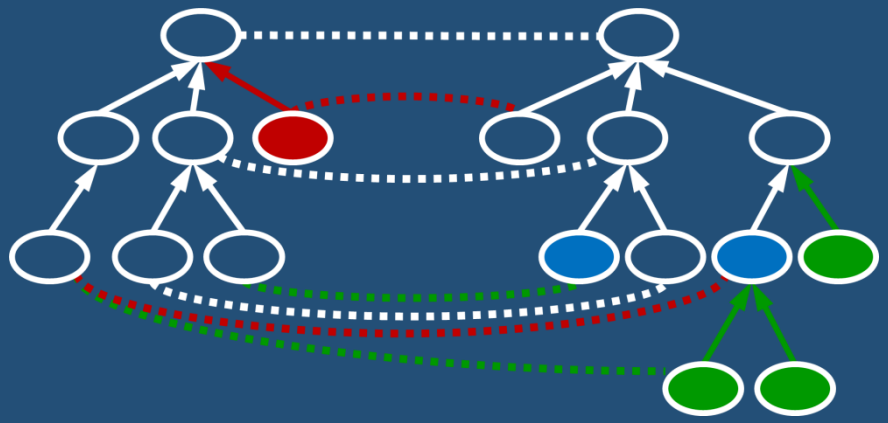

How do Ontology Mappings Change in the Life Sciences?

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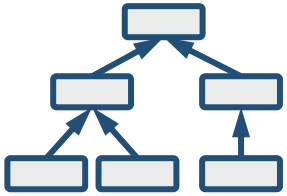
Andreas Thor, Erhard Rahm

UNIVERSITÄT LEIPZIG

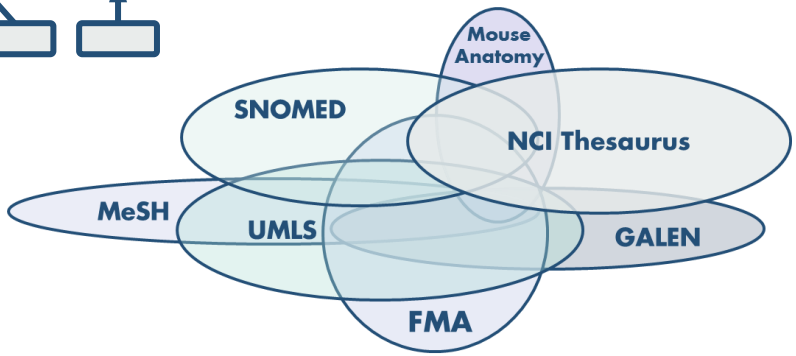
Poster Presentation, 28th June 2012, DILS, College Park, Maryland

Ontologies and Ontology Mappings

Ontologies



- Knowledge representation
- Multiple interrelated ontologies in a domain



Ontology mapping

- Set of semantic correspondences between concepts of different ontologies
- Manual identification or (semi-) automatic matching approaches

