WP 2: Learning Web-service Domain Ontologies

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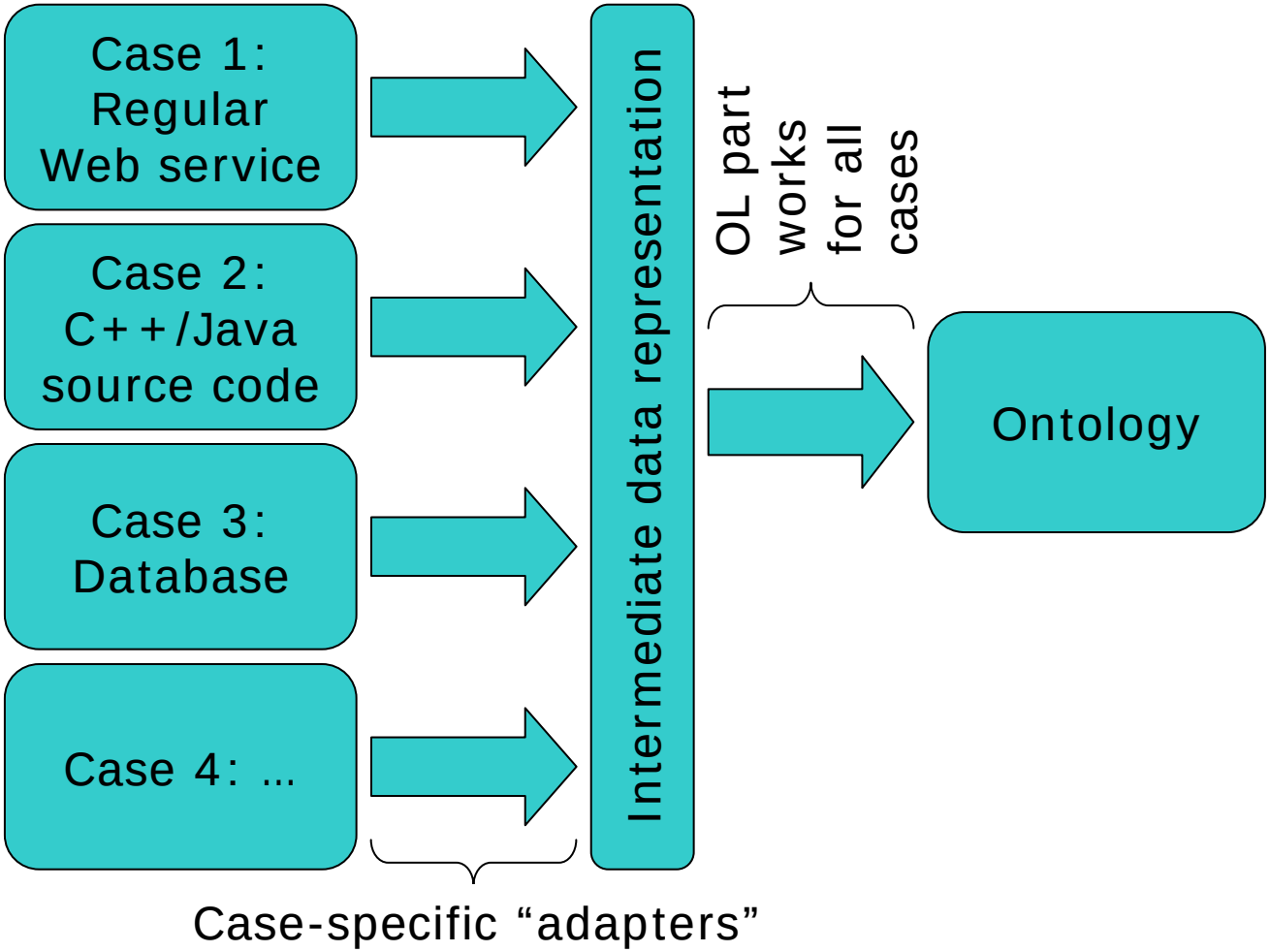
Outline of the Presentation

- The goal of WP 2
- Introduction to application mining
- Creating a document network
- Transforming a document network into feature vectors
- LATINO: Link-analysis and text-mining toolbox
- OntoGen: a system for semi-automatic data-driven ontology construction
- WP 2 and the Dassault case study
- Conclusions and future work

