



POLITECNICO
MILANO 1863

The Swiss Federal Legislation as a Property Graph

Filippo Galetti, Anna Bernasconi, Stefano Ceri, Francesco Invernici, Andrea Colombo

Why a Property Graph for Legislation

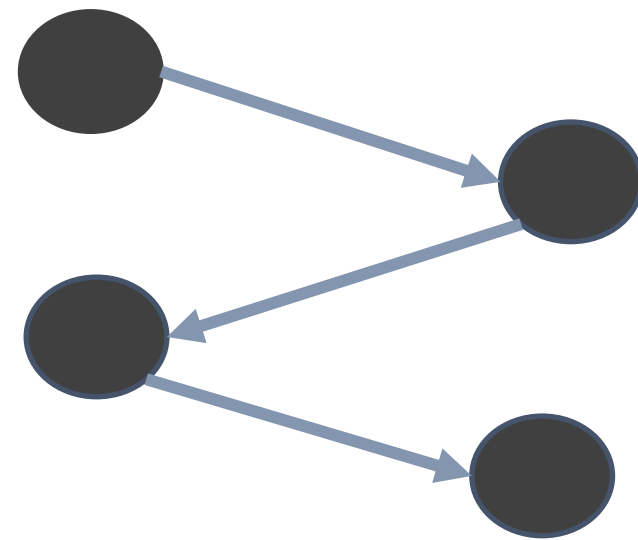
Explicit Relationship Modeling



Relationships are “*first-class citizens*”

e.g., interdependency between laws

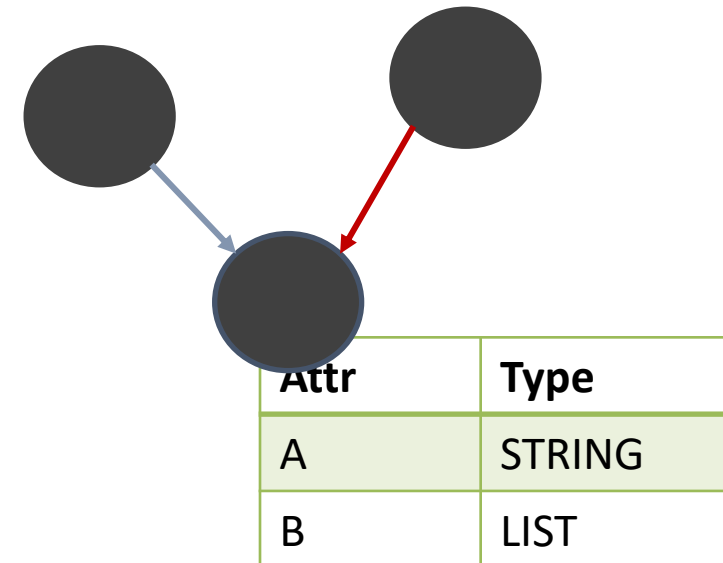
Efficient Traversal and Querying



A data model designed for fast traversal of edges

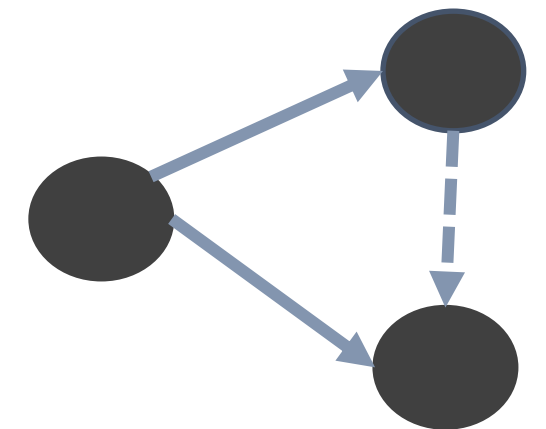
→ Chains of interdependencies, never cited laws...

Flexible Schema



Support for complex data structures (temporal versioning), compact modelling

Advanced Pattern Detection and Analytics

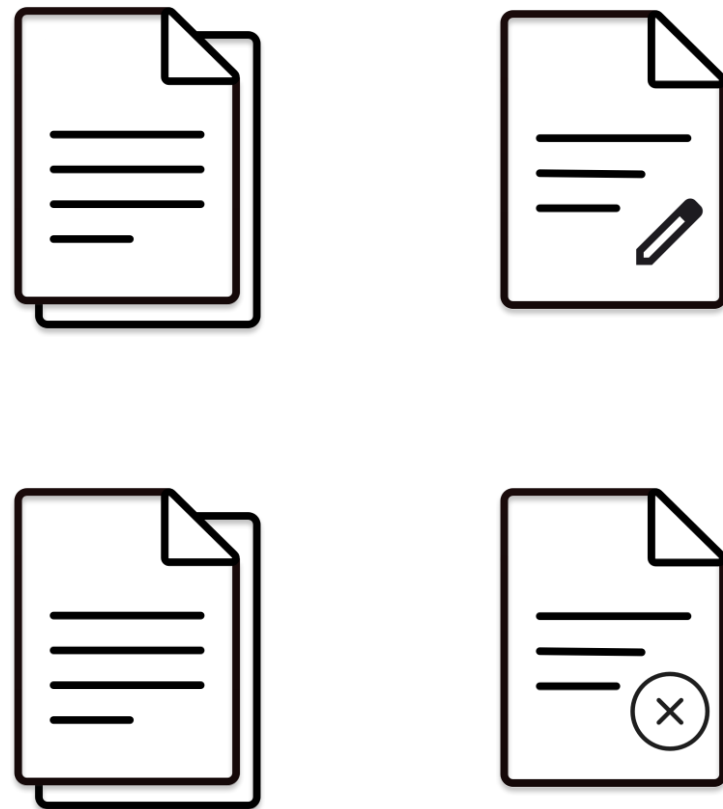


A natural starting point to detect inconsistencies or run network analysis and link prediction tasks

