A Text Analysis Framework for Automatic Semantic Knowledge Representation of Legal Documents

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Motivation

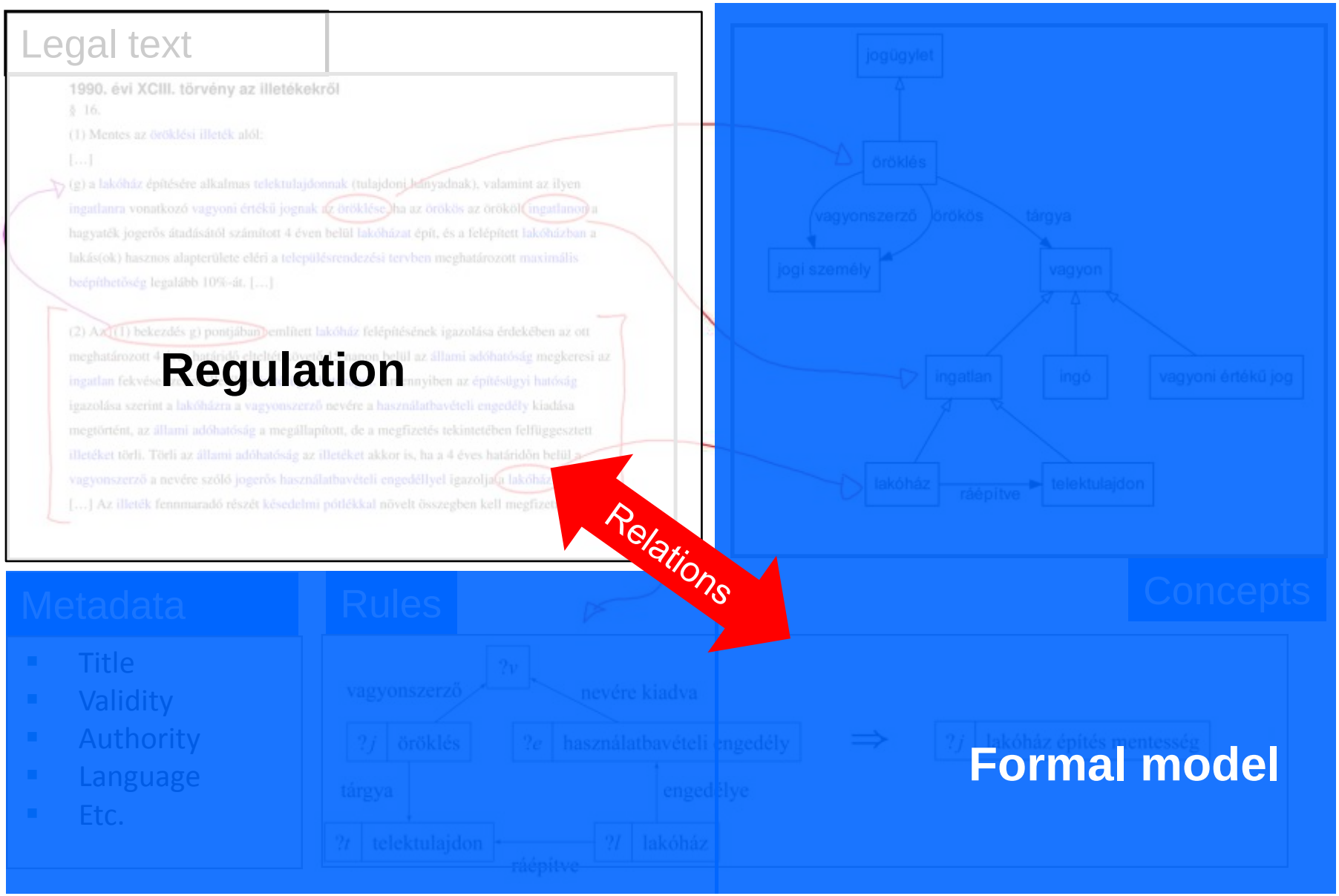
- Assumtion:
  - The electronic representation of legal texts exist
- Problems:
  - How can we
    - exploit data discovery to answer specific legal questions?
    - assist information access by discovering latent topics / trends?
    - assist information organization to discover hidden structures / outliers?

