Ontology coverage check

Support for evaluation in ontology engineering

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Motivation for ontology evaluation

- 🌐 Ontologies need to be created

  - ◆ Manually

  - ◆ Automatically (ontology learning)

- 🌐 Ontologies need to be selected / assessed

Approaches to ontology evaluation

- Which users are addressed? Ontology engineers, ontology users…

- Which properties are evaluated? Structure, function, usability…

- What is the ontology evaluated against? Human expert, golden standard, application…

Bad

Good
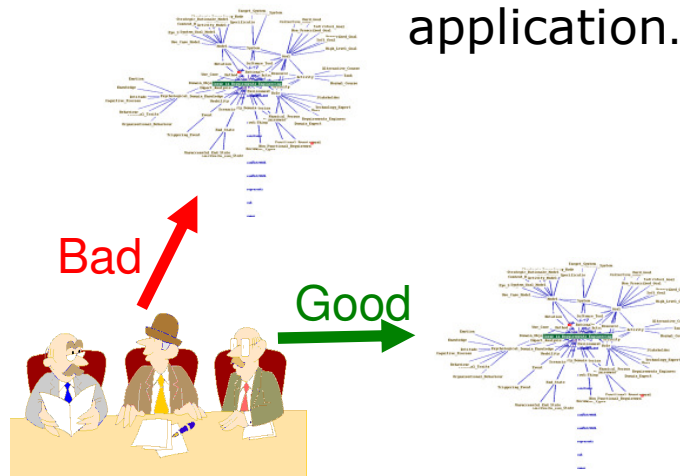
Scenario (1/3)

- Eve is part of a community

- Eve's community shares a broad document base

- Current status: documents are searched by keywords and by folder-structure

- **Goal**: facilitate usage of document base

- Chosen method: transform the knowledge implicit in documents to explicit knowledge (ontology)

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Scenario (2/3)

Benefit:

- Documents can be found by topic (ontology concept)

- Navigation through documents along relations in ontology

- Eve is an amateur ontology engineer

- Eve's main interest in creating the ontology lies in creating a productive work / learn environment

Scenario (3/3): Workflow

Eve

- Identifies relevant concepts, relations, individuals, facts

- Formalizes knowledge

At this point, Eve needs to

- Make sure that knowledge available in documents is used

- Get **feedback**

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Requirements on ontology evaluation

Evaluation method

- Embedded in ontology engineering

- Gives feedback

- Considers especially that user is not ontology expert

⟹ support for evaluation in ontology engineering / support for ontology engineering by evaluation

Ontology engineering and unit tests

Software engineering

- Unit tests

- Source code coverage

Ontology engineering

- Populate ontology for test purposes

    - Meaningful individuals, corresponding to real-world data
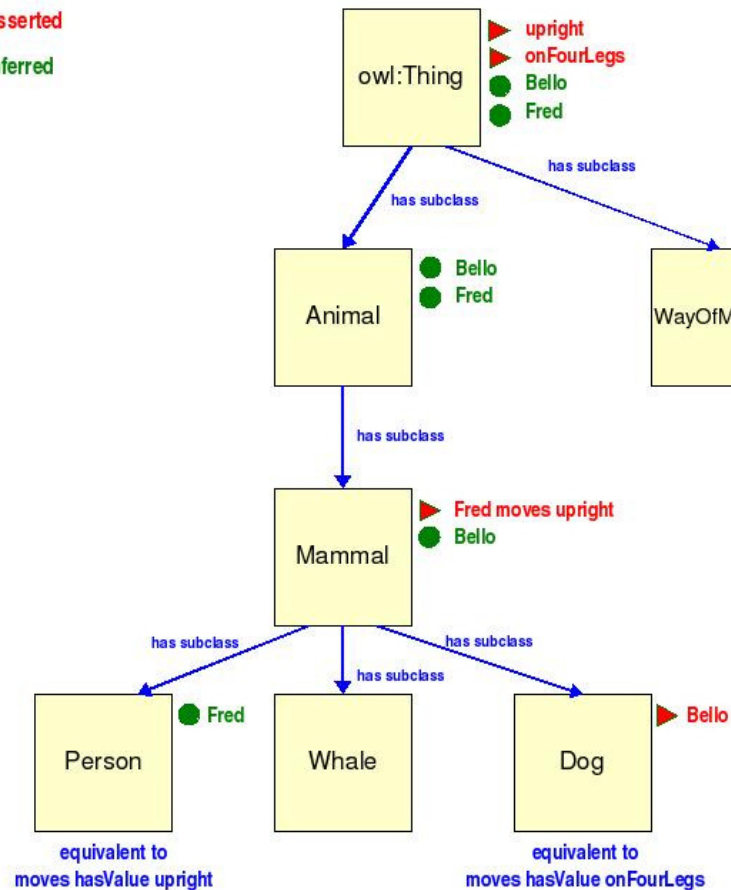
- Coverage of ontology by individuals

