*Total number of printed pages–9*

**53 (CS 711) ARIN**

**2018**

# ARTIFICIAL INTELLIGENCE

Paper : CS 711

*Full Marks : 100*

Time : Three hours

***The figures in the margin indicate full marks for the questions.***

*Answer **any five** questions.*

1. *(a)* What is PEAS description and explain the taxi's task environment and medical diagnosis agent's system with the basic PEAS elements ? 6

   *(b)* Distinguish the supervised, unsupervised, and reinforcement learning. 9

*Contd.*

(c) Consider the problem faced in learning to play badminton. Explain how this process fits into the general learning model, identifying each of the components of the model as appropriate. Is this supervised learning or reinforcement learning ? 5

2. (a) Describe the wumpus world according to the properties of task environments. 5

(b) Suppose the agent has progressed and perceived nothing in [1,1], a breeze in [2,1], and a stench in [1, 2] and is now concerned with the contents of [1, 3], [2, 2], and [3, 1]. Each of these can contain a pit and at most one can contain a wumpus. Construct the set of possible worlds. Mark the worlds in



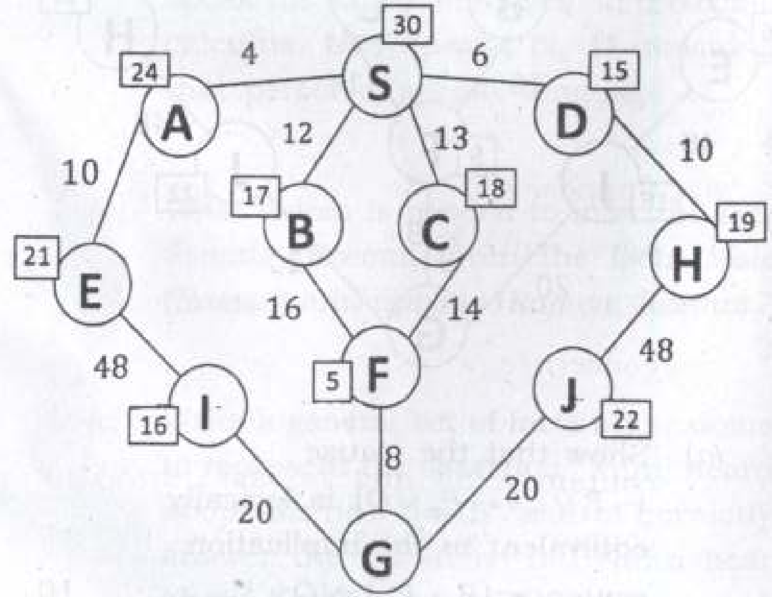
which the KB is true and those in which each of the following sentences is true :

$s_1$ = "There is no pit in [2, 2]"

$s_2$ = "There is a wumpus in [1, 3]"

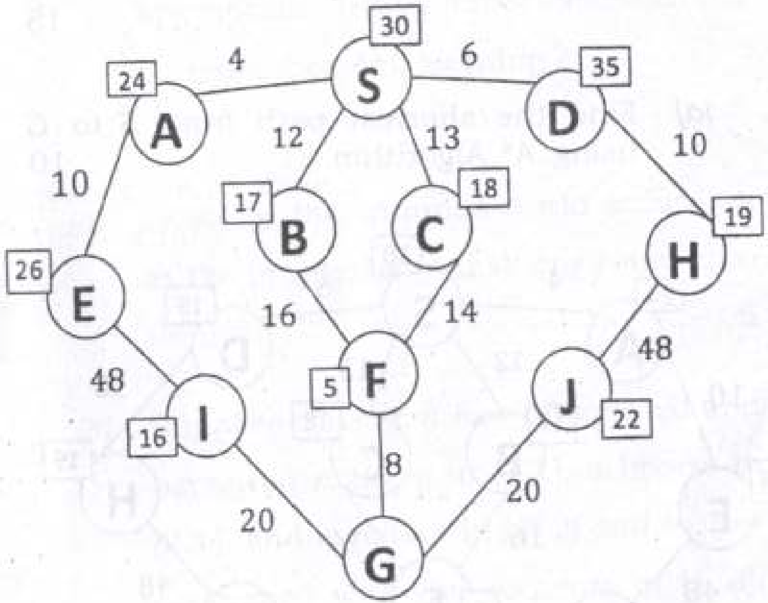
Hence show that KB $\models s_1$ and KB $\models s_2$ 15

3. (a) Find the shortest path from *S* to *G* using *A** Algorithm. 10



(b) Write down the Algorithm of uninformed search algorithm. 10

4. Find the short path from $S$ to $G$ using $A^*$ algorithm. Check the admissible condition also. 20




5. (a) Show that the clause $(\neg P_1 \vee ... \vee \neg P_m \vee Q)$ is logically equivalent to the implication sentence $(P_1 \wedge P_m) \Rightarrow Q$. 10

(b) Show that every clause (regardless of the number of positive literals) can be written in the form $(P_1 \wedge .... \wedge P_m) \Rightarrow (Q_1 \vee .... \vee Q_m)$ where the $Ps$ and $Qs$ are proposition symbols. A knowledge base consisting of such sentences is in implicative normal IMPLICATIVE NORMAL FORM form or Kowalski form. 10

