Course Name: Introduction to Machine Learning
Assignment – Week 7 (Computational Learning theory, PAC Learning, Sample Complexity, VC Dimension, Ensemble Learning)
TYPE OF QUESTION: MCQ/MSQ

Number of Question: 10   **Total Marks: 10X2 = 20**

Question 1:

Which of the following options is / are correct regarding the benefits of ensemble model?

  1. Better performance
  2. More generalized model
  3. Better interpretability

  A) 1 and 3
  B) 2 and 3
  C) 1 and 2
  D) 1, 2 and 3

Correct Answer: C
Detailed Solution: 1 and 2 are the benefits of ensemble models. Option 3 is incorrect because when we ensemble multiple models, we lose interpretability of the models)

Question 2:

In AdaBoost, we give more weights to points having been misclassified in previous iterations. Now, if we introduce a limit or cap on the weight that any point can take (for example, say we introduce a restriction that prevents any point's weight from exceeding a value of 10). Which among the following would be the effect of such a modification?

  A) It will have no effect on the performance of the Adaboost method.
  B) It makes the final classifier robust to outliers.
  C) It may result in lower overall performance.
  D) None of these.

Correct Answer: B, C
Detailed Solution: Outliers tend to get misclassified. As the number of iterations increases, the weight corresponding to outlier points can become very large resulting in subsequent classifier models trying to classify the outlier points correctly. This generally has an adverse effect on the overall classifier. Restricting the weights is one way of mitigating this problem. However, this can also lower the performance of the classifier.

Question 3:

Identify whether the following statement is true or false:
"*Boosting is easy to parallelize whereas bagging is inherently a sequential process.*"
   A) True
   B) False

Correct Answer: B) False.
Detailed Solution: Bagging is easy to parallelize whereas boosting is inherently a sequential process.

Question 4:

Considering the AdaBoost algorithm, which among the following statements is true?
   A) In each stage, we try to train a classifier which makes accurate predictions on a subset of the data points where the subset contains more of the data points which were misclassified in earlier stages.
   B) The weight assigned to an individual classifier depends upon the weighted sum error of misclassified points for that classifier.
   C) Both option A and B are true
   D) None of them are true

Correct Answer: C
Detailed Solution: In each stage, Adaboost algorithm tries to train a classifier which makes accurate predictions on a subset of the data points where the subset contains more of the data points which were misclassified in earlier stages. The weight assigned to an individual classifier depends upon the weighted sum error of misclassified points for that classifier.

Question 5:

Which of the following is FALSE about bagging?
   A) Bagging increases the variance of the classifier
   B) Bagging can help make robust classifiers from unstable classifiers.
   C) Majority Voting is one way of combining outputs from various classifiers which are being bagged.

Correct Answer: A
Detailed Answer: Bagging decreases the variance of the classifier.

Question 6:

Suppose the VC dimension of a hypothesis space is 6. Which of the following are true?

    A) At least one set of 6 points can be shattered by the hypothesis space.
    B) Two sets of 6 points can be shattered by the hypothesis space.
    C) All sets of 6 points can be shattered by the hypothesis space.
    D) No set of 7 points can be shattered by the hypothesis space.

Correct Answer: A, D

Detailed Solution: If the VC dimension of a hypothesis is d:
- There exists at least one set of d points that can be shattered by the hypothesis space.
- No set of (d+1) points can be shattered by the hypothesis space.

Question 7:

Identify whether the following statement is true or false:
"Ensembles will yield bad results when there is a significant diversity among the models."
    A) True
    B) False

Correct Answer: **B**
Detailed Solution: Ensemble is a collection of a diverse set of learners to improve the stability and the performance of the algorithm. So, the more diverse the models are, the better will be the performance of the ensemble.
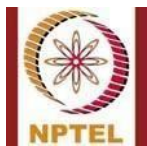

Question 8:

Which of the following algorithms is not an ensemble learning algorithm?
    A) Random Forest
    B) Adaboost
    C) Decision Trees

Correct Answer: **C**.
Detailed Solution: Decision trees do not aggregate the results of multiple trees, so it is not an ensemble algorithm.

Question 9:

Suppose you have run Adaboost on a training set for three boosting iterations. The results are classifiers h1, h2, and h3, with coefficients $\alpha1 = 0.2$, $\alpha2 = -0.3$, and $\alpha3 = -0.2$. For a given test input x, you find that the classifiers results are $h1(x) = 1$, $h2(x) = 1$, and $h3(x) = -1$, What is the class returned by the Adaboost ensemble classifier H on test example x?

   A) 1
   B) -1

Correct Answer: A
Detailed Solution:
The final output is $H(x) = sign((\alpha1*h1(x))+(\alpha2*h2(x))+(\alpha3*h3(x)))$
$H(x) = sign((0.2*1) + (-0.3*1) + (-0.2*-1)) = sign(0.1) = 1$.

Question 10:

Generally, an ensemble method works better, if the individual base models have _____? (Note: Individual models have accuracy greater than 50%)
   A) Less correlation among predictions
   B) High correlation among predictions
   C) Correlation does not have an impact on the ensemble output
   D) None of the above.

Correct Answer: A
Detailed Solution: A lower correlation among ensemble model members will increase the error-correcting capability of the model. So it is preferred to use models with low correlations when creating ensembles.

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