CS 540-1 -- Introduction to Artificial Intelligence

Final Exam - December 16, 1992

(Rm 6203, Soc Sci Building)

CLOSED BOOK

120 minutes (5:05-7:05 pm)

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 eight problems on ten pages.

Name _____

Student ID _____

Problem	Score	Max Score
1	_____	20
2	_____	15
3	_____	35
4	_____	15
5	_____	15
6	_____	20
7	_____	15
8	_____	15
Total	_____	150

PROBLEM 1 - Non-Linear Planning (20 points)

Consider the following TWEAK operators:

Operator 1
preconditions: $A \wedge \neg C$
postconditions: $\neg A \wedge C$

Operator 2
preconditions: $\neg A \wedge C$
postconditions: $X \wedge A$

Operator 3
preconditions: $\neg B$
postconditions: $Y \wedge \neg X \wedge \neg Z$

Operator 4
preconditions: $\neg C$
postconditions: $\neg Y \wedge Z$

Assume the task is to construct a plan that correctly converts the initial state $A \wedge \neg B \wedge \neg C$ into the final state $X \wedge Y \wedge \neg Z$.

Show a *sequence* of partial plans that TWEAK could produce during its search for an acceptable non-linear plan. *When choosing goals from the list of unachieved goals, always choose the one earliest in the alphabet.* Briefly explain the reason for each of TWEAK's alterations of the current partial plan.

PROBLEM 2 - Decision Trees (15 points)

Assume you are given the following three features of used cars, with the possible values shown.

Age	∈	{Old, New}
Size	∈	{Tiny, Large}
Repairs	∈	{Zero, One, Two}

Assume Quinlan's ID3 algorithm is given the following set of classified training examples. Calculate the decision tree that ID3 would produce. *Show all your work.* (You may use the abbreviations that are used to describe the examples.)

```
A = O    S = T    R = 2        +
A = N    S = T    R = 2        -
A = O    S = L    R = 1        -
A = N    S = L    R = 1        -
A = O    S = L    R = 0        +
```

---

lg is the base 2 log

lg(a*b) = lg(a) + lg(b)
lg(a/b) = lg(a) - lg(b)

lg(1) = 0
lg(2) = 1
lg(3) = 1.58
lg(4) = 2
lg(5) = 2.32

PROBLEM 3 - Neural Networks and Inductive Learning (35 points)

Part A. Show that performing gradient descent for the perceptron leads to the *delta rule* for weight adjustment. You may assume that the activation function for the output unit is $f(x)=x$, i.e. the value of the output unit is simply the weighted sum of its inputs. Also, assume the error measure is one-half the square of the difference between the teacher's and the network's values.

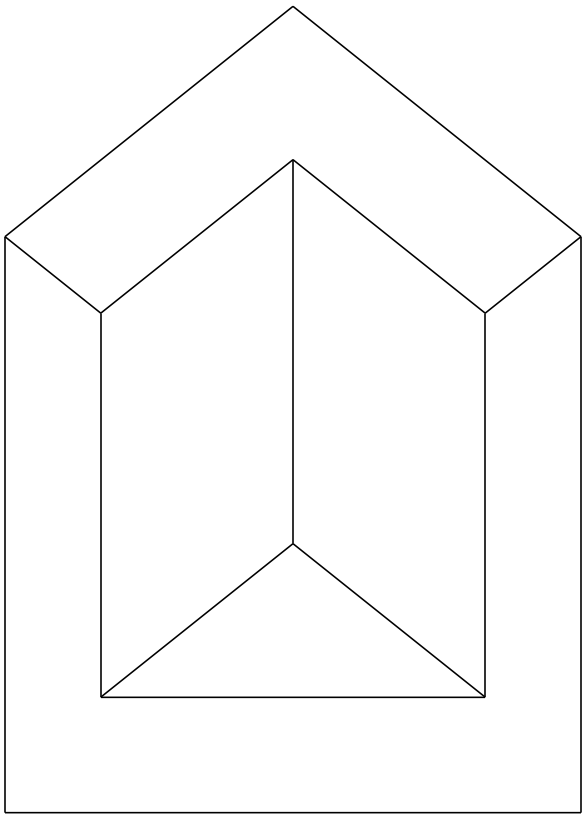
Part B. Describe the spaces searched by backpropagation and ID3.

