PaTrOnto, an ontology for patents and trademarks*

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Abstract. In this work, we introduce PaTrOnto, a multilingual ontology designed for legal knowledge extraction in the domain of patents and trademarks. To the best of our knowledge, this is the first attempt to build an ontology which comprehensively covers the domain of patents and trademarks in a multilingual scenario. PaTrOnto is an OWL ontology with SKOS multilingual lexicalisation, designed to capture the most most important concepts which occur within legal judgments related to patents and trademarks. We release the first version of this ontology in English, Italian and Bulgarian. The relevance of this ontology is that it allows for both reasoning (being written in OWL) and knowledge extraction (thanks to the use of some SKOS properties which provide each ontological concept with informations such as synonyms, examples, definitions, normative references). Furthermore, it has been created in close cooperation with legal experts and computer scientists.

Keywords: Legal Knowledge Representation · Ontology · Patent · Trademarks · AI&Law.

1 Introduction

In recent times, the Artificial Intelligence and Law (AI&Law) sector has undergone substantial growth, driven by advancements in Artificial Intelligence (AI) and Natural Language Processing (NLP). This has led to the creation of numerous applications designed to support legal experts, enhance the availability of justice, and streamline legal system operations. The community has witnessed significant and noteworthy expansion during this period, propelled by the progress made in AI and NLP.

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In the AI and Law community, one of the primary objectives is to identify and develop comprehensive and suitable methods for representing legal knowledge. This involves exploring various techniques and strategies to effectively capture the complexities and nuances of legal concepts, principles, and reasoning. By doing so, the community aims to enhance the accuracy and efficacy of AI-driven tools and applications designed to support legal professionals, improve access to justice, and streamline the functioning of legal systems.

Utilizing ontologies, which are structured representations of knowledge within a particular domain, can help attain these goals, as they offer a means to precisely depict intricate symbolic information in a format that machines can interpret, all while maintaining the benefits of modularity and interoperability. They can be particularly powerful also in combination with other methods of AI, both symbolic and non-symbolic.

In this work, we propose a first version of PaTrOnto (the Patent and Trademark Ontology), which is designed to facilitate both reasoning and knowledge extraction from legal judgments in the context of patent and trademarks.

We will start with Section 2, discussing some related studies. Then, we will focus on PaTrOnto in Sections 3 and 4, where we will respectively discuss about the general methodology we employed and the more specific structure of PaTrOnto. Finally, we will conclude with some ideas for the future in Section 5.

2 Related Works

Historically, ontologies have played a significant role both as domain-specific tools and as upper-ontologies. As domain-specific tools, they have been extensively employed to capture knowledge and concepts unique to particular fields, allowing for more effective organization, retrieval, and analysis of information. This has proven invaluable across various disciplines, including medicine, finance, and law, among others. In the context of upper-ontologies, they have served as foundational structures, providing a framework for integrating and connecting multiple domain-specific ontologies. This has facilitated interoperability and collaboration between different knowledge domains, promoting a more comprehensive understanding of complex, interdisciplinary problems. Consequently, ontologies have become indispensable assets in the realm of knowledge representation and management, also in the field of law [18].

In the field of AI&Law, we can find examples of both domain-specific ontologies and upper ontologies. Starting from the higher levels of abstraction, one can find upper ontologies such as the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE) [1], the Basic Formal Ontology (BFO) [16] or the Suggested Upper Merged Ontology (SUMO) [15]. These ontologies provide a foundational structure for integrating and aligning various domain-specific ontologies, which allows for improved interoperability and collaboration across different fields. However, one can also find domain-specific upper ontologies, i.e. ontologies which are located at abstract layers of abstraction but with the goal of representing the upper conceptual ideas of a specific domain. For example,

in the legal domain we can find ontologies such as the Legal Knowledge Interchange Format (LKIF) [8], or the Ontology of Professional Judicial Knowledge (OPJK) [3]. The focus of domain-specific upper ontologies is to capture the unique concepts and relationships within a domain, thus enabling more precise representation and analysis of domain-specific (e.g. legal) information. These two types of upper ontologies serve as a backbone for connecting legal knowledge with other disciplines, fostering a more comprehensive understanding of complex, interdisciplinary legal issues. Consequently, both domain-specific and upper ontologies have become crucial components in the advancing landscape of AI&Law.