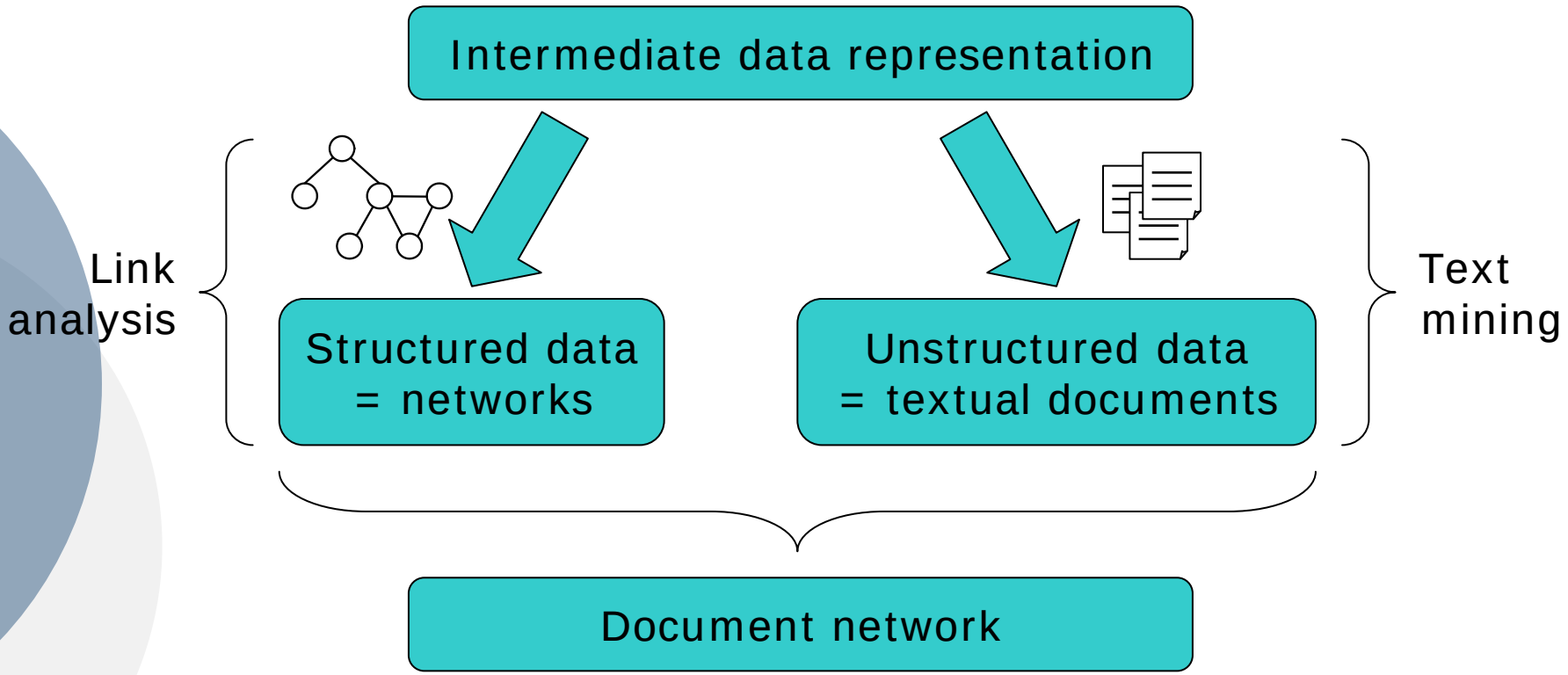
Learning Web-service Ontologies

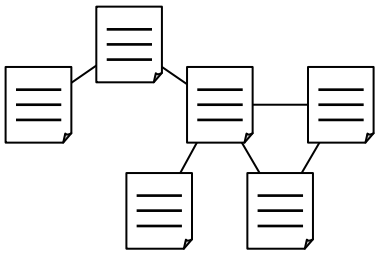
- The goal is to facilitate the acquisition of domain ontologies from legacy applications by:
  1. Identifying data sources that contain knowledge to be transitioned into an ontology
  2. Employing data mining techniques to aid the domain expert in building the ontology

Application Mining



Application Mining





= A set of interlinked documents; each link has a type and a weight

GATE Case Study

- Software library for natural language processing (NLP)
- ~600 Java classes
  - Language resources = data
  - Processing resources = algorithms
  - Graphical user interfaces = GUI
- Developed at University of Sheffield
- Freely available at http://gate.ac.uk/download/

Data Sources

- Structured
  - Code samples
  - Web service usage logs
  - Source code
  - Reference manual (function declarations)
  - WDSL ...
- Unstructured
  - Web pages
  - User's manual
  - Tutorials, lectures, forums, newsgroups, etc.
  - Reference manual (textual descriptions)
  - Source code comments ...

A Typical Java Class

Class comment

Comment references

```
/** The format of Documents. Su umentFormat know about
  * particular MIME types and how to unpack the information in any
  * markup or formatting they contain into GATE annotations. Each MIME
  * type has its own subclass of DocumentFormat, e.g. XmlDocumentFormat,
  * RtfDocumentFormat, MpegDocumentFormat. These classes register themselves
  * with a static index residing here when they are constructed. Static
  * getDocumentFormat methods can then be used to get the appropriate
  * format class for a particular document.
  */
public abstract class DocumentFormat
extends AbstractLanguageResource implements LanguageResource{
```

Class name

Super-class (base class)

Implemented interface

A field

```
/** The MIME type of this format. */
 private MimeType mimeType = null;
```

Field comment

Field type

Field name

A method

Method comment

```
/**
  * Find a DocumentFormat implementation that deals with a particular
  * MIME type, given that type.
  * @param  aGateDocument this document will receive as a feature
  *                       the associated Mime Type. The name of the feature is
  *                       MimeType and the format type/subtype
  * @param  mimeType the mime type that is given as input
  */
 static public DocumentFormat getDocumentFormat(gate.Document aGateDocument,
                                                MimeType mimeType){
```

