PatOMat project
(Czech Science Foundation, 2010-2012)
Meaning of „PatOMat“?

• The whole title: „Automation of Ontology Pattern Detection and Exploitation“
• „Mat“ also evokes „ontology matching“, as an important (though not exclusive) target application

• Project website to appear in the next few weeks…
Project team

- Vojtěch Svátek
  - coordination, logical patterns
- Ondřej Zamazal
  - transformation and alignment patterns, software engineering
- Miroslav Vacura
  - content patterns, foundational issues
- Petr Strossa
  - naming patterns
- Currently also: Aristotelis Triantafyllopoulos (U.Patras)
  - OWL expressivity wrt. logical patterns
- Support by local experts e.g. in LOD
- Heavily building on foreign collaborations!
Research threads

• Central thread: „metamorphing ontologies“
  – the same conceptualisation can be expressed differently in the given language (OWL),
    depending on the modelling style used
  – The modelling style should (semi-)
    automatically adjust to the application needs
    • For example, for the given ontology to smoothly
      map to or be imported to another one
    • Or for removing features that make problems to a reasoner
Example of style heterogeneity

Notion of „acceptance/rejection of a paper at a conference“

• Modelling via *siblings classes*

• Modelling via *object properties*:

• Modelling via enumeration class, i.e. *individuals*
  – reviewerDecision Domain: Paper.
  – reviewerDecision Range: (EquivalentTo {acceptance, rejection}).
PatOMat and patterns

• Alternative modelling styles can be captured via *ontology patterns*
• Transformation of one pattern into another is defined via a *transformation pattern*
• Both types of patterns may contain *naming patterns* based on linguistic techniques
  – naming detection patterns
  – naming transformation patterns
Ex. of transformation pattern

- **OP1**: \( E = \{ \text{Class: } ?A, \text{Class: } ?B, \text{Class: } ?C, \text{ObjectProperty: } ?p \} \),
  \( NDP = \{ \text{comparison}(?B, \text{head term}(?p)), \text{exists}(\text{verb form}(?C)) \} \)

- **OP2**: \( E = \{ \text{Class: } ?D, \text{Class: } ?E, \text{Class: } ?F, \text{Class: } ?G, \text{ObjectProperty: } ?q \} \),
  \( Ax = \{ ?q \text{ Domain: } ?D, ?q \text{ Range: } ?E, ?F \text{ SubClassOf: } ?E, \text{EquivalentTo: } ( ?q \text{ some } ?F ) \} \)

  \( NTP = \{ ( ?G, \text{make passive verb}(?C) + \text{head noun}(?A)) \} \)
Ex. of transformation pattern

  NDP={comparison(?B, head term(?p)), exists(verb form(?C))}


  NTP= {( ?G, make passive verb(?C) + head noun(?A))}
Ex. of transformation pattern

  $NDP = \{\text{comparison}(?B, \text{head term}(?p)), \text{exists}(\text{verb form}(?C))\}$

  $Ax = \{?q \text{ Domain: } ?D, ?q \text{ Range: } ?E, ?F \text{ SubClassOf: } ?E, ?G \text{ EquivalentTo: } (?q \text{ some } ?F)\}$

Ex. of transformation pattern

<table>
<thead>
<tr>
<th>Paper</th>
<th>Decision</th>
<th>Acceptance</th>
<th>hasDecision</th>
</tr>
</thead>
</table>

• OP1 : $E=\{\text{Class: } ?A, \text{ Class: } ?B, \text{ Class: } ?C, \text{ ObjectProperty: } ?p\}$,
  $NDP=\{\text{comparison(?B, head term(?p)), exists(verb form(?C))}\}$

• OP2 : $E=\{\text{Class: } ?D, \text{ Class: } ?E, \text{ Class: } ?F, \text{ Class: } ?G, \text{ ObjectProperty: } ?q\}$,

  $NTP=\{( ?G, \text{ make passive verb(?C) + head noun(?A))}\}$.
Ex. of transformation pattern

  NDP={comparison(?B, head term(?p)), exists(verb form(?C))}
  ‘Decision’=‘Decision’


  NTP= {( ?G, make passive verb(?C) + head noun(?A))}. 

