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# Reporting Requests Modelling in European Legislation with a Hybrid Al Approach

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# Introduction

### Reporting Requests/Requirements (RR) are normative provisions

- requiring institutions to produce reports, plans, budgets, opinions, or standards
- aimed at other bodies (e.g., Commission, the Parliament, agencies, Member States) with a temporal parameter
- to monitor the quality of legislation

### They change over time (e.g., during the COVID pandemic).

**Monitoring** RR is crucial for the compliance of institutions and their efficiency. RRs represent **meta-rules** addressed to the legislative system.

We focus our attention on the EU Legislation and on the types of RR where the EU institutions are agents.



### Example







3.

## **Example**



Dir. 2014/65 Art. 90 "Before 3 March 2020 the Commission shall [...] present a report to the **European Parliament** and the Council"



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# **Research Questions**

### **Research questions:**

- 1) Is it possible to **perform RR detection** from AKN4EU documents?
- 2) Is it possible to **provide context** to the RR by navigating pointin-time the normative references of AKN4EU documents?
- 3) Is it possible to use the extracted entities in a Knowledge Graph to analyse different kinds of RRs, redundancies and overlapping?
- 4) Is it possible to **use RDF metadata** to detect modifications to the RR and update the Knowledge Graph?



## **Research Motivation and Goals**

**Problem statement:** 60% of the EU legislation contains RR (EU Parliament, 2024). As the volume and complexity of RRs have significantly increased, EU bodies face challenges managing overlapping mandates, especially as legislation evolves through **amendments and derogations.** 

**Research goal**: allowing **complex queries** such as: "Return all the Reporting Requests that the EU Commission shall produce, addressed to the European Parliament and Council (contextually), at biannual frequency, but suspended for COVID during the period 2019-2020 concerning standards about the quality of food"

- → Supporting Better Regulation principles
- $\rightarrow$  Supporting legal drafters in an explainable manner



# Methodology and Tools

#### Steps:

- 1. Legal analysis
- 2. Data Preparation
- 3. Annotation
- 4. Experiments
- 5. Validation
- 6. Modelling
- 7. Output

**European standards** The **Reporting** (AKN4EU, CELLAR, ELI) to **Requirement Metadata** build a time-aware legal model **Vocabulary** (RRMV) to keep into account ontology as to extract modifications and derogations entities and represent European Legislation knowledge RRMV Integration on Data Repository through Hybrid Al Methodology **OL**ìme Microsoft 2 annotators (1 junior, 1 **3 Open-source Transformers** senior) to extract qualified and 4 open-source LLMs to elements in RRs and validate perform replicable findings – output in AKN classification and detection tasks

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## **Dataset + RRMV Ontology**

- **48 EU legislative documents** (1998 to 2021, including consolidated texts until 2023
- 991 paragraphs for binary (RR / not-RR) classification
- **86 paragraphs** for fine-grained (entity) annotations
  - Which gave us 493 legal annotated elements according to the RRMV ontology
- RRMV: under revision by JRC, SEMIC, Publication Office, DG Informatics: https://semiceu.github.io/RRMV/releas es/0.1.1/



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### **RR Classification**

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### **RR Classification: evaluation**

- Binary classification task (RR/not-RR)
- AKN allows the retrieval of legal references within the text
- Supervised
   Transformers
- 3 strategies for LLMs (0-shot, 4-shot, 10shot)
- Best results from
   LEGAL-BERT

Madal	Stuatomy		Other			RR		AVG				
Model	Strategy	Р	R	F1	Р	R	F1	Р	R	F1		
BERT		0.987	0.952	0.969	0.516	0.800	0.627	0.751	<u>0.876</u>	0.798		
LEGAL-BERT	supervised	0.978	<u>0.990</u>	<u>0.984</u>	<u>0.813</u>	0.650	<u>0.722</u>	<u>0.895</u>	0.820	<u>0.853</u>		
ModernBERT		0.984	0.977	0.981	0.682	0.750	0.714	0.833	0.864	0.847		
	zero-shot	0.995	0.626	0.768	0.141	0.950	0.245	0.568	0.788	0.507		
Llama 3.3	4-shot	0.995	0.613	0.758	0.137	0.950	0.239	0.566	0.781	0.499		
	10-shot	0.991	0.713	0.829	0.168	0.900	0.283	0.580	0.806	0.556		
	zero-shot	0.976	0.803	0.881	0.187	0.700	0.295	0.582	0.752	0.588		
Mixtral-8x7B	4-shot	0.971	0.855	0.909	0.211	0.600	0.312	0.591	0.727	0.610		
	10-shot	0.974	<u>0.955</u>	<u>0.964</u>	<u>0.462</u>	0.600	<u>0.522</u>	<u>0.718</u>	0.777	<u>0.743</u>		
	zero-shot	<u>1.000</u>	0.306	0.469	0.085	<u>1.000</u>	0.157	0.543	0.653	0.313		
Gemma 2 27B	4-shot	<u>1.000</u>	0.594	0.745	0.137	<u>1.000</u>	0.241	0.568	0.797	0.493		
	10-shot	0.996	0.777	0.873	0.216	0.950	0.352	0.606	<u>0.864</u>	0.613		
	zero-shot	0.990	0.610	0.754	0.129	0.900	0.226	0.560	0.755	0.490		
Phi-3.5-MoE	4-shot	<u>1.000</u>	0.442	0.613	0.104	<u>1.000</u>	0.188	0.552	0.721	0.400		
	10-shot	0.992	0.761	0.861	0.196	0.900	0.321	0.594	0.831	0.591		







