Task: Information Extraction for the Semantic Web *Solution*: Integration of PDT Tools with GATE and Inductive Logic Programming

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Outline

1. **Problem**
   - Information Extraction
   - Semantic Annotation
   - Example Tasks
2. **Solution**
   - Basic Idea
   - Linguistics we Are Using
   - Manually Created Rules
   - Semantic Interpretation
   - Learning of Rules
   - Evaluation
3. **Implementation Details**
   - Integration of Linguistic Tools (GATE)
   - Integration with Semantic Tools
   - Conclusion

Information Extraction and the Semantic Web

- The Task of Information Extraction
  - Automatically find the information you're looking for.
  - Pick out the most useful bits.
  - Present it in preferred manner, at the right level of detail.
- Semantic Web
  - Web as universal medium for the exchange of information.
  - Not only for humans but also for software agents.
  - Main problem today: lack of semantic data on the Web.
- Extraction of information for the Semantic Web
  - Let's use information extraction to produce semantic data.

Semantic Web Introduction

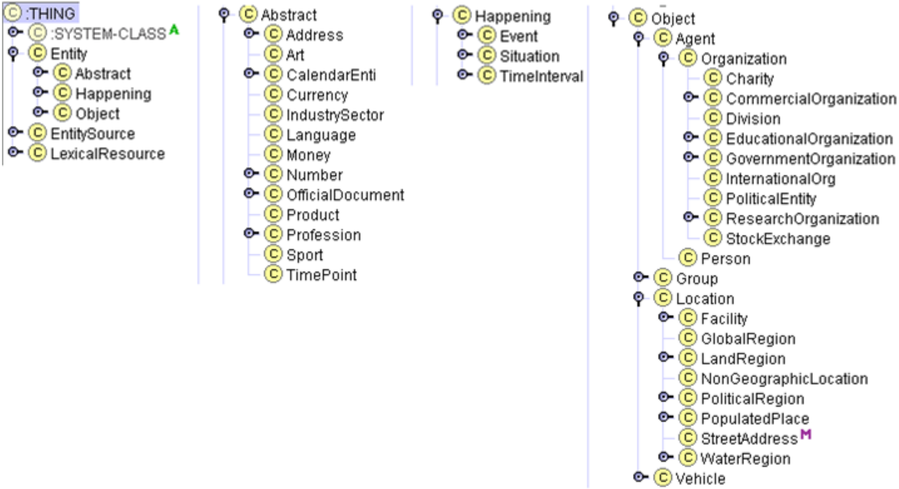
We use semantic web ontologies to express the semantics.

- RDF, OWL languages
- Motivated by description logics

- Concepts or Classes
- Predicates or Relations
- Individuals or Instances

- RDF triples: <Subject> <Predicate> <Object>
- RDF triples form a named oriented graph
  - Basic data structure of the Semantic Web

Ontology (example)



- :THING
  - :SYSTEM-CLASS A
  - Entity
    - Abstract
    - Happening
    - Object
  - EntitySource
  - LexicalResource

- Abstract
  - Address
  - Art
  - CalendarEnti
  - Currency
  - IndustrySector
  - Language
  - Money
  - Number
  - OfficialDocument
  - Product
  - Profession
  - Sport
  - TimePoint

- Happening
  - Event
  - Situation
  - TimeInterval

- Object
  - Agent
    - Organization
      - Charity
      - CommercialOrganization
      - Division
      - EducationalOrganization
      - GovernmentOrganization
      - InternationalOrg
      - PoliticalEntity
      - ResearchOrganization
      - StockExchange
    - Person
  - Group
  - Location
    - Facility
    - GlobalRegion
    - LandRegion
    - NonGeographicLocation
    - PoliticalRegion
    - PopulatedPlace
    - StreetAddress M
    - WaterRegion
  - Vehicle

- PROTON (PROTo ONtology)
  `http://proton.semanticweb.org/`

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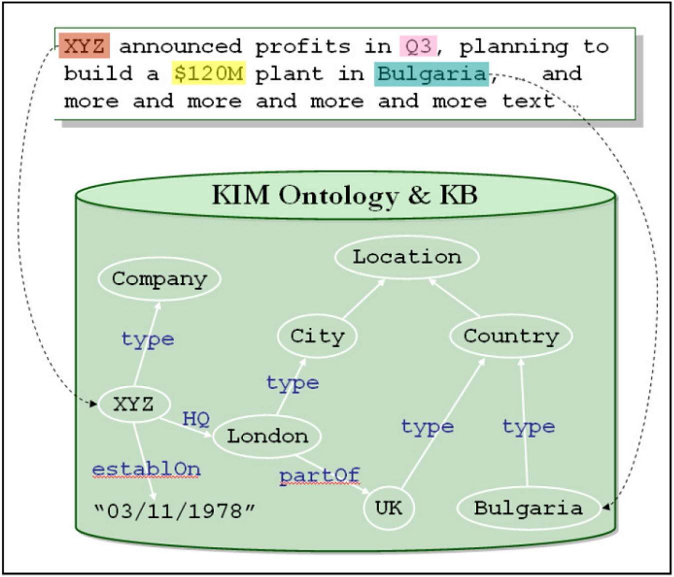
Semantic Annotation (`http://www.ontotext.com/kim/`)


XYZ announced profits in Q3, planning to build a $120M plant in Bulgaria, and more and more and more and more text

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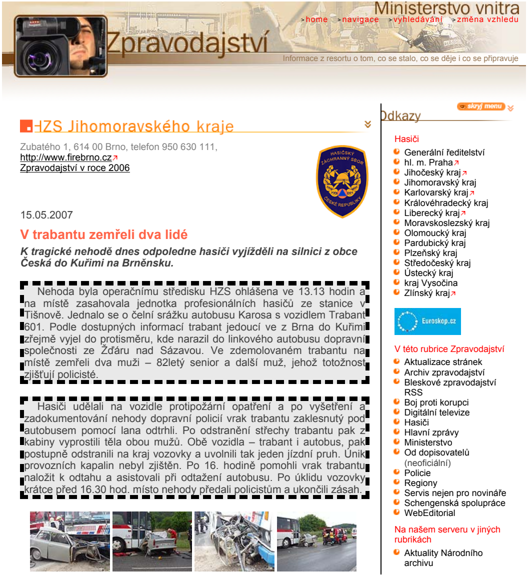
Example of the web-page with a report of a fire department



Ministerstvo vnitra

> home > navigace > vyhledávání > změna vzhledu

Zpravodajství

Informace z resortu o tom, co se stalo, co se děje i co se připravuje

HZS Jihomoravského kraje

Zubatého 1, 614 00 Brno, telefon 950 630 111,
http://www.firebrno.cz
Zpravodajství v roce 2006

15.05.2007

V trabantu zemřeli dva lidé

K tragické nehodě dnes odpoledne hasiči vyjížděli na silnici z obce Česká do Kuřimi na Brněnsku.

