

Semantic Web Rules for Business Information

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NBBizKB: New Brunswick Business Knowledge Base

- ▷ Static source: “Biznet Directory of Manufacturers and Selected Services to Industry” (Biznet)
- ▷ Dynamic source: Yahoo! Canada Business Finder (Yahoo!)
- ▷ Extract factual data from these sources and integrate them via rules
- ▷ Use case for data interchange with POSL/RuleML rules

POSL and RuleML: Knowledge on the Web

- ▷ Semantic knowledge representation requires taxonomies and rules
- ▷ POSL integrates **p**ositional and **s**lotted knowledge for humans
(e.g.: Prolog's positional and F-logic's slotted knowledge)
- ▷ RuleML marks up such knowledge for machines
- ▷ POSL ↔ RuleML translators in OO jDREW and via Java Web Start
(<http://www.jdrew.org/ooidrew>)

Yahoo! Data Record as POSL Fact

```
YAHOO_ENT (  
  OPER_NAME->"Nackawic Mechanical Ltd";  
  PHONE->" (506) 575-2218";  
  ...  
  CATEGORY->"Mechanical Contractors";  
  WEB_SITE->).
```

Yahoo! Data Record as RuleML Fact

<Atom>

<Rel>YAHOO_ENT</Rel>

<slot><Ind>OPER_NAME</Ind><Ind>Nackawic Mechanical Ltd</Ind></slot>

<slot><Ind>PHONE</Ind><Ind>(506) 575-2218</Ind></slot>

...

<slot><Ind>CATEGORY</Ind><Ind>Mechanical Contractors</Ind></slot>

<slot><Ind>WEB_SITE</Ind><Ind/></slot>

</Atom>

Mapping Rules

Instance-based taxonomy alignment, where instances are RuleML facts

1. Remove duplicates from each fact base
2. Find set of enterprises in both fact bases by some identity criterion
3. For each overlapping pair of enterprise facts derive a candidate sector-category mapping
4. A mapping is considered valid if at least n enterprise pairs support it

Enterprise Identity Across Fact Bases

- ▷ Phone number generally provided: BIZNET_ENT's CONTACT/PHONE slot and YAHOO_ENT's PHONE slot
- ▷ Requires minimal normalization: Add missing area codes and handle variations in use of, e.g., spaces, hyphens, and parentheses
- ▷ Multiple-slot identity over more contact details or enterprise name
- ▷ Basic overlap between 10,738 Yahoo! and 2,108 Biznet facts: 706 enterprises

Phone-Identified Sector-Category Pairs

In IdSectorCategory, I, S and C constitute a Phone-identified Sector-Category pair if there is some BIZNET_ENT with CONTACT/PHONE P having NAICS_INDUSTRY_SECTOR S and some YAHOO_ENT with PHONE Q having CATEGORY C and there is an I such that normalphone holds for P and I as well as Q and I.

```
IdSectorCategory(?I, ?S, ?C) :-  
    BIZNET_ENT (CONTACT[PHONE->?P ! ?]; NAICS_INDUSTRY_SECTOR->?S ! ?),  
    YAHOO_ENT (PHONE->?Q; CATEGORY->?C ! ?),  
    normalphone (?P, ?I),  
    normalphone (?Q, ?I).
```


Coping with Many-to-Many Mappings

Mapping analysis showed: **sector** *many – to – many* **category**

- ▷ Sector 336612 (Boat Building) maps to categories “Boat Builders” and “Canoes Kayaks”
 - ▷ Category “Draperies & Curtains Retail & Custom Made” maps to sectors 314120 (Curtain and Linen Mills) and 337920 (Blind and Shade Manufacturing)
- ↪ Sector-category pair found via any identity criterion only accepted if also in 2nd enterprise, with non-identity based again on phones

2-Enterprise-Supported Pairs

Sector S and Category C form a 2-enterprise-supported SectorCategory pair if IdSectorCategory holds for a first normalized PHONE I1 with S and C, and for a second normalized PHONE I2 with S and C, where I1, I2 are notEqual.

```
SectorCategory(?S, ?C) :-  
    IdSectorCategory(?I1, ?S, ?C),  
    IdSectorCategory(?I2, ?S, ?C),  
    notEqual(?I1, ?I2).
```

Generalizing such 2-enterprise-supported pairs, *n*-enterprise-supported pairs can be introduced

Mapping Results and Use

- ▷ From the 706 overlapping facts, mapping rules discovered 84 2-enterprise-supported sector-category pairs
- ▷ If, for every category, only maximally-supported sector chosen, 27 of the 84 pairs are eliminated, leaving 57 reliable sector-category pairs
- ▷ Some rules on top of `SectorCategory` relation:
 - ▷ `uniqueCategory` tests whether `YAHOO_ENT` category from global category list is unique for `BIZNET_ENT` sector
 - ▷ `CSCPath` chains `Category-Sector-Category` paths connecting categories via intermediate sectors

Integration Rules

New NBEnterprise relation defined through view-like rules integrating the BIZNET_ENT and YAHOO_ENT facts

- ▷ *Total view of* NBEnterprise *as* BIZNET_ENT:
no information loss

NBEnterprise *assumes all slots unchanged from* BIZNET_ENT *facts.*

```
NBEnterprise(! ?All) :- BIZNET_ENT(! ?All).
```

Partial Views

- ▷ *Partial view* of NBEnterprise as YAHOO_ENT:
information loss
- ▷ SectorCategory rule used to derive sectors from categories
 - ▷ Unify slots of YAHOO_ENT with variables and employ SectorCategory right-to-left in premises
 - ▷ Conclusion is NBEnterprise relation containing renamed versions of slots – filled with variable values and derived NAICS_INDUSTRY_SECTOR

NBEnterprise *assumes all slots from* YAHOO_ENT *facts, using a* SectorCategory *mapping, where the* CONTACT *slots are renamed and* *restructured as defined in* BIZNET_ENT.

<pre> NBEnterprise (NAME->?Ne; NAICS_INDUSTY_SECTOR->?S; CONTACT-> [PHONE->?P; FAX->?Fax; WEB_SITE->?URL; MAILING_ADDRESS-> [ADDRESS_LINE1_ENG->?MLe; CITY->?MCity; PROVINCE->?MProv; POSTAL_CODE->?MCode]]) </pre>	<pre> YAHOO_ENT (OPER_NAME->?Ne; PHONE->?P; FAX->?Fax; MAIL_ENG->?MLe; MAIL_PLACE->?MCity; MAIL_PROV->?MProv; MAIL_POST->?MCode; CATEGORY->?C; WEB_SITE->?URL) , SectorCategory (?S, ?C) . </pre>
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Integration Results and Benefit

- ▷ From 10,738 YAHOO_ENT facts above NBEnterprise rule creates NBEnterprise facts:
 - ▷ 2,700 if categories are mapped to multiple sectors
 - ▷ 1,470 if categories are mapped to maximally-supported sector
 - ▷ Other rules provide further NBEnterprise slots such as COUNTY
- ↪ Secondary dynamic source plus rules helps to maintain primary static source

Conclusions

- ▷ Presented data interchange use case with RuleML POSL syntax
- ▷ New Brunswick Business Knowledge Base being maintained at <http://www.ruleml.org/usecases/nbbizkb>
- ▷ View-based exchange of objected-centred data via OO RuleML rules
- ▷ Mapping rules essential part of integration rules
- ▷ Tradeoff: Transformation (preprocessing) vs. view (querying) rules
- ▷ RuleML rules themselves constitute (XML) data for interchange