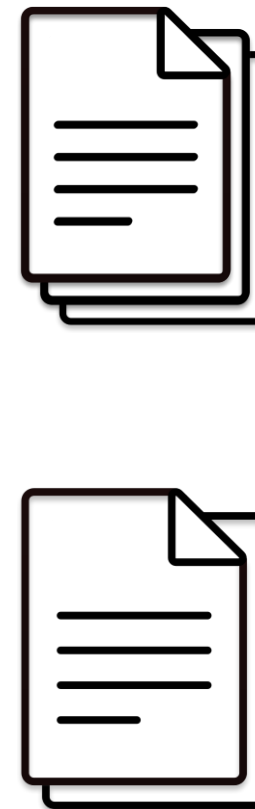
→ Comparison of legislative systems

Data Sources

Official Compilation



Systematic Compilation

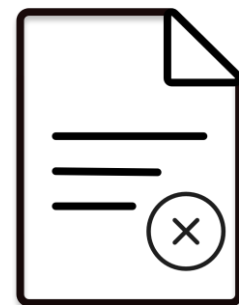


→ For the goal of conducting advanced pattern detection, we need the original version, not the consolidated ones.

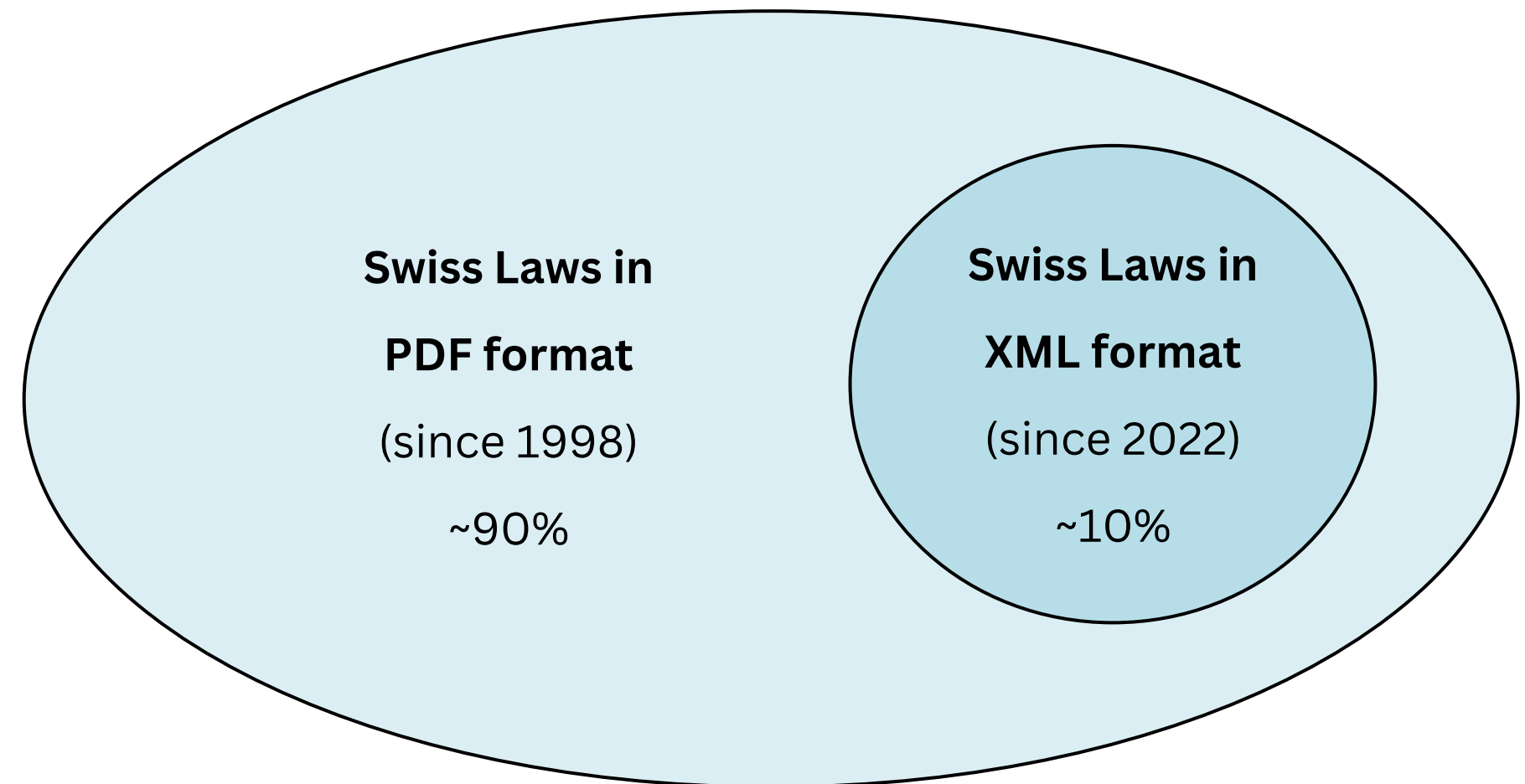
→ In-force texts can be derived through a query