Going towards lower layers of abstraction (i.e. towards a more domain-specific dimension), we can find ontologies designed to represent specific legal domains, such as privacy law [17] or the recent Artificial Intelligence Act ontology [4]. Our contribution is located in this level of abstraction, since we are proposing an ontology related to patents and trademarks. In this regard, there have been only few studies attempting to build ontologies in these two areas. Some study focused on specific analytical angles such as infringement [20] [12] [13] [9]. Other works developed patent ontologies focused on the specific technical or technological characteristics [11] [21].

Unlike the previous few works on patent ontologies, PaTrOnto has the broader scope of integrating patent and trademarks into the same conceptual framework, focusing in particular on the key conceptual features which judges consider when producing judgements related to patents and trademarks. The idea of creating an ontology for modeling these two areas is due to the fact that these two areas share several similar juridical concepts.

As a side note, we emphasize that PaTrOnto incorporates support for the recently introduced Unitary Patent, which is a novel type of patent available at the European level.

3 Methodology

We started building this ontology from a collection of annotated judgements. Our original idea was to create two different ontologies, one for the domain of patents and the other one for domain of trademarks. However, we realised that the most critical underlying concepts were actually shared between these two domains in a almost symmetrical way (this symmetry is even more evident when watching Figure 8, in the next Section).

Regarding the methodology, we were inspired by [17]. More precisely, we followed a top-down approach which includes the reuse of pre-existing ontology patterns [7] and which is performed on legal sources (i.e. legal judgements). Our results are strengthened by the committment to foundational and upper ontologies (in particular LKIF [8], DOLCE [5] and DUL [2]), and we followed the principles in the OntoClean [6] method, according to which each ontological concept can be evaluated based on three meta-properties:

1. “identity” (a class must be uniquely identifiable)

2. "unity" (instances of a class must form meaningful and cohesive wholes)
3. "rigidity" (referring to whether a property is essential to the instances of a class or if it can change over time)

Our validation process engaged a highly interdisciplinary team, which included lawyers, computer scientists, logicians, and philosophers. This diverse composition enabled us to incorporate a comprehensive range of expertise from various disciplines.

Our approach can be summarised as follows:

(i) a group of legal experts selected nearly 500 legal judgements related to the domain of patents and trademarks in Italian and Bulgarian;
(ii) the judgements were analyzed and the portions of text related with the judges' motivations were annotated;
(iii) Italian and Bulgarian legal experts analysed the most important concepts mentioned in the judgements, checking these concepts against their respective statutory backgrounds;
(iv) our technical team received the selected concepts and portions of text from the legal experts to map them into the ontology;
(v) for each element of the ontology our legal experts provided a range of linguistic variations/synonyms, a definition, the most common examples instantiating that concept, the most common related terms, and any relevant normative references related to the concept;
(vi) the gathered results were validated by the legal team that returned them to the technical team who implemented the new information in the ontology;
(vii) the steps from (iii) to (vi) were iterated several times to refine the ontology;

Currently, we are working on developing an algorithm that utilizes PaTrOnto to establish the relevance of an ontological concept in judgments pertaining to patents and trademarks. This process can be summarised as follows:

1. legal experts were asked to select from PaTrOnto the ontological concepts which are considered more relevant in the judges' decisions.
2. considering the concepts selected in the previous step, legal experts were asked to manually annotate nearly 70% of the judgements by including the information of whether each selected concept is relevant in each judgement by associating a binary value, where 0 means "non relevant" and 1 means "relevant" (the concept is considered relevant if the court's decision concerns that concept from the substantial point of view);
3. an algorithm designed by the technical team encodes the information contained in the ontology to predict whether or not a concept is relevant (comparing the results with the gold standard defined in the previous step);

At present, we are finalizing step 2 and executing step 3. Our preliminary results shows that by using PaTrOnto enables us to capture the most significant relevant concepts within the judges' decisions.

