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RExtractor: a Robust Information Extractor

Aplikace NLP, 17.3.2015
MFF UK
Motivation

- large collections of documents
- efficient browsing & querying
- typical approaches
  - full-text search
  - metadata search
- semantic interpretation of documents → suitable DB & query language → user-friendly browsing & querying
Scenario

- **Cooperation between**
  - Information Extraction
  - Semantic Web
Scenario

- **Extracting knowledge base**
  - set of entities and relations between them
  - linguistic analysis (RExtractor)

- **Knowledge base representation**
  - Linked Data Principles
  - Resource Description Framework (RDF)
Scenario

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  - Resource Description Framework (RDF)
RExtractor Architecture

Conversion Component
- HTML
- TXT
- PDF
- XML

NLP Component
- Segmentation
- Tokenization
- Tagger
- Morphology
- Parser

Relation Extraction
- PML-TQ
- Database of queries

Entity Detection
- PML-TQ
- Database of entities
Conversion Component

• converts various input formats into a unified representation (XML)
RExtractor Architecture

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NLP Component

- **Prague Dependency Treebank** framework
  - [http://ufal.mff.cuni.cz/pdt3.0](http://ufal.mff.cuni.cz/pdt3.0)

- **Tools**
  - segmentation & tokenization
  - lemmatization & morphology
  - syntactic parsing
(3) Accounting units, which keep books in simplified extent, create fixed items and reserves according to special legal regulations.
(3) **Accounting units**, which keep books in simplified extent, **create fixed items and reserves** according to special legal regulations.
RExtractor Architecture
Entity Detection Component

• Database of Entities
  – entities specified by domain experts

• PML-TQ (http://ufal.mff.cuni.cz/pmltq)
  – tree queries better than regular expressions
    • coordination
    • several word forms in inflective languages
  – find the entity current tangible assets in the text current tangible and intangible assets
Entity Detection Component

- find the entity *current tangible assets* in the text *current tangible and intangible assets*
Accounting units, which keep books in simplified extent, create fixed items and reserves according to special legal regulations.
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Relation Extraction Component

- **Database of Queries**
  - queries formulated by domain experts
  - their formulation in the form of PML-TQ queries on dependency trees

- **RDF ready output**
  - triples \((subject, predicate, object)\)
  - each position
    - is annotated in a text \((text\ chunk)\)
    - has a specific **ontological concept** \((RDF\ Class)\)
Relation Extraction Component

- Accounting units' obligations

<table>
<thead>
<tr>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity</td>
<td>hasToCreate</td>
<td>Something</td>
</tr>
<tr>
<td>Accounting units</td>
<td>create</td>
<td>fixed items</td>
</tr>
<tr>
<td>Accounting units</td>
<td>create</td>
<td>reserves</td>
</tr>
</tbody>
</table>
Case study on legislative domain

Legal texts

- specialized texts operating in legal settings
- they should transmit legal norms to their recipients
- they need to be clear, explicit and precise

Sentences

- simple sentences are very rare
- usually long and very complex

Legal texts are “generally considered very difficult to read and understand” (Tiersma, 2010)
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NLP Component

Automatic parsers for Czech

- trained on **newspaper texts**
- verification whether we can use the parser trained on newspaper texts or some modifications are needed
- **MST parser**
NLP Component

Corpus of Czech legal texts (CCLT)

- Accounting Act (563/1991 Coll.)
- Decree on Double-entry Accounting for undertakers (500/2002 Coll.)
- automatically parsed, then manually checked
  - 1,133 manually annotated dependency trees
  - 35,085 tokens
Accounting units create fixed items according to § 16, 26, 31, 55 and 57 and not apply § 27, § 14, 39, § 51 - 55, § 58, 60 and 69
Accounting units create fixed items according to § 16, 26, 31, 55 and 57 and not apply § 27, § 14, 39, § 51 - 55, § 58, 60 and 69
Accounting units create fixed items according to § 16, 26, 31, 55 and 57 and not apply § 27, § 14, 39, § 51 - 55, § 58, 60 and 69
RExtractor Architecture
ENTITY DETECTION COMPONENT

ENTITIES IN CCLT

- Accounting subdomain
- Entities manually annotated by domain experts
  - Decree on Double-entry Accounting for undertakers (500/2002 Coll.)

SAMPLE

(1) Vyhláška se vztahuje na účetní jednotky podle § 1 odst. 2 písm. a) a b) zákona, s výjimkou účetních jednotek uvedených v odstavci 2, a na účetní jednotky podle § 1 odst. 2 písm. d) až h) zákona.

