Inconsistencies, Negations and Changes in Ontologies

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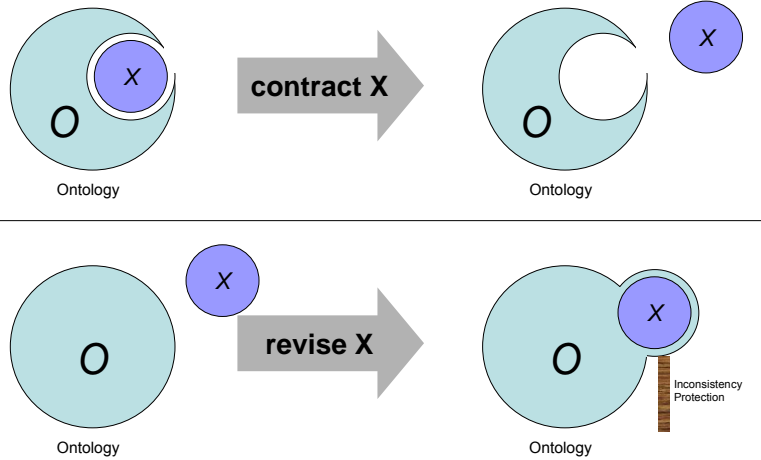[3]CWI Amsterdam, P.O.Box 94079, The Netherlands

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Ontology Evolution

contract X

revise X

Inconsistency Protection

Problem: Characteristics of Change Operators

(B−1)   K−X⊆L   (*generalized base closure*)
(B−2)   K−X⊆K   (*generalized base inclusion*)
(B−3)   If K⊭X, then K−X=K   (*generalized base vacuity*)
(B−4)   If ∅⊭X, then K−X⊭X   (*generalized base success*)
(B−5)   If X≅Y, then K−X=K−Y   (*generalized base preservation*)
(B−6)   K⊆Cn((K−X)∪X)   (*generalized base recovery*)

(B+1)   K+X=Cn(K+X)
(B+2)   X⊆K+X
(B+3)   If Cn(K∪X)≠L then K+X=Cn(K∪X)
(B+4)   If Cn(X)≠L, then Cn(K+X)≠L
(B+5)   If Cn(X)=Cn(Y), then K+X=K+Y
(B+6)   (K+X)∩K ≠ K−(¬X)

Harper: K−x=(K+ ¬x)∩K
Levi: K+x=Cn((K− ¬x)∪{x})

- Belief Revision: 2 x 6 AGM postulates
- AGM postulates describe minimal characteristics for contraction and revision

BUT Problem:
- Many description logics (including OWL DL) are not AGM-compliant
- Problem: (implicit) negation and base recovery postulate

Incoherency, Inconsistency and Negations

- *Incoherent Ontology*
An ontology O is incoherent iff there exists an unsatisfiable named concept.

- *Inconsistent Ontology*
An ontology O is inconsistent iff it has no interpretation.
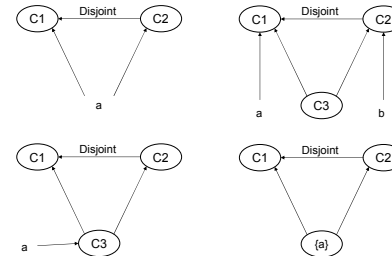
- *Coherence-Negation*
An axiom ψ is said to be a coherence-negation of an axiom ϕ, written ψ=∼ϕ,iff
  - (Incoherence) {ϕ, ψ} is incoherent,
  - (Minimality) There exist no other ψ' such that ψ' satisfies the condition (i), and Cn({ψ'}) ⊂ Cn({ψ}).

- *Consistency-Negation*
An axiom ψ is said to be a consistency-negation of an axiom ϕ, written ψ=¬ϕ, iff
  - (Inconsistency) {ϕ, ψ} is inconsistent,
  - (Minimality) There exist no other ψ' such that ψ' satisfies the condition (i) and Cn({ψ'}) ⊂ Cn({ψ}).

New Postulates for Change Operators

(O-1)   O-X ⊆ O.
(O-2)   If O ⊭ X, then O-X=O.
(O-3)   If ∅ ⊭ X, then O-X ⊭ X.
(O-4)   If X ≅ Y, then O-X=O-Y.
(O-5)   If Cn((O-X) ∪ X) ⊂ Cn(Y ∪ X) for some Y⊆ O, then Y ⊨ X and ∅ ⊭ X.

(O+1)   X ⊆ O+X.
(O+2)   If Cn(O ∪ X) ≠ L, then O+X=O ∪ X.
(O+3)   If Cn(X) ≠ L, then Cn(O+X) ≠ L.
(O+4)   If X ≅ Y, then O+X ≅ O+Y.
(O+5)   (O+X) ∩ O ≅ O-¬ X.

Harper: O-X≅ Cn(O+ ¬ X) ∩ Cn(O)
Levi: O+X≅ Cn(O- ¬ X) ∪ Cn(X).

Results:
- Framework accounts for negation, inconsistency and change for DL-based ontologies for management of dynamic ontologies.
- Proposed negations achieve the Harper identity and Levi identity for ontology change
- Distinction between incoherence and inconsistency provides us two different approaches covering different needs in different application scenarios.