



C.I.R.S.F.I.D
Alma Mater Studiorum Università di Bologna
Research Centre of History of Law,
Philosophy and Sociology of Law,
Computer Science and Law

Hybrid AI for Legal Domain

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CIRSFID, University of Bologna
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KW4Law2023, Sherbrooke
FOIS2023, Canada

LegalRuleML



HYPERMODELEX



European Research Council
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Outline

- Legal Knowledge modelling framework
- Hybrid AI in Legal Domain
- Legal Ontologies: some lessons learnt
- Methodology: from the legal text to legal rules passing through legal ontology
- Example: Derogations in Legislation
- Example: Privacy Regulation and Privacy Policy
- Example: Decisions/Requests in Legal domain
- Take away

ChatGPT is now writing legislation. Is this the future?



Analysis by [Cristiano Lima](#)
with research by [Aaron Schaffer](#)


January 23, 2023 at 8:55 a.m. EST

But in what may be a first, a Massachusetts state senator has used a [surging new tool](#) to help write a bill aimed at restricting it: ChatGPT, the artificial intelligence chatbot.

Artificial Intelligence (AI) in parliaments – preliminary analysis of the Eduskunta experiment

Fotios Fitsilis 

Pages 621-633 | Published online: 10 Sep 2021

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 <https://doi.org/10.1080/13572334.2021.1976947>



GPT Takes the Bar Exam

December 29, 2022

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2 Bucerius Law School (Hamburg, Germany)

3 CodeX - The Stanford Center for Legal Informatics (Stanford, CA USA)

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Abstract

Nearly all jurisdictions in the United States require a professional license exam, commonly referred to as “the Bar Exam,” as a precondition for law practice. To even sit for the exam, most jurisdictions require that an applicant completes at least seven years of post-secondary education, including three years at an accredited law school. In addition, most test-takers also undergo weeks to months of further, exam-specific preparation. Despite this significant investment of time and capital, approximately one in five test-takers still score under the rate required to pass the exam on their first try. In the face of a complex task that requires such depth of knowledge, what, then, should we expect of the state of the art in “AI”? In this research, we document our experimental evaluation of the performance of OpenAI’s TEXT-DAVINCI-003 model, often-referred to as GPT-3.5, on the multistate multiple choice (MCB) section of the exam. While we find no benefit in fine-tuning over GPT-3.5’s zero-shot performance at the scale of our training data, we do find that hyperparameter optimization and prompt engineering positively impacted GPT-3.5’s zero-shot performance. For best prompt and parameters, GPT-3.5 achieves a headline correct rate of 50.3% on a complete NCBE MBE practice exam, significantly in excess of the 25% baseline guessing rate, and performs at a passing rate for both Evidence and Torts. GPT-3.5’s ranking of responses is also highly-correlated with correctness; its top two and top three choices are correct 71% and 88% of the time, respectively, indicating very strong non-entailment performance. While our ability to interpret these results is limited by nascent scientific understanding of LLMs and the proprietary nature of GPT, we believe that these results strongly suggest that an LLM will pass the MBE component of the Bar Exam in the near future.

	GPT	GPT Top 2	GPT Top 3	NCBE
Evidence	63%	84%	98%	65%
Torts	62%	72%	93%	71%
Civil Procedure	52%	63%	79%	59%
Constitutional Law	49%	67%	87%	72%
Real Property	45%	72%	83%	65%
Contracts	45%	77%	86%	70%
Criminal Law & Procedure	35%	62%	86%	71%

Table 2. Summary of performance by question category for GPT-3.5 and NCBE-Reported Students

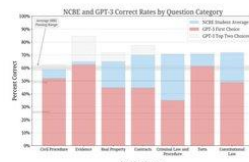


Fig 1. Summary of performance by question category for GPT-3.5 and NCBE-Reported Students

NCBE vs. GPT Performance on the MBE

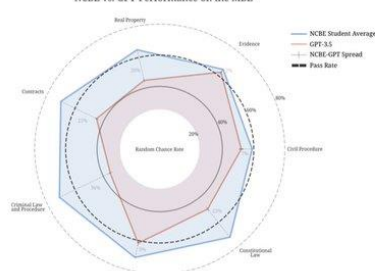


Fig 2. Accuracy by Question Category for GPT and Average Test-Takers

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Volume 48, April 2023, 105772





Comment

Representing legislative Rules as Code: Reducing the problems of ‘scaling up’

[Andrew Mowbray](#) ^a , [Philip Chung](#) ^b , [Graham Greenleaf](#) ^c  

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Hallucination AI

Lawyer apologizes for fake court citations from ChatGPT

By [Ramishah Maruf](#), CNN

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US judge orders lawyers to sign AI pledge, warning 'they make stuff up'

By [Jacqueline Thomsen](#) ✓

May 31, 2023 8:56 PM GMT+2 · Updated 10 hours ago

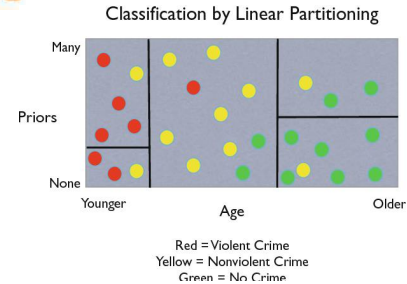
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EU Commission issues internal guidelines on ChatGPT, generative AI

By [Luca Bertuzzi](#) | [EURACTIV.com](#) © Est. 4min

📅 31 mag 2023

eLegal evolution

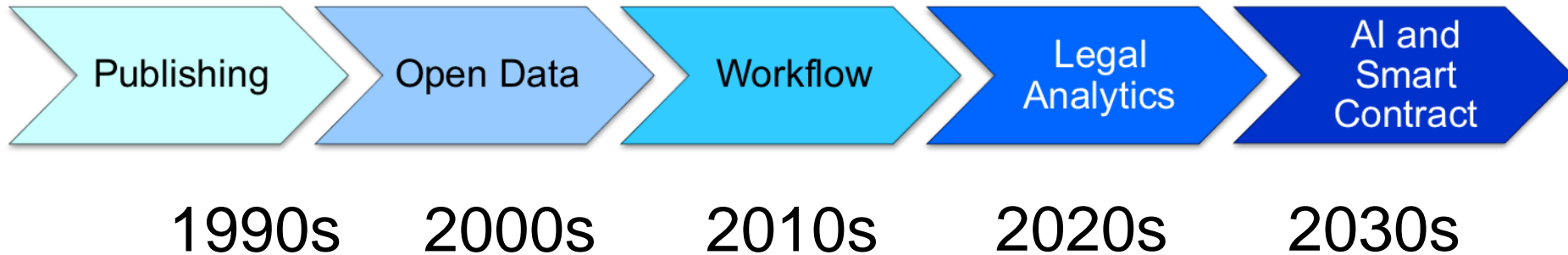


```
pragma solidity ^0.4.17;

contract SimpleStorage {
    uint storedData;

    function set(uint x) public {
        storedData = x;
    }

    function get() public view returns (uint) {
        return storedData;
    }
}
```



AI and Law

Logic programming – Symbolic AI

Semantic Web and Knowledge representation

ML, Classification, clustering, NLP, predict

Legal data analytics

Blockchain & Smart Contract

Legal Knowledge Modelling

Legal Semantic Web ecosystem



International

European

rules

LegalRuleML - OASIS

ontologies

PROV-O

OCD/OSR

UNDO

LKIF

Linguistic source

EUROVOC

WORDNET

metadati

PREMIS/
METS

ELI

ECLI

LKIF

Legal XML

LegalDocML Akoma Ntoso - OASIS

IRI/URI/URN

URN:LEX

ELI

ECLI

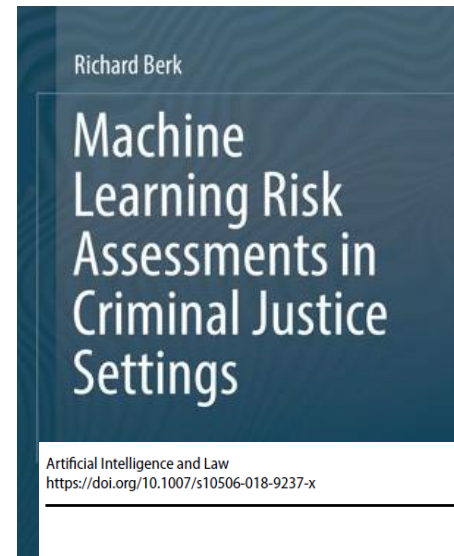
AKN

Different goals of AI in Legal Domain

- 1. Generation** of the legislation/amendment/debates/summary – *ex-ante*
- 2. Modelling**/representing/classifying/extracting the source of the law– *ex-post*
- 3. Prediction** of some output– *pro-futuro*
- 4. Executing**/reasoning rules– *real-time*

