Doctoral Exam in Artificial Intelligence
August 1993

Part I. (6 points each)

For each of the following terms, give either a brief definition or a brief example. (2 or 3 sentences each should suffice.)

1. Back propagation (in a neural net).
2. Forward chaining.
3. Iterative deepening.
4. Selectional restrictions.
5. Non-monotonic inference.

Part II. (15 points each)

6. Let $\mathcal{L}$ be a first-order language with the following primitives:

   p(X, Y) — Predicate. X is a parent of Y.
   g(X, Y) — Predicate. X is a grandparent of Y.

   A. Express the following facts in $\mathcal{L}$:
      i. Everyone has a parent.
      ii. X is a grandparent of Y if X is a parent of a parent of Y.
      iii. Everyone has a grandparent.

   B. Show how (iii) can be proven from (i) and (ii) using resolution. You must show all the clauses and resolutions used. You need not show the intermediate steps of Skolemization.

7. Consider a modification of the blocks world in which no tower is allowed to be more than 3 blocks high. To represent such a world using STRIPS actions, it will be necessary to divide the category of "moving block X" into 9 separate cases, depending on the number of blocks below X in its initial position (0, 1, or 2), and the number of blocks below X in its final position (0, 1, or 2).

   A. Assume that the only fluents used are "on(Z, Y)" and "clear(Y)". Show the STRIPS representation of the action of moving X from a position where it is on top of one other block to a position where it is on top of two blocks. You need not distiguish between filter preconditions and other preconditions.

   B. The "Sussman anomaly", shown below, is not solvable by STRIPS in the usual blocks world. Show that STRIPS can find the solution in this modified world. (You need not give a full trace, just a brief explanation.)

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Starting state                Goal:
     B                         on(C,B) and on(A,C).
     A    C
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8. The process of finding a syntactic parse of a natural language sentence can be viewed as a state-space search, where a goal state is a syntax tree for the sentence. Other aspects of the state space depend on the nature of the parse being done. Describe what kind of state space is being searched — what is the initial state? what are the intermediate states? what are the operators? — by

   A. A top-down parser, such as an ATN.

   B. A bottom-up parser, such as a chart parser.

Part III (25 points)

Answer ONE of the following essay questions:

- It has recently been claimed that AI researchers should not try to emulate human intelligence. Do you agree?
- What is a heuristic, and why are heuristics important to AI?
- Describe the use of frame-based reasoning in AI.
- Describe how automated learning can be used in the construction of a lexicon for a natural-language processor.