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Towards Semantically Grounded Decision Rules Using ORM+

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RuleML 2007 (Florida, USA)

Summary

- Background: Ontologies and semantically grounded decision rules
- ORM approach to ontological commitments and its problems
- The solution: ORM+
- Discussion
- Conclusion
- Future Work

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Background

- Why semantically grounded decision rules?
  - Decision support systems mainly contain *non-sharable* decision rules
    - Decision rules are rarely written in an agreed, formal way
  - Difficult to check the *redundancy* and *similarity* in the decision rule set
    - E.g. **if** (weather is bad) **then** (stay at home)
      else if(weather is good) **then** (go for a walk).
    - **if not** (it's sunny) **then** (stay at home)
      else if (it's sunny) **then** (go for a walk).
- Use ontology to store the conceptual definition and decision items
  - E.g. "bad weather"
- Ontology
  - Explicit, sharable, formal, conceptual, stored in computers
  - DOGMA (Developing Ontology-Grounded Methods and Applications) Approach to ontology:
    - *Double articulation*: ontology = lexon base+ commitment (R. Meersman, 1999)

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Double articulation principle of ontology engineering

- Lexon (conceptualization):
  - Lexon: plausible binary fact
  - E.g. <*γ, driver, has, is issued to, drivers license*>; < *γ, driving experience, is of, has, driver*>
- Commitment (axiomatization):
  - Describes particular application views of reality
    - the use of lexons
  - Provides multiple views on stored lexons
  - Needs to be expressed by commitment language

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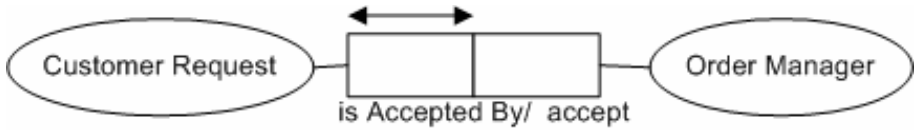
ORM approach to commitment and its problems

- ORM
  - Object Role Modeling, Terry Halpin, 1990's
  - Intended for modeling and querying DB at a conceptual level
  - Why ORM?
    - Semantically rich modeling language to model and visualize commitments for non-technical domain experts
      - Expressive capabilities in its graphical notation
      - Verbalization possibilities
    - ORM-ML for machines
      - Store ORM graphs
      - Can be mapped to OWL



  - Problems
    - ORM still lacks several logical operators and connectors for the decision semantics, e.g. implication
    - Difficulties to specify some logical operators, e.g. negation

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The solution: ORM+

- ORM+ : an extension of ORM
  - Basic propositional logic connectives
    - Negation
    - Conjunction
    - Disjunction
    - Implication
  - Modality operators
    - Necessity
    - Possibility
  - Process operator
    - Sequence

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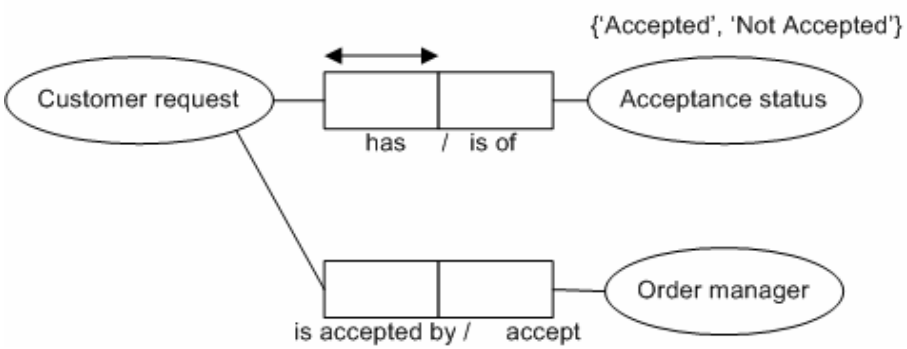
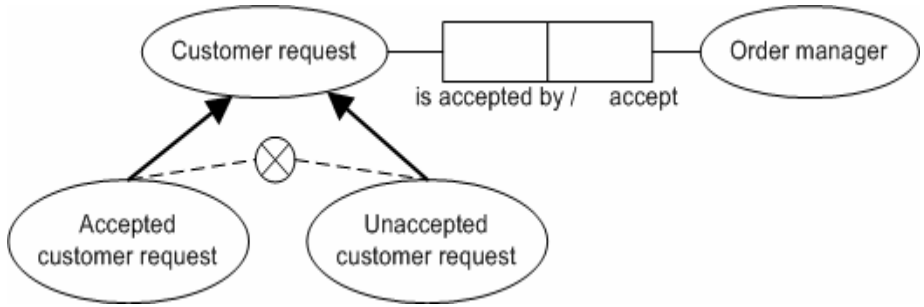
ORM+ Approach to Commitments – Negation

