ste ss Re ognition and Reasoning: Questions

Multiple Choice Questions

Question - 1: What is the primary aim of Systemss Recognition 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default assumptions" when information is insufficient, potentially leading to unsound conclusions that may need to be withdrawn?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 ($\surd$)
- 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 (¬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 ($\mathbf{F} \models \mathbf{G}$)?

- a. F ∧ G is a tautology.
- b. F ↔ G is satisfiable.
- c. (F ∧ ¬G) is unsatisfiable.
- d. ¬F ∨ 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. $(p \to q) \land (p \land \neg q)$
- b. $(p \to q) \to (\neg p \lor q)$
- c. $(p \to (q \to p))$
- d. $\neg$p $\lor$ 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 $\land$ and ✓
- 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) $\land$ 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. $\forall x\,(\text{Teenager}(x) \rightarrow \neg\text{Adult}(x))$
- 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?

$$\forall \mathbf{x}\,(\mathbf{P}(\mathbf{x}) \rightarrow \mathbf{Q}(\mathbf{x}, \mathbf{y})) \wedge \exists \mathbf{y}\,\mathbf{R}(\mathbf{y}, \mathbf{z})$$
$$1234567$$

- 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:

$$(((\neg \mathbf{p} \vee \mathbf{q}) \wedge (\mathbf{r} \rightarrow \mathbf{s})) \rightarrow ((\mathbf{t} \wedge \neg \mathbf{u}) \vee \mathbf{v}))$$

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

$$(\forall \mathbf{x}\,(\mathbf{P}(\mathbf{x}) \vee \mathbf{Q}(\mathbf{x}))) \rightarrow (\exists \mathbf{y}\,\mathbf{R}(\mathbf{x}, \mathbf{y}))$$

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 $\mathbf{p}, \mathbf{q}$ and $\mathbf{r}$.

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