Machine learning for Legal Domain

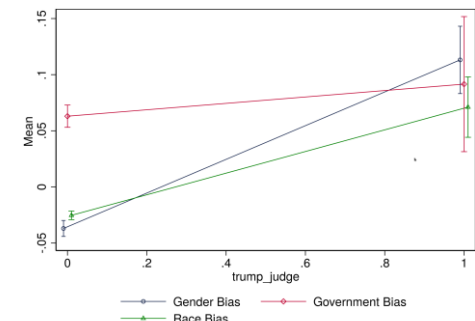
- **Regression** → to correlate phenomena and to predict future trends (e.g., legislative impact)
- **Classification** → text classification (e.g., derogation), classification of the facts/persons (e.g., rights/obligations)
- **Clustering** → to group documents (e.g., convergent definitions)
- **Association** → sociological analysis using the social media (e.g., social needs)
- **Control** → optimization of the order of the day in Parliament



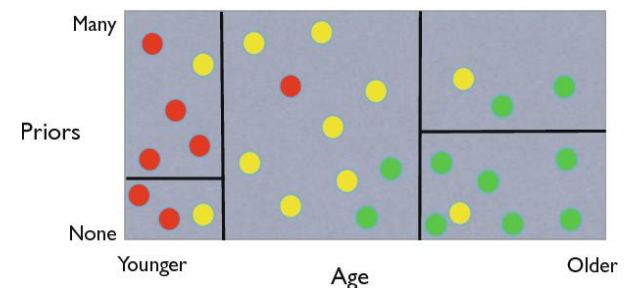
Judicial analytics and the great transformation of American Law

Daniel L. Chen¹

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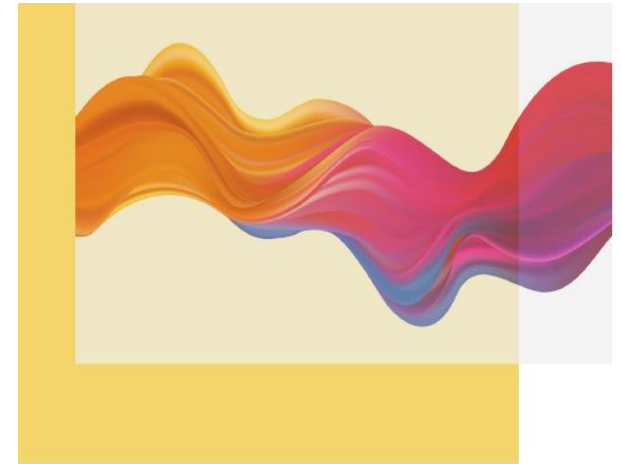
Classification by Linear Partitioning



Red = Violent Crime
Yellow = Nonviolent Crime
Green = No Crime

AI in legislation

- Support the **drafting/translation/planning/definitions**
 - classification, reinforcement learning
- Support of the **decision /checking compliance/ implementation of the Directive/ implementing regulation/ delegation acts**
 - similarity, association, legal reasoning, neural network
- Legal system **analytics/**
 - Clustering, regression
- Predict **predict/anticipate** of the needs from the society
 - Pro-futuro



Legal Drafting in the Era of
Artificial Intelligence and
Digitisation



Directorate-General for
Informatics
Solutions for
Legislation, Policy &
HR

Weakness of ML in legal domain

- **Granularity** vs. **Structure**: ML works at **sentence level** and this approach is not capable to link different **parts of the speech semantically connected** (e.g., obligation-exception, duty-penalty)
- **Content** vs. **Context**: ML loses the **context** (e.g., jurisdiction, temporal parameters)
- **Past** vs. **Future**: ML depends to the **past data series** (e.g., new brilliant solution has no historical series)
- **Internal** vs. **External** info: ML does not consider the **normative and juridical citations**.
- **Static** vs. **Dynamic**: The normative references evolve over time (e.g., “art. 3” is not the same forever)

Critical issues in legal domain

- **Temporal view**

New events respect the past:

- Definition of “European Citizenship” → Brexit
- Trends of travels → COVID-19

- **Institution view**

Political decisions:

- End of life → each country defines different solutions

- **Values view**

- Algorithms (e.g., ChatGPT), dataset, data training need to be customized to each legal system context and not to be used *as-is*
- ***Transparency, Neutrality, Impartiality, Explicability***

Transparency: Black box risk in Legal Norms Modelling

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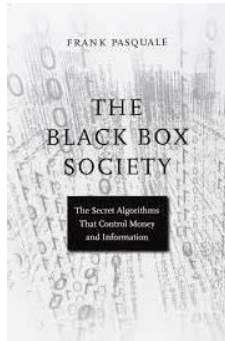
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8.3 You have the right to object at any time (i) to the processing of your personal data for the purpose of direct marketing, or (ii) to the processing of your personal data for other purposes on grounds relating to your particular situation (your right to object to processing). Please note that in the latter case, this right only applies if the processing of your personal data is based on our legitimate interest.

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Lawyer-readable

Human-readable



Legal norms modelling without explicability

“White box” approach in AI

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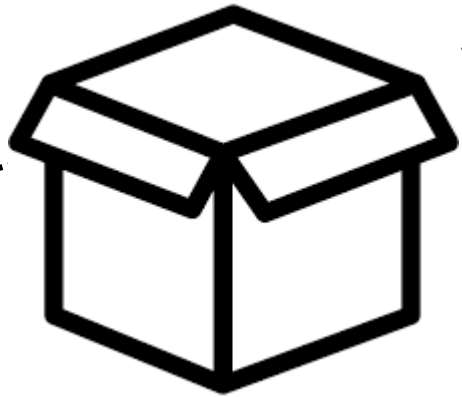


AKOMA NTOSO

Architecture for Knowledge-Oriented Management of African Normative Texts using Open Standards and Ontologies

OASIS LegalXML

LegalRuleML



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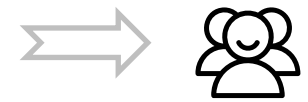
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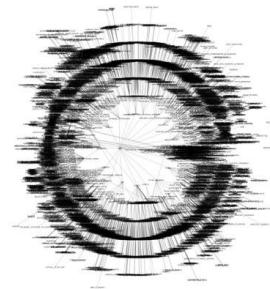
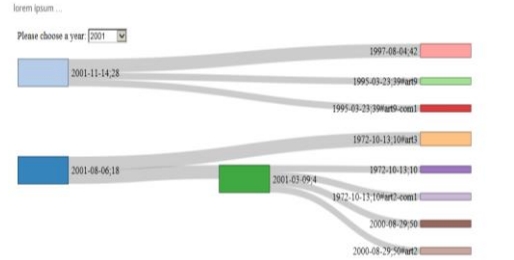
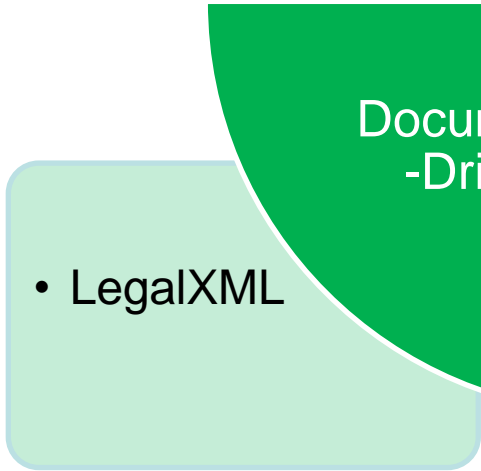
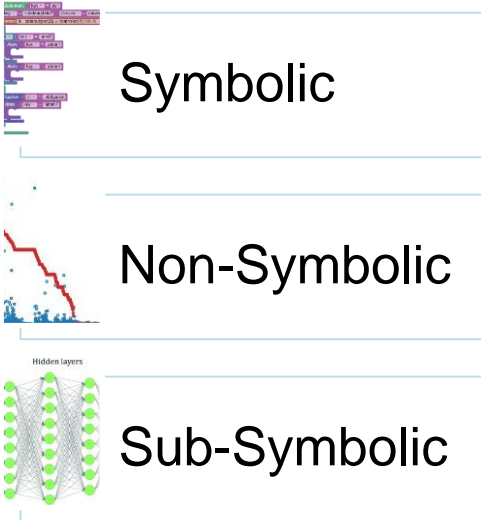
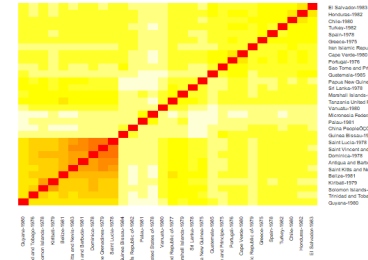
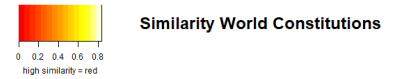
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Machine-readable

