

CSE 460 Butunleme Exam

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I. QUESTION (20 POINTS)

Given the grammar G, solve the following questions.

$S \rightarrow NP VP$

$S \rightarrow \text{either } S \text{ or } S$

$NP \rightarrow \text{Determiner Modifier Noun}$

$NP \rightarrow \text{Pronoun|ProperNoun}$

$\text{Determiner} \rightarrow a|the|every$

$\text{Pronoun} \rightarrow she|he|it|him|her$

$\text{Modifier} \rightarrow \text{Adjective}^*|\text{Noun}^*$

$\text{Adjective} \rightarrow red|green|smelly$

$\text{Noun} \rightarrow golf|club|green$

$VP \rightarrow \text{Verb } NP$

$VP \rightarrow \text{Copula Adjective}$

$\text{Verb} \rightarrow cleans|breaks|is$

$\text{Copula} \rightarrow is|seems$

$\text{ProperNoun} \rightarrow Bill$

Which of the following sentences are generated by the grammar?

- (5 points) either either Bill is smelly or Bill is green or the green is red
- (5 points) every green green green is a green green
- (5 points) the golf club breaks smelly Bill
- (5 points) either the green golf club is smelly or it is red

II. QUESTION (15 POINTS)

Assume you are given the following three features of TV shows, with the possible values shown, and wish to learn how to predict future top-10 shows.

$Type \in \{Comedy, Drama, News, Sports\}$

$Location \in \{LA, NYC, Various\}$

$Duration \in \{30min, 60min\}$

Assume decision tree construction algorithm is used on the following examples. Show the resulting tree.

Type	Location	Duration	ClassInfo
C	NYC	30	+
C	LA	60	-
N	Var	60	+
N	LA	30	+
S	Var	60	-
D	LA	60	-

III. QUESTION (10 POINTS)

Consider the following fitness function:

$$fitness = 5a + 3bc - d + 2e$$

where a-e are all Boolean-valued parameters.

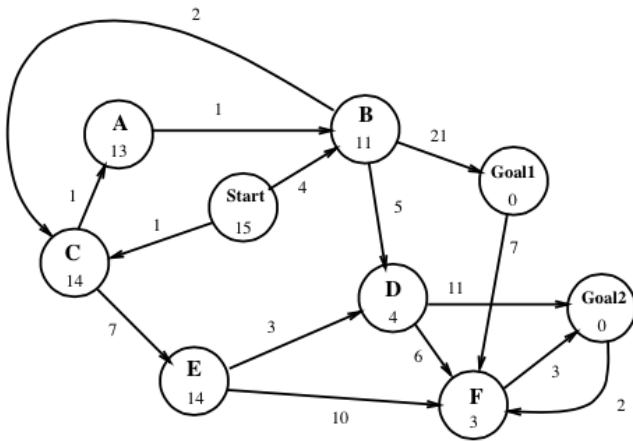
a	b	c	d	e
1	1	0	1	1
0	1	1	0	1
1	1	0	0	0
1	0	1	1	1
1	0	0	0	0

- (3 points) Compute the fitness of each of the members of the initial population above.
- (4 points) Also compute the probability that each member of the population will be selected during the fitness-proportional reproduction process.
- (3 points) Assuming the first two of members of the population are selected for reproduction, and the cross-over point is that between the b and the c, show the resulting children.

IV. QUESTION (16 POINTS)

Consider the search graph drawn below. The initial state is at the top, and goal states are represented by Goal1 and Goal2. For each of the search strategies listed below, indicate which goal state is reached (if any) and list, in order, the states explored. When all else is equal, nodes should be expanded in alphabetical order.

- (4 points) Depth-First Search
- (4 points) Breadth-First Search
- (4 points) Iterative Deepening
- (4 points) A^* Search



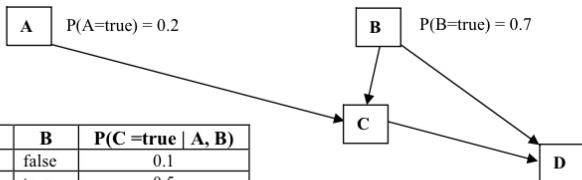
V. QUESTION (12 POINTS)

Using the inference rules for logic, complete the natural deduction proof below, whose task is to show that $\exists xZ(x)$ follows from the givens. Be sure to justify your steps by stating the inference rule used, along with the previous line(s) to which it was applied.

#	WFF
1	$P(1)$
2	$W(1) \wedge W(2) \wedge W(3)$
3	$\forall x[P(x) \Rightarrow \neg R(x)]$
4	$\forall x[Q(x) \vee R(x)]$
5	$\forall x[\{Q(x) \wedge W(x)\} \Rightarrow Z(x)]$

VI. QUESTION (15 POINTS)

Consider the following Bayesian Network, where variables A-D are all Boolean-valued:



A	B	$P(C=\text{true} \mid A, B)$
false	false	0.1
false	true	0.5
true	false	0.4
true	true	0.9

B	C	$P(D=\text{true} \mid B, C)$
false	false	0.8
false	true	0.6
true	false	0.3
true	true	0.1

- (5 points) What is the probability that all four of these Boolean variables are false?
- (5 points) What is the probability that C is true, D is false, and B is true?
- (5 points) What is the probability that C is true given that D is false and B is true?

VII. QUESTION (12 POINTS)

Consider a perceptron that has two real-valued inputs and an output unit with a sigmoidal activation function. All the initial weights and the bias (threshold) equal 0.1. Assume the teacher has said that the output should be 0 for the input $x_1 = 5$ and $x_2 = -3$.

Show how the perceptron learning rule would alter this neural network upon processing this training example. Let ν (the learning rate) be 0.2, and be sure to adjust the output units bias during training.