

Example 1: Resolution Examples

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① Considering the KB in CNF. \rightarrow clause form

S1: $\neg \text{American}(x) \vee \neg \text{Weapon}(y) \vee \neg \text{Sells}(x, y, z)$
 $\vee \neg \text{Hostile}(z) \vee \text{Criminal}(x)$

S2: $\neg \text{Missile}(y) \vee \neg \text{Owns}(\text{Nono}, y) \vee \text{Sells}(\text{West}, y,$
 $\text{Nono})$

S3: $\neg \text{Enemy}(x, \text{America}) \vee \text{Hostile}(x)$

S4: $\neg \text{Missile}(x) \vee \text{Weapon}(x)$

S5: $\text{Owns}(\text{Nono}, M_1)$

S6: $\text{Missile}(M_1)$

S7: $\text{American}(\text{West})$

S8: $\text{Enemy}(\text{Nono}, \text{America})$

and include the negated goal:

S9: $\neg \text{Criminal}(\text{West})$ clauses

First look for pairs of sentences with
opposing predicates that can

- 2) S2 & S6 \Rightarrow Predicate: missile unify
Subst: x/M_1
Result: $\neg \text{Owns}(\text{Nono}, M_1) \vee$
 $\neg \text{Sells}(\text{West}, M_1, \text{Nono})$
2 predicates
- 3) S3 & S8 \Rightarrow Predicate: enemy
Subst: x/Nono
Result: $\text{Hostile}(\text{Nono})$ 1 pred
- 3) S4 & S6 \Rightarrow Predicate: missile
Subst: x/M_1
Result: $\text{Weapon}(M_1)$ 1 pred

4) $S_2 \wedge S_5 \Rightarrow$ Predicate: Owns)
Subst: y/M_1 } Result: $\neg \text{Missile}(H_1) \vee$
 $\underline{\text{sells(West, H}_1, \text{Now})}$ 2

5) $S_1 \wedge S_2 \Rightarrow$ Predicate: American
Subst: $x/West$ } Result:
 7 weapon(y) v
 7 sells(West,y,z) v
 7 Hostile(z) v
 Criminal(wes)

6) S1 2sg \Rightarrow Predicate: Criminal
S1 2sg \Rightarrow sells x/west } Result: 7 American(West),
 } 7 Weaponry(y) ✓
 } 7 sells(ANet, q, z) ✓
 } V7 Hostile(z)

Aspect the pains and rock me

Inspect the pairs and pick one
with smallest number of predicates
in resulting clause:

- the pair S3 & S8 generate a clause with
1 predicate

after rent liability
is applied !

- the pair S_4 & S_8 generate a clause with
↓
1 predicate

^b after resolution
is applied.

pick one of these pairs!

→ Select S3 & S8

use $\theta = \pi / N_{\text{ono}}$ S10: Hostile (Nono)

a new axiom! 

Are there any new pairs of unifiable sentences, after S10 is added?

→ where do I find $\frac{7 \text{ Hostile}}{\text{predicate}}$?

↓
in S1 ~~A~~

$S1 \wedge S10 \Rightarrow \frac{\text{Subst}}{\text{Predicate Hostle}} \} \Rightarrow \begin{cases} S11: 7 \text{ American}(x) \\ \vee 7 \text{ Weapon}(y) \\ \vee 7 \text{ sells}(x, y, \text{Nono}) \\ \vee \text{Criminal}(x) \end{cases}$
4 predicates!

What do we do next?

We still have the pair

$S4 \wedge S6$ which generates a new clause with
only 1 predicate!
after resolution is applied

$S12: \text{Weapon}(M1) \quad \theta: * / M1$

Are there any clauses where 7 Weapon appears?

by considering $S12 \wedge S11 \Rightarrow \frac{\text{Pred: Weapon}}{\text{Subst: } y / M1} \} S13$
 $\Rightarrow S11$

$S13: 7 \text{ American}(*) \vee 7 \text{ sells}(*, M1, \text{Nono}) \vee$
 $\text{Criminal}(*) \quad \theta: y / M2$

What do we do now?

4

→ Are there any sentences in S1,..S12 that have predicates unifiable with those from S13?

Yes!

a) $(S13, S7) \Rightarrow \frac{\text{Predicate: American}}{\text{Subst: } X/\text{West}} \Rightarrow \frac{\text{Result:}}{\begin{array}{l} \neg \text{sells(West, MI, Nono)} \\ \vee \text{Criminal(West)} \end{array}}$

2 predicates

b) $(S13, S2) \Rightarrow \frac{\text{Predicate: sells}}{\text{Subst: } \neg X/\text{West}} \Rightarrow \frac{\text{Result:}}{\begin{array}{l} \neg \text{American(X/West)} \vee \\ \text{Criminal(West)} \vee \\ \neg \text{Missile(X)} \vee \\ \neg \text{Owns(Nono, Y)} \end{array}}$

4 predicates

c) $(S13, S9) \Rightarrow \frac{\text{Predicate: Criminal}}{\text{Subst: } X/\text{West}} \Rightarrow \frac{\text{Result:}}{\begin{array}{l} \neg \text{American(West)} \vee \\ \neg \text{sells(West, MI, Nono)} \end{array}}$

2 predicates

We can select either

$(S13, S7)$ or $(S13, S9)$,
as both yield new sentences
with only 2 predicates.

Case A If we select $(S13, S9)$:

$\Rightarrow S14: \neg \text{American(West)} \vee \neg \text{sells(West, MI, Nono)}$
with $\neg X/\text{West}$

But $S14 \wedge S7 \Rightarrow$

$S15: \neg \text{sells(West, MI, Nono)}$

Instead of performing resolution
between S_{15} and S_2

(which will result in
a new sentence with 2
predicates!)

we perform resolution between S_2 and S_6 :

predicate: misses
subset of y/M_1

$S_{16} : \exists \text{Owns}(\text{Nono}, M_1) \vee \text{Sells}(\text{West}, M_1, \text{Nono})$

$\theta : \exists y/M_1$

By performing resolution between S_{16} and S_5
we obtain:

$S_{17} : \text{Sells}(\text{West}, M_1, \text{Nono})$

Again resolution between S_{17} and S_{15} :

$S_5 \& S_{17} \Rightarrow \text{NIL}$

problem!

Select (S_{13}, S_7) you have only
 $S_1 - S_{13}$ at that
point!

Case B

resolution is
producing

$S'_4 : \exists \text{sells}(\text{West}, M_1, \text{Nono}) \vee \text{Criminal}(\text{West})$

$S'_4 \& S_8 \Rightarrow$ the same

Resolution $S'_4 \& S_8 \Rightarrow$ the same
 $S_{15} : \exists \text{sells}(\text{West}, M_1, \text{Nono})$

S_{15} as before!