**ME 620: Fundamentals of Artificial Intelligence**
**January - May 2024**

**Published: Mar 22, 2024**
**Assignment: 2** **Due: April 05, 2024**
**Max Marks: 35**

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## General Guidelines

1. **This assignment is of 35 Marks and carries weightage for FINAL evaluation of ME 620.**
2. Please **upload screenshots / PDF of handwritten pages as a single file to MS Teams under Assignment Tab.** Submission as posts on MS Teams or email submission would not be entertained.
3. You may discuss with other students about this assignment. Ask TAs for clarifications. Consult outside sources such as the Internet and take help to learn the material. Finally, **the solutions you submit should be your own work, not copied** from a peer or an abridged outline from any solution manual.
4. **Note that the assignment has two sections. You are required to do ONLY one section.**

## Section A: For People Interested in Pen-Paper Assignment

### A1. FOPC Axiomatization

Refer to Module III- Lecture 17 on *A Simple Genealogy KB*. The following predicates / similar predicates are already defined

ParentOf(x,y) : x is the parent of y
ChildOf(x,y) : x is the child of y
Male(x) : x is a Male
Female(x) : x is a Female
Married(x, y) : x is married to y

Write *axioms* describing the following predicates

GrandChild(x,y)
GreatGrandParent(x,y)
Sister-in-Law(x,y)
Aunt(x,y)

### A2. FOPC Resolution Proof

Fuzzy-Wuzzy was a bear,
Fuzzy-Wuzzy had no hair.
Was he fuzzy?

Consider the above nursery rhyme, and Fuzzy-Wuzzy's universe to be governed by the following axioms:

A1. Every bear owns a coat.
A2. No coat is both a raincoat and a furcoat.
A3. Every coat is either a raincoat or a furcoat, or both.
A4. Anything that owns a fur coat is fuzzy.
A5. Anything that has hair is fuzzy.
A6. Fuzzy Wuzzy doesn't own a raincoat.

Use the following predicates

| | |
|---|---|
| Bear(x) | : x is a bear |
| Coat(x) | : x is a coat |
| RainCoat(x) | : x is a rain-coat |
| FurCoat(x) | : x is a fur-coat |
| Has(x,y) | : x has y |
| HasHair(x) | : x has hair |
| Fuzzy(x) | : x is fuzzy. |

Two clauses from the nursery rhyme part of the KB are

Bear(Fuzzy-Wuzzy)
¬HasHair(Fuzzy-Wuzzy)

Convert each of the six rules into Clausal Normal Form (CNF).
Using resolution, prove that Fuzzy-Wuzzy is fuzzy. Give the resolution trace of the proof.

## Section B: For People Interested in Programming / AI Tools

### Automated Theorem Proving

Automated theorem proving (also known as ATP or automated deduction) is a subfield of automated reasoning and mathematical logic dealing with proving mathematical theorems by computer programs. Automated Theorem Provers show that some statement (the conjecture) is a logical consequence of a set of statements (the axioms and hypotheses). The language in which the conjecture, hypotheses, and axioms (generically known as formulae) are written is a logic, often classical First Order Logic. You are required to study one such ATP – SPASS.

SPASS is an automated theorem prover for first-order logic with equality. The input for the prover is a first-order formula in a given syntax. Running SPASS on such a formula results in the final output SPASS beiseite: Proof found. if the formula is valid, SPASS beiseite: Completion found. if the formula is not valid and because validity in first-order logic is undecidable, SPASS may run forever without producing any final result.

You are encouraged to use version on the web: WebSPASS. https://webspass.spass-prover.org/

Consider Region Connection Calculus (RCC) a language for qualitative spatial representation and reasoning. RCC abstractly describes regions (in Euclidean space, or in a topological space) by their possible relations to each other. RCC8 consists of 8 basic relations. The axiomatization is described here http://link.springer.com/content/pdf/10.1007%2F3-540-70736-0_4.pdf
For further details (if required) see https://en.wikipedia.org/wiki/Region_connection_calculus

Generate SPASS Proofs for the following:

a. x is a *part-of* y and y is a *part-of* z: x is *part-of* z; i.e. *parthood* is a transitive relation.
b. x is a *non-tangential proper-part* of y and z and x are *connected*: z *overlaps y.*

here the *relations* referred to above in *italics* are described in the PDF of the axiomatization.