Applying text mining approach:
Semi-automated knowledge extraction from unstructured data sources to build knowledge base

Our Goals

- Extracting information and build knowledge base from unstructured regulations using
  - Metadata (such as title, authority)
  - Concepts based on controlled vocabularies (such as EUROVOC: http://eurovoc.europa.eu/)
  - Citations
  - Versions (such as validity, language versions)
- To provide
  - Semantic search possible
  - Understanding the law more deeply

Our overall goal

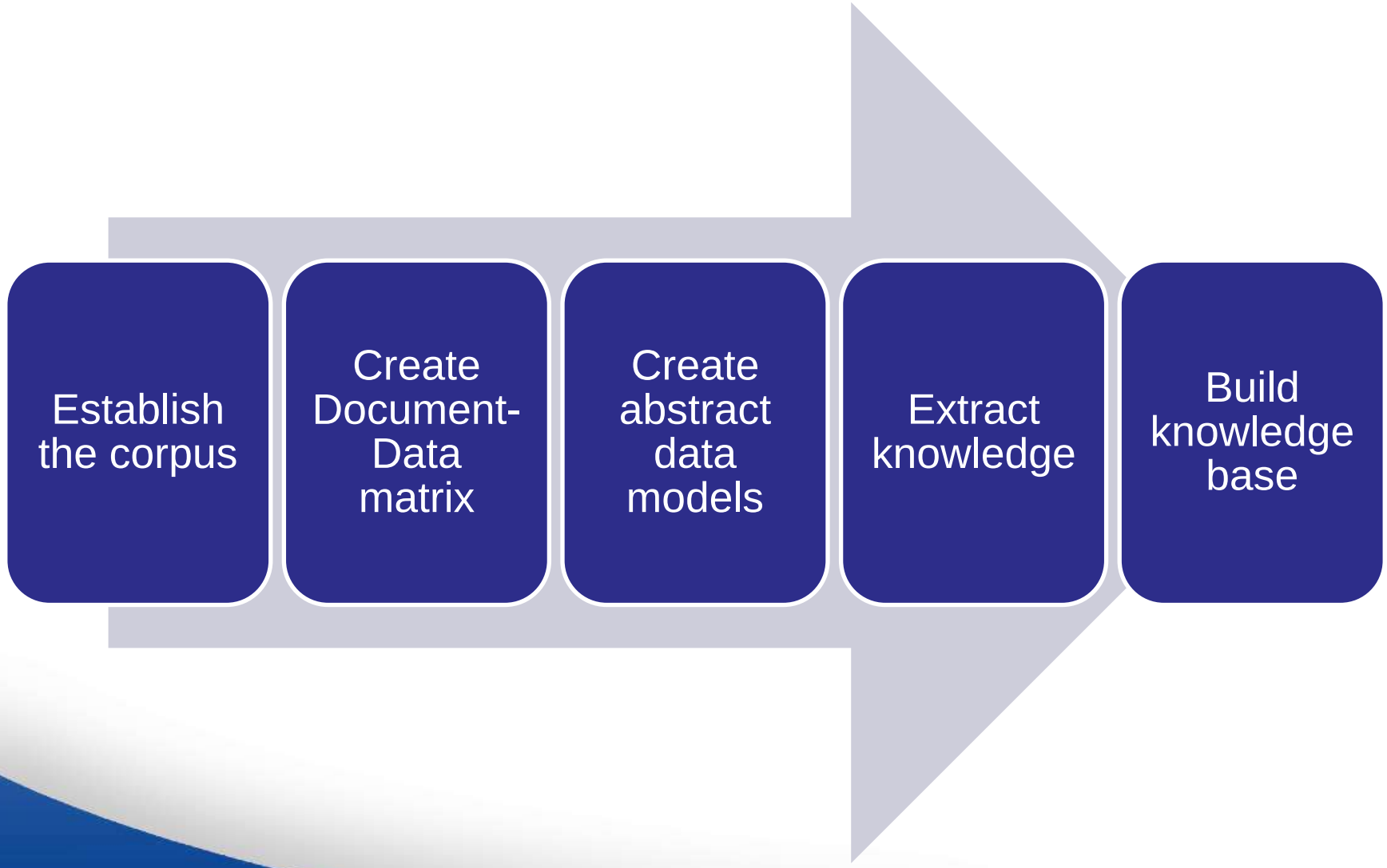


Agenda

- Our Methodology
- Architecture of the Framework
- Evaluation and Future Work

Our Process of Extraction

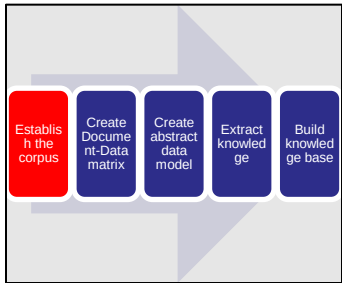
The Process of Extraction



Step 1: Establish the corpus

- Collect all relevant unstructured data
  - Web pages (HTML documents)
- Standardize the collection
  - XML format → CEN MetaLex compliant
- Place the collection in a common place

