

CS 572(Assignment 6)

Aashish Dhakal
aashish@iastate.edu

Problem 8.24

Vocabulary:

$Student(x)$, $Person(x)$, $Man(x)$, $Barber(x)$, $Expensive(x)$, $Agent(x)$, $Insured(x)$, $Smart(x)$, $Politician(x)$

F, G : French and German Courses

$x > y$: x is greater than y

$Take(x, c, s)$: student x takes course c in sem s

$Pass(x, c, s)$: student x passes course c in sem s

$Score(x, c, s)$: student x scores c in sem s

$Sub(c, f)$: subject of course c is field f

$Buys(x, y, z)$: x buys y from z

$Sells(x, y, z)$: x sells y to z

$Shaves(x, y)$: x shaves y

$Parent(x, y)$: x is a parent of y

$Citizen(x, c, r)$: x is a citizen of c for reason r

$Resident(x, c)$: x is a resident of country c

$Birthplace(x, c)$: person x was born in country c

$Fool(x, y, t)$: person x fools person y at time t

Answers

- (a) $\exists Student(x) \wedge Takes(x, F, Spring2001)$.
- (b) $\forall x, s \ Student(x) \wedge Takes(x, F, s) \Rightarrow Passes(x, F, s)$
- (c) $\exists Student(x) \wedge Takes(x, G, Spring2001) \wedge \forall y \ y \neq x \Rightarrow \neg Takes(y, G, Spring2001)$
- (d) $\forall s \exists x \forall y \ Score(x, G, s) > Score(x, F, s)$
- (e) $\forall x \ Person(x) \wedge (\exists y, z \ Policy(y) \wedge Buys(x, y, z)) \Rightarrow Smart(x)$
- (f) $\forall x \ y \ z \ Person(x) \wedge Policy(y) \wedge Expensive(y) \Rightarrow \neg Buys(x, y, z)$
- (g) $\exists x \ Agent(x) \wedge \forall y, z \ Policy(y) \wedge Sells(x, y, z) \Rightarrow (Person(z) \wedge \neg Insured(z))$
- (h) $\exists x \forall y \ Barber(x) \wedge Man(y) \wedge \neg Shave(y, y) \Rightarrow Shaves(x, y)$
- (i) $\forall x \ Person(x) \wedge Born(x, UK) \wedge (\forall y \ Parent(y, x) \Rightarrow (\exists r \ Citizen(y, UK, r)) \vee Resident(y, UK))) \Rightarrow Citizen(x, UK, Birth)$
- (j) $\forall x \ Person(x) \wedge \neg Born(x, UK) \wedge (\exists y \ Parent(y, x) \wedge Citizen(y, UK, Birth)) \Rightarrow Citizen(x, UK, Descent)$

- (k) $\forall x \text{ Politician}(x) \Rightarrow (\exists y \forall t \text{ Person}(y) \wedge \text{Fools}(x, y, t)) \wedge (\exists t \forall y \text{ Person}(y) \wedge \text{Fools}(x, y, t)) \wedge \neg(\forall t \forall y \text{ Person}(y) \wedge \text{Fools}(x, y, t))$

Problem 9.4

1. Progressive Unification:

$$\begin{aligned} &P(A, B, B), P(x, y, z) : \{x/A\}, \\ &P(A, B, B), P(A, y, z) : \{x/A, y/B\} \\ &P(A, B, B), P(A, B, z) : \{x/A, y/B, z/B\} \end{aligned}$$

2. Progressive Unification:

$$\begin{aligned} &Q(y, G(A, B)), Q(G(x, x), y) : \{y/G(x, x)\} \\ &Q(G(x, x), G(A, B)), Q(G(x, x), G(x, x)) : \{y/G(x, x)\} \\ &Q(G(x, x), G(A, B)), Q(G(x, x), G(x, x)) : \{y/G(x, x), x/A\} \\ &Q(G(A, A), G(A, B)), Q(G(A, A), G(A, A)) : \{y/G(x, x), x/A\} \end{aligned}$$

Unification of A and B cannot be done.

3. Progressive Unification:

$$\begin{aligned} &\text{Older}(\text{Father}(y), y), \text{Older}(\text{Father}(x), \text{John}) : \{\} \\ &\text{Older}(\text{Father}(y), y), \text{Older}(\text{Father}(x), \text{John}) : \{x/y\} \\ &\text{Older}(\text{Father}(x), x), \text{Older}(\text{Father}(x), \text{John}) : \{y/x, x/\text{John}\} = \{y/\text{John}, x/\text{John}\} \end{aligned}$$

4. Progressive Unification:

$$\begin{aligned} &\text{Knows}(\text{Father}(y), y), \text{Knows}(x, x) : \{x/\text{Father}(y)\} \\ &\text{Knows}(\text{Father}(y), y), \text{Knows}(\text{Father}(y), \text{Father}(y)) : \{x/\text{Father}(y)\} \end{aligned}$$

Cannot unify variable y with $\text{Father}(y)$.

Problem 9.20

$S(p, q)$ represents p shaves q

(a) $\exists p \forall q S(p, q) \Leftrightarrow \neg S(p, q)$

- (b) We will have two clauses because we have a bidirectional implication in a

$$\begin{aligned} &1: \exists p \forall q S(p, q) \Rightarrow \neg S(p, q) \\ &\rightarrow \neg S(C, q) \vee \neg S(q, q) \\ &2: \neg S(p, q) \Rightarrow \exists p \forall q S(p, q) \\ &\rightarrow S(C, q) \vee S(p, q) \end{aligned}$$

- (c) Applying factoring to 1, using the substitution q/C

3: $\neg S(C, C)$.

Applying factoring to 2, using substitution q/C :

4: $S(C, C)$

And finally when we resolve 3 4, we get a null clause.