Data Sources

Official Compilation

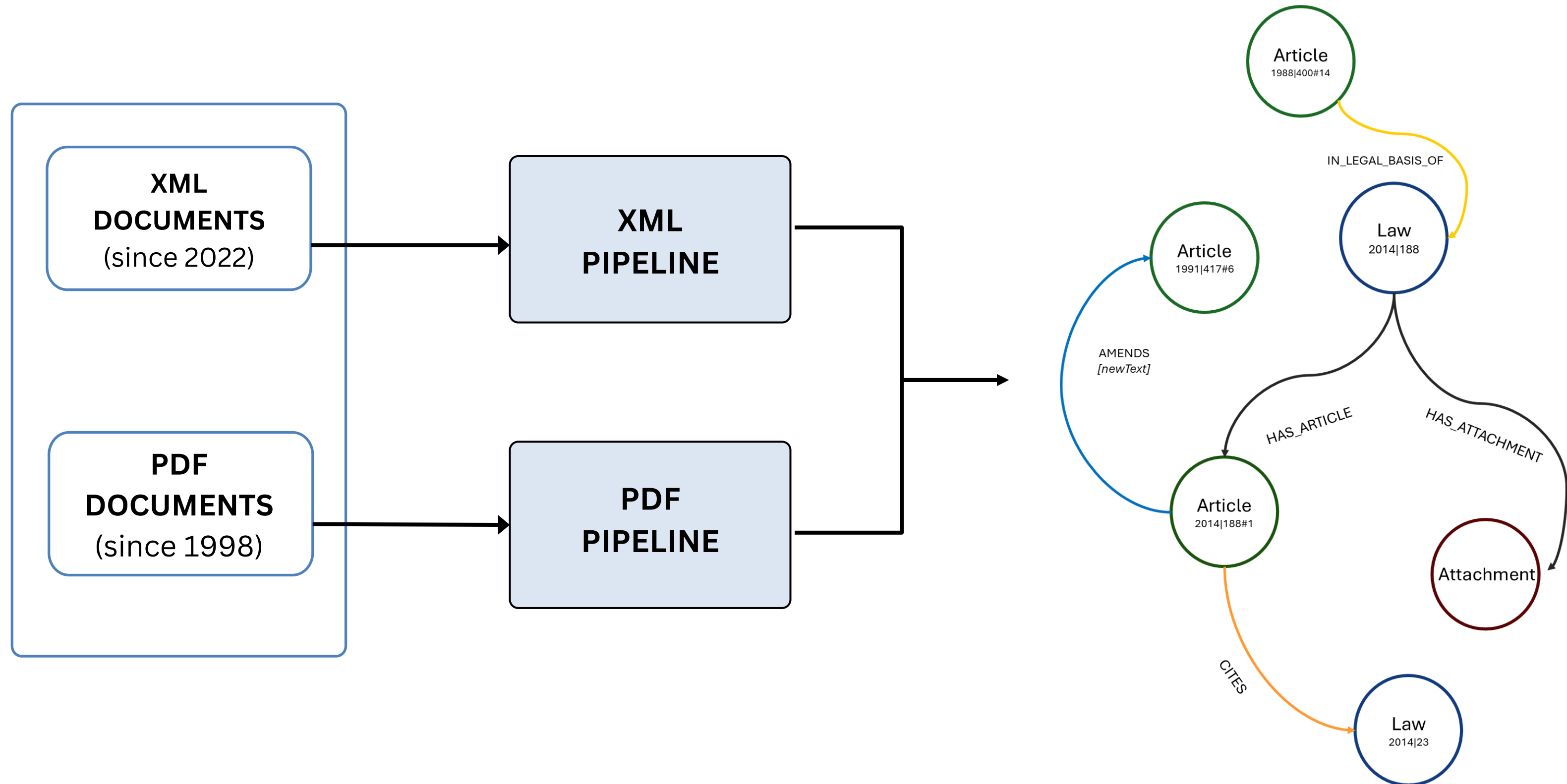


Documents Availability



→ Need to **unify** the data into the same DB

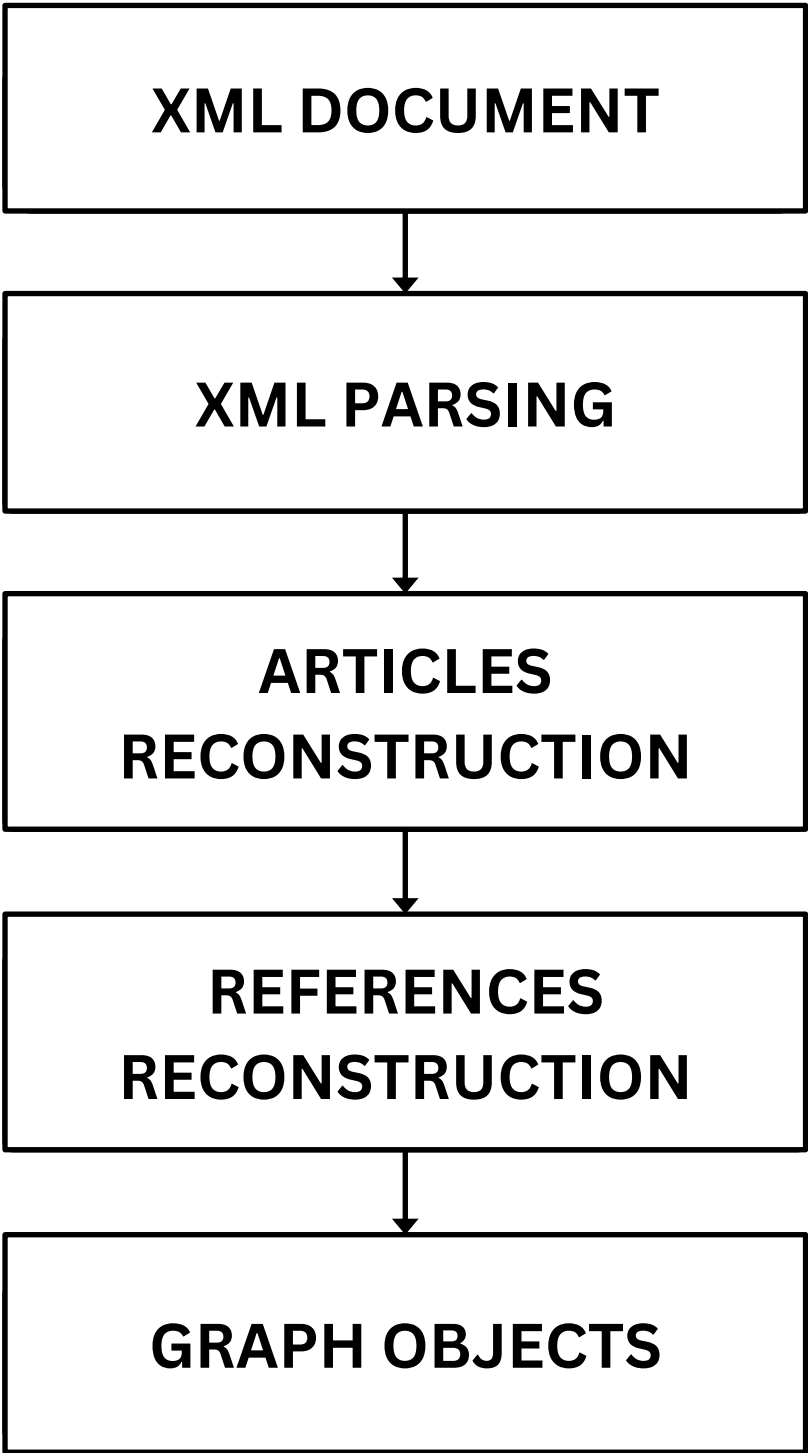
Information Extraction



The XML Extraction Pipeline

Akoma Ntoso Namespace

Tag Name	Description
<act>	<i>The Root element</i>
<meta>	<i>A container for metadata</i>
<heading>	<i>An element marking the title</i>
<authorialNote>	<i>A container for the act references</i>
<article>	<i>A hierarchical component for an article</i>



Deconstructing a PDF File

**Legge federale
sulla cooperazione internazionale in materia di educazione,
