Using Intuitionistic Logic as a basis for Legal Ontologies

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Considerations on Legal Ontologies

What is an Ontology ?

- ▶ A declarative description of a domain.

- ▶ Ontology consistency is mandatory.

- ▶ Consistency means absence of contradictions.

- ▶ Negation is an essential operator.

- ▶ Concretely, an Ontology is a Knowledge Base:

- ▶ A set of Logical Assertions on a Domain that aim to describe it completely.

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What does it mean the term "Law" ?

- ▶ What does count as the "unit of law" ? Open question, a.k.a. "The individuation problem".

- ▶ (Raz1972) What is to count as one "complete law" ?

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Two main (distinct) approaches to the "Individuation problem".

- ▶ Taking all (existing) legally valid statements as a whole. This totality is called "the law".

- ▶ ▷ Legal Positivism tradition (Kelsen1991). Question: Natural coherence versus Knowledge Management resulted coherence.

- ▶ Taking into account all individual legally valid statement as individual laws.

- ▶ ▷ Facilitates the analysis of structural relationship between laws, viz. Primary and Secondary Rules.

- ▶ **The second seems to be quite adequate to Legal AI**.

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Why we do not consider Deontic Modal Logic ?

- ▶ Deontic Logic does not properly distinguish between the normative status of a situation from the normative status of a norm (rule). (Valente1995)

- ▶ Norms should not have truth-value, they are not propositions. (Kelsen1991)

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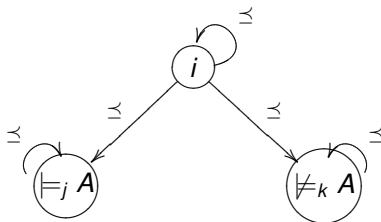
<u>Intuitionistic versus Classical Negation</u>:

What does it mean to negate a proposition ??

<u>Classical Negation classifies</u>

$$
\begin{array}{rcl}
\text{"John is of Legal Age"} & \Longrightarrow & John \in JuridicalActors \\
\text{NOT "John is of Legal Age"} & \Leftrightarrow & \text{"John is not of Legal Age"} \\
\text{"John is not of Legal Age"} & \Longrightarrow & John \in NonJuridicalActors
\end{array}
$$

Intuitionistic versus Classical Negation:

What does it mean to negate a proposition ??

The Intuitionistic Negation

$\models_i \neg A$, iff, for all j, if $i \preceq j$ then $\not\models_j A$

$\not\models_i \neg\neg A \rightarrow A$ and $\not\models_i A \vee \neg A$

Intuitionistic versus Classical Negation:

What does it mean to negate a proposition ??

The Intuitionistic Set Theory Approach to Law

"John is of Legal Age" $\implies$ *John $\in$ JuridicalActors*

"John is not of Legal Age" means

> No legal concept dominating "Legal Age" has *John* in it

John $\notin$ JuridicalActors a.w.a.

> *John $\notin$ C* for all *JuridicalActors $\preceq$ C*

Intuitionistic versus Classical Negation:

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The Intuitionistic Description Logic approach to Law

The universe is inhabited by Valid Legal Statments (*VLS*).

BR is the set of Valid Legal Statments in Brasil.

"Mary is 18 and lives in Rio"	$\implies$	"Mary is of Legal Age"$\in BR$
"John is 17 years old"	$\implies$	"John is of Legal Age"$\notin BR$

NOT "John is of Legal Age"$\in BR$ means

> There is no *VLS*
> dominating
> "John is of Legal Age"
> in *BR*

"John is not of Legal Age"   may not be | a Valid Legal Statment |

The Intuitionistic Description Logic *iALC*

Syntax

$$C, D ::= A \mid \bot \mid \top \mid \neg C \mid C \sqcap D \mid C \sqcup D \mid C \sqsubseteq D \mid \exists R.C \mid \forall R.C$$

Semantics

By a structure $\mathcal{I} = (\Delta^{\mathcal{I}}, \preceq^{\mathcal{I}}, \cdot^{\mathcal{I}})$ closed under refinement, i.e., $x \in A^{\mathcal{I}}$ and $x \preceq^{\mathcal{I}} y$ implies $y \in A^{\mathcal{I}}$.