- ORM: “closed-world” assumption1) use value type; 2)use exclusion constraint





- ORM+: “open-world” assumption
  - because machine needs to know whether the negative situation is taken or not

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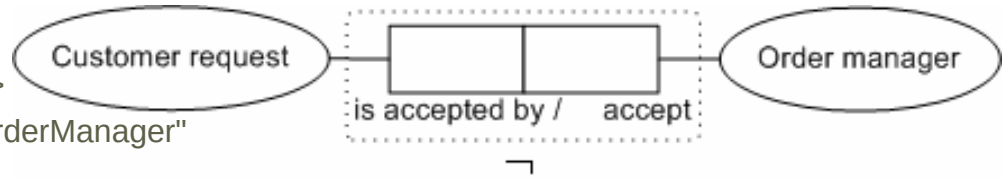
ORM+ Negation Graph & Markup Language

```
<Predicate id="lexon-2">
   <Object_Role ID="lexon2_forward"
Object="CustomerRequest" Role="isAcceptedBy"/>
   <Object_Role ID="lexon2_backward" Object="OrderManager"
Role="Accept"/>
</Predicate>
…
<Neg>
    <Atom>
        <Predicate>
            <Object_Role>lexon2_forward</Object_Role>
        </Predicate>
    </Atom>
    <Atom>
        <Predicate>
            <Object_Role>lexon2_backward</Object_Role>
        </Predicate>
    </Atom>
</Neg>
```



ORM ML+ RuleML

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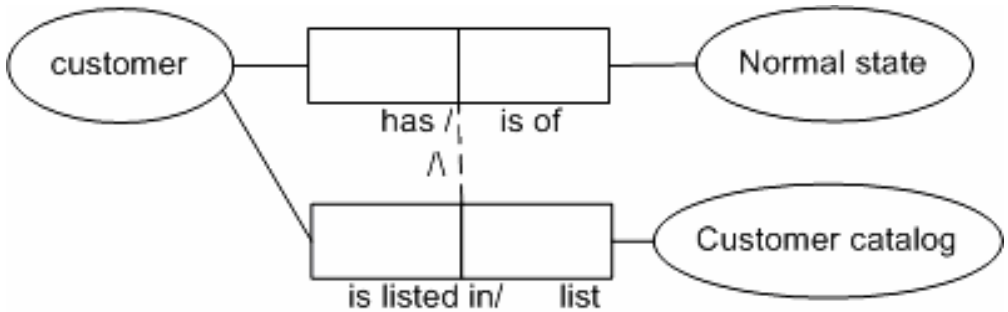
ORM+ Approach to Commitments – Conjunction

- ORM: doesn't exist
- ORM+




```
…
<Predicate id="lexon-3">
   <Object_Role ID="lexon3_forward"
    Object="Customer" Role="has"/>
   <Object_Role ID="lexon3_backward"
    Object="NormalState" Role="isOf"/>
</Predicate>

<Predicate id="lexon-4">
   <Object_Role ID="lexon4_forward"
    Object="Customer" Role="isListedIn"/>
   <Object_Role ID="lexon4_backward"
    Object="CustomerCatalog" Role="list"/>
</Predicate>
…
<And>
  <Atom>
    <Predicate>lexon-3</Predicate>
  </Atom>
  <Atom>
     <Predicate>lexon-4</Predicate>
  </Atom>
</And>
…
```