formazione professionale, gioventù e mobilità**

dell'8 ottobre 1999

*L'Assemblea federale della Confederazione Svizzera,
visti gli articoli 54 e 66 della Costituzione federale;
visto il messaggio del Consiglio federale del 25 novembre 1998¹,
decreta:*

Art. 1 Principio

La Confederazione può promuovere la cooperazione internazionale in materia di educazione, formazione professionale, gioventù e mobilità degli studenti e dei docenti.

Art. 2 Trattati internazionali

¹ Il Consiglio federale è autorizzato a stipulare i relativi trattati.
² Prima di stipulare un trattato consulta i Cantoni.

Art. 3 Borse di studio

La Confederazione può concedere borse di studio a coloro che intendono studiare presso istituti europei.

Art. 4 Finanziamento

L'Assemblea federale stanza i crediti d'impegno necessari con decreto federale semplice.

Art. 5 Referendum, entrata in vigore e durata di validità

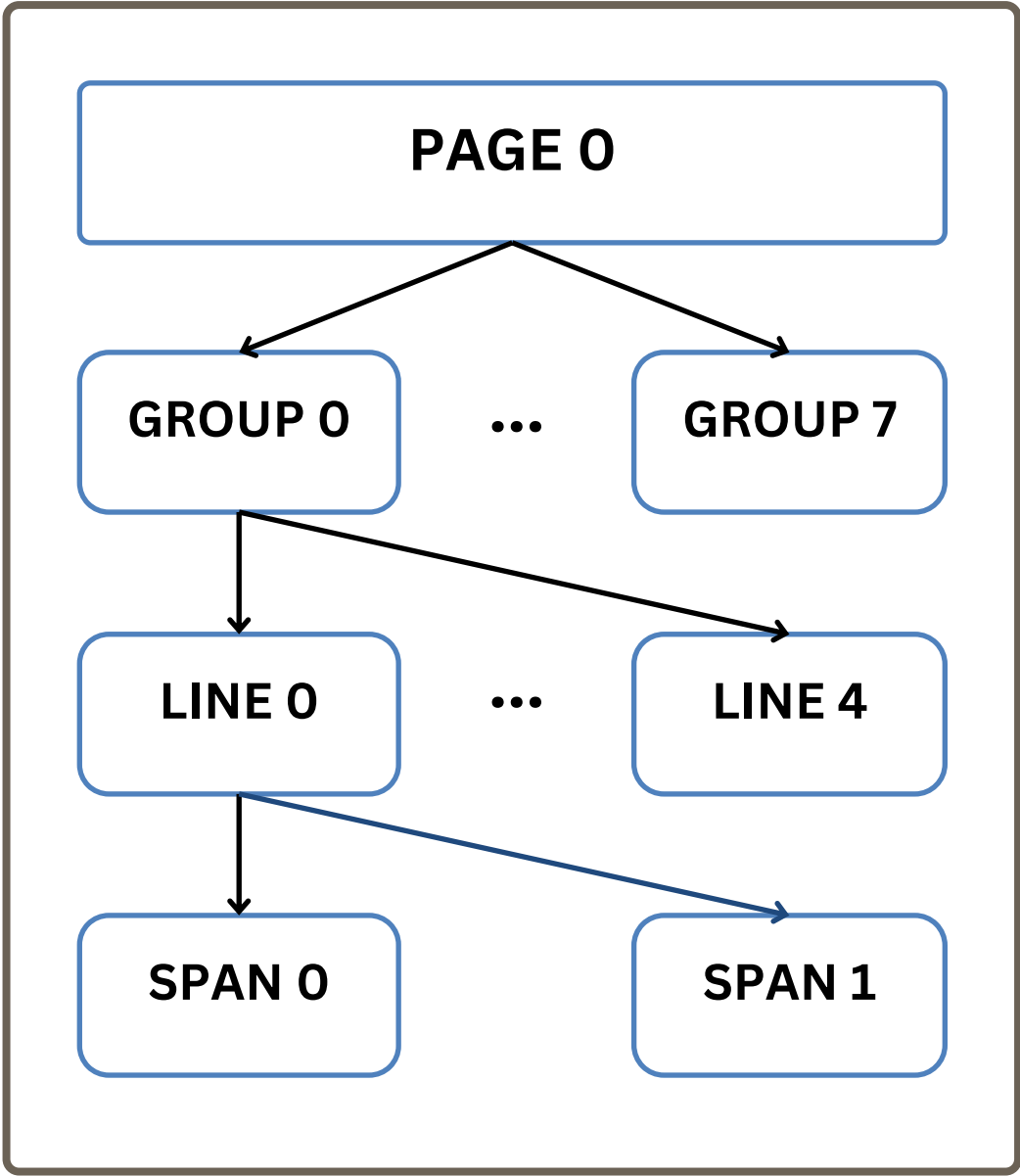
¹ La presente legge sottostà al referendum facoltativo.
² Sostituisce il decreto federale del 22 marzo 1991² sulla cooperazione internazionale in materia di formazione superiore e di mobilità.
³ Entra in vigore il 1° gennaio 2000 e vige fino al 31 dicembre 2003.