Comment reference

Return type

Method name

```
  } // getDocumentFormat(aGateDocument, MimeType)

} // class DocumentFormat
```

Creating a Document Network

DocumentFormat.class

```
/** The format of Documents. Subclasses of DocumentFormat know about
 * particular MIME types and how to unpack the information in any
 * markup or formatting they contain into GATE annotations. Each MIME
 * type has its own subclass of DocumentFormat, e.g. XmlDocumentFormat,
 * RtfDocumentFormat, MpegDocumentFormat. These classes register themselves
 * with a static index residing here when they are constructed. Static
 * getDocumentFormat methods can then be used to get the appropriate
 * format class for a particular document.
 */
public abstract class DocumentFormat
extends AbstractLanguageResource implements LanguageResource{
```

```
/** The MIME type of this format. */
 private MimeType mimeType = null;
```

```
/**
   * Find a DocumentFormat implementation that deals with a particular
   * MIME type, given that type.
   * @param  aGateDocument this document will receive as a feature
   *                       the associated Mime Type. The name of the feature is
   *                       MimeType and its value is in the format type/subtype
   * @param  mimeType the mime type that is given as input
   */
 static public DocumentFormat getDocumentFormat(gate.Document aGateDocument,
                                                MimeType mimeType){
```

```
 } // getDocumentFormat(aGateDocument, MimeType)

} // class DocumentFormat
```

