CSE140: Introduction to Intelligent Systems

Quiz - 1

Date of Examination: 23/01/2025

Duration: 45 mins Total Marks: 10 marks

Instructions –

- Attempt all questions.
- MCQs have a single correct option. 1 mark each
- State any assumptions you have made clearly.
- Standard institute plagiarism policy holds.
- No evaluations without suitable justifications for MCQs.

MCQ : (1 Mark each)

1. In a knowledge base, "All cats are mammals" is stored as a predicate: "For all x, if Cat(x), then Mammal(x)." If "Whiskers" is a cat, what can you infer?
   A. "Whiskers" is not a mammal.
   B. "Whiskers" is a mammal.
   C. The predicate does not apply to "Whiskers."
   D. The predicate is invalid.

   Answer:
   Correct Answer: B. "Whiskers" is a mammal.

   Explanation: Applying the predicate logic, "Whiskers" satisfies the condition and is inferred to be a mammal.

   The predicate logic states:
   "For all x, if Cat(x), then Mammal(x)."
   This means that for any entity x, if x is a cat, it must also be a mammal. Since "Whiskers" is given as a cat, it satisfies the condition Cat(Whiskers), and by the rule, it can be inferred that Mammal(Whiskers).

   A. Incorrect: The predicate explicitly states that all cats are mammals. Since "Whiskers" is a cat, it must also be a mammal.

   C. Incorrect: The predicate applies to all entities x. Since "Whiskers" is explicitly stated to be a cat, it is included in the scope of the predicate.

D. Incorrect: The predicate is logically valid and correctly represents the relationship between cats and mammals. There is no issue with its validity.

2. Which of the following is the negation of the statement "It is not true that I am tired"?
   A. I am tired.
   B. I am not tired.
   C. I am either tired or not tired.
   D. I am not not tired.
   Correct answer: A. I am tired.

   "It is not true that I am tired.”

   This can be rewritten in propositional logic as:

   ¬(I am tired)

   The negation of this statement removes the "not," which results in:

   I am tired

3. A semantic network contains nodes for "bird," "sparrow," and "penguin." If "sparrow" and "penguin" are linked to "bird," what can you infer?
   A. "Bird" is a type of "sparrow" and "penguin."
   B. "Sparrow" and "penguin" are types of "bird."
   C. "Bird" is unrelated to "sparrow" and "penguin."
   D. "Sparrow" and "penguin" are not linked to "bird."

   Answer:
   Correct Answer: B. "Sparrow" and "penguin" are types of "bird."
   Explanation: Semantic networks use hierarchical links to show relationships, indicating "sparrow" and "penguin" are subclasses of "bird."

   A. Incorrect: The relationship is hierarchical, with "bird" as the general category and "sparrow" and "penguin" as subtypes, not the other way around.

   C. Incorrect: The links in the semantic network show that "sparrow" and "penguin" are directly related to "bird."

   D. Incorrect: The problem explicitly states that "sparrow" and "penguin" are linked to "bird," showing a clear relationship.

4. Consider the following two statements.
   S1: If a candidate is known to be corrupt, then he will not be elected.
   S2: If a candidate is kind, he will be elected.

Which one of the following statements follows from S1 and S2 as per sound inference rules of logic? (1 Mark).

(A) If a person is known to be corrupt, he is kind
(B) If a person is not known to be corrupt, he is not kind
(C) If a person is kind, he is not known to be corrupt
(D) If a person is not kind, he is not known to be corrupt

Answer: (C)

5. The CORRECT formula for the sentence, "**not all Rainy days are Cold**" is:
   A. $\forall d(Rainy(d) \wedge \neg Cold(d))$
   B. $\forall d(\neg Rainy(d) \rightarrow Cold(d))$
   C. $\exists d(\neg Rainy(d) \rightarrow Cold(d))$
   D. $\exists d(Rainy(d) \wedge \neg Cold(d))$

   Answer: D. $\exists d(Rainy(d) \wedge \neg Cold(d))$

Short Answer Questions:

1. The elevator in the IIIT-Delhi R & D building operates with a series of well-defined rules that dictate its movement. Here's what we know:
   - At any given time, the elevator can be in one of three states: "Idle", "Moving Up", or "Moving Down". It is never in more than one state simultaneously.

   - The elevator moves between floors based on requests:
     - If the elevator is "Idle", it can be called to either move "Up" or "Down" depending on the direction requested by the user.
     - When it's "Moving Up", it will continue to move upward until it reaches the top floor or a stop is requested on a lower floor. Once it reaches the destination, it transitions to "Idle".
     - When it's "Moving Down", it will continue to move downward until it reaches the ground floor or a stop is requested on an upper floor. Once it reaches the destination, it transitions to "Idle".
   - Emergency Stop: If the elevator is in the "Moving Up" or "Moving Down" state, it can be stopped at any point by pressing an "Emergency Stop" button. Once the emergency stop is triggered, the elevator will immediately transition to the "Idle" state, regardless of its previous direction.

   Represent these rules using Propositional Logic (PL)**(2.5 marks).**

State Variables:
I **— The elevator is in the Idle state.**
U **— The elevator is Moving Up.**
D **— The elevator is Moving Down.**

Request Variables:
RU — A request to move Up.
RD — A request to move Down.

Stopping Conditions:
TS — The elevator reaches the Top Floor.
GF — The elevator reaches the Ground Floor.
SU— A stop request while moving up.
SD— A stop request while moving down.

Emergency Condition:
E — Emergency Stop button is pressed.

- $(I \lor U \lor D) \land \neg(I \land U) \land \neg(U \land D) \land \neg(I \land D)$
-
    - $I \land RU \rightarrow U$
      $I \land RD \rightarrow D$
    - $U \land \neg TS \land \neg S \rightarrow U$
      $(U \land (TS \lor S\ U)) \rightarrow I$
    - $D \land \neg GF \land \neg S \rightarrow D$
      $(D \land (GF \lor SD)) \rightarrow I$

- $(U \lor D) \land E \rightarrow I$

2. Our friends in the ocean are having an intellectual argument about reading, literacy, and intelligence. Here are the statements of interest:

• **Whoever can read is literate**

$\forall x\ (Read(x) \rightarrow Literate(x))$

• **Dolphins, unfortunately, are not literate**
$\forall x\ (Dolphin(x) \rightarrow \neg Literate(x))$
• **Some dolphins are intelligent.**
$\exists x\ (Dolphin(x) \land Intelligent(x))$
• **Some who are intelligent cannot read**
$\exists x\ (Intelligent(x) \land \neg Read(x))$

• **There exists a dolphin who is both intelligent and can read, but for every intelligent dolphin, if it can read, it must be that it is not literate.**
$\exists x\ (Dolphin(x) \land Intelligent(x) \land Read(x)) \land \forall x\ (Dolphin(x) \land Intelligent(x) \land Read(x) \rightarrow \neg Literate(x))$.
Represent these statements (highlighted in bold) using FOL. Define appropriate propositional variables and predicates to capture this dolphin debate. **(2.5 marks)**