Grad. Comp. Exam: Artificial Intelligence (Fall 2014)   Student ID: ⎯⎯⎯⎯⎯⎯⎯⎯⎯

Answer all questions on the exam. You may use the back for additional space. Total: 100 points. Good Luck.

1. (25 pts) Constraint Satisfaction Problems

    (a) What are the components of a constraint satisfaction problem?

    (b) Model as a CSP the problem of finding a one week (5 days) schedule for 8 employees (5 programmers and 3 testers) where each has to work at least 3 days a week and has preferences as to which day they want to work. Each day there should be at least 4 people working (at least 2 programmers and at least 1 tester).

2. (25 pts) Logic

    (a) Discuss soundness and completeness of an inference procedure.

    (b) Explain why Modus Ponens is not complete.

    (c) Given the following sentences in the knowledge base:

- $(P \wedge Q) \Rightarrow R$
- $Q \Leftrightarrow (S \vee W)$
- P
- W

      i. convert the sentences into clauses (CNF)

     ii. show your steps in using Resolution to prove (or disprove) R

3. (25 pts) Search

   (a) What are the elements of formulating a problem as a search problem?

   (b) What are the space and time complexities of (i) breadth first, (ii) depth first, and (iii) iterative deepening search algorithms?

   (c) What is an admissible heuristic?

   (d) Give the proof of optimality of A*

   (e) Propose an admissible heuristic for the problem of proving theorems based on a set of known Horn rules/clauses.

4. (25 pts) Uncertain Reasoning: Let $\mathcal{P}(A, B, C, D)$ be the joint probability distribution of four boolean variables A, B, C, and D.

(a) Derive the number of probabilities in the distribution $\mathcal{P}(A, B, C, D)$.

(b) Knowing D is independent from A, B, and C, how can we reduce the number of probabilities need to be stored to obtain the distribution $\mathcal{P}(A, B, C, D)$? How many probabilities do we need?

(c) Given the distribution $\mathcal{P}(A, B, C, D)$, how can we calculate the distribution $\mathcal{P}(A, B|C)$?

(d) Given the distribution $\mathcal{P}(A, B, C, D)$, how can we calculate the distribution $\mathcal{P}(A|B)$?