

1. (a) Give the formulation of soft margin SVM. Write down the objective function and the constraints clearly. Draw a figure illustrate the formulation. Under what circumstances the soft-margin SVM will degenerate to hard-margin SVM?
(b) Is it necessary to determine whether a given training data set is linearly separable or not before you can apply SVM? Justify your answer. [6+4]

2. Give a 2D dataset for binary class classification problem for which:
(a) Hard-margin SVM will be preferred over self-margin SVM
(b) Soft-margin SVM will be preferred over hard-margin SVM
(c) Soft-margin SVM will be preferred over non-linear SVM
(d) Non-linear SVM will be preferred over soft-margin SVM
Draw the separating hyperplane along with margin, wherever possible. [4*2.5=10]

3. (a) Draw the 2D-XOR function. Convert it into a 3D-XOR function such that it becomes linearly separable. Specify the transformation clearly.
(b) Find a mapping $\phi: \mathbb{R}^2 \rightarrow \mathbb{R}^6$ corresponding to the kernel, $K(\vec{X}, \vec{Y}) = [2(\vec{X} \cdot \vec{Y}) + 3]^2$ [5+5]

4. Partition a 2-dimensional space using rectilinear lines in such a way that you can illustrate the concept of overfitting and underfitting (in separate figures) in decision trees. Use twenty (20) 2-dimensional points belonging to 2 classes (circles and crosses). It is given that that variables X and Y are both numeric having values in [0, 20]. [10]

5. You are given a 1-d data which is not linearly separable.



- (a) Give a family of nonlinear transformations which would make the points linearly separable in some high dimensional space.
- (b) Take the transformed linearly separable in 2-d and fit a decision tree on the data.
- (c) Which other (other than decision trees) classifiers will work nicely (zero training error and no overfitting) for the transformed data? [4+3+3]

6. (a) Pictorially illustrate that both regression and classification are function approximation problems.
(b) Pictorially illustrate that PCA is not necessarily good for classification.
(c) What are the objectives of PCA and FLD? Give one-line answer for each. [4+3+3]