Combining heterogeneous text-technological resources for anaphora resolution

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CoGETI Workshop
Heidelberg, 24.11.2006

Overview

1. Projekt and Research Group
2. Application Domain: Anaphora Resolution
3. Corpus Annotation
4. Sample Annotation
5. Corpus Study
6. Use of logical document structure
7. Combining heterogeneous XML resources
8. Conclusion and Outlook

Projekt and Research Group

- DFG Research Group 437 „Text-technological Modelling of Information“ (2002–2008)
- Projekt A2 „Sekimo“ – Secondary Information Modelling and Combination of text-technological Resources

Projekt and Research Group

- DFG Research Group 437 „Text-technological Modelling of Information“ (2002–2008)
- Projekt A2 „Sekimo“ – Secondary Information Modelling and Combination of text-technological Resources
  - Abstract representation to model multi-layered XML annotations
  - Architecture for the combination of heterogeneous linguistic resources
  - Markup-Unification
  - Generation of new – richer annotated – XML documents
  - Creation of a corpus of anaphoric relations
  - Application domain: resolution of definite description anaphora

The application domain

- Development of a system for the automatic resolution of anaphoric relations (decision tree based)
- Subgoals
  - Annotation of a training and evaluation corpus
  - Integration of necessary knowledge (morpho-syntactic and semantic information, anaphora-antecedent distance etc.)
  - Creation of anaphora-antecedent-candidate pairs
  - Detection of the correct antecedent

The Corpus

- 47 German linguistic articles (collected in the C1 project, Giessen)
- 6 German newspaper articles
- Evaluation based on a subset of 2 linguistic articles, 1 newspaper article and 1 hypertext article:
  - 4196 discourse entities
  - 1971 anaphoric relations
- XML annotated corpus
- Corpus annotation is done semi-automatically

Annotation Schema

- The annotation schema
  - Is an extension of the annotation Schema developed for the B1 project of the DFG research group (Anke Holler)
  - Defines three primary semantic relation types
    - cospecLink *The man – he , city – hanseatic city*
    - bridgingLink *The room – the window*
    - corefLink as a text-world relation
  - cospecLinks and bridgingLinks hold between discourse entities (in A2 DE of type *nominal* and *namedEntity*)
  - In the XML annotation, semantic relations are modelled using ID/IDREF

Annotation Schema

- The Annotation is done in two steps:
    1. Annotation/Detection of Discourse Entities
    2. Annotation of semantic relations
- In A2 only intra-textual relations are annotated

Annotation Schema

- For each primary relation type several secondary relation types exist
- cospecLink
  ident, synonym, hyperonym, hyponym, paraphrase, addInfo, isA
  a man – the man
  Peter – he
  the horse – the animal
  Mary Baggins – the 17 year old girl
- bridgingLink
  possession, meronym, holonym, setMember, hasMember, association
  Peter – his mother
  a room – the window
  two men – the younger one

Sample Annotation

- „Lurup is a social ghetto of the hanseatic city (Hansestadt), an outskirt with single unit houses but also many appartment blocks in the west of the city (Stadt)“

```
<cnx-pi_sentence id="w826" auto="no">
    Lurup ist ein sozialer Brennpunkt
    <de deID="de226" headRef="w833">
        <cnx-pi_token ref="w832">der</cnx-pi_token>
        <cnx-pi_token ref="w833">Hansestadt</cnx-pi_token>
    </de>
    , ein Vorort mit Einzelhäusern, aber auch vielen Wohnblocks im Westen
    <de deID="de231" headRef="w848">
        <cnx-pi_token ref="w847">der</cnx-pi_token>
        <cnx-pi_token ref="w848">Stadt</cnx-pi_token>
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    , ein Vorc
    <de deI
        <c
        <c
    </de>.
</cnx-pi_sentence>
```

```
<cnx-pi_token_ref text="Hansestadt" dependHead="w831"
pos="N" syntax="@NH" heur="no"
lemma="hanse#stadt" dependValue="mod" morpho="FEM SG
GEN" id="w833" skip="no" cnx-output="correct"/>
```

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        <cnx-pi_token ref="w848">Stadt</cnx-pi_token>
    </de>.
</cnx-pi_sentence>