Human-readable

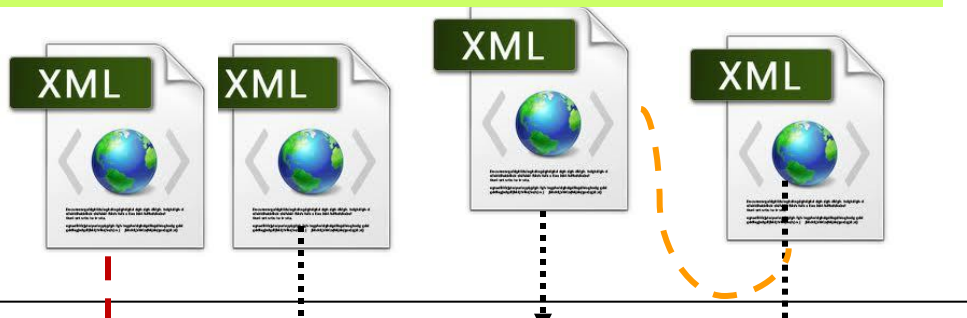


Hybrid AI for Legal Domain

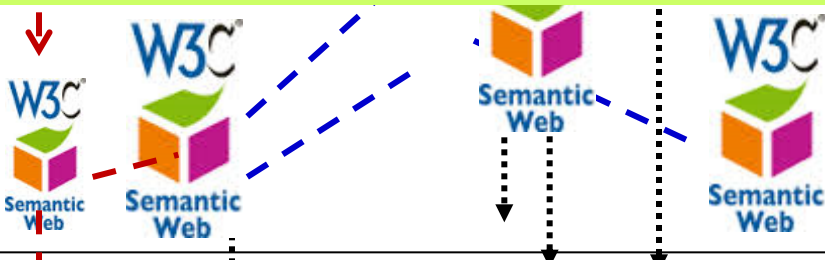


Legal Knowledge Modelling

Legal document in XML - context



Legal Ontology – semantic level



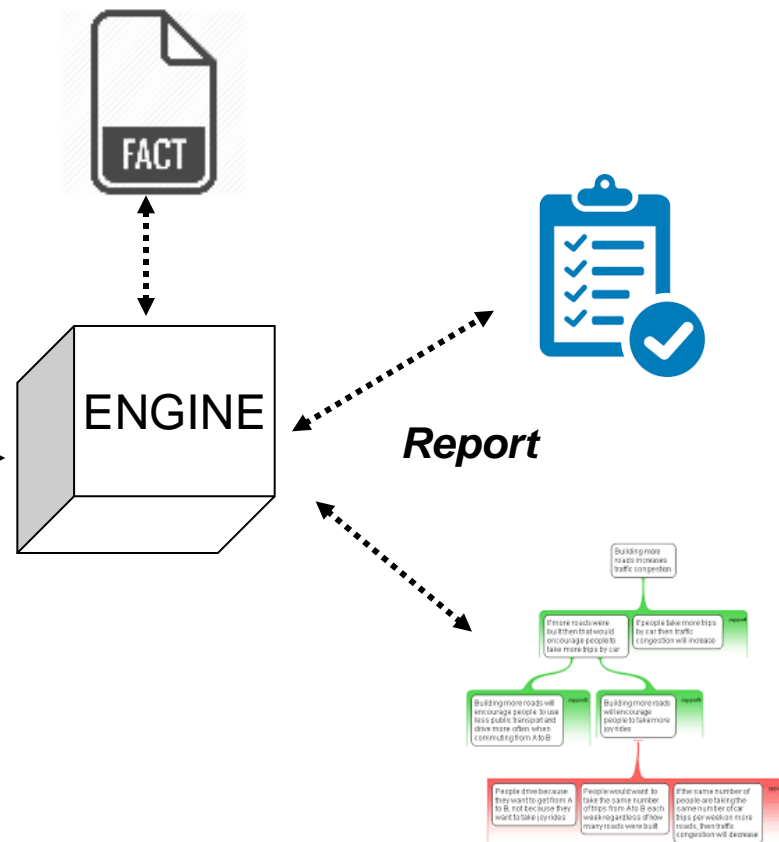
Logic Rules – deontic level



Argumentation/Justification

Services

- GOAL definition



Different levels of legal ontologies

- Legal core ontologies – Legal person
- Legal document ontologies – Consolidation, definitions, modifications
- Legal process ontologies – Parliament law-making process
- Legal domain ontologies – IPR, Privacy, eCommerce, eTender, eJustice, etc.
- Legal rules ontologies – Legal reasoning
- Legal Linguistic ontologies - Eurovoc



Legal ontologies over time: A systematic mapping study

Cleyton Mário de Oliveira Rodrigues^{a,b,*}, Frederico Luiz Gonçalves de Freitas^b,
Emanoel Francisco Spósito Barreiros^a, Ryan Ribeiro de Azevedo^c,
Adauto Trigueiro de Almeida Filho^a

^aUniversity of Pernambuco, Garanhuns-PE, ZIP 55294-902, Brazil

^bFederal University of Pernambuco, Center of Informatics (CIn/UFPE) P.O. Box 7851, Recife-PE, Brazil

^cFederal Rural University of Pernambuco, (UAG) ZIP 55292-270, Garanhuns-PE, Brazil



4315 papers

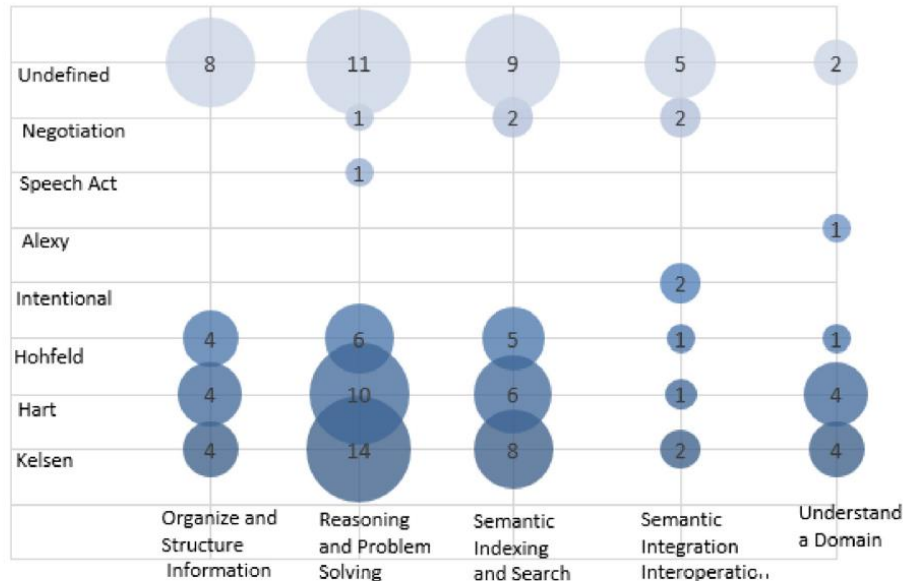


Fig. 4. Legal theories by purpose of ontology.