This approach can be adapted and utilized across various fields. For instance, we implemented the same methodology in the creation of another ontology associated with the VAT (Value-Added Tax) domain, which we called OntoVAT [14]. The primary distinction between OntoVAT and PaTrOnto pertains to the previously mentioned step (iii), as the statutory context of VAT domain differs significantly, especially in terms of harmonization at the European level. While for OntoVAT we relied on the European VAT Directive, which provides a quite harmonised framework, the analysis of the statutory background for patents and trademarks was more heterogeneous.

4 The design of PaTrOnto

PaTrOnto is a multilingual OWL ontology, featuring a SKOS lexicalization and available in English, Italian, and Bulgarian. The OWL+SKOS multilingual lexicalization addresses the challenge of semantic inconsistencies in multilingualism, as highlighted in prior research by [10]. The ontology, implemented using VocBench 3 [19], presently consists of 191 concepts (meaning OWL classes) and 107 properties (relations between classes). A detailed numerical breakdown can be found in Table 1.

Element	Quantity
Number of classes	191
Number of properties	101
Number of datatype properties	6
Number of transitive properties	0
Number of disjoint class pairs	904
Number of subclass relations	157

Table 1. PaTrOnto in numbers.

By employing SKOS, every ontological concept (that is, each OWL class) is enhanced with particular properties that are integrated into the SKOS data model, specifically:

- skos:definition
- skos:scopeNote
- skos:altLabel
- skos:hiddenLabel
- skos:example

Incorporating these properties into each ontological concept (across English, Italian, and Bulgarian) enables the inclusion of vital information within the ontology, which in turn makes PaTrOnto highly expressive and capable of representing complex legal information.

In particular, **skos:definition** contains the definition of each single OWL class (i.e., the definition of each single concept). In **skos:scopeNote**, we added relevant specifications about the skos:definition field (whenever was necessary to further specify the interpretative angle of the chosen definition). Furthermore, scopeNotes also contain all relevant normative references (if any) describing the concept. We also added any relevant synonyms in the three different languages as **skos:altLabel** properties. In **skos:example**, we added some examples of the concept (this can be considered like defining subclasses of the concept). Finaly, the property **skos:hiddenLabel** is used to store terms in natural language which might signal the presence of the concept in the text (this can be useful for any application layers built on top of PaTrOnto).

Specifically, the **skos:definition** comprises a descriptive definition of each individual ontological concept (i.e., the meaning of each distinct OWL class). Within **skos:scopeNote**, we incorporated additional details about the definition, therefore integrating the information already provided in the skos:definition field (this was done only when it was necessary to further clarify the interpretation of the ontological concept). We also employed the skos:scopeNote property to add any pertinent normative reference related to the concept, if applicable. Using **skos:altLabel**, we also included relevant synonyms in all three languages, while the **skos:example** property has been employed to describe examples for the concept. Lastly, the **skos:hiddenLabel** property stores natural language terms that may indicate the presence of the concept in the text, which can be beneficial for any application layers built on top of PaTrOnto.

To ensure a consistent and harmonious conceptual framework, we developed the PaTrOnto ontology using concepts that are applicable across multiple countries, with guidance from Italian and Bulgarian lawyers. As a result, the semantic meaning of concepts is generally harmonious between Italy and Bulgaria. This means that a single skos:definition in English is provided for each OWL class, and it is translated into Italian and Bulgarian without modifications. However, in a few instances, the definitions of concepts (i.e., their semantic meaning) differ at the national level. In such cases, national definitions take precedence, and the skos:definition in Bulgarian/Italian will not be a mere translation from English; instead, it will be a distinct definition that aligns with the respective national legislation. Furthermore, when additional clarification is needed to explain the scope of the concepts' meaning (at Bulgarian, Italian, and European levels), we employed a skos:scopeNote property in Bulgarian/Italian/English. Finally, since national legislations may use alternative terms, we treated these alternative terms as synonyms (skos:altLabel) in Italian/Bulgarian.

In summary, we address the multilingual challenge by customizing skos properties such as skos:definitions, skos:scopeNotes, and skos:altLabels when necessary, without compromising the consistency of the ontological concepts or their relationships. Figure 1 shows an example of how multilinguality is handled for a specific concept/class.