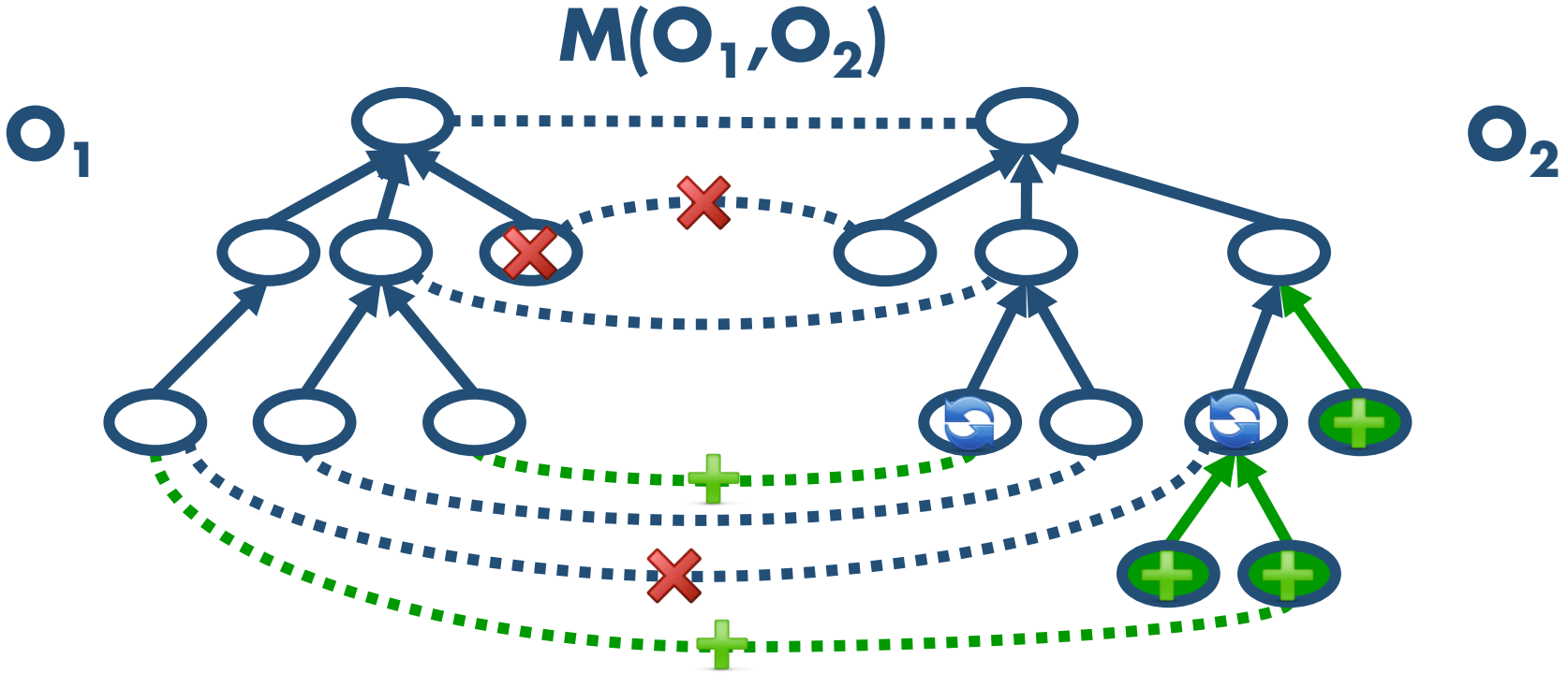
Use of mappings

- Ontology merging - creation of the integrated cross-species anatomy ontology "Uber ontology"
- Knowledge transfer - experiments for different species
- Ontology curation - find missing ontology annotations
- …

Ontology Evolution

- Ongoing research, new findings → continuous modifications
- Periodical release of new ontology versions
- Ontology changes

- **Invalidate previously determined ontology mappings?**



Ontology Evolution

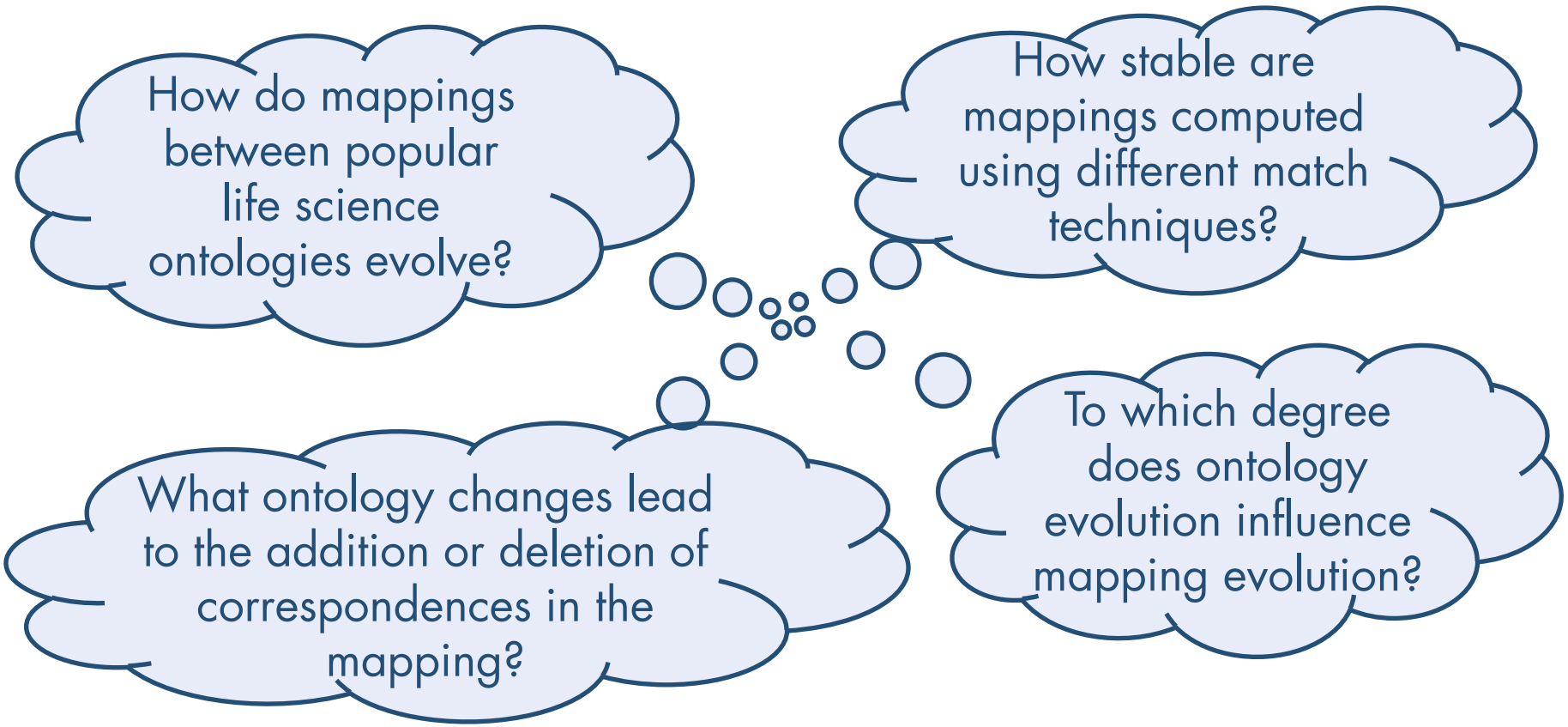
- Ongoing research, new findings → continuous modifications
- Periodical release of new ontology versions
- Ontology changes 