Nehoda byla operačnímu středisku HZS ohlášena ve 13.13 hodin a na místě zasahovala jednotka profesionálních hasičů ze stanice v Tišnově. Jednalo se o čelní srážku autobusu Karosa s vozidlem Trabant 601. Podle dostupných informací trabant jedoucí ve z Brna do Kuřimi zřejmě vyjel do protisměru, kde narazil do linkového autobusu dopravní společnosti ze Žďáru nad Sázavou. Ve zdemolovaném trabantu na místě zemřeli dva muži – 82letý senior a další muž, jehož totožnost zjišťují policisté.

Hasiči udělali na vozidle protipožární opatření a po vyšetření a zadokumentování nehody dopravní policií vrak trabantu zaklesnutý pod autobusem pomocí lana odtrhli. Po odstranění střechy trabantu pak z kabiny vyprostili těla obou mužů. Obě vozidla – trabant i autobus, pak postupně odstranili na kraj vozovky a uvolnili tak jeden jízdní pruh. Únik provozních kapalin nebyl zjištěn. Po 16. hodině pomohli vrak trabantu naložit k odtahu a asistovali při odtažení autobusu. Po úklidu vozovky krátce před 16.30 hod. místo nehody předali policistům a ukončili zásah.

skryj menu

Odkazy

Hasiči

- Generální ředitelství
- hl. m. Praha
- Jihočeský kraj
- Jihomoravský kraj
- Karlovarský kraj
- Královéhradecký kraj
- Liberecký kraj
- Moravskoslezský kraj
- Olomoucký kraj
- Pardubický kraj
- Plzeňský kraj
- Středočeský kraj
- Ústecký kraj
- kraj Vysočina
- Zlínský kraj

Euroskop.cz

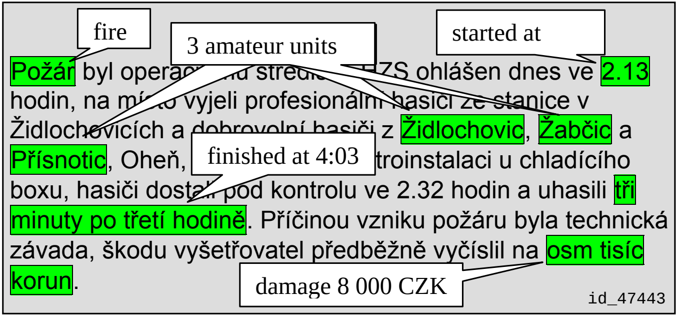
V této rubrice Zpravodajství

- Aktualizace stránek
- Archiv zpravodajství
- Bleskové zpravodajství RSS
- Boj proti korupci
- Digitální televize
- Hasiči
- Hlavní zprávy
- Ministerstvo
- Od dopisovatelů (neoficiální)
- Policie
- Regiony
- Servis nejen pro novináře
- Schengenská spolupráce
- WebEditorial

Na našem serveru v jiných rubrikách

- Aktuality Národního archivu

Text of an Accident Report and Contained Information

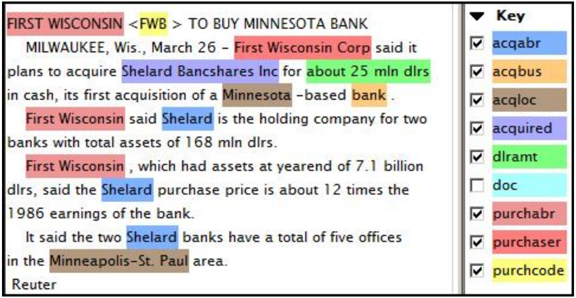


Požár byl operačním střediskem HZS ohlášen dnes ve 2.13 hodin, na místo vyjeli profesionální hasiči ze stanice v Židlochovicích a dobrovolní hasiči z Židlochovic, Žabčic a Přísnotic, Oheň, [illegible] troinstalaci u chladícího boxu, hasiči dostali pod kontrolu ve 2.32 hodin a uhasili tři minuty po třetí hodině. Příčinou vzniku požáru byla technická závada, škodu vyšetřovatel předběžně vyčíslil na osm tisíc korun.

- Information to be extracted is decorated.

Acquisitions Corpus

- Corporate Acquisition Events
- Acquisitions v1.1 version[1]



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

▼ Key
- ☑ acqabr
- ☑ acqbus
- ☑ acqloc
- ☑ acquired
- ☑ dlramt
- □ doc
- ☑ purchabr
- ☑ purchaser
- ☑ purchcode

[1] from the Dot.kom project's resources: http://nlp.shef.ac.uk/dot.kom/resources.html

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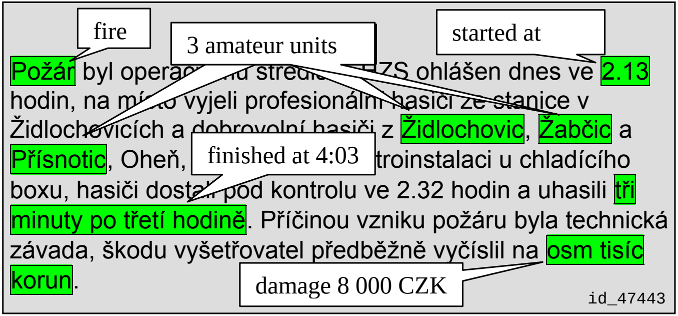
How to extract the information about the damage of the accident?



Požár byl operac u středi ZS ohlášen dnes ve 2.13 hodin, na místo vyjeli profesionální hasiči ze stanice v Židlochovicích a dobrovolní hasiči z Židlochovic, Žabčic a Přísnotic, Oheň, troinstalaci u chladícího boxu, hasiči dostali pod kontrolu ve 2.32 hodin a uhasili tři minuty po třetí hodině. Příčinou vzniku požáru byla technická závada, škodu vyšetřovatel předběžně vyčíslil na osm tisíc korun.

fire

3 amateur units

started at

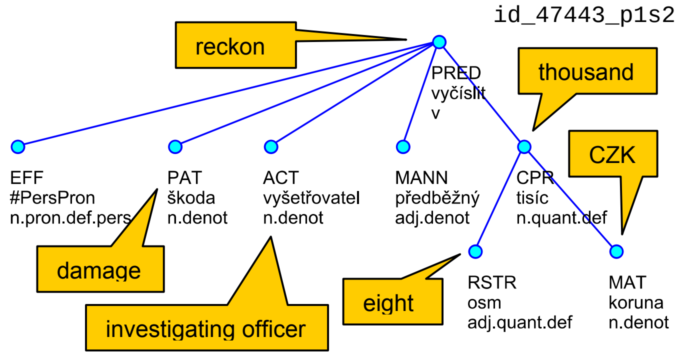
finished at 4:03

damage 8 000 CZK

id_47443

- How to extract the information about the damage of the accident?
- See the last sentence on the next slide.