DocumentFormat

Creating a Document Network

DocumentFormat.class

```
/** The format of Documents. Subclasses of DocumentFormat know about
 * particular MIME types and how to unpack the information in any
 * markup or formatting they contain into GATE annotations. Each MIME
 * type has its own subclass of DocumentFormat, e.g. XmlDocumentFormat,
 * RtfDocumentFormat, MpegDocumentFormat. These classes register themselves
 * with a static index residing here when they are constructed. Static
 * getDocumentFormat methods can then be used to get the appropriate
 * format class for a particular document.
 */
public abstract class DocumentFormat
extends AbstractLanguageResource implements LanguageResource{
```

```
/** The MIME type of this format. */
 private MimeType mimeType = null;
```

```
/**
   * Find a DocumentFormat implementation that deals with a particular
   * MIME type, given that type.
   * @param  aGateDocument this document will receive as a feature
   *                       the associated Mime Type. The name of the feature is
   *                       MimeType and its value is in the format type/subtype
   * @param  mimeType the mime type that is given as input
   */
 static public DocumentFormat getDocumentFormat(gate.Document aGateDocument,
                                                MimeType mimeType){
```

```
  } // getDocumentFormat(aGateDocument, MimeType)

} // class DocumentFormat
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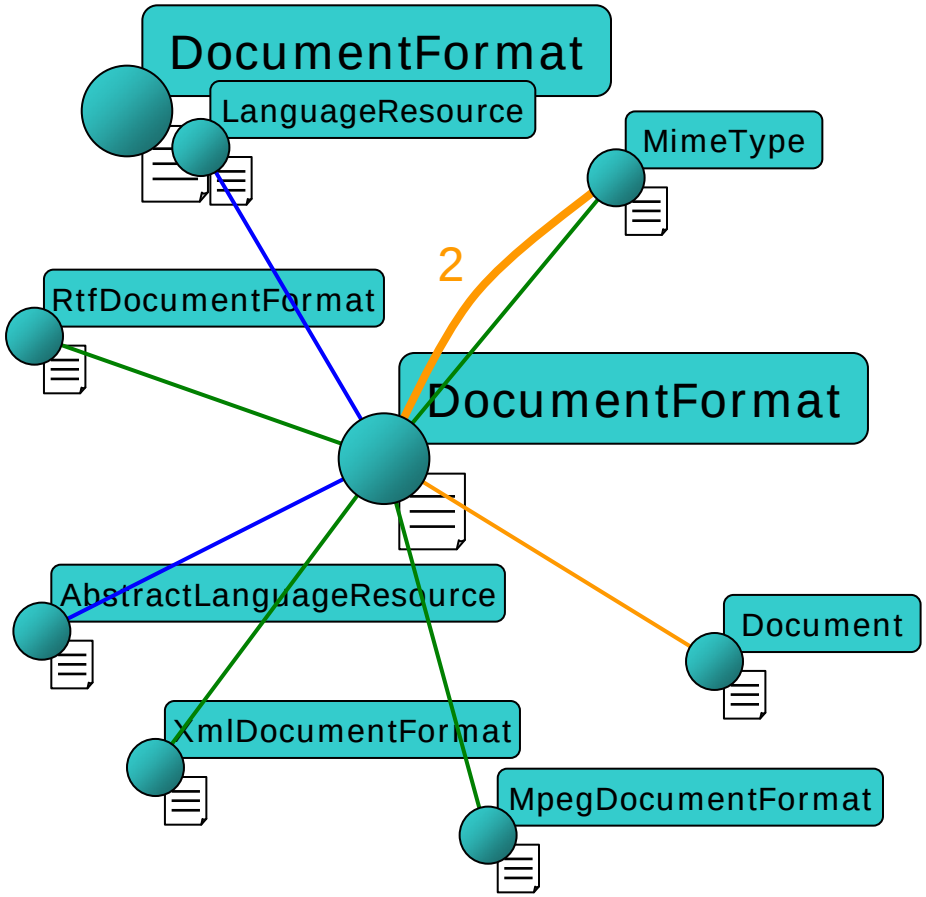
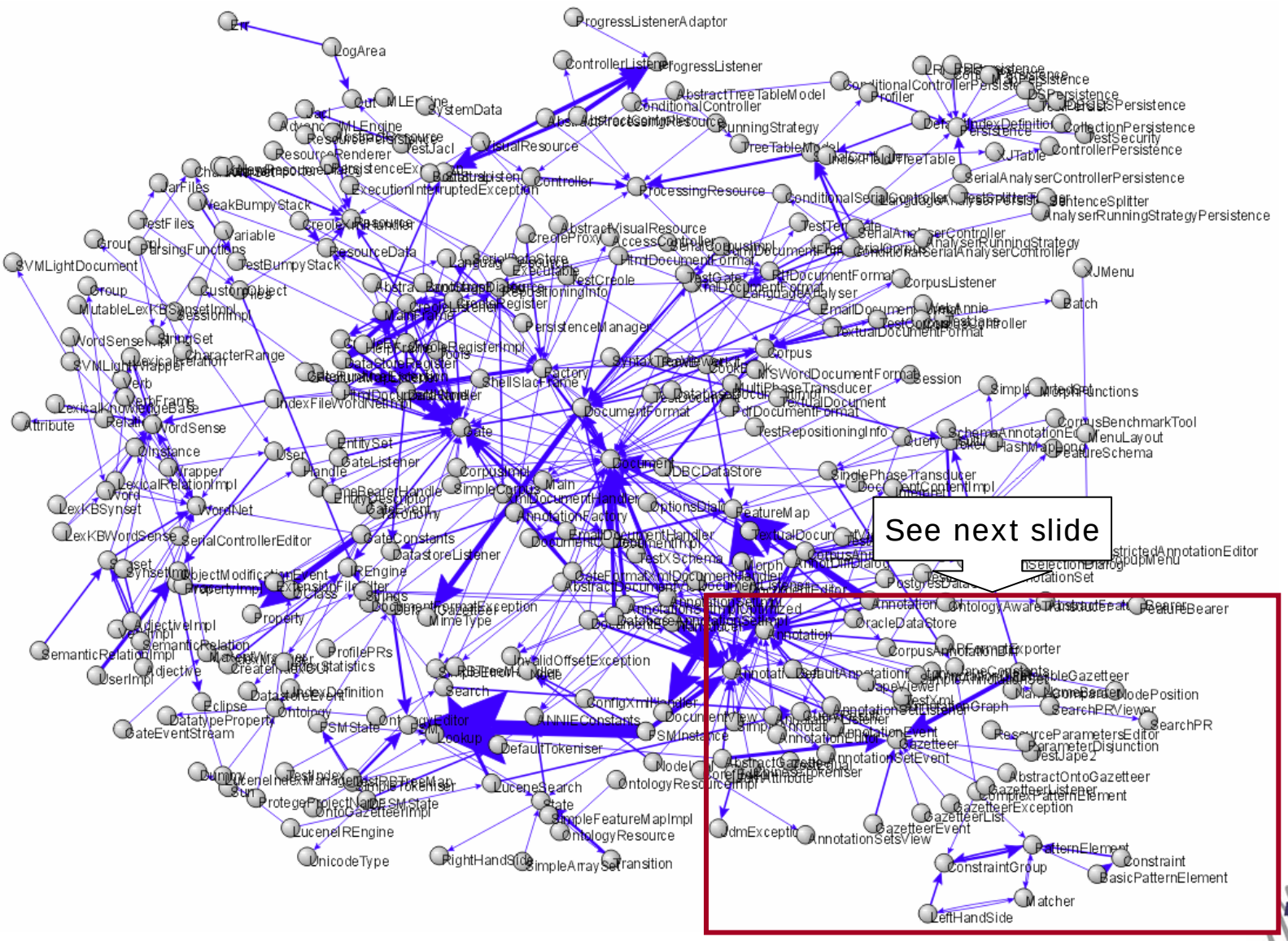
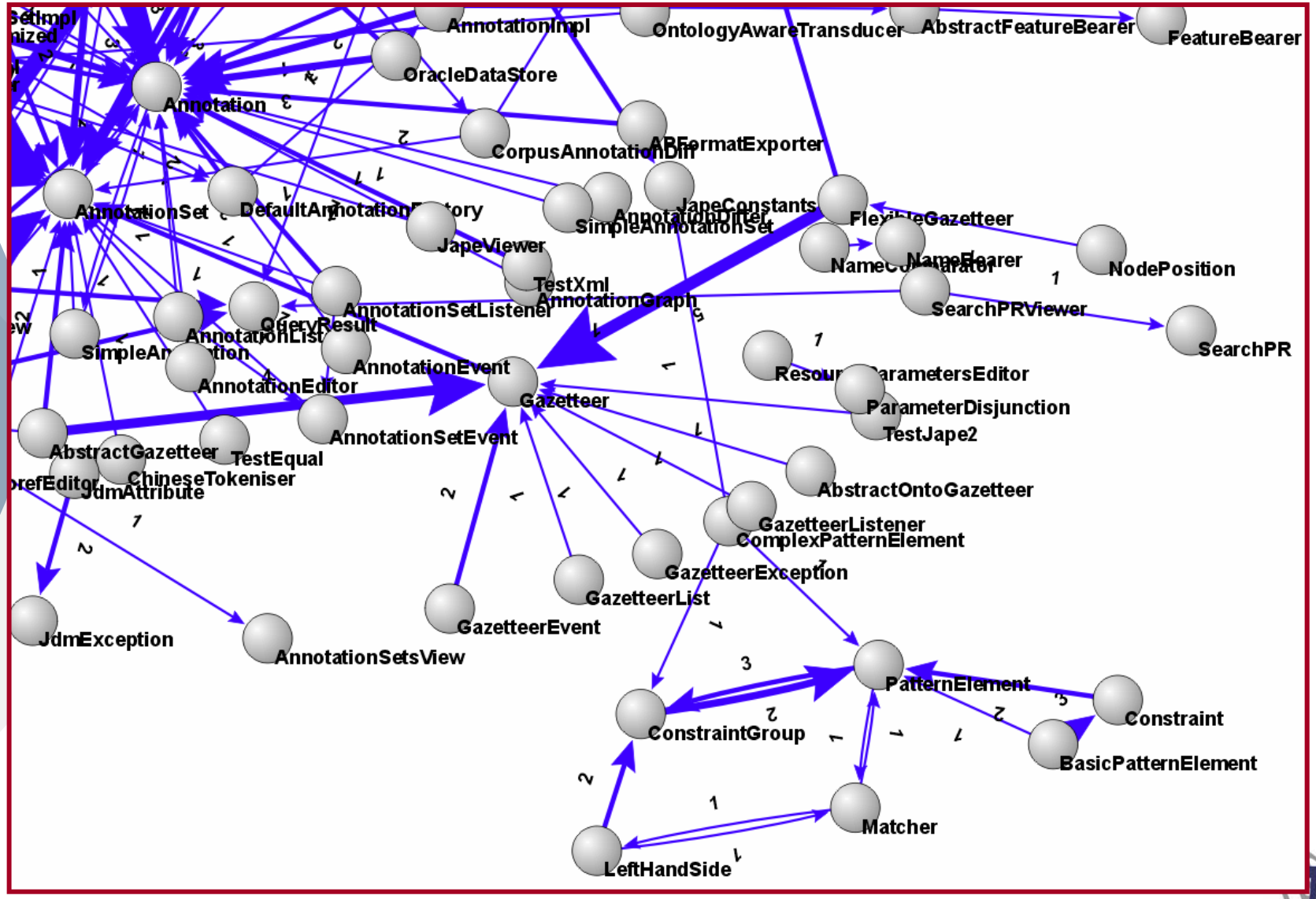


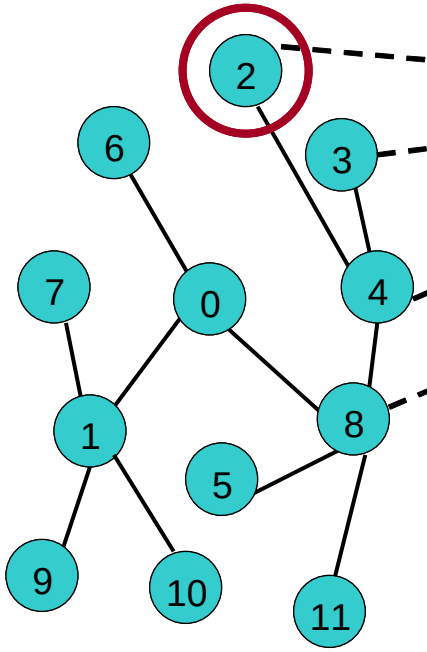
GATE Comment Reference Network



GATE Comment Reference Network

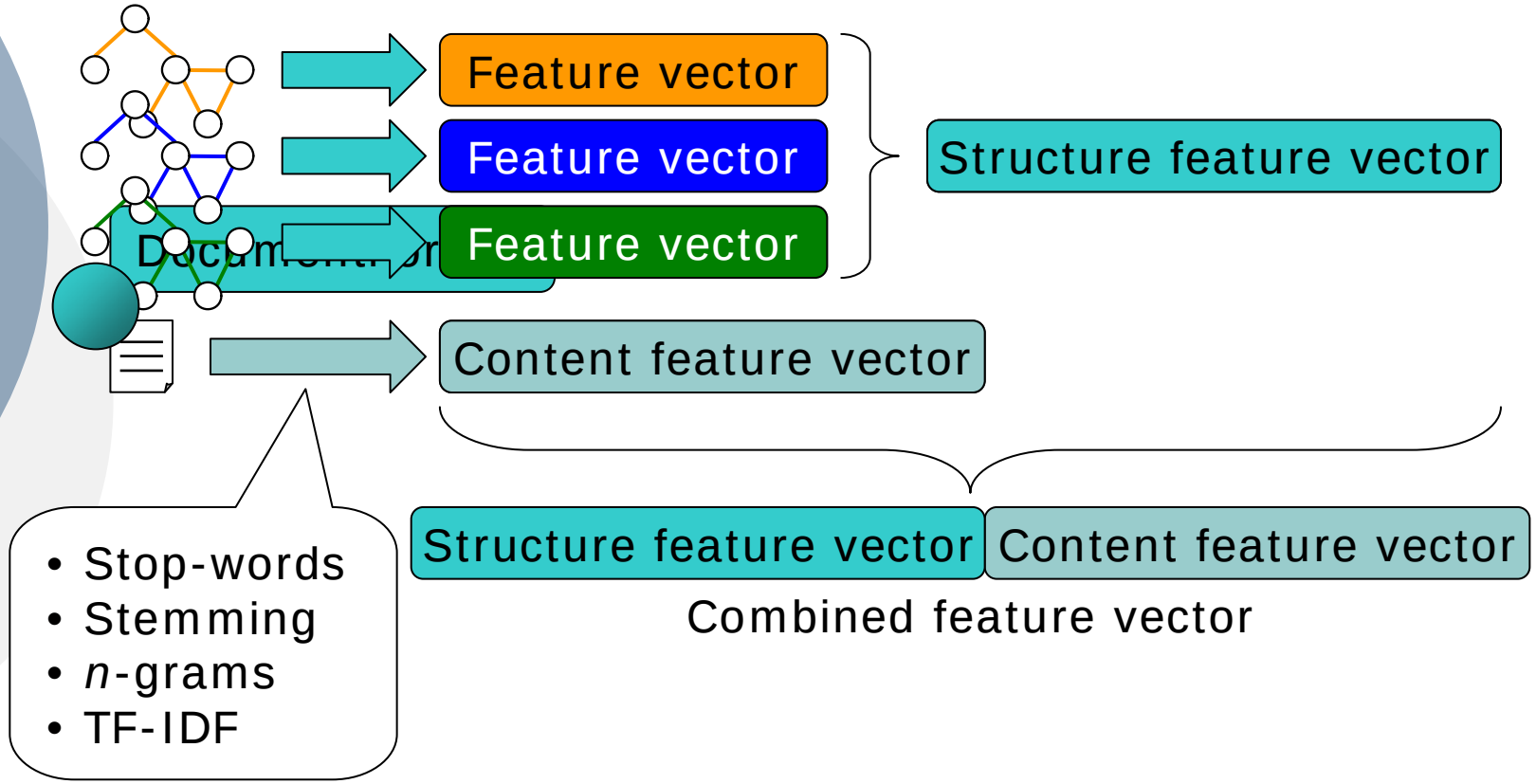


Transforming Networks into Feature Vectors



	0	1	2	3	4	5	6	7	8	9	10	11
0	1	0.5			0.25	0.25	0.5	0.25	0.5	0.25	0.25	0.25
1	0.5	1					0.25	0.5	0.25	0.5	0.5	
2			1	0.25	0.5				0.25			
3			0.25	1	0.5				0.25			
4	0.25		0.5	0.5	1	0.25			0.5			0.25
5	0.25				0.25	1			0.5			0.25
6	0.5	0.25					1		0.25			
7	0.25	0.5						1		0.25		
8	0.5	0.25	0.25	0.25	0.5	0.5	0.25		1			0.5
9	0.25	0.5						0.25		1	0.25	
10		0.25								0.5	1	
11	0.25				0.25	0.25			0.5			1

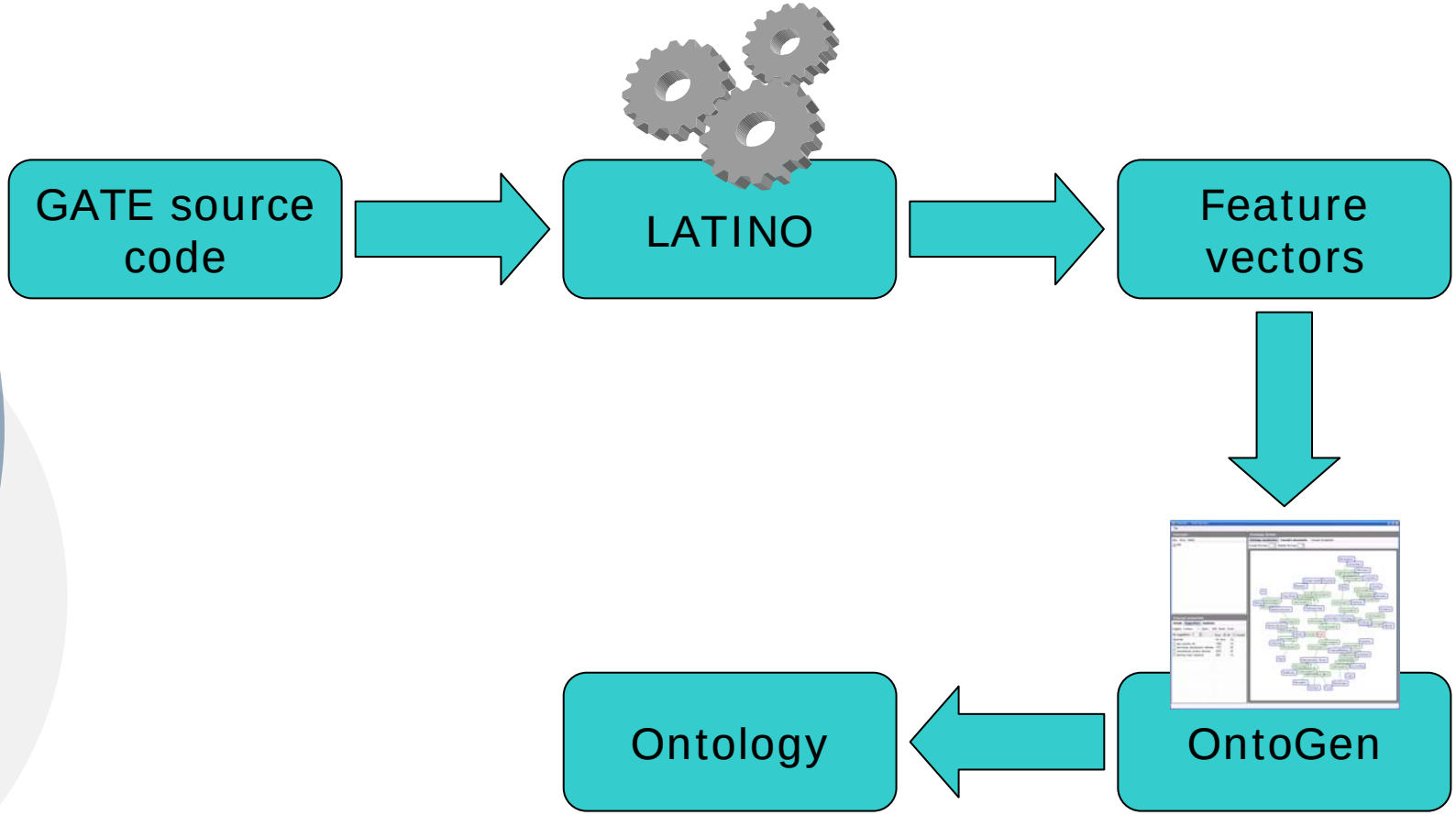
Combining Feature Vectors



LATINO & OntoGen Demo

- LATINO: Link analysis and text mining toolbox
  - Software being developed in the course of TAO WP 2
