Constraints

Up to now - unconstrained datasets
   any dataset from its Herbrand base is acceptable

Not always the case
   person cannot be own parent
   person cannot be both dead and alive
   every parent in parent relation must be in adult relation
illegal
  Boolean / 0-ary predicate
  true if and only if dataset violates at least one constraint

We encode constraints by defining illegal.
A person cannot be his own parent.

\[
\text{illegal} :- \text{parent}(X,X)
\]

A person cannot be both male and female.

\[
\text{illegal} :- \text{male}(X) \& \text{female}(X)
\]

Every parent is an adult.

\[
\text{illegal} :- \text{parent}(X,Y) \& \sim\text{adult}(X)
\]
Optimization
Earlier we saw techniques for reordering or dropping subgoals and dropping rules.

By limiting our attention to a subset of all datasets, opportunities arise that would not otherwise be justified.
Constraints

illegal :- p(X,X)
illegal :- p(X,Y) & p(Y,X)

View Definition

r(X,Y,Z) :- p(X,Y) & p(Y,Z)
r(X,Y,Z) :- p(X,Y) & p(Y,Z) & p(Y,X)

Analysis

First rule okay.
Second rule violates antisymmetry (p(X,Y) and p(Y,X))
Subgoal Elimination

Constraints

illegal :- f(X,Y) & ~p(X,Y)
illegal :- m(X,Y) & ~p(X,Y)

View Definition

r(X,Y,Z) :- f(X,Y) & p(X,Y) & p(Y,Z)
r(X,Y,Z) :- f(X,Y) & p(Y,Z)

Analysis

f(X,Y) and p(X,Y) are redundant
Drop p(X,Y) since guaranteed by f(X,Y)
Subgoal Ordering

View Definition
\[ r(X,Y) :- p(X,Y) & q(X,Y) \]

Constraint
\[ \text{illegal} :- q(X,Y) & q(X,Z) & \text{distinct}(Y,Z) \]

Analysis
At most one answer to \( q(X,Y) \) for any given \( x \)
Put \( q(X,Y) \) before \( p(X,Y) \)
View Definition
\[ r(X,Z) :- p(X,Y) & p(Y,Z) & p(Z,W) \]

Constraint
\[ illegal :- p(X,Y) & p(Y,Z) & \neg gp(X,Z) \]

Better Definition
\[ r(X,Z) :- gp(X,Z) & p(Z,W) \]
Managing Inconsistency
Techniques

Reporting Violated Constraints
Reporting Specific Conflicts
Repairing Errors
Paraconsistent Reasoning
General Error Messages

error("Parenthood is irreflexive.") :-
    parent(X,X)

error("Parenthood is antisymmetric.") :-
    parent(X,Y) & parent(Y,Z)

Customized Error Messages

error(Msg) :-
    parent(X,X) &
    stringify(X,XS) &
    stringappend(XS," cannot be own parent.",Msg)
Reporting Conflict Sets

Constraints

illegal :- p(a) & q(a)
illegal :- ~q(a) & r(a)

Dataset

p(a) q(a) r(a)

Conflict Sets

\{p(a), q(a)\}
\{~p(a), r(a)\}
Think of every conflict set as a conjunction of conditions that must all be made false to eliminate the inconsistency.

To repair a conflict set, at least one of the conjuncts must be made false.
Unfortunately, just choosing an arbitrary element is not good enough, as this can lead to new inconsistencies. illegal :-

Constraints
illegal :- p(a) & q(a)
illegal :- ~q(a) & r(a)

Dataset
p(a) q(a) r(a)

Deducing Additional Constraints
illegal :- p(a) & r(a)
Paraconsistent Reasoning is reasoning in the presence of contradictions. The aim is to produce results that follow reasonably from premises and to avoid results that follow from contradictory data.

One Technique: Find consistent subsets of data and apply view definitions to those datasets only.

Combine in various ways:

- **Conservative** - conclusions true in every consistent subset
- **Liberal** - conclusions true in any consistent subset
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- Conservative - conclusions true in every consistent subset
- Liberal - conclusions true in any consistent subset