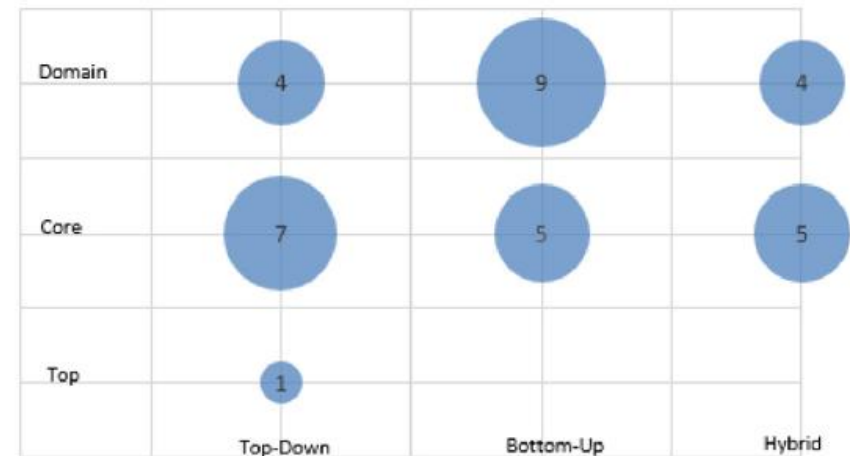
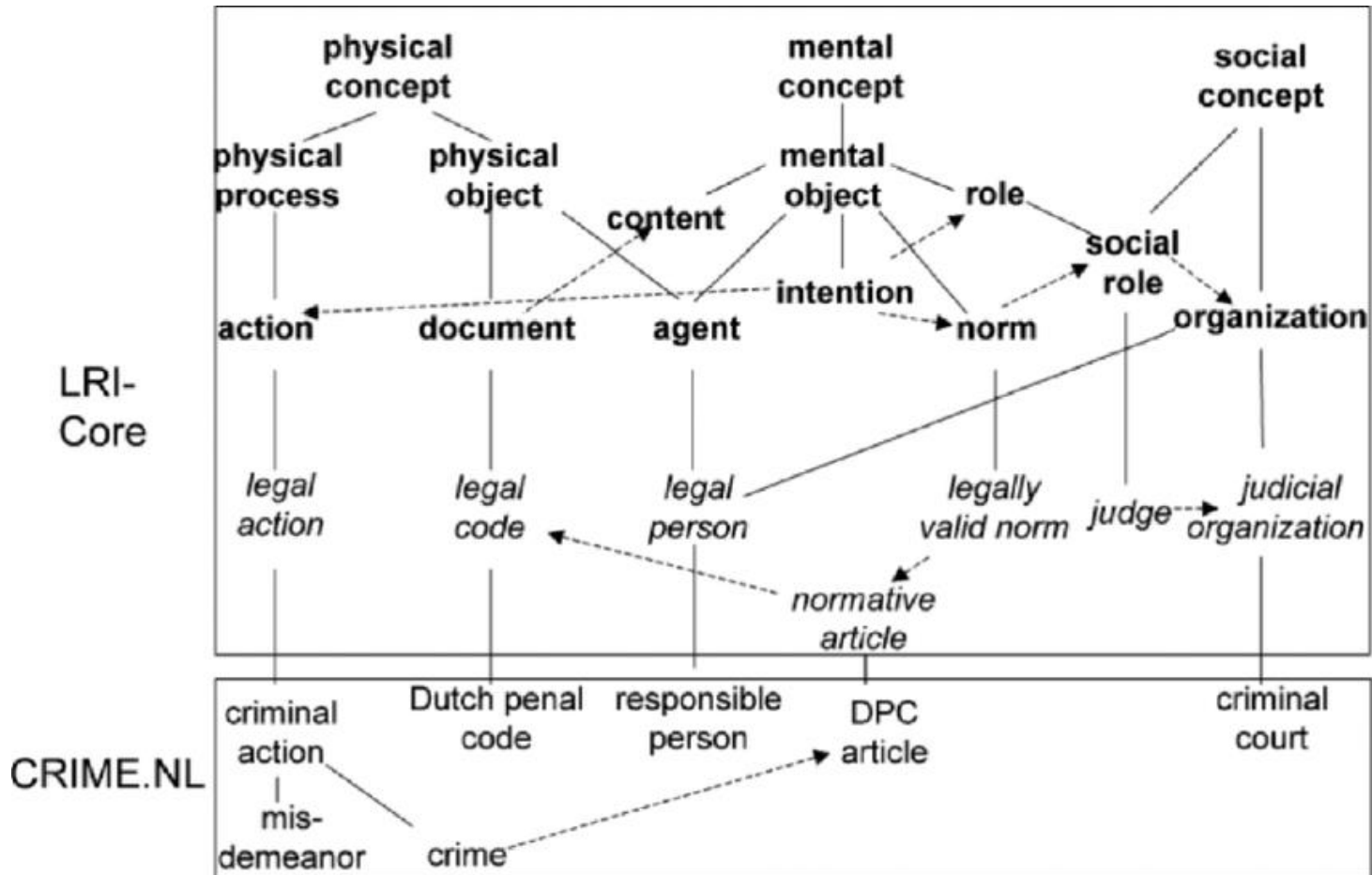


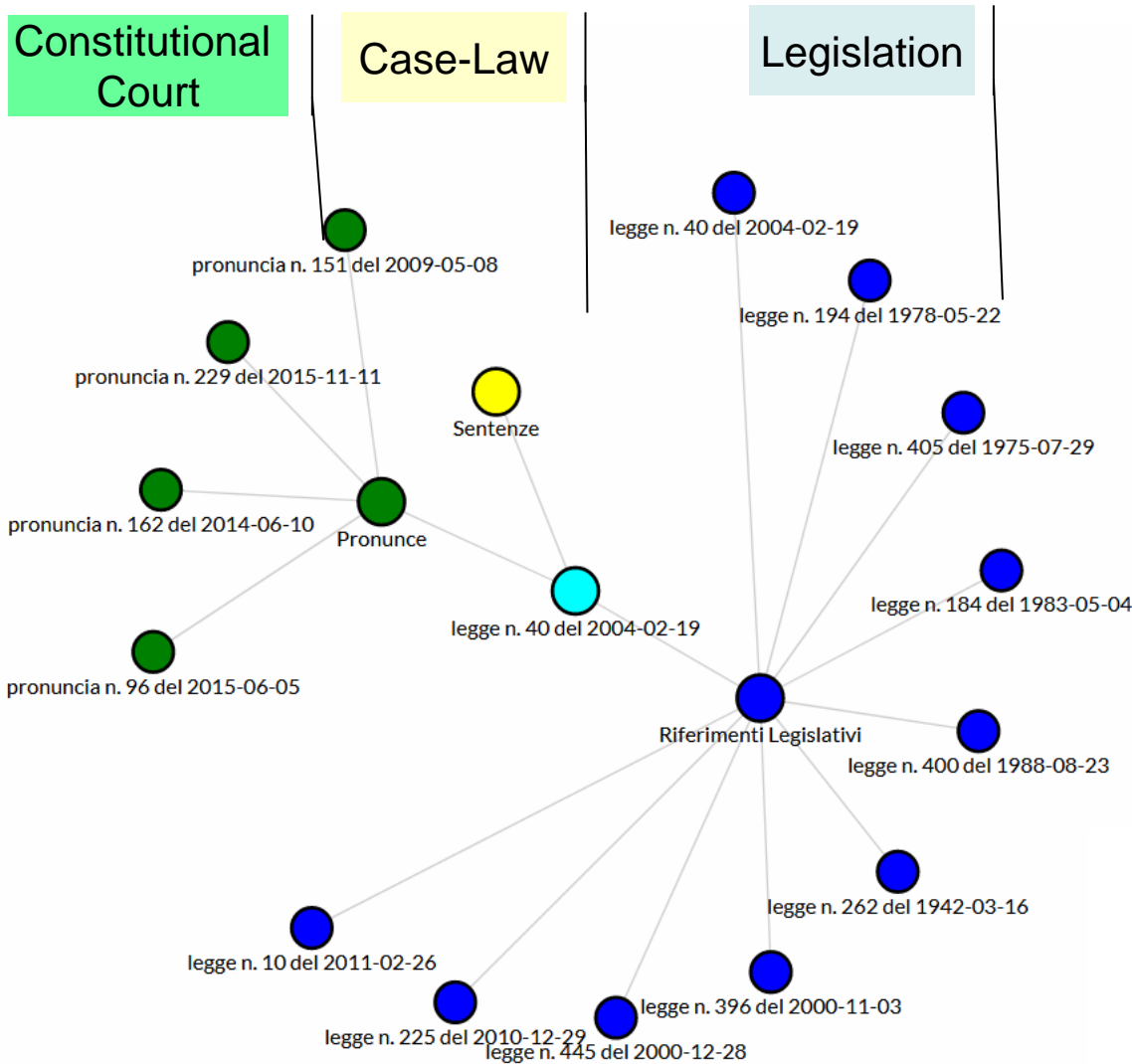
Fig. 8. Generalization level by engineering approaches.