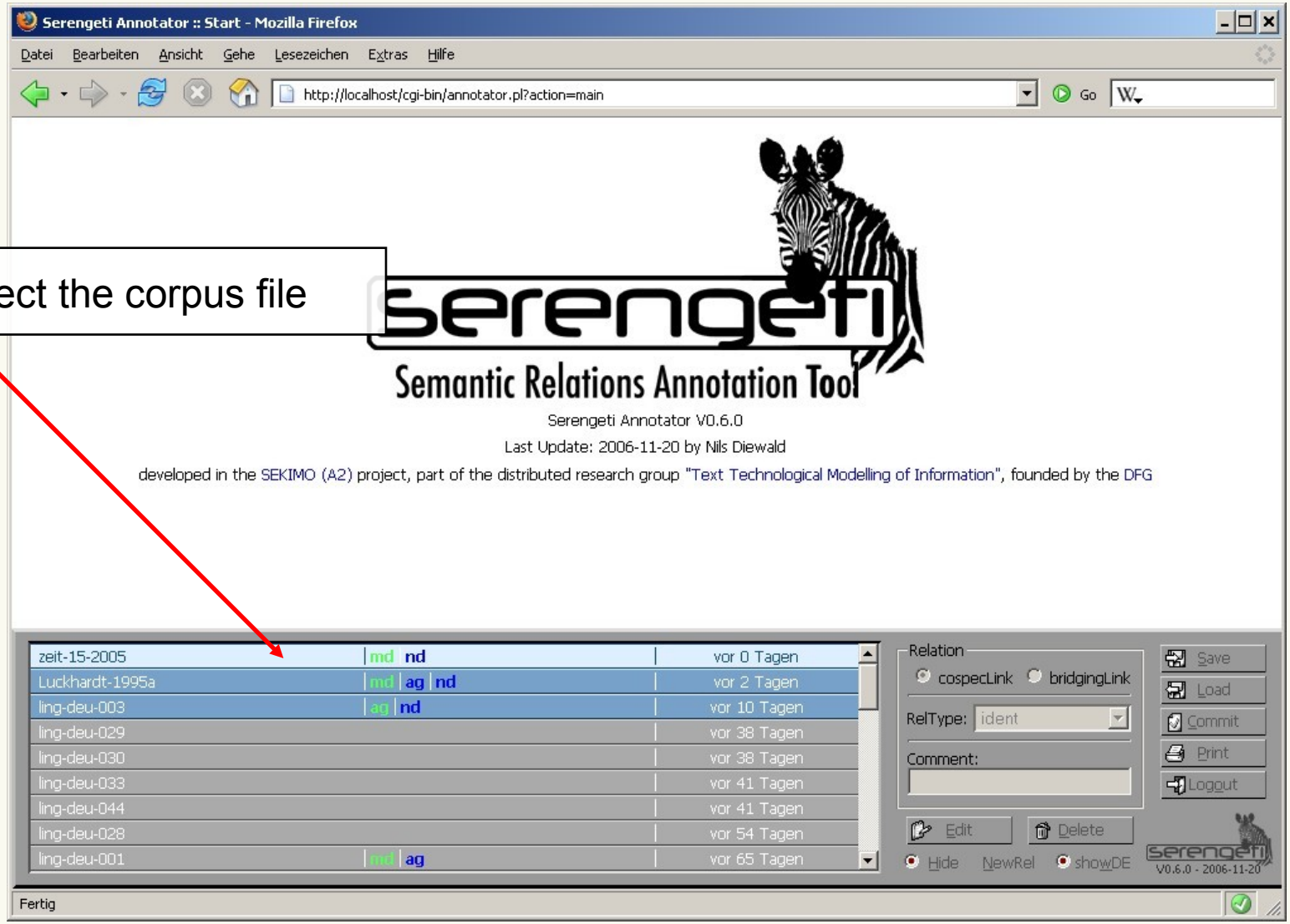
<cospecLink relType="hyperonym" phorIDRef="de231"
    antecedentIDRefs="de226" />
```

Corpus Annotation

- Automatic discourse entity detection based on the tagger output
- Annotation of semantic relations using the tool Serengeti
  - web based client-server-application
