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DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination — Winter Semester, A. Y. 2022-2023
Course No.: EEE 4709 — Time: 3 hours
Course Title: Artificial Intelligence and Machine Learning — Full Marks: 150

There are 6 **(six)** questions. Answer all 6 **(six)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. A group of researchers from Bangladesh curated a dataset from a hospital containing the records of 1800 people who visited the hospital in November. Their aim is to find out the major factors responsible for diabetes in this country. The data had a total of 16 attributes and 220 patients with diabetes. Among the remaining patients, some had other health issues while some did not have any problems.

   The researchers developed a decision-supporting tool to predict the cases of diabetes and utilized the SFS feature selection technique to identify the most relevant attributes characteristic of diabetes patients. The researchers reported that they achieved excellent prediction performance with an accuracy score of 96.8% using the SVM classifier with a 10-fold cross-validation technique. They also identified 3 features most relevant to predicting diabetes.

   a) Identify the most critical issues in the system designed by those researchers. **5 (CO1, PO1)**

   b) An ML practitioner suggested that using the RF classifier instead of SVM would mitigate the problem with the current system. Do you agree with the suggestion? Justify your answer. **5 (CO1, PO1)**

   c) How likely is it going to improve performance if you change the SVM from hard margin to soft margin? Explain your answer. **5 (CO2, PO1)**

   d) Illustrate with appropriate figures how the decision boundary would change with – **5 (CO2, PO1)**
      i. The type of kernel
      ii. C value
      iii. Gamma value

   e) One of the researchers suggested that it is very important to have a transparent system to increase the reliability of the diagnostic tool. Describe the different ways you can achieve that. **5 (CO3, PO3)**

2. a) Describe the architecture of the Random Forest model with appropriate illustrations and explain how it is able to outperform DTs. **10 (CO2, PO1)**

b) Describe the boosting mechanism and explain how different boosting algorithms differ from one another. **10 (CO2, PO1)**

c) Explain whether you can use other algorithms like SVM or NB in place of DTs while building a bagging classifier. **5 (CO2, PO1)**

3. a) Justify the necessity of the use of activation functions in ANN and explain how the following transfer functions differ from one another with proper illustrations. **10 (3+7) (CO2, PO1)**

- Sigmoid
- Leaky ReLU
- Swish
- Tanh
- ELU
- ReLU
- Softmax

b) Describe how the gradient descent algorithm works and explain the differences between different gradient descent techniques namely Stochastic, Batch, and Mini-Batch GD. **10 (CO2, PO1)**

c) Explain how you can control overfitting and underfitting in an MLP model. **5 (CO2, PO1)**

4. a) Explain why the ANN architecture is not suitable for machine translation or image classification tasks. **10 (5+5) (CO1, PO1)**

b) Describe the concept of AI bias and how it can have severe consequences. Further, explain why it is so difficult to make AI fair and unbiased. **10 (CO1, PO1)**

c) Briefly discuss the main differences between the following CNN architectures: AlexNet, VGGNet, ResNet, and Inception. **5 (CO2, PO1)**

5. a) Briefly discuss the t-SNE technique. **5 (CO2, PO1)**

b) For the dataset provided in Table – 1, find the probability of fraud for the following queries – **10 (CO3, PO3)**

- Credit history = paid, Guarantor = none, Accommodation = rent
- Credit history = paid, Guarantor = guarantor, Accommodation = free

Table – 1

A dataset from a loan application fraud detection domain.

ID	Credit History	Guarantor /CoApplicant	Accommodation	Fraud
1	current	none	own	true
2	paid	none	own	false
3	paid	none	own	false
4	paid	guarantor	rent	true
5	arrears	none	own	false
6	arrears	none	own	true
7	current	none	own	false
8	arrears	none	own	false
9	current	none	rent	false
10	none	none	own	true
11	current	coapplicant	own	false
12	current	none	own	true
13	current	none	rent	true
14	paid	none	own	false
15	arrears	none	own	false
16	current	none	own	false
17	arrears	coapplicant	rent	false
18	arrears	none	free	false
19	arrears	none	own	false
20	paid	none	own	false

c) With the help of the confusion matrix given in Table 2, calculate the following performance measures – **5 (CO2, PO1)**

Table - 2

	Predicted False	Predicted True
Actual False	300	150
Actual True	100	600

- Specificity
- F2-score
- NPV
- Precision
- MCC

d) For the dataset provided in Table – 3, create the conditional probability table. **5 (CO3, PO3)**

Table – 3

ID	STORM	BURGLAR	CAT	ALARM
1	false	false	false	false
2	false	false	false	false
3	false	false	false	false
4	false	false	false	false
5	false	false	false	true
6	false	false	true	false
7	false	true	false	false
8	false	true	false	true
9	false	true	true	true
10	true	false	true	true
11	true	false	true	false
12	true	false	true	false
13	true	true	false	true

6. a) For a convnet consisting of a couple of conv and pooling layer blocks, determine the array size after flattening the output from the hidden layers. Here, **10 (CO2, PO1)**

- Input image size: 28*28
- Conv – 1: kernels = 32, filter size = 5*5, S=1, P=2
- Pooling – 1: size = 2*2, S=2
- Conv – 2: kernels = 64, F = 3*3, S=2, P=1
- Pooling – 2: size = 2*2, S=1

b) Explain the vanishing and exploding gradient problem and how to tackle these issues. **10 (CO2, PO1)**

c) Explain the differences between 'same' and 'valid' padding as well as their advantages and disadvantages. **5 (CO2, PO1)**