Assignment 4: Decision Making under Uncertainty and Learning

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Question 1:

Question 2:

a

b

c

Question 3:

a

b

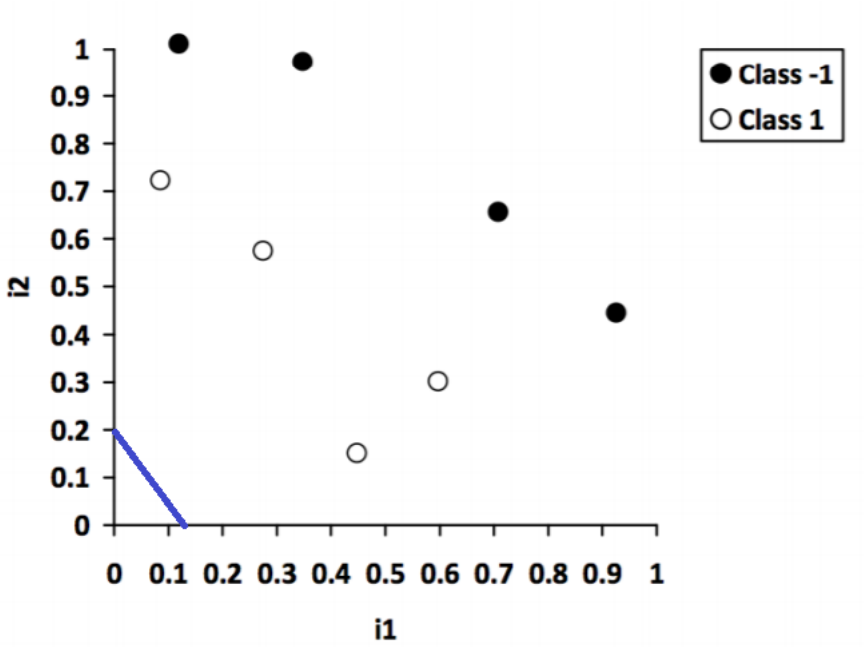
c

Question 4:

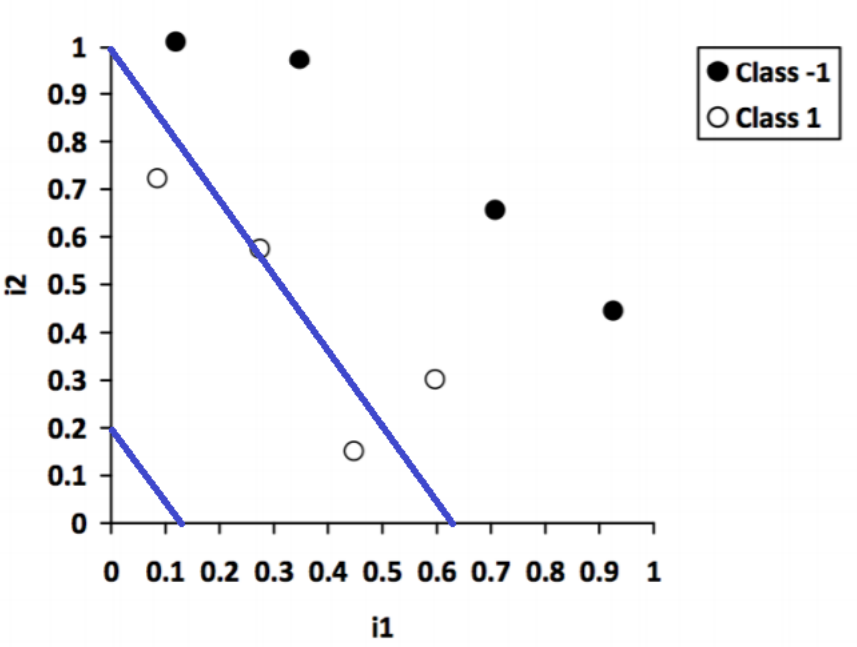
a

Constant offset = 1
Class -1 Inputs:
(0.1, 1), (0.35, 0.95), (0.7, 0.65), (0.9, 0.45)
Class 1 Inputs:
(0.1, 0.7), (0.3, 0.55), (0.45, 0.15), (0.6, 0.3)
Initial Weights:
$w_0 = 0.2$
$w_1 = 1$
$w_2 = -1$

$y = (0.2 * 1) + ((0.1 * -1) + (0.35 * -0.95) + (0.7 * -0.65) + (0.9 * -0.45) + (0.1 * -0.7) + (0.3 * -0.55) + (0.45 * -0.15) + (0.6 * -0.3))x$
$y = 0.2 + (-0.1 - 0.3325 - 0.455 - 0.405 - 0.07 - 0.165 - 0.0675 - 0.18)x$
$y = -1.775x + 0.2$