  - enables distributed work on same corpus by user accounts
  - low system requirements on client-side
  - annotation and corpus organisation in one system
  - interface for corpus analysis (inter-annotator reliability, etc.)
  - developed in the project A2 „Sekimo“

Annotation Tool

Annotation Tool



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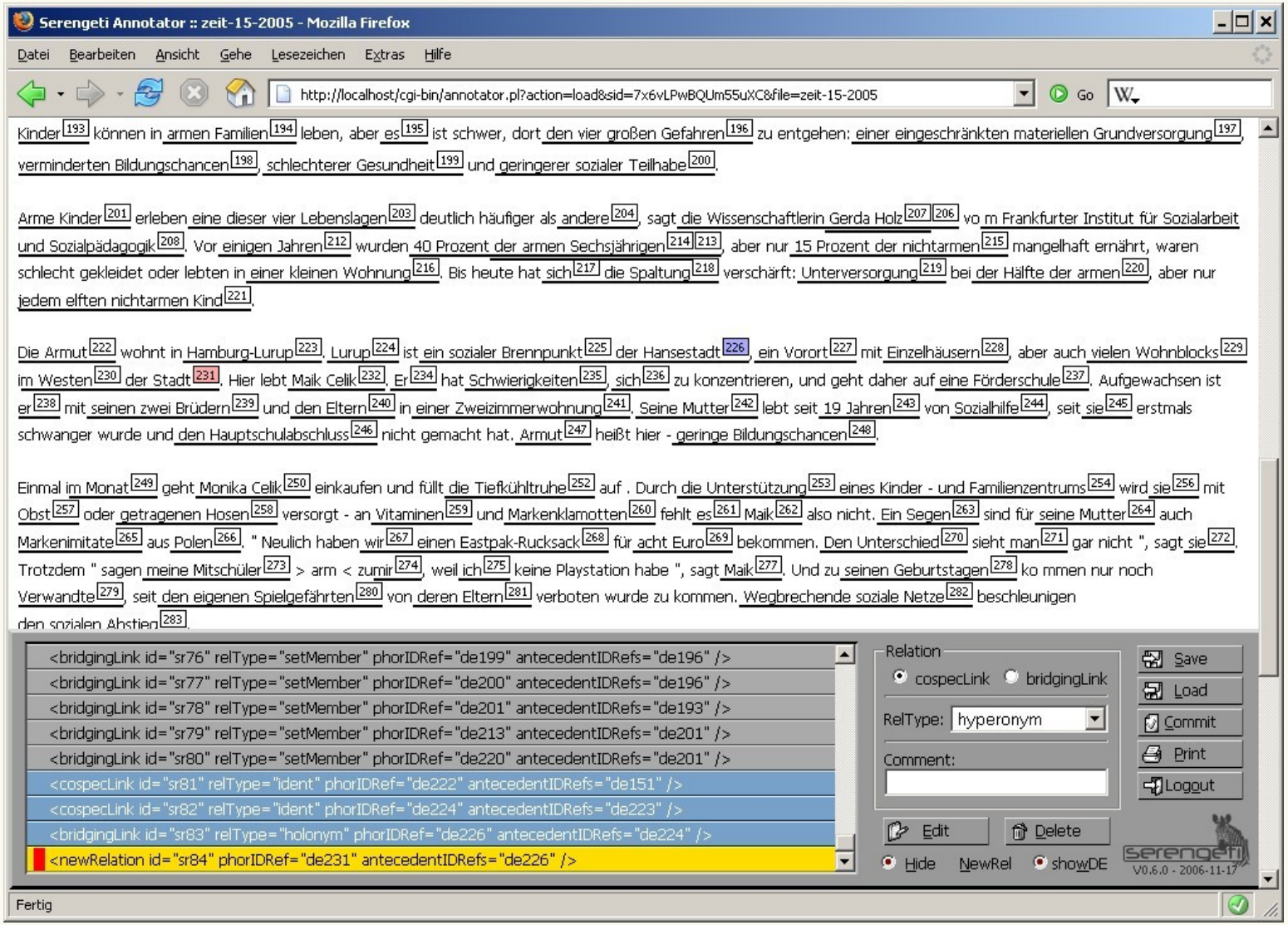

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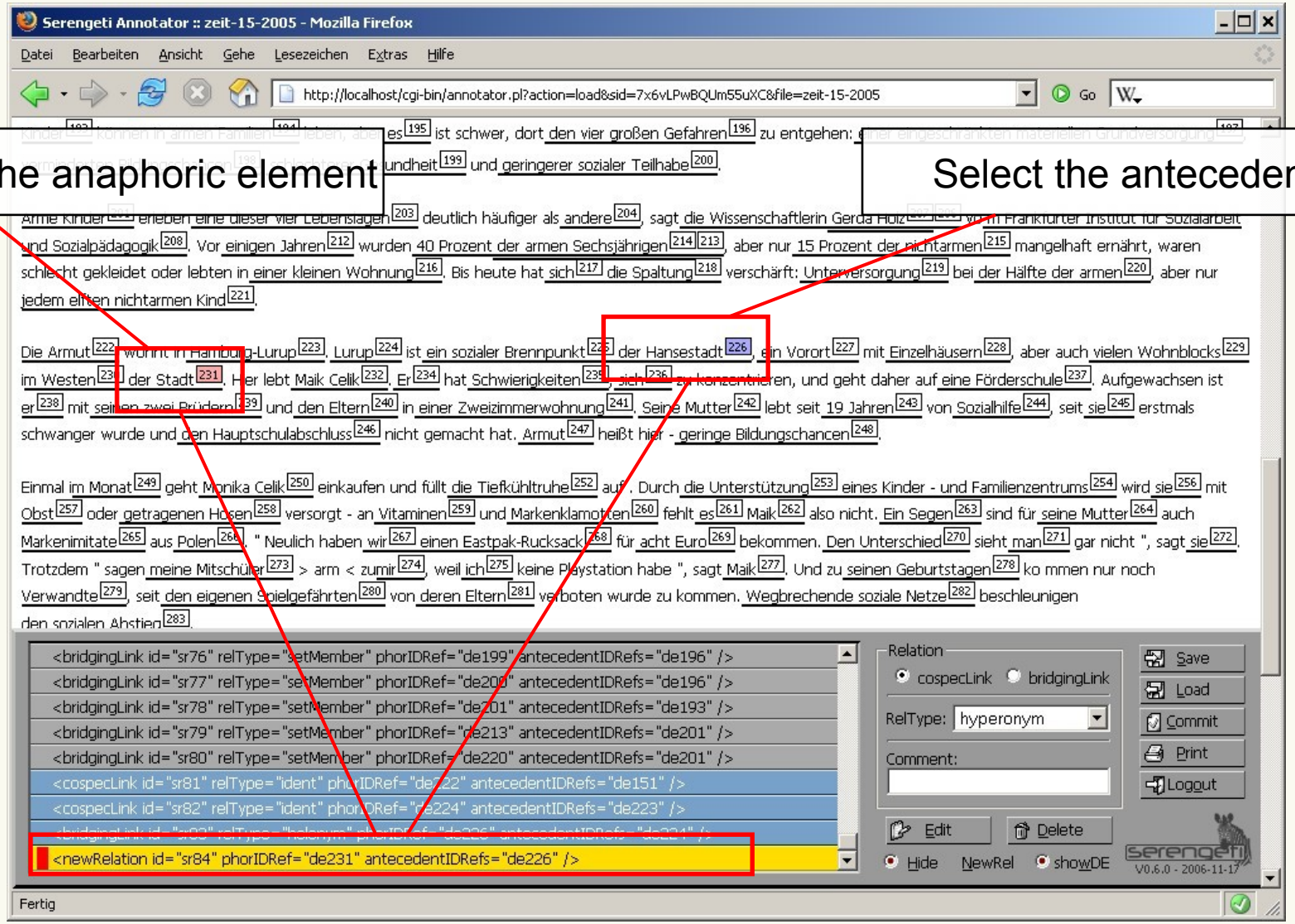

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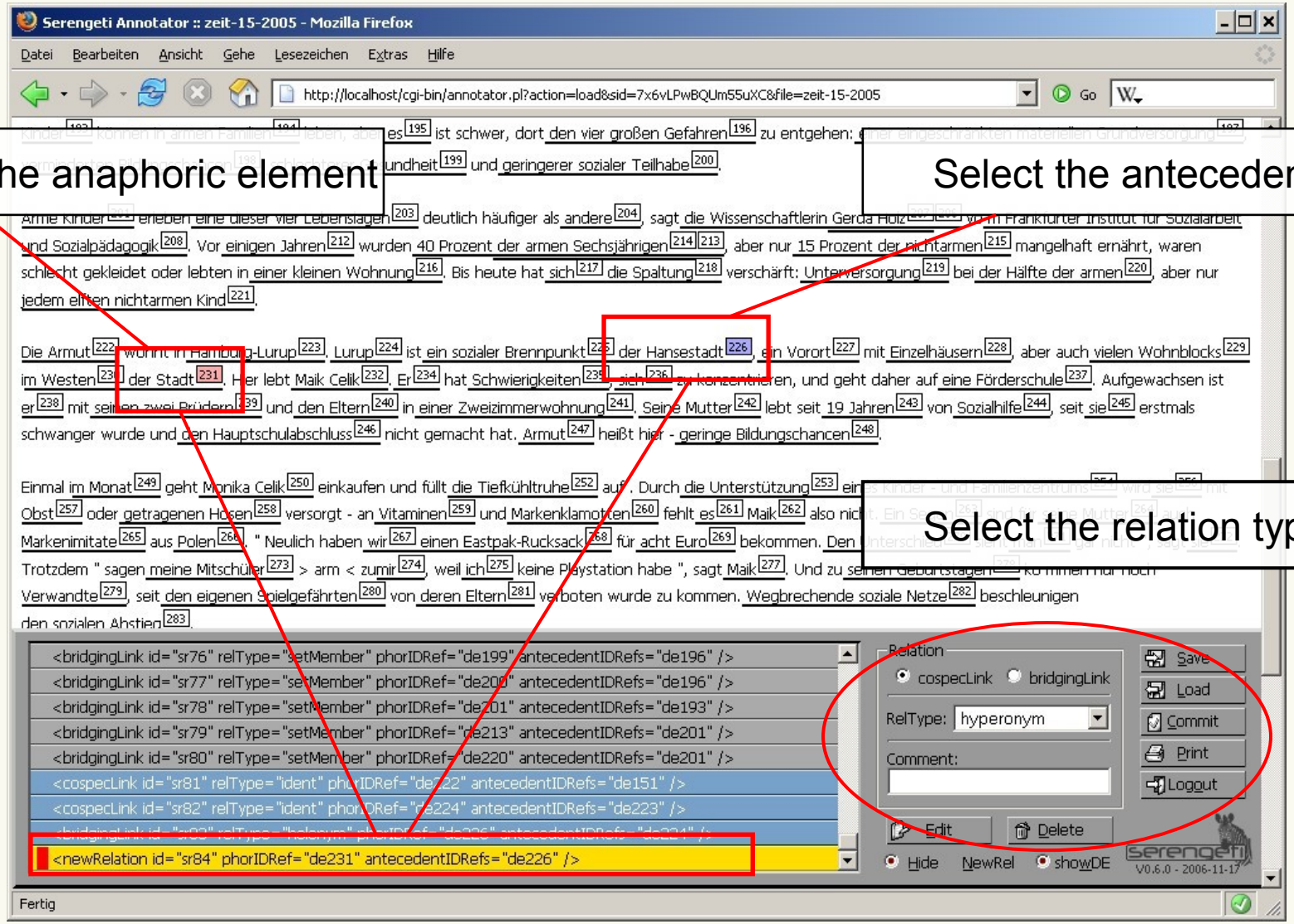

Training and Evaluation Set

Text Technological Modelling of Information

anaphoric element