Reflects URI



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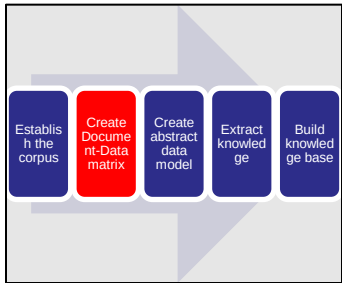
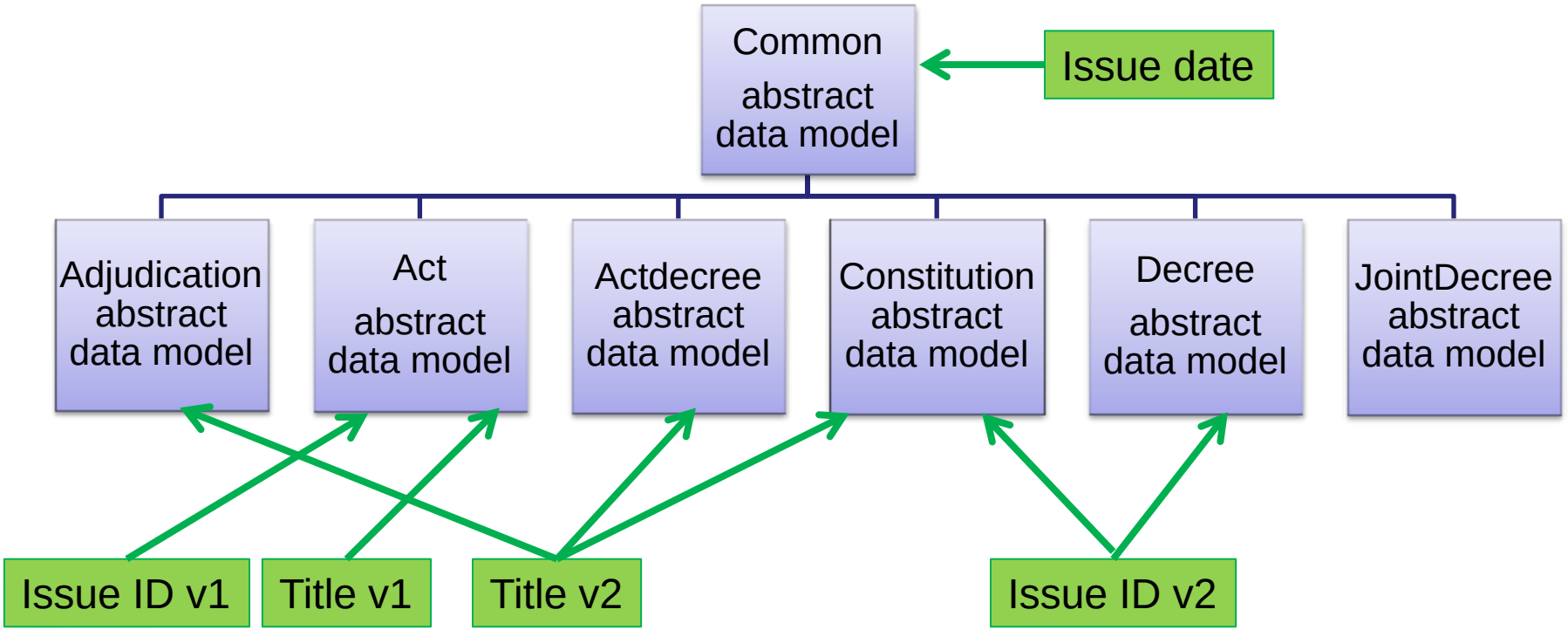
Step 2: Create Document-Data matrix

- Determine the extractable data
- Determine their relations with document types

		Data					
		Title v1	Title v2	Issue ID v1	Issue ID v2	Issue date	…
Document types	Adjudication		X		X	X	
	Act	X		X		X	
	Actdecree		X		X	X	
	Constitution		X			X	
	Decree		X		X	X	
	JointDecree		X		X	X	