- **Invalidate previously determined ontology mappings?**
- Example: Anatomy reference mapping at *OAEI* *
  - Based on 5 year old versions
  - Quality w.r.t. current ontology versions?
- Re-determination of mappings is an expensive process
  - Manual verification of correspondences
  - Parametrization effort
- Future aim: (semi-)automatic mapping adaptation

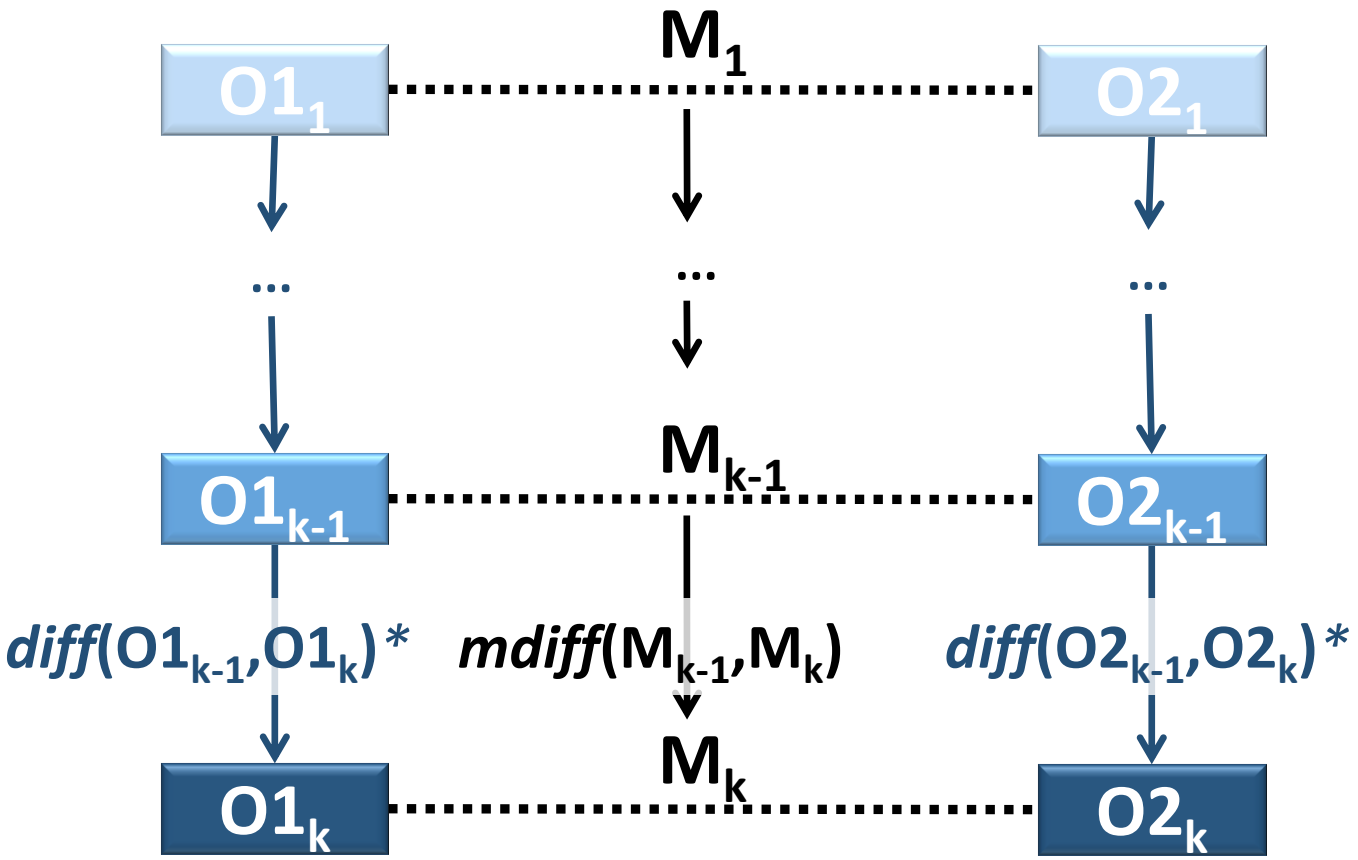
* OAEI = Ontology Alignment Evaluation Initiative

