ProbaMap: a scalable tool for discovering probabilistic mappings between taxonomies

Rémi Tournaire
Jean-Marc Petit - Marie-Christine Rousset - Alexandre Termier

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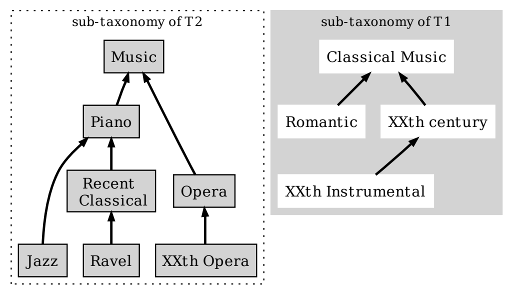
General problem addressed: ontology alignment

- Scalable automatic discovery of mappings between taxonomies
  $\longrightarrow$ Major issue for the future Semantic Web
- Decentralized nature of the web
  $\longrightarrow$ independent construction of **personalized** lightweight ontologies (often taxonomies) to annotate documents
- Mappings enable collaborative exchange of documents in the Web. In particular, *inclusion mappings* are the basis for query reformulation.



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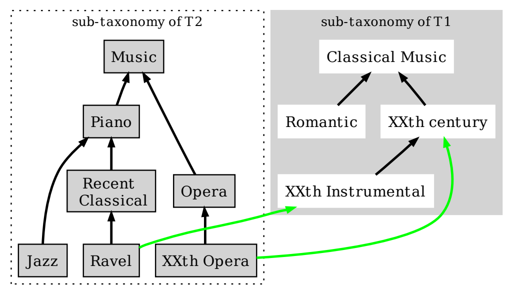


Main distinguishing points of our approach

Ontology alignment: a lot of existings methods

Surveys: [Schvaiko Euzenat 2005] [Rahm Bernstein 2001]

Yearly Ontology Alignment Evaluation Initiative(OAEI) contest.

Lot of remaining challenging issues.

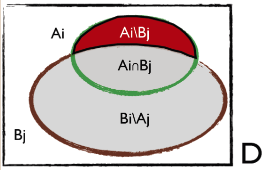
Focus of our work:

1. Inclusion mappings discovery
2. Handling uncertainty with a clear semantics
3. Scalability

Modeling uncertainty with probabilities

Two probabilistic semantics for inclusion mappings

Considered probabilistic semantics extends the logical semantics.



1. $P_c(A_i \sqsubseteq B_j) = P(B_j|A_i) = \frac{P(A_i \cap B_j)}{P(A_i)}$
2. $P_u(A_i \sqsubseteq B_j) = 1 - P(A_i \setminus B_j) = 1 - P(A_i) + P(A_i \cap B_j)$

Bayesian estimators for $P(A_i \cap B_j)$ and $P(A_i)$ based on instances :

$\widehat{P(A_i)} = \frac{1+|Ext(A_i, T_i)|}{2+|Ext(T_i)|}$ $\widehat{P(A_i \cap B_j)} = \frac{1+|Ext(A_i \cap B_j, T_i \cup T_j)|}{4+|Ext(T_i \cup T_j)|}$

Usage of classifiers to compute $Ext(A_i \cap B_j, T_i \cup T_j)$.

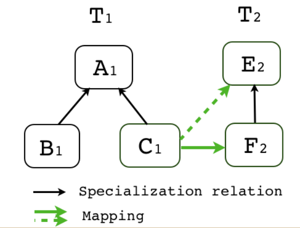
Relation between logical and probabilistic semantics

P_u and P_c are monotonous with respect to the logical implication

$$T_i, T_j, m \models m' \Rightarrow P_u(m) \leq P_u(m')$$

Weaker property for P_c

Example



$$C_1 \sqsubseteq F_2, T_1, T_2 \models C_1 \sqsubseteq E_2$$

$$P_u(C_1 \sqsubseteq F_2) \leq P_u(C_1 \sqsubseteq E_2)$$
$$P_c(C_1 \sqsubseteq F_2) \leq P_c(C_1 \sqsubseteq E_2)$$

The ProbaMap algorithm

A scalable algorithm to discover the most probable mappings between two taxonomies.

Input

- Two taxonomies $\mathcal{T}_i$, $\mathcal{T}_j$ and their instances
- Two thresholds S_u and S_c

Output

All mappings m between $\mathcal{T}_i$ and $\mathcal{T}_j$
for which $P_u \geq S_u$ and $P_c \geq S_c$.

Principle overview

- Generation of candidate mappings to be tested from the most general to the most specific ones, according to the logical implication.
- Pruning of the search space by exploiting the monotony properties

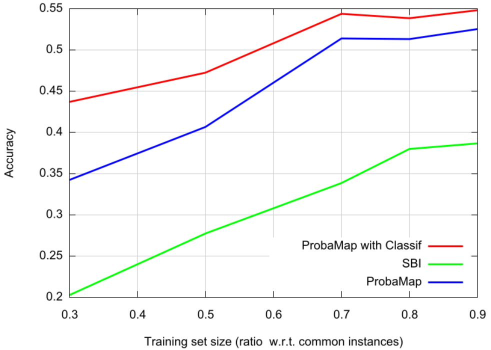
Quantitative and qualitative experiments

Scalability: experiments on taxonomies larger than 3000 classes.
ProbaMap handles a search space larger than 30 millions mappings.

Comparative experiment

Experiments conducted on Yahoo and Google subdirectories alignment.
Comparison with SBI[Ichise et. al, IJCAI 2003] in term of accuracy of the alignment.

Results for the subdirectories
`Google/Recreation/Autos` vs. `Yahoo/Recreation/Automotive`



Conclusion & Perspectives

Conclusion

- 2 probabilistic semantics for inclusion mappings
  that extend and connect to the logical semantics
- probabilities estimation with statistics on instances
- a scalable algorithm for mapping discovery: ProbaMap

Perspectives

Probabilistic query reformulation

- based on discovered mappings
- in order to associate probabilities to answers

For more details...

You are invited to come to see our poster.

Thanks for your attention !