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### **Entity Extraction: evaluation**

- Plain text vs RDF XML (in the prompt)
- Best result from LEGAL-BERT, followed closely by GEMMA 10-shot and Llama3.3 10-shot RDF
- LLMs can classify all classes, ML models cannot
- Excellent performance on Action
- Lower performance on PeriodOfTime

Model	Strategy	Action		Addressee		Addresser			PeriodOfTime			ActionResult			AVG				
wiodei		Р	R	F1															
BERT		0.467	0.500	0.483	0.583	0.667	0.622	0.818	0.692	<u>0.750</u>	0.045	0.062	0.053	0.556	0.625	0.588	0.494	0.509	0.499
LEGAL-BERT	supervised	0.333	0.429	0.375	<u>0.762</u>	<u>0.762</u>	<u>0.762</u>	0.750	<u>0.692</u>	0.720	<u>0.059</u>	<u>0.062</u>	<u>0.061</u>	0.625	0.625	0.625	<u>0.506</u>	<u>0.514</u>	<u>0.509</u>
ModernBERT		<u>0.600</u>	0.429	<u>0.500</u>	0.684	0.619	0.650	0.571	0.308	0.400	0.000	0.000	0.000	0.364	0.500	0.421	0.444	0.371	0.394
Llama 3.3	zero-shot	0.500	0.143	0.222	0.667	0.571	0.615	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.233	0.143	0.168
Llama 3.3	zero-shot rdf	0.500	0.143	0.222	0.706	0.571	0.632	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.241	0.143	0.171
Llama 3.3	4-shot	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.667	0.095	0.167	0.450	0.692	0.545	0.167	0.062	0.091	0.667	0.250	0.364	0.590	0.363	0.400
Llama 3.3	4-shot rdf	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.667	0.095	0.167	0.474	0.692	0.562	0.200	0.062	0.095	<u>1.000</u>	<u>0.500</u>	<u>0.667</u>	0.668	<u>0.413</u>	0.465
Llama 3.3	10-shot	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.667	0.190	0.296	0.550	<u>0.846</u>	<u>0.667</u>	0.200	<u>0.125</u>	0.154	0.000	0.000	0.000	0.483	0.375	0.390
Llama 3.3	10-shot rdf	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.600	0.143	0.231	0.550	<u>0.846</u>	<u>0.667</u>	0.200	<u>0.125</u>	0.154	0.000	0.000	0.000	0.470	0.366	0.377
Mixtral-8x7B	zero-shot	0.571	0.286	0.381	0.471	0.381	0.421	0.333	0.077	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.275	0.149	0.185
Mixtral-8x7B	zero-shot rdf	0.625	0.357	0.455	0.611	0.524	0.564	0.333	0.077	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.314	0.192	0.229
Mixtral-8x7B	4-shot	0.900	0.643	0.750	0.000	0.000	0.000	0.444	0.308	0.364	0.000	0.000	0.000	0.000	0.000	0.000	0.269	0.190	0.223
Mixtral-8x7B	4-shot rdf	<u>1.000</u>	0.500	0.667	0.000	0.000	0.000	0.400	0.308	0.348	0.000	0.000	0.000	0.000	0.000	0.000	0.280	0.162	0.203
Mixtral-8x7B	10-shot	<u>1.000</u>	0.643	0.783	0.000	0.000	0.000	0.556	0.385	0.455	0.143	0.062	0.087	0.000	0.000	0.000	0.340	0.218	0.265
Mixtral-8x7B	10-shot rdf	<u>1.000</u>	0.571	0.727	0.000	0.000	0.000	0.556	0.385	0.455	0.143	0.062	0.087	0.000	0.000	0.000	0.340	0.204	0.254
Gemma 2 27B	zero-shot	<u>1.000</u>	0.214	0.353	0.737	0.667	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.347	0.176	0.211
Gemma 2 27B	zero-shot rdf	<u>1.000</u>	0.214	0.353	0.778	<u>0.667</u>	<u>0.718</u>	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.356	0.176	0.214
Gemma 2 27B	4-shot	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.750	0.143	0.240	0.444	0.615	0.516	0.143	0.062	0.087	<u>1.000</u>	0.250	0.400	0.667	0.357	0.415
Gemma 2 27B	4-shot rdf	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.750	0.143	0.240	0.389	0.538	0.452	0.200	0.062	0.095	<u>1.000</u>	0.375	0.545	0.668	0.367	0.433
Gemma 2 27B	10-shot	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	<u>0.800</u>	0.190	0.308	0.500	0.615	0.552	<u>0.400</u>	<u>0.125</u>	<u>0.190</u>	0.750	0.375	0.500	<u>0.690</u>	0.404	<u>0.477</u>
Gemma 2 27B	10-shot rdf	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.667	0.095	0.167	0.533	0.615	0.571	0.286	<u>0.125</u>	0.174	0.750	0.375	0.500	0.647	0.385	0.449
Phi-3.5-MoE	zero-shot	0.400	0.286	0.333	0.737	<u>0.667</u>	0.700	0.333	0.077	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.294	0.206	0.232
Phi-3.5-MoE	zero-shot rdf	0.571	0.286	0.381	0.786	0.524	0.629	<u>1.000</u>	0.077	0.143	0.000	0.000	0.000	0.000	0.000	0.000	0.471	0.177	0.230
Phi-3.5-MoE	4-shot	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.000	0.000	0.000	0.417	0.385	0.400	0.000	0.000	0.000	0.500	0.375	0.429	0.383	0.295	0.332
Phi-3.5-MoE	4-shot rdf	<u>1.000</u>	<u>0.714</u>	<u>0.833</u>	0.000	0.000	0.000	0.417	0.385	0.400	0.000	0.000	0.000	0.500	0.375	0.429	0.383	0.295	0.332
Phi-3.5-MoE	10-shot	0.909	<u>0.714</u>	0.800	0.000	0.000	0.000	0.385	0.385	0.385	0.000	0.000	0.000	0.500	0.125	0.200	0.359	0.245	0.277
Phi-3.5-MoE	10-shot rdf	0.909	<u>0.714</u>	0.800	0.000	0.000	0.000	0.385	0.385	0.385	0.000	0.000	0.000	0.500	0.125	0.200	0.359	0.245	0.277



