Knowledge Representation & Reasoning

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Strategies

1. Clause elimination

- pure clause

    contains literal *ρ* such that *ρ* does not appear in any other clause

        clause cannot lead to []

- tautology

    clause with a literal and its negation

        any path to [] can bypass tautology

- subsumed clause

    a clause such that one with a subset of its literals is already present

        path to [] need only pass through short clause

    can be generalized to allow substitutions

2. Ordering strategies

    many possible ways to order search, but best and simplest is

- unit preference

    prefer to resolve unit clauses first

        Why? Given unit clause and another clause, resolvent is a smaller one ➟ []

Strategies 2

3. Set of support

    KB is usually satisfiable, so not very useful to resolve among clauses with only ancestors in KB

    contradiction arises from interaction with ¬Q

  always resolve with at least one clause that has an ancestor in ¬Q

    preserves completeness (sometimes)

4. Connection graph

    pre-compute all possible unifications

  build a graph with edges between any two unifiable literals of opposite polarity

    label edge with MGU

  Resolution procedure:

    repeatedly: select link
    compute resolvent
    inherit links from parents after substitution

  Resolution as search: find sequence of links L_1, L_2, ... producing []

Strategies 3

5. Special treatment for equality

   instead of using axioms for =

   relexitivity, symmetry, transitivity, substitution of equals for equals

   use new inference rule: <u>paramodulation</u>

   from $\{(t{=}s)\} \cup C_1$ and $\{P(\ldots\ t'\ldots)\} \cup C_2$

   where $t\theta = t'\theta$

   infer $\{P(\ldots\ s\ \ldots)\}\theta \cup C_1\theta \cup C_2\theta$.

   collapses many resolution steps into one

   see also: theory resolution (later)

6. Sorted logic

   terms get sorts:

   x: Male mother:[Person $\rightarrow$ Female]

   keep taxonomy of sorts

   only unify $P(s)$ with $P(t)$ when sorts are compatible

   assumes only “meaningful” paths will lead to []

Finally...

7. Directional connectives

given $[\neg p, q]$, can interpret as either

from *p*, infer *q* (forward)

to prove *q*, prove *p* (backward)

procedural reading of $\supset$

In 1st case: would only resolve $[\neg p, q]$ with $[p, ...]$ producing $[q, ...]$

In 2nd case: would only resolve $[\neg p, q]$ with $[\neg q, ...]$ producing $[\neg p, ...]$

Intended application:

forward: $\text{Battleship}(x) \supset \text{Gray}(x)$

do not want to try to prove something is gray
by trying to prove that it is a battleship

backward: $\text{Person}(x) \supset \text{Has}(x,\text{spleen})$

do not want to conclude the spleen property for
each individual inferred to be a person

This is the starting point for the procedural representations