



## Article

# Semantic Representation of the Intersection of Criminal Law & Civil Tort

Alexandros Z. Spyropoulos <sup>1,2,3,\*</sup> , Angelos Kornilakis <sup>2,4</sup>, Georgios C. Makris <sup>2,5</sup> , Charalampos Bratsas <sup>2,6</sup> , Vassilis Tsiantos <sup>1,\*</sup> and Ioannis Antoniou <sup>2,5,\*</sup>

<sup>1</sup> Department of Physics, School of Science, Kavala's Campus, International Hellenic University (IHU), GR-57001 Thessaloniki, Greece

<sup>2</sup> Inter-Faculty Master Program on Networks and Complexity, Aristotle University of Thessaloniki (AUTH), GR-54124 Thessaloniki, Greece

<sup>3</sup> Department of Library Science, Archives and Information Systems, School of Social Sciences, Alexander's Campus, International Hellenic University, GR-57400 Thessaloniki, Greece

<sup>4</sup> School of Law, Aristotle University of Thessaloniki (AUTH), GR-54124 Thessaloniki, Greece

<sup>5</sup> Department of Mathematics, Aristotle University of Thessaloniki (AUTH), GR-54124 Thessaloniki, Greece

<sup>6</sup> Department of Information and Electronic Engineering, Alexander's Campus, International Hellenic University (IHU), GR-57400 Thessaloniki, Greece

\* Correspondence: azspyropo@auth.gr (A.Z.S.); tsianto@physics.ihu.gr (V.T.); iantonio@math.auth.gr (I.A.)

**Abstract:** The more complex and globalized social structures become, the greater the need for new ways of exchanging information and knowledge. Legal science is a field that needs to be codified to allow the interoperability between people and states, as well as between humans and machines. The objective of this work is to develop an ontology in order to describe two different pillars of codified law (civil and criminal) and be able to depict the interaction between them. To answer the above question, we examine the Greek Criminal Law as depicted in the Greek Penal Code (ΠΙΚ) and the way its articles can be analyzed. Then we examine Tort as described in the Greek Civil Code (ΑΚ) and link the two codifications through the concepts of illegality and damage, both being prerequisites of tortious liability. Following that, through the Protégé application, a legal ontology is created in the OWL semantic language, while finally, four articles of the Penal Code are codified in the ontology and a presentation of their relation to the civil tort is required from a reasoning algorithm.

**Keywords:** legal ontology; semantic network; criminal law; tort



**Citation:** Spyropoulos, A.Z.; Kornilakis, A.; Makris, G.C.; Bratsas, C.; Tsiantos, V.; Antoniou, I. Semantic Representation of the Intersection of Criminal Law & Civil Tort. *Data* **2022**, *7*, 176. <https://doi.org/10.3390/data7120176>

Academic Editor: Francesco M. Donini

Received: 31 October 2022

Accepted: 7 December 2022

Published: 9 December 2022

**Publisher's Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



**Copyright:** © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

Knowledge Management is a critical challenge for modern humans [1]. The more complex and globalized the social structures become, the greater the need for new ways of exchanging information and knowledge [2].

One of the problems humanity has to manage heading into the 21st century is the reduction of complexity through data integration [3,4]. Present-day states, organizations, associations and enterprises maintain databases that not only cannot interact with each other, but also, most of the time, they do not even have the same 'knowledge fields', lacking even corresponding fields of knowledge [5].

The problem of integrating and comparing data from different databases becomes greater when the data represent knowledge about objects that change from time to time and also from place to place [5,6]. Knowledge related to the law is a classic example of this issue, as the legal provisions regulating certain behaviors vary according to prevailing circumstances [7].

From recorded history to date, complex legislation has been developed those spans hundreds of thousands of volumes of paper or the equivalent digital information. In Greece, like in all developed countries, one piece of legislation succeeds the other.

In that framework it is, perhaps, of great interest that provisions regulating completely different issues coexist in the same text [8].

The use of methods of representation of knowledge using semantic tissue (ontologies) can help solve the above problems [9–12].

### 1.1. Background

How to approach the issue of Legal Ontologies is not new to the contributory sciences: law, mathematics and computer science. In the USA, a jurisdiction belonging to the Anglo-Saxon (common law) legal family, they have already made huge strides involving ontologies—through the development of artificial intelligence—in judicial decision-making involving matters such as detentions, inheritances and the resolution of corporate disputes [13–15].

Below are some of the most famous approaches to the development of Legal Ontologies. The Greek effort to create a Legal Ontology in 2016, which took place within the framework of a joint European action, is also examined.