# **Semantic and Modelling**

Extracted entities are exported in JSON and serialised in **RDF-XML** using the **RRMV** ontology

This allows the generation of a **Knowledge Graph** that dynamically integrates regulatory modifications

<prmv:request rdf:about="http://data.europa.eu/2qy/rrmv#Request82"> <dcterms:ispartof rdf:datatype="http://www.w3.org/2001/XMLSchema#anyURI"> /akn/eu/act/directive/elb/2001-03-12/18/eng@2018-03-29 </dcterms:ispartof></prmv:request>
<pre><rrmv:hasannotation> 5. Every three years, the Commission shall publish a summary based on the reports referred to in paragraph 4. </rrmv:hasannotation></pre>
<rrmv:hasuri rdf:datatype="http://www.w3.org/2001/XMLSchema#anyURI"> /akn/eu/act/directive/elb/2001-03-12/18/eng@2018-03-29~sec_Dart_31para_5 </rrmv:hasuri>
<pre><rrmv:produces></rrmv:produces></pre>
<pre><rrmv:produces <rrmv:action="" rdf:about="http://data.europa.eu/2qy/rrmv#Request82Action1"></rrmv:produces></pre>
rdf:resource="http://data.europa.eu/2qy/rrmv#Request82Action1PeriodOfTime1" /> <rrmv:<b>hasAgentRole</rrmv:<b>
rdf:resource="http://data.europa.eu/2qy/rrmv#Request82Action1AgentRole1" /> <rrmv:<b>hasAgentRole</rrmv:<b>
rdf:resource="http://data.europa.eu/2qy/rrmv#Request82Action1AgentRole2" /> <rrmv:hasresult< td=""></rrmv:hasresult<>
rdf:resource="http://data.europa.eu/2qy/rrmv#Request1Action1ActionResult1" />

# Conclusions

The generated KG is suitable for real-world applications

- It is consistent with a time-aware and dynamic legal system, in which legal references are extracted and validated (also temporally)
- It allows legal experts to link the extracted categories to their conceptual framework, which is integrated in the RRMV ontology, thus providing intelligible results
- Future works include:
  - A larger dataset to include more types of RR
  - Refining PeriodOfTime extraction with different typologies (after, before, not later of, within)
  - Refining the **conditions** (e.g., after the application of the Delegated Acts, when the Member States apply, etc.)





#### Credits:

#### Michele Corazza, Monica Palmirani, Generoso Longo, Salvatore Sapienza

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