Corresponding linguistic tree



…, škodu vyšetřovatel předběžně vyčíslil na osm tisíc korun.

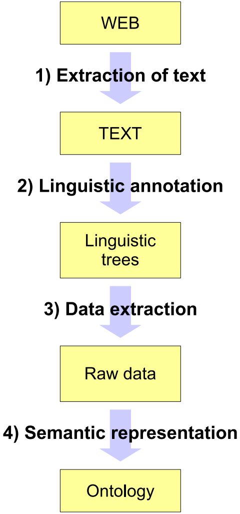
…, investigating officer preliminarily reckoned the damage to be 8 000 CZK.

- Basic Idea: use tree queries (tree patterns) to extract the information.

Introduction of Our Solution

- Extraction of semantic information from texts.
- Exploiting of linguistic tools.
  - Mainly “from” the Prague Dependency Treebank project.
    - Related tools – language analyzers (TectoMT), Netgraph, etc.
  - Experiments with the Czech WordNet.
- Rule based extraction method.
  - Extraction rules $\approx$ tree queries
  - ILP learning of extraction rules

Schema of the extraction process



WEB

1) Extraction of text

TEXT

2) Linguistic annotation

Linguistic trees

3) Data extraction

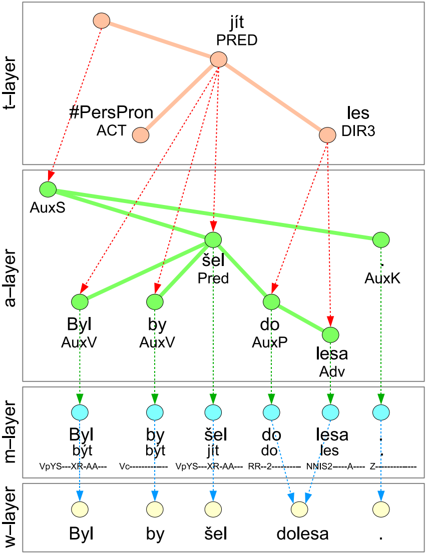
Raw data

4) Semantic representation

Ontology

1. Extraction of text
   - Using RSS feed to download pages.
   - Regular expression to extract text.
2. Linguistic annotation
   - Using chain of 6 linguistic tools (see on next slides).
3. Data extraction
   - Exploitation of linguistic trees.
   - Using extraction rules.
4. Semantic representation of data
   - Ontology needed.
   - Semantic interpretation of rules.
   - Far from finished in current state.

Layers of linguistic annotation in PDT



- Tectogrammatical layer
- Analytical layer
- Morphological layer

- PDT 2.0 on-line:

`http://ufal.mff.cuni.cz/pdt2.0/`

Sentence:

Byl by šel dolesa.
He-was would went toforest.

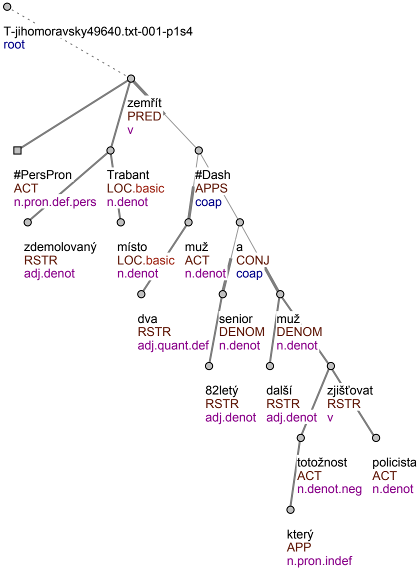
Tools for machine linguistic annotation

1. Segmentation and tokenization
2. Morphological analysis
3. Morphological tagging
4. McDonnald's Maximum Spanning Tree parser
   – Czech adaptation
5. Analytical function assignment
6. Tectogrammatical analysis
   – Developed by Václav Klimeš

- Available within the TectoMT[2] project

[2] http://ufal.mff.cuni.cz/tectomt/

Example of an output tectogrammatical tree



- Lemmas
- Functors
- Semantic parts of speech

Sentence:

Ve zdemolovaném trabantu na místě zemřeli dva muži – 82letý senior a další muž, jehož totožnost zjišťují policisté.

Two men died on the spot in demolished trabant – . . .

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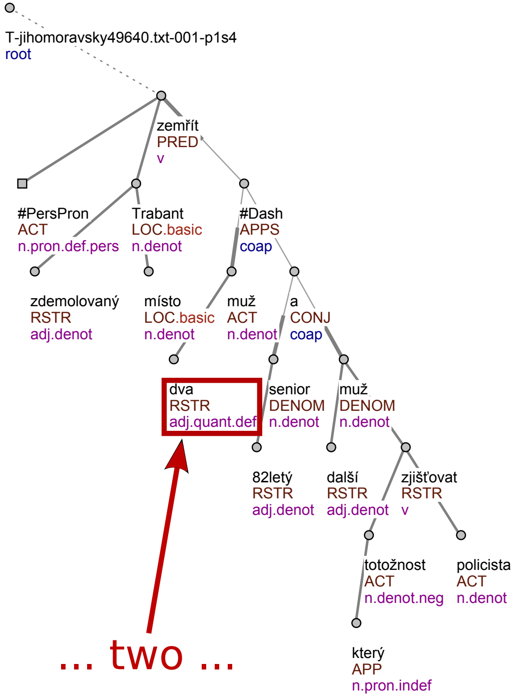
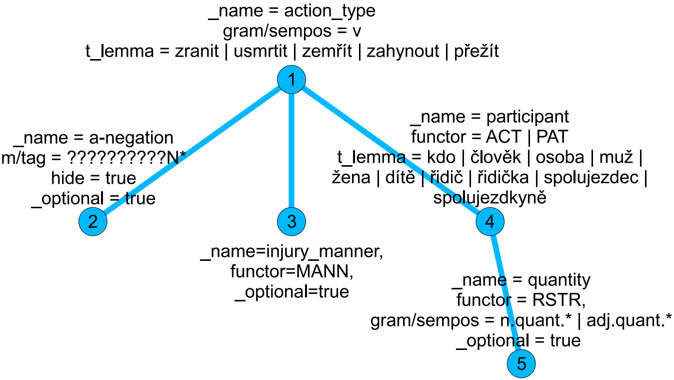


- How to extract the information about two dead people?

