CMPSCI 683 Fall 1996
Prof. Victor Lesser October 24, 1996

MID-TERM EXAM

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

Advance Search (35)

a) Use of Hierarchy/Abstraction in Controlling Search (**14**)

Explain in general terms why subproblem interaction is one of the characteristics that makes search complex. Explain why this is the case and how in some cases an "abstract/meta-level" view of the search space can be effective in such situations.

We saw at least four examples of systems in class (ABSTRIPS, NOAH, KNOBLOCK's Tower of Hanoi example, and HEARSAY-II) that used hierarchy/abstraction to make decisions on which subproblems to solve next. Try to characterize the specific knowledge that each system used.

b) HEARSAY-II as a complex search process (**14**):

Explain how HEARSAY-II in contrast to A* represents a complex search problem in terms of monotonicity, cost of operator application, cost of making control decisions, and the decision about when to terminate problem solving.

The HEARSAY-II speech understanding system involves a combination of both bottom-up (data-driven) processing and top-down (model-directed) processing, often opportunistically switching among modes. Why do you need both modes, in general? Give a concrete example of where this occurred in HEARSAY-II.

c) Explain the basic idea behind how RTA* can be used in making decisions when there is not sufficient time to guarantee an optimal solution to the A* problem (**7**).

Decision Trees/Influence Diagrams/Belief Networks (27)

Recently, researchers have suggested the use of influence diagrams to represent the high-level decision process involved in searching the WWW for information. In order to use influence diagrams in this application they have introduced time and cost of information acquisition into the formula that describes for each node (variable) the value of information gathering with a particular allocation of (time/cost) resources.

K - current information available to the agent

□□ the current best decision

$E_{N,j}$ - evidence regarding node (variable) N in the decision model where j=1 ,,, is a possible value

T - given amount of time

C - given cost

O_i - possible outcomes of the user's decision

Q_N (T,C) quality of information obtained

The following formula for the value of information can be formulated

$$V_K(E_N,T,C) = (\sum_j P(E_N = E_{N,j} \mid K)\, EU(\square \mid K, E_N = E_{N,j}, Q_N(T,C))) - EU(\square \mid K)$$

where $$EU(\square \mid K, E_N, Q_N(T,C)) = \max_A \sum_i P(O_i \mid K, E_N, Q_N(T,C), Do(A))\, U(O_i, T, C)$$

a) Explain what this formula means (**10**)

b) Given this formula and assuming you can gather one piece of information, what would be the formula that would specify which node to choose next to gather information and how much time and cost you should allocate to this process (**10**).

c) A similar but obviously easier problem occurs in belief networks (i.e., no time or cost considerations) where you need to decide which node to gather information from next. Suppose you had a standard package to evaluate belief networks, how could use the idea of "conditioning," to determine what information to gather next so as to minimize the degree of uncertainty in the network (**7**)?

Iterative Repair (20)

For many of you, doing a straightforward translation of the word problem into a 3-SAT problem led to a problem representation that was very hard to solve computationally.

a) Explain in terms of hill-climbing terminology why this search space led to difficulties (**8**)

b) Two possible approaches that people tried for making the problem easier to solve were

1) representing the problem as an N-SAT problem rather than a 3-SAT problem

2) adding domain dependent heuristics to reduce the number of literals and clauses by, for instance, specializing the algorithm that minimizes conflicts to know that two variables cannot have the same value

Explain why these approaches could potentially solve the problems. What are the potential drawbacks to these approaches? (Hint some of these drawbacks can be explained in terms of the balance between meta-level processing and base-level processing) (**12**)

Representation of Uncertainty (18)

Certainty Factors, Dempster-Shafer and Belief Networks each make different assumptions about the availability of information, the independence of evidence and the type of reasoning that is important in problem solving. Explain these differences.