```
<?xml version="1.0" encoding="iso-8859-1"?>
<hypo filename="zeit-15-2005-chs.xml" max_de_distance="15">
  <semRel_candidate type="cospecLink" relType="hyperonym">
    <anaphora>
     <de deID="de231"  antecedentID="de226"
        GN_lookup="1" GN_lexUnitID="nOrt.1750.Stadt" GN_propernoun="nein" GN_artificial="nein" GN_wordClass="nomen" GN_sense="1"
         text="Stadt" pos="N" syntax="@NH" lemma="stadt" dependValue="mod" morpho="FEM SG GEN"
         id="w848" sentence_pos="8" position="201">der Stadt</de>
    </anaphora>
     <antecedent de_distance="15" GN_rel="" pattern="" LSA="" score="">
     <de deID="de216"
          GN_lookup="1" GN_lexUnitID="nArtefakt.3281.Wohnung" GN_propernoun="nein" GN_artificial="nein" GN_wordClass="nomen" GN_sense="1"
          text="Wohnung" dependHead="w789" pos="N" syntax="@NH" lemma="wohnung" dependValue="advl" morpho="FEM SG DAT"
          id="w793" sentence_pos="4" position="186">einer kleinen Wohnung</de>
     </antecedent>
      [.....]
     <antecedent de_distance="5" GN_rel="hyperonymy" pattern="" LSA="" score="">
      <de deID="de226"  anaphora="yes"
          GN_lookup="1" GN_lexUnitID="nOrt.1768.Hansestadt" GN_propernoun="nein" GN_artificial="nein" GN_wordClass="nomen" GN_sense="1"
          text="Hansestadt" dependHead="w831" pos="N" syntax="@NH" lemma="hanse#stadt" dependValue="mod" morpho="FEM SG GEN"
          id="w833" sentence_pos="3" position="196">der Hansestadt</de>
     </antecedent>
      [....]
  </semRel_candidate>
</hypo>
```

antecedent candidate

Issues

Text Technological Modelling of Information

How to define the set of antecedent candidates?

How to select the correct antecedent?

Resolving definite description anaphora

- How to define the set of antecedent candidates?
- Definition of a *flexible* search window

	#Occurences	MIN-distance	MAX-distance
Identity	998	1	2262
NPform=pron	688	1	19
Paraphrase	166	1	2211
Proper Name	41	1	122
Synonymy	90	2	1699
Hyperonymy	10	2	1969
Hyponymy	4	12	99
Meronymy	17	1	50
Association	102	1	1849

Definition of a flexible search window

- Anaphora-antecedent distance varies according to the NP type of the anaphoric element (e.g. Mitkov 2002 for an overview)
- Accessibility of antecedent candidates is dependent on the hierarchical structure of the text (e.g. Vieira & Poesio 2001)

Definition of a flexible search window

- Anaphora-antecedent distance varies according to the NP type of the anaphoric element (e.g. Mitkov 2002 for an overview)
- Accessibility of antecedent candidates is dependent on the hierarchical structure of the text (e.g. Vieira & Poesio 2001)
- Problem: Annotation of hierarchical discourse structure is needed
- Possible solution: Use knowledge of logical document structure, e.g. DocBook, LaTeX, HTML
- Logical document structure describes the organization of a text in terms of chapters, sections, paragraphs and the like

Logical Document Structure

- Influence of the logical document structure on the choice of an antecedent
- Two hypotheses
  1. Influence on the discourse entity (*antecedent life span*)
     DEs in <title>-elements are more accessible than DEs in <footnote>-elements
  2. Influence on the search window for a given anaphoric element (comparable to different window sizes according to the NP form)

Logical Document Structure

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  2. Influence on the search window for a given anaphoric element (comparable to different window sizes according to the NP form)
- Corpus analysis to check hypothesis
  - 3490 discourse entities (anaphora:antecedent 1,36:1)
  - 1675 anaphoric expressions
  - 1234 antecedents

Distribution of Discourse Entities

	ling-deu-003	ling-deu-010	zeit-15-2005
<article>	1,35 : 1	1,3 : 1	1,6 : 1
<sect1>	1,3 : 1	1,31 : 1	1,6 : 1
<sect2>	1,3 : 1	no elements	no elements
<para>	1,35 : 1	1,35 : 1	1,6 : 1
<title>	0,84 : 1	0,25 : 1	(0)
<subtitle>	(0:2)	no elements	1,3 : 1
<listitem>	1,5 : 1	2,72 : 1	no elements
<footnote>	2,4 : 1	no elements	no elements
<glossentry>	1,4 : 1	1,15 : 1	no elements
<glossterm>	0,66 : 1	0,6 : 1	no elements
<glossdef>	1,55 : 1	1,2 : 1	no elements

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Interpretation of results

- The relationship of anaphoric and antecedent DEs is quite stable throughout a document (sect1, sect2, para)
- There are elements that tend to contain more likely antecedent elements (title, subtitle, glossterm introduce the text‘s topics)
- There are elements that tend to contain more likely anaphoric elements (footnote, listitem)

Interpretation of results

- A closer look at footnotes and listitems
  - For 60% of the antecedents within a listitem element, the anaphoric element is within the same element. For 66% the distance between antecedent and anaphora is smaller than 10 DEs.
  - All antecedents within a footnote element have their anaphora within the same element, for 56% of the antecedents, the anaphoric element is only one or two DEs away (often pronouns), less than 1% are more than 10 DEs away

→ The parent element of a DE serves as a clue for the antecedent life span.

How to integrate the document structure?

→ Markup Unification

Combination of resources

Logical document structure vs. Semantic relations

