On Extending RuleML for Modal Defeasible Logic

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NICTA

University of Queensland

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Guido gives a talk on Friday 31 October at 9:15am

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INT Guido gives a talk on Friday 31 October at 9:15am

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Normal Modal Logic

1. propositional logic
2. $\Box(A \rightarrow B) \rightarrow (\Box A \rightarrow \Box B)$
3. $\vdash A / \vdash \Box A$ or $A \vdash B / \Box A \vdash \Box B$
4. $\Box A \rightarrow A$ $(\Box A \vdash A)$
5. $\Box A \rightarrow \neg\Box\neg A$ $(\Box A \vdash \neg\Box\neg A)$
6. $\Box A \rightarrow \Box\Box A$ $(\Box A \vdash \Box\Box A)$
7. $\Box A \rightarrow \neg\Box\neg\Box A$ $(\Box A \vdash \neg\Box\neg\Box A)$

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- $1 + 2 + 3 =$ Logical omniscience (and expected side-effects)
- $1 =$ monotonic

Being Lazy

Factual omniscience and (non-)monotonic reasoning

$$PhD \rightarrow Uni$$

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$$\begin{aligned} \mathit{PhD} &\rightarrow \mathit{Uni} \\ \mathit{Weekend} &\rightarrow \neg \mathit{Uni} \\ \mathit{PublicHoliday} &\rightarrow \neg \mathit{Uni} \\ \mathit{Sick} &\rightarrow \neg \mathit{Uni} \end{aligned}$$

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VIC= Very Important Conference

Being Lazy: Reasonable Results with Minimum Eff

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$$Phd \wedge (\neg Weekend \vee (Weekend \wedge VICdeadline \wedge \neg PartnerBirthday)) \wedge \neg Sick \ldots \rightarrow Uni$$

Why Defeasible Logic?

Rule-based non-monotonic formalism

- Flexible
- Efficient (linear complexity)
- Directly skeptic semantics
- Argumentation semantics
- Constrictive proof theory
- Optimised/efficient implementations (1000000 rules)
- Extensible

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Defeasible Logic: Strength of Conclusions

- Derive (plausible) conclusions with the minimum amount of information.
  - Definite conclusions
  - Defeasible conclusions
- Defeasible Theory
  - Facts
  - Strict rules ($A \rightarrow B$)
  - Defeasible rules ($A \Rightarrow B$)
  - Defeaters ($A \leadsto B$)
  - Superiority relation over rules

Conclusions in Defeasible Logic

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Example

Facts: A_1, A_2, B_1, B_2

Rules: $r_1 : A_1 \Rightarrow C$
$r_2 : A_2 \Rightarrow C$
$r_3 : B_1 \Rightarrow \neg C$
$r_4 : B_2 \Rightarrow \neg C$
$r_5 : B_3 \Rightarrow \neg C$

Superiority relation:

$r_1 > r_3$
$r_2 > r_4$
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Phase 3: Rebut the counterarguments

r_3 weaker than r_1

r_4 weaker than r_2

r_5 is not applicable

Modal Defeasible Logic: Mode and Strength

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   - $A_1, \ldots, A_n \Rightarrow_{OBL} B$ (an agent has the obligation B when $A_1, \ldots, A_n$ are the case)

Conclusions in Basic Modal Defeasible Logic

- $+\Delta_{\Box_i} q$, which is intended to mean that q is definitely provable (i.e., using only facts and strict rules of mode $\Box_i$);
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We obtain $\Box_i p$ iff $+\partial_{\Box_i} p$.

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$$\frac{A_1, \ldots, A_n \Rightarrow_{\Box_1} B}{\Box_2 A_1, \ldots, \Box_2 A_n \vdash \Box_2 B}$$

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- Put in a mixer and shake well!

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Inclusion $\Box_1 \rightarrow \Box_2$

1. Give an argument for the conclusion you want to prove using rules for either $\Box_1$ or $\Box_2$
2. Consider all possible counterarguments to it
3. Rebut all counterarguments
   - Defeat the argument by a stronger one (same as 1)
   - Undercut the argument by showing that some of the premises do not hold

Conflict $\Box_1 \rightarrow \neg\Box_2\neg$

1. Give an argument for the conclusion you want to prove
2. Consider all possible counterarguments to it using rules for both $\Box_1$ and $\Box_2$
3. Rebut all counterarguments
   - Defeat the argument by a stronger one
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Conversion $\Box_1$ to $\Box_2$

1. Give an argument for the conclusion you want to prove using rules for either $\Box_2$ or rules of mode $\Box_1$ st all premises are provable with mode $\Box_2$
2. Consider all possible counterarguments to it
3. Rebut all counterarguments
   - Defeat the argument by a stronger one (same as 1)
   - Undercut the argument by showing that some of the premises do not hold (for rules of mode $\Box_1$ show that the premises are not provable with mode $\Box_2$)

Social Agent

```
<?xml version="1.0" encoding="UTF-8"?>
<ModeSet xmlns="http://www.example.org/modeset-ns"
    xmlns:ruleml="http://www.ruleml.org/0.91/xsd"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.example.org/xsd/ruleset.xsd" >
  <Mode id="BEL1" href="http://www.example.org/mode/belief" >
    <ruleml:Ind>agent1</ruleml:Ind>
  </Mode>
  <Mode id="OBL" href="http://www.example.org/mode/obligation"/>
  <Mode id="INT1" href="http://www.example.org/mode/intention" >
    <ruleml:Ind>agent1</ruleml:Ind>
  </Mode>
  <Conflict between="OBL INT1"/>
  <Conversion from="BEL1" to="INT1"/>
  <Conversion from="BEL1" to="OBL"/>
</ModeSet>
```

- Choose the appropriate modalities
- Create a defeasible consequence relation for each modality
- Identify relationships between modalities:
  - inclusion
  - conflicts
  - conversions from one modality to another modality
- Put in a mixer and shake well!

Implementation

- Apply transformation to remove defeaters
- Apply transformation to remove superiority relation
- Scan the set of rules for rules with empty body
- Take the consequent of rules with empty body and check whether there are no rules for its opposite. If so the consequent is provable
  - remove provable consequents from the body of rules
  - remove rules where the negation of provable consequents are in the body
- Scan the list of literals for literal not appearing as consequent of rules. The literal is non provable
- remove rules with non provable literals
- repeat

Why Modal Defeasible Logic

- Modelling and monitoring contracts (and norms)
- Modelling BIOlogical agents
- Compliance of business processes
- Modelling workflows
- Extended with time (instant, intervals, duration and periodicity)
- Modelling norm dynamics

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</talk>