Contributions

- Investigate evolution of life science ontology mappings
- Generic model for ontology and mapping evolution and their inter-dependencies
- Evaluation for three life science scenarios



General Evolution Scheme



Current version *k*

* *Hartung, M.; Groß, A.; Rahm, E.:*

- ***COnto-Diff**: Generation of Complex Evolution Mappings for Life Science Ontologies, Journal of Biomedical Informatics, 2012.*
- ***CODEX**: Exploration of semantic changes between ontology versions, Bioinformatics 28 (6): 895-896, 2012.*

Change Operations

Ontology changes:

Extension set:

$Ext(O_{v \to v+1})$

Insert new concept, subgraph, relationship, attribute,

…

Reduction set:

$Red(O_{v \to v+1})$

Delete existing concept, subgraph, relationship, set concept to obsolete,

…

Revision set:

$Rev(O_{v \to v+1})$

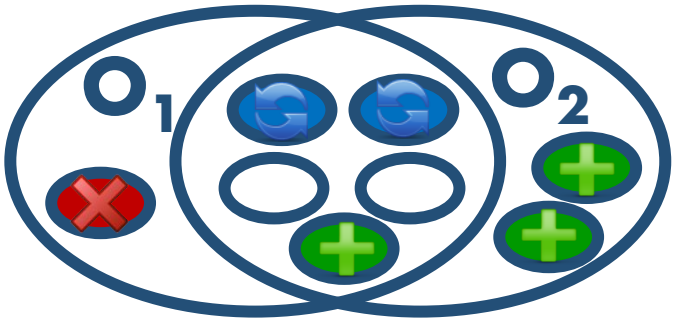
Split, merge, substitute, move concept, change attribute value,

…

Mapping changes

- **Addition set:** $Add(M_{v \to v+1}) = M_{v+1} \backslash M_v$
- **Deletion set:** $Del(M_{v \to v+1}) = M_v \backslash M_{v+1}$

Measures



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Ontology Change Ratio $OCR(O_{v \to v+1})$

- Degree of ontology changes during evolution from O_v to O_{v+1}
- Fraction of concepts in $\boldsymbol{Ext} \cup \boldsymbol{Red} \cup \boldsymbol{Rev}$ versus all concepts $(O_v \cup O_{v+1})$

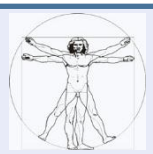
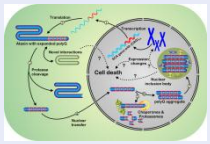
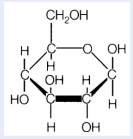
Mapping Change Ratio $MCR(M_{v \to v+1})$

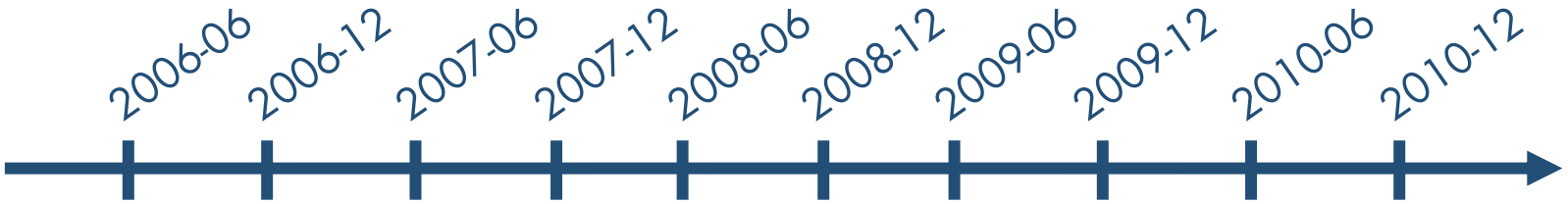
- Degree of mapping changes during evolution from M_v to M_{v+1}
- Fraction of correspondence in $\boldsymbol{Add} \cup \boldsymbol{Del}$ versus all correspondences $(M_v \cup M_{v+1})$

