TRIBHUWAN UNIVERSITY

INSTITUTE OF ENGINEERING

CENTRAL CAMPUS, PULCHOWK

A LAB REPORT

ON

ARTIFICIAL INTELLIGENCE

LAB 3

EXPERIMENTS DATE: 2074-03-09
SUBMISSION DATE: 2074-03-23

SUBMITTED BY:

NAME: Anish Parajuli
GROUP: A
ROLL No: 071-BCT-503

SUBMITTED TO:

DEPARTMENT OF
ELECTRONICS AND COMPUTER
ENGINEERING

Artificial Intelligence
Lab 3

Introduction to First Order Predicate Logic(FOPL)

First-order logic

First-order logic is a collection of formal systems used in mathematics, philosophy, linguistics, and computer science. First-order logic uses quantified variables over non-logical objects and allows the use of sentences that contain variables, so that rather than propositions such as Socrates is a man one can have expressions in the form "there exists X such that X is Socrates and X is a man" and there exists is a quantifier while X is a variable.This distinguishes it from propositional logic, which does not use quantifiers or relation.

The use of symbolic logic to represent knowledge is not new in that it predates the modern computer by a number of decades. Even so, the application of logic as a practical means of representing and manipulating knowledge was not demonstrated until the early 1960s. Today First Order Predicate Logic (FOPL) or predicate calculus has assumed one of the important roles in AI for representing the knowledge.

The understanding of FOPL for AI student has several benefits. One, logic offers the formal approach to reasoning that has a sound theoretical foundation. Next, the structure of FOPL is flexible enough to permit the accurate representation of the natural language reasonably well.

- Ram loves all animals.
  ∀xAnimals(x) Loves(ram, x)

- Poppy is a
  dog.
  Dog(Poppy)

- Grandparent is a parent of one's parent
  ∀x, yGrandparent(x, y) ∃zParent(x, z) ∩ Parent(z, y)

- Parent and child are inverse relation.
  ∀x, yParent(x, y) Child (y, x)

- Rules combine facts to increase knowledge of the system
  son(X,Y):-male(X),child(X).
  X is a son of Y if X is male and X is a child of Y.

Monkey-Banana Problem

Problem Statement

A monkey is in a room. Suspended from the ceiling is a bunch of bananas, beyond the monkey's reach. However, in the room there are also a chair and a stick. The ceiling is just the right height so that a monkey standing on a chair could knock the bananas down with the stick. The monkey knows how to move around, carry other things around, reach for the bananas, and wave a stick in the air. What is the best sequence of actions for the monkey?

Now the problem is to use FOPL to represent this monkey-banana problem and prove that monkey can reach the bananas.

Program Code:

```
PREDICATES
in_room(symbol)
dexterous(symbol)
tall(symbol)
can_move(symbol,symbol,symbol)
can_reach(symbol,symbol)
get_on(symbol,symbol)
can_climb(symbol,symbol)
close(symbol,symbol)
under(symbol,symbol)
can_climb(symbol,symbol)

CLAUSES in_room(bananas).
in_room(chair). in_room(monkey).
dexterous(monkey). tall(chair).
can_move(monkey,chair,bananas).
can_climb(monkey,chair).
can_reach(X,Y):-
dexterous(X),close(X,Y).
close(X,Z):-
get_on(X,Y),
under(Y,Z),
tall(Y).
get_on(X,Y):-
can_climb(X,Y).
under(Y,Z):-
in_room(X),
in_room(Y),
in_room(Z),
can_move(X,Y,Z).

GOAL
can_reach(monkey,appple).
```

Output:

```
No
```

Assignment I

Write the following statements in FOPL form and by converting them into prolog program test the given goal.

- Every American who sells weapons to hostile nations is a criminal.

∀x,y (American(x) ∩ sells_missiles(x,y) ∩ hostile(y)) Criminal(x)

- Every enemy of America is a hostile.

∀x enemy_of_america(x)

- Iraque has some missiles.

∃x missile(x) belongs(x,Iraq)

- All missiles of Iraque were sold by George.

∀x,y (George(x) ∩ missile_of_iraq(y)) sells_missile(x,y)

- George is an American.

American(George)

- Iraque is a country.

Country(Iraq)

- Iraque is the enemy of America.

Enemy_of_america(“Iraq”)

- Missiles are weapons.

weapon(missile)

Program Code:

```
PREDICATES
hostile(STRING)
enemy_of_america(STRING)
american(STRING)
criminal(STRING)
sells_missiles(STRING, STRING)
has_missile(STRING)
country(STRING)

CLAUSES
criminal(X):-
american(X), sells_missiles(X, Y), hostile(Y).
enemy_of_america(X) :-
hostile(X).
enemy_of_america("Iraq").
hostile(X):-
country(X).
has_missile("Iraq").
sells_missiles("George", "Iraq").
american("George").
hostile(x)country("Iraq").

GOAL
criminal(“George").
```

Output:

Yes

Discussion:

The goal of the above program is to fine whether George is a criminal or not based on the given predicate logic. According to the statements every american who sells weapons to hostile nation is a criminal and every enemy of america is hostile. Missiles are weapon and Iraq is a hostile nation.
In our program George is an american and he sells missiles to Iraq. Now since George, being an american citizen, sells weapons to hostile nation. Hence it can be inferred that George is a criminal.

Assignment II

Write the following statements in FOPL form and by converting them into prolog program test the different goals.

- Horses are mammals.

∀x horse(x) mammal(x)

- An offspring of a horse is a horse.

∀x,y(horse(x) ∩ offspring(y,x)) horse(y)

- Bluebeard is a Charlie's parent.

Parent(bluebeard,Charlie)

- Offspring and parents are inverse relations. ∀x, yParent(x, y) offsring(y,x)
- Every mammal has a parent.

∀x mammal(x)
yParent(y,x)

- Bluebeard is a horse.

Horse(Bluebeard)

Program Code:

```
PREDICATES
horse(STRING)
mammals(STRING)
offspring(STRING,STRING)
parent(STRING,STRING)

CLAUSES
parent("Bluebeard","Charlie").
horse("Bluebeard").
horse(X):-
mammals(X), offspring(X,Y), horse(Y).
mammals(X):-
parent(Y,X), offspring(X,Y).
```

```
offspring(X,Y):-
parent(Y,X).

GOAL
horse("Charlie").
```

Output:

Yes.

Discussion:

The goal of the above program is to fine whether Charlie is a horse or not based on the given predicate logic. Horses are mammal and offspring of a horse is a horse. Every mammal has a parent and Bluebird is Charlie's parent. Since Bluebird is a horse, it can be inferred from the statements that Charlie is also a horse.

Conclusion:

Thus, after performing the programs in this lab session, we became familiar about the FOPL(First Order Predicate Logic) and then converting them to the Prolog program which is based on predicate logic.