Semantic Annotation Semantically: Using a Shareable Extraction Ontology and a Reasoner

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Outline

Semantic Annotation of Text (Problem)

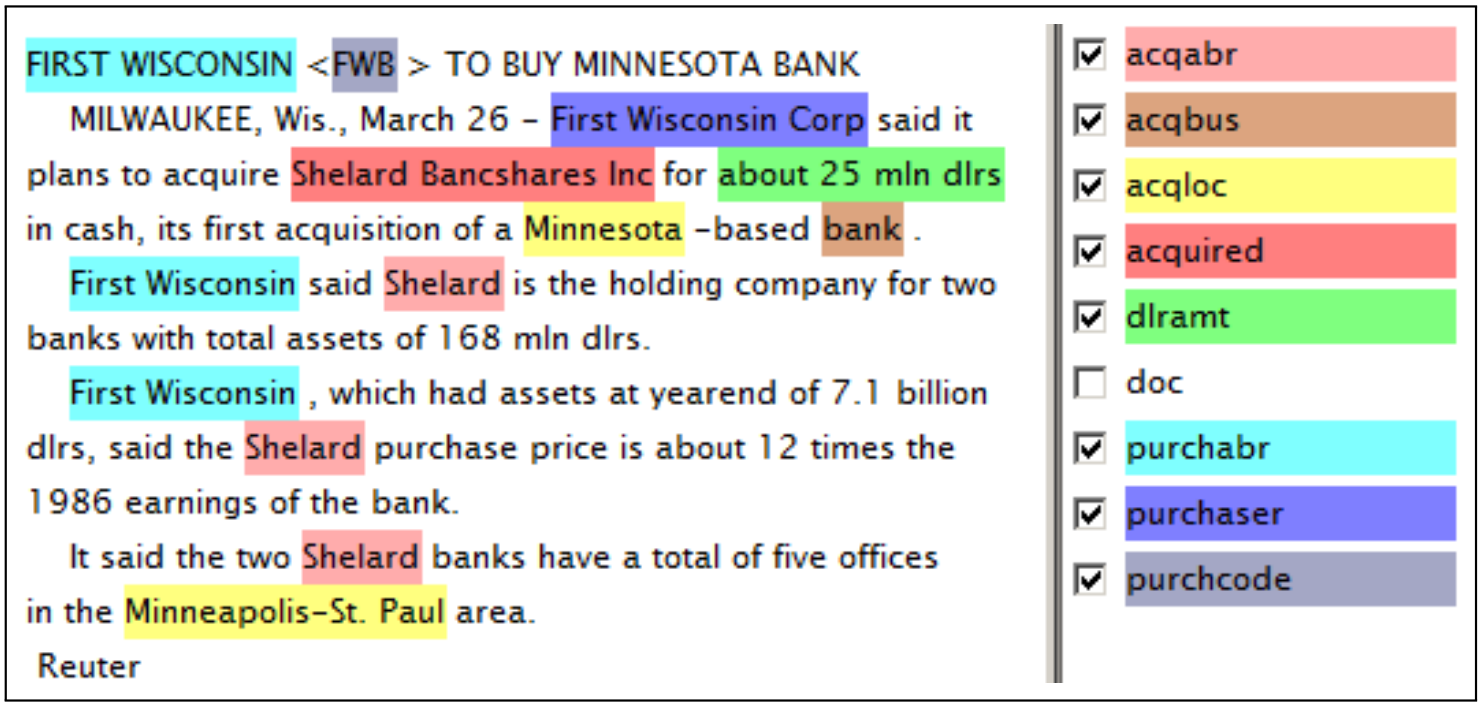
- Let's have a text describing an acquisition event.

> FIRST WISCONSIN <**FWB** > TO BUY MINNESOTA BANK
>
> MILWAUKEE, Wis., March 26 - **First Wisconsin Corp** said it plans to acquire **Shelard Bancshares Inc** for **about 25 mln dlrs** in cash, its first acquisition of a Minnesota -based **bank** .
>
> **First Wisconsin** said **Shelard** is the holding company for two banks with total assets of 168 mln dlrs.
>
> **First Wisconsin** , which had assets at yearend of 7.1 billion dlrs, said the **Shelard** purchase price is about 12 times the 1986 earnings of the bank.
>
> It said the two **Shelard** banks have a total of five offices in the Minneapolis-St. Paul area.
>
> Reuter

- What was the object of the acquisition?
- Who was the buyer?
- What was the deal amount?

Semantic Annotation of Text (Solution)

- Well, there are Information Extraction tools that can identify and extract such information.
  - Of course not 100% accurete...



