Knowledge Base System

Topic: Resolution in FOL

Steps for Resolution:

1. Conversion of facts into FOL
2. Convert FOL Statement into CNF (Conjunctive Normal form)
3. Negate the statement which needs to prove (by contradiction)
4. Draw the resolution graph (unification)

Examples:

a. John likes all kind of food.
b. Apples and Vegetables are food.
c. Anything anyone eats and not killed is food
d. Anil eats peanuts and still alive
e. Harry eats everything that anil eats
f. John like peanuts → Prove by resolution

Step 1:

Conversion of facts into FOL

a.

$$\forall x: food(x) \longrightarrow likes(John, x)$$

b.

$$food(Apple) \wedge food(vegetables)$$

c. $\forall x \forall y : eats(x,y) \wedge \sim killed(x) \rightarrow food(y)$

d. $eats(Anil, peanuts) \wedge alive(Anil)$

e. $\forall x : eats(Anil, x) \rightarrow eats(Harry, x)$

f. $\forall x : likes(John, peanuts)$

Some predicates: these facts can be derived from existing facts.

g. $\forall x : \sim killed(x) \rightarrow alive(x)$

h. $\forall x : alive(x) \rightarrow \sim killed(x)$

Step2:

Conversion of FOL into CNF

i) Eliminates all implications $(\rightarrow)$ and rewrite

$a \rightarrow b$ can be written as

$\sim a \vee b$

a. $\forall x \sim food(x) \vee likes(John, x)$

b. $food(Apple) \wedge food(vegetables)$

c. $\forall x \forall y \sim [eats(x,y) \wedge \sim killed(x)] \vee food(y)$

d. $eats(Anil, peanuts) \wedge alive(Anil)$

e. $\forall x \sim eats(Anil, x) \vee eats(Harry, x)$

f. $likes(John, peanuts)$

g. $\forall x \sim [\sim killed(x)] \vee alive(x)$

h. $\forall x \sim alive(x) \vee \sim killed(x)$

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ii) Move negations $(\sim)$ inwards and rewrite

a) $\forall x \sim food(x) \vee likes(John, x)$

b) $food(Apple) \wedge food(vegetables)$

c) $\forall x \forall y \sim eats(x,y) \vee killed(x) \vee food(y)$

d) $eats(Anil, peanuts) \wedge alive(Anil)$

e) $\forall x \sim eats(Anil, x) \vee eats(Harry, x)$

f) $likes(John, peanuts)$

g) $\forall x \sim killed(x) \vee alive(x)$

h) $\forall x \sim alive(x) \vee \sim killed(x)$

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iii) Rename variables or standardize variables

a) $\forall x \sim food(x) \vee likes(John, x)$

b) $food(Apple) \wedge food(vegetables)$

c) $\forall y \forall z \sim eats(y,z) \vee killed(y) \wedge food(z)$

d) $eats(Anil, peanuts) \wedge alive(Anil)$

e) $\forall w \sim eats(Anil, w) \vee eats(Harry, w)$

f) $\forall q \sim killed(q) \vee alive(q)$

g) $\forall k \sim alive(k) \vee \sim killed(k)$

h) $likes(John, peanuts)$

iv) Eliminate existential instantiation quantifiers:

But here in our example there are no $\exists$

so all statements remain same.

v) Drop the universal quantifiers:

a) $\neg$ food(x) $\lor$ likes(John, x)
b) food(Apple)
c) food(vegetables)
d) $\neg$ eats(y, z) $\lor$ killed(y) $\lor$ food(z)
e) eats(Anil, peanuts)
f) alive(Anil)
g) $\neg$ eats(Anil, w) $\lor$ eats(Harry, w)
h) killed(g) $\lor$ alive(g)
i) $\neg$ alive(k) $\lor$ $\neg$ killed(k)
j) likes(John, peanuts)

vi) Distribute Conjunction ($\land$) over disconjuction. $\neg$
This step will not make any change.

Step 3:

Negate the statement to be proved.

We will apply negation to the conclusion statement

$\neg$ likes(John, peanuts)

Step 4:

Draw resolution graph.
In this step, we will solve the problem
by resolution tree using **Subsitution**

¬ likes (John, peanuts)   ¬ food (x) ∨ likes (John, x)

$\{$ peanuts / x)

¬ food (peanuts)   ¬ eats (y, z) ∨ killed (y) ∨ food (z)

$\{$ peanuts / z $\}$

¬ eats (y, peanuts) ∨ killed (y)   eats (Anil, peanuts)

$\{$ Anil / y $\}$

killed (Anil)   ¬ alive (k) ∨ ¬ killed (k)

$\{$ Anil / k $\}$

¬ alive (Anil)   alive (Anil)

$\{$ $\}$ Hence Proved.