Paper Decision Acceptance hasDecision

‘Decision’=‘Decision’ accept (according to WordNet)
Ex. of transformation pattern

Paper Decision Acceptance hasDecision


Ex. of transformation pattern

Paper  Decision  Acceptance  hasDecision

- **OP1**: \( E = \{\text{Class}: ?A, \text{Class}: ?B, \text{Class}: ?C, \text{ObjectProperty}: ?p\}, \)
  \( Ax = \{?p \text{ Domain}: ?A, ?p \text{ Range}: ?B, ?C \text{ SubClassOf}: ?B\}, \)
  \( NDP = \{\text{comparison}(?B, \text{head term}(?p)), \text{exists}(\text{verb form}(?C))\} \)
  'Decision'='Decision'  accept (according to WordNet)

- **OP2**: \( E = \{\text{Class}: ?D, \text{Class}: ?E, \text{Class}: ?F, \text{Class}: ?G, \text{ObjectProperty}: ?q\}, \)
  \( Ax = \{?q \text{ Domain}: ?D, ?q \text{ Range}: ?E, ?F \text{ SubClassOf}: ?E, ?G \text{ EquivalentTo}: (?q \text{ some } ?F)\} \)

- **PT**: \( LI = \{?A \text{ EquivalentTo}: ?D, ?B \text{ EquivalentTo}: ?E, ?C \text{ EquivalentTo}: ?F, \text{EquivalentProperties}: ?p, ?q\}, \)
  \( NTP = \{( ?G, \text{make passive verb}(?C) + \text{head noun}(?A))\} \) accepted Paper
Ex. of transformation pattern

- **OP1**: \( E = \{ \text{Class: } ?A, \text{Class: } ?B, \text{Class: } ?C, \text{ObjectProperty: } ?p \} \),
  \( NDP = \{ \text{comparison}(?B, \text{head term}(?p)), \text{exists}(\text{verb form}(?C)) \} \)

- **OP2**: \( E = \{ \text{Class: } ?D, \text{Class: } ?E, \text{Class: } ?F, \text{Class: } ?G, \text{ObjectProperty: } ?q \} \),
  \( Ax = \{ ?q \text{ Domain: } ?D, ?q \text{ Range: } ?E, ?F \text{ SubClassOf: } ?E, ?G \text{ EquivalentTo: } (?q \text{ some } ?F) \} \)

  \( NTP = \{ ( ?G, \text{make passive verb}(?C) + \text{head noun}(?A)) \} \)

\( \text{Paper} \quad \text{Decision} \quad \text{Acceptance} \quad \text{hasDecision} \)

\( \text{accepted Paper Decision Acceptance AcceptedPaper} \quad \text{hasDecision} \)

\( \text{AcceptedPaper} = \text{hasDecision some Acceptance} \)
Transformation patterns

• Cooperation with University of Manchester
  – using the OPPL pre-processor
• Three-phase transformation
  – detection of source pattern in ontology
  – generation of transformation instructions
    • instantiation of the transformation part of the pattern
  – actual transformation
    • using OPPL and OWL-API
Ontology Transformation Framework
Core Ontology Transformation Web Services

- Ontology Pattern Detection
- Instruction Generator
- Ontology Transformation

- The user can interact in each step.