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Ontology coverage check (OCC)

Feedback by

- Percentage of used classes (basic OCC)

- Percentage of used axioms (extended OCC)

    - Axioms that constitute necessary & sufficient condition for a class

    - Axioms that are existential (owl:someValuesFrom), quality (owl:hasValue) or minimum cardinality (owl:minCardinality)
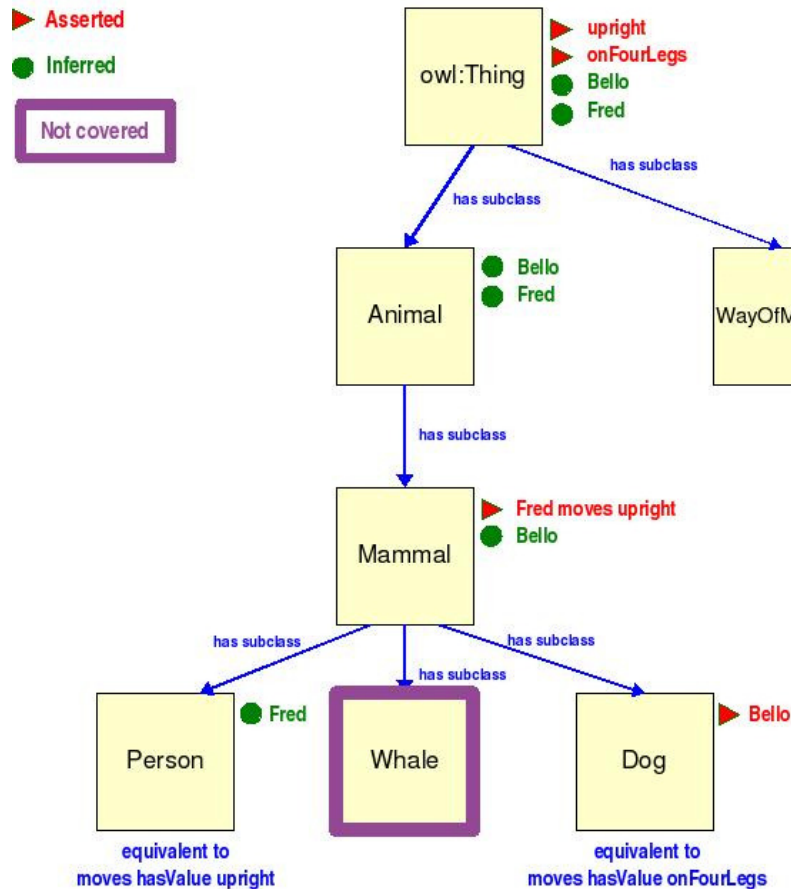
Example (1/3)

Asserted
Inferred

owl:Thing
- upright
- onFourLegs
- Bello
- Fred

has subclass *has subclass*

Animal
- Bello
- Fred

WayOfMoving
- upright
- onFourLegs

has subclass

Mammal
- Fred moves upright
- Bello

has subclass *has subclass* *has subclass*

Person
- Fred

Whale

Dog
- Bello

equivalent to
moves hasValue upright

equivalent to
moves hasValue onFourLegs

Eve creates the following ontology:

- Person: any individual that moves upright

- Dog: any individual that moves on four legs

- Whale: not described in detail

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Example (2/3)