4 samples are misclassified after the initial line of separation is placed. Class 1 input (0.1, 0.7) is misclassified, so the weights will be adjusted accordingly.
$w_0 = 1$
$w_1 = 1$
$w_2 = -1$
$y = (1 * 1) + ((0.1 * -1) + (0.35 * -0.95) + (0.7 * -0.65) + (0.9 * -0.45) + (0.1 * -0.7) + (0.3 * -0.55) + (0.45 * -0.15) + (0.6 * -0.3))x$
$y = 1 + (-0.1 - 0.3325 - 0.455 - 0.405 - 0.07 - 0.165 - 0.0675 - 0.18)x$
$y = -1.775x + 1$



2 samples are misclassified after the second line is placed. Class 1 input (0.3, 0.55) is misclassified, so the weights will be adjusted accordingly.

$w_0 = 1$

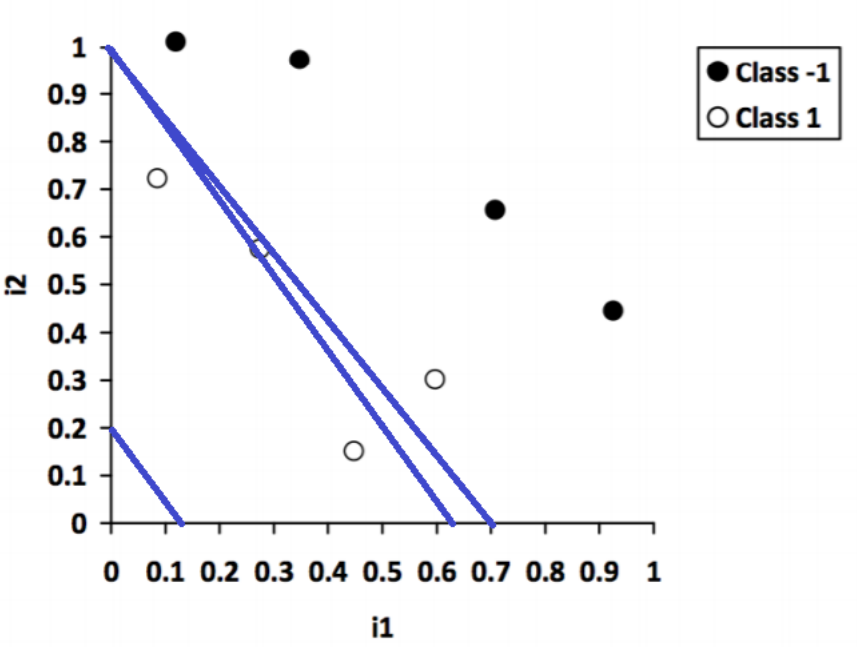
$w_1 = 0.8$

$w_2 = -1$

$y = (1 * 1) + ((0.08 * -1) + (0.28 * -0.95) + (0.56 * -0.65) + (0.72 * -0.45) + (0.08 * -0.7) + (0.24 * -0.55) + (0.36 * -0.15) + (0.48 * -0.3))x$

$y = 1 + (-0.08 - 0.266 - 0.364 - 0.324 - 0.056 - 0.132 - 0.054 - 0.144)x$

$y = -1.42x + 1$



1 sample is misclassified after the third line is placed. Class 1 input (0.6, 0.3) is misclassified, so the weights will be adjusted accordingly.