Legal core ontology

Ikifocore

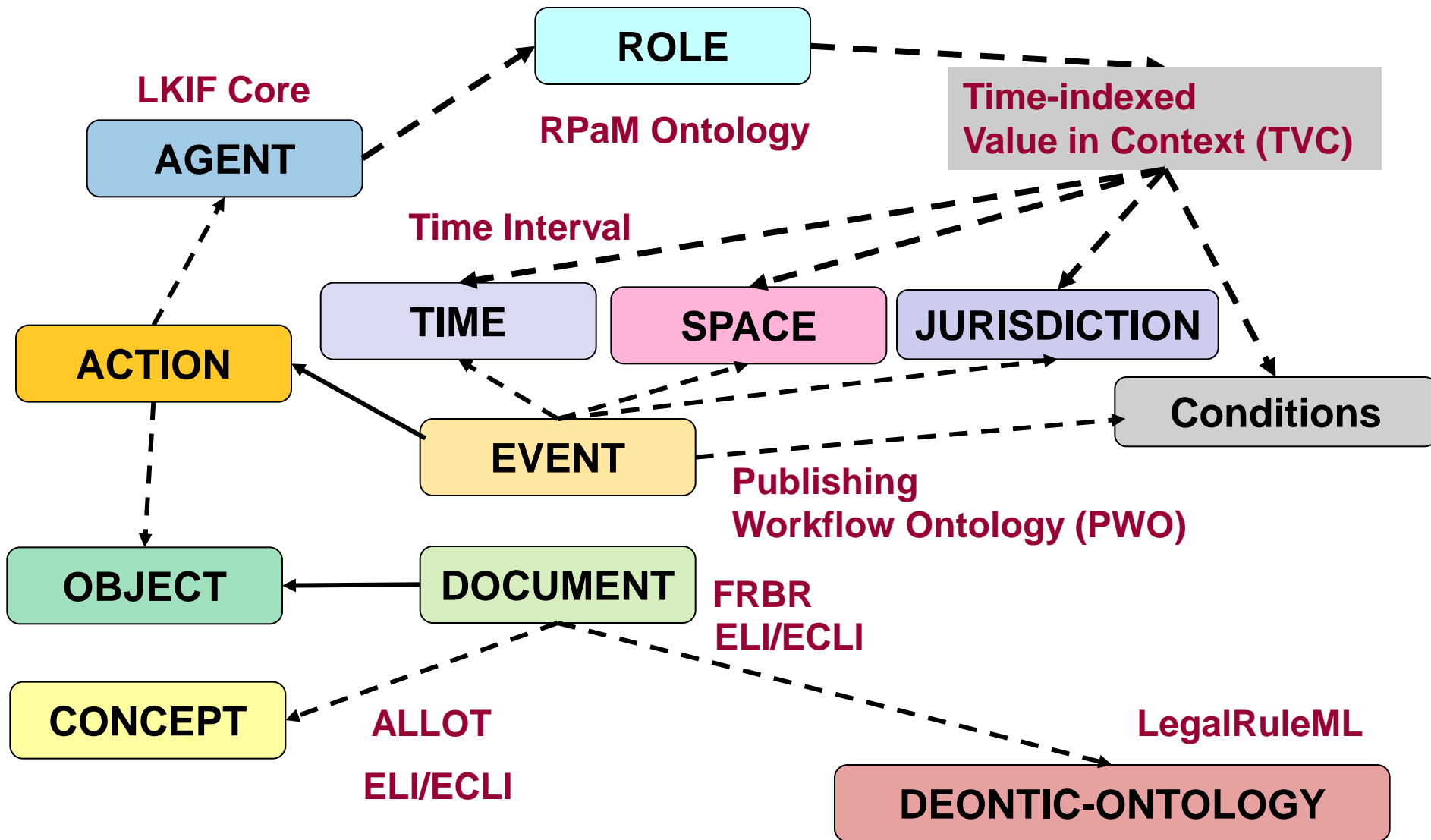


Integration of multiple legal sources

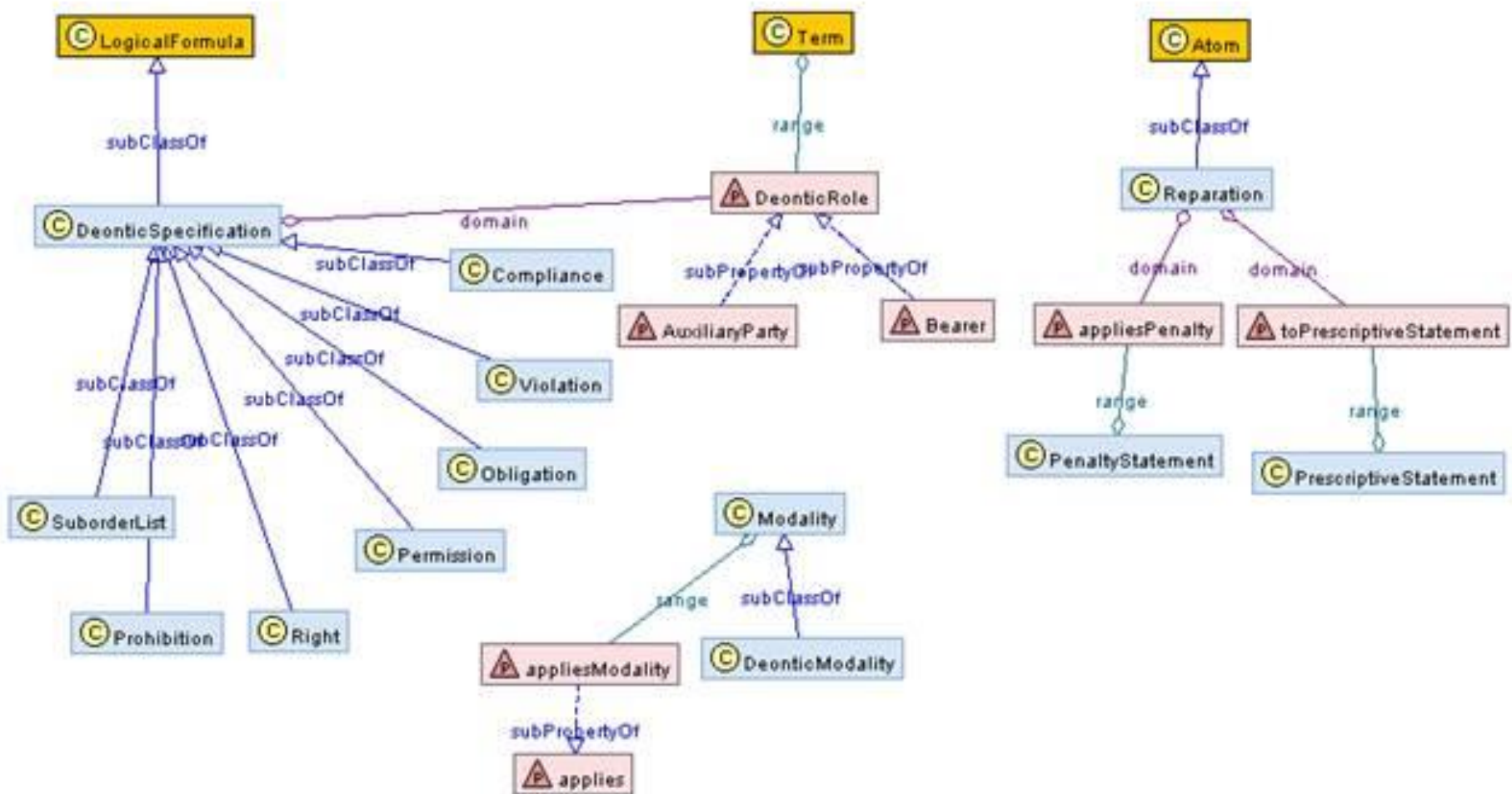


EUROPEAN COURT OF HUMAN RIGHTS
COUR EUROPÉENNE DES DROITS DE L'HOMME

Ontology Design Patterns for Legal Domain



LegalRuleML: Legal deontic ontology



METHODOLOGY

MelOn methodology

Dolce
Iki**core**

FRBR



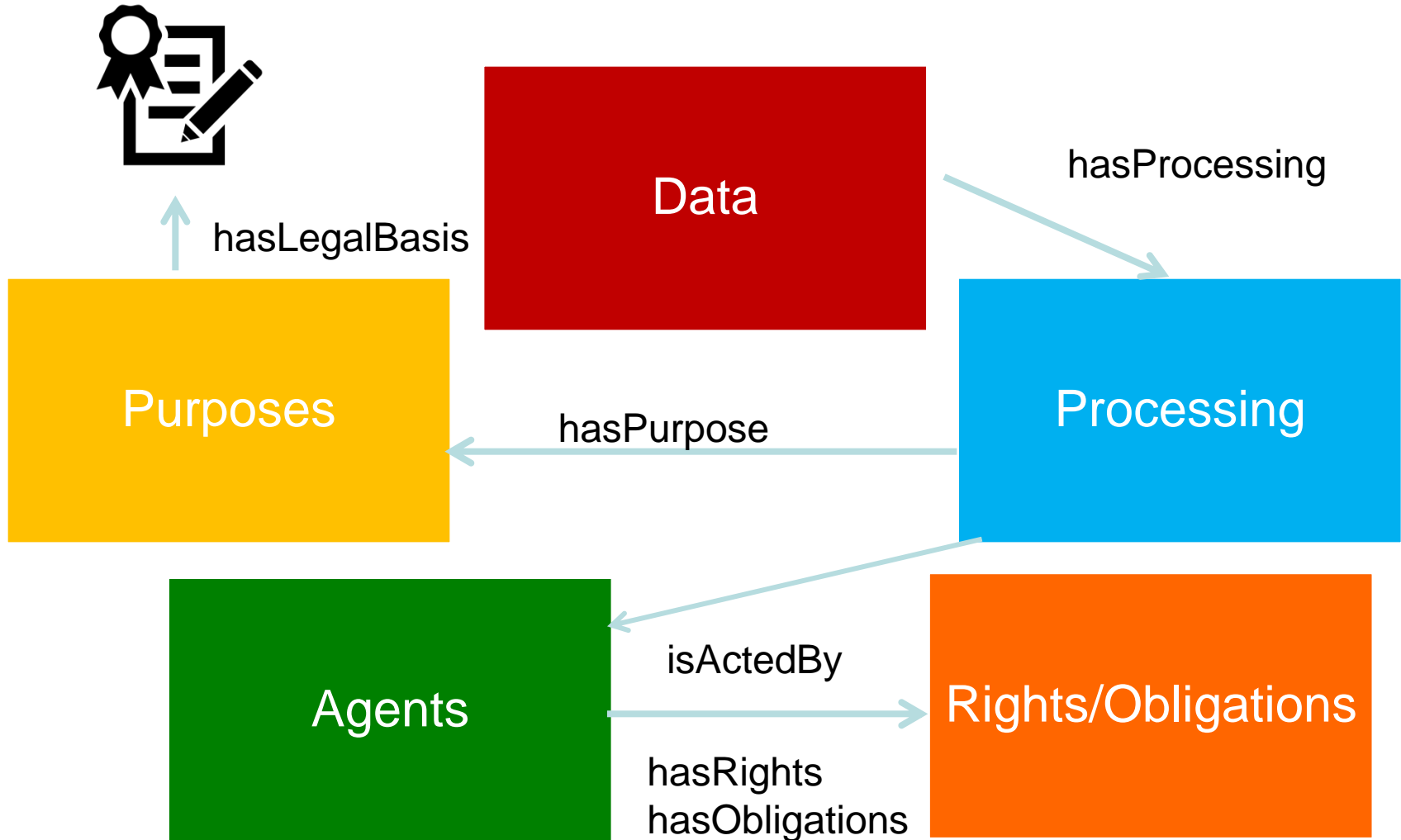
1. Describe the goal of the ontology (storytelling)
2. Evaluation indicators and parameters/indicators to evaluate the ontology
3. State of the art survey and other existing domain vocabularies
4. List all the relevant terminology and produce a glossary
5. Use tables to model the knowledge-base of the legal domain (excel)
6. Contingency questions
7. Transform the tables in UML model using the Graffo tool
8. Transform the UML into OWL/XML serialization
9. Test the output under the technical and legal point of view (SPARQL queris on individuals)
10. Refine and optimize OWL by ontologist experts
11. Evaluate the ontology using the OntoClean method and goto 2)
12. Publish the document with the LODDE tool and github
13. Collect feedbacks from the community (Validation)

Methodology of Hybrid AI

- 1. start to the context (terms/taxonomy) with legal experts (e.g., MeLOn)
- 2. use NLP for discovering relevant portions of the text (regEx/POS/NER/NLP/AI)
- 3. identify the main relationships between concepts (ontology/ML/DL)
- 4. detection of the fine-fragments in the text (ML/LLM)
- 5. modelling rules in logic (symbolic/deontic)
- 6. represent in LegalRuleML
- 7. check the consistency (legal reasoner)
- 8. training again the AI model
- 9 testing, evaluating, validating

PRIVACY REGULATION AND PRIVACY POLICY

PrOnto ontology of GDPR



Right to data portability: legal analysis

generates
-- -- -->

Right of the data subject

Ob1: Obligation to provide data to data subject in machine-readable manner

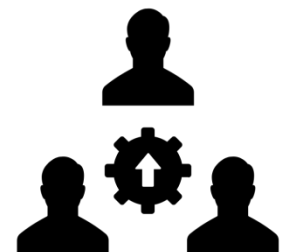
Data subject



Controller



Other Controller



Ob2: Obligation to transmit data to data subject to other controller

generates



Text: Art. 20 GDPR