Extraction rules – Netgraph queries



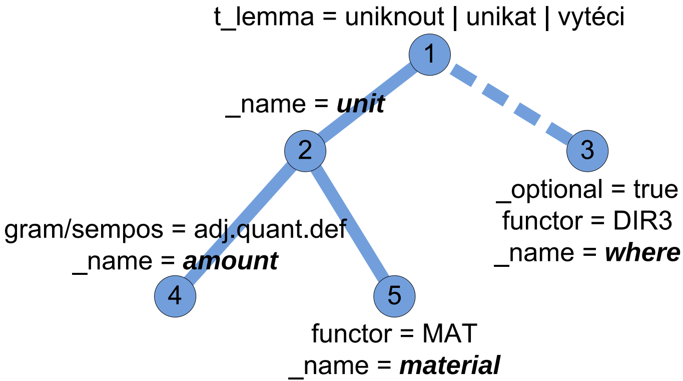
- Tree patterns on shape and nodes (on node attributes).
- Evaluation gives actual matches of particular nodes.
- Names of nodes allow use of references.

Raw data extraction output

```
<QueryMatches>
  <Match root_id="T-vysocina63466.txt-001-p1s4" match_string="2:0,7:3,8:4,11:2">
    <Sentence>
      Při požáru byla jedna osoba lehce zraněna - jednalo se
      o majitele domu, který si vykloubil rameno.
    </Sentence>
    <Data>
      <Value variable_name="action_type" attribute_name="t_lemma">zranit</Value>
      <Value variable_name="injury_manner" attribute_name="t_lemma">lehký</Value>
      <Value variable_name="participant" attribute_name="t_lemma">osoba</Value>
      <Value variable_name="quantity" attribute_name="t_lemma">jeden</Value>
    </Data>
  </Match>
  <Match root_id="T-jihomoravsky49640.txt-001-p1s4" match_string="1:0,13:3,14:4">
    <Sentence>
      Ve zdemolovaném trabantu na místě zemřeli dva muži - 82letý senior
      a další muž, jehož totožnost zjišťují policisté.
    </Sentence>
    <Data>
      <Value variable_name="action_type" attribute_name="t_lemma">zemřít</Value>
      <Value variable_name="participant" attribute_name="t_lemma">muž</Value>
      <Value variable_name="quantity" attribute_name="t_lemma">dva</Value>
    </Data>
  </Match>
  <Match root_id="T-jihomoravsky49736.txt-001-p4s3" match_string="1:0,3:3,7:1">
    <Sentence>Čtyřiatřicetiletý řidič nebyl zraněn.</Sentence>
    <Data>
      <Value variable_name="action_type" attribute_name="t_lemma">zranit</Value>
      <Value variable_name="a-negation" attribute_name="m/tag">VpYS---XR-NA---
      </Value>
      <Value variable_name="participant" attribute_name="t_lemma">řidič</Value>
    </Data>
  </Match>
</QueryMatches>
```

SELECT action_type.t_lemma, a-negation.mtag, injury_manner.t_lemma, participant.t_lemma, quantity.t_lemma **FROM** ****extraction rule****

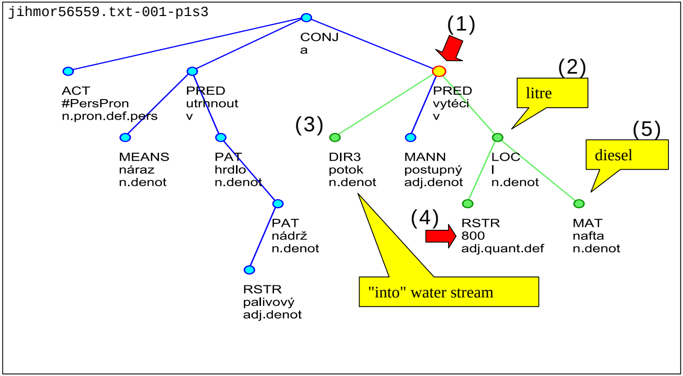
Extraction rules – Environment Protection Use Case



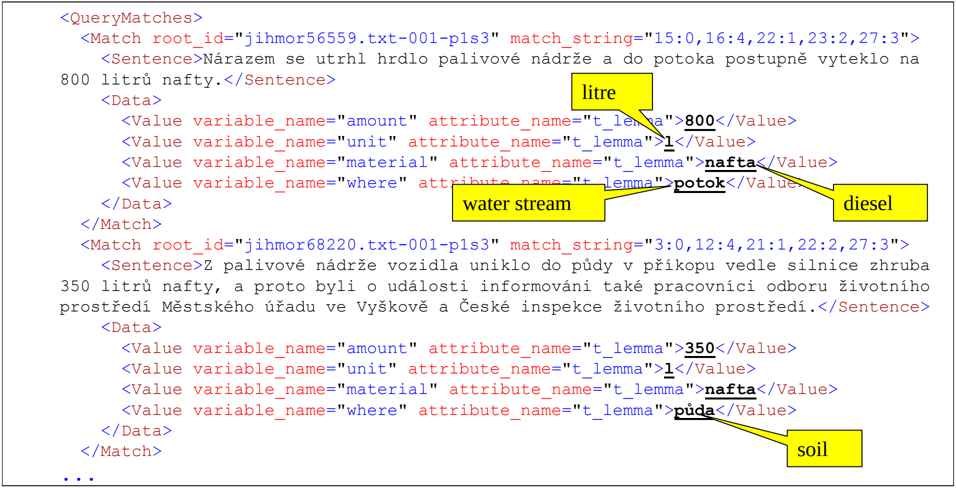
Matching Tree

"Due to the clash the throat of fuel tank tore off and 800 litres of oil (diesel) has run out to a stream."

“Nárazem se utrhl hrdlo palivové nádrže a do potoka postupně vyteklo na 800 litrů nafty.”