Part C. Which search-control strategy does backpropagation use (e.g., depth-first search, beam search, best-first search, etc.)? What about ID3? Explain your answers.

PROBLEM 4 - Waltz Labeling (15 points)

cover this with the figure of label types from the book!!!!!!!

Label the line segments in the figure below using the vertex labels provided above. Assume the outermost segments are figure/background boundaries.



PROBLEM 5 - Predicate Calculus (15 points)

Represent the following English sentences using predicate calculus. In the first two sentences, be sure to represent *stack* and *wash* as situation calculus operators. If you feel a sentence is ambiguous, you need only give one FOPC representation, but also provide an unambiguous paraphrase.

When stacking, blocks can be placed on any clear block except those that are spheres.

Washing a car does not change who owns it.

Every tree in Mary's yard has no leaves.

Every room in Hotel AI has at least two exits.

Finishing the CS540 final makes everyone happy.

PROBLEM 6 - Miscellaneous Questions (20 points)

Answer the following *true* (T) or *false* (F). Provide brief justifications of your answers.

If hill climbing finds a solution path, S-P, beam search will also produce S-P as its answer.

Ans: _____ Just:

Best-first search is guaranteed to find an optimal solution.

Ans: _____ Just:

F(F(?x, k, ?y), h, ?y) and F(?z, ?x, G(?x)) unify.

Ans: _____ Just:

$\forall x\ F(x)$ *is logically equivalent to* $\neg\forall x\ \neg F(x)$.

Ans: _____ Just:

The Waltz labeling procedure produces exactly one interpretation for each drawing.

Ans: _____ Just:

The use of scripts can aid the task of natural language understanding.

Ans: _____ Just:

Viewer-center representations require less storage than object-oriented ones.

Ans: _____ Just:

PROBLEM 7 - Important AI Concepts (15 points)

In the space below, provide *brief and succinct* summaries of why the following are important. *You need to only summarize five (5) of the seven (7) concepts. Be sure you clearly indicate which five you are answering.*

---

resolution theorem proving

---

*A**

---

iterative deepening

ISA hierarchies

---

frame axioms

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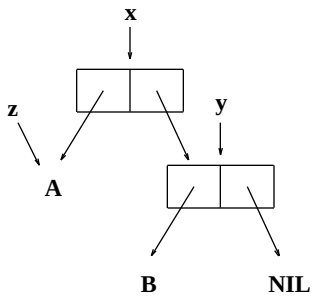
test sets (in machine learning)

---

hidden units in a neural network

PROBLEM 8 - Lisp and Prolog (15 points)

Part A. In a Common Lisp system the value of *x* is *(A B)*, of *y* is *(B)*, and of *z* is *A*, as indicated in the *cons-cell* structure drawn below. Indicate (in cons-cell notation) how each of the following commands changes this internal structure - *i.e., in each case, start with the initial memory state drawn below and draw the new memory structure.* Cross out any commands that would generate a Common Lisp error and assume erroneous commands do not affect memory.



`(SETF x y)` new internal structure:

`(SETF y (FIRST x))`

`(SETF z (CONS 'A (CONS 'B NIL)))`

`(SETF w (CONS z x))`

Part B. Write a Prolog program for the predicate *double_list(List, Doubled_list)*. This predicate is true when *Doubled_list* contains an item-by-item duplicated version of *List*, as illustrated below:

```
?- double_list([a,b,c], [a,a,b,b,c,c]).
   yes

?- double_list([a,b,c], X).
   X = [a,a,b,b,c,c]

?- double_list(X, [a, a, b, b]).
   X = [a,b]
```

The end - have a good vacation!