- Services available via POST method at:
  http://owl.vse.cz:8080
Workflow of Services
Next steps

• *Tutorial* for using the current services

• Canonical methods for swapping info between *logical* and *annotation* spaces while transforming

• *LOPS ontology*
  – „Logical Ontology Pattern Structure“ under development
  – incl. naming and annotation aspects
  – incl. transformation patterns on top of logical ones

• Graphical interface for *transformation pattern authoring* and *instruction generation* monitoring
Other research threads

• Supporting the first one, with own results
  – Recommendation of *logical-structural patterns* (cooperation with Univ.Manchester)
  – Recommendation of *naming patterns* (cooperation with Univ.Freiburg)

• Self-standing
  – Detection of *anti-patterns* and subsequent *refactoring* (cooperation with Univ.Mannheim and UPMadrid)
  – „Shortcut“ *mapping patterns*
    • „Canonical“ simplification of sophisticated ontologies
    • Mapping (disambiguation) of Linked Data vocabularies to more sophisticated ontologies
Other research threads

• Supporting the first one, with own results
  – Recommendation of *logical-structural patterns* (cooperation with Univ.Manchester)
  – Recommendation of *naming patterns* (cooperation with Univ.Freiburg)

• Self-standing
  – Detection of *anti-patterns* and subsequent *refactoring* (cooperation with Univ.Mannheim and UPMadrid)
  – „Shortcut“ *mapping patterns*
    • „Canonical“ simplification of sophisticated ontologies
    • Mapping (disambiguation) of Linked Data vocabularies to more sophisticated ontologies
Recommendation of *logical-structural patterns*

- **LOPU ontology** – under development
  - „Logical Ontology Pattern Usage“
  - classifies the patterns according to the *abstracted state of affairs* (ASoA) for which they are relevant
  - Recommendation within the given ASOA based on preferences over *target ontology features* (such as expressivity)
- Envisaged a *demo application* using LOPU a and recommending the user a pattern for his modelling situation
Pattern selection using LOPU onto

• Modelling situation by the W3C Note
  – Books describing the life of animals
  – Necessity to somehow interlink the taxonomy of animals at the level of classes and concrete books in the library catalogue as individuals
  – „Classes as property values“?
„Classes as property values“?

Initial problem formulation

Abstracted state of affairs

Logical pattern

Ontology feature

Individual truly related to a class as unary predicate

Direct connection from individual to class

OWL Full

Individual related to an abstract topic

Instance of existentially defined named class

OWL DL

Individual related to individual/s of the class

Instance of existentially defined anonymous class

Editing problems?

Connection to anonymous instance (b-node)

Confusing?

Connection to named „placeholder“ inst.
Other research threads

• Supporting the first one, with own results
  – Recommendation of *logical-structural patterns* (cooperation with Univ.Manchester)
  – Recommendation of *naming patterns* (cooperation with Univ.Freiburg)

• Self-standing
  – Detection of *anti-patterns* and subsequent *refactoring* (cooperation with Univ.Mannheim and UPMadrid)
  – „Shortcut“ *mapping patterns*
    • „Canonical“ simplification of sophisticated ontologies
    • Mapping (disambiguation) of Linked Data vocabularies to more sophisticated ontologies
Other research threads

• Supporting the first one, with own results
  – Recommendation of *logical-structural patterns* (cooperation with Univ.Manchester)
  – Recommendation of *naming patterns* (cooperation with Univ.Freiburg)

• Self-standing
  – Detection of *anti-patterns* and subsequent *refactoring* (cooperation with Univ.Mannheim and UPMadrid)
  – „Shortcut“ *mapping patterns*
    • „Canonical“ simplification of sophisticated ontologies
    • Mapping (disambiguation) of Linked Data vocabularies to more sophisticated ontologies

No specific presentation for these…
Other research threads

• Supporting the first one, with own results
  – Recommendation of *logical-structural patterns* (cooperation with Univ.Manchester)
  – Recommendation of *naming patterns* (cooperation with Univ.Freiburg)

• Self-standing
  – Detection of *anti-patterns* and subsequent *refactoring* (cooperation with Univ.Mannheim and UPMadrid)
  – *Shortcut* *mapping patterns*
    • „Canonical“ simplification of sophisticated ontologies
    • Mapping (disambiguation) of Linked Data vocabularies to more sophisticated ontologies