Step 3: Create abstract data models



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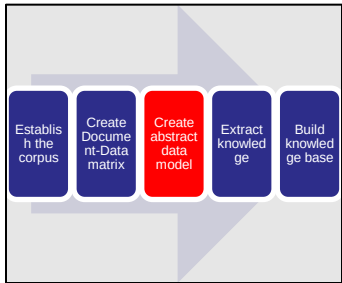
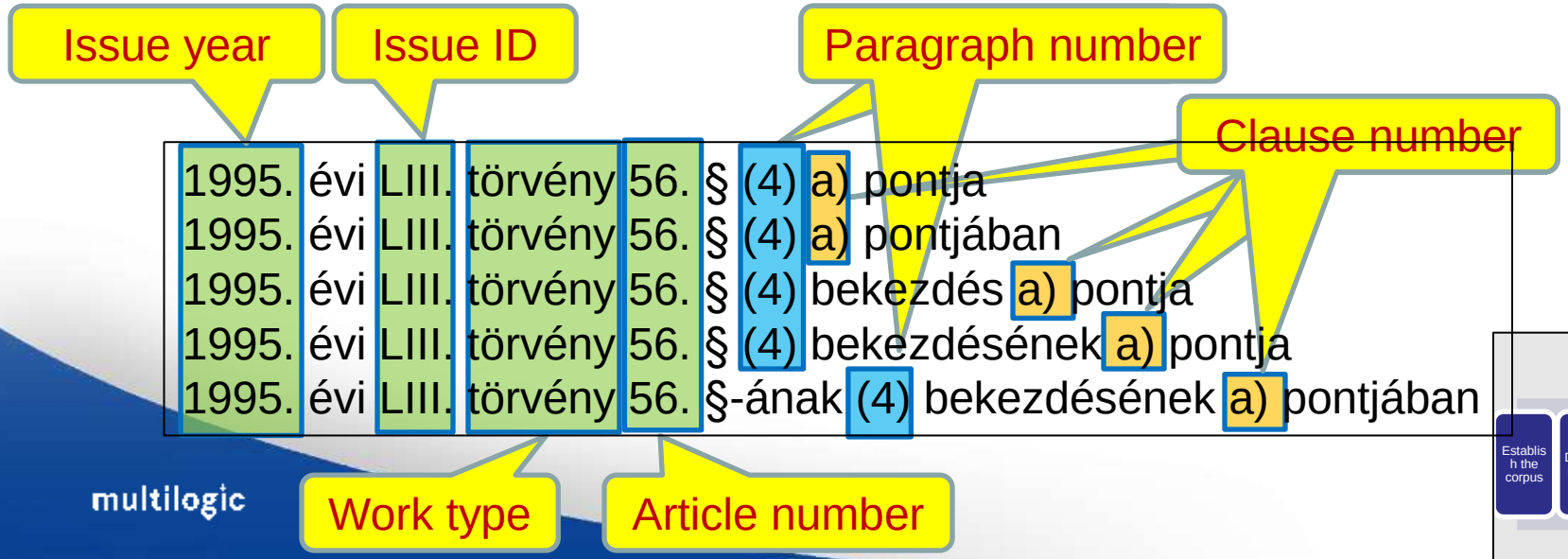


Step 4: Extract knowledge

- Determine the patterns of extraction
  - Clustering the information
  - Improve search recall
  - Improve search precision

Example: Clustering the information

Different forms of one citation style:
(IssueYear, IssueID, WorkType, Anum, Pnum, Cnum)



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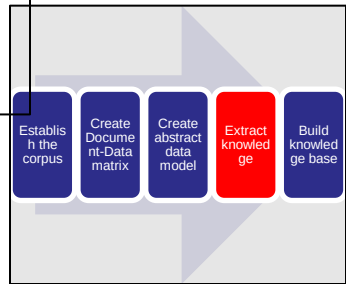

Step 3: Extract knowledge - Example

- Applied semantic vocabularies:
  - MetaLex OWL
  - Legal Knowledge Interchange Format
  - Dublin Core, Dublin Core Terms
  - Open Provenance Model Vocabulary
  - W3C Time ontology
  - Friend of a Friend