```
layer doc:<para>… im Westen der Stad …</para>
layer de :<analysis>… im Westen <de>der Stadt</de>…<analysis>
```

```
#char     0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
          i m   W e s t e n   d  e  r     S  t  a  d  t
  <para>i m   W e s t e n   d  e  r     S  t  a  d  t</para>
  <analysis>  …           <de>d  e  r     S  t  a  d  t</de>…</…>
```

```
node( doc,          0, 18, [1], element(para) ).
node( analysis,     0, 18, [1], element(analysis) ).
node( analysis,    10,18, [1,1], element(de) ).
```

Markup Unification:

```
<analysis><para>… im Westen </de>der Stadt</de>…</para></an…>
```

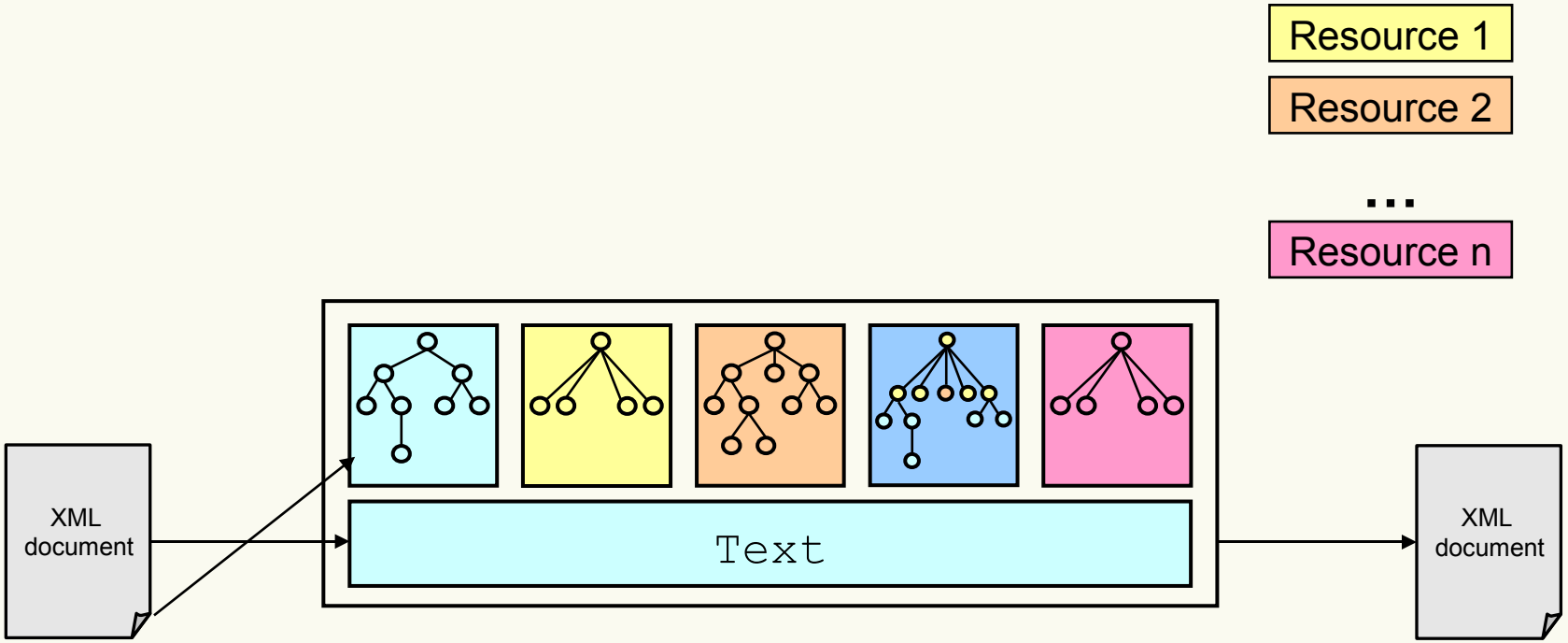
Combination of resources

Text Technological Modelling of Information

Benefit of Markup Unification

