JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATIONS-2022

B.Tech - VI Semester (ECE)

COURSE CODE (CREDITS): 18B11BI611 (3) MAX. MARKS: 35

COURSE NAME: Machine learning for Bioinformatics

COURSE INSTRUCTORS: Dr. Vikas Baghel MAX. TIME: 2 Hours

Note: All questions are compulsory. Marks are indicated against each question in square brackets.

Q1. Consider a single unit in a neural network that receives two binary inputs x_1, x_2 and computes a linear combination followed by a threshold activation function, namely **[5] [CO5]**

$$\sigma(z) = \begin{cases} 1 & z \geq 0 \\ 0 & otherwise \end{cases}$$

We have chosen a bias term of $b = 5$. Provide values for the two weights w_1 and w_2 that allow you to compute the NAND function.

Q2. **a)** Why are context-free grammars context-free? How do you simplify the context-free grammars explain? What are the applications of Stochastic Context Free Grammars. **[3] [CO6]**

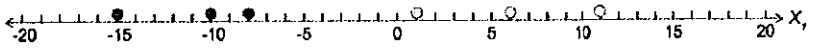
b) What is Chomsky's hierarchy explain and why is it important? **[2]**

Q3. The table below is a list of sample points in $\mathbb{R}^2$. Suppose that we run the perceptron algorithm, with a fictitious dimension, on these sample points. We record the total number of times each point participates is a stocahstic gradint descent step because it is misclassified, throughout the run of the algorithm. **[5] [CO5]**

x_1	x_2	y	**Times misclassified**
-3	2	$+1$	0
-1	1	$+1$	0
-1	-1	-1	2
2	2	-1	1
1	-1	-1	0

Suppose that the learning rate is $\epsilon = 1$ and the initial weight vector is $w^{(0)} = (-3,2,1)$, where the last component is the bias term. What is the eqaution of the separating line found by the algorithm, in terms of the features x_1 and x_2?

Q4. Find the decision boundary given by the following algorithms. Provide a range of values if the algorithm allows for multiple feasible decision boundaries. If there exists no feasible decision boundary, state "None". **[5] [CO5]**



a) Perceptron: X_1 =_____

b) Hard-Margin SVM X_1 =_____

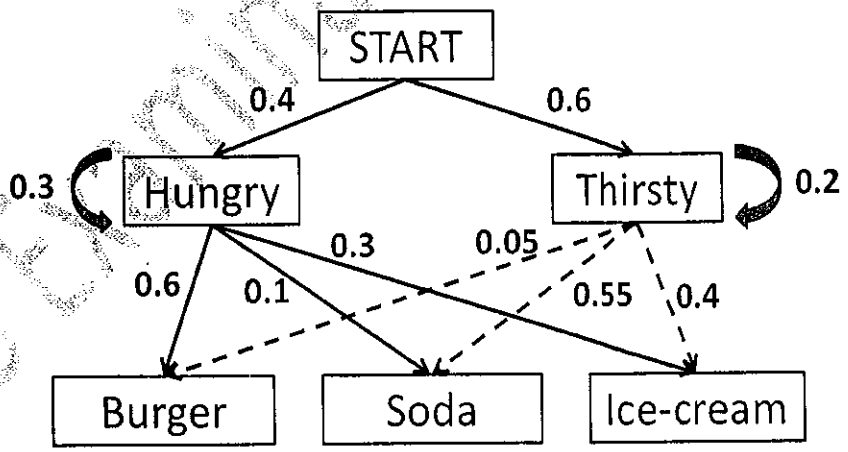
Q5. For the grammar given below, find out the context free language. The grammar $G = (\{S\}, \{a, b\}, S, P)$ with the productions are; **[5] [CO6]**

S → aSa, (Rule: 1)

S → bSb (Rule: 2)

S → ε (Rule: 3)

Q6. **[5] [CO2]**



Let's imagine we have a big fattening lunch leading to this sequence of observations: Burger — Ice-cream — Soda or (B-I-S). Given the graphical probabilistic model (above) for our lunch, find

a) How likely is it to start lunch with a Burger, then have an Ice-cream and then finish with a Soda?

b) After eating a Burger, an Ice-cream and finishing my lunch with a Soda, what is my current state? Was I more likely to have a Soda because I was Thirsty or Hungry?

c) Given the two possible states of our system, the three possible observations, and an example of observations (our big fattening lunch), which transition and emission matrices best describes the lunch we just had?

Q7. Figure shows a two-state HMM. The transition probabilities of the Markov chain are given in the transition diagram. The output distribution corresponding to each state is defined over {1, 2, 3, 4} and is given in the table next to the diagram. The HMM is equally likely to start from either of the two states. **[5] [CO2]**

s	1	2
P(x=1)	0	0.1
P(x=2)	0.199	0
P(x=3)	0.8	0.7
P(x=4)	0.001	0.2

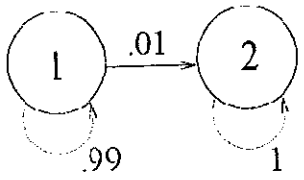


Figure: A two-state HMM

a) Give an example of an output sequence of length 2 which cannot be generated by the HMM in Figure.

b) We generated a sequence of $6,867^{2002}$ observations from the HMM, and found that the last observation in the sequence was 3. What is the most likely hidden state corresponding to that last observation?

c) Consider an output sequence 3 3. What is the most likely sequence of hidden states corresponding to these observations?

d) Now, consider an output sequence 3 3 4. What are the first two states of the most likely hidden state sequence?