Impact Ratio $IR(O_{Ch}, M_{Ch})$

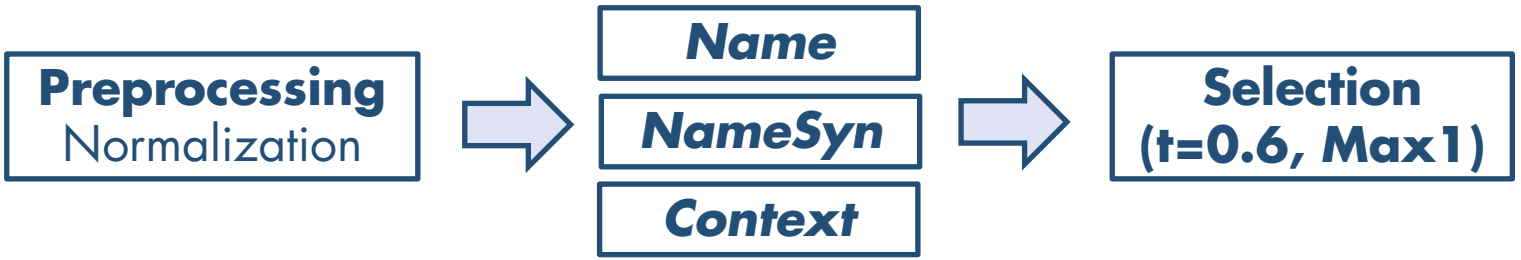
- Share of changed concepts that actually had an impact on changed correspondences
- Fraction of additive ontology changes that led to new correspondences: $IR(\boldsymbol{Ext}, \boldsymbol{Add})$

Evaluation Setup

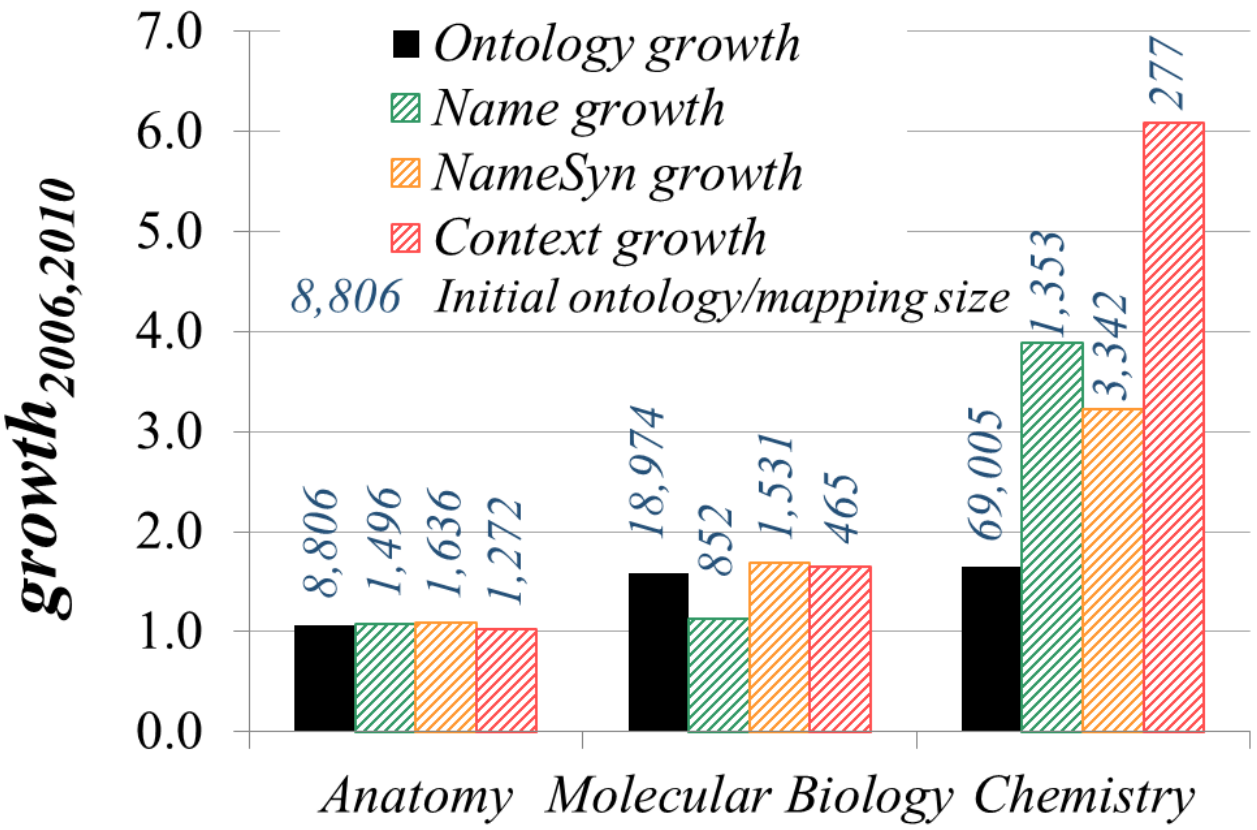
	***Anatomy***	Adult Mouse Anatomical Dictionary (MA)	NCI Thesaurus Anatomy part (NCITa)
	***Molecular Biology***	Molecular Functions (MF)	Biological Processes (BP)
	***Chemistry***	Chemical Entities of Biological Interest (ChEBI)	NCI Thesaurus (NCIT)