RS 414.51
¹ FF 1999 243
² RU 1991 1972, 1995 1443

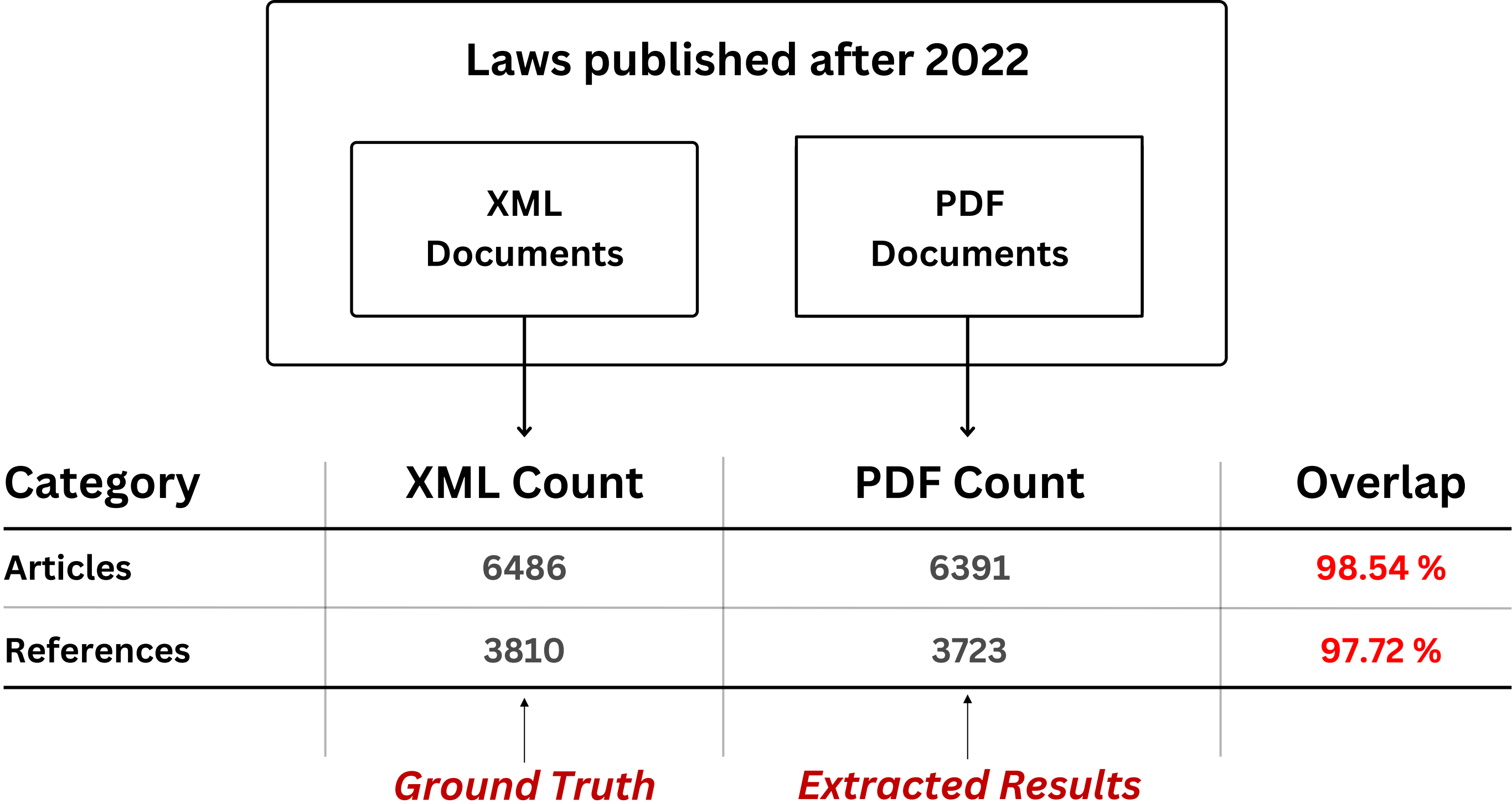
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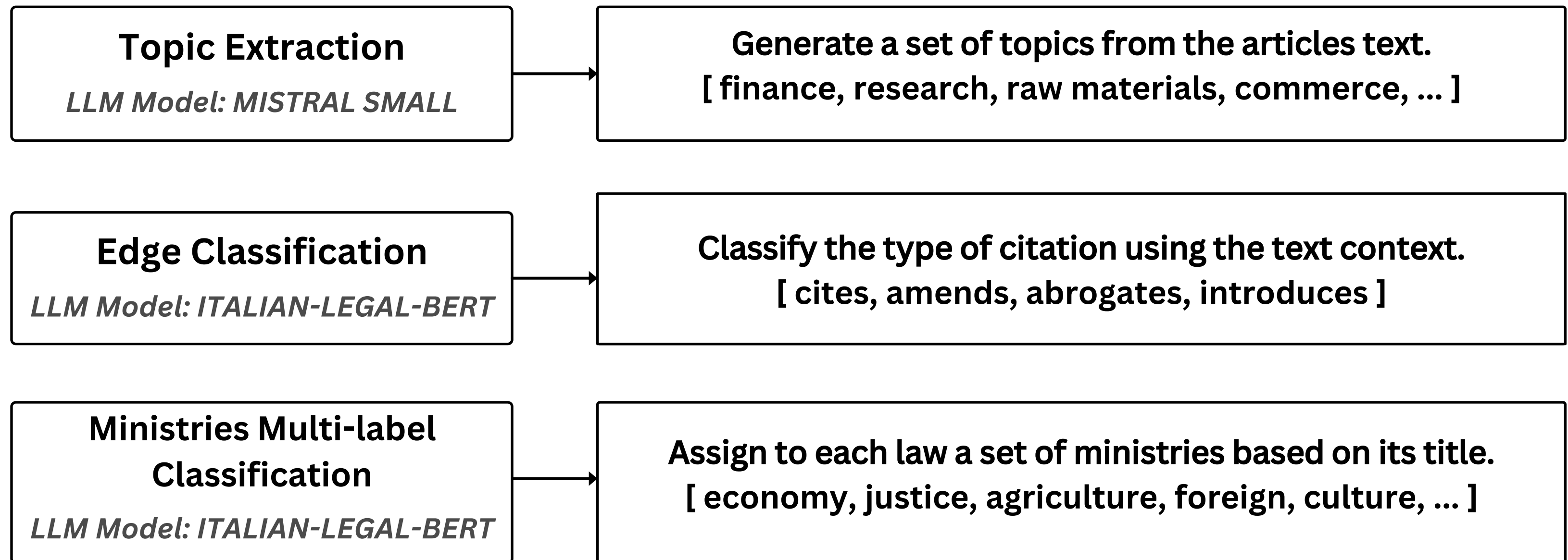
→ We developed a **heuristic-based Python library** that visually analyse the PDF and transform it into a “hierarchical tree” → which can be mapped into graph objects