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ORM+ Approach to Commitments – Disjunction

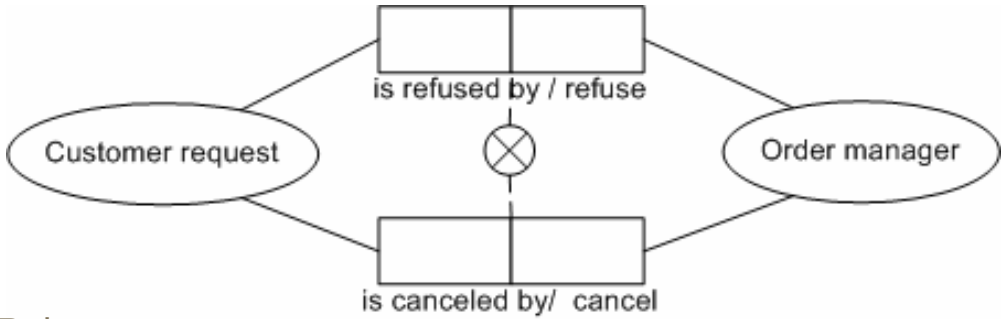
- ORM:
  - exclusive-or constraint
  - without (ordinary or)
- ORM+:
  - reuse the exclusive constraint

```
<constraint type="exclusive-or">
   <Object_Role>lexon-5</Object_Role>
   <Object_Role>lexon-6</Object_Role>
</constraint>
```

  - Ordinary or

```
<Or>
   <Atom>
      <Predicate>lexon-5</Predicate>
   </Atom>
   <Atom>
      <Predicate>lexon-6</Predicate>
   </Atom>
</Or>
```

…



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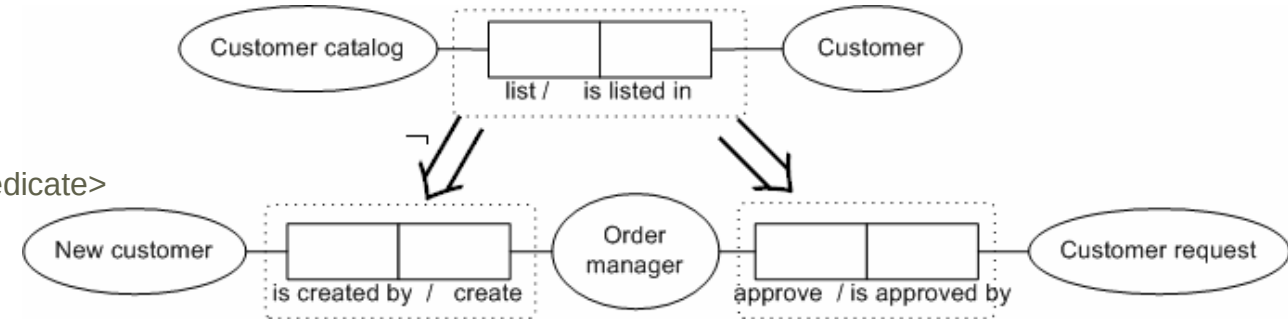
ORM+ Approach to Commitments – Implication

- ORM: doesn't exist
- ORM+:

```
<Rule type="Implies">
  <head>
    <Atom>
      <Predicate>lexon-7</Predicate>
    </Atom>
  </head>
  <body>
    <Neg>
      <Atom><Predicate><Object_Role>lexon8-
      forward</Object_Role></Predicate></Atom>
      <Atom><Predicate><Object_Role>lexon8-
      backward</Object_Role></Predicate></Atom>
    </Neg>
  </body>
</Rule>
<Rule type="Implies">
  <head>
    <Atom><Predicate>lexon-9</Predicate></Atom>
  </head>
  <body>
    <Atom><Predicate>lexon-8</Predicate></Atom>
  </body>
</Rule>…
```



