CMPSCI 683 **Fall 2002**
Prof. Victor Lesser October 31, 2002

MID-TERM EXAM

The answers to these questions should be specific and to the point; we are not looking for essays!

1. **Short questions (*10 out of 14*, 5 Points each)**

Justify your answer with a "short" explanation

a) Explain the common reason/principle for the use of the techniques of mini-conflict in GSAT and variable/value goodness in CSP (constraint satisfaction).

b) IDA*, RBFS and SMA* all exploit a depth-first search and monotonicity of f*. Explain why these are key concepts for these types of search processes.

c) Explain the common reason/principle for the use of the techniques of simulated annealing in hill climbing and random restart in GSAT.

d) How does RTA* avoid loops as actions (movements) are taken in the real world?

e) Draw the performance profile of Anytime-A* in the following situations: 1) There are very few solution nodes and 2) There are a large number of solution nodes.

f) Explain why structuring a search hierarchically can be advantageous and in what situations is it counterproductive.

g) If you are given a problem to solve using search, what criteria would you use to decide whether you would use a systematic search such as A* vs. a stochastic search such as GSAT?

h) Describe how co-articulation phenomena in speech create interacting subproblems in the interpretation of speech data.

i) Explain how Hearsay-II uses a combination of bottom-up processing and top-down processing to solve the interacting data interpretation subproblems created by co-articulation.

j) The beam search is a search technique where *n* search paths are followed concurrently from one stage to the next. Explain why it is not always advisable to choose the most highly rated search paths for the *n* paths.

k) Imagine a search problem to which we want to apply a breadth-first search. Assume a fixed branching factor *b*, and that all solutions lie at depth *d*. Now suppose that, in addition to the start state, you are given an intermediate state at depth *k* that is known to be on a path to a solution. Determine the efficiency gain (in terms of time savings) realizable with the additional knowledge of this intermediate state, compared to the time that it would take to find a solution if we only had a start state. Answer assuming that the search only has to return a goal state.

l) Explain the intent of the process of defuzzification as used in Fuzzy Logic.

m) You need to make a decision and you set up your problem as a decision tree. Suppose you now want to assess the value of acquiring some information before you make the decision. Would the entire structure of your decision tree need to change, or just the value of some of the outcome leaves, or just the likelihood of some chance nodes?

n) What is the connection between a belief network, where some nodes just have priors (i.e., nodes without parents whose value is not yet set as a result of evidence), and a non-empty belief interval in Dempster-Shafer?

2. Belief Networks Question (25 Points)

Consider the classic example we discussed in class;

> "Suppose that you have a new burglar alarm installed at home. It is fairly reliable at detecting a burglary, but also responds on occasion to minor earthquakes. You also have two neighbors, John and Mary, who have promised to call you at work when they hear the alarm. John always calls when he hears the alarm, but sometimes confuses the telephone ringing with the alarm and calls then, too. Mary, on the other hand, likes rather loud music and sometimes misses the alarm altogether. Given the evidence of who has or has not called, we would like to estimate the probability of a burglary."

Let us consider the following more detailed version of this problem where we now introduce the random variable "weather near the house." If the "weather near the house" is stormy it can sometimes set off the alarm, it can also affect whether the telephone lines are up, and whether Mary hears the alarm. Let us add further detail to the problem by introducing another random variable that is the "weather at work." The "weather near the house" is often the same as the "weather at work."

a) (7 points) Draw a belief network describing the extended problem

b) (6 points) What is the additional probabilistic information that would be needed to construct this network?

c) (12 points) If I know the value for "weather at work," and that John and Mary have not called, how would I compute how my confidence that there has not been burglary is affected by knowing the "weather near my house"? Show the symbolic expressions in terms of conditional probability expressions whose values are held in the network.

You don't need to fully generate the expressions. Rather you should sketch out the process of how you would generate them and show 5 steps in the derivation process.

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3. Search (25 Points)

Suppose that, in addition to an admissible A* heuristic function *h(n),* you are told that there is a solution whose cost is *K*.

a) (points 8) How would you change A* to take advantage of information to reduce the number of nodes needed to be expanded, while maintaining optimality? Explain clearly all the changes.

Instead, suppose you are given a function *H(n)* that is an upper bound on the distance to the goal. That is, *H(n) >= h*(n)*. Assume that *h* is monotone and that *H (n) = infinity* when there is no path to the goal.

b) (points 8) How would you change A* to take advantage of *H (n)* in order to reduce memory requirements, while maintaining optimality? Explain clearly all the changes.

c) (points 4) Will the proposed changes affect the number of nodes expanded? Explain.

d) (points 5) Is the assumption that *h* is monotone essential? Explain.