- Meta-data based matchers



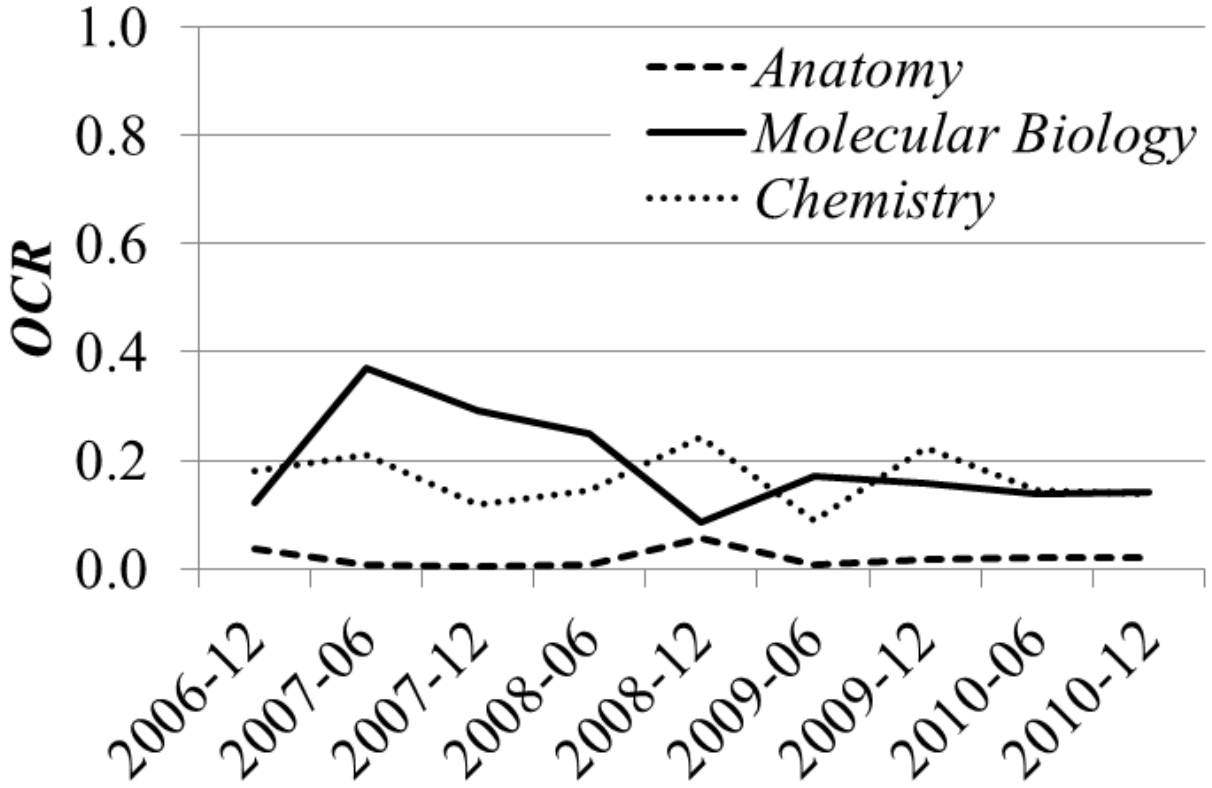
Ontology and Mapping Growth



2006 → 2010:

