IITJ, B.Tech 3rd year(CSE), II Semester
First Mid-Sem. Examination-2015
CS324: Artificial Intelligence

Duration: 1 Hour Max. Marks 17

Instructions:

- Attempt all questions.
- All questions are written in detail and complete in every respect.
- Avoid seeking clarifications from the invigilators.

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1. Represent the following sentences in first-order predicate logic (FOPL). [3]

   (a) A person born in India, each of whose parents is an Indian citizen or an Indian resident, is an Indian citizen.

   Ans. $\forall x \forall y(bornin(x, India) \wedge parentof(y, x) \wedge citigenof(y, Inda) \Rightarrow citigenof(x, Inda))$

   (b) You can fool some of the people all of the time, or can fool all of the people some of the time, but cannot fool all the people all the time.

   Ans. $[\exists x((fool(you, x) \ \wedge \ geater(time, 0)) \ \vee \forall y((you(fool, y) \ \wedge \ time \equiv k))] \wedge (\forall x \neg fool(you, x) \ \wedge greater(time, 0)]$

2. Convert the following FOPL formula into clauses form. [3]

   $\forall x \forall y((P(x) \wedge Q(y)) \Rightarrow \exists z R(x, y, z))$

Ans. The clauses can be deduced as follows:

$$
\begin{aligned}
&\forall x \forall y((P(x) \wedge Q(y)) \Rightarrow \exists z R(x, y, z)) \\
&\Rightarrow \forall x \forall y(\neg(P(x) \wedge Q(y)) \vee \exists z R(x, y, z)) \\
&\Rightarrow \forall x \forall y(\neg(P(x) \wedge Q(y)) \vee R(x, y, f(x, y))) \\
&\Rightarrow \forall x \forall y((\neg P(x) \vee \neg Q(y)) \vee R(x, y, f(x, y))) \\
&\Rightarrow \forall x \forall y(\neg P(x) \vee \neg Q(y) \vee R(x, y, f(x, y))) \\
&\Rightarrow \neg P(x) \vee \neg Q(y) \vee R(x, y, f(x, y))
\end{aligned}
$$

3. Given the premises: [3]

   "All dogs bark",

   "Snoopy is a Dog",

   making use of resolution based theorem proving, prove that "Something barks", i.e., $(\exists x \ barks(x))$.

Ans. We can represent these in predicate as:

1. $\forall x(dog(x) \Rightarrow bark(x))$
2. $dog(snoopy)$

3. The first statement in clause form: $\neg dog(x) \vee bark(x)$

   Unify 2, 3 with $\sigma = \{snoopy/x\}$, and on resolving after, we get:

   $bark(snoopy)$, from this we derive $\exists x\ bark(x)$

4. Consider the following possibilities, suggest the solution strategy to be adopted if the system is implemented as a rule based system: [3]

   (a) A subgoal literal is generated such that the higher goal is a subset of the subgoal.

   Ans. We start data driven, i.e. forward chaining or bottom-up approach. This is because if input are satisfied, and all the inputs are available, the goal shall be definitely proved.

   (b) A subgoal literal is generated whose negation unifies with the higher-goal.

   Ans. Start with the goal for backward chaining, and try to find out which variable is not satisfied (negation).

   (c) A subgoal S literal is generated that is equal to another goal G, and G is neither higher nor lower to S.

   ans. If any one of the predicate is true, it will serve the purpose.

5. The doctors usually diagnose a patient's disease based on symptoms, for example, on the evidence of fever, shivering, and data of blood-test, a patient is diagnosed having malaria. Though, the evidences are symptoms, the cause of these symptoms has been malaria. Which of the forward or backward rule chaining is efficient for reasoning for patients diagnosis? Justify. Also, demonstrate the reasoning process that uses this approach, considering any suitable set of rules having premises and consequences. [5]

Ans. backward-chaining. (however one can justify forward also.) We need to reach from goal to assertions. Efficient, because only required assertions needs to be proved, and not all. One can suggest algorithm for reasoning to carry out. { Note: A lot part depends on the creativity, hence there is no fixed answer.}