- Add new informationen from heterogeneous resources
- Resources can be developed independently
- Flexible use of resources: No conversion necessary
- Extraction of relevant parts: Application of resources only for relevant text parts
- Reuse of existing resources

Integration of linguistic resources



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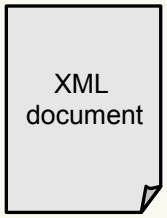

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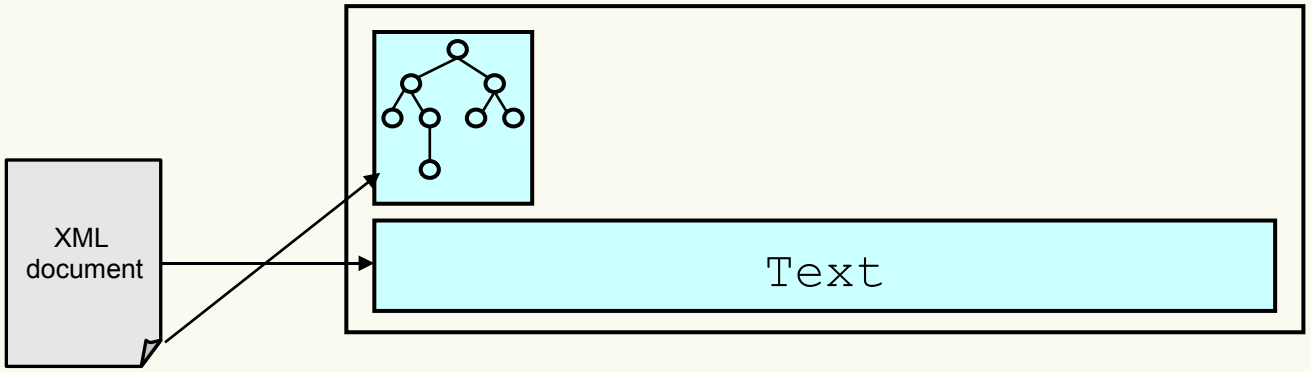

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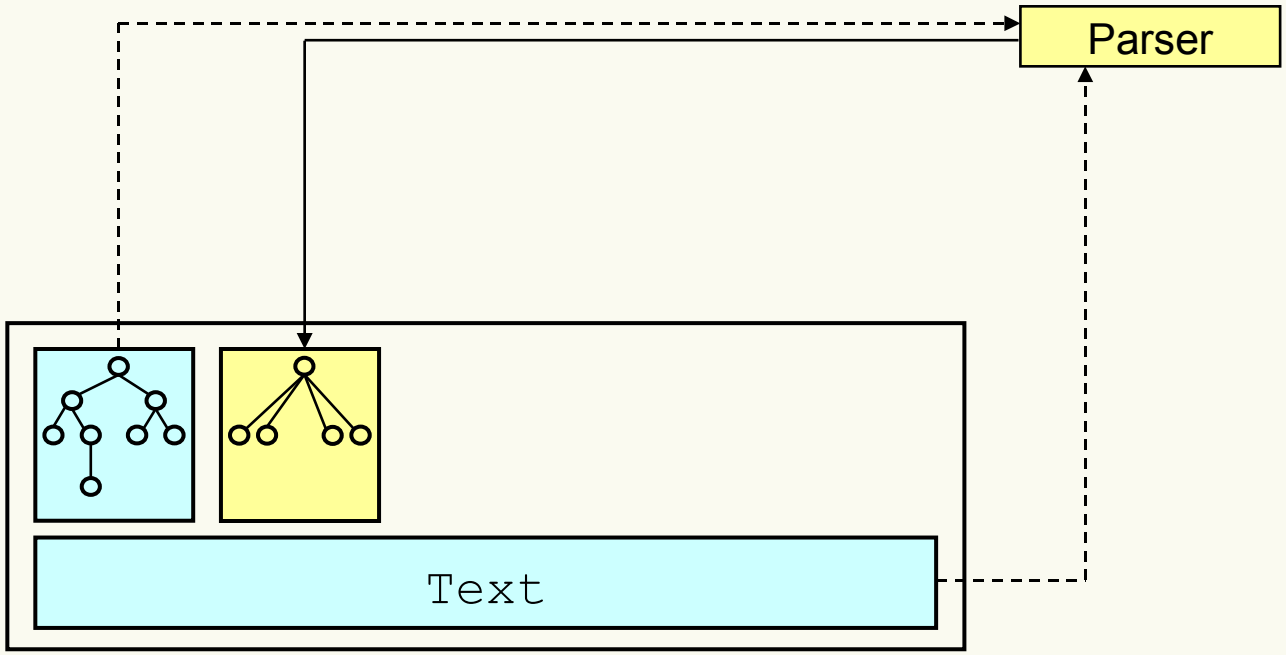

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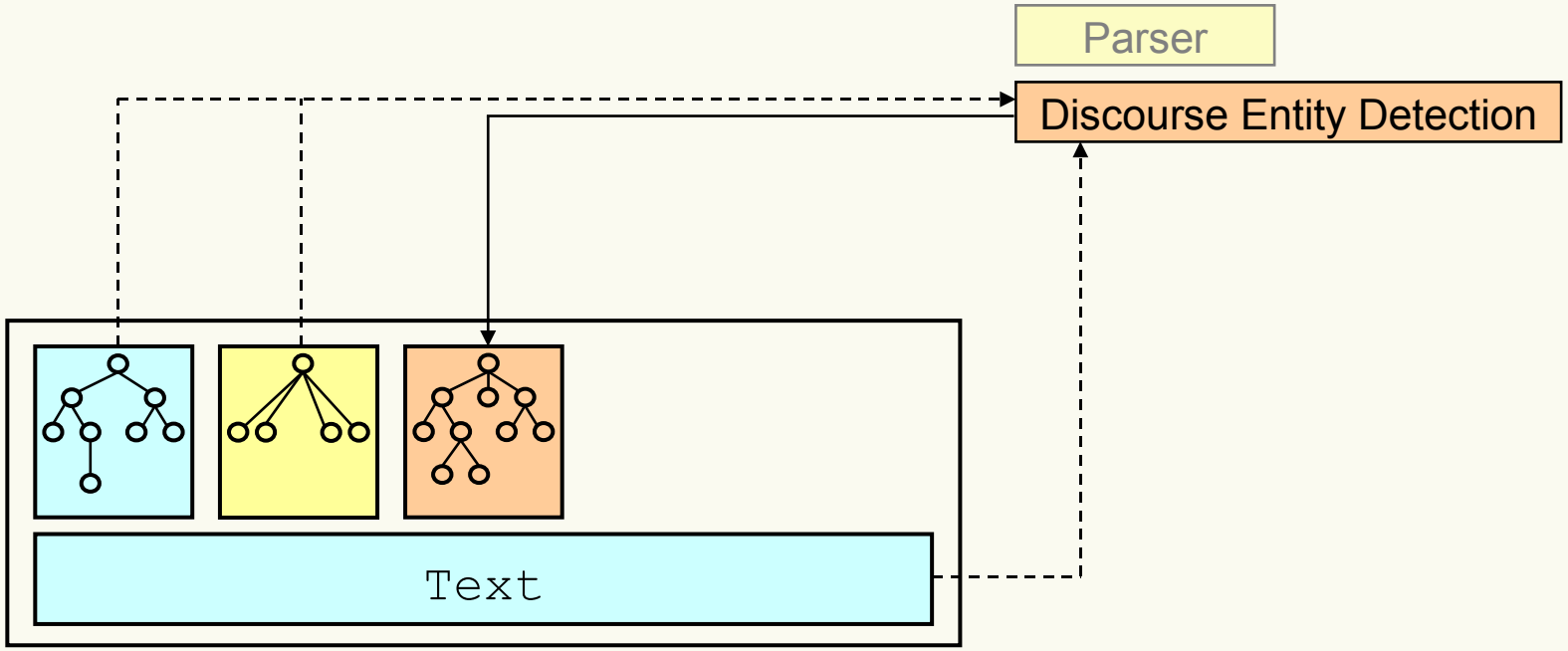
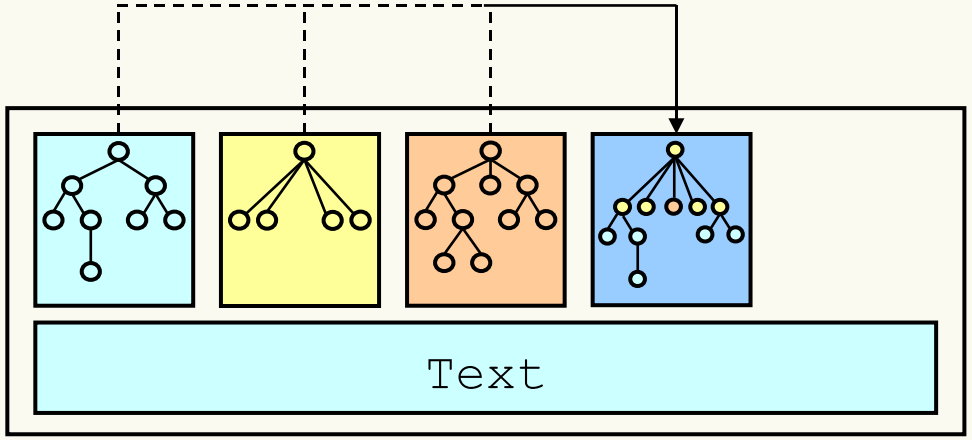


Integration of linguistic resources

Parser

Discourse Entity Detection