6. (a) Represent the sentence "All Indian speak the same languages" in predicate calculus. Use Speaks (x, 1), meaning that person x speaks language 1. 2

(b) What axiom is needed to infer the fact *Female* (*Reema*) given the facts *Male* (*Raman*) and *Spouse* (*Raman*, *Reema*) ? 2

(c) Write a general set of facts and axioms to represent the assertion "Kunti heard about Karna's death" and to correctly answer the question "Did Kunti hear about Karna's death ?" 1

*(d)* Takes (s,c,o) / Takes (s,c,e) : student s takes course c in semester o/e ;

Passes (s,c,o) / Passes (s,c,e) : student s passes course c in semester o/e ;

Grade (s,c,o) / Grade(s,c,e) : the grade obtained by student s in course c in semester o/e ;

DM and AI : specific DM and AI courses

x>y : x is greater than y ;

Student (s) : Predicates satisfies by members of the corresponding categories.

Student (s), course (c), & semester (o/e)

*(i)* Every student took AI in odd semester 2017.

*(ii)* All students who take AI pass it.

*(iii)* Only one student fails AI in odd semester 2017.

*(iv)* The best grade in AI is always higher than the best grade in DM.



*(v)* Students can pass some of the courses all the semesters, and they can pass all of the courses some of the semester, but they can't pass all of the courses in all the semesters. 3×5=15

Standard logical equivalences :

| | | | |
|---|---|---|---|
| $(\alpha \wedge \beta)$ | $\equiv$ | $(\beta \wedge \alpha)$ | (commutativity of $\wedge$) |
| $(\alpha \vee \beta)$ | $\equiv$ | $(\beta \vee \alpha)$ | (commutativity of $\vee$) |
| $((\alpha \wedge \beta) \wedge \gamma)$ | $\equiv$ | $(\alpha \wedge (\beta \wedge \gamma))$ | (associativity of $\wedge$) |
| $((\alpha \vee \beta) \vee \gamma)$ | $\equiv$ | $(\alpha \vee (\beta \vee \gamma))$ | (associativity of $\vee$) |
| $\neg(\neg \alpha)$ | $\equiv$ | $\alpha$ | (double negation elimination) |
| $(\alpha \Rightarrow \beta)$ | $\equiv$ | $(\neg \beta \Rightarrow \neg \alpha)$ | (contraposition) |
| $(\alpha \Rightarrow \beta)$ | $\equiv$ | $(\neg \alpha \vee \beta)$ | (implication elimination) |
| $(\alpha \Leftrightarrow \beta)$ | $\equiv$ | $((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha))$ | (biconditional elimination) |
| $\neg(\alpha \wedge \beta)$ | $\equiv$ | $(\neg \alpha \vee \neg \beta)$ | (De Morgan's Law) |
| $\neg(\alpha \vee \beta)$ | $\equiv$ | $(\neg \alpha \wedge \neg \beta)$ | (De Morgan's Law) |
| $(\alpha \wedge (\beta \vee \gamma))$ | $\equiv$ | $((\alpha \wedge \beta) \vee (\alpha \wedge \gamma))$ | (distributivity of $\wedge$ over $\vee$) |
| $(\alpha \vee (\beta \wedge \gamma))$ | $\equiv$ | $((\alpha \vee \beta) \wedge (\alpha \vee \gamma))$ | (distributivity of $\vee$ over $\wedge$) |

7. *(a)* The given knowledge base (KB) = September month falls with good intensity earthquake, August to September months also fall with heavy rain, and August and September are months.

In First order Logic (FOL), KB =

$\exists x$ Month ($x$) $\Rightarrow$ Falls ($x$, *Heavy rain*)

$\exists x \exists y$ (Month ($x$) $\wedge$ Falls ($x$, $y$)) $\Rightarrow$ Falls ($x$, $y$)

Month (August)

$\exists x$ Month($x$) $\Rightarrow$ sudden occurred (*Earthquake*, $x$)

$\exists x \exists y$ (Month($x$) $\wedge$ sudden occurred (*Earthquake*, $x$)) $\Rightarrow$ sudden occurred (*Earthquake*, $x$)

Month (September)

**Query** : Does August month fall with heavy rain ?

**Query** : Does Earthquake occurred in September month ?

*(Hint : Use Generalized Modus Ponens (GMP))* 10



*(b)* Maximize the function $f(x, y) = x^2 + y^2$ over the range of integers from 0...15 and 0...7 respectively. Apply a genetic algorithm to solve this problem. Show at least the possible solution (*i.e.* near to termination criteria).

(Note : $x$ and $y$ represent four and three digit unsigned binary integers, $f(x, y)$ value itself a fitness solution, Coding in binary form having 4 and 3 bits string length (represent 16 numbers, Four chromosomes (0110, 1110, 1001, 1001) and represent 8 numbers, three chromosomes (010, 110, 100, 001) as initial populations, Decode individual for further evaluation (like fitness *i.e.* $x^2 + y^2$ (1000 = 8 and 010 = 2 ; $8^2 + 2^2 = 64 + 4 = 68$), probability, random number, crossover and mutation). 10