Right of portability of data

“1. The data subject shall have the **right to receive the personal data concerning him or her, which he or she has provided to a controller, in a structured, commonly used and machine-readable format** and have **the right to transmit those data to another controller without hindrance from the controller to which the personal data have been provided**, where: R1

- (a) the processing is based on consent pursuant to point (a) of Article 6(1) or point (a) of Article 9(2) or on a contract pursuant to point (b) of Article 6(1); and R2
- (b) the processing is carried out by automated means.”

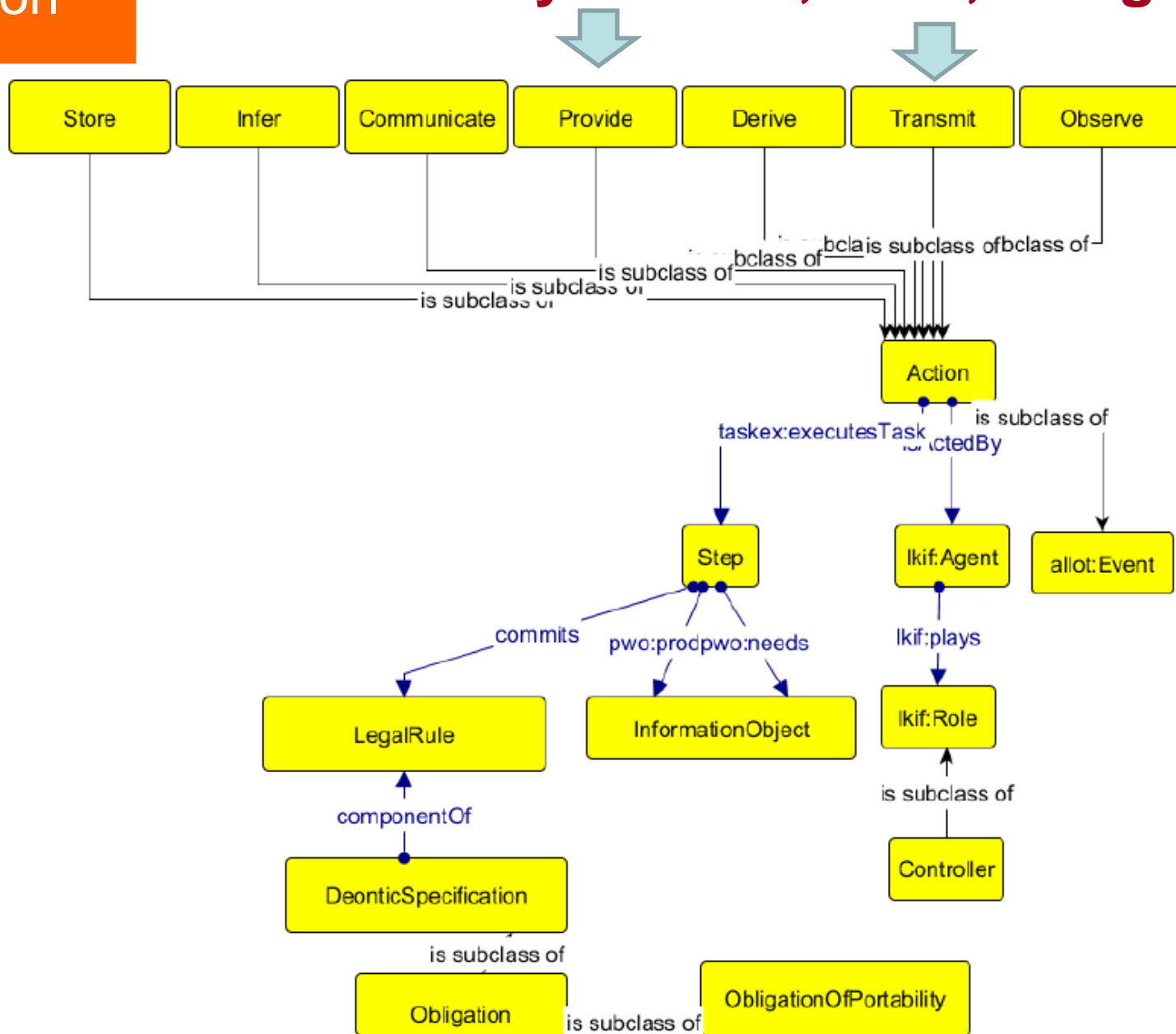
Text : Art. 20 GDPR

Right of portability of data

- “ 2. In exercising his or her right to data portability pursuant to paragraph 1, the data subject shall have the right to have the personal data transmitted directly from one controller to another, where technically feasible. **Specification of R2**
- 3. The exercise of the right referred to in paragraph 1 of this Article shall be without prejudice to Article 17. That right shall not apply to processing necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the controller. **Exception- R1 and R2**
- 4. The right referred to in paragraph 1 shall not adversely affect the rights and freedoms of others.” **Specification of R1 and R2**

Rights/
Obligation

Concepts: The Right to Data Portability: Action, Rule, Obligation



Detection of fragments: Art. 20 GDPR

Right of portability of data

“1. The **data subject** shall have the **right to receive the personal data** concerning him or her, which he or she has provided to **a controller**, in a structured, commonly used and **machine-readable format** and have **the right to transmit those data to another controller without hindrance from the controller to which the personal data have been provided**, where: R1

- (a) the processing is based on **consent** pursuant to point (a) of Article 6(1) or point (a) of Article 9(2) or on a **contract** pursuant to point (b) of Article 6(1); and R2
- (b) the processing is carried out by **automated means**.”

