**COMPREHENSIVE EXAM Artificial Intelligence Spring 2018**

[5 questions, 20 pts each, Total 100 points]

*Students may ignore the following (three evaluation criteria for accreditation purposes only):*

*Knowledge: Problem Solving: Communication Skill:*

**Q1.** a) Proof by resolution needs conjunctive normal form of the knowledge base.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

b) Conjunctive normal form is disjunction of conjunctions.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

b) Modus ponens is at the heart of model checking algorithms.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

c) A Horn clause has one or more positive literals in the clause.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

d) A Definite clause has exactly zero positive literals in the clause.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

e) Forward chaining or goal directed reasoning is complete.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

f) How many quantifiers are there in the standard First order logic.

|  |  |
| --- | --- |
|  | 1 |
|  | 2 |

|  |  |
| --- | --- |
|  | 3 |

g) ∀x (￢ P) is equivalent to:

|  |  |
| --- | --- |
|  | ∃ x (P) |
|  | ￢∃ x (P) |

|  |  |
| --- | --- |
|  | ￢∃ x (￢P) |

h) ∃ x (P)  is equivalent to:

|  |  |
| --- | --- |
|  | ￢∀x (˥ P) |
|  | ∀x (˥ P) |

|  |  |
| --- | --- |
|  | ￢ ∀x (P) |

i) A Horn clause has one or more positive literals in the clause.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

j) A Definite clause has exactly zero positive literals in the clause.

|  |  |  |
| --- | --- | --- |
|  | | True |
|  | False | |

**Q2.** Suppose someone is planning to visit from New York to come to San Diego. Here is a price list for one-way tickets for direct flights:

*From To*

New York MIami is $300; PHoenix is $700; CHIcago is $200

MIami CHIcago is $500; PHoenix is $700.

PHoenix San Diego is $200; San Francisco is $600

CHIcago San Francisco is $400; PHoenix is $500

San Francisco San Diego is $200.

The following is a Depth First Search tree to find a flight path from New York to San Diego, with cumulative costs:

NY, 0

MI,300 PH,700 CHI,200

CHI,800 PH,1000

SF,1200 PH,1300

SD,1400

This plan includes *five* airports and costs $1400!

**a.** Use a Breadth first search algorithm to minimize the number of airports to go through. Draw a tree like the one above.

**b.** What is the minimum number of airports in the path from New York to come to San Diego, including both? How much is the total ticket price?

**c.** Discuss briefly what should be an algorithm to find a minimum cost path.

**Q3.** Consider the problem of *k* queens on an *n x n* chessboard (queens attack any visible piece horizontally, vertically and diagonally) to be placed in such a way that they are not attacking each other, where ***k ≤n2***. Consider each rook coordinate (*xp,yp*) as a state variable, where *x* is horizontal axis and *y* is vertical axis of the board (1*≤* *p ≤* *n*).

**a.** What is the domain size of each variable? [4]

**b.** What are the constraints in the above problem between a pair of variables expressed *mathematically*? [6]

**c.** Design another state space that will have lower domain size for each variable. Mention the size of your state space and domain of state variables. [6]

**d.** Draw a constraint graph for the state spaces as in the question description. [4]

**Q4.** Given the following conditional probabilities over propositional variables Test={test,￢test} and Disease={disease,￢disease}. [20]

P(test|disease) = 0.99

P(￢test|￢disease) = 0.99

P(disease) = 0.0001

Find P(disease|test), P(￢disease|test), P(disease|￢test), P(￢disease| ￢test).

The formulation showing how to compute is required. You need not actually compute final numerical values (no calculator may be needed, but is allowed). Normalization of your values are not necessary.

**Q5.**

Consider a vocabulary with the following symbols and express the English statements in Q5a and Q5b in *First Order logic*: *Occ(p, c):* Predicate for “person *p* has occupation *c”; Cust(p1, p2)*: Predicate for “person *p1* is a customer of person *p2”*; *Emp(p, q)*: Predicate for “person *p* employs *q”*. Constants denoting occupations are: *Doctor (D), Surgeon (S), Lawyer (L)*.

**a.** There exists a lawyer all of whose customers are doctors. [5]

**b.** Every surgeon employs a lawyer. [5]

**c.** When should you use classification over regression? (Within 50 words) [5]

**d.** How is the k-nearest neighbor algorithm different from k-means clustering? (Within 50 words)

[5]