- The tools can also interpret such information in terms of a Semantic Web Ontology.

Extraction Ontology

- And even more!
- The knowledge (extraction model) used in the extraction process can itself be saved in an ontology.
  - So called Extraction Ontology

- D. W. Embley, “Toward semantic understanding: an approach based on information extraction ontologies,” in *ADC ’04*. Darlinghurst: ACS, 2004, pp. 3–12.
- M. Labský et al., “The Ex Project: Web Information Extraction Using Extraction Ontologies,” in *Knowledge Discovery Enhanced with Semantic and Social Information*, ser. Studies in Comput. Intellig. Springer, 2009, vol. 220, pp. 71–88.

Are Such Extraction Ontologies Shareable?

Question

- But are these Extraction Ontologies shareable?
- Is it possible to use them outside of the original tool?

Answer

? ...

Example [Embley]

CarAds Extraction Ontology

```
<ObjectSet x="329" y="51" lexical="true" name="Mileage" id="osmx50">
    <DataFrame>
      <InternalRepresentation>
        <DataType typeName="String"/>
      </InternalRepresentation>
      <ValuePhraseList>
        <ValuePhrase hint="Mileage Pattern 1">
          <ValueExpression color="ffffff">
            <ExpressionText>[1-9]\d{0,2}[kK]</ExpressionText>
          </ValueExpression>
          <LeftContextExpression color="ffffff">
          ...
      <KeywordPhraseList>
        <KeywordPhrase hint="New phrase 1">
          <KeywordExpression color="ffffff">
            <ExpressionText>\bmiles\b</ExpressionText>
            ...
```

http://www.deg.byu.edu/presentations/ColloqSemanticUnderstanding.Jun2006.ppt

Example [Labský]

```
<attribute id="city" type="name" card="0-1" eng="0.50">
  <pattern id="eu_big_cities" src="eu_cities.txt" encoding="utf-8"/>
  <pattern id="us_big_cities" src="us_cities.txt" encoding="iso-8859-1" />
  <pattern id="all_cities">
    <pattern ref="europe_big_cities"/> | <pattern ref="us_big_cities"/>
  </pattern>
  <pattern id="city_suffix"> City | Village | Town </pattern>
  <value>
    <pattern p="0.55" cover="0.05">
      <tok case="CA|UC"/>{1,2} <pattern ref="city_suffix"/>
    </pattern>
    <pattern p="0.80" cover="0.50" ignore="case" case="^CA|UC">
      <tok case="all_cities"/> <pattern ref="city_suffix"/>?
    </pattern>
  </value>
```

... pattern for matching city names which will utilize large lists of known cities.

`http://eso.vse.cz/~labsky/ex/ex_tutorial.pdf`

Are Such Extraction Ontologies Shareable?

Question

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Answer

Not yet.
Although they are conceptually modeled, the native tool is the only tool capable of interpretation of these models (ontologies).

Our Idea: Shareable Extraction Ontologies

- **Publish** your extraction ontology on the web and **anybody can use it with a standard reasoner**!
- How this can be done?
- Can a reasoner process textual reports?

Text Processing by a Reasoner

- Can a reasoner process textual reports?
- Well, not from the beginning :-(
- Semantic Web reasoners work only with Semantic Web ontologies.
  (Not with textual documents)
- They can read RDF & OWL files.
- And also XHTML and XML files, but ...
  - But only the semantic part provided by RDFa annotations or by a GRDDL transformation.
- So we need some preprocessing...

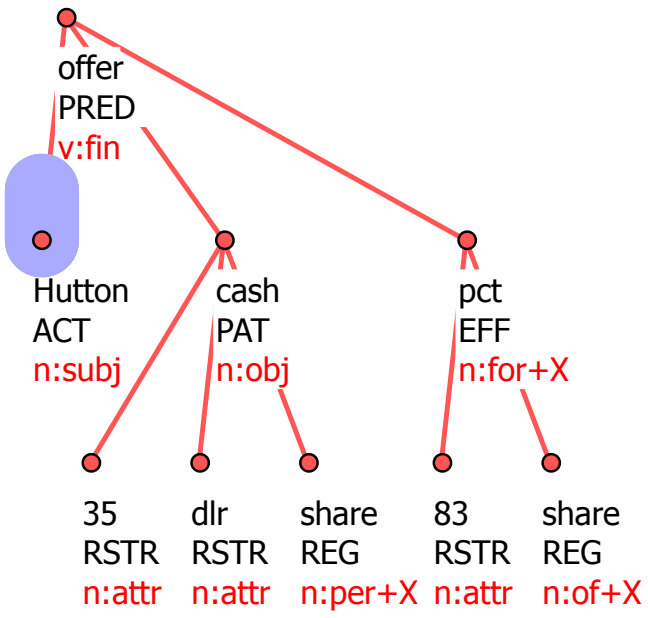
Document Ontologies

- ...we need some preprocessing.
- That will convert a (textual) document to a ontology.
- TXT (PDF, HTML) $\rightarrow$ RDF (OWL)
- Document $\rightarrow$ Document Ontology (reasoner readable)
- We call the ontological representation of a document a Document Ontology.
- Document Ontology contains:
  - All words of a document
  - Other units necessary for:
    - Information Extraction
    - Document reconstruction (Document Ontology $\rightarrow$ Document)