Raw data extraction output



```
<QueryMatches>
  <Match root_id="jihmor56559.txt-001-p1s3" match_string="15:0,16:4,22:1,23:2,27:3">
    <Sentence>Nárazem se utrhl hrdlo palivové nádrže a do potoka postupně vyteklo na
800 litrů nafty.</Sentence>
    <Data>
      <Value variable_name="amount" attribute_name="t_lemma">800</Value>
      <Value variable_name="unit" attribute_name="t_lemma">l</Value>
      <Value variable_name="material" attribute_name="t_lemma">nafta</Value>
      <Value variable_name="where" attribute_name="t_lemma">potok</Value>
    </Data>
  </Match>
  <Match root_id="jihmor68220.txt-001-p1s3" match_string="3:0,12:4,21:1,22:2,27:3">
    <Sentence>Z palivové nádrže vozidla uniklo do půdy v příkopu vedle silnice zhruba
350 litrů nafty, a proto byli o události informováni také pracovníci odboru životního
prostředí Městského úřadu ve Vyškově a České inspekce životního prostředí.</Sentence>
    <Data>
      <Value variable_name="amount" attribute_name="t_lemma">350</Value>
      <Value variable_name="unit" attribute_name="t_lemma">l</Value>
      <Value variable_name="material" attribute_name="t_lemma">nafta</Value>
      <Value variable_name="where" attribute_name="t_lemma">půda</Value>
    </Data>
  </Match>
...
```

litre

water stream

diesel

soil

SELECT amount.t_lemma, unit.t_lemma, material.t_lemma, where.t_lemma

FROM ****extraction rule****

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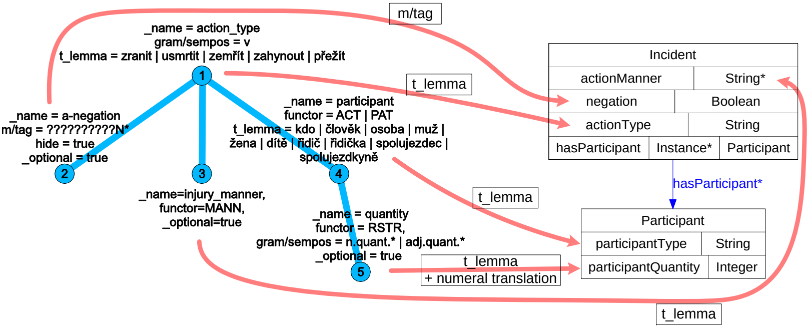
Semantic interpretation of extraction rules

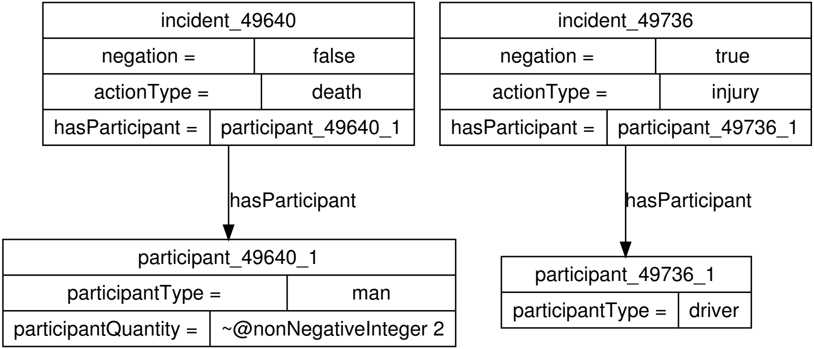


Incident	
actionManner	String*
negation	Boolean
actionType	String
hasParticipant	Instance* Participant

Participant	
participantType	String
participantQuantity	Integer

- Determines how particular values of attributes are used.
- Gives semantics to extraction rule.
- Gives semantics to extracted data.

Semantic data output



incident_49640	
negation =	false
actionType =	death
hasParticipant =	participant_49640_1

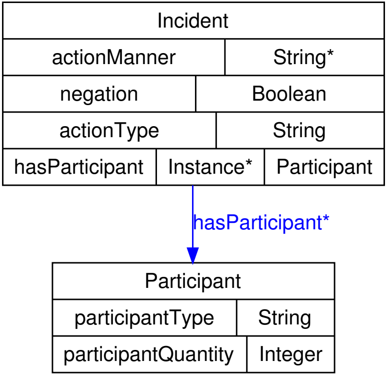
incident_49736	
negation =	true
actionType =	injury
hasParticipant =	participant_49736_1

participant_49640_1	
participantType =	man
participantQuantity =	~@nonNegativeInteger 2

participant_49736_1	
participantType =	driver

- Two instances of two ontology classes.

The experimental ontology



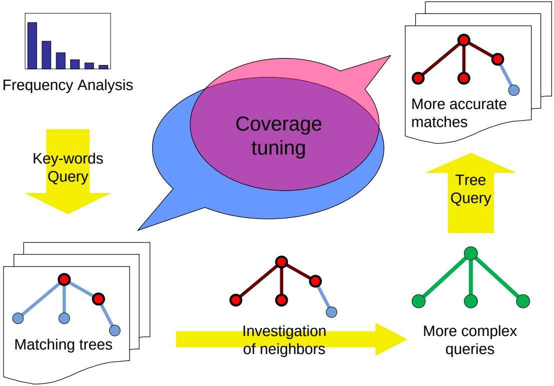
Incident		
actionManner	String*	
negation	Boolean	
actionType	String	
hasParticipant	Instance*	Participant

hasParticipant*

Participant	
participantType	String
participantQuantity	Integer

- Two classes
  - Incident and Participant
- One object property relation
  - hasParticipant
- Five datatype property relations
  - actionManner (light or heavy injury)
  - negation
  - actionType (injury or death)
  - participantType (man, woman, driver, etc.)
  - participantQuantity

Design of extraction rules – iterative process



1. Frequency analysis → representative key-words.
2. Investigating of matching trees → tuning of tree query.
3. Complexity of the query ≅ complexity of extracted data.

Corpus of Fire-department articles

- Fire-department articles
- Published by The Ministry of Interior of the Czech Republic[3]
- Processed more than 800 articles
  from different regions of Czech Republic
- 1.2 MB of textual data
- Linguistic tools produced 10 MB of annotations,
  run time 3.5 hours
- Extracting information about injured and killed people
- 470 matches of the extraction rule,
  200 numeric values of quantity (described later)

[3] `http://www.mvcr.cz/rss/regionhzs.html`

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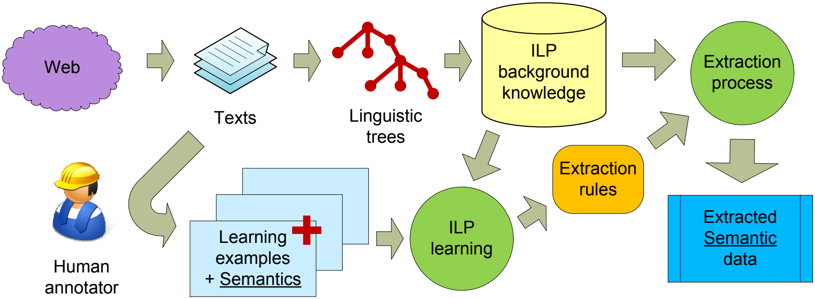
Inductive Logic Programming

