

# A Study on Translating Regulatory Rules from Natural Language to Defeasible Logic

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# Overview

- Goal – translation of regulations from natural language to a formalisation.
- Approach – C&C/Boxer and DL translations.
- Comparison.
- Discussion.

# Context

- Legal regulations are expressed in Natural Language.
- To automatically process, the regulations must be translated to a machine-readable formalisation.
- Advantages:
  - consistency and redundancy
  - draw inferences given ground facts
  - provide explanations of determinations
- Use cases:
  - extracting and formalising relevant rules for rulebooks
  - checking for compliance to regulations
  - serving expert system web-front ends to users

# Problem

- The language of legal regulations (Wyner and Peters 2011):
  - long, complex sentences
  - embedded constructions
  - lists
  - terminology
- Time, labour, knowledge-intensive to translate (difficult to understand even without translation).

# Example Materials

8.2 Consumers or former Customers who make a Complaint to a Supplier will be treated with fairness and courtesy, and their Complaint will be dealt with objectively and efficiently by the Supplier.

- 8.2.1 A Supplier must take the following actions to enable this outcome:
  - (a) **Demonstrate fairness, courtesy, objectivity and efficiency:** Suppliers must demonstrate, fairness and courtesy, objectivity, and efficiency by: ....
    - (xiii) completing all necessary actions to deliver the Resolution offered within 10 Working Days of the Consumer's or former Customer's acceptance of that Resolution unless:
      - otherwise agreed with the Consumer or former Customer; or
      - the actions are contingent on actions by the Consumer or former Customer that have not been completed;

# Long History

- Efforts to manually translate the *British Nationality Act (1981)* to a logic program – Sergot et al. (1986).
- *Oracle Policy Management* – manual 'normalisation' of regulations into a CNL (see also ACE, SBVR, other CNLs).
- Other studies:
  - Wyner, van Engers, and Bahreini (2010), Wyner and Peters (2011), Wyner, et al. (2012), Levi and Nazarenko (2013), Abi-Lahoud et al. (2013)....
- Drawbacks:
  - Manual and high cost. No NLP or *translation target* to support transformation of NL to a formal language.

# Proposal

- Translate automatically using *C&C/Boxer*.
- Manually translate to *Defeasible Logic* (serving as a Gold Standard).
- Compare outputs.

# Materials

- Clauses from the Australia's *Telecommunications Consumer Protections Code (2012)* on complaint management.
- Source (formatted, elliptical) -> Modified Source (sentences, fill in ellipses).



# Materials – Modified Source

- 8.2.1.a.xii. Suppliers must advise consumers in everyday language of the resolution of their complaint as soon as practicable after the supplier completes its investigation of the complaint.
- 8.2.1.a.xiii. B. Suppliers must complete all necessary actions to deliver the resolution offered within 10 working days of the consumer's acceptance of that resolution unless the actions are contingent on actions by the consumer that have not been completed.
- 8.2.1.a.xi. Suppliers must provide a means for the consumer to monitor the complaint's progress.

# Method – C&C/Boxer

A parser with semantic representation.

Bill threw the ball into the street.

Can also output this as RuleML.

```
x1 x3 e5 x7 t9 t10
```

```
named(x1, bill, nam)
ball(x3)
throw(e5)
Cause(e5, x1)
Theme(e5, x3)
street(x7)
into(e5, x7)
now(t9)
e5  $\subseteq$  t10
t10 < t9
```

# Method – Defeasible Logic + Deontic Operators

- facts - indisputable statements, e.g. *Bill is happy* is  $happy(bill)$ ;
- strict rules - material implication in classical logic, e.g. *Emus are birds* is  $r'$ :  $emu(X) \rightarrow bird(X)$ ;
- defeasible rules - rules from which we draw inferences, unless the rule is defeated by superior, contrary evidence, e.g. *Birds typically fly* is  $r''$ :  $bird(X) \Rightarrow fly(X)$ ;
- defeaters - rules that prevent conclusion of a defeasible rule from holding. They produce contrary evidence, e.g. *If an animal is heavy then it might not be able to fly* is  $heavy(X) \rightsquigarrow \neg fly(X)$ , which only prevents the conclusion  $fly(X)$  where  $heavy(X)$ ;
- a superiority relation among rules - the relation allows us to draw a “winning” conclusion from rules with opposition conclusions, e.g. where  $r'''$ :  $brokenWing(X) \Rightarrow \neg fly(X)$  and  $r''' > r''$ , the bird with a broken wing does not fly.

**Maintenance obligation (OM)** - obligations that, once introduced, require that a state be maintained for a given period of time, e.g. *After opening a bank account, customers must keep a positive balance until bank charges are taken out.*

# Method – Translate and Compare

- Apply C&C/Boxer to all the sentences of the corpus.
- Provide DL representations for all the sentences of the corpus.
- Observe aspects of each.
- Compare outputs.
  
- Some DL aspects that are not apparent in the source (defeaters and superiority relation). We give just a small example.