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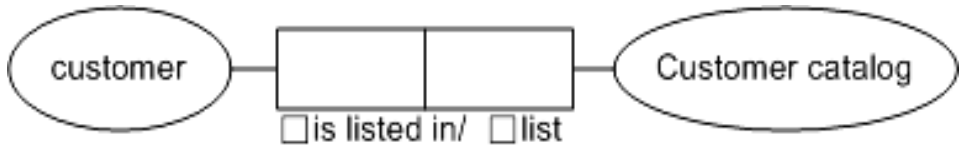
ORM+ Approach to Commitments – Necessity

- ORM: verbalization only (ORM2)
- ORM+:




```
…
<Predicate id="lexon-9">
   <Object_Role ID="lexon9_forward"
    Object="Customer" Role="isListedIn"/>
   <Object_Role ID="lexon9_backward"
    Object="CustomerCatalog" Role="list"/>
</Predicate>
…
<Constraint xsi:type= "Necessity">
   <Object_Role>
       lexon9_forward
   </Object_Role>
   <Object_Role>
      lexon9_backward
   </Object_Role>
</Constraint>
…
```

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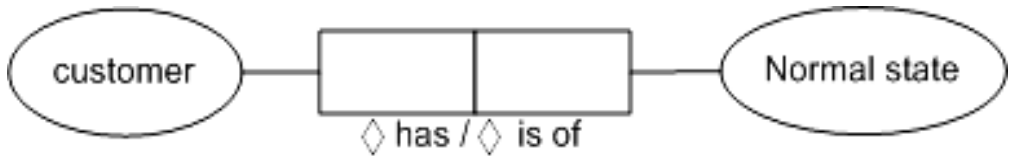
ORM+ Approach to Commitments – Possibility

- ORM: verbalization only (ORM2)
- ORM+:




```
…
<Predicate id="lexon-10">
   <Object_Role ID="lexon10_forward"
    Object="Customer" Role="has"/>
   <Object_Role ID="lexon10_backward"
    Object="NormalState" Role="isOf"/>
</Predicate>
…
<Constraint xsi:type= "Possibility">
  <Object_Role>
       lexon10_forward
  </Object_Role>
  <Object_Role>
       lexon10_backward
  </Object_Role>
</Constraint>
…
```

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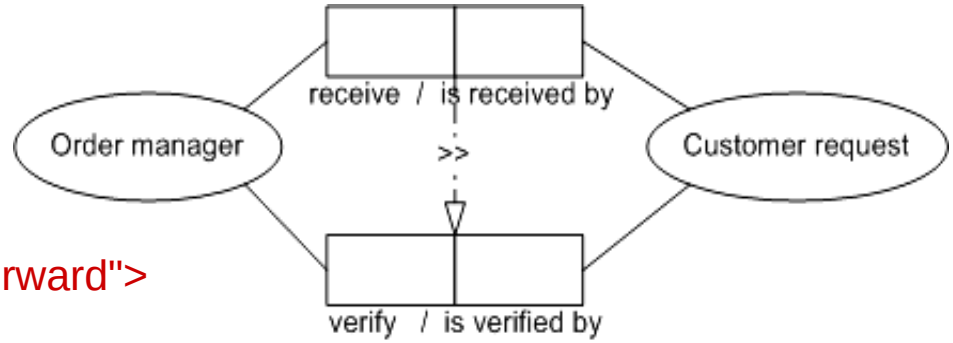
ORM+ Approach to Commitments – Sequence

- ORM: doesn't exist
- ORM+: used to control the process flow




```
...
<Rule xsi:type="Sequence" direction="forward">
    <Atom>
        <Predicate>lexon-11</Predicate>
    </Atom>
    <Atom>
        <Predicate>lexon-12</Predicate>
    </Atom>
</Rule>
...
```