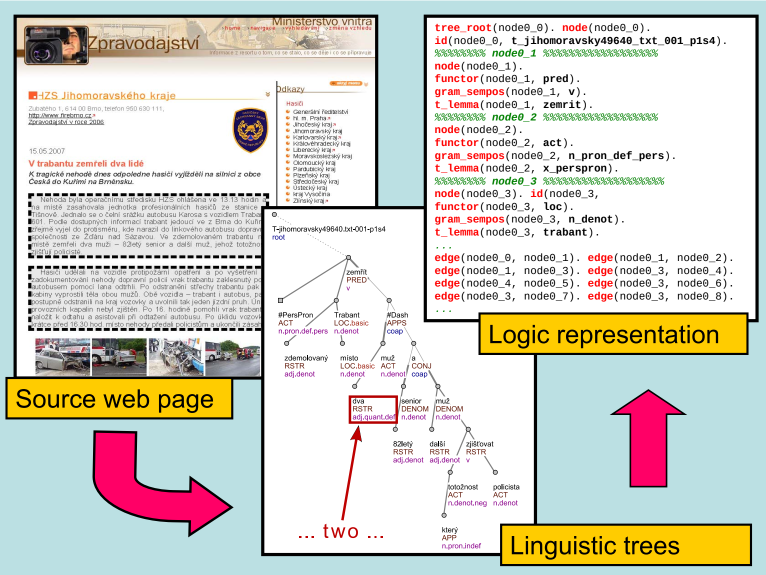
- Inductive Logic Programming (ILP)
  - is a Machine Learning procedure for multirelational learning
  - Heuristic and iterative method, learning is usually slow
  - It is capable to deal with graph or tree structures naturally
  - Learns form positive and negative examples
    - Positive and negative tree nodes
    - It is necessary to label tree nodes from corresponding labeled text (not trivial problem)
  - Learned rules are strict (no weights, probabilities, etc.)
    - Easier human understanding, modification
    - Possibility of sharing of rules amongst different tools
    - Lower performance (precision, recall)

Integration of ILP in our extraction process



- Main point: transformation of trees to logic representation.
- Human annotator does not need to be a linguistic expert.

Logic representation of linguistic trees



Ministerstvo vnitra
› home › navigace › vyhledávání › změna vzhledu
Zpravodajství
Informace z resortu o tom, co se stalo, co se děje i co se připravuje

HZS Jihomoravského kraje

Zubatého 1, 614 00 Brno, telefon 950 630 111,
http://www.firebrno.cz
Zpravodajství v roce 2006

15.05.2007

V trabantu zemřeli dva lidé

K tragické nehodě dnes odpoledne hasiči vyjížděli na silnici z obce Česká do Kuřimi na Brněnsku.

Nehoda byla operačnímu středisku HZS ohlášena ve 13.13 hodin a
na místě zasahovala jednotka profesionálních hasičů ze stanice
Tišnově. Jednalo se o čelní srážku autobusu Karosa s vozidlem Trabar
601. Podle dostupných informací trabant jedoucí ve z Brna do Kuřir
zřejmě vyjel do protisměru, kde narazil do linkového autobusu dopravi
společnosti ze Žďáru nad Sázavou. Ve zdemolovaném trabantu n
místě zemřeli dva muži – 82letý senior a další muž, jehož totožnos
zjišťují policisté.

Hasiči udělali na vozidle protipožární opatření a po vyšetření
zadokumentování nehody dopravní policií vrak trabantu zaklesnutý po
autobusem pomocí lana odtrhli. Po odstranění střechy trabantu pak
kabiny vyprostili těla obou mužů. Obě vozidla – trabant i autobus, pa
postupně odstranili na kraj vozovky a uvolnili tak jeden jízdní pruh. Ún
provozních kapalin nebyl zjištěn. Po 16. hodině pomohli vrak trabant
naložit k odtahu a asistovali při odtažení autobusu. Po úklidu vozovk
krátce před 16.30 hod. místo nehody předali policistům a ukončili zásah

Source web page

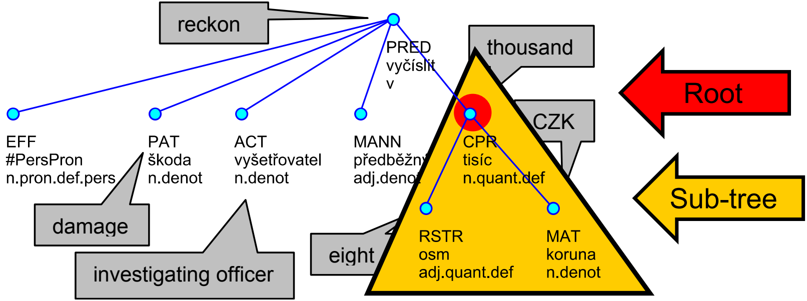
... two ...

Linguistic trees

```
tree_root(node0_0). node(node0_0).
id(node0_0, t_jihomoravsky49640_txt_001_p1s4).
%%%%%%%% node0_1 %%%%%%%%%%%%%%%%%%
node(node0_1).
functor(node0_1, pred).
gram_sempos(node0_1, v).
t_lemma(node0_1, zemrit).
%%%%%%%% node0_2 %%%%%%%%%%%%%%%%%%
node(node0_2).
functor(node0_2, act).
gram_sempos(node0_2, n_pron_def_pers).
t_lemma(node0_2, x_perspron).
%%%%%%%% node0_3 %%%%%%%%%%%%%%%%%%%
node(node0_3). id(node0_3,
functor(node0_3, loc).
gram_sempos(node0_3, n_denot).
t_lemma(node0_3, trabant).
...
edge(node0_0, node0_1). edge(node0_1, node0_2).
edge(node0_1, node0_3). edge(node0_3, node0_4).
edge(node0_4, node0_5). edge(node0_3, node0_6).
edge(node0_3, node0_7). edge(node0_3, node0_8).
...
```

Logic representation

Root/Subtree Preprocessing/Postprocessing (Chunk learning)



…, škodu vyšetřovatel předběžně vyčíslil na osm tisíc korun.

…, investigating officer preliminarily reckoned the damage to be eight thousand Crowns (CZK).

Examples of learned rules, Czech words are translated.