$$
\begin{aligned}
\top^{\mathcal{I}} &=_{df} \Delta^{\mathcal{I}} \\
(\neg C)^{\mathcal{I}} &=_{df} \{x \mid \forall y \in \Delta^{\mathcal{I}}.x \preceq y \Rightarrow y \notin C^{\mathcal{I}}\} \\
(C \sqcap D)^{\mathcal{I}} &=_{df} C^{\mathcal{I}} \cap D^{\mathcal{I}} \\
(C \sqcup D)^{\mathcal{I}} &=_{df} C^{\mathcal{I}} \cup D^{\mathcal{I}} \\
(C \sqsubseteq D)^{\mathcal{I}} &=_{df} \{x \mid \forall y \in \Delta^{\mathcal{I}}.(x \preceq y \text{ and } y \in C^{\mathcal{I}}) \Rightarrow y \in D^{\mathcal{I}}\} \\
(\exists R.C)^{\mathcal{I}} &=_{df} \{x \mid \forall y \in \Delta^{\mathcal{I}}.x \preceq y \Rightarrow \exists z \in \Delta^{\mathcal{I}}.(y, z) \in R^{\mathcal{I}} \text{ and } z \in C^{\mathcal{I}}\} \\
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Using *iALC* to formalize Conflict of Laws in Space

A Case Study

Peter and Maria signed a renting contract. The subject of the contract is an apartment in Rio de Janeiro. The contract states that any dispute will go to court in Rio de Janeiro. Peter is 17 and Maria is 20. Peter lives in Edinburgh and Maria lives in Rio.

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The valid legal statements (individuals)

Only legally capable individuals have civil obligations:

contract $\preceq$ *PeterLegalAge*

contract $\preceq$ *MariaLegalAge*

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The concepts and their relationships

BR is the "set" of Brazilian Valid Legal Statments

SC is the "set" of Scottish Valid Legal Statments

PIL_{BR} is the "set" of Private International Law in Brasil

ABROAD is the "set" of *VLS* abroad Brasil

LexDomicilium is a legal connection:

▷ The pair ⟨*PeterLegalAge*, *PeterLegalAge*⟩ is in it

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The Axioms (Subsumptions)

> *MariaLegalAge* $\in$ *BR*
> *PeterLegalAge* $\in$ *SC*
> *contract* $\preceq$ *PeterLegalAge*
> *contract* $\preceq$ *MariaLegalAge*
> $PIL_{BR} \sqsubseteq BR$
> $SC \sqsubseteq ABROAD$
> $\exists LexDomicilium.SC \sqsubseteq \exists LexDomicilium.ABROAD$
> $\exists LexDomicilium.ABROAD \sqsubseteq PIL_{BR}$
> $\langle PeterLegalAge, PeterLegalAge \rangle \in LexDomicilium$

Using *iALC* semantics, one concludes that: *contract* $\in$ *BR*. Each legal statement generalizing ($\preceq$) *contract* is in *BR*. Interesting case
PeterLegalAge $\in \exists LexDomicilium.SC \sqsubseteq PIL_{BR} \sqsubseteq BR$.

Using *iALC* to formalize Conflict of Laws in Space

Summary of the Approach

- ▶ Individual Legal Valid Statements are the individuals of the universe.
- ▶ **Concepts** are Classes of individual laws.
- ▶ **Roles** (relationships) between individuals laws denote kinds of Legal Connections
- ▶ Subsumptions and Negations are intuitionistically interpreted (*iALC*)

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Conclusions

- ▶ (+) Using *ALC* instead of *iALC* seems to
  - ▶ lead us considering a legal ontology involving non-valid Legal Statements
  - ▶ deal with ad hoc ontology regarding jurisprudence main concepts.
  - ▶ increase complexity, since many non-valid Legal Statements might have to be considered.
- ▶ (+) More adequate according philosophical and jurisprudence theory.
- ▶ (+) Juridic cases can be analyzed in the ABOX.
- ▶ (+) TBOX describes "The Law".
- ▶ (+) There is a Deductive System for *iALC*, the logic is decidable.
- ▶ (-) *preceq* is not always specified at the level of the TBOX.
- ▶ (-) It seems to scale, but there is no empirical evidence.
- ▶ (?) Is the coherence analysis easier ?

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