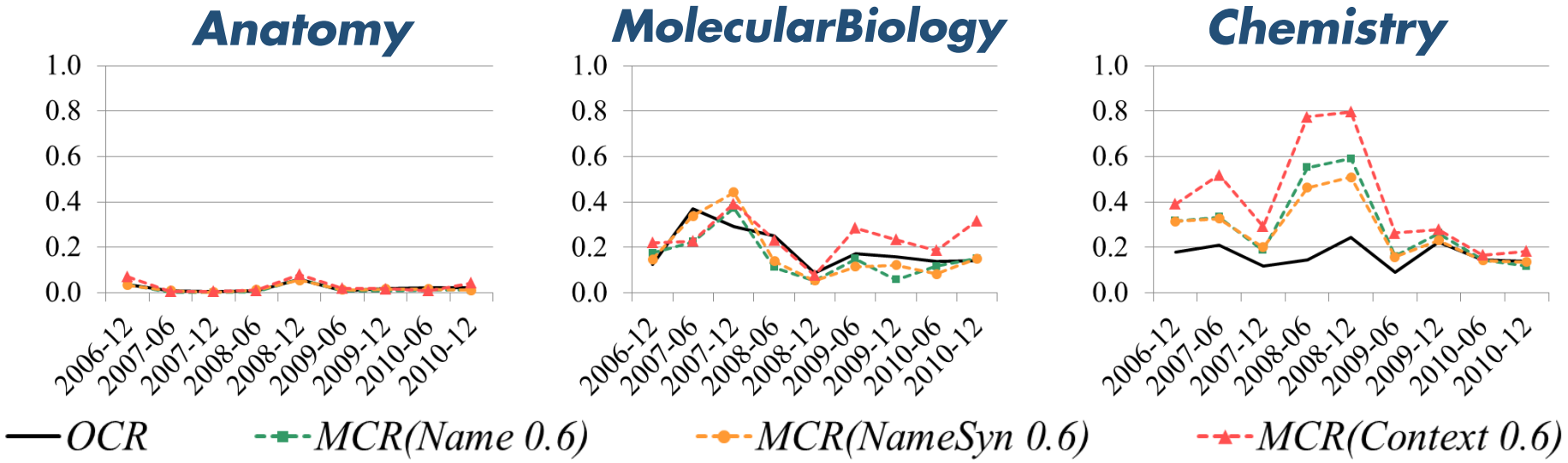
- Slight ontology growth for *Anatomy* (10%)
- 60-70% for *MolecularBiology* and *Chemistry*
- Mapping growth similar to ontology growth, except for chemistry

Ontology Change Ratio



- *Anatomy*: only few changes
- *Molecular Biology*: high change rates until 2007 (nearly 40%)
- *Chemistry*: change rates around 20%

Comparison of Change Ratios



Correlation between the ontology and mapping change factors

Domains *Anatomy*: few mapping changes, relatively stable

MolecularBiology, Chemistry: high degree of mapping changes , between 10 and 80 %

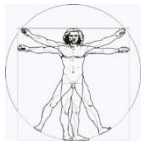
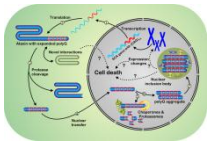
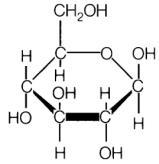
Matcher *Name*: relatively stable

Context: most heavily influenced by ontology evolution, 2008, *Chemistry* 80% mapping changes

Conclusions & Future Work

- Study the evolution of ontology mappings
  - General evolution scheme and measures (change factors)

- Evaluation for ontology mappings in three life science domains + comparison of three match strategies