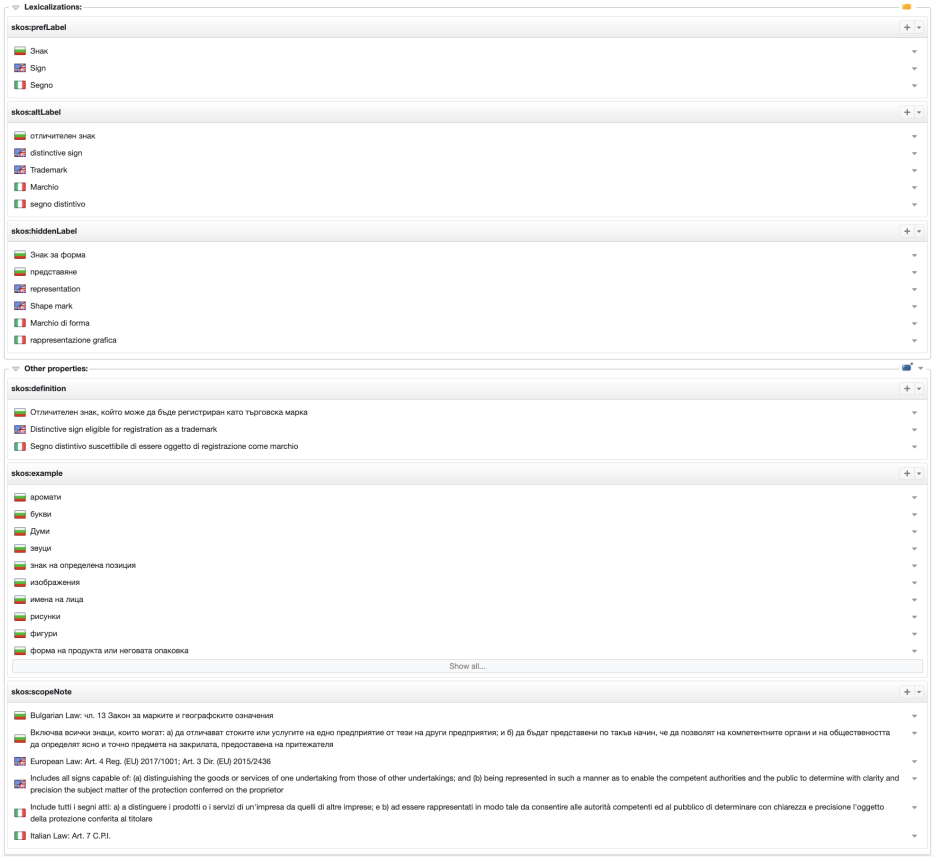

Fig. 1. An example of multilingual lexicalisation, related to the OWL class (i.e. the concept) "Sign".

We meticulously assigned a definition to each concept, prioritizing definitions derived from domain-specific legislative sources when the concept exists within that domain.

Whenever the concept is not mentioned in either national or European legislative sources, we sought a definition in the case law of the Court of Justice of the European Union (CJEU). When the concept is not defined in legislation or CJEU case law neither, as is often the case with "factual concepts", we provided a definition based on a straightforward description from legal encyclopedias or dictionaries.

By doing so, we ensured that the definition of each concept is firmly rooted in legal sources, which is essential in ensuring that the ontology can be effectively utilized in Natural Language Processing pipelines in the context of automated legal knowledge extraction.

4.1 Commitment and scope

To grant ontological robustness across the conceptual framework, most classes in PaTrOnto are designed to be disjointed. However, we decided to keep some potential overlaps in some cases.

For example, we did not disjoin all the subclasses of "Authority Of Industrial Property Right", since the same industrial property right (IPR) authority can deal with both patent and trademarks (Figure 2).

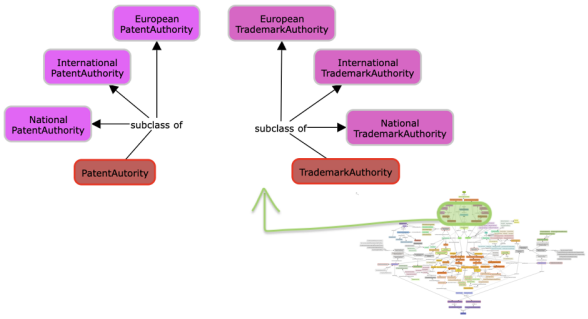

Fig. 2. Portion of PaTrOnto related to the IPR authorities.