Modelling Rules: Art. 20 GDPR

Right of portability of data

Legal Text

«The data subject shall have the **right to receive the personal data concerning him or her, which he or she has provided to a controller, in a structured, commonly used and machine-readable format** »

Logic rule

IF

$\text{datasubject}(X) \wedge \text{personalData}(D) \wedge \text{controller}(Y) \wedge \text{legalBasis}(\text{consent or contract}) \wedge \text{automatedProcess}(D)$

THEN

$\text{obligation_to_provide_in_mrf}(Y, D, X)$

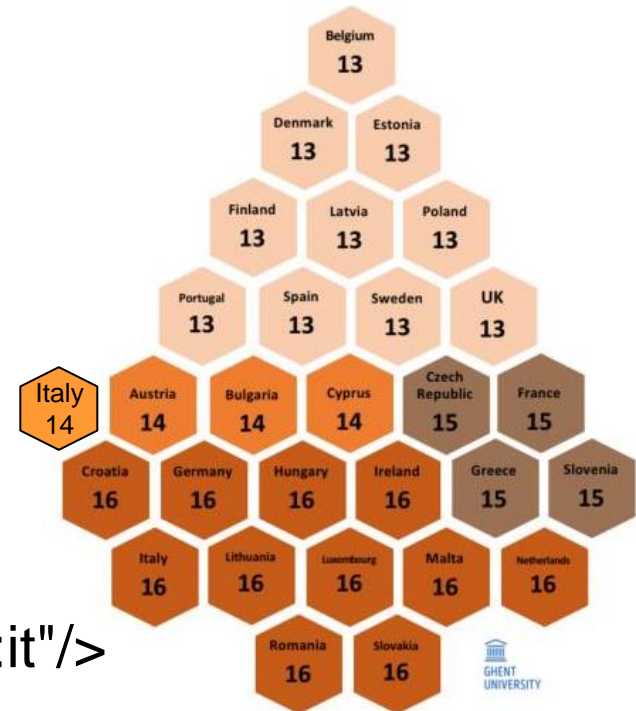
Exceptions

Art. 8 GDPR admits being trumped by domestic regulation
«Member States may provide by law for a lower age for those purposes provided that such lower age is not below 13 years.»
At present in Europe different age limitations are in place (e.g, age 13 in Spain; 14 in Italy; 11 15 in France). LegalRuleML makes it possible to use defeasible operators

`<lrml:appliesStrength iri="lrmlv:Defeasible"/>`

And defying jurisdiction

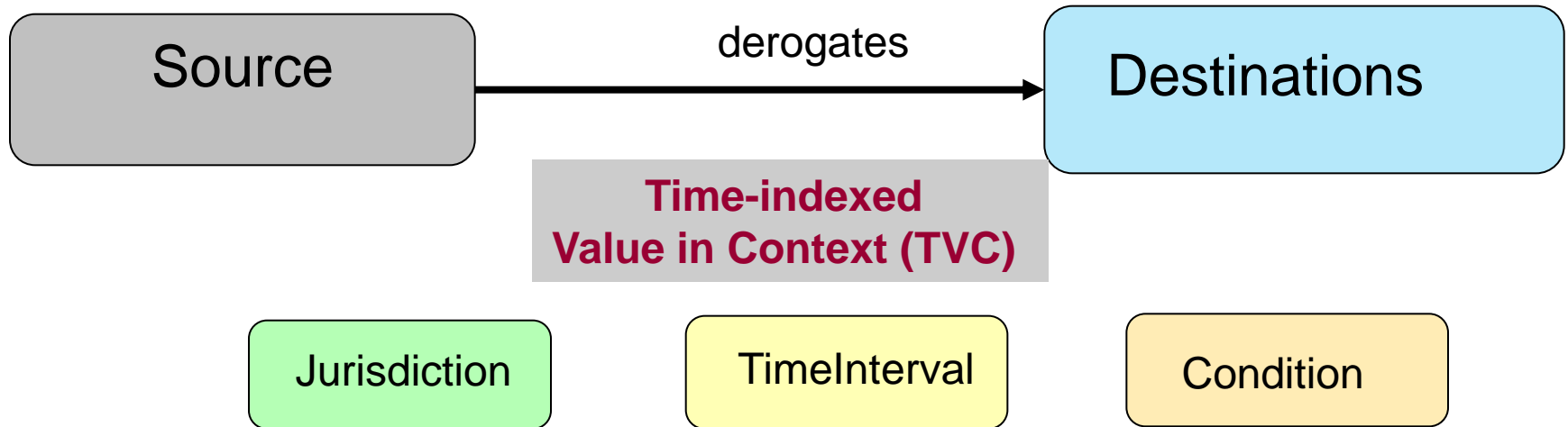
`<lrml:appliesJurisdiction keyref="jurisdictions:it"/>`



DEROGATION

Anatomy of a derogation

$R1_{t_1}$ derogated to $R2_{t_2}$



By way of derogation from paragraphs 1 and 2, in Cyprus, Croatia, Malta and Slovenia, the amount referred to in those paragraphs may be set at a value lower than EUR 500, but not less than EUR 200 or, in the case of Malta, not less than EUR 50.

Dataset

- The dataset is composed by legislative act in the span of time 2010-2020 for a total of 15.328 documents.
- Regulation, Directive, Implementation instruments
- The documents are converted in Akoma Ntoso in order to have the structure of the document and the context annotated
- We have extracted 13.587 partitions involved in the derogation using a preliminary taxonomy of “RegEx”
- Then using Tree Kernel/ supervised ML

Akoma Ntoso: detection of knowledge

```
<alinea eld="body__art_2__al_3">
  <content eld="body__art_2__al_3__content">
    <mod eld="body__art_2__al_3__content__mod_1">
      <p>By way of derogation from the second paragraph,
Member States may choose not to apply the provisions of point
ORO.FTL.205(e) of
      <ref eld="ref_1"
href="/akn/eu/act/regulation/2012-02-17/965-
2012/!main/>annex_III">Annex III to Regulation (EU) No 965/2012 </ref>
and continue to apply the existing national provisions concerning in-flight
rest until
      <date date="2017-02-17" refersTo="#derogationTime">17 February
2017</date>.</p>
    </mod>
  </content>
</alinea>
```


Legal Knowledge extraction and Akoma Ntoso serialization

```
<scopeMod type="exceptionOfScope">
  <source href="body__art_2__al_3__content__mod_1"/>
  <destination
    href="/akn/eu/act/regulation/2012-02-17/965-
2012/!main/annex_III"/>
  <force>
    <date date="2014-02-20"/>
  </force>
  <duration>
    <date date="2017-02-17" refersTo="#endDate"/>
  </duration>
  <condition/>
  <domain/>
</scopeMod>
```

<https://cirsfid.gitlab.io/derograph/>

Analysis of the Derogations in EU Legislation using Network Analysis

This is a visualization map for AKN derogations of the EU legislation from 2010 to 2020

Eurovocs:

Select a Eurovoc

Places

Select a Place

Duration:

22/03/2015

01/04/2022

Conditions:

