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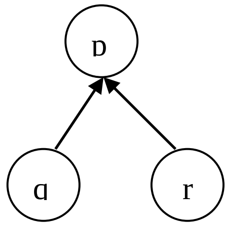
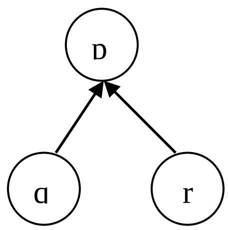
AND/OR Graphs

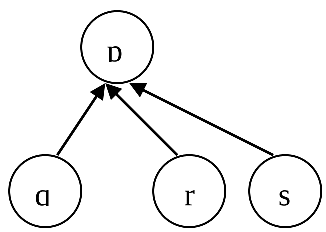
$q \vee r \rightarrow p$

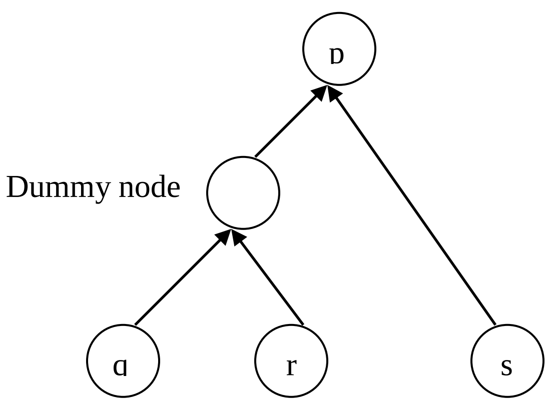


$q \wedge r \rightarrow p$



$$\left.\begin{array}{l} q \wedge r \rightarrow p \\ s \rightarrow p \end{array}\right\} \equiv (q \wedge r) \vee s \rightarrow p$$





- AND/OR Rule based deduction system:

Consider the problem

Goal: $p \wedge (q \vee r)$

Clauses:

C1: $\neg s \vee p$

C2: $\neg u \vee s$

C3: u

C4: $\neg w \vee r$

C5: w

$\neg(p \wedge (q \vee r)) \rightarrow \neg p \vee \neg (q \vee r)$

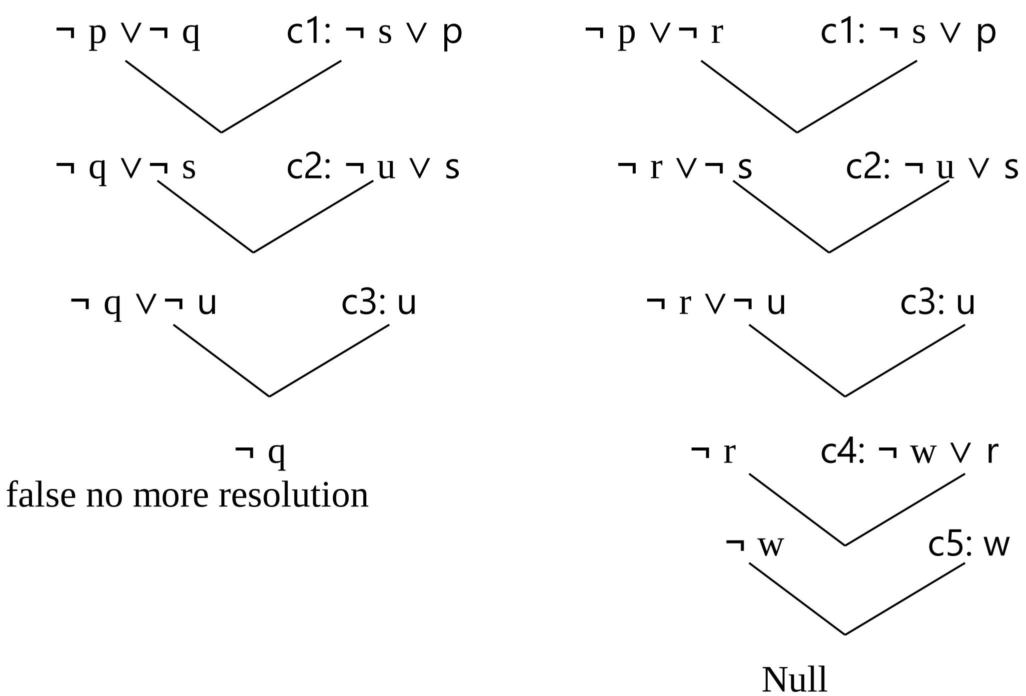
$\rightarrow \neg p \vee (\neg q \wedge \neg r)$

$\rightarrow (\neg p \vee \neg q) \wedge (\neg p \vee \neg r)$

G1: $(\neg p \vee \neg q)$

G2: $(\neg p \vee \neg r)$

Take g1   Take g1



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Forward AND/OR rule based deduction system

1- facts: fact must be converted into a form called AND/OR form.
In this form, a fact must be represented as a conjunction of disjunction of literals. If the facts are not in this form. Then you have to convert to this form using the following steps:

1- eliminate $\rightarrow$

2- reduce scope of negation.

