Final Exam I - TDBC70 – Artificial Intelligence
Thursday October 31th, 2002
9.00 - 15.00

(Write the number on the back of this cover sheet onto each sheet in the exam body -10pts if your name appears in the exam body)

NAME: _____

PERSON NUMBER: _____

EMAIL: _____@cs.umu.se

Extra Credit: _____

Exam Point Total: _____

Total Points: _____

Grade: _____

1 True or False - 150 points

Each question is worth 10 points. If you mark a question wrong, then you loose 5 points. The lowest possible score on the entire section will be 0 points.

- 1.) Minsky and Pappert identified the inability of perceptrons to express XOR. _____.
- 2.) A reflex agent without state can do what a reflex agent with state can do provided its look-up table is large enough. _____.
- 3.) Backgammon is a deterministic, accessible game. _____.
- 4.) Pathmax will make any heuristic function admissible. _____.
- 5.) If $\alpha \vdash \beta$ whenever $\alpha \models \beta$ then our proof method is sound. _____.
- 6.) $(\forall x)(P(x) \wedge Q(x)) \Rightarrow (\forall x)(P(x)) \wedge (\forall x)(Q(x))$ is valid. _____.
- 7.) To apply resolution, you must convert your formula to a CNF. _____.
- 8.) Modern planning systems conduct their search over the space of plans rather than over the space of situations. _____.
- 9.) Probability theory and propositional logic make the same ontological commitments. _____.
- 10.) Bayesian networks are a compact way in which to represent a joint probability distribution. _____.
- 11.) Probability theory, just as logic, can not handle the qualification problem._____.
- 12.) Neural networks are better suited to tasks in perception than to tasks in natural language understanding. _____.
- 13.)Back propagation generalize beyond the input / output patterns given during training. _____.
- 14.) Decision Trees occasionally test the same attribute twice along a path from the root to a leaf node. _____.
- 15.) The person inside the room in the *Chinese room argument* is a native speaker of Chinese. _____.

2 Short answers (50 points)

- 1.) How many boolean functions are there are over n boolean variables?_____.
- 2.) Over the propositions a, b and c how many valid models are there for $a \Rightarrow b$? _____.
- 3.) Express $P(H|e)$ in terms of $P(e|H)$, $p(H)$ and $P(e|\neg H)$. _____.
- 4.) If I tell you, "brothers and sisters have I none, but that man's father, is my father's son." Who is that man?_____.
- 5.) Play the qualification game: I say "If a tomato is red then buy it.". You say (be creative):

3 Lisp (100 points)

Given an input list specifying one way cost between any two points in a directed graph, write a recursive function(s) that calculate the total cost of a tour. Return nil if no such tour is possible.

Example runs:

```
> (tour '(a b c) '((a b 10)(b c 15)(a d 45)))
25

> (tour '(b a) '((a b 10)(b c 15)(a d 45)))
nil
```

4 Search (100 points)

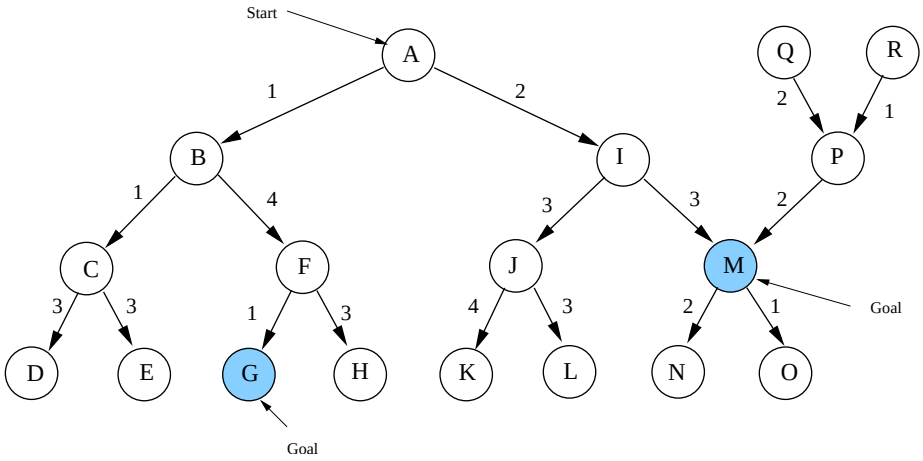

Figure 1: Search Tree

The heuristic measures are: $h(A) = 4$,$h(B) = 3$,$h(C) = 5$,$h(D) = 4$,$h(E) = 7$,$h(F) = 1$,$h(G) = 0$,$h(H) = 3$,$h(I) = 4$,$h(J) = 3$,$h(K) = 6$,$h(L) = 4$, $h(M) = 0$,$h(N) = 2$,$h(O) = 11$,$h(P) = 1$,$h(Q) = 5$ and $h(R) = 3$. Nodes are processed left to right:
Give the order of expansion under the following search strategies.:

- depth first _____
- breadth first_____
- iterative deepening_____
- greedy_____
- A*_____
- Bidirectional - breadth in forward, iterative deepening backward
  Forward (from A): _____
  Backward (from M): _____
  Backward (from G): _____

Is the heuristic function *admissible*? _____.

