AGENT-BASED SYSTEMS SEMINAR #2

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Knowledge Representation and Reasoning

1) Minesweeper is a $r \times c$ rectangular grid, with M mines scattered around.

The agent can probe any square. If the agent probes a square containing a mine, she dies immediately. If not, then she receives a number, which reveals the amount of mines surrounding the probed square. The game ends if the agent dies or has managed to probe all unmined squares.

1.1) Let $X_{i,j}$ be the proposition stating that square $[i, j]$ contains a mine. Let $[0, 0]$ be the starting square. Write down the assertion that exactly two mines are adjacent to [1,1] only using logical combinations of such propositions.

1.2) Generalise your assertion from (a) by explaining how to construct a sentence in conjunctive normal form asserting that k of n neighbours contain mines.

1.3) Construct instances of probe values that induce long-range dependencies, i.e., the content of a given unprobed square would give information about the contents of a far-distant square.

2) Explain what is wrong with the following proposed definition of adjacent squares in the Wumpus World:

$$\forall x, y[A([x, y], [x + 1, y]) \wedge A([x, y], [x, y + 1])]$$

3) Suppose you are given the following axioms

(1) $0 \leq 4$
(2) $5 \leq 9$
(3) $\forall x[x \leq x]$
(4) $\forall x[x \leq x + 0]$
(5) $\forall x[x + 0 \leq x]$
(6) $\forall x, y[x + y \leq y + x]$
(7) $\forall w, x, y, z[w \leq y \wedge x \leq z \Rightarrow w + x \leq y + z]$
(8) $\forall x, y, z[x \leq y \wedge y \leq z \Rightarrow x \leq z]$

a) Give a backward-chaining proof of the sentence $5 \leq 4 + 9$.

b) Give a forward-chaining proof of the same sentence.

Only use the axioms given, modus ponens and the *follows from* relation $\Rightarrow$.

Decision Theory

1) A used-car buyer can decide to carry out various tests with various costs (e.g., kick the tires, take the car to a qualified mechanic) and then, depending on the outcome of the tests, decide which car to buy. We will assume that the buyer is deciding whether to buy car c_1, that there is time to carry out at most one test, and that t_1 is the test of c_1 and costs £50.

A car can be in good shape (quality q^+) or bad shape (quality q^-), and the tests might help indicate what shape the car is in. Car c_1 costs £1.500 and its marked value is £2.000 if it is in good shape. If not £700 repairs are needed.

The buyer thinks that c_1 has a 70% chance of being in good shape.

Tests can be described by the probability that the car will pass or fail the test given that the car is good or in bad shape. We have the following info. If the car is good it passes with probability 0.8, if bad with probability 0.35.

(1) Calculate the expected net gain from the car, given no test
(2) Use Bayes rule to determine the probability that the car will pass the test and hence the probability that is good (or bad) given each possible test outcome.
(3) Calculate the opimal decisions given either pass or fail, and their expected utilities.