$w_0 = 1$

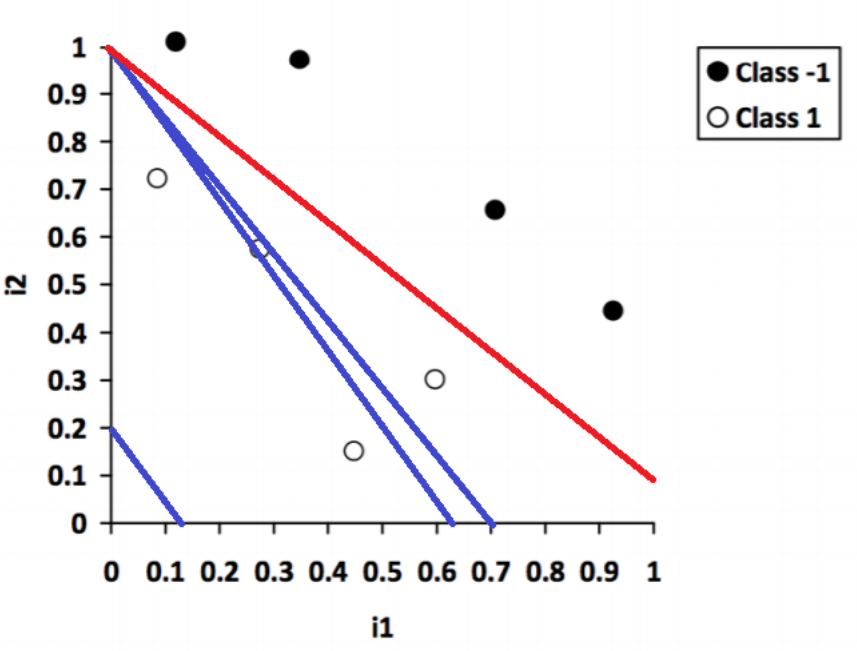
$w_1 = 0.5$

$w_2 = -1$

$y = (1 * 1) + ((0.05 * -1) + (0.175 * -0.95) + (0.35 * -0.65) + (0.45 * -0.45) + (0.05 * -0.7) + (0.15 * -0.55) + (0.225 * -0.15) + (0.3 * -0.3))x$

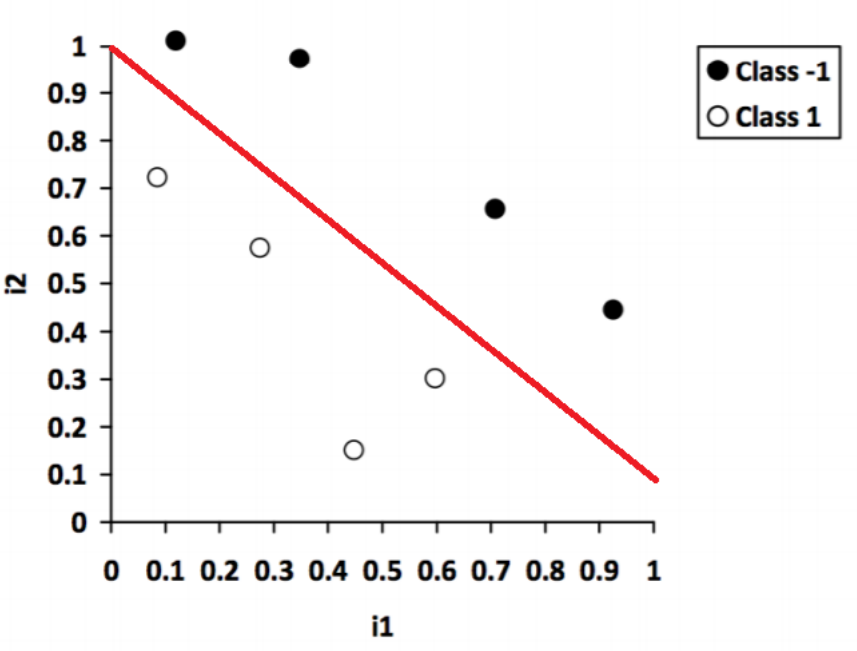
$y = 1 + (-0.05 - 0.16625 - 0.2275 - 0.2025 - 0.035 - 0.0825 - 0.03375 - 0.09)x$

$y = -0.8875x + 1$



No samples are misclassified after the fourth line is placed.

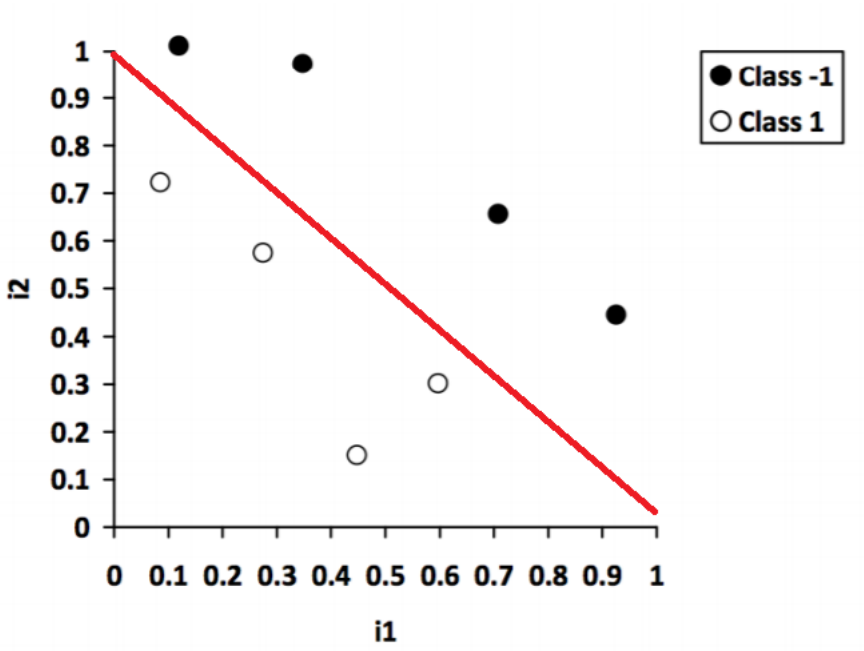
b



This is the final line that achieved perfect classification.
$w_0 = 1$
$w_1 = 0.5$
$w_2 = -1$
$y = -0.8875x + 1$

c

Constant offset = 1
Class -1 Inputs:
(0.1), (0.35), (0.7), (0.9)
Class 1 Inputs:
(0.1), (0.3), (0.45), (0.6)
Initial Weights:
$w_0 = 1$
$w_1 = -0.25$
$y = (1 * 1) + (-0.025 - 0.0875 - 0.175 - 0.225 - 0.025 - 0.075 - 0.1125 - 0.15)x$
$y = -0.875 + 1$