Step 4: Build knowledge base

- Data model excerpt of regulations

```
[WorkURI]
  rdf:type metalex-owl:BibliographicWork
  metalex-owl:resultOf [WorkCreationEventURI]
  rdf:type metalex-owl-ext#<work-category> # e.g. "metalex-owl-ext#act"
  dcterms:title "<Title of the legal document>"^^<xsd:string>
  metalex-owl:Author [WorkAuthorURI] # e.g. some ministry
  metalex-owl:countryCode "<jurisdiction-code>"^^<xsd:string> -- e.g. "hu"
  metalex-owl:issueID "<document-id>"^^<xs:integer> -- e.g. "11"
  metalex-owl-ext:issueDate "<date>"^^<xs:integer> -- e.g. "1960"

[ExpressionURI]
  rdf:type metalex-owl:BibliographicExpression
  metalex-owl:resultOf [ExpressionCreationEventURI]
  time-modification:in_force [ExpressionTimeModificationURI]
  metalex-owl:languageCode "<language code>"^^<xsd:language> -- e.g. "hun"
  metalex-owl#realizes [WorkURI]
  metalex-owl:cites [WorkURI]

[WorkCreationEventURI]
  rdf:type metalex-owl:LegislativeDelivery
  metalex-owl:participant [ParticipantURI] -- e.g. "Parliament"

[ExpressionCreationEventURI]
  rdf:type metalex-owl:LegislativeModification
  metalex-owl:participant [ParticipantURI] -- e.g. "Parliament"
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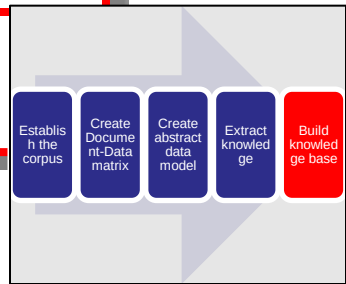
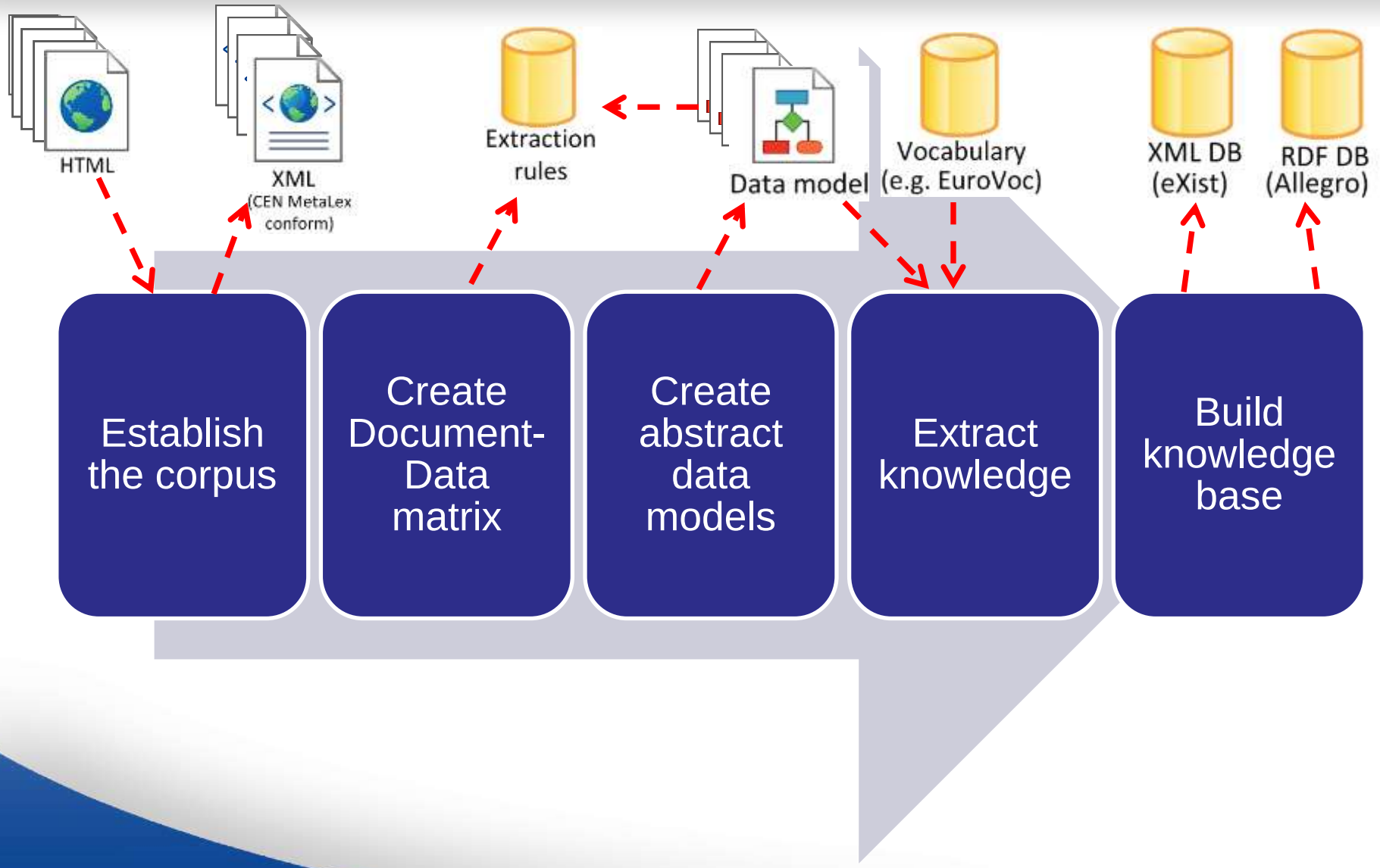
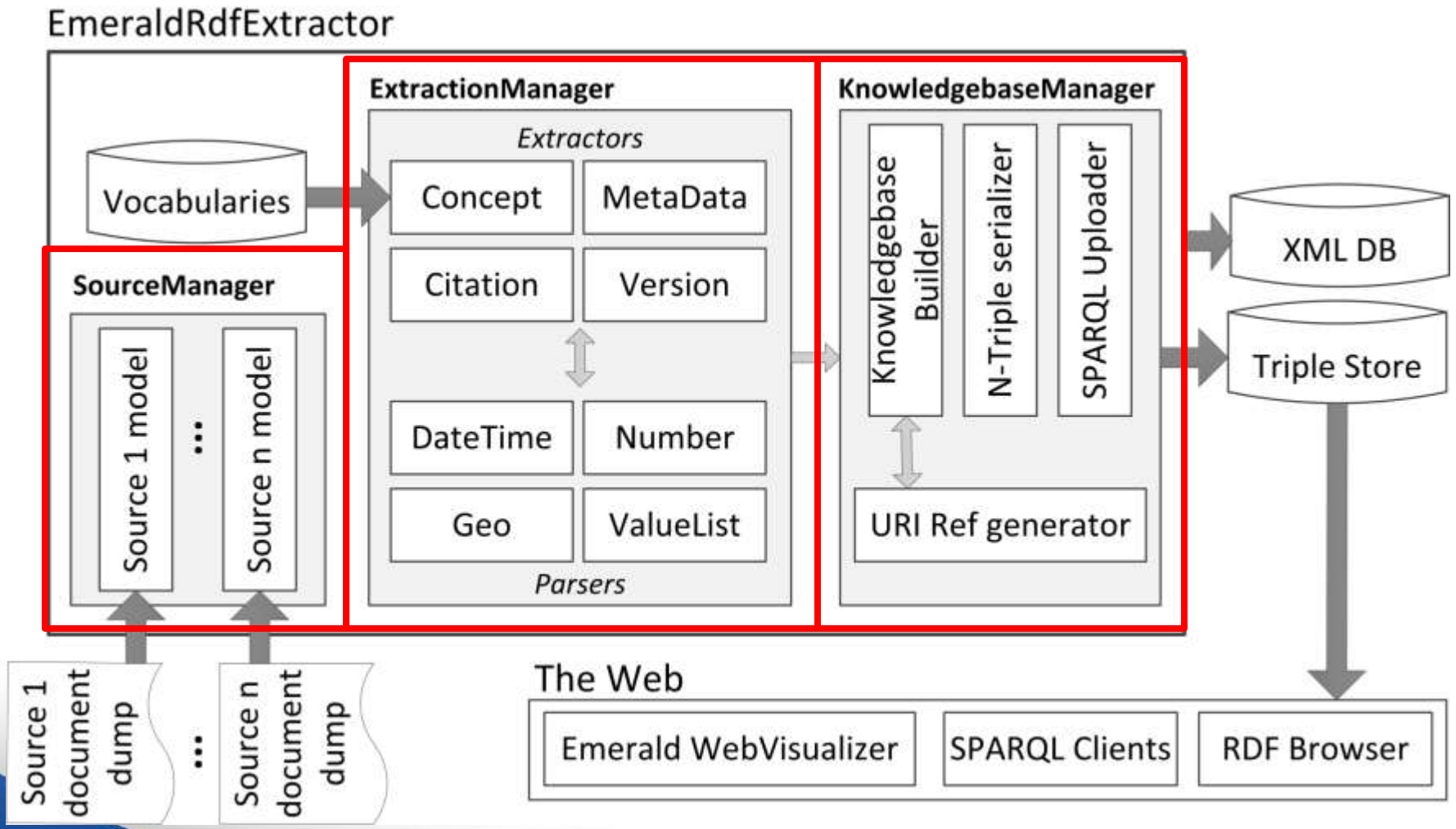


Summary: The Process of Extraction



Architecture of the Framework



Evaluation and Future Work

Evaluation with a case study

- Purpose
  - To evaluate our proposed method on a real-life situation
- Background
  - Hungarian legislative documents (www.njt.hu)
  - 256 most popular Hungarian regulations (work)
  - 3502 version of documents (expressions)
