CS 540: Introduction to Artificial Intelligence

Final Exam: 10:05am-12:05pm, December 19, 2011
Room 168 Noland

CLOSED BOOK
(two sheets of notes and a calculator allowed)

Write your answers on these pages and show your work. If you feel that a question is not fully specified, state any assumptions that you need to make in order to solve the problem. You may use the backs of these sheets for scratch work.

Write your name on this page and initial all other pages of this exam. Make sure your exam contains eight problems on ten pages.

Name ______________________________

Student ID ______________________________

Problem	**Score**	**Max Score**
1	______	**10**
2	______	**15**
3	______	**20**
4	______	**15**
5	______	**15**
6	______	**10**
7	______	**6**
8	______	**9**
TOTAL	______	**100**

Initials: ________________________

Problem 1 – *K*-Nearest Neighbors (10 points)

Consider the *training set* below.

Ex #	**A**	**B**	**C**	**D**	**Output**
1	True	True	False	True	True
2	True	True	True	True	False
3	False	False	True	False	True
4	False	True	False	True	False
5	True	True	False	False	True
6	True	False	True	True	False

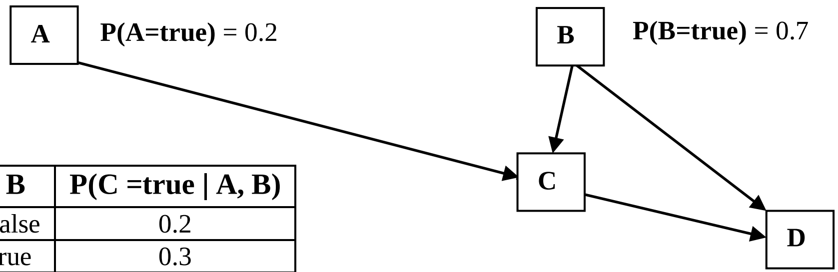
Assume you wish to use the *K*-nearest neighbors algorithm on this dataset and set aside the last two examples as a *tuning* set.

Would you prefer *K*=1 or *K*=3? K = __________

Justify your answer below.

Problem 2 – Bayesian Networks (15 points)

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



A	B	P(C =true | A, B)
false	false	0.2
false	true	0.3
true	false	0.1
true	true	0.6

B	C	P(D =true | B,C)
false	false	0.9
false	true	0.8
true	false	0.4
true	true	0.3

a) What is the probability that *all four* of these Boolean variables are false? ________________
[Be sure to show your work for Parts a-c.]

b) What is the probability that ***A*** is true, **C** is true, and ***D*** is false? ________________

c) What is the probability that ***A*** is true *given* that ***C*** is true and ***D*** is false? ________________

Initials: ______________________

Problem 3 – Probabilistic Reasoning and Learning (20 points)

a) In the general population, 5 in a 100,000 people have the dreaded *Senioritis* disease. Fortunately, there is a test (*test4it)* for this disease that is 99.9% accurate. That is, if one has the disease, 999 times out of 1000 *test4it* will turn out positive; if one does *not* have the disease, 1 time out of 1000 the test will turn out positive.

   You take *test4it* and the results come back true. Use Bayesian reasoning to calculate the probability that you actually have *Senioritis*. That is, compute:

   Prob(haveSenioritis = true | test4it = true) = ______________________________

   Be sure to show your work below. It is fine if your answer is an arithmetic expression that contains only numbers and *, /, +, and/or -. It is <u>not</u> necessary to plug the numbers into a calculator and produce a single number as the answer.

b) Consider the first five examples of Question 1's training set again (copied below), but this time use Naïve Bayes and do *not* create a tuning set.

Ex #	**A**	**B**	**C**	**D**	**Output**
1	True	True	False	True	True
2	True	True	True	True	False
3	False	False	True	False	True
4	False	True	False	True	False
5	True	True	False	False	True

Calculate the ratio below, showing your work below it and putting your (numeric) answer on the line to the right of the equal sign.

$$\frac{\text{Prob(Output = True | A = False, B = False, C = False, D = False)}}{\text{Prob(Output = False | A = False, B = False, C = False, D = False)}} = \underline{\hspace{3cm}}$$

c) Draw a Bayesian Network for the task in Part b that is <u>different</u> from Naïve Bayes, and <u>explain</u> how it is different from Naïve Bayes. You only need to create the Conditional Probability Table (CPT) for <u>one</u> node, but do use the data in the table in Part b.

Initials: ________________________

Problem 4 – Representing Knowledge with First-Order Logic (15 points)

Convert each of the following English sentences into *First-Order Predicate Calculus* (FOPC), using reasonably named predicates, functions, and constants. If you feel a sentence is ambiguous, clarify which meaning you're representing in logic. (Write your answers in the space *below* each English sentence.)

Everyone except Paul knows someone taller than they are.

Often students take cs540 the semester after they took cs367.
[You must use the notation of *Markov Logic Networks* here.]

Passing the ball from one player to another changes who has it, but not the team they are on.
[You must use *situation calculus* here.]

Initials: ______________________

Problem 5 – Propositional Reasoning (15 points)

a) Is the following wff *valid*, *satisfiable*, or *unsatisfiable?* Justify your answer formally.

$$(P \rightarrow Q) \leftrightarrow (P \vee \neg Q)$$

b) Put these wff's in clausal form; show your work below and put your answers on the right.

$(\neg P \vee Q) \vee (R \rightarrow \neg S)$ ______________________________

$(P \vee Q) \rightarrow (R \vee S)$ ______________________________

c) We wish to use search to find an interpretation that satisfies all the clauses below.
Show how this set of clauses can be simplified before starting the search.
Justify your simplification(s).

$(P \vee \neg Q \vee \neg R \vee \neg W)$

$(\neg P \vee Q \vee S)$

$(P \vee Q \vee \neg R)$

$(P \vee \neg Q \vee \neg S)$

(W)

Initials: ______________________

Problem 6 – FOPC Reasoning (10 points)

a) What is the *most-general unifier* (mgu), if any, of these two wff's? ____________________

P(?x, ?y, ?y)   *P(?y, f(1,?x), ?z)*

b) Given the following background knowledge:

1. $\forall$ x { p(x) $\leftrightarrow$ [q(x) $\vee$ r(x)] }
2. $\forall$ y [$\neg$ q(y) $\rightarrow$ p(y)]
3. p(1)
4. p(2)
5. q(1)
6. $\neg$ q(2)

Show: $\exists$ z r(z) by filling out the table below, using as many lines as needed.

Number	WFF	Justification
7.		
8.		
9.		
10.		
11.		
12.		

Initials: ________________________

Problem 7 – Neural Networks (6 points)

Consider a *perceptron* that has two real-valued inputs and an output unit that uses a *step function* as its output function. All the initial weights and the output unit's threshold equal 0.1. Assume the teacher has said that the output should be 0 for the input *in1 = 0.7* and *in2 = 0.4.*

Show how the perceptron learning rule (also called the delta rule) would alter this neural network upon processing this training example. Let η (the learning rate) be 0.25. You do <u>not</u> need to adjust the output unit's threshold during training.

Perceptron BEFORE Training

Perceptron AFTER Training

Did these changes improve the network? _________
Explain your answer.

Initials: ______________________

Problem 8 – Important AI Concepts (9 points)

Describe each of the following AI concepts and briefly explain its most significant aspect. (Write your answers in the space *below* the AI concept.)

Tree Pruning

description:

significance:

Multiple Restarts

description:

significance:

Uniform Cost

description:

significance:

Have a good vacation!