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We also allowed potential overlap under the class "Invention", because an instance can belong to all the subclasses (Figure 3).

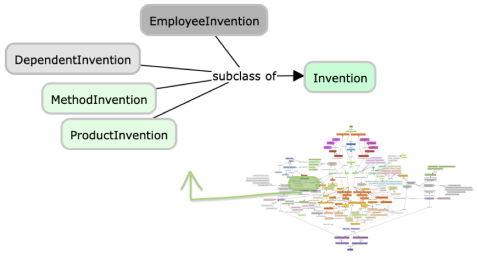

Fig. 3. Portion of PaTrOnto related to the class "Invention".

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We also allowed overlaps under the class "Trademark", since an instance can belong to all the subclasses (Figure 4).

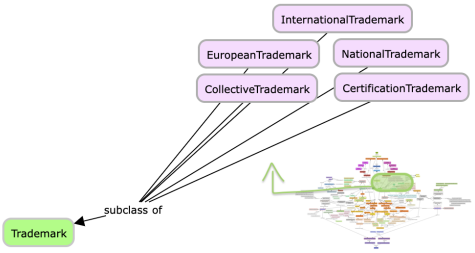

Fig. 4. Portion of PaTrOnto related to the class "Trademark".

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Other overlaps are allowed under class "Sign" (see Figure 5), where we applied disjointness (i.e. prevented the overlap of instances) only in three cases:

- **denominative**, **figurative**, and **composite**
- **unregistered** and **registered**
- **strong** and **weak**

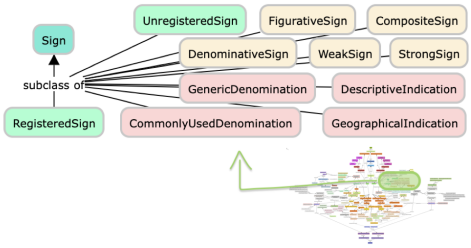

Fig. 5. Portion of PaTrOnto related to the class "Sign".

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Regarding the invalidity, please note that "Invalidity Of Industrial Property Right" is the superclass for the "Patent Invalidity" and "Trademark Invalidity" (which are disjoint). Under "Patent Invalidity", we disjoined:

- Patent's **partial** and **total** invalidity

Under "Trademark Invalidity", we disjoined:

- Trademark's **absolute** and **relative** invalidity
- Trademark's **partial** and **total** invalidity

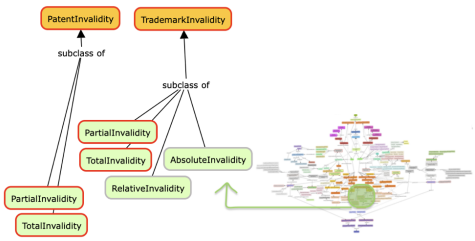

Fig. 6. Portion of PaTrOnto related to the classed "Patent Invalidity" and "Trademark Invalidity".

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Finally, we did not disjoin the subclasses of "Owner Of Industrial Property Right" (i.e. **"Patent Owner"** and **"Trademark Owner"**) simply because an individual of the "Patent Owner" class can also be an individual of the "Trademark Owner" class. Similarly, we allowed overlapping between three classes referred to dates ("Registration Date Of Industrial Property Right", "Priority Date", and "Application Filing Date Of Industrial Property Right"). In this last case, we applied disjointness only in the following three cases:

- **"Patent Application Filing Date"** disjoined with **"Patent Granting Date"**
- **"Trademark Application Filing Date"** disjoined with **"Trademark Registration Date"**
- **"Priority Date"** disjoined with **"Patent Granting Date"**

4.2 PaTrOnto's language-specific concepts

In PaTrOnto we decided to add a class which is not present to the Bulgarian law, since it is very often taken into account within the reasoning of judges of other non-Bulgarian judgements. This class is the "Problem-Solution Approach", which is a way to evaluate the "Inventive Step" of a "Patentable Solution". In Figure 7, we put in evidence the relative concepts and relationship between concepts.

