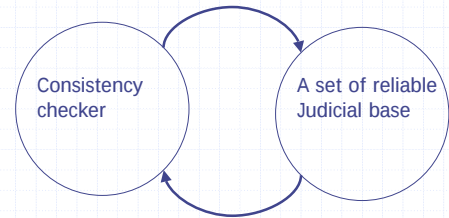


Title	Inference from paraconsistent legal knowledge
Author(s)	Tojo, Satoshi
Citation	
Issue Date	2005-03-11
Type	Presentation
Text version	publisher
URL	http://hdl.handle.net/10119/8272
Rights	
Description	JAIST 21世紀COEシンポジウム2005「検証進化可能電子社会」 = JAIST 21st Century COE Symposium 2005 “Verifiable and Evolvable e-Society”, 開催 : 2005年3月10日～11日, 開催場所 : 石川ハイテク交流センター, Technical session 2 <Legal Reasoning>

Inference from paraconsistent legal knowledge

Satoshi Tojo
JAIST

For safe e-society



Inconsistency checker

- ◆ Influence on code change, revision, or update
- ↓
- ◆ Necessity of logical consistency

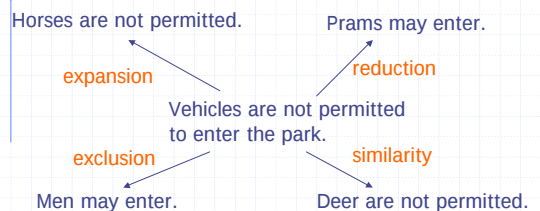
Legal reasoning, thus far

- ◆ Expert system based on First-order logic
- ◆ Rule-based reasoning
- ◆ Case-based reasoning
- ◆ Defeasible reasoning by multi-agents
- ◆ Similarity
- ◆ Event and temporal reasoning
- ◆ ...

Ex1: negative connective ($\neg$)

- ◆ 'Self-defence is tolerable.'
 $\forall x[act(x) \wedge selfdefence(x) \rightarrow tolerable(x)]$
- ◆ 'Self-defence would not be punished.'
 $\forall x[act(x) \wedge selfdefence(x) \rightarrow \neg crime(x)]$

Ex2: revision



Nonmonotonic reasoning

- ◆ Belief revision
 - expansion
 - revision
 - contraction
- ◆ Default logic
- ◆ Circumscription

Belief revision

$$\{\alpha, \alpha \rightarrow \beta, \beta \rightarrow \gamma\} \vdash \neg \gamma$$



$$\begin{aligned} &\{\alpha, \alpha \rightarrow \beta, \neg \gamma\}, \text{ or} \\ &\{\alpha, \beta \rightarrow \gamma, \neg \gamma\}, \text{ or} \\ &\{\alpha \rightarrow \beta, \beta \rightarrow \gamma, \neg \gamma\} \end{aligned}$$

Circumscription

$$\{r(a), p(x) \rightarrow r(x), q(x) \rightarrow r(x)\}$$

Predicate completion

$$r(x) \rightarrow p(x) \vee q(x) \vee (x = a)$$

'Vehicles are not permitted, exclusive of small and ones.'

$$vehicle(x) \rightarrow \neg permitted(x).$$

$$vehicle(x) \wedge light(x) \rightarrow permitted(x).$$

↓ circumscription

$$permitted(x) \rightarrow \neg vehicle(x) \vee (vehicle(x) \wedge light(x))$$

Logic with paraconsistency

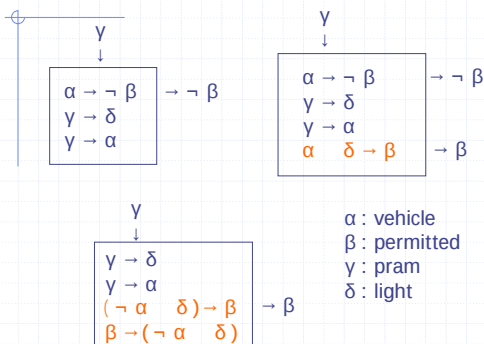
- ◆ Multiple concepts of negation



- ◆ Reasoning from an inconsistent knowledge



- ◆ Prover with paraconsistent logic



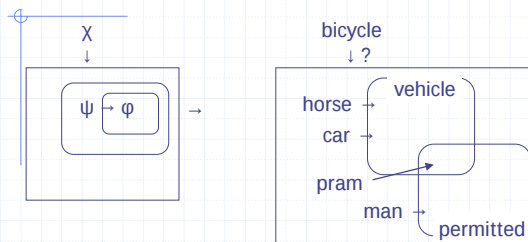
Minimal negation

Graded negation

$$\Delta \vdash \neg_{\varphi} \psi \text{ iff } \Delta \vdash \varphi \text{ and } \varphi \wedge \psi \vdash \perp$$

Minimal negation $\Delta \vdash \ominus_{\varphi} \chi$

$\Delta \vdash \neg_{\varphi} \chi$, and for any ψ , if $\Delta \vdash \neg_{\psi} \chi$ and $\vdash \varphi \rightarrow \psi$ then $\psi \rightarrow \varphi$



Maximal toleration

$$\Delta \vdash \circ_{\varphi} \psi \text{ iff } \Delta \vdash \varphi \text{ and } \varphi \wedge \psi \not\vdash \perp.$$

Maximal toleration $\Delta \vdash \oplus_{\varphi} \chi$

$\Delta \vdash \circ_{\varphi} \chi$, and for all ψ , if $\Delta \vdash \circ_{\psi} \chi$ and

$\vdash \psi \rightarrow \varphi$ then $\varphi \rightarrow \psi$

In multiple $MC(\Delta)$,

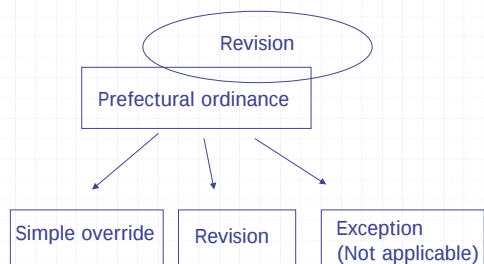
Absolute reject: for all,

$$\Delta^* \in MC(\Delta), \Delta^* \cup \{\chi\} \vdash \perp.$$

Possibly reject: there exists

$$\Delta^* \in MC(\Delta) \text{ that } \Delta^* \cup \{\chi\} \not\vdash \perp.$$

Ex3. Code revision



Summary

We admit:

- ◆ Multiple negations, and
 - ◆ Knowledge-base may be inconsistent
- But,
- ◆ Minimal negation,
 - ◆ Maximal toleration, and
 - ◆ Prover.