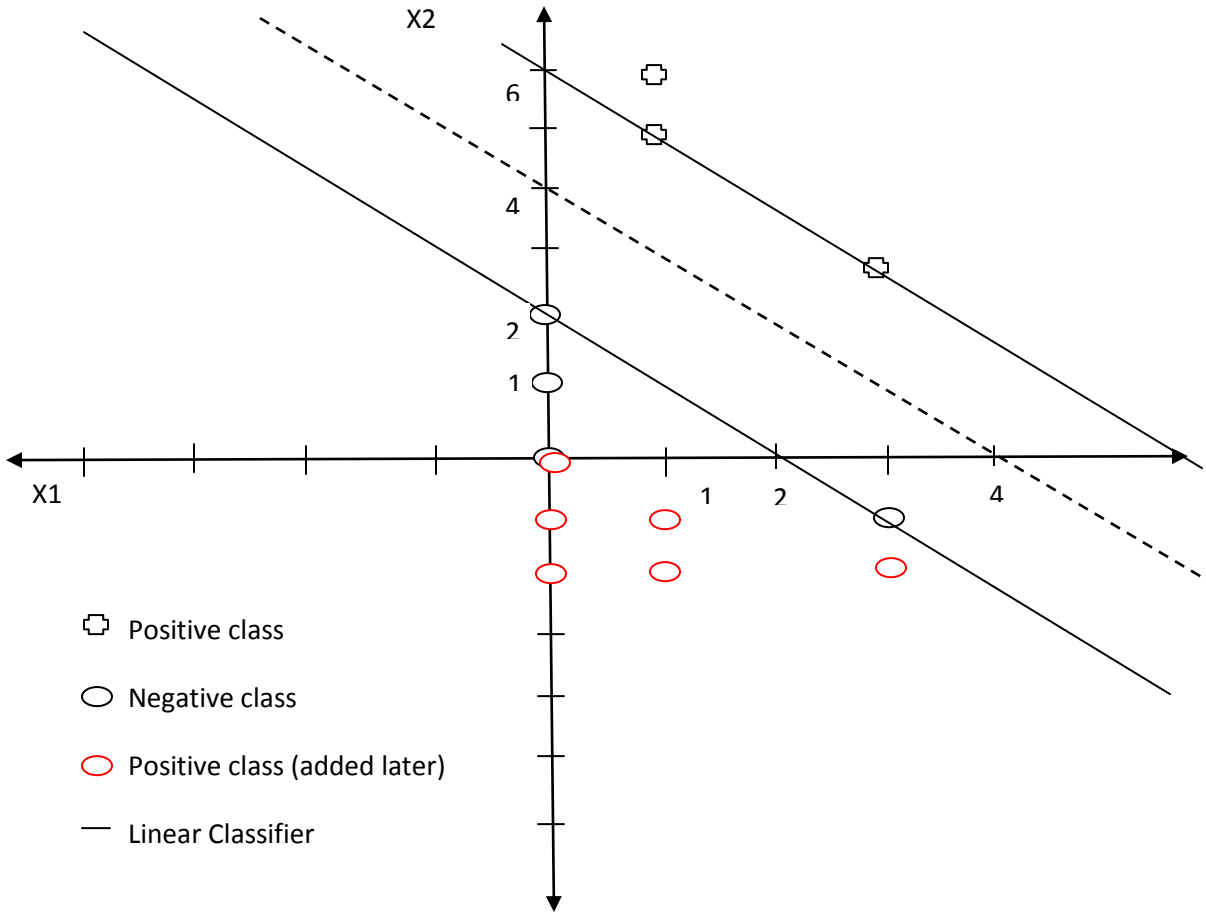
Published = I(3/5,2/5)- [2/5 * I(1,0) + 3/5 * I(1/3, 2/3)] = 0.972 - 0.5436 = 0.4284

Reco = I(3/5,2/5) – [1 * I(3/5,2/5)] = 0



1. **C)** The tree is different from the one given. **No. 1** for example, the given tree will first go down the tree on the branch good recommendation. Then classify using the GPA. In the decision tree above. The data point will classify in the first step itself as positive.

