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Towards annotating potential incoherences in BioPortal mappings

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Optique

Outline

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Introduction

BioPortal

- 373 ontologies
- 13 million mappings between them
- Mappings represented as a 4-tuple ‹e_1; e_2; *Rel*; *Ann*›
- Relationships can be:
  - *skos:exactMatch* (same URI)
  - *skos:closeMatch* (used for LOOM and UMLS mappings)
  - *skos:relatedMatch* (used for OBO cross-references)
  - *skos:narrowMatch* / *skos:broadMatch*

Introduction

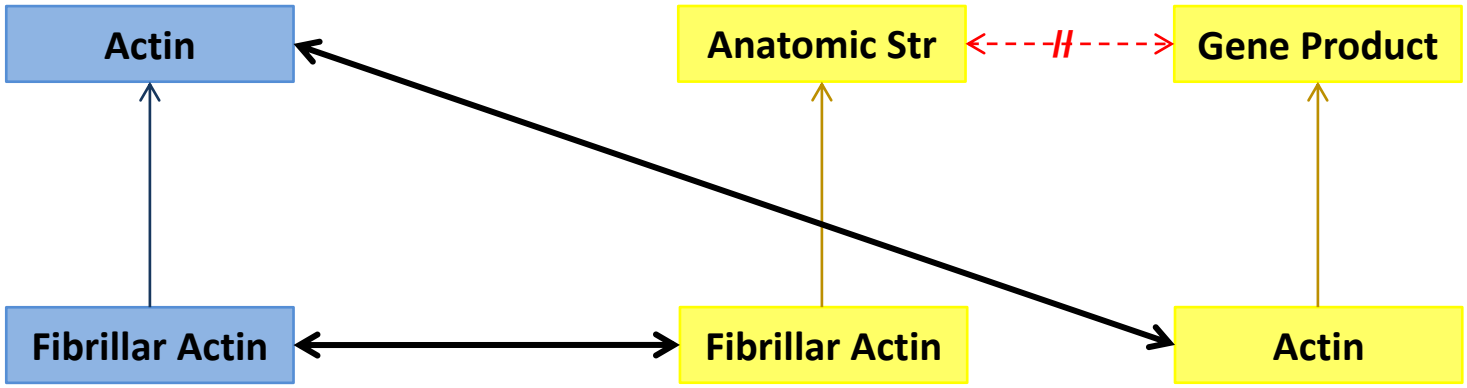
Close Match vs. Equivalence

- *skos:closeMatch* lacks a clear semantic meaning:
  - BioPortal need not be concerned with exact mapping semantics or their logical entailments
- *owl:equivalentClass* is a stronger assertion, but:
  - Without it, mappings are of limited use
- Most users will implicitly or explicitly assume equivalence
- Providing information about the logical entailments under this assumption will be helpful for these users

Introduction

Mapping Repair

- Integrating two ontologies through an alignment may lead to unsatisfiable classes (even if everything is “correct”, though generally it is a sign that something is wrong)



Introduction

Mapping Repair

- Incoherent alignment: set of mappings that causes unsatisfiable classes
- Conflict set: minimal set of mappings responsible for one or more unsatisfiabilities; removing one mapping will solve them
- Mapping repair: remove mappings from an incoherent alignment so as to increase its coherence; minimize the impact of the procedure on the alignment

Introduction

Mapping Repair

- Repair algorithms can be classified with regard to:
  - Completeness of analysis (complete vs. approximate repair)
  - Optimality of removal (optimal, global heuristic, or local heuristic)
- Complete analysis and optimal removal do not scale well for large ontologies with many unsatisfiabilities

Introduction

Mapping Repair

- AML-Repair: approximate, global heuristic (computes all conflict sets of mappings, then resolves them)
- LogMap-Repair: approximate, local heuristic (resolves conflict sets individually for each unsatisfiable class)
- Nearly equivalent with respect to completeness
- LogMap-Repair more efficient
- AML-Repair closer to optimality

Evaluation

Dataset

- 19 ontology pairs from BioPortal, such that:
  - Each pair had >500 mappings
  - At least one ontology had disjointness clauses
  - Both ontologies were biomedical
- 11 pairs had incoherent alignments

Evaluation

Automatic Repair Evaluation

- Completeness:
  - AML-Repair and LogMap-Repair resolve most unsatisfiable classes, produce coherent alignments in many cases
  - AML-Repair less complete than LogMap-Repair, but has been improved
- Optimality:
  - Repairs not aggressive (at most 6-7% of input mappings removed, in task where 61% involved in conflicts)

Evaluation

Automatic Repair Evaluation

- Relevance:
  - 11 of 19 BioPortal alignments incoherent
  - On average 22% of BioPortal mappings from incoherent alignments involved in conflict sets
  - Some key mappings are involved in multiple unsatifiabilities
- Efficiency:
  - Both systems tackled largest tasks in a few minutes

Evaluation

Manual Analysis

- Erroneous mappings:
  - Involve obsolete / deprecated / retired classes
  - Non-related entities (back [body part] vs. back [direction])
  - Related entities but not closely (a gene vs. the protein it encodes)
- Correct mappings but in conflict with erroneous ones
- Errors account for over 60% of removed mappings

Conclusions

- Identifying incoherence-causing BioPortal mappings is:
  - Critical for applications that require logical coherence
  - Helpful for finding potentially erroneous mappings

- Approximate mapping repair systems are:
  - Capable of tackling large datasets such as BioPortal
  - Able to identify most logical conflicts

Future Work

- Goals:
  - Analyze all BioPortal mappings
  - Extend BioPortal by storing and enabling querying of annotations about mappings involved in logical conflicts
  - Develop lightweight mapping analyzer, to analyze new mappings upon submission (preclude errors, remain up to date)
- Challenges:
  - Analyze new mappings on-the-fly, particularly involving huge ontologies
  - Tackle complex mapping networks between three or more ontologies?

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LogMap is open source and available at https://code.google.com/p/logmap-matcher/

AML is open source and available at https://github.com/AgreementMakerLight

There is a PhD scholarship opportunity in our research group: http://goo.gl/KrYJpS

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