CS 540: Introduction to Artificial Intelligence

Final Exam: 7:25-9:25 pm, December 17, 1999
Room 107 Psychology

CLOSED BOOK
(one new sheet + the midterm sheet of notes allowed)

Write your answers on these pages and **show** your work. If you feel that a question is not fully specified, state any assumptions 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 and all other pages of this exam. Make sure your exam contains seven problems on seven pages.

Name ______________________________

Student ID ______________________________

Problem	**Score**	**Max Score**
1	______	**30**
2	______	**10**
3	______	**20**
4	______	**5**
5	______	**5**
6	______	**10**
7	______	**20**
TOTAL	______	**100**

Problem 1 – Decision Trees [30]

[15] a) Formulate Decision Tree Learning as a Search Problem by describing the following items:

Search Method:

State (Hypothesis) Space:

Initial State:

Goal Test (State) / Evaluation (Value) Function:

Operators (or Successor Function):

Path Cost (if it applies):

Heuristic Function (if it applies):

[15] b) Given the following training examples show the decision tree that would be learned by ID3 **using information gain**. All features and the target are boolean valued. Here are some logarithm you might need: log2(1) = 0, log2(2) = 1, log2(3) = 1.6, log2(4) = 2, log2(5) = 2.3, and log2(6) = 2.6. Also, log(x/y) = log(x) - log(y).

F1	F2	F3	Target
1	1	1	1
0	1	0	1
1	0	0	0
0	0	0	0

Problem 2 – Experimental Methodology [10]

Give two reasons for using a tuning (validation or pruning are alternative names) set on Machine Learning.

Problem 3 – Neural Networks [20]

Consider applying a perceptron to problem (1b) with a step function unit with threshold 0.2, learning rate 0.2, and initial weights W1 = -0.1 , W2 = 0.3 , W3 = -0.2 .

[5] a) What is its output given the first example? Show your calculations.

[10] b) What are the weights (and threshold) values after applying the Perceptron Learning Rule? Show your calculations.

[5] c) Suppose we have a multi-layer neural network (at least one hidden layer) with all units having a linear activation function ($g(x) = ax + b$); there is a theorem saying that we can reduce this network (with any number of hidden layers) to a network without any hidden layer that computes the same function. What kind of restriction do linear activation functions place on your hypothesis space?

Problem 4 – Prolog [5]

Can we prove daughter(mary, john)from the clauses below using Prolog?
(Hint: ask <= daughter(mary, john)). The operator **not** is negation by failure. Show the steps.

daughter(X, Y) <= **not** male(X), mother(Y, X)
daughter(X, Y) <= female(X), father(Y, X)
mother(john, mary) <=

Problem 5 – Uncertainty Reasoning [5]

We are given the following information:

P(Test | Disease) = 0.99

P(Disease) = 0.0001

P(Test) = 0.01

What is the P(Disease | Test) ?

Problem 6 – FOIL [10]

How does FOIL cover positive examples? Explain this part of the FOIL algorithm.

Problem 7 – Planning [20]

[8] a) Define two STRIPS operators for the actions *Cook(x)* and *Freeze(x)*, where Cooking makes food Hot and Freezing makes food not Hot. You can only Cook food when it is at the same location as a STOVE, and you can only Freeze food when it is at the same location as a FREEZER. Use the following predicates and objects:

(i) At(x, y) means object x is at location y.
(ii) Food(x) means object x is food.
(iii) Hot(x) means object x is hot.
(iv) STOVE is an object denoting a stove.
(v) FREEZER is an object denoting a freezer.

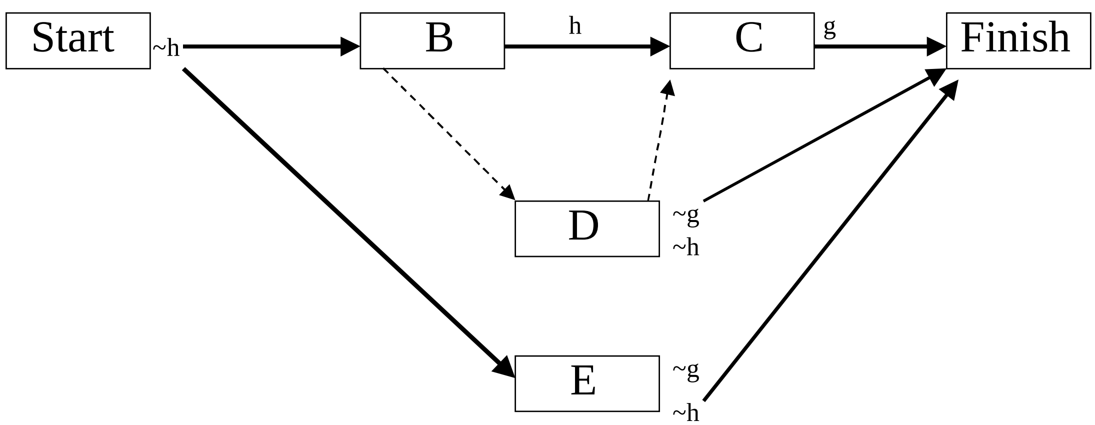
[6] b) Define a successor state axiom for the Hot predicate using situation calculus and the above predicates and actions.

[6] c) Consider the following partially-ordered plan:

(i) Which steps possibly threaten the causal link from B to C satisfying precondition h of C?

(ii) Which steps necessarily threaten this link?

(iii) How can the plan be refined to remove a possible threat to this link?



Solid lines represent causal links and dotted lines represent temporal links