2.



A) The linear classifier that separates the data with maximum margin is given above as the dotted line.

B) The equation of the dotted line is

$x2 = -x1 + 4$ or

$x2 + x1 - 4 = 0$

This means the function $h(x) = w^T x + b$ is given by

$$h(x) = [1 \ , \ 1]x - 4$$

Hence, the vector w is [1 1] and b = -4.

C) After plotting the new points we can see that the closest points still remain the same, so the linear classifier doesn't change.

3 A) The perceptron Program achieves perfect classification in 6 iterations.

The code can be found in 1.py
Analysis of executing the code and :

Iteration : 1

wo: -0.8 w1: 1.1102230246251565e-16 w2: -2.1

Number of Misclassified Data Points: 5

Iteration : 2

wo: 0.19999999999999996 w1: -0.04999999999999982 w2: -2.1500000000000004

Number of Misclassified Data Points: 5

Iteration : 3

wo: 0.19999999999999996 w1: -0.6499999999999998 w2: -2.1000000000000005

Number of Misclassified Data Points: 2

Iteration : 4

wo: 0.19999999999999996 w1: -1.4999999999999998 w2: -1.8000000000000007

Number of Misclassified Data Points: 2

Iteration : 5

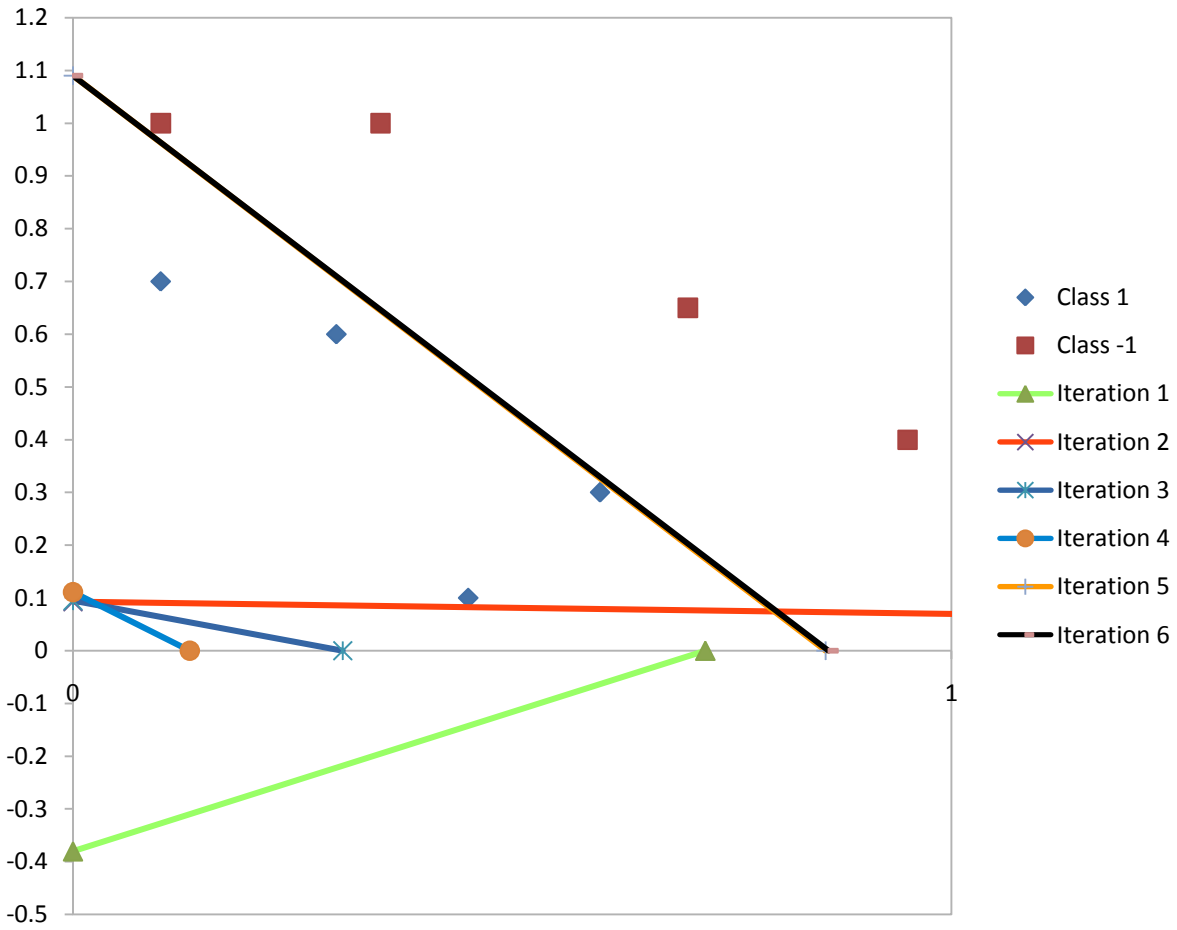
wo: 1.2 w1: -1.3999999999999997 w2: -1.1000000000000008

