

## Additional sample exam questions for first-order logic inference

### Question 1

Suppose our knowledge base consists only of the following two statements (copied from question 9.19 in the textbook):

$$\begin{aligned} & \text{Ancestor}(\text{Mother}(x), x) \\ & \text{Ancestor}(x, y) \wedge \text{Ancestor}(y, z) \Rightarrow \text{Ancestor}(x, z) \end{aligned}$$

Use propositionalization followed by resolution to prove that for a person named Ravi, we have

$$\text{Ancestor}(\text{Mother}(\text{Mother}(\text{Ravi})), \text{Ravi}).$$

Clearly label every use of Universal Instantiation and Existential Instantiation. Clearly explain every step in the proof by resolution.

### Question 2

Explain in your own words why the question of entailment for first-order logic is semidecidable.

### Question 3

Answer *true*, *false* or *unknown* to each of the following statements:

- Any valid statement in first-order logic can be proved via propositionalization and resolution
- Gödel's results show that first-order logic is semidecidable
- There exist statements about arithmetic which are true, but can't be proved using the standard inference rules of arithmetic
- Suppose we are given a statement  $S$  in first-order logic, and we are guaranteed that a proof of  $S$  exists. Then we can use an algorithm to find a proof of  $S$ .
- The satisfiability of a statement in propositional logic can be determined in polynomial time.
- The satisfiability of a statement in first-order logic can be determined in polynomial time.