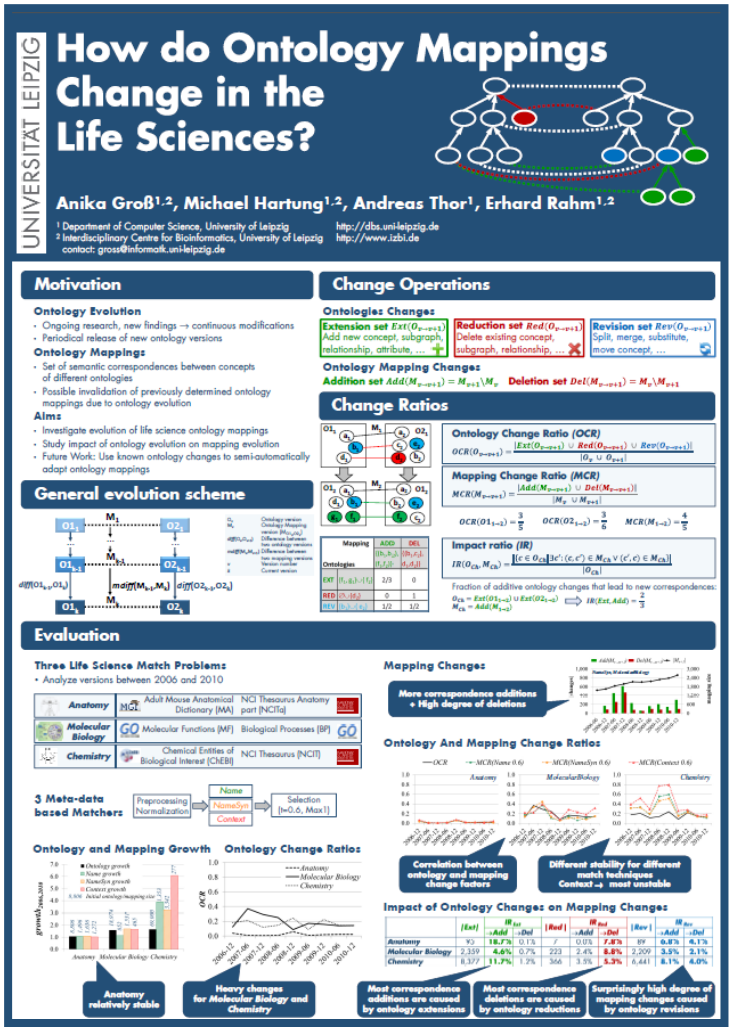
  - Correlation between ontology and mapping change factors
  - Different stability for different match techniques and domains
  - Impact of ontology on mapping changes
    - Most correspondence *Add* / *Del* are caused by ontology *Ext* / *Red*
    - Surprisingly high degree of mapping changes caused by ontology *Rev*

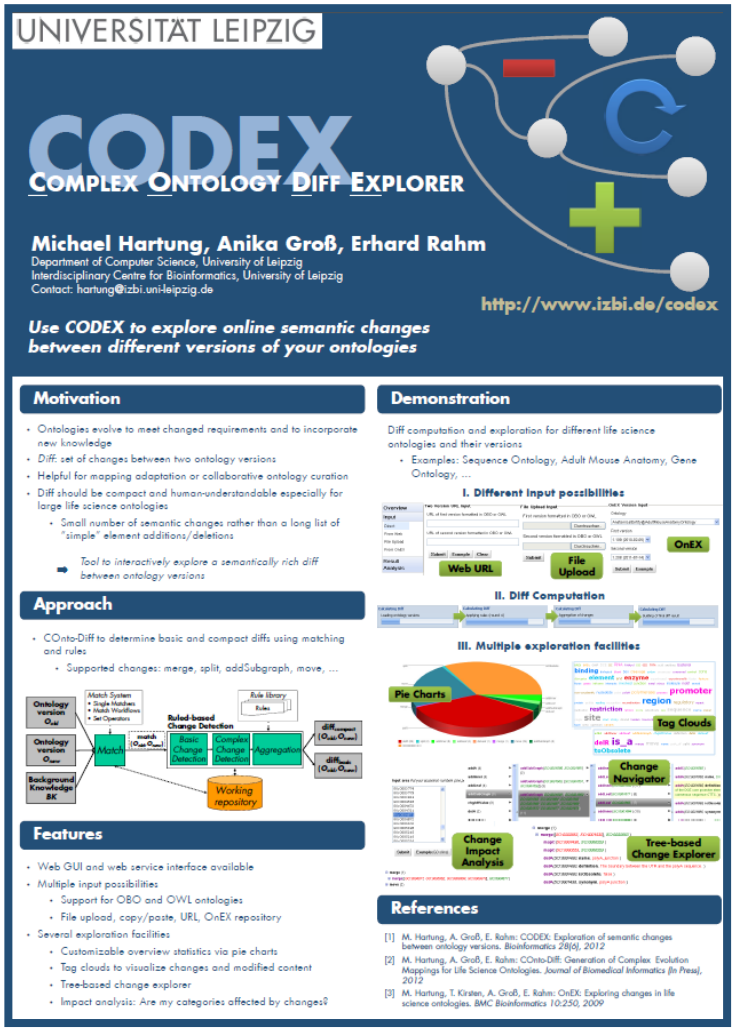
Future Work

- Use known ontology changes to semi-automatically adapt ontology mappings (without completely new mapping determination)

How do Ontology Mappings Change in the Life Sciences?

Poster Session This Afternoon





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