#### 1.1.1. Legal Ontologies and How to Choose Them

In past investigations such as [16], researchers refer to the importance of developing Legal Ontologies. Legal Ontologies represent the relationships between different legal entities. There is special mention of how these ontologies end up helping public administration as well as private companies, while also providing legal information to smart systems. The researchers note that it is not unusual for end-users with no technical knowledge to interact with ontologies. They therefore categorize ten key Legal Ontologies, as follows (Table 1):

**Table 1. Ontologies in Legal Domain.**

Ontologies	Content
LegalRuleML [17,18] NRV [19]	Legal Rules: ontologies model the rules as they can be found in legal documents issued by local, national or international governmental bodies.
ODRL [20] LDR	Policies: ontologies model the permitted, mandatory, and prohibited actions that can be done digitally or physically.
CC [21] L4LOD [22]	Licenses: ontologies model the actions allowed on an intellectual property-protected resource.
Eurovoc ELI ontology	Representation   indexing of legal documents: ontologies represent the structure of the text of legal documents and their subjects.
GDPRtEXT [23]	Secrecy in GDPR: ontologies model the concepts involved in the new European General Data Protection Regulation (GDPR).
LOTED2 PPROC [24]	Offers and Public Procurement: ontologies model the procedures used by the public administration in cases of public procurement.

All the above ontologies have managed to model some portion of legal knowledge by supporting their structure on elements such as the subject matter concerned, the date of publication of the law, the authority that issued it, and some actions described in it.

The researchers conclude that the scope of semantic representation of legal knowledge is highly complex and special tools are needed to make it easier for users to find the ontologies that will serve them.

#### 1.1.2. Ontologies in the Legal Domain

In the paper “Ontologies in the Legal Domain” [9], the authors examine the question of the representation of legal knowledge in the semantic web, while at the same time studying the FOLaw and LRI-Core ontologies. In short, the following uses of legal entities are presented:

1. Organization and structure of information;
2. Reasoning and problem solving;
3. Semantic indexing and searching;
4. Integration and inter-functional semantics;
5. Understanding the field of knowledge.

Next, the researchers present the key components of FLOaw ontology, which they characterize more as a “reference framework” and less as an ontology. In particular, they say that this effort took place in the mid-1990s and therefore has many relatively primitive characteristics. They also mention the attempt to distinguish terms of legal science, as well as the operation of a kind of indexing of legal concepts.

On the other hand, the LRI-Core ontology, which aspired to be a “superstructure”, provides knowledge on specialized extremely abstract legal concepts such as causal link, criminal intent, etc. The creators of LRI-Core have tried to fill the gap between other existing ontologies used by science, in particular.

The researchers conclude that although the LIR-Core was a good effort, it was not able to perform its purpose, as it was particularly difficult to operate.

#### 1.1.3. Encoding Ontology/Greek Ministry of Interior

In 2016, the Greek Ministry of the Interior initiated a public consultation through [www.opencov.gr](http://www.opencov.gr) [access date 31 December 2016] on an ontology [25] created under the European Union’s ISA (Interoperability Solutions for European Public Administrations) program. As stated in the introduction “The Ministry of Interior and Administrative Reconstruction plans the National Strategy for the Coding and Reform of Greek Legislation with the aim of creating a modern regulatory environment characterized by clarity, coherence and absence of inactive, contradictory, overlapping or outdated provisions. The main focus of the strategy is the wide-ranging deregulation of the law by removing useless, overlapping or contradictory provisions, codifying the remaining regulations and establishing a permanent mechanism for assessing the quality of legislation” [26], (p. 2).

This ontology has “properties” such as Signature Date, Publish Date, Effective Date, etc. The result is the formation of a legal ontology, one which covers the specifications of the European program, but in practice, with the above codification, ontology can only function as an index of legal texts.

#### 1.1.4. European Legislation Identifier

The European Legislation Identifier [27] initiated by the European Council is the framework which the Greek ontology described in Section 1.1.3 has tried to implement. The conditions are:

1. Identification of legislation via HTTP URI, setting URI standards at European, national, and local levels.
2. Description of legal information by means of metadata, setting out a data model for the description of legal information.
3. Ensuring that the data model is detectable through the creation of legal websites and the availability of open data in a form understood by machines, in order to facilitate the analysis and extraction, and therefore the exchange, of legal information.

The European Legislation Identifier calls on the Member States of the European Union to create legal entities in any software by recommending RDF modelling and integration into HTML websites.

#### 1.2. Research Objectives

The attempts to represent legal knowledge through ontologies have found application in large indexes. While this is useful and obviously serves users’ need for quick access to knowledge, it refrains, however, from creating the conditions that would promote the involvement of artificial intelligence in the administration of justice. At the same time,

it does not create the right conditions for comparing and jointly monitoring different legal systems or even different branches of law in the same jurisdiction.

The objective of this work is “**to develop an ontology in order to describe two different pillars of the Greek law** (civil and criminal), *and depict the interaction between them*”. The desired ontology should be applicable not only to Greek law but also to all Continental jurisdictions, since they share the same system, based rather on codification (i.e., Civil code) than on case law (the latter being the system adopted by Anglo-Saxon jurisdictions). The ontology should be integrated with other international ontologies presently in use.