3- standardize quantifiers.

1- move all quantifiers to the left and skolomize $\exists$variables

2- drop $\forall$ quantifiers

3- rename variables over the main conjunctions of the expression.

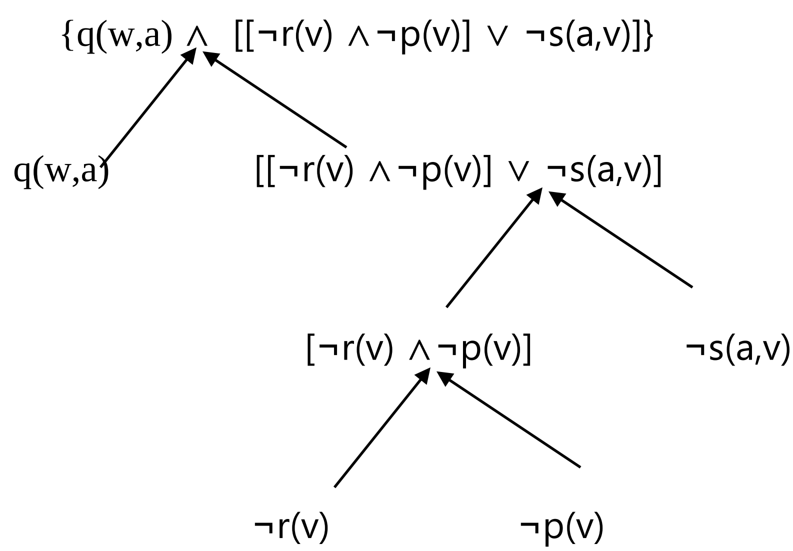
Ex: $\exists u \forall v \{q(v,u) \wedge \neg [[r(v) \vee p(v)] \wedge s(u,v)]\}$

$\exists u \forall v \{q(v,u) \wedge [[\neg r(v) \wedge \neg p(v)] \vee \neg s(u,v)]\}$

$\forall v \{q(v,a) \wedge [[\neg r(v) \wedge \neg p(v)] \vee \neg s(a,v)]\}$

$\{q(w,a) \wedge [[\neg r(v) \wedge \neg p(v)] \vee \neg s(a,v)]\}$

Note: represent the fact expression in this AND/OR form as an AND/OR graph such that conjuncts are represented by OR nodes, disjuncts are represented by AND nodes.



2- rules: rules in the forward AND/OR deduction systems must have the form $L \rightarrow W$, where L is a literal, W is an expression which is an AND/OR form.

Quantification in rules must be over the entire rule to make the quantification on over the entire rule, perform the following steps:-

1- eliminate $\rightarrow$
2- reduce scope of negation.
3- standardize quantifiers.
4- move all quantifiers to the left
5- skolomize $\exists$variables
6- drop $\forall$ quantifiers
7- convert back to implication form using

$\neg p \vee q \equiv q \rightarrow p$

Ex:

$(\forall x) \{[(\exists y) (\forall z) p(x,y,z)] \rightarrow \forall u\ q(x,u)\}$

