Knowledge Representation and Reasoning: Questions

Multiple Choice Questions

Question - 1: What is the primary aim of Knowledge Representation and Reasoning?

- a. To enable computers to process vast amounts of data efficiently.

- b. To develop advanced machine learning algorithms.

- c. To understand the nature of intelligence and cognition to simulate human-like abilities in computers.

- d. To create complex robotic systems for automation.

Question - 2: Which type of reasoning is described as "jumping to conclusions based on some default assumptions" when information is insufficient, potentially leading to unsound conclusions that may need to be withdrawn?

- a. Deductive reasoning

- b. Abductive reasoning

- c. Epistemic reasoning

- d. Default reasoning

Question - 3: In propositional logic, what is an "atom"?

- a. A logical connective like 'and' or 'or'.

- b. A formula composed of multiple propositions.

- c. The smallest unit to which a truth value (true/false) can be assigned.

- d. A symbol representing a numerical value.

Question - 4: Which of the following connectives is considered a unary propositional connective?

- a. Conjunction ($\wedge$)

- b. Implication ($\rightarrow$)

- c. Disjunction ($\bigvee$)

- d. Negation ($\neg$)

Question - 5: A propositional formula F is a tautology if:

- a. At least one interpretation satisfies F.

- b. F can be reduced to a Conjunctive Normal Form (CNF).

- c. Every interpretation satisfies F.

- d. Its negation ($\neg F$) is satisfiable.

Question - 6: What does it mean for a propositional formula F to be satisfiable?

- a. F is true for all possible interpretations.

- b. There exists at least one interpretation that satisfies F.

- c. F contains no logical connectives.

- d. F can be reduced to an empty clause.

Question - 7: Which of the following is equivalent to saying that F entails G ($\mathbf{F \vDash G}$)?

- a. $F \wedge G$ is a tautology.

- b. $F \leftrightarrow G$ is satisfiable.

- c. $(F \wedge \neg G)$ is unsatisfiable.

- d. $\neg F \vee G$ is a contradiction.

Question - 8: What is the total number of subformulas that can be formed for the propositional formula

$$\neg(\mathbf{p} \wedge \mathbf{q}) \vee (\mathbf{r} \rightarrow \neg \mathbf{p})$$

- a. 8

- b. 10

- c. 7

- d. 9

Question - 9: What is a key characteristic of a Herbrand interpretation for a given signature σ (containing at least one object constant)?

- a. Its universe is any non-empty set of individuals.

- b. Its universe is the set of all ground (variable-free) terms of σ, and every ground term is interpreted as itself.

- c. It always makes all quantified formulas true.

- d. It must contain at least one function constant of arity greater than 0.

Question - 10: Which of the following statements about SAT solvers is correct?

- a. SAT solvers only accept formulas in Disjunctive Normal Form (DNF).

- b. SAT solvers decide satisfiability of propositional formulas, often using DPLL.

- c. SAT solvers can only handle problems with at most 100 variables.

- d. SAT solvers are inefficient and rarely used in practice.

Question - 11: Every atom, $\top, \bot$, and any recursive combination of formulas with connectives are considered valid formulas in propositional logic.

- a. True

- b. False

Question - 12: Which of the following statements is a tautology?

- a. $(p \rightarrow q) \wedge (p \wedge \neg q)$

- b. $(p \rightarrow q) \rightarrow (\neg p \vee q)$

- c. $(p \rightarrow (q \rightarrow p))$

- d. $\neg p \vee p$

Question - 13: Which of the following is a key limitation of propositional logic that First-Order Logic overcomes?

- a. Inability to represent negation

- b. Inability to express relations between individuals and relations

- c. Inability to use logical connectives such as $\wedge$ and $\checkmark$

- d. Inability to reason with truth values

Question - 14: Which of the following is a valid term in FOL?

- a. $\forall x \, P(x)$

- b. $P(x) \wedge Q(y)$

- c. father(john)

Question - 15: What is the Herbrand Universe of a signature σ?

- a. The set of all formulas in σ.

- b. The set of all predicates in σ.

- c. The set of all ground terms of σ.

- d. The set of all interpretations over σ.

Question - 16: Which of the following is an example of a terminological axiom in FOL?

- a. $\forall x\,(\text{Teenager}(x) \to \neg\text{Adult}(x))$

- b. $\text{Child}(\text{John})$

- c. $\text{Affects}(\text{JRA}, \text{Mary})$

- d. $\neg\text{Affects}(\text{JRA}, \text{Mary})$

Question - 17: What are some of the free occurrences of a variable in the formula below?

$$\forall x\,(P(x) \to Q(x, y)) \wedge \exists y\,R(y, z)$$
$$1234567$$

- a. 4, 7

- b. 2, 3

- c. $1, 6, 7$

- d. None of the above

Long Answer Questions

1. Construct the parse tree for the following propositional logic formula:

$$(((\neg p \vee q) \wedge (r \to s)) \to ((t \wedge \neg u) \vee v))$$

2. Draw a parse tree of the following formula and specify bound and free variables.

$$(\forall x\,(P(x) \vee Q(x))) \to (\exists y\,R(x, y))$$

3. Starting with an empty set U of literals, apply unit propagation to the formula below. Show how F and U (the set of unit clauses) change in each iteration and say what is the interpretation of p, q and r.

$$r \wedge (\neg q \vee \neg r) \wedge (p \vee q \vee \neg r) \wedge (\neg p \vee r)$$