From now the idea is strait forward!

- The **semantics of the Extraction Model** has to be converted to the **semantics of the Extraction Ontology**.
- A reasoner can then interpret the Extraction Ontology in the same way as the original tool would interpret the Extraction Model.
- Application of the Extraction Ontology on the Document Ontology by a reasoner will result in "Annotated Document Ontology"
  - Annotated Document can be reconstructed from it.

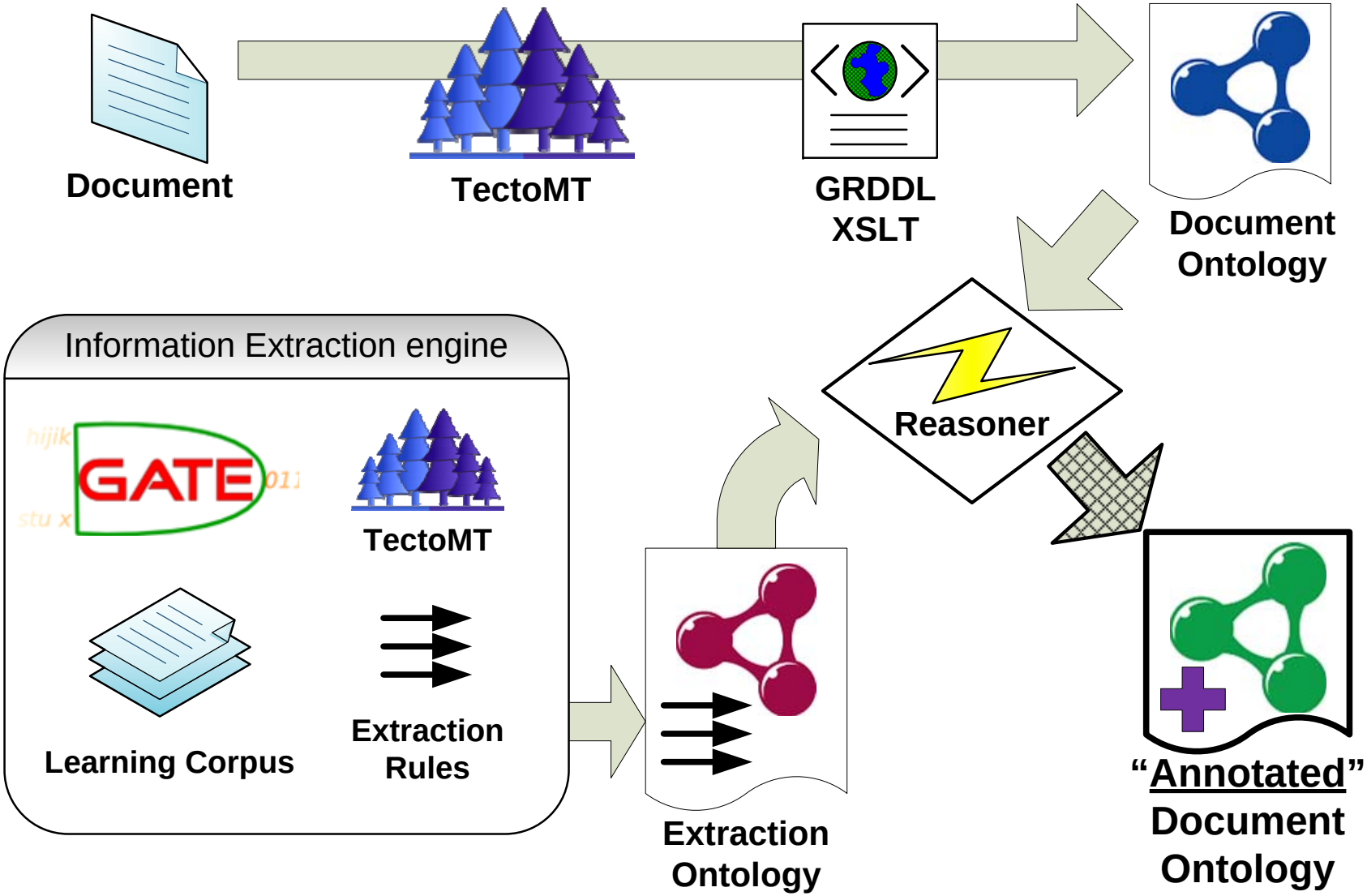
Information Extraction Engine



"Hutton is offering 35 dlrs cash per share for 83 pct of the shares."