$(\forall x) \{\neg [(\exists y) (\forall z) p(x,y,z)] \vee \forall u\ q(x,u)\}$

$(\forall x) \{(\forall y) (\exists z) \neg p(x,y,z)] \vee \forall u\ q(x,u)\}$

$(\forall x) (\forall y) (\exists z) (\forall u) \{\neg p(x,y,z)] \vee q(x,u)\}$

$(\forall x) (\forall y) (\forall u) \{\neg p(x,y,f(x,y))] \vee q(x,u)\}$

$\{\neg p(x,y,f(x,y))] \vee q(x,u)\}$

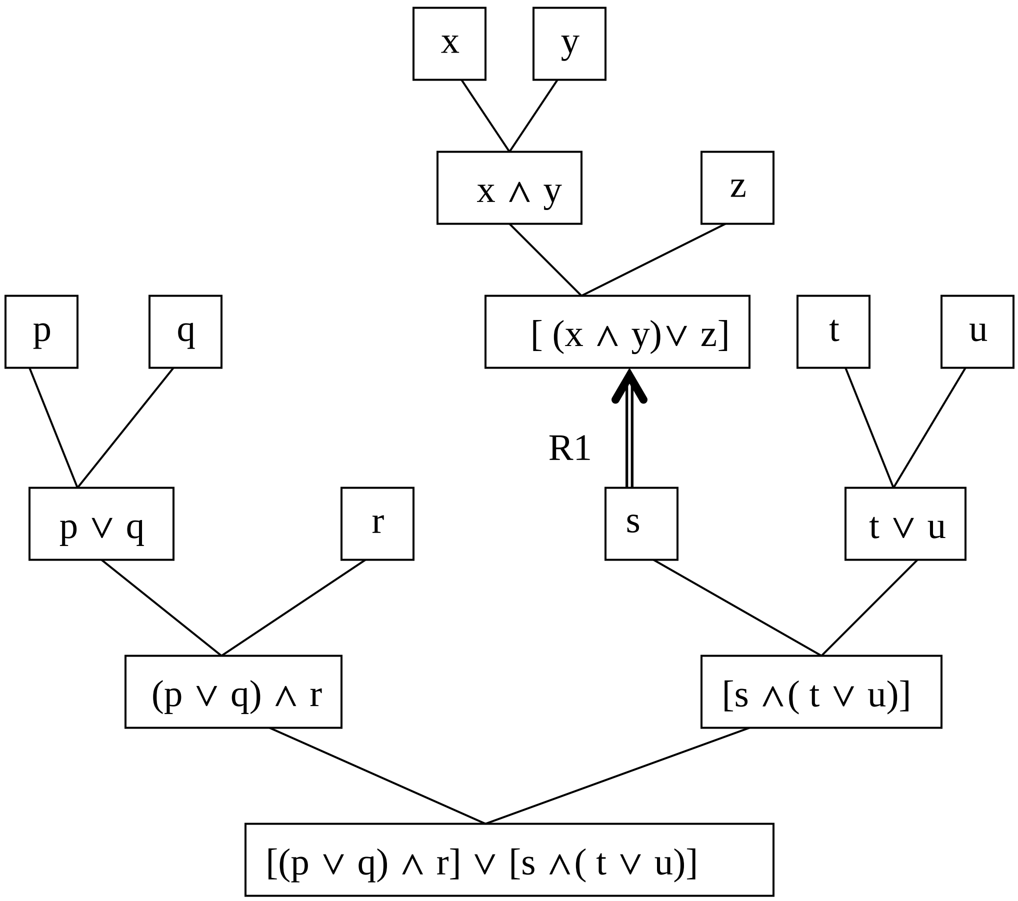
$\neg p(x,y,f(x,y)) \rightarrow q(x,u)\}$

3- goal: the goal must be in the format of disjunction of literals.

Ex:

Fact: $[(p \vee q) \wedge r] \vee [s \wedge (t \vee u)]$

Rule: R1: $s \rightarrow [(x \wedge y) \vee z]$



After Appling R1, the following clauses are generated

p ∨ q ∨ x ∨z

p ∨ q ∨ y ∨z

r ∨ x ∨z

r ∨ y ∨z

p ∨ q ∨ s

p ∨ q ∨ t ∨u

r ∨ s

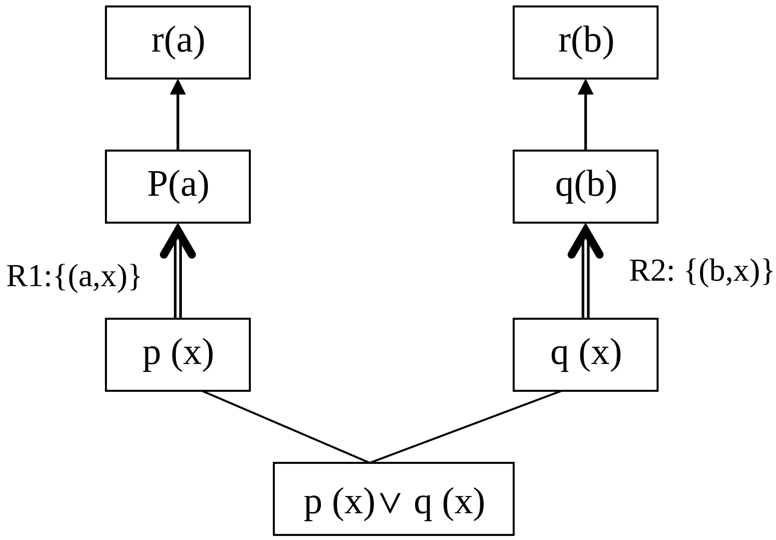
r ∨ t ∨ u

Ex: with variables

Fact: p (x)∨ q (x)

Rules: R1: p(a) → r(a)

R2: $q(b) \rightarrow r(b)$



Unifier composition = {(a,x),(b,x)}
This is not a consistent solution