

AI3003 Programming Assignments 2024

- Each assignment is to be done by a team of two.
- Some assignments may be assigned to two different teams.
- Some assignments (5-9, 14-15, 16-18) have a group of more than one team working together.
- The deadline for submission (code plus a writeup) is April 3.
- After the submission a set of demos and viva will be scheduled.

The assignments below involve implementation of parts of a KRR software package by this class. Please refer to the accompanying Language Specification for input/output syntax. XML will be the interchange format between program modules.

The language specification for the input, as well as a parser to generate the XML representation will be provided.

Propositional Logic

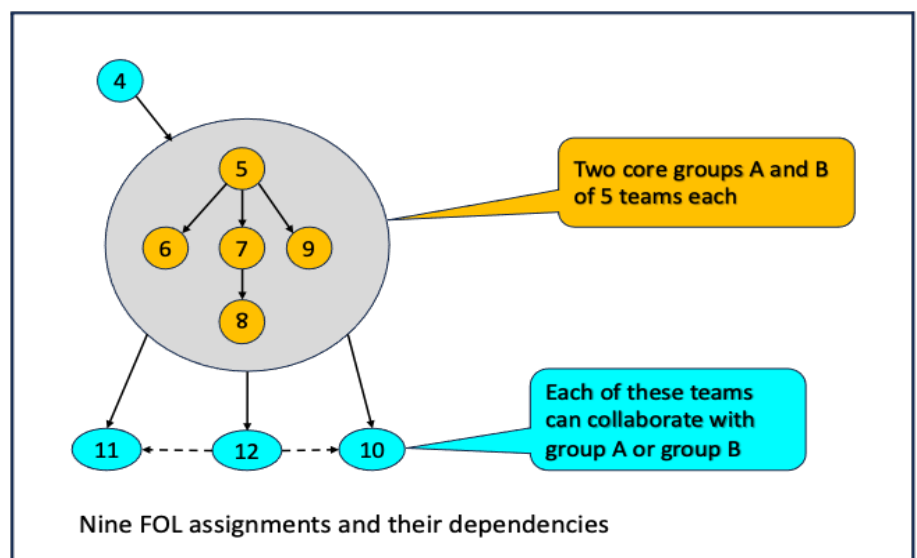
1. Write a program to read a set of PL formulas, and a set of rules of inference, from a text file. Given a goal formula, write a program to search for a proof using natural deduction. Display the derivation DAGs in graphical form. **[1 team]**
2. Write a program to read a set of PL formulas from a text file and convert it to CNF. Given a goal formula, add its negation to the KB, and use the resolution refutation method to prove/disprove the goal. Display the derivation DAGs in graphical form. **[1 team]**
3. Write a program to read a set of PL formulas, and a set of Tableau rules, from a text file. Given a goal formula, add its negation to the KB, and use the Tableau method to search for a model. Display the tableau generated in graphical form. **[1 team]**

First Order Logic

There are 9 FOL problems. Each problem is to be done by 2 teams of 2.

In addition, problems 5–9 form a larger team, referred to as core Group A and core Group B in the figure. These five teams have to work together.

The figure also depicts dependencies between assignments. Either one program is called by another or may pass data to the other.



4. (For input to reasoners below) Given a set of natural language sentences (like a word problem) construct a corresponding FOL representation as per the Language specification.
(teams with interest in NLP) [2 teams]

[Problems 5, 6, 7, 8, 9 — Two Groups of 5 teams — Total 10 teams]

5. Implement the Unification algorithm to operate on formulas in the prescribed XML notation. The program should return the MGU for two formulas. Extend the algorithm to find the MGU of a set of N formulas.
6. Implement a Forward Chaining algorithm to accept a KB in the specified form, convert it to XML, and generate a proof for a given theorem/query. The proof should be in the form of a numbered sequence of statements starting with the statements from the KB used in the proof.
7. Given a set of FOL formulas in the prescribed syntax, read the formulas from a text file and convert each one to clause form. For each predicate and function, add the appropriate equality axioms and convert them to clause form. Choose an appropriate naming convention for Skolem constants and functions.
8. For a given set of formulas in the clause form generated by the above assignment, implement the resolution method. Use the Unification algorithm implemented in Assignment 4. Allow the user to choose between a set of strategies. (Optional) Display the derivation DAGs in graphical form.
9. Backward Chaining. Implement a Prolog like backward chaining system, using a depth first strategy. Accept rules from a keyboard or file (see the language specification file). The user should be able to save a program and read it from a file. Accept goal from keyboard. Show the final proof for the goal (if possible graphically as a tree). One should be able to opt for more than one solution, on giving a goal. Allow the use of Cut.
10. Create a family knowledge base of the primitive relations: Parent(Parent, Child), Male(Person), Female(Person), and Married(Person, Person). Define a set of 10 relations (for example: Brother, Sister, Chacha, Chachi, Cousin, ...). Write a program to interactively answer queries like Chacha(Sneha, ?X)? etcetera. [2 teams]
11. Create a family knowledge base of the primitive relations: Parent(Parent, Child), Male(Person), Female(Person), and Married(Person, Person). Define a set of 10 relations (for example: Brother, Sister, Chacha, Chachi, Cousin...). Write a program to interactively answer the following kind of queries – “How is X related to Y”. How will you generate the shortest possible chain of relations? For example “Ramesh is Sunita’s maami’s cousin”. [2 teams]
12. (For someone interested in NLP) Create a NL module to accept sentences like “Suresh is Prachi’s nana” and populate the KB in terms of the primitive relations. [2 teams]

The following assignments can optionally be chosen by some team that is assigned one of the above. Only one team per assignment is allowed.

13. (For someone interested in NLP) Given a word problem dealing with length / distance / height and so on, represent it in FOL and derive an answer using theorem proving. A theorem prover from assignment X, Y or Z may be used. **[optional]**

DESCRIPTION LOGIC

The following two assignments can be done by a group of two teams of two persons each.

14. Write a program to determine if one concept subsumes another. **[optional]**
15. Given a set of concepts read from a file, construct a Taxonomy. Display the graph on a screen and allow users to read concept definitions attached to nodes on demand. Accept a new concept and classify it into the taxonomy. **[optional]**

RETE NET

The following three assignments can be done by a group of three teams of two persons each.

16. Read a set of rules (or productions) and construct a Rete Net. What is the strategy that one would use to create a compact network that shares as many matches as possible? **[optional]**
17. Create a mechanism of storing WMEs in the Alpha nodes. Accept a (+WME) or (-WME) as input at the root and let it travel down the network. Create a mechanism to add a matching rule to the Conflict Set. Initially assume that there are no negative preconditions in rules. **[optional]**
18. Implement the Recency and Specificity conflict resolution strategies. Select a rule based on the chosen strategy from the conflict set and execute the actions in the rule. **[optional]**