5 Game Trees (50 points)

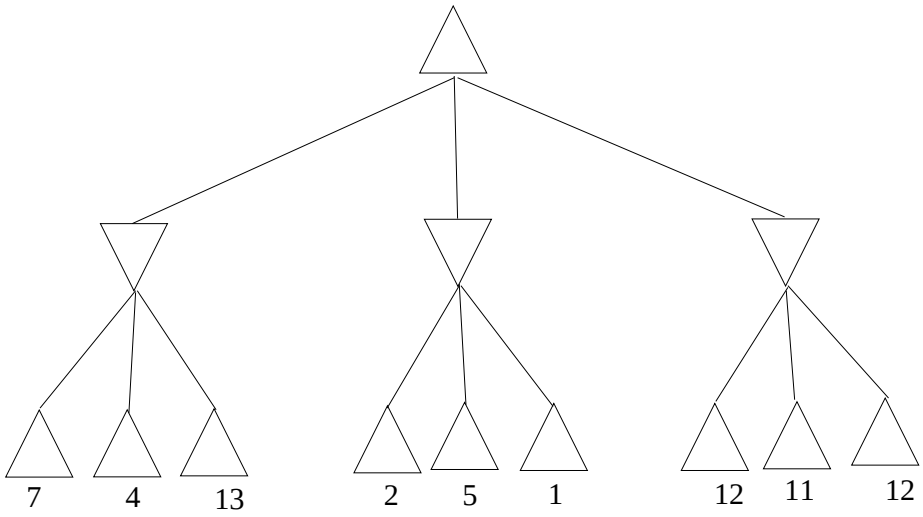

Figure 2: Search Tree

- Back up the values in the game tree and indicate the path of expected game play.
- Assuming that search order is left to right, mark the nodes that get expanded under alpha beta pruning.

6 Logic (150 points)

Over the unary predicate $Student(X)$, the binary predicate $Takes(X, courseName)$, and $Knows(X, topic)$ express the following:

1.) Every student takes either networks or databases.

2.) Every student who takes databases knows SQL.

3.) John is a student who did not take networks.

4.) John knows SQL.

Now show that 4 follows from 1,2,3 through resolution:

7 Situation Calculus/Planning (100 points)

Consider that you have a number of trucks that must pick up cargos at various locations and deliver these cargos to a set of destination locations. Trucks may only carry one piece of cargo at a time.

There are three unary predicates: $Truck(T)$, $Cargo(C)$ and $Location(L)$. Locations are connected by the binary predicate $Road(L_1, L_2)$. Trucks and cargos may be at single locations in a given situation S. This is expressed in the two predicate (fluents) $TruckAt(T, L, S)$ and $CargoAt(C, L, S)$. Finally we have the relation (fluent) $In(C, T, S)$ which says that a piece cargo is being carried by a truck in a given situation.

Now we consider the actions: $Move(T, L_1, L_2)$ makes a truck travels from L_1 to L_2, via a road. $Load(C, T)$ places cargo onto a truck. $Unload(C, T, S)$ removes cargo from a truck.

- Define the successor state axioms for the four fluents.

- Show the three STRIPS operator schemas for the actions.

8 Bayesian Networks (100 points)

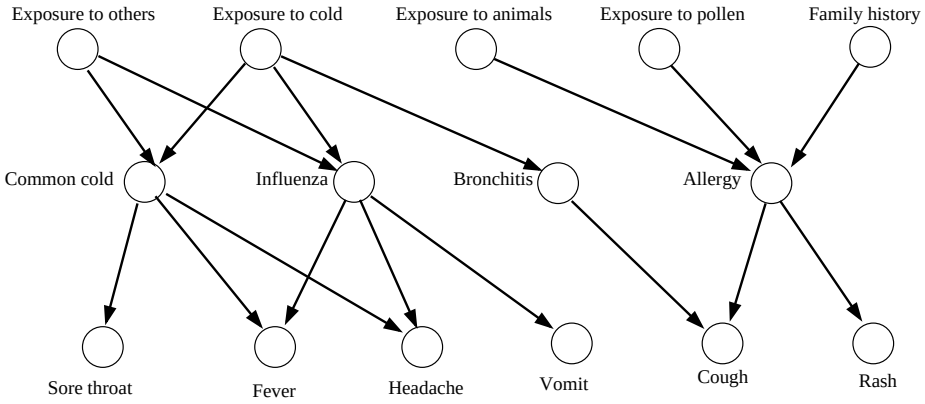

Figure 3: Example Network

Assume that each of the 15 variables in the network are boolean.

- Ignoring the network structure, how many parameters are required to specify the full joint probability distribution over all of the variables? _____.
- Can you say what the sum of all these parameters would be? _____.
- How many parameters would be required to specify the joint probability given the network? _____.
- Is the network a DAG? _____.
- Is the network a Poly-Tree? _____.
- Is the cost for answering arbitrary queries over this network polynomial or exponential? _____
- Does $P(Cough|Allergy) = P(Cough|Allergy \wedge ExposureToPollen)$? _____
- Does $P(Fever|\neg CommonCold \wedge Influenza) = (Fever|\neg CommonCold \wedge Influenza \wedge ExposureToCold \wedge ExposureToOthers)$? _____
- Does $P(Brochitis|Cough) = P(Bronchitis|Cough \wedge Allergy)$? _____
- Does $P(Cough!Allergy) = P(Cough|Allergy \wedge Rash)$? _____

9 Decision Trees - you may answer this question in Swedish (100 points)

Describe how information theoretic principles is used when creating a DT. Explain all used concepts.

10 Artificial Neural Networks (ANN) - you may answer this question in Swedish (100 points)

a What is Early stopping and why is it used?

b Describe the Back propagation algorithm in detail