  - Data preprocessing, machine learning, and data visualization capabilities
- OntoGen
  - A system for *data-driven semi-automatic* ontology construction
  - SEKT technology (http://sekt-project.org)
  - Freely available at http://ontogen.ijs.si

LATINO & OntoGen Demo



OntoGen Demo

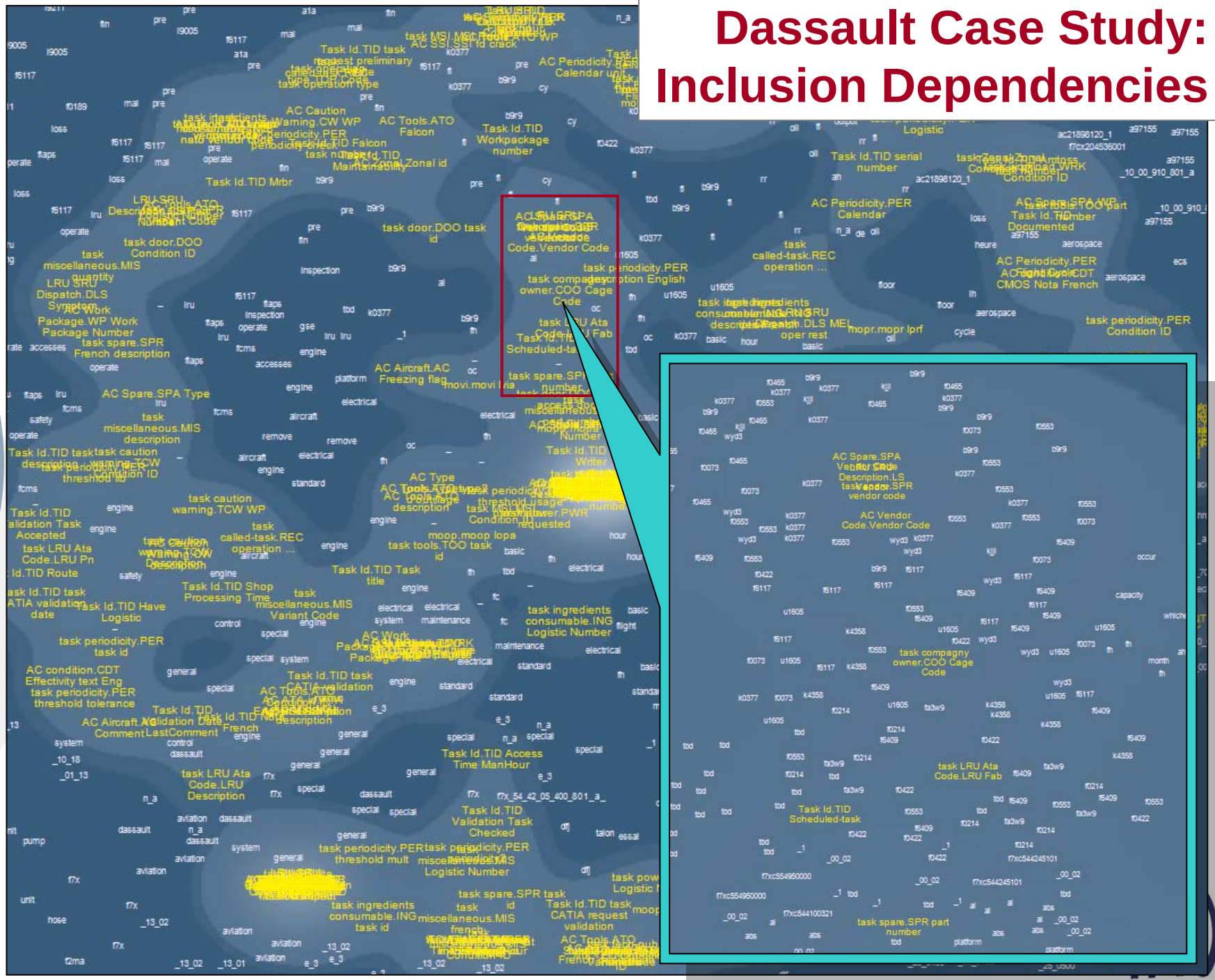
Dassault Case Study: Inclusion Dependencies

- Inclusion dependencies express subset-relationships between database tables and are thus important indicators of redundancy
- Discovery of ID important in the context of information integration
- Dassault Case Study
  - Problem: Dassault databases contain ID which should be taken into account when transitioning databases to ontologies
  - LATINO/OntoGen can help detect ID

Dassault Case Study: Inclusion Dependencies

- Dataset
  - The content of database tables in XML format
  - Ignore non-textual and empty table columns
- LATINO setting
  - Instances: columns (i.e. fields) in tables
  - Documents: concatenated values
  - Relations between instances:
    - Cosine similarity between documents
    - Similarity between sets of values
      - Jaccard, $|A \cap B| / |A \cup B|$
      - Alt., $|A \cap B| / \min\{|A|, |B|\}$