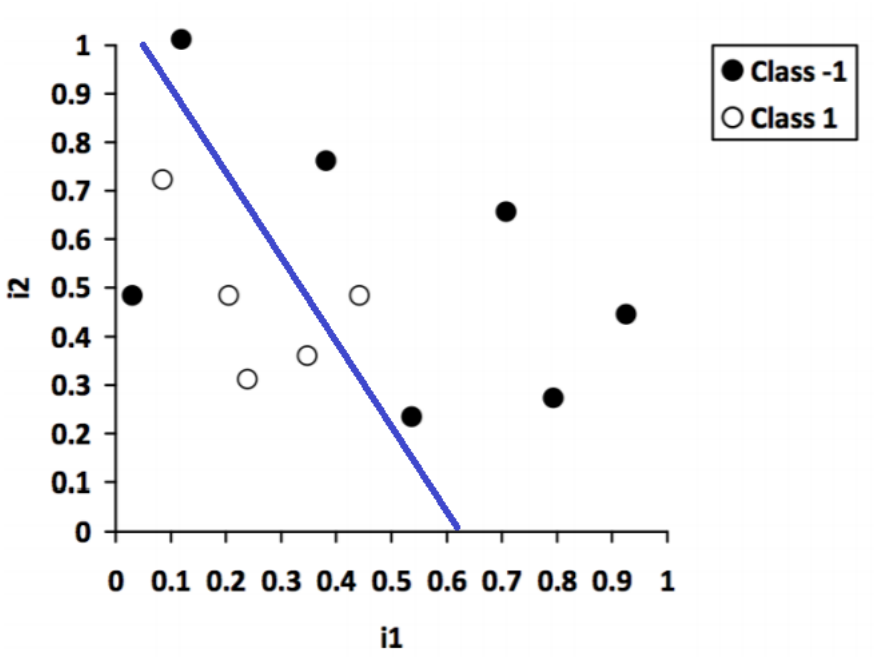


The error for this input space separation is 0 because all of the inputs are correctly classified.

Question 5:

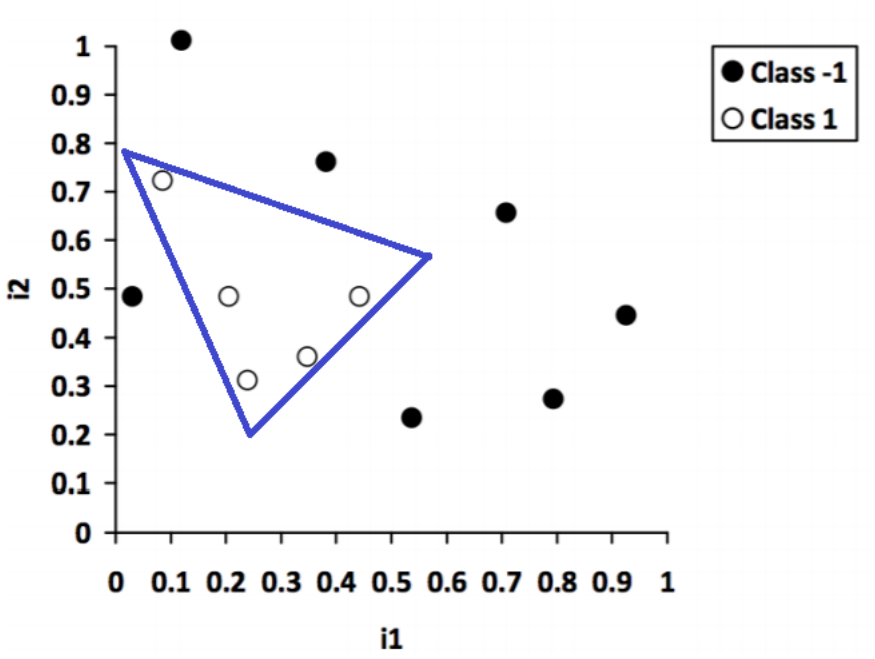
a

The minimum error that can be reached with a single perceptron for this classification task is 2, which means 2 points will be classified incorrectly no matter how much learning the perceptron does.



b

Final result of the multilayer perceptron line drawing:


Class -1
Class 1
i2
i1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1