- Based on dependency parsing
- Linguistic trees
  - Transfered to Document Ontology
- Extraction rules
  - Tree patterns
- Machine learning of rules using Inductive Logic Programming (ILP)
  - It works – really :-)
  - See e.g. [8] (self citation)
- Rules can be also handcrafted.
- These extraction rules can be directly exported to ontology using SWRL!

System Architecture



Examples of native extraction rules

[Rule 1] [Pos cover = 23 Neg cover = 6]

```
mention_root(acquired,A) :-
    'lex.rf'(B,A), t_lemma(B,'Inc'),
    tDependency(C,B), tDependency(C,D),
    formeme(D,'n:in+X'), tDependency(E,C).
```

[Rule 11] [Pos cover = 25 Neg cover = 6]

```
mention_root(acquired,A) :-
    'lex.rf'(B,A), t_lemma(B,'Inc'),
    tDependency(C,B), formeme(C,'n:obj'),
    tDependency(C,D), functor(D,'APP').
```

[Rule 75] [Pos cover = 14 Neg cover = 1]

```
mention_root(acquired,A) :-
    'lex.rf'(B,A), t_lemma(B,'Inc'),
    functor(B,'APP'), tDependency(C,B),
    number(C,pl).
```

SWRL (OWL/XML) Representation

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE Ontology [
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
  <!ENTITY pml "http://ufal.mff.cuni.cz/pdt/pml/" >
]>
<Ontology xmlns="http://www.w3.org/2002/07/owl#"
  ontologyIRI="http://czsem.berlios.de/onto ... rules.owl">
  <DLSafeRule>
    <Body>
      <ObjectPropertyAtom>
        <ObjectProperty IRI="&pml;lex.rf" />
        <Variable IRI="urn:swrl#b" />
        <Variable IRI="urn:swrl#a" />
      </ObjectPropertyAtom>
...
      <DataPropertyAtom>
        <DataProperty IRI="&pml;number" />
        <Variable IRI="urn:swrl#c" />
        <Literal>pl</Literal>
      </DataPropertyAtom>
    </Body>
    <Head>
      <DataPropertyAtom>
        <DataProperty IRI="&pml;mention_root" />
        <Literal>acquired</Literal>
        <Variable IRI="urn:swrl#a" />
      </DataPropertyAtom>
    </Head>
  </DLSafeRule>
</Ontology>
```

The same in Jena rules format

```
@prefix pml: <http://ufal.mff.cuni.cz/pdt/pml/>.
[rule-75:
        ( ?b pml:lex.rf ?a )
        ( ?c pml:tDependency ?b )
        ( ?b pml:functor 'APP' )
        ( ?c pml:number 'pl' )
        ( ?b pml:t_lemma 'Inc' )
    ->
        ( ?a pml:mention_root 'acquired' )
]
```

Datasets & Reasoners

dataset	domain	language	num of files	data size (MB)	num of rules
czech_fireman	accidents	Czech	50	16	2
acquisitions	finance	English	600	126	113

reasoner	**czech_fireman**	stdev	**acquisitions-v1.1**	stdev
Jena	161 s	0.226	1259 s	3.579
HermiT	219 s	1.636	$\gg$ 13 hours	
Pellet	11 s	0.062	503 s	4.145
FaCT++	Does not support rules.			

- How poor is the poor performance? :-)

Conclusion

- Idea of Shareable Extraction Ontologies presented
  - With the drawback of the necessity of document preprocessing (TXT $\rightarrow$ RDF)
- Realization of the idea demonstrated by adaptation of our IE system
- Performance evaluation experiment done
  - Poor performance (as expected)
  - But bearable
- New public OWL (+SWRL) reasoning benchmark created as a side effect

Future Work

- Compare the performance with rules translated to SPARQL
  - Increased performance could be expected
- Annotated Document Ontologies $\rightarrow$ Fact Ontologies
  - Data integration and duplicity of information issues
  - Technological problems: creating new individuals during (safe) reasoning
- General Shareable Extraction Ontology creation guidelines
  - E.g. how to encode a gazetteer list this way

Thank you for your attention!

Questions?