    - Edit distance (normalized) between column names

Dassault Case Study: Inclusion Dependencies



Dassault Case Study: Inclusion Dependencies

Candidates according to bag-of-words cosine sim

1.00 AC_Periodicity.PER_Aircraft : moop.moop_aircraft
1.00 AC_Periodicity.PER_Aircraft : mopa.mopa_kav
1.00 AC_Periodicity.PER_Aircraft : movi.movi_kav
1.00 AC_Periodicity.PER_Aircraft : AC_Zonal.Zonal_ac
1.00 AC_Tools.ATO_nato_vendor_code : task_miscellan to_vendo
...
0.99 AC_Tools.ATO_nato_vendor_code : task_ingredients_con nato_ve
0.99 task_ingredients_consumable.ING_nato_vendor_code : _Nato_v
0.99 task_ingredients_consumable.ING_nato_vendor_code
task_miscellaneous.MIS_nato_vendor_code
0.99 Task_Id.TID_task_owner : task_ingredients_consumable ndor_co
0.98 AC_Zonal.Zonal_ac : LRU_SRU_Description.LS_Aircraft
...
0.50 task_periodicity.PER_periodicity_usage_parameter2 : ts meter.US
0.50 task_periodicity.PER_threshold_usage_parameter : task eter.USP
0.49 Task_Id.TID_usage parameter : task_periodicity.PER_ _parame
0.48 mope.mope_kpe : task_periodicity.PER_threshold_tol us
0.48 mope.mope_kpe : task_periodicity.PER_periodicity_usage
...
0.21 AC_Vendor_Code.Vendor Code : task_LRU_Ata_Code LRU
0.21 AC_Zonal.Zonal_title : moid.moid_lida
0.21 task_compagny_owner.COO_Cage_Code : task_LRU_Ata b
0.21 Task_Id.TID_Task_Writer : task_miscellaneous.MIS_part
0.20 Task_Id.TID_Scheduled-task : task_spare.SPR_part_num

Task_Id.TID_task_owner	task_ingredients_consumable.ING_nato_vendor_code
F0189	
198	
F6117	
F6117	
F6117	F6117
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F6117	F6117
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F6117	
K4358	
F0073	198
	198
F0073	198
F6117	I9005
F0189	
F6117	
F6117	

Conclusions and Future Work

- Plans for LATINO
  - (Recognized?) open-source architecture for text mining and link analysis
  - Build a user community, put up a Web site, training, promotion ...
  - Applications!
    - ... in case studies
    - ... in other EU projects
    - ... outside the context of EU projects
    - ... competing in data mining contests
- Future work
  - Implementation of a visualization tool similar to DocumentAtlas (required for setting the weights and exploring the semantic space)
  - Evaluation!
    - Can we solve problems introduced by case studies better if we use LATINO methodology rather than using standard text mining approach?
  - Continue the development of LATINO