(2) Z účetních jednotek uvedených v odstavci 1 se tato vyhláška nevztahuje na účetní jednotky podle § 19a zákona, pokud zvláštní právní předpis 1c) nestanoví jinak, a na účetní jednotky, jejichž účetnictví upravuje zvláštní právní předpis 1d). Dále se tato vyhláška, s výjimkou § 62 odst. 2 až 5, nevztahuje na účetní jednotky podle § 23a zákona.
Entity Detection Component

Initializing DBE with entities from CCLT

- Each (unique) entity parsed automatically by MST
- Automatic procedure takes an entity dependency tree and creates a PML-TQ query
Entity Detection Component

Experiment

- identify entities in the gold standard trees in CCLT
  - with re-tokenized tokens and *(very)* long sentences
- identify entities in the trees created by MST
  - with re-tokenized tokens and split sentences

<table>
<thead>
<tr>
<th>Parsing method</th>
<th>Extracted</th>
<th>TP</th>
<th>FP</th>
<th>FN</th>
<th>Precision</th>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>16428</td>
<td>9549</td>
<td>6879</td>
<td>628</td>
<td>58.1</td>
<td>93.8</td>
</tr>
<tr>
<td>Automatic</td>
<td>16160</td>
<td>9278</td>
<td>6882</td>
<td>838</td>
<td>57.4</td>
<td>91.7</td>
</tr>
</tbody>
</table>

Results

- high False positives
- automatic parser has low influence on detection
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Relation Extraction Component

Manual design of queries

- **Strategy**: cover maximum of relations with minimum of queries

- tree query expert
  - observes typical constructions for a given relation type
  - designs a query for the most frequent construction
  - goes through matches and redesigns the query if needed
Types of relations

- **Definitions**
  - entities are defined or explained

- **Obligations**
  - an entity is obligated to do something

- **Rights**
  - an entity has right to do something
Query design & evaluation on CCLT

- Query design
  - on *Accounting Act (563/1991 Coll.)*
  - 5 queries for **Definitions**
  - 4 queries for **Rights**
  - 2 queries for **Obligations**

- Evaluation
  - on *Decree on Double-entry Accounting for undertakers (500/2002 Coll.)*
### Relation Extraction Component

#### Results

<table>
<thead>
<tr>
<th></th>
<th>D</th>
<th>R</th>
<th>O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td># of queries</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Goldstandard</td>
<td>97</td>
<td>308</td>
<td>62</td>
<td>467</td>
</tr>
<tr>
<td>Extracted</td>
<td>70</td>
<td>255</td>
<td>41</td>
<td>366</td>
</tr>
<tr>
<td>True positive</td>
<td>53</td>
<td>206</td>
<td>36</td>
<td>295</td>
</tr>
<tr>
<td>False negative</td>
<td>44</td>
<td>102</td>
<td>26</td>
<td>172</td>
</tr>
<tr>
<td>False positive</td>
<td>17</td>
<td>49</td>
<td>5</td>
<td>71</td>
</tr>
<tr>
<td><strong>Precision (%)</strong></td>
<td><strong>75.7</strong></td>
<td><strong>80.8</strong></td>
<td><strong>87.8</strong></td>
<td><strong>80.6</strong></td>
</tr>
<tr>
<td><strong>Recall (%)</strong></td>
<td><strong>54.6</strong></td>
<td><strong>66.9</strong></td>
<td><strong>58.1</strong></td>
<td><strong>63.2</strong></td>
</tr>
</tbody>
</table>
Relation Extraction Component

Error analysis

<table>
<thead>
<tr>
<th>Error</th>
<th># of errors</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parser</td>
<td>145</td>
<td>59.7%</td>
</tr>
<tr>
<td>Query</td>
<td>93</td>
<td>38.3%</td>
</tr>
<tr>
<td>Entity</td>
<td>5</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

Results

- errors in automatic parsing
- query design
Scenario

- Extracting knowledge base
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- Knowledge base representation
  - Linked Data Principles
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Legal ontologies

• Document structure
  – Act » Expression » Section

• Document semantic
  – Legal Concepts Ontology (lexc:)
    • represents entities & relations
    • Concept » Concept Version
    • Property » hasDefinition, hasRight, hasObligation, ...
  – Linguistic Ontology (lingv:)
    • links entities with their appearance in texts
Conclusion

• general pipeline for **extraction** and **representation** of information that is presented in raw texts
  - processes input texts by linguistically-aware tools
  - extracts entities and relations from sentence syntactic representation
  - Linked Data principles

• **Legal documents** as a pilot domain