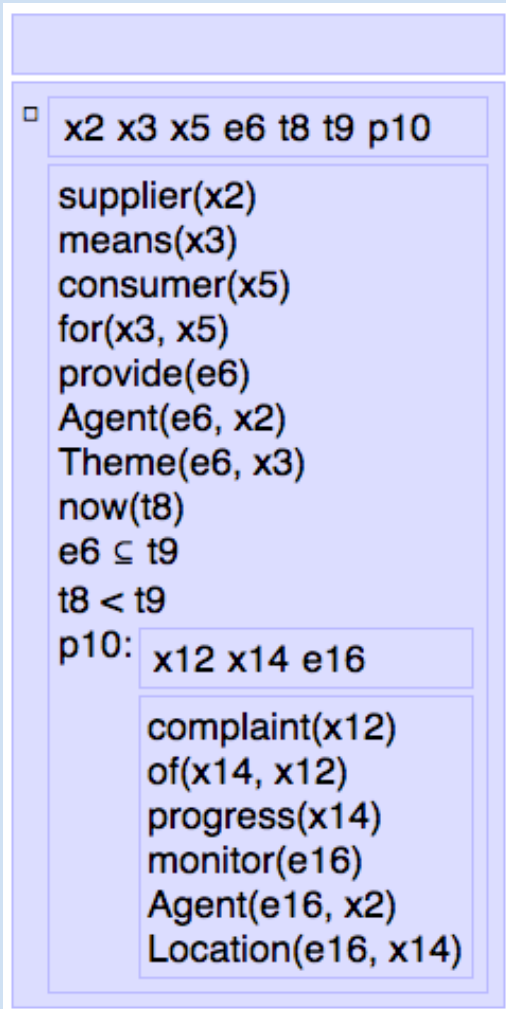
# Sample

Sentence:

*Suppliers must provide a means for the consumer to monitor the complaint's progress.*

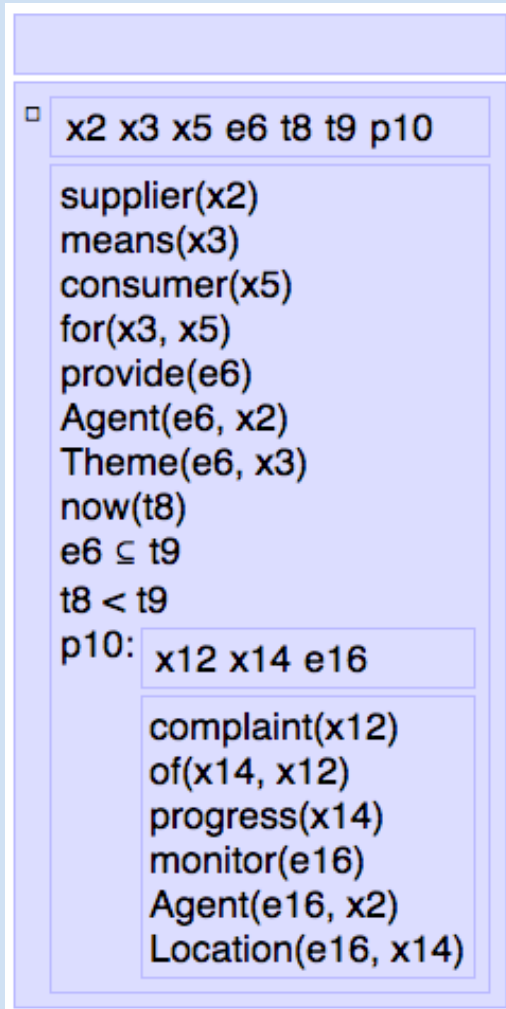
Defeasible Logic:

*complaint(X),  
complaint\_acknowledgment(X) =>  
[OM]customer\_monitor\_progress(X)*



# Sample

- C&C/Boxer correctly outputs some aspects of the sentence.
- Highly articulated.
- Misses the generic, law-like interpretation.
- 'must' is the 'box', undirected (no bearer), wide scope.
- Parsing and representation issues: progress as location; agent of monitoring is supplier rather than consumer.
- No defeasibility.



# Sample

Defeasible Logic:

$complaint(X), complaint\_acknowledgment(X) \Rightarrow$   
 $[OM]customer\_monitor\_progress(X)$

- Manual and intuitive translation.
- Introduces a presupposition (complaint acknowledged).
- Narrow scope of modal.
- Maintenance obligation – lexical source.
- Coarse-grained analysis: no tense, no thematic roles, complex predicates, omitted terms (e.g. *means*), no subjects.
- Undirected obligation (no bearer).
- Defeaters and superiority relation.

# Future Work

- These specific observations help us understand what each approach does and, if desired, what specifically needs to be done to be able to automatically parse and semantically represent sentences in a suitable formal representation.
- Continue to make such comparisons and contrasts, resulting in guidance for the development of future systems.



# Thanks for your attention!

- Questions?
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