Example

[Rule 1] [Pos cover = 14 Neg cover = 0]

```
damage_root(A) :- lex_rf(B,A), has_sempos(B,’n.quant.def’),
   tDependency(C,B), tDependency(C,D),
   has_t_lemma(D,’investigator’).
```

[Rule 2] [Pos cover = 13 Neg cover = 0]

```
damage_root(A) :- lex_rf(B,A), has_functor(B,’TOWH’),
   tDependency(C,B), tDependency(C,D), has_t_lemma(D,’damage’).
```

[Rule 1] [Pos cover = 7 Neg cover = 0]

```
injuries(A) :- lex_rf(B,A), has_functor(B,’PAT’),
   has_gender(B,anim), tDependency(B,C), has_t_lemma(C,’injured’).
```

[Rule 8] [Pos cover = 6 Neg cover = 0]

```
injuries(A) :- lex_rf(B,A), has_gender(B,anim), tDependency(C,B),
   has_t_lemma(C,’injure’), has_negation(C,neg0).
```

Evaluation results

task/method	matching	missing	excess	overlap	prec.%	recall%	F1.0%
damage/ILP	14	0	7	6	51.85	70.00	59.57
damage/ILP – lenient measures					74.07	100.00	85.11
dam./ILP-roots	16	4	2	0	88.89	80.00	84.21
damage/Paum	20	0	6	0	76.92	100.00	86.96
injuries/ILP	15	18	11	0	57.69	45.45	50.85
injuries/Paum	25	8	54	0	31.65	75.76	44.64
inj./Paum-afun	24	9	38	0	38.71	72.73	50.53

- 10-fold cross validation
- Two tasks: ‘damage’ and ‘injuries’
- Root/subtree preprocessing/postprocessing used for ‘damage’ task

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   - Integration with Semantic Tools
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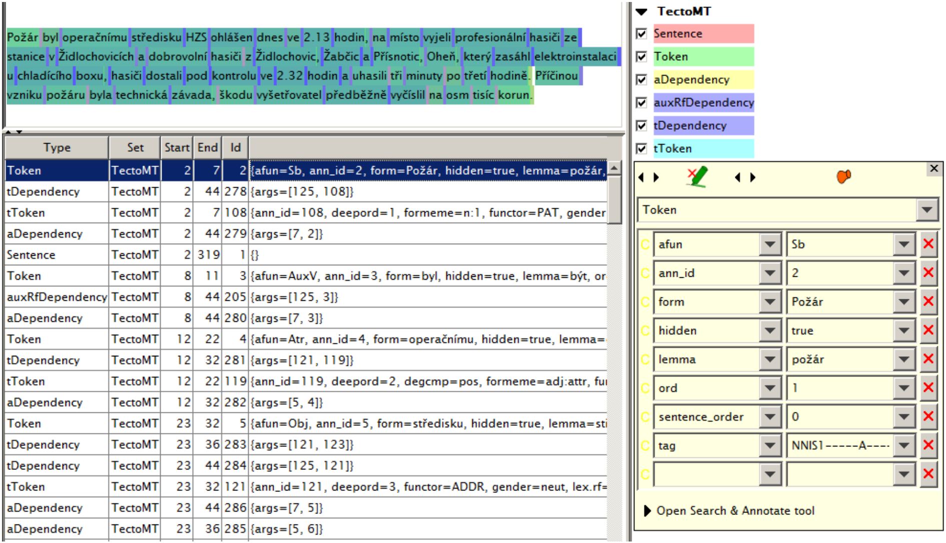
GATE

- GATE: General Architecture for Text Engineering
- The University of Sheffield
- `http://gate.ac.uk/`
- Implemented Batch TectoMT Language Analyzer
    - Transformation of PDT annotations to GATE
- Netgraph used as a tree viewer
    - Works also for Standford Depndencies

PDT in GATE



Požár byl operačnímu středisku HZS ohlášen dnes ve 2.13 hodin, na místo vyjeli profesionální hasiči ze stanice v Židlochovicích a dobrovolní hasiči z Židlochovic, Žabčic a Přísnotic. Oheň, který zasáhl elektroinstalaci u chladícího boxu, hasiči dostali pod kontrolu ve 2.32 hodin a uhasili tři minuty po třetí hodině. Příčinou vzniku požáru byla technická závada, škodu vyšetřovatel předběžně vyčíslil na osm tisíc korun.

Type	Set	Start	End	Id	
Token	TectoMT	2	7	2	{afun=Sb, ann_id=2, form=Požár, hidden=true, lemma=požár,
tDependency	TectoMT	2	44	278	{args=[125, 108]}
tToken	TectoMT	2	7	108	{ann_id=108, deepord=1, formeme=n:1, functor=PAT, gender
aDependency	TectoMT	2	44	279	{args=[7, 2]}
Sentence	TectoMT	2	319	1	{}
Token	TectoMT	8	11	3	{afun=AuxV, ann_id=3, form=byl, hidden=true, lemma=být, or
auxRfDependency	TectoMT	8	44	205	{args=[125, 3]}
aDependency	TectoMT	8	44	280	{args=[7, 3]}
Token	TectoMT	12	22	4	{afun=Atr, ann_id=4, form=operačnímu, hidden=true, lemma=
tDependency	TectoMT	12	32	281	{args=[121, 119]}
tToken	TectoMT	12	22	119	{ann_id=119, deepord=2, degcmp=pos, formeme=adj:attr, fu
aDependency	TectoMT	12	32	282	{args=[5, 4]}
Token	TectoMT	23	32	5	{afun=Obj, ann_id=5, form=středisku, hidden=true, lemma=st
tDependency	TectoMT	23	36	283	{args=[121, 123]}
tDependency	TectoMT	23	44	284	{args=[125, 121]}
tToken	TectoMT	23	32	121	{ann_id=121, deepord=3, functor=ADDR, gender=neut, lex.rf=
aDependency	TectoMT	23	44	286	{args=[7, 5]}
aDependency	TectoMT	23	36	285	{args=[5, 6]}

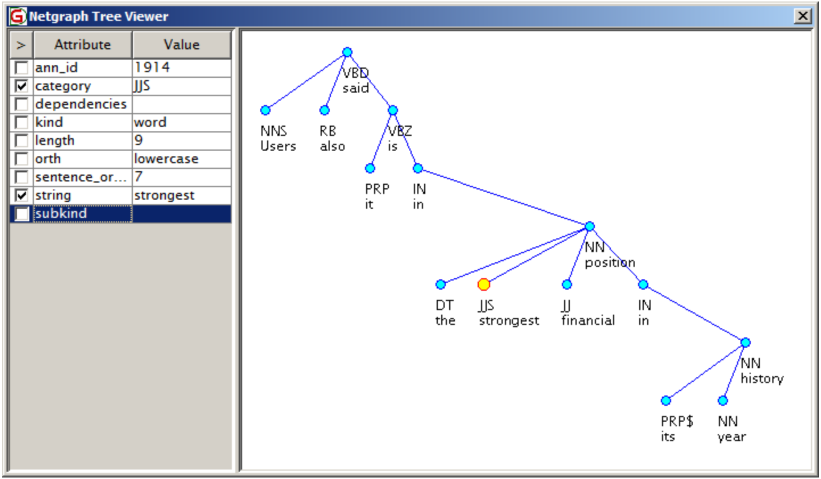
TectoMT
- ☑ Sentence
- ☑ Token
- ☑ aDependency
- ☑ auxRfDependency
- ☑ tDependency
- ☑ tToken

Token

afun	Sb
ann_id	2
form	Požár
hidden	true
lemma	požár
ord	1
sentence_order	0
tag	NNIS1-----A----

▶ Open Search & Annotate tool

Netgraph Tree Viewer in GATE (for Stanford Dependencies)



Netgraph Tree Viewer

>	Attribute	Value
☐	ann_id	1914
☑	category	JJS
☐	dependencies	
☐	kind	word
☐	length	9
☐	orth	lowercase
☐	sentence_or...	7
☑	string	strongest
☐	subkind	

Sentence: Users also said it is in the strongest financial position in its 24-year history.