Asserted
Inferred
Not covered

owl:Thing — upright, onFourLegs, Bello, Fred

Animal — Bello, Fred

WayOfMoving — upright, onFourLegs

Mammal — Fred moves upright, Bello

Person — Fred
equivalent to
moves hasValue upright

Whale

Dog — Bello
equivalent to
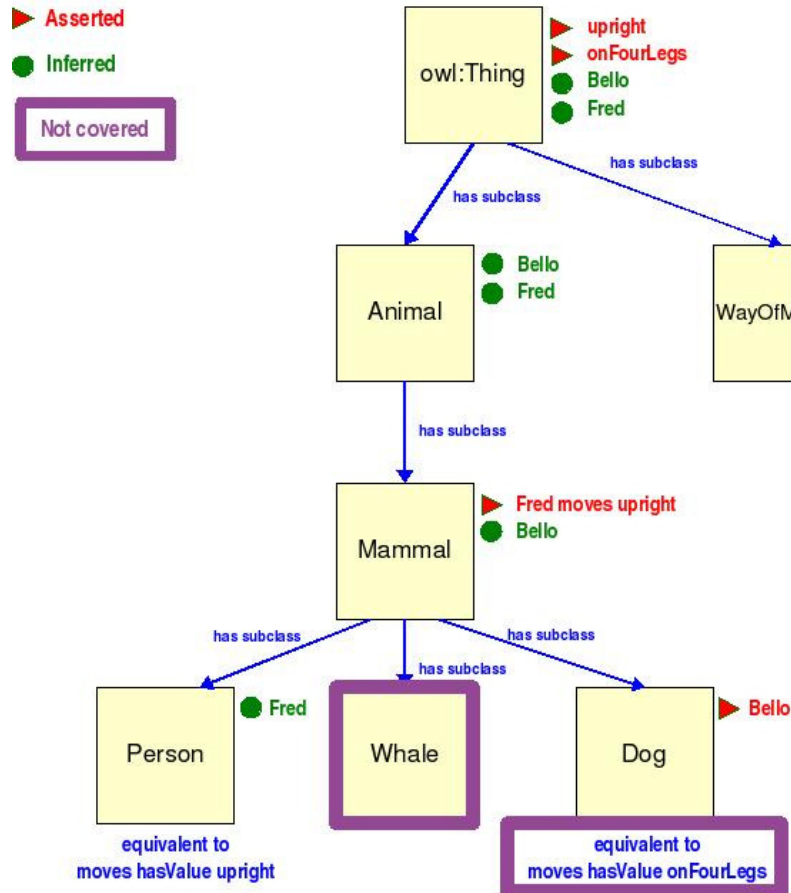moves hasValue onFourLegs

Eve applies basic OCC:

- Check for (un)used classes: Whale is uncovered

As a consequence, Eve:

- Checks for instances of Whale occuring in document base

  - If they exist, leave Whale in ontology.

  - If not, remove Whale.

Example (3/3)

Eve applies extended OCC:

- Check for (un)used axioms: Axiom that defines Dog is uncovered
  - No individual is asserted to „move on four legs"

As a consequence, Eve can:

- Find instances in document base which are dogs and about who it is known that they move on four legs.

Evaluation of OCC (1/3)

- Small ontology dealing with Requirements Engineering

  - developed at Know-Center

  - OCC used during development

  - 15 classes, 3 axioms, 35 instances

  - One unused axiom was found after first iteration of ontology building

  - Trying to have unused axiom covered lead to re-modelling.

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Evaluation of OCC (2/3)

- Medium-sized ontology, used for the EON2006, describes the organisation of the AIFB Karlsruhe[1]

  - 55 classes, 68 axioms, 1150 instances

  - 51% of classes are covered, no axiom is used

  - Interpretation:

    – Part of the axioms are universal, i.e. not checked by OCC

    – Ontology is used by non-expert ontology users who do not fully profit from the ontology's expressiveness.

    – Question: model unnecessarily complex too high for application?

Evaluation of OCC (3/3)

- OCC results were analysed for 4 more ontologies

  - 1 more at Know-Center

  - 1 more describing an academic organisation[1]

  - 1 meta-data ontology[2]

  - 1 mid-level ontology[3]

[1] http://www.aifb.uni-karlsruhe.de/WBS/dvr/rove/
[2] http://ontoware.org/projects/omv/
[3] http://www.ontologyportal.org/

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Discussion (1/2)

Observation on OCC:

- If an ontology imports a higher-level ontology, this leads to large unpopulated areas.

General observation:

- Publicly available ontologies are schemas or upper- and mid-level ontologies

- Interpretation: Individuals are seen as (sensitive) data that are not intended to be published

Discussion (2/2)

With regard to requirements:

- Support for non-ontology experts: OCC offers to support a part of ontologies that may be counter-intuitive for non-expert users: axioms

- Give feedback: Delivers a hint on where to test the ontology

Further work

- Extend meaning of uncovered axioms to universal and (max-)cardinality axioms.

- Provide graphic user interface.

- Give hints on how to improve ontology.

Conclusion

- OCC checks the usage of an ontology's schema entities (concepts, axioms) by a set of individuals

- Novelty: extending meaning of unpopulated areas to axioms

- Support for non-ontolgy experts during ontology engineering

- Gives feedback on where to test the ontology further

Test me!

Thank you!

Questions?

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