Ref. No. : Ex/PG/CSE/T/114A/2018

MASTER OF COMPUTER SCIENCE AND ENGINEERING 1st Year 1st Semester EXAMINATION 2018

Advances in Artificial Intelligence

Time: Three hours

Full Marks: 100

Answer any ***five***

1(a) How would you define comparative 'informedness' of two admissible heuristic functions $h_1(n)$ and $h_2(n)$ for some node n ? Answer why a more informed heuristic function cannot always ensure more efficiency.

(b) Assume A_1 and A_2 are two versions of A^* algorithm using heuristic functions $h_1(n)$ and $h_2(n)$ respectively. $h_1(n)$ is less informed than $h_2(n)$. Now prove that A_1 always expands at least as many nodes as does A_2 at the termination of their searches on any graph having a path from start node to a goal node.

(2+4)+14

2(a) Give an algorithm for learning a heuristic function with the assumptions that the state space graph can be stored explicitly and the model of the effects of the agent's actions is known.

What modifications the algorithm needs in case no model of the effects of the agent's actions is available. Can this technique result in learning optimal paths ? If not, why is it so ?

(b) How would you define an optimal action policy for an agent performing a task of ongoing nature, e.g., a boundary following robot ? Describe the algorithm for Value iteration and explain how this can be of help in employing an optimal action policy.

10+10

3 (a) What are the major problems that one has to face in employing State Space Search for generating Plans for a mobile robot ? How can Sense/Plan/Act architecture developed by Nilsson be of help in such situations ? What is the time constraint for the search algorithm running under this architecture ?

(b) Why Approximate Search is required ? Describe an algorithm suitable for performing approximate search. Which feature of Sense/Plan/Act architecture makes it suitable for approximate search ?

12+8

4. An expert system is used to estimate whether or not students are fit for admission to a PhD program on the basis of a number of factors that combine to produce a *numeric score*. To be fit for admission to the PhD program, the score must be higher than some number, N. The designers of the expert system won't say what the value of N is, but we have learned that Pat is judged as fit for admission to the PhD program and that John's score is higher than Pat's. We can prove that John

would also be judged as fit for admission to the PhD program by using the following domain rules

$\forall(x,y,z)$ [Greater(x,y)∧ Greater(y,z)⇒ Greater(x,z)]

∀(x)[Admit(x)⇒ Greater(score(x),N)]

∀(x)[Greater(score(x),N)⇒Admit(x)]

and the following data:

$Admit(Pat)$
$Greater(score(John), score(Pat))$

First, use these axioms and data to prove that John is fit for admission to the PhD program, and then use explanation-based generalization techniques on your proof to establish the rule

$\forall(x,y)\{[Greater(score(x), score(y)) \wedge Admit(y)] \Rightarrow Admit(x)\}$ 20

5 (a) Explain why a PROLOG interpreter running a PROLOG program cannot be used to prove the negation of an atom.

(b) The PROLOG interpreter, as you have studied, performs a prescribed resolution at each step. If all of the statements in a PROLOG program were converted to disjunctions of literals, describe a control strategy for a resolution refutation system that performs the same resolutions as does the PROLOG interpreter.

(c) An inductive learning system observes that every time Q is true , one of the following formulas is also true:
P(A,B)
P(C,B)
P(D,B)
This learning system decides to create the rule
(∀x)(P(x,B)⇒Q)

What is the rationale for this inductive generalization? Why did not the system create the rule
$(\forall x, y)\left(P(x,y) \Rightarrow Q\right)$?

(d) Convert the following well formed formula to clausal form:

$(\forall x)\left[P(x) \Rightarrow \left\{(\forall y)\left(P(y) \Rightarrow P(f(x,y))\right) \wedge \sim(\forall y)\left(Q(x,y) \Rightarrow P(y)\right)\right\}\right]$ 3+3+4+10

6(a) Sam, Clyde, and Oscar are elephants. We know the following facts about them :

Sam is pink. Clyde is gray and likes Oscar. Oscar is either pink or gray (but not both) and likes Sam.

Use resolution refutation to prove that a gray elephant likes a pink elephant, that is, prove
$\exists(x,y)[Gray(x) \wedge Pink(y) \wedge Likes(x,y)]$

(b) Find the mgu of $E = \{P(x,z,y), P(w,u,w), P(A,u,u)\}$ 14+6

7(a) Represent the following sentences with predicate calculus well formed formulas (Wffs):

Apples and Bananas are nourishing.

You can fool some of the people all of the time.

Everything made of Iron is attracted by all magnets.

Not every integer is positive.

(b) Justify the statement "Resolution based systems are designed to produce proofs by contradiction."

(c) Discuss about practical limitations of a Resolution Refutation System. What are the compromises made for efficient reasoning through PROLOG.

2x4+6+6