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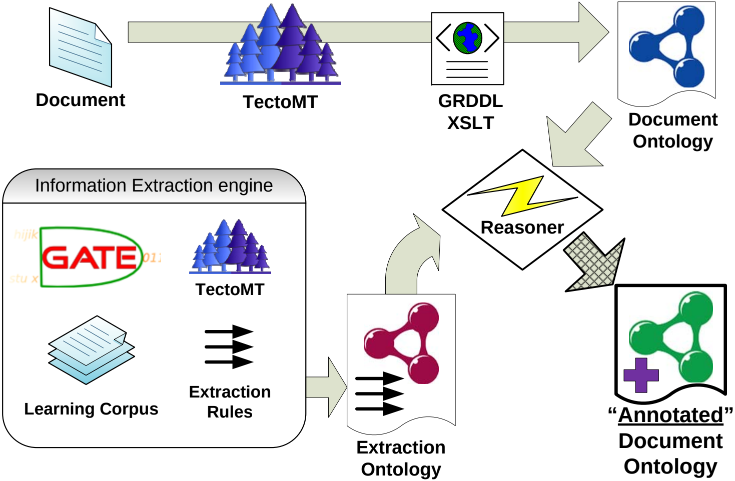
Transformation of PML to RDF

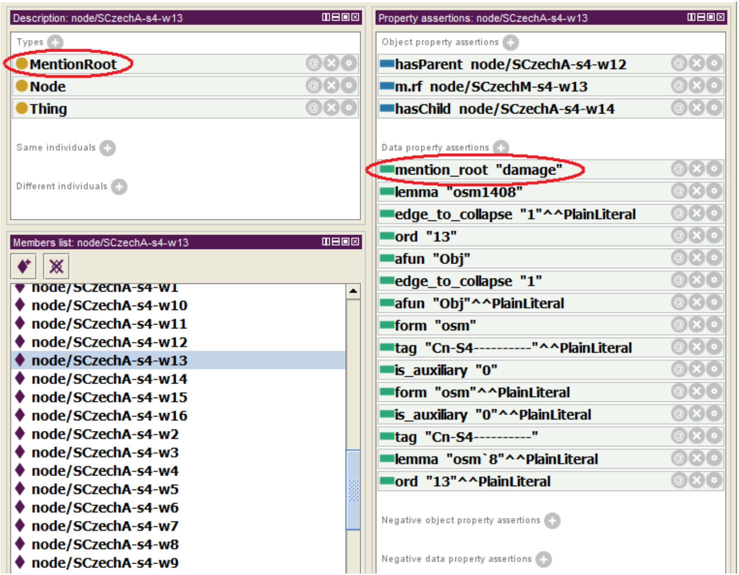
- Quite simple XSLT transformation
- Allows working with PDT annotations inside Semantic Web tools
  - Ontology Editors
  - Reasoners
  - Query tools (graph queries)
  - ?Visualization and navigation tools?
- In our case interpretation of extraction rules by a OWL reasoner

Extraction Rules Interpreted by OWL Reasoner



- Tool independent extraction ontologies

PDT in The Protégé Ontology Editor



Description: node/SCzechA-s4-w13

Types

- MentionRoot
- Node
- Thing

Same individuals

Different individuals

Members list: node/SCzechA-s4-w13

- node/SCzechA-s4-w1
- node/SCzechA-s4-w10
- node/SCzechA-s4-w11
- node/SCzechA-s4-w12
- node/SCzechA-s4-w13
- node/SCzechA-s4-w14
- node/SCzechA-s4-w15
- node/SCzechA-s4-w16
- node/SCzechA-s4-w2
- node/SCzechA-s4-w3
- node/SCzechA-s4-w4
- node/SCzechA-s4-w5
- node/SCzechA-s4-w6
- node/SCzechA-s4-w7
- node/SCzechA-s4-w8
- node/SCzechA-s4-w9

Property assertions: node/SCzechA-s4-w13

Object property assertions

- hasParent node/SCzechA-s4-w12
- m.rf node/SCzechM-s4-w13
- hasChild node/SCzechA-s4-w14

Data property assertions

- mention_root "damage"
- lemma "osm1408"
- edge_to_collapse "1"^^PlainLiteral
- ord "13"
- afun "Obj"
- edge_to_collapse "1"
- afun "Obj"^^PlainLiteral
- form "osm"
- tag "Cn-S4----------"^^PlainLiteral
- is_auxiliary "0"
- form "osm"^^PlainLiteral
- is_auxiliary "0"^^PlainLiteral
- tag "Cn-S4----------"
- lemma "osm`8"^^PlainLiteral
- ord "13"^^PlainLiteral

Negative object property assertions

Negative data property assertions

Examples of extraction rules in the native Prolog format.

[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).
```

Examples of extraction rules in Protégé 4 – Rules View’s format

[Rule 1]

```
lex.rf(?b, ?a), t_lemma(?b, "Inc"), tDependency(?c, ?b),
tDependency(?c, ?d), formeme(?d, "n:in+X"),
tDependency(?c, ?e)
      -> mention_root(?a, "acquired")
```

[Rule 11]

```
lex.rf(?b, ?a), t_lemma(?b, "Inc"), tDependency(?c, ?b),
formeme(?c, "n:obj"), tDependency(?c, ?d), functor(?d, "APP")
      -> mention_root(?a, "acquired")
```

[Rule 75]

```
lex.rf(?b, ?a), t_lemma(?b, "Inc"), functor(?b, "APP"),
tDependency(?c, ?b), number(?c, "pl")
      -> mention_root(?a, "acquired")
```

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Summary

- Implemented a system for extraction of semantic information
- Based on third party linguistic tools (TectoMT[4])
- Extraction rules adopted from Netgraph[5] application.
- ILP used for learning rules.
- All methods integrated inside GATE[6].

- Main advantages:
  - Automated selection of learning features
  - “Language independent”
  - Rule based

[4] http://ufal.mff.cuni.cz/tectomt/

[5] http://quest.ms.mff.cuni.cz/netgraph/

[6] http://gate.ac.uk/

Future work

- Use some Knowledge Base (e.g. WordNet).
- Adaptation of this method on other languages.
- Evaluation of the method on other datasets.
- Be able to provide more semantics.
    - e.g. sophisticated semantic interpretation of extracted data