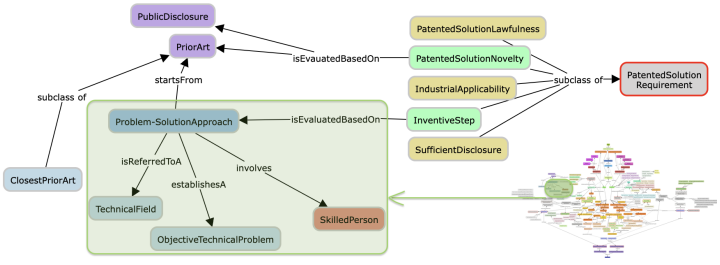

Fig. 7. Classes which do not apply to the Bulgarian system (see green area).

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4.3 Alignment with upper ontologies

To enhance the robustness and interoperability of PaTrOnto, we are investigating potential alignments with other prominent legal upper ontologies, specifically LKIF (Legal Knowledge Interchange Format) [8]. We list the current alignments of our classes in Table 2, while Figure 8 depicts a simplified conceptual map which provides a clearer understanding of PaTrOnto, showing most of its classes and properties [3].

PaTrOnto class	Aligned with class	In
Agreement	Legal Document	LKIF
Application Filing Date of Industrial Property Right	Spatio Temporal Occurrence	LKIF
Application of Industrial Property Right	Legal Document	LKIF
Authority of Industrial Property Right	Agent	LKIF
Duration of Industrial Property Right	Temporal Occurrence	LKIF
Effectiveness of Industrial Property Right	Norm	LKIF
Exclusive Patrimonial Right to Industrial Property	Right	LKIF
Industrial Property Requirement	Norm	LKIF
Industrial Property Use	Action	LKIF
Infringement of Industrial Property Right	Action	LKIF
Intellectual Property	Creation	LKIF
Intellectual Property Right	Right	LKIF
Invalidity of Industrial Property Right	Norm	LKIF
Inventor	Agent	LKIF
Lapse Cause of Industrial Property Right	Spatio Temporal Occurrence	LKIF
Licence Duration of Industrial Property Right	Temporal Occurrence	LKIF
Moral Right to Patented Solution	Right	LKIF
Objective Technical Problem	Mental Entity	LKIF
Owner of Industrial Property Right	Legal Role	LKIF
Patent Limitation	Norm	LKIF
Patent Part	Owl:Thing	/
Patent Text	Owl:Thing	/
Patent Text Translation	Owl:Thing	/
Principle of Exhaustion	Norm	LKIF
Prior Art	Observation	LKIF
Prior Use	Action	LKIF
Priority Date	Spatio Temporal Occurrence	LKIF
Problem-Solution Approach	Process	LKIF
Public Disclosure	Action	LKIF
Registration Date of Industrial Property Right	Spatio Temporal Occurrence	LKIF
Registration Number of Industrial Property Right	Owl:Thing	/
Reputation	Observation	LKIF
Scope of Patent Protection	Norm	LKIF
Secondary Meaning	Observation	LKIF
Sign	Owl:Thing	/
Skilled Person *(note: fictional agent)*	Agent	LKIF
Technical Field	Qualification	LKIF
Territoriality of Industrial Property Right	Place	LKIF
Trademark Class	Qualification	LKIF
Trademark Validation	Observation	LKIF
Triple Identity Test	Process	LKIF
Validity of Industrial Property Right	Norm	LKIF

Table 2. Alignment and interoperability with upper ontologies.

[3] In this simplified map, relations such as "has" connecting to a target concept are represented in OWL as "hasTargetConcept", while relations such as "can be" are translated in OWL as datatype properties with a boolean value.

