Artificial Intelligence
CIS Ph.D. Comprehensive Exam., Spring 1997, Closed-Book
Answer all questions in four hours

1. How may machine learning be viewed as a task involving heuristic search? Identify the states, operators/moves, heuristics, and goal states, preferably in the context of a specific machine learning algorithm.

2. Consider the sentences

   The apprentice painted the hull of the ship with a toothbrush.
   The apprentice painted the ship with green paint after dinner.
   The apprentice painted the ship with the toothbrush with soft bristles.

   Describe a simple context-free grammar which will yield a correct parse of these sentences. What are all the parses obtained for these sentences? From among these, how can a language recognition system find the semantically meaningful correct parses?

3. (a) Precisely what is meant when it is claimed that resolution provides a proof procedure that is complete?
   (b) Why is resolution theorem-proving harder (or easier) when the equality predicate is included?
   (c) What is the "factor" of a clause in first order logic?

4. Speakers of one language often import grammatical features from the language they first learnt (mother tongue) into a language they learn later. For instance, a speaker of Spanish may speak English words arranged in a manner that would be more reasonable in Spanish than in English. Suggest the design of a language understanding system tailor-made to understand such sequences of English words, e.g., if the system is informed that the speaker's original language is Spanish.

5. Discuss the main problems to be addressed in three-dimensional object recognition, assuming that algorithms are available to perform two-dimensional exact shape matching invariant to rotation, translation and scaling. Structure your answer, separating issues related to representation, matching, inference, etc.

6. Answer one of the following:
   (a) Suggest an adaptive algorithm that adds hidden nodes to a feedforward network as needed for a specific problem.
   (b) Suggest an adaptive algorithm that constructs and modifies a probabilistic inference system as new example data become available for a problem.