Number of Misclassified Data Points: 1

Iteration : 6

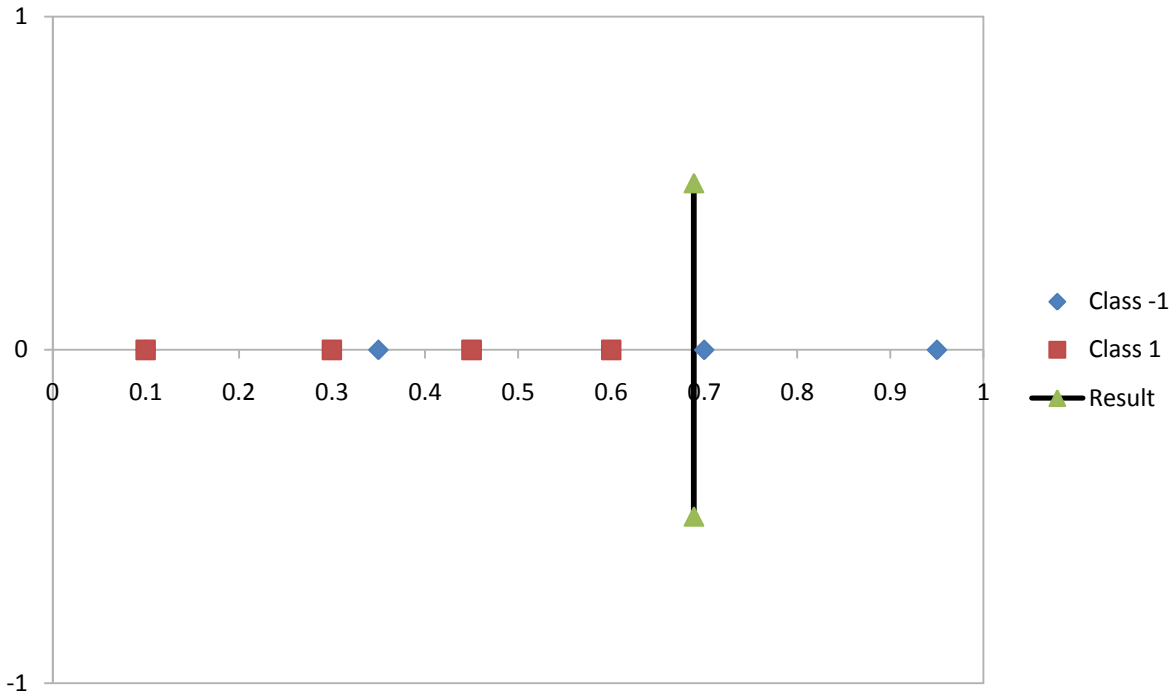
wo: 1.2 w1: -1.3999999999999997 w2: -1.1000000000000008

