FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE
Lab Exercise – 6

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CDAC – NOIDA
PGDAI

ASSIGNMENT NO

Q. Consider the following paragraph:

" anything anyone eats are called food. Milka likes all kind of food. Bread is a ? food. Mango is a food. Alka eats pizza. Alka eats everything milka eats."

Translate the following sentences into (WFF) in predicate logic and then into set of clauses. Using resolution principle answer the following:

1. Does Milka like pizza?
2. what food Alka eats[Question answering]

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FOAI ⇒ ASSIGNMENT No: 6

Q:1: I. Translate into Predicate logic

(A) If someone eats something, it is food
⇒ $\forall x \forall y$ (Eats(x,y) → Food(y))
In clause form: ¬Eats(x,y) ∨ Food(y)

(B) Milka likes all food
⇒ $\forall y$ (Food(y) → Likes(Milka, y))
In clause form: ¬Food(y) ∨ Likes(Milka, y)

(C) Bread and mango are food
⇒ Food(Bread) Food(Mango)

(D) Alka eats pizza
⇒ Eats(Alka, Pizza)

(E) Alka eats everything Milka eats
⇒ $\forall y$ (Eats(Milka, y) → Eats(Alka, y))
In clause form: ¬Eats(Milka, y) ∨ Eats(Alka, y)

II. (A) Does Milka like pizza?
i.e. To prove: Likes(Milka, Pizza)
Given: Food(Pizza)
¬Food(y) ∨ Likes(Milka, y)
Substitute y = Pizza
∴ ¬Food(Pizza) ∨ Likes(Milka, Pizza)
∵ Food(Pizza) = True
∴ Likes(Milka, Pizza)
Hence, Proved
∴ Milka likes pizza.

II. (B) What food does Alka eat?
Given: Eats[Alka, Pizza]
¬Eats[Milka, y] ∨ Eats[Alka, y]
∵ Milka eats food items she likes (all food)
∴ Eats[Milka, y] ⇒ Eats[Alka, y]
(y = any food)

Hence, proved.

∴ Alka eats everything Milka eats [all food].

Q. Consider the following axioms:

1. Every child loves Santa.
2. Everyone who loves Santa loves any reindeer.
3. Rudolph is a reindeer, and Rudolph has a red nose.
4. Anything which has a red nose is weird or is a clown.
5. No reindeer is a clown.
6. Scrooge does not love anything which is weird.
7. (Conclusion) Scrooge is not a child.

Represent these axioms in predicate calculus; skolemize as necessary and convert each formula to clause form. (Note: `has a red nose' can be a single predicate. Remember to negate the conclusion.) Prove the unsatisfiability of the set of clauses by resolution.

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Q:2:

I. Predicates:-

(A) Child (x) ⇒ x is a child
(B) loves (x, y) ⇒ x loves y
(C) Reindeer (x) ⇒ x is a reindeer
(D) RedNose (x) ⇒ x has a Red Nose
(E) Weird (x) ⇒ x is weird.
(F) clown (x) ⇒ x is a clown.

II. Constants: (A) Santa ⇒ represents Santa
(B) Rudolph ⇒ represents Rudolph
(C) Scrooge ⇒ represents Scrooge.

~~Terpave~~: Scrooge is not a child
Negation ⇒ Scrooge is a child.

III. (A) Every child loves Santa
$\Rightarrow \forall x\,(Child(x) \rightarrow Loves(x, Santa))$
$\neg Child(x) \vee Loves(x, Santa)$ — (i)

(B) Everyone who loves Santa loves any Reindeer
$\Rightarrow \forall x\,(Loves(x, Santa) \rightarrow \forall y\,(Reindeer(y) \rightarrow Loves(x,y)))$
$\Rightarrow \forall x \forall y\,((Loves(x, Santa) \wedge Reindeer(y)) \rightarrow Loves(x,y))$