Unification



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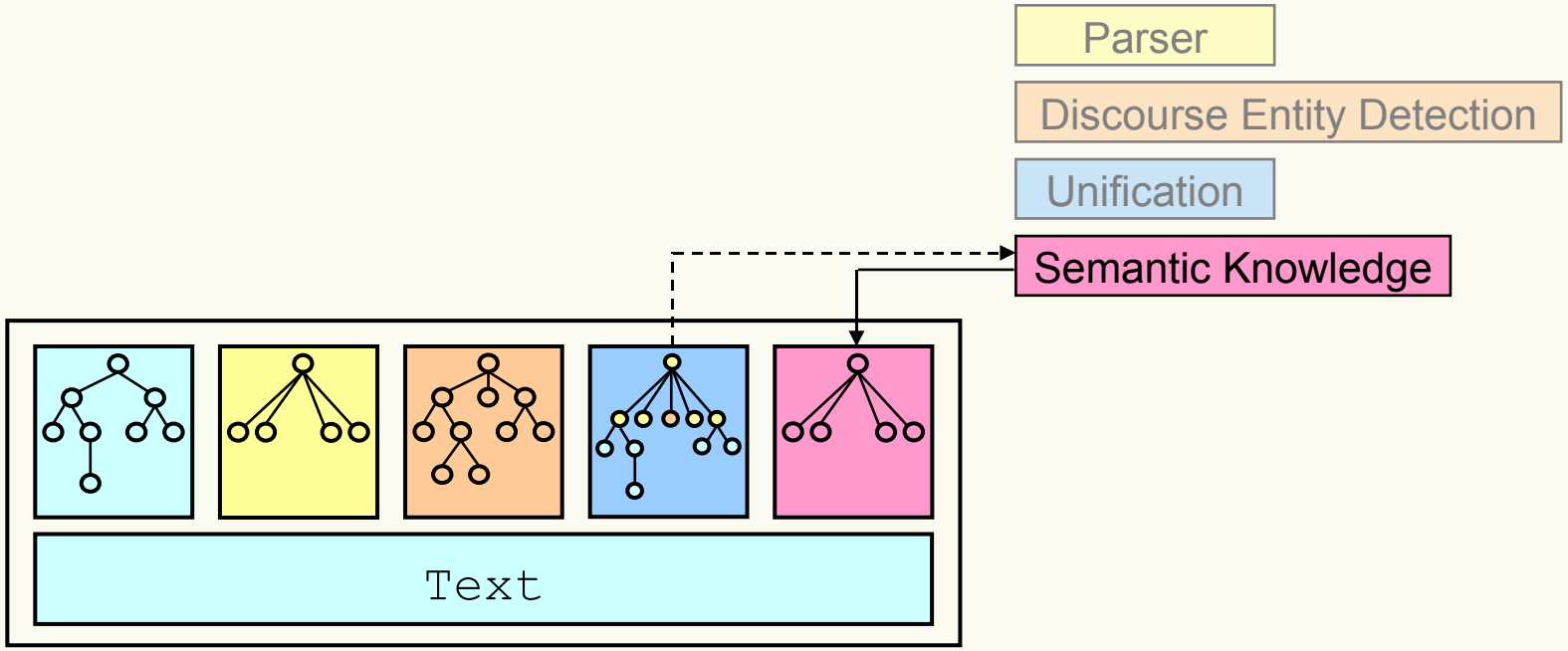

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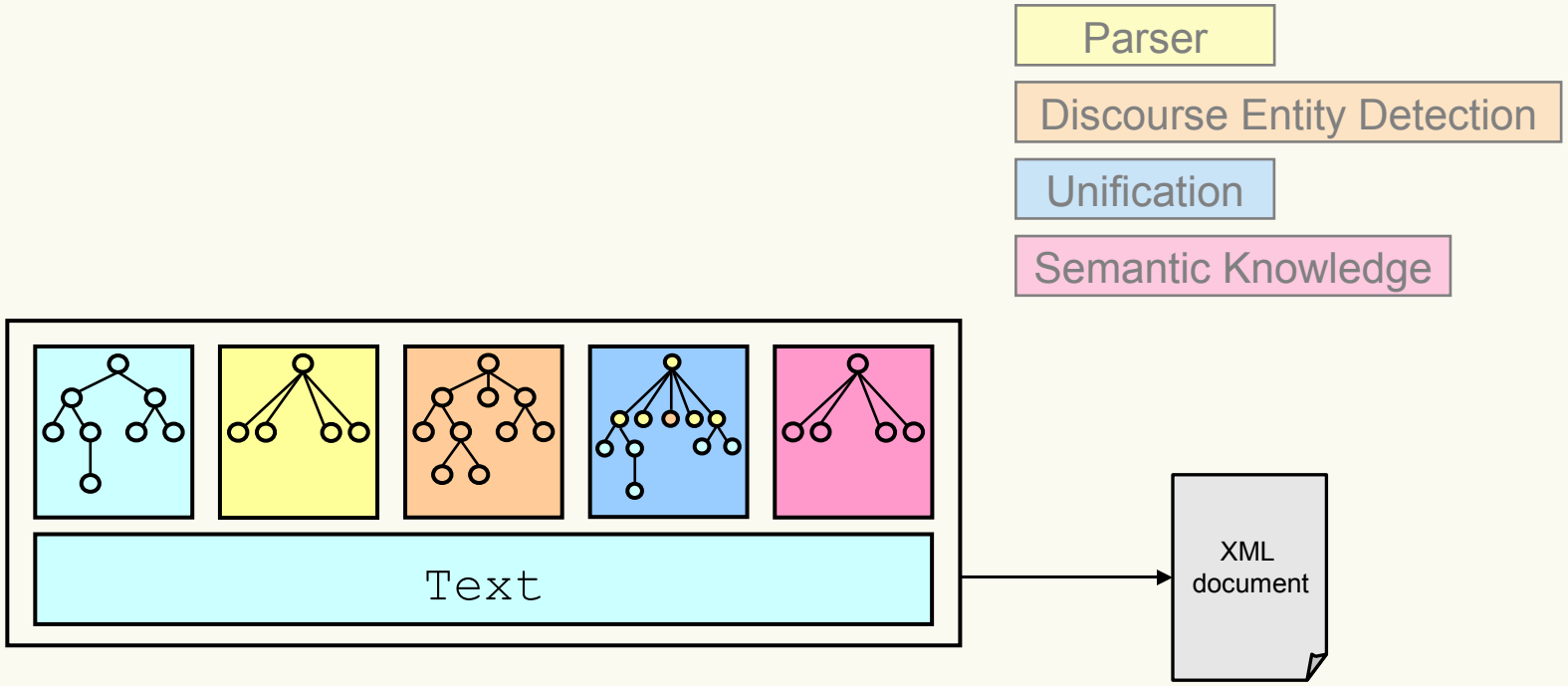
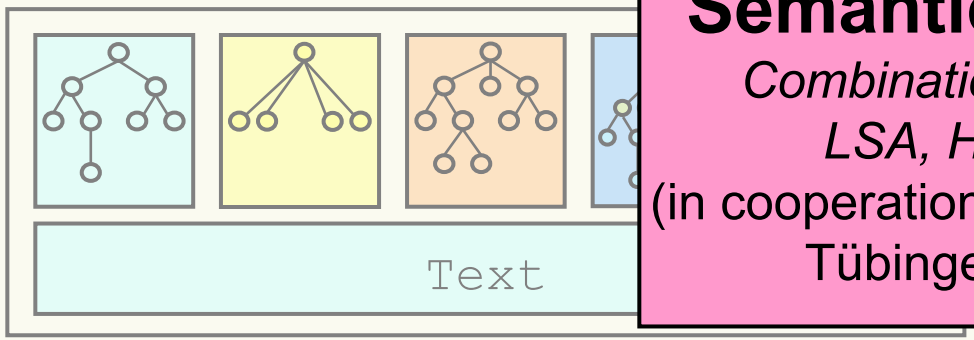


Integration of linguistic resources

Parser

Discourse Entity Detection

Unification



Semantic Knowledge

Combination of GermaNet, LSA, Hearst Pattern

(in cooperation with the C2 project, Tübingen/Osnabrück)

Conclusion and outlook

- Extend the corpus analysis
- Translate corpus findings into suitable features and XML attributes
- Translate XML annotations into feature vectors
- Train decision trees to resolve definite description anaphora automatically

Thank you!

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