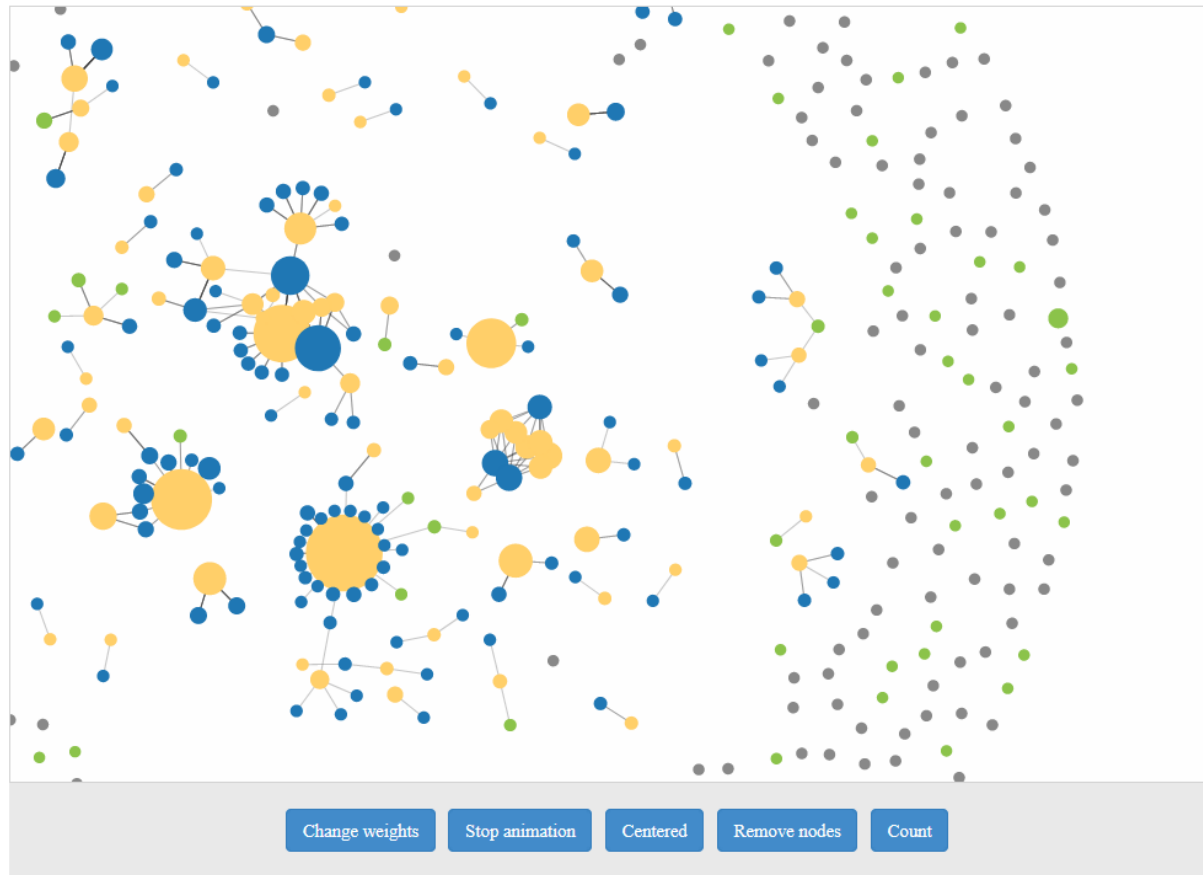
Select a Condition

Domains:

Select a Domain

Match all filters (narrow results)

Update



$$w = k * (\#ActiveDerogations + \#ReflexiveDerogations + \#PassiveDerogations)$$

DECISIONS

Measuring the Policy



AKOMA NTOSO

Architecture for Knowledge-Oriented Management of African Normative Texts using Open Standards and Ontologies

Testo

Informazioni sul documento

Procedimento

Sintesi del documento

Salvare nei "miei elementi"

Link aggiornato

Link permanente

Scaricare la nota

Segui questo documento

Indice

Nascondi le versioni consolidate

12/08/2022

01/11/2019

Atto giuridico

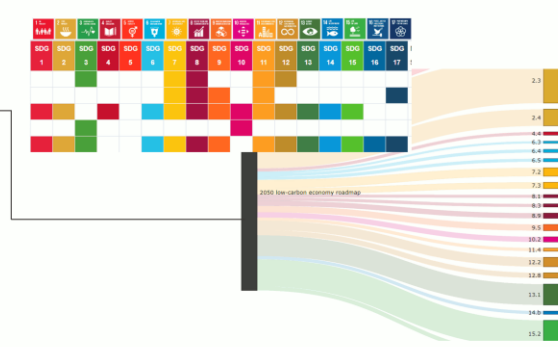
Nazioni e altre misure considerate in conformità con le Direttive 2009/127/CE e 2010/75/CE sono di applicazione ai infringements of Articles 13 and 14 of this Regulation.

CHAPTER IX
REVIEW
Article 29
Reports and review

1. Within 36 months of the date of entry into force of the delegated act adopted by the Commission pursuant to Article 4(9), the Commission shall, after consulting ESMA, submit a report on the effectiveness, efficiency and proportionality of the obligations laid down in this Regulation to the European Parliament and to the Council, together with any appropriate proposals. That report shall include, in particular, an overview of similar reporting obligations laid down in third countries taking into account work at international level. It shall also focus on the reporting of any relevant transactions not included in the scope of this Regulation, taking into account any significant developments in market practices, as well as on the possible impact on the level of transparency of securities financing operations.

For the purposes of the report referred to in the first subparagraph, ESMA shall, within 24 months of the date of entry into force of the delegated act adopted by the Commission pursuant to Article 4(9), and every three years thereafter, or more frequently where significant developments in market practices arise, submit a report to the European Parliament, to the Council and to the Commission on the efficiency of the reporting, taking into account the appropriateness of single-side reporting, in particular in terms of reporting coverage and quality as well as reduction of reports to trade repositories, and on significant developments in market practices with a focus on transactions having an equivalent objective or effect to an SFTR.

2. Following completion of, and taking into account, work at international level, the report referred to in paragraph 1 shall also identify material risks related to the use of SFIs by credit institutions and listed companies and analyse the appropriateness of providing for additional disclosure by those entities in their periodical reports.



Obbligations

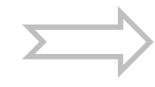
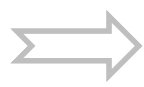
Policy

LegalRuleML

Legal Text

Machine-readable metadata

Integration



Regulation (EU) 2016/1011 on indices used as benchmarks in financial instruments and financial contracts

Art. 54


2. Review the evolution of international principles applicable to benchmarks and of legal frameworks and supervisory practices in third countries concerning the provision of benchmarks and report to the European Parliament and to the Council every five years after 1 January 2018. That report shall assess in particular whether there is a need to amend this Regulation and shall be accompanied by a legislative proposal, if appropriate.




Reports


2023 2028 2033 etc.


Managing the decisions and the policies



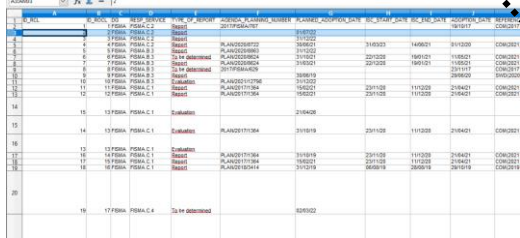
ROD








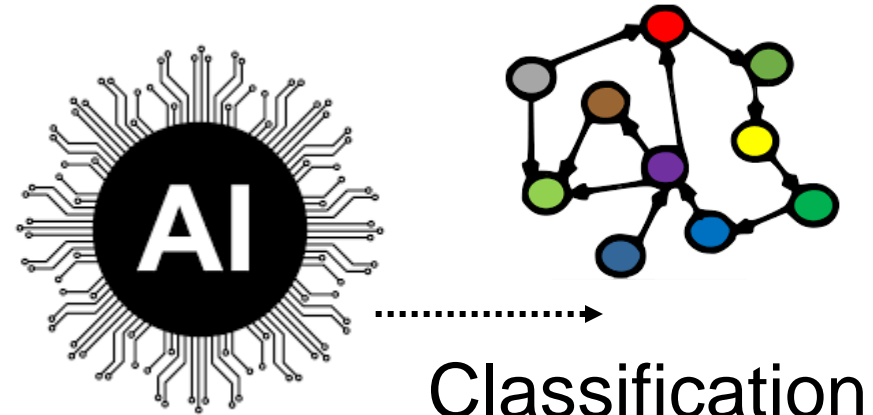
KOEL





AKOMA NTOSO
Architecture for Knowledge-Oriented Management of African Normative Texts using Open Standards and Ontologies

Annotated information



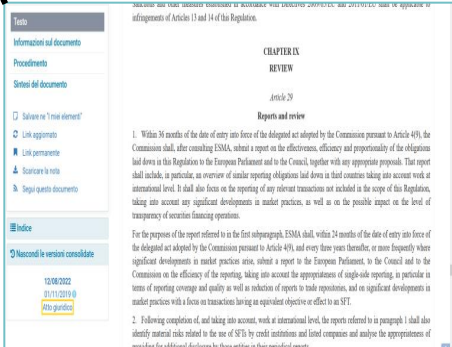
Training

Classification
Extraction



Baseline

New Law



Conclusions

Legal ontology level is good for:

1. Methodology for analysing a legal domain in formal way
2. Discover hidden/implicit legal knowledge that only the experts know
3. Formalize the legal concepts and their relationships
4. Support AI dataset annotation and training
5. Provide “ingredients” for the XAI – explicable AI
6. Support the Legal Rule modelling using stable predicates and constitutive axioms (definitions)



Hybrid AI for Legal Domain

Thanks for your attention

monica.palmirani@unibo.it