  - HTML format
  - Different types (6):

Main types	Subtypes
Adjudication	67 + 5
Act	1
Actdecree	1
Constitution	1
Decree	67
JointDecree	1

Results - 1

- We created
  - 6 document data models
  - 67 extraction rules of 32 kinds of citations
- We extracted
  - 524k triples (cca. 150 triples per document)
  - Cca. 73% of the triples were citations
  - 1672 documents were cited from the 256 documents → 7350 links

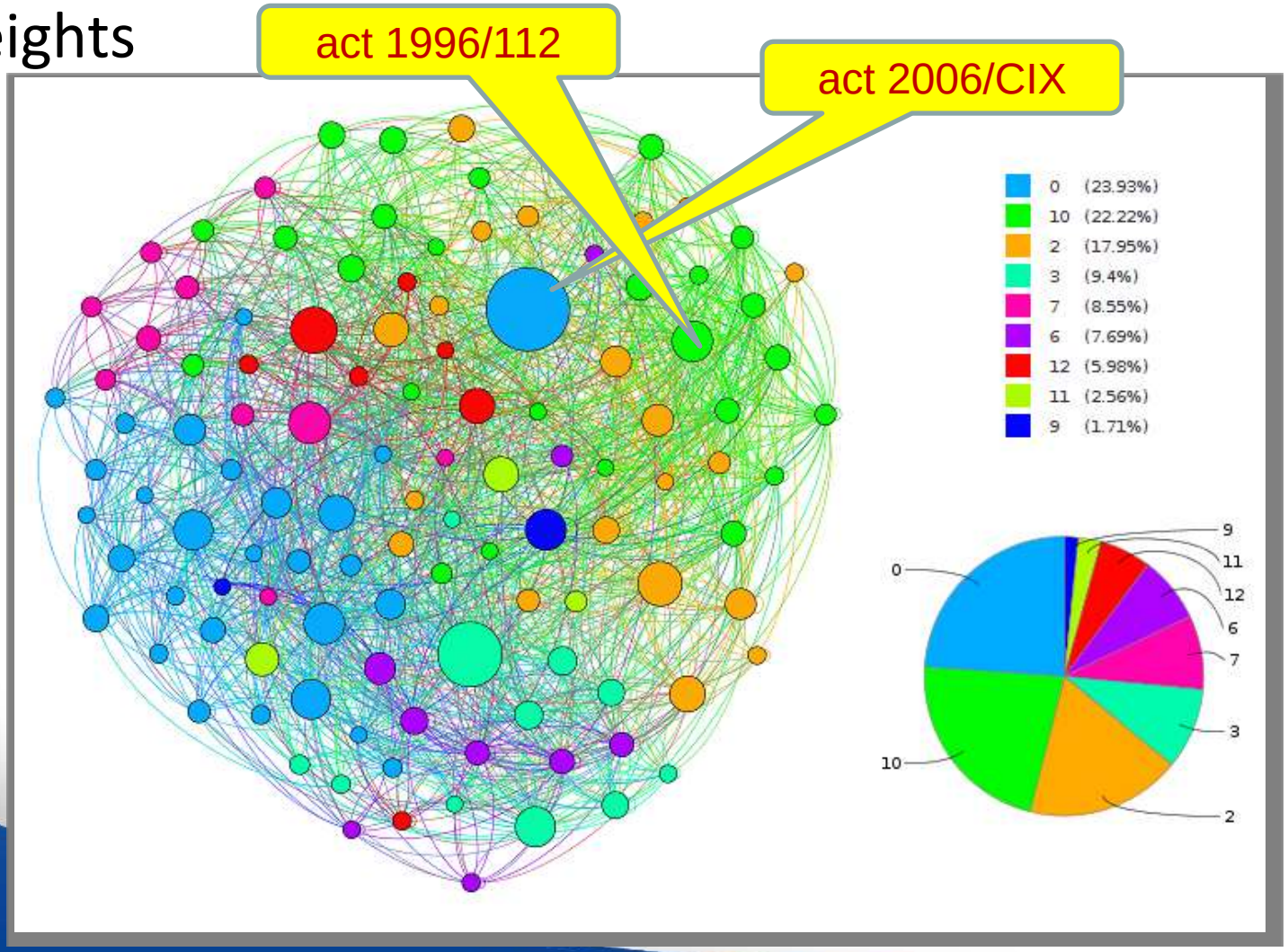
Results - 2

- Citation network analysis:

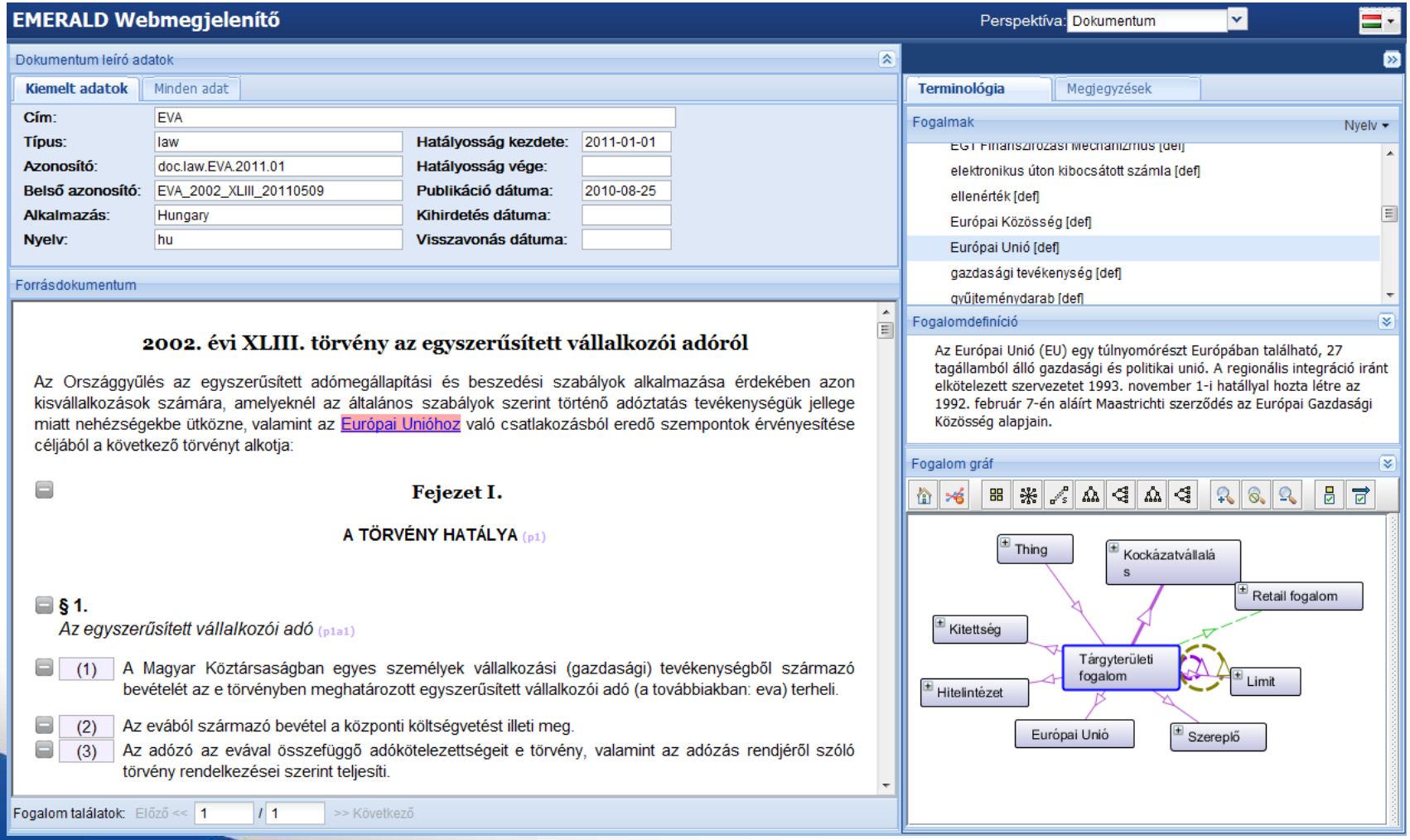
Metrics	Definition	Value
In-degree	the number citations from a document	[1, 129]
Out-degree	the number citations to a document	[1, 121]
Average degree	the number citations from/to a document	4.4
Network diameter	the maximum citation-distance between all pairs of documents	9
Average path length	the average number steps along the shortest path for all documents	3.4
Modularity	the strength of division of the network into communities	0.39
Number of communities	detected communities using resolution = 1:0	15

Results - 3

- Filtered citation network (nodes less than 35 degdee) and its communities with their relative weights



Implementation: Emerald



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Conclusions

The presented framework aims at:

- Standardizing data collections (CEN MetaLex Standard)
- Building knowledge models based on
  - document metadata (MetaLex, LKIF, …)
  - controlled vocabularies (EuroVoc and other custom vocabularies)
  - citation informations
  - version information
- Providing joint management of legal texts (XML) and their formal representations (formal model): metadata and concepts