Testing Efficacy of the PDF Pipeline



Graph Enrichment



All models were fine-tuned on the Italian law graph → allows to compare the two systems based on the same unifying properties

Resulting Graph

22k

Law Nodes

158k

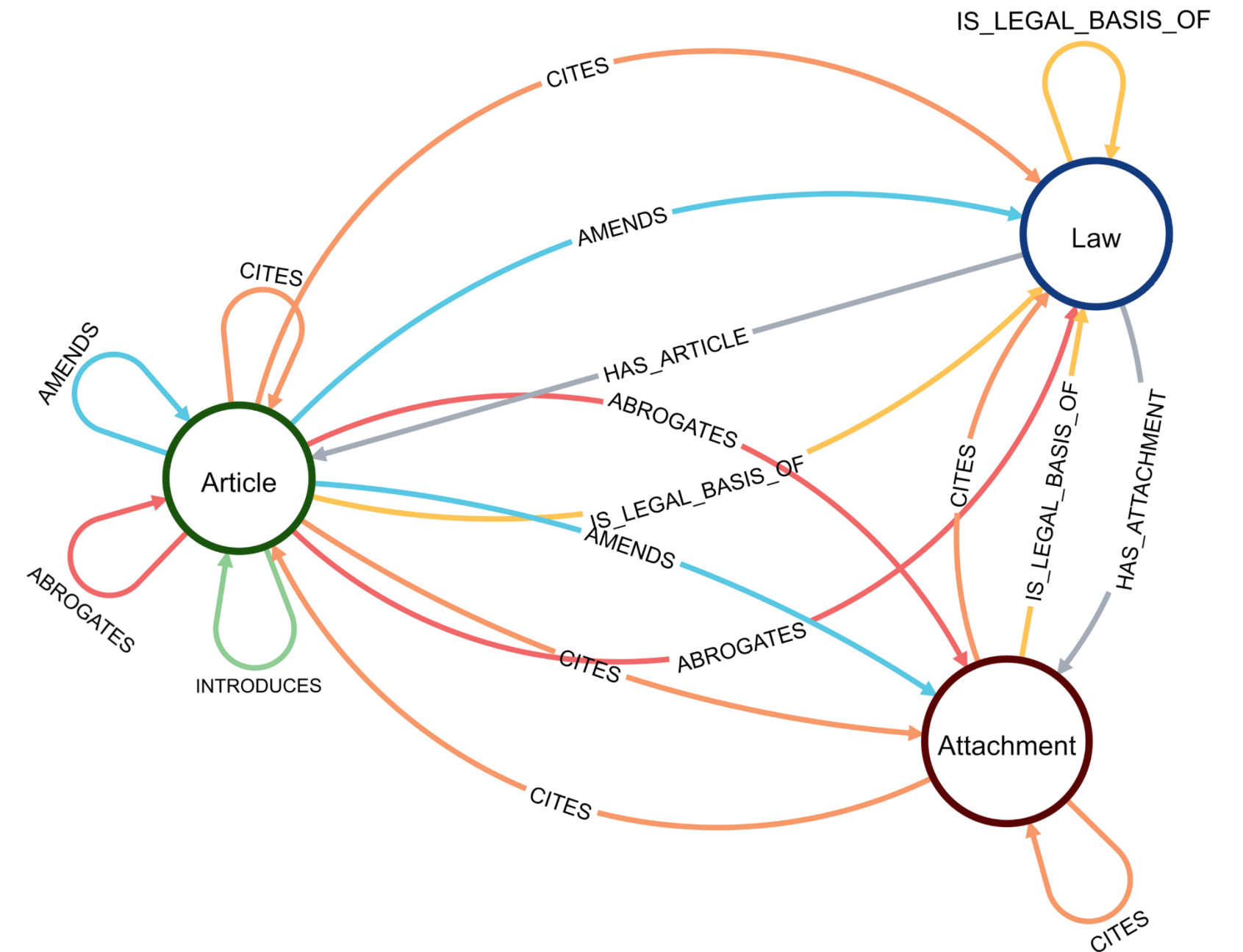
LawUnit Nodes

→ All enriched with valuable properties

60k

Citations

→ Classified into subtypes through BERT



→ A **unifying** base schema that focuses on enabling **data science/machine learning applications** maintaining **rich semantics (vs traditional network approaches)**

Graph-based Knowledge Management

→ Property Graphs offers, through Cypher and GQL, **native and declarative tools for:**

Answer systemic questions with simple queries in milliseconds

Applications of network theory on graph projections

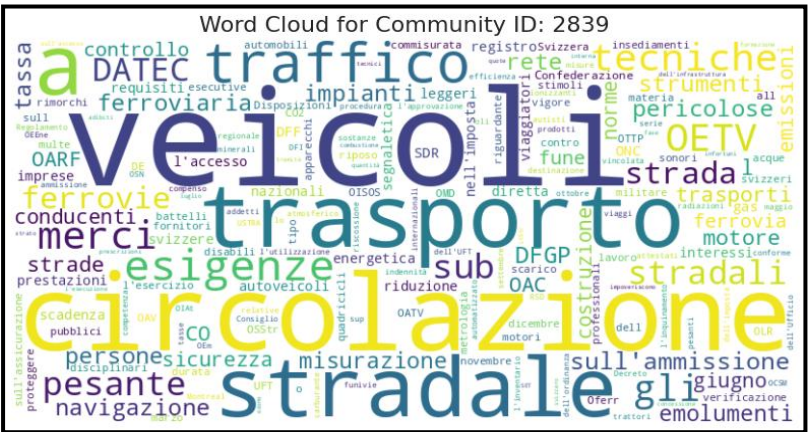
Examples:

- How many laws have never been cited?
- What is the stock of in-force laws through time?
- Are regulations about a certain topic stable?

Centrality

Rank	Title	Score
1	Costituzione federale della Confederazione Svizzera	120
2	Ordinanza sulle importazioni agricole	61
3	Legge sulle pubblicazioni ufficiali	58
4	Legge sugli embarghi	51
5	Legge sull'agricoltura	41