Number of Misclassified Data Points: 0



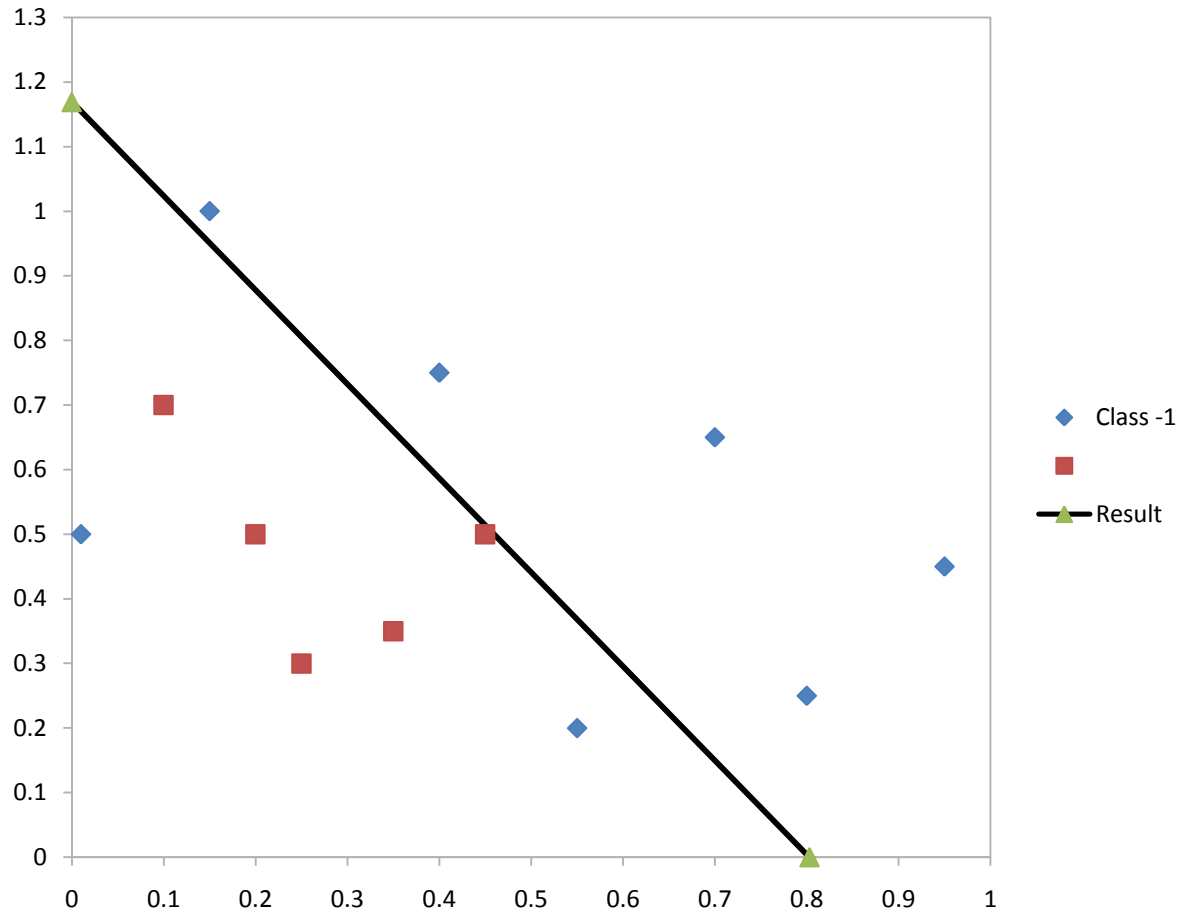
B) Perfect separation was achieved.

C) The result of the constraint looks as below. The weights w0=0.005, w1 = -0.00725. The program 2.py calculates the desired weights.



4. A) The minimum error produced by a single perceptron is (2 out of 7): 28.57%
The code for the same is given in 3.py

The dividing line in the input space produced by the perceptron is shown by Result in the graph below.



4. B) The divisions made my multi-layer perceptron could make divisions like follows. Essentially the area enclosed by all the division lines could give the optimal solutions.