

CS 540: Introduction to Artificial Intelligence

*Final Exam: 2:45-4:45pm, May 11, 2008
Room 1240 Computer Sciences*

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. There also is one blank page at the end of the exam.

Write your name on this and all other pages of this exam. Make sure your exam contains seven problems on eleven pages.

Name _____

Student ID _____

<u>Problem</u>	<u>Score</u>	<u>Max Score</u>
1	_____	18
2	_____	15
3	_____	25
4	_____	10
5	_____	5
6	_____	12
7	_____	15
TOTAL	_____	100

Problem 1 – Reasoning with Probability Distributions (18 points)a) Consider the *joint probability distribution* below.

A	B	C	P(A, B, C)
False	False	False	0.10
False	False	True	0.13
False	True	False	0.15
False	True	True	0.12
True	False	False	0.01
True	False	True	0.19
True	True	False	0.07
True	True	True	0.23

i. What is $P(A = \textit{false})$? _____ Show your work below.ii. What is $P(A=\textit{true} \textit{ or } B=\textit{true})$? _____ Explain.

Name: _____

- b) Consider the task of diagnosing a human disease D , given two symptoms, A and B , where we have gathered some historical data from a large population of people. (A , B and D are all Boolean-valued.)

We found that when D =true, then A =true 60% of the time.

Also, when D =true, we found that B =true 20% of the time.

When D =false, then A =true 30% of the time.

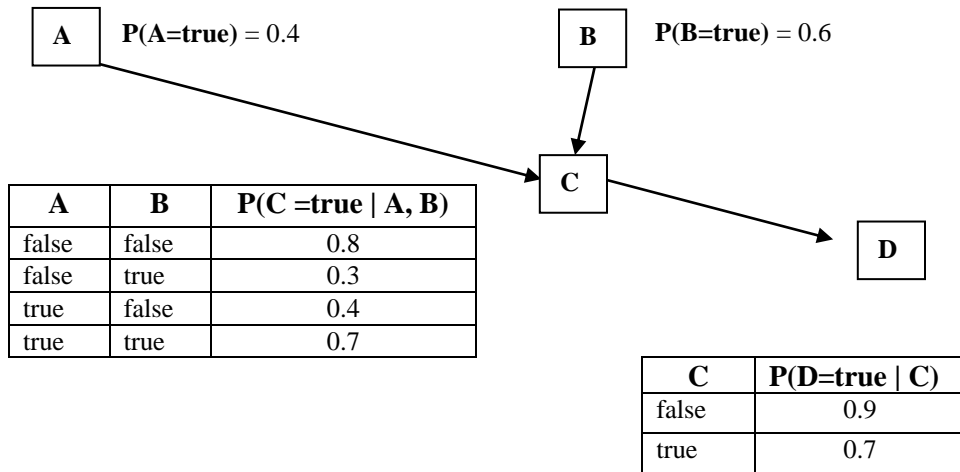
When D =false, then B =true 80% of the time.

Finally, in this data D is true 10% of the time.

Using this information, estimate whether D is more likely true or false, for a new person where A =true and B =false. Show and justify your calculations, including any assumptions you need to make.

Problem 2 – Bayesian Networks (15 points)

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



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

b) What is the probability that *A* is false and *D* is false? _____

c) What is the probability that *B* is true *given* that *C* is false and *D* is true? _____

Problem 3 – Representing Knowledge with First-Order Logic (25 points)

- a) 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.)
-

Some person is in both CS 538 and CS 540 during Spring term 2008.

Every dog hates the same cat.

Driving to work changes one's location but not one's boss
[You must use *situation calculus* here.]

Name: _____

- b) Provide a formal interpretation that shows that the following translation from English to FOPC is *incorrect*. Be sure to *explain your answer formally* using the interpretation you provide.

There exists a blue dress.

$\exists x [\text{dress}(x) \rightarrow \text{blue}(x)]$

- c) What is the *most-general unifier* (mgu) of these two wff's? _____

$P(f(?x), ?y, g(?y))$

$P(?a, h(1, 2, ?b), g(?c))$

Justify that your mgu unifies these two expressions:

Problem 4 – Logical Reasoning (10 points)

Given the following background knowledge:

1. $\forall x \{ [p(x) \wedge q(x)] \longrightarrow [r(x) \vee s(x)] \}$ _____

2. $\forall y [q(y) \longrightarrow \neg s(y)]$ _____

3. $p(1)$ _____

4. $p(2)$ _____

5. $q(2)$ _____

Show: $\exists z [r(z)]$

Do this by putting wff's 1-5 into CNF and use the resolution inference rule. Put the CNF on the lines above, to the right of the wff's. Put the CNF that results from the query below.

6. _____

Problem 5 – Neural Networks (5 points)

Consider a *perceptron* that has three real-valued inputs and an output unit with a *step function* as its activation function. All the initial weights and the bias (“threshold”) equal -1.0. Assume the teacher has said that the output should be 1 for the input $in1 = -2$, $in2 = 0$, and $in3 = 4$.

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

Perceptron BEFORE Training

Perceptron AFTER Training

Problem 6 – Important AI Concepts (12 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.)

Similarity Functions

description:

significance:

CLOSED Lists

description:

significance:

Semi-Decidability

description:

significance:

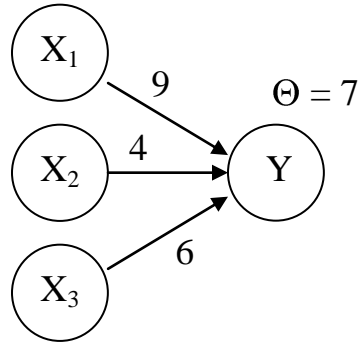
Alpha-Beta Pruning

description:

significance:

Problem 7– Learning What a Neural Network Learned (15 points)

Assume we have successfully trained the simple neural network below. The output unit uses a “step function,” whose “threshold” is 7, to compute its output given its weighted input. The inputs are binary-valued (i.e., either 0 or 1).



- a) We would like to understand what this neural network has learned. So we decide to address this task by giving all of the eight possible input vectors to this neural network, collecting this set of input/output pairs into a training set. Complete the contents of this training set below:

X_1	X_2	X_3	Y
0	0	0	___
0	0	1	___
0	1	0	___
0	1	1	___
1	0	0	___
1	0	1	___
1	1	0	___
1	1	1	___

[Feel free to use the empty space around this training set for your calculations for Part b.]

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- b) We next decide to learn a *decision tree* that fully fits Part a's training set, since decision trees are often easy to interpret. Show all the calculations needed to create this tree, and show the final decision tree that results. (Feel free to do some of your calculations on the previous page.)

- c) Should we worry about *pruning* Part b's decision tree? Why or why not?

Have a good summer!