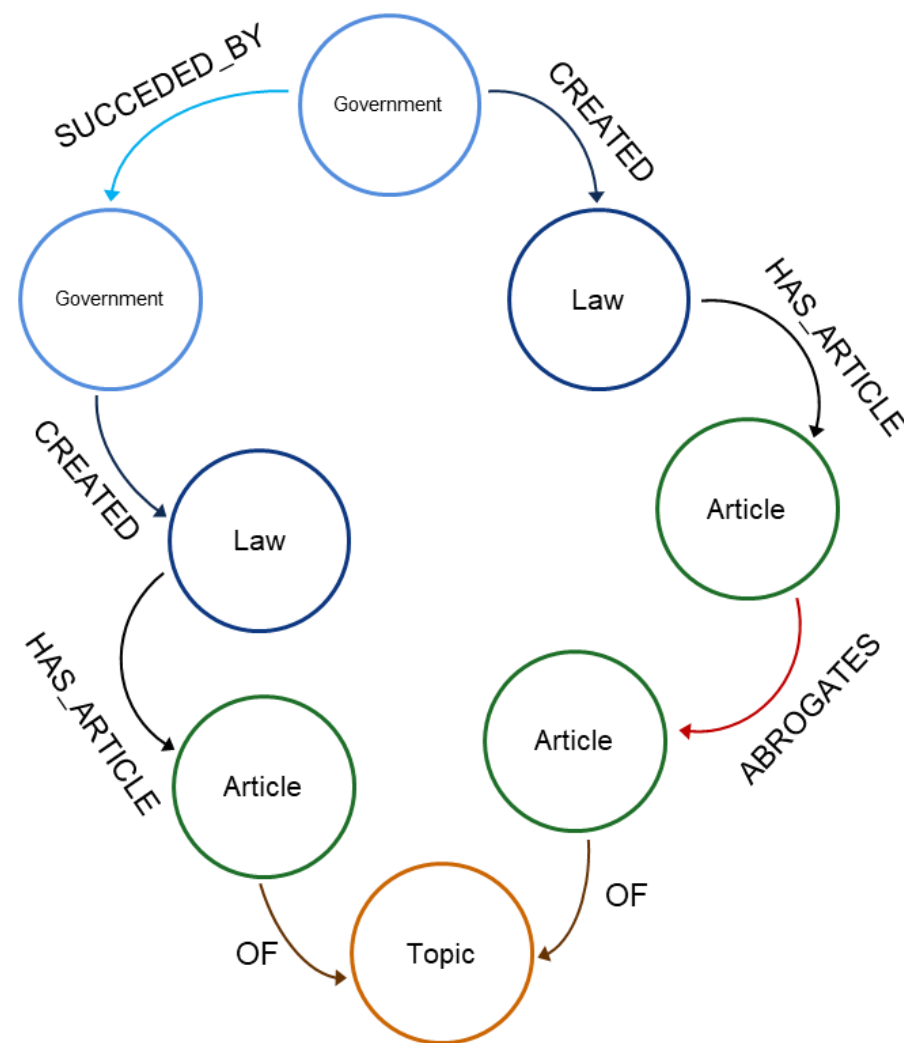
Community Detection and Analysis



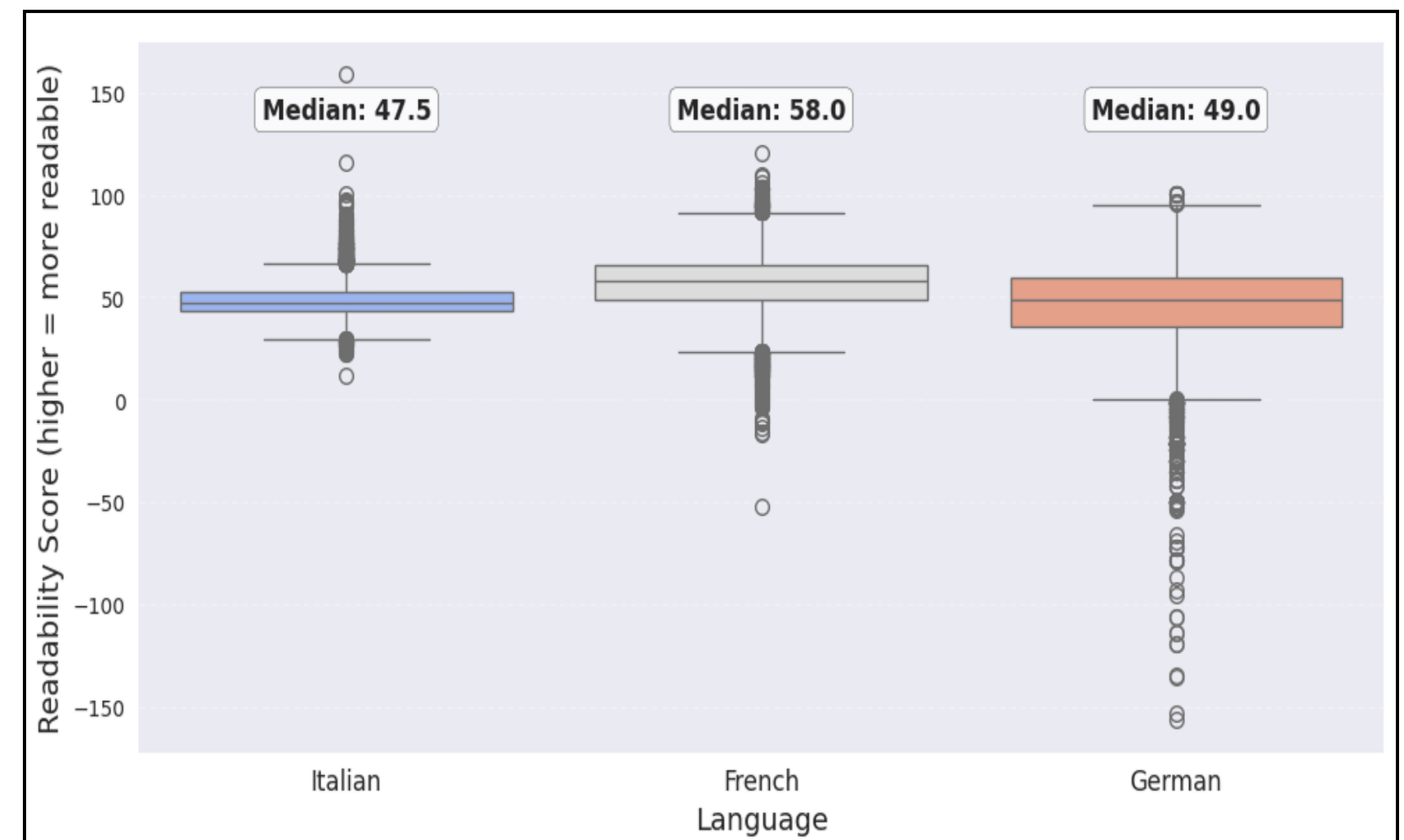
Graph-based Knowledge Management

By having a baseline unifying model, you can compare legislative systems, running the same queries, testing assumptions on different systems

«Are procurement regulations more stable in Italy or in Switzerland?»



Is there any difference in law readability?



Conclusions

We created a property graph of the Swiss Legislation following a simple but effective schema, empowering data science approaches

We enriched information through Transfer Learning to enhance the information of the resulting database.

We showed how the model allows to answer queries and derive insights on the Swiss Legislation.



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DATA SCIENCE LAB

Contacts

andrea1.colombo@polimi.it