$\neg Loves(x, Santa) \vee \neg Reindeer(y) \vee Loves(x,y)$ — (ii)

(C) Rudolph is a reindeer, and Rudolph has a red nose.
$\Rightarrow$ Reindeer (Rudolph) — (iii) RedNose (Rudolph) — (iv)

(D) Anything which has a red Nose is weird or is a clown.
$\Rightarrow \forall x\,(RedNose(x) \rightarrow (Weird(x) \vee Clown(x)))$

$\Rightarrow \neg RedNose(x) \vee Weird(x) \vee Clown(x)$ — (v)

(E) No reindeer is a clown.
$\Rightarrow \forall x\,(Reindeer(x) \rightarrow \neg Clown(x))$

$\Rightarrow \neg Reindeer(x) \vee \neg Clown(x)$ — (vi)

(F) Scrooge does not love anything which is weird.

$\Rightarrow \forall y\,(Loves(Scrooge, y) \rightarrow \neg Weird(y))$

$\Rightarrow \neg Loves(Scrooge, y) \vee \neg Weird(y)$ — (vii)

(G) (Conclusion) Scrooge is not a child
Let's assume, ~~Th~~ Scrooge is a child

$\Rightarrow$ Child (Scrooge) — (viii) [Negation of conclusion]

Q. Consider the following axioms:

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7. (Conclusion) Scrooge is not a child.

Represent these axioms in predicate calculus; skolemize as necessary and convert each formula to clause form. (Note: `has a red nose' can be a single predicate. Remember to negate the conclusion.) Prove the unsatisfiability of the set of clauses by resolution.

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III. (A) From clause (i) and (viii)

From clause (viii) $Child(Scrooge)$

clause (i) (with $x = Scrooge$)

$\neg Child(Scrooge) \vee Loves(Scrooge, Santa)$

∵ $Child(Scrooge) = True$

∴ By Disjunction, $Loves(Scrooge, Santa)$ ——— (ix)

(B) From clause (ii) and (ix)

From clause (ii) with $x = Scrooge$

$\neg Loves(Scrooge, Santa) \vee \neg Reindeer(y) \vee Loves(Scrooge, y)$

From clause (ix) $Loves(Scrooge, Santa)$

$\neg Loves(Scrooge, Santa) = False$

∴ $\neg Reindeer(y) \vee Loves(Scrooge, y)$ ——— (x)

(C) From clause (iii) and (x)

Let $y = Rudolph$ in clause (x)

i.e. $\neg Reindeer(Rudolph) \vee Loves(Scrooge, Rudolph)$

But, $\neg Reindeer(Rudolph) \Rightarrow False$

∴ $Loves(Scrooge, Rudolph)$ ——— (xi)

(D) From clause (vii) and (xi)

Let $y = Rudolph$ in clause (vii)

i.e. $\neg Loves(Scrooge, Rudolph) \vee \neg Weird(Rudolph)$

From clause (xi) [$Loves(Scrooge, Rudolph)$]

∴ $\neg Loves(Scrooge, Rudolph) \Rightarrow False$

∴ $\neg Weird(Rudolph)$ ——— (xii)

(E) Let $x = Rudolph$ in clause (iv) and (v)

From clause (iv) $RedNose(Rudolph)$

Clause (v)

$\neg RedNose(Rudolph) \vee Weird(Rudolph) \vee Clown(Rudolph)$

∵ $RedNose(Rudolph) = True$

∴ $Weird(Rudolph) \vee Clown(Rudolph)$

From clause (xii)

∴ $Clown(Rudolph)$ ——— (xiii)

(F) Let, $x = Rudolph$ in clause (iii), (vi) and (xiii)

From clause (vi) $\neg Reindeer(Rudolph) \vee \neg Clown(Rudolph)$

From clause (iii) $\Rightarrow Reindeer(Rudolph) \Rightarrow True$

∴ $\neg Reindeer(Rudolph) = False$

and From clause (xiii) $Clown(Rudolph) \Rightarrow True$

∴ $\neg Clown(Rudolph) = False$

yielding a contradiction [an empty clause]

∵ We derived a contradiction

∴ The original set of clauses, including the negated conclusion $Child[Scrooge]$ is unsatisfiable

∴ By Resolution, we conclude that the original axioms logically imply that

"Scrooge is not a child"

Resolution qUESTION

(a) Marcus was a man.
(b) Marcus was a Roman.
(c) All men are people.
(d) Caesar was a ruler.
(e) All Romans were either loyal to Caesar or hated him (or both).
(f) Everyone is loyal to someone.
(g) People only try to assassinate rulers they are not loyal to.
(h) Marcus tried to assassinate Caesar

qUERY::::::::::::::::::

Who hated Caesar?

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Q.3:

I. (A) Marcus was a man ⇒ man(Marcus) — (i)

(B) Marcus was a Roman ⇒ Roman(Marcus) — (ii)

(C) All men are people

man(x) → Person(x) — (iii)

¬man(x) ∨ Person(x)

(D) Caesar was a ruler ⇒ Ruler(Caesar) — (iv)

(E) All Romans were either loyal to Caesar or hated him (or both)

⇒ Roman(x) → (LoyalTo(x, Caesar) ∨ Hated(x, Caesar))

⇒ ¬Roman(x) ∨ LoyalTo(x, Caesar) ∨ Hated(x, Caesar) — (v)

(F) Everyone is loyal to someone

⇒ Person(x) → ∃y LoyalTo(x, y) — (vi)

(G) People only try to assassinate rulers they are not loyal to.

⇒ (TryAssassinate(x,y) ∧ Ruler(y)) → ¬LoyalTo(x,y)

⇒ ¬TryAssassinate(x,y) ∨ ¬Ruler(y) ∨ ¬LoyalTo(x,y) — (vii)

(H) Marcus tried to assassinate Caesar.

⇒ TryAssassinate(Marcus, Caesar) — (viii)

To find: Who hated Caesar.

Hated(?, Caesar) ⇒ (Q)

II. (A) From Statement (ii) Roman(Marcus)

(B) From Statement (v) Let, x = Marcus

∴ ¬Roman(Marcus) ∨ LoyalTo(Marcus, Caesar) ∨ Hated(Marcus, Caesar)

∵ Roman(Marcus) = True

∴ LoyalTo(Marcus, Caesar) ∨ Hated(Marcus, Caesar) — (ix)

(C) From Statement (vii)

Let, x = Marcus, y = Caesar

¬TryAssassinate(Marcus, Caesar) ∨ ¬Ruler(Caesar) ∨ ¬LoyalTo(Marcus, Caesar)

∵ From statement (iv) Ruler(Caesar) = True

∴ ¬TryAssassinate(Marcus, Caesar) ∨ ¬LoyalTo(Marcus, Caesar) — (x)

(D) From Statement (viii)

TryAssassinate(Marcus, Caesar) — (xi)

(E) From Statement (x) and (xi)

(x) ⇒ ¬TryAssassinate(Marcus, Caesar) ∨ ¬LoyalTo(Marcus, Caesar)

(xi) ⇒ TryAssassinate(Marcus, Caesar) = True

∴ ¬TryAssassinate(Marcus, Caesar) = False

∴ ¬LoyalTo(Marcus, Caesar) — (xii)

Resolution qUESTION

-

(a) Marcus was a man.
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qUERY::::::::::::::::::

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F From ix and xi :

Statement ix :
loyalTo (Marcus, Caesar) ∨ Hated (Marcus, Caesar)
Statement xi :
¬ loyalTo (Marcus, Caesar)
Resolving, we have

Hated (Marcus, Caesar)
Comparing with statement (5) ; we have
so Marcus hated Caesar

"MARCUS HATED CAESAR"