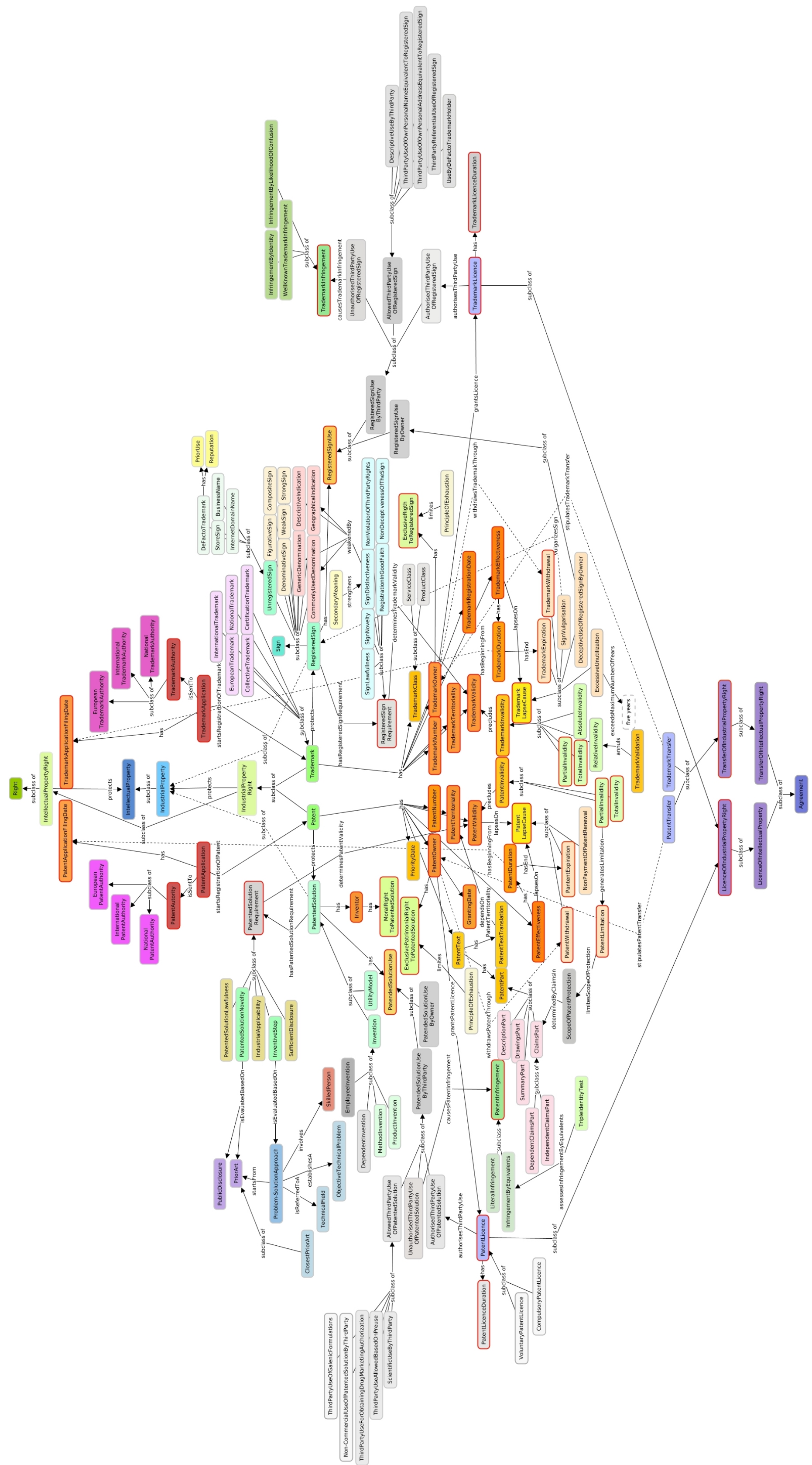

Fig. 8. Simplified map of the main concepts and relations in PaTrOnto.

5 Conclusion

In this study, we introduced the initial version of PaTrOnto, the first formal ontology in the legal domain of patents and trademarks. Developed in collaboration with domain experts and computer scientists, the ontology is designed to encapsulate critical domain-specific concepts found in legal judgments. PaTrOnto is structured in OWL and enriched with a SKOS lexicalization in English, Italian, and Bulgarian.

As for its application, we are currently employing PaTrOnto in a scenario where it supports a Natural Language Processing (NLP) pipeline for extracting the relevance of domain-specific concepts from our dataset of annotated legal judgments. This combination of PaTrOnto and an NLP pipeline represents just one of the potential uses for this ontology. In the future, we plan to investigate other objectives related to legal knowledge extraction, including the incorporation of Machine Learning algorithms.

In general, PaTrOnto can facilitate various types of targets. Presently, we are utilizing it to enable automated legal knowledge extraction from domain-specific legal documents and to develop a navigation tool which allows users to find relevant judgments from our dataset, based on selected ontological concepts, by using semantic similarity measures.

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