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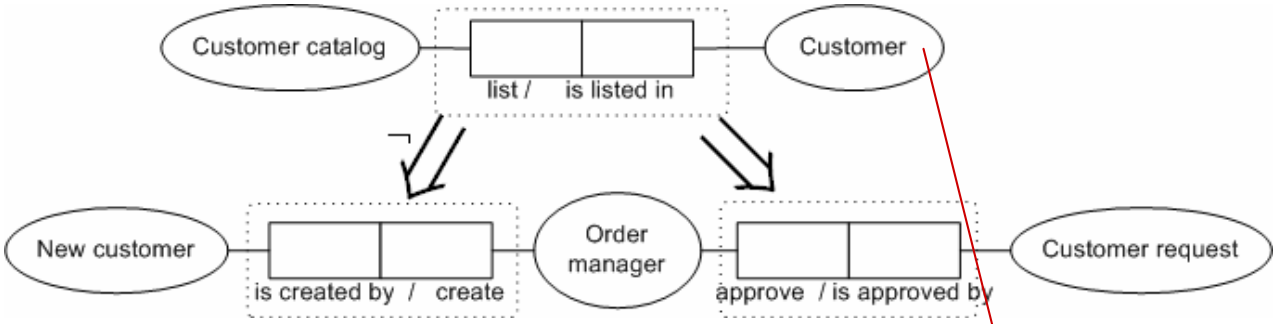
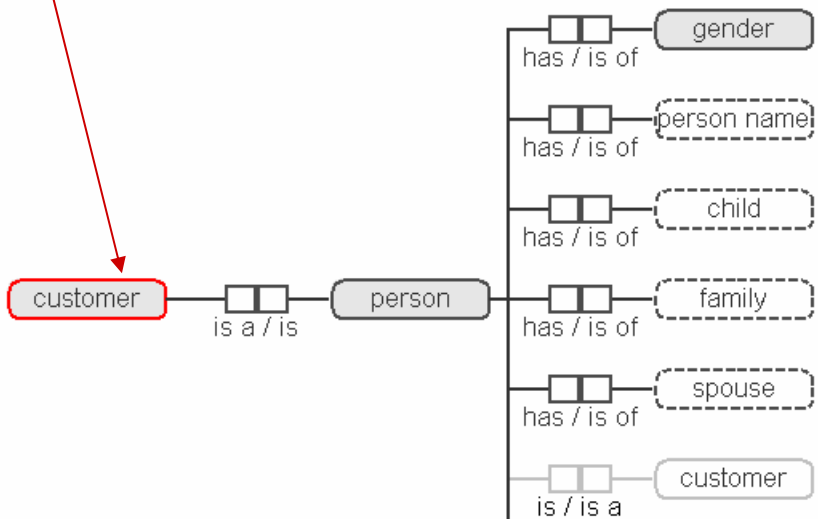
Semantically rich decision rules (example)



- Concepts are defined in domain ontologies
- Decision items need to be annotated with domain ontologies
  - Tools: T-Lex, SDT plugin @ STARlab



Conclusion

- Conclusion
  - ORM+ is to *model*, *visualize*, *store* and *share* semantically rich decision rules
  - ORM+ extends ORM graphical notations
  - ORM+ ML = ORM ML + RuleML + others
    - ORM+ ML schema reuses **31** type definitions from ORM ML schema, **10** type definitions from *FOL Rule-ML* and introduces **7** new type definitions
    - Can be used by different rule engines
      - InfoSapient
      - JLisa
      - OpenRules
      - OpenLexicon
      - Etc.

Discussion and Future Work

- Discussion:
  - More symbols, more difficult to verbalize the commitments
  - Complexity
- Future work:
  - Mapping ORM$^+$ ML to one inference engine
  - ORM$^+$ visualization tool

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Questions?

- Thank you!