## 2. Ontology Development

Approaching an reached to the research objectives objectives in Section 1.2, this study examines the presentation in the semantic web of knowledge of both of the elements that contribute to both a criminal offence in Greek criminal law [28] and a tort in the Greek Civil Code ([29] Art. 914 AK). This creates a legal ontology that does not remain in the simple visualization of indexing data, but enters the core of the relative legal provisions and represents their structure. Thus, it will be possible to understand whether there is also an interaction between two different pillars of the same legal system.

In addition, four articles of the Greek Penal Code [28] will be incorporated as a model in order to study which of them directly correlates with Tort (Art. 914 AK).

The Protégé [30] software is used to create an ontology in a Web Ontology Language (OWL) syntax [31].

### 2.1. Semantic Representation of Tortious Liability According to the Greek Civil Code (Art. 914 AK)

Greek law is part of the Continental legal families (also known as civil law systems), as opposed to the Anglo-Saxon ones, and more specifically of the Germanic legal family [32], (p. 201). The distinction is based, among others, on the architecture of the legal systems. Continental legal systems are based on codifications (statutory law), that is, written legal statutes according to the positivist tradition. They present a systematic approach to law based on concepts of different degrees of abstraction, using consistent terminology to describe these concepts. Concepts of a higher degree of abstraction usually form the General Part of each legal area, providing the basic general concepts (i.e., a contract is, for Continental jurisdictions, just a form of the broader concept of a “legal transaction”), and thus forming conceptual hierarchies that can be depicted as networks [32], (p. 385) ss. This architecture enables deductive thought, enabling Continental lawyers to reach further conclusions, given a point of departure, even one of high abstraction, derivable from it in a consistent manner. Moreover, due to the high abstraction of the general concepts they—at least should—encompass in principle all cases that might arise in the real world. So, one could say that, like formal axiomatic systems, one would expect legal codification systems like the Continental ones to be complete (being able to demonstrate that a proposition is false or true), consistent (no contradictions) and decidable.

From a technical point of view, legal norms in a codification are organized in Articles, which, in turn, are divided into Paragraphs and Sections within the paragraphs. Therefore, for example, in the Greek Civil Code the concept of “written form” is presented in Art. 160 AK as follows:

#### 2.1.1. Article 160

If the law or the parties have prescribed the written form in respect of a transaction, the document must bear the handwritten signature of the person who issued the document. (Paragraph 1)

In the matter of contracts, the signatures of the parties hereto must be affixed on the same document. (Paragraph 2, Section 1) If the contract has been drawn up in several originals the signature of each party on the document destined for the other shall be sufficient. (Paragraph 2, Section 2)

In general, tortious liability is the legal duty to compensate someone for damages caused. In Continental jurisdictions tortious liability arises when the conditions set in the relevant legal norm, found in the respective Civil Code, are met. According to the Greek Civil Code, Tort is defined as follows:

### 2.1.2. Article 914

A person who has caused illegally and through his fault prejudice to another shall be liable for compensation [33].

It follows from the said definition that the existence of a tort is subject to the following conditions [29], p. 225, 245:

1. Human conduct: The conduct that caused damage must be attributed to a human, as only such conduct can be illegal. Furthermore, the conduct in question must be deliberate, in other words, such a conduct must be controlled by the person causing the damage (i.e., this is not the case in case of force majeure). The conduct can be an act or an omission.
2. Illegality: The concept of illegal (unlawful) conduct is complex and certainly exceeds the scope of the present work. For the purposes of this work, illegal conduct broadly concerns an act which is expressly prohibited by penal law. Every crime described by the provisions of the Greek Penal Code that were chosen for this study is simultaneously illegal conduct regarding tortious liability. For a positive finding on tortious illegality, it suffices that the objective features (cf. infra-2.2) of each provision of the penal code describing a crime are met.
3. Fault: Fault is an independent condition for attributing tortious liability. It is defined as the special mental position of the culprit towards the illegal result of his action, which is condemned and disapproved by law. The two main categories of fault are (i) intent (fraud) and (ii) negligence. Intent is not legally described in the Greek Civil Code, the only relevant provision being that of Art. 27 IIK, which is used also for the civil cases. On the contrary, negligence is legally described, as a general concept applying not only in cases of tortious but also of contractual liability, in Art. 330 AK as the situation “when the care required in the carrying of the business has not been furnished” [33].

Fault is a feature common to both penal crimes and tortious acts. Hence, the application of a penal provision presupposes a judgment addressing fault, according to the penal code. Nevertheless, the question of fault should be addressed independently in the field of tortious liability, although it should not lead to differentiated outcomes concerning the applicability of the relative provisions.

4. Damage: Damage appears to be the most objective condition of Art. 914 AK because it concerns the difference in the victim's estate before and after the tortious act. It is described, again as a general concept, in Art. 298 AK as follows:

### 2.1.3. Article 298

Damages shall comprise the decrease in the existing patrimonium of the creditor (positive prejudice) as well as loss of profit.

5. Causal relation [34], (p. 207) e.s.: Although causal relation is not expressly mentioned in the provision, it is a necