Cogui Tutorial

Rules
Rules to enhance expressivness

- The vocabulary can be seen as a *lightweight* ontology.
- We can enrich it with **rules** expressing properties of relations and concepts.
  - `parentOf` and `childOf` are inverse relations:
    - For all `x` and `y`, if `parentOf(x,y)` then `childOf(y,x)`
    - For all `x` and `y`, if `childOf(x,y)` then `parentOf(y,x)`
  - `ancesterOf` is a transitive relation:
    - For all `x`, `y` and `z`, if `ancesterOf(x,y)` and `ancesterOf(y,z)` then `ancesterOf(x,z)`
  - `siblingOf` is a symmetrical relation:
    - For all `x` and `y`, if `siblingOf(x,y)` then `siblingOf(y,x)`
More rules

- The vocabulary already encodes some kinds of rules
  
  **Definition of motherOf from parentOf**
  - For all $x$ and $y$, if motherOf($x,y$) then parentOf($x,y$) and Woman($x$) already encoded in the vocabulary by subtyping and the signature of motherOf
  - For all $x$ and $y$, if parentOf($x,y$) and Woman($x$) then motherOf($x,y$) not encoded in the vocabulary

- Rules may introduce new unknown individuals
  
  **Definition of SiblingOf from parentOf**
  - For all $x$, $y$ and $z$, if parentOf($z,x$) and parentOf($z,y$) then siblingOf($x,y$)
  - For all $x$ and $y$, if siblingOf($x,y$) then there exists $z$ such that parentOf($z,x$) and parentOf($z,y$)
Conceptual Graph Rule: « ancestorOf » is transitive

Frontier nodes: *in green*

Logical translation:

\[ \forall x \forall y \forall z ( \text{Adult}(x) \land \text{Adult}(y) \land \text{Person}(z) \land \text{ancestorOf}(x, y) \land \text{ancestorOf}(y, z) ) \rightarrow \text{ancestor}(x, z) \]
Another Conceptual Graph Rule

\[
\forall x \forall y \left( \text{Person}(x) \land \text{Person}(y) \land \text{siblingsOf}(x,y) \right) \Rightarrow \exists z \left( \text{Person}(z) \land \text{parentOf}(z,x) \land \text{parentOf}(z,y) \right)
\]

Frontier nodes: *in green*
Rule application

- A rule $H \rightarrow C$ is applicable to a fact $F$ if $H$ projects to $F$

Given a projection $\pi$ from $H$ to $F$, applying the rule consists in:

1. adding $C$ to $F$
2. merging each frontier node $c'_i$ of $C$ with $\pi(c_i)$ in $F$
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Redundant rule application

- Example: trying to apply the previous sibling rule to this fact
Forward Chaining (FC) Scheme

Level 1
F1
Find new rule applications
STOP when?
- the goal (f.i. query) has been found
- there is no new and non-redundant rule application...

Level 2
F2
Forward Chaining (FC) may not halt

∀x (Person(x) → ∃y (Person(y) ∧ motherOf(y,x)))
Forward chaining soundness and completeness

- Knowledge base $K$ with a set of facts $F$ and a set of rules $R$
- Query $Q$
- $Q$ is logically deducible from $K$ if and only if there is a projection from $Q$ to a fact produced by FC ($K$)
RULES
USING COGUI
Go to Rules in the project menu
RIGHT CLICK ON DEFAULT SET AND SELECT NEW RULE
NAME YOUR RULE AND EDIT THE HYPOTHESIS AND THE CONCLUSION
To edit your rule do the same as for editing facts.
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To express that two concept nodes design the same entity add a coref relation.
DO NOT FORGET TO ADD THE COREF RELATIONS BETWEEN ALL CONCEPTS
To construct a new rule right click on default_set of rules.
WE WILL EDIT THE SIBLING OF RULE DESCRIBED EARLIER IN THE TUTORIAL
THE RULE: IF A HUMAN IS THE SIBLING OF ANOTHER HUMAN THEN THERE EXISTS AN ADULT WHO IS THE PARENT OF THE TWO HUMANS
Let us try to apply this rule on the fact example-fact-solution1
TO APPLY RULES, CLICK ON REASONING THEN SELECT APPLY RULES
SELECT THE FACT ON WHICH YOU WANT TO APPLY THE RULE AND THE DESIRED RULE
To apply the rule click Next.
THE RULES ASSISTANT PROVIDES THREE BUTTONS

use left buttons to see rule applications
THE FIRST BUTTON ALLOWS THE STEP BY STEP APPLICATION OF THE RULE
THE SECOND BUTTON ALLOWS THE SATURATION OF THE GRAPH WITH THE SELECTED RULE
The third button allows the storage of the graph enriched after rule application.
GOING BACK TO THE EXAMPLE WHEN WE CLICK ON APPLY RULE NOTHING HAPPENS!! WHY?
WE EDIT THE SIBLINGOF RULE
THE SIBLINGS OF rule edited so that the added information concerns the mother of the two humans in the hypothesis.
WE APPLY THE NEWLY EDITED RULE
WE SELECT THE STEP BY STEP APPLICATION OF THE RULE
The three nodes in the conclusion have been added in pink on the fact.
THE RULE CANNOT BE RE-APPLIED WITHOUT CAUSING REDUNDANCY
You can store the resulting graph
TO STORE THE GRAPH DRAG AND DROP
The new graph is visible in the facts set.