Q1. Given a set of training datapoints (dimension: 4), create a **random forest** with 3 trees, where every tree has depth 1 only. For each tree, choose any 2 of the dimensions. Given the test datapoint, what will be output of the random forest?

Training set: (x_1=1,x_2=2,x_3=1,x_4=4,y=1); (x_1=5,x_2=2,x_3=1,x_4=4,y=2); (x_1=1,x_2=2,x_3=1,x_4=2,y=3);(x_1=1,x_2=2,x_3=8,x_4=4,y=1); (x_1=1,x_2=5,x_3=3,x_4=2,y=2); (x_1=5,x_2=2,x_3=3,x_4=4,y=3); (x_1=9,x_2=2,x_3=8,x_4=4,y=1); (x_1=8,x_2=2,x_3=5,x_4=4,y=2); (x_1=3,x_2=2,x_3=2,x_4=3,y=3); (x_1=6,x_2=9,x_3=9,x_4=8,y=1); (x_1=9,x_2=8,x_3=7,x_4=6,y=2); (x_1=1,x_2=9,x_3=5,x_4=5,y=3);

Test set: (x_1=7,x_2=1,x_3=9,x_4=3,y=?); (x_1=-4,x_2=9,x_3=1,x_4=3,y=?); (x_1=12,x_2=-3,x_3=-9,x_4=18,y=?)

Q2. You are given 6 2D data points with binary class labels. Start with a linear classifier y = sign(x1 – x2) where x1, x2 are the two dimensions. Run Adaboost algorithm for 2 iterations, and thus obtain 2 more linear classifiers along with their weights. Carry out ensemble classification of these points using the 3 linear classifiers (including initial one).

IDNo	**1**	**2**	**3**	**4**	**5**	**6**
X1	**2.3**	**4.8**	**2.1**	**4.5**	**7.2**	**1.7**
X2	**3.8**	**3.4**	**5.8**	**7.3**	**11.6**	**6.2**
Y	**1**	**1**	**-1**	**1**	**-1**	**-1**

Q3. Given a set of 2D training datapoints with binary labels, find a **linear classifier** for them using **perceptron algorithm**. Start iterations with the X-axis (x_2=0) as w.

(x_1=4,x_2=2,y=1); (x_1=2,x_2=3,y=1); (x_1=3,x_2=6,y=1); (x_1=4,x_2=4,y=1);

(x_1=6,x_2=2,y=-1); (x_1=8,x_2=5,y=-1); (x_1=7,x_2=1,y=-1); (x_1=6,x_2=6,y=-1)

Q4. Consider a dataset with 4 labelled points:

ID	1	2	3	4
X1	2	3	5	6
X2	3	1	3	2
Y	A	A	B	B

Find a linear classifier parallel to the X2-axis, such that the total margin with respect to both of the classes is maximized. What is the total margin of your classifier? Suppose you build an SVM on these 4 points, and it returns w = (1, 0, b). What can be possible values of "α" and 'b' for the 4 points?

Q5. Consider the following 8 labelled points. Suppose you train a soft-margin SVM on them, and the resulting α-values are given below. What are the max-margin and marginal classifiers? Calculate the slack variables attached with each of the data-points in the above situation.

ID	1	2	3	4	5	6	7	8
X1	-4	-6	1	6	-3	2	-2	2
X2	3	1	2	0	-2	1	-3	-5
Y	B	B	B	B	A	A	A	A
α	0	0	5/8	0	-3/8	5/8	3/8	0