Mo | Tu | We | Th | Fr | Sa | Su

Memo No. ________
Date / /

CSC 520 FALL 2023 [ASSIGNMENT 3]

NAME: RUCHA MAHESH KULKARNI

STUDENT ID: 200537346.

Q1. <Solution>

1) • All lions are animals.

$\forall x[\text{lion}(x) \rightarrow \text{animal}(x)]$

• The head of a lion is the head of an animal.

$\forall h \forall x[\text{head}(h,x) \wedge \text{lion}(x) \rightarrow (\exists y[\text{head}(h,y) \wedge \text{animal}(y)])]$

2) Logic Statements to CNF.

GIVEN STATEMENTS:

• $\forall x[\text{lion}(x) \longrightarrow \text{animal}(x)]$

• $\forall h \forall x[\text{head}(h,x) \wedge \text{lion}(x) \longrightarrow (\exists y[\text{head}(h,y) \wedge \text{animal}(y)])]$

STEP 1: Remove implication

i) $\forall x[\neg \text{lion}(x) \vee \text{animal}(x)]$

ii) $\forall h \forall x[\neg(\text{head}(h,y) \wedge \text{lion}(x)) \vee (\exists y[\text{head}(h,y) \wedge \text{animal}(y)])]$

STEP 2: Apply quantifier distribution & push negation inside

i) $\forall x [\neg lion(x) \vee animal(x)]$

ii) $\forall h \forall x [(\neg head(h,x) \vee \neg lion(x)) \vee \exists y [head(h,y) \wedge animal(y)])]$

STEP 3: SKOLEMIZATION

Adding function $f(H,x)$ to define y

i) $\forall x [\neg lion(x) \vee animal(x)]$

ii) $\forall h \forall x [(\neg head(h,x) \vee \neg lion(x)) \vee \exists y [head(h, \cancel{(H,x)} f(H,x) \wedge animal(f(H,x))])]$

STEP 4: Distribute $\vee$ over $\wedge$:

ii) $\forall h \forall x [(\neg head(h,x) \vee \neg lion(x) \vee head(h, f(H,x))) \wedge (\neg head(h,x) \vee \neg lion(x) \vee animal(f(H,x)))]$

STEP 5: Apply the Distributive law to expand $\wedge$:

Mo Tu We Th Fr Sa Su

Memo No. ________
Date / /

ii) $\forall h \forall x [((\neg head(h,x) \vee \neg lion(x) \vee head(h, f(H,X))) \wedge (\neg head(h,x) \vee \neg lion(x) \vee animal(f(H,x))))]$.

This statement is now in CNF form.

3) FOPL Resolution

Given Statements

i) $\forall x [\neg lion(x) \vee animal(x)]$

ii) $\forall h \forall x [((\neg head(h,x) \vee \neg lion(x) \vee head(h, f(H,X))) \wedge (\neg head(h,x) \vee \neg lion(x) \vee animal(f(H,X))))]$.

STEP 1: Resolve clause 2 with itself.

Use substitution of H with $f(H,X)$:

$[((\neg head(f(H,x), \cancel{x}\, x) \vee \neg lion(x) \vee head(f(H,X), f(f(H,X), \cancel{x}\, X))) \wedge (\neg head(f(H,X), X) \vee \neg lion(x) \vee animal(f(f(H,X),X)))]$

Memo No.
Date / /

STEP 2: Substitute 'x' for 'a' for a fresh variable:

Clause 1: $[\neg lion(a) \vee animal(a)]$

Clause 2: $[((\neg head(f(H,a),a) \vee \neg lion(a) \vee head(f(H,x), f(f(H,x),a)))$
$\wedge (\neg head\ f(H,a),a) \vee \neg lion(a) \vee animal(f(f(H,a),a)))]$.

STEP 3: Resolve the subformulas in 2:

Subformula 1:
$[\neg head(f(H,a),a) \vee \neg lion(a) \vee head(f(H,x), f(f(H,x),a))]$

Subformula 2:
$[\neg head(f(H,a),a) \vee \neg lion(a) \vee animal(f(f(H,a),a))]$

STEP 4: Resolution

$[(\neg head(f(H,a),a) \vee \neg lion(a) \vee head(f(H,x), f(f(H,x),a))) \vee (\neg head(f(H,a),a) \vee \neg lion(a) \vee animal(f(f(H,a),a)))]$

Memo No. ______
Date / /

Now,

$[(\neg lion(a) \vee head(f(H,x), f(f(H,x), a)))$
$\vee (\neg lion(a) \vee animal(f(f(H,a), a))]$

STEP 5: Distribute '$\vee$' operator:

$[\neg lion(a) \vee head(f(H,x), f(f(H,x), a))$
$\vee \neg lion(a) \vee animal(f(f(H,a), a))]$

Then:

$[head(f(H,x), f(f(H,x), a)) \vee$
$animal(f(f(H,a), a))]$

Hence the result.

The resulting clause does not have any conflicting literal.
Therefore, second sentence follows the first using FOPL

Memo No. ______
Date / /

$T(1) \Rightarrow lion(x) \wedge \neg animal(x)$

If we consider resolving lion(x) with

T(2) lion (x) $\neg$ lion (x) $\vee$ $\neg$head(h(x)) $\vee$ animal(y)

[φ] → query is entailed

$\neg$ animal (x) $\neg$ lion(x) $\vee$ $\neg$head(h(x)) $\vee$ animal(y)

unify (x, y) = [φ]

So, query is satisfied.

Memo No.
Date / /

Q3.

Solution: PROBLEM - Predicting chances of getting into an university

Criterias - to determine chances.
- standardized test scores.
- GPA
- recommendation letters
- other activities

Why?
- Universities can use to screen students (candidates).
- Students are aided to make informed decisions.
- Eligilibity of scholarships can be determined.

Memo No.
Date / /

Knowledge Base:

1) $(SAT(x) > 1300) \wedge (GPA(x) > 3.5) \rightarrow Admit(x)$
2) $Recommendation(x) \wedge Extracurr(x) \rightarrow Admit(x)$
3) $(GPA(x) < 2.0) \vee Misconduct(x) \rightarrow Reject(x)$
4) $SAT(x) > 1500 \rightarrow Fix(x)$
5) $\forall x\, Fix(x) \rightarrow Admit(x)$
6) $(SAT(x) < 1000) \wedge (GPA(x) < 2.0) \rightarrow FixReject(x)$
7) $\forall x\, FixReject(x) \rightarrow Reject(x)$
8) $\neg admit(x) \vee \neg reject(x) \rightarrow waitlist(x)$

This knowledge base can be used to provide informed decisions.

Sample Query:

$(SAT(x) = 1400)$ & $(GPA(x) = 3.0)$ & $(Recommendation(x))$ & $\neg Misconduct(x)$

Mo Tu We Th Fr Sa Su

Memo No.
Date / /

* BACKWARD CHAINING RESOLUTION STEPS:

1. Resolve Rule 1 with Query:

$$(SAT(x) > 1300) \wedge (GPA(x) > 3.5) \longrightarrow Admit(x)$$

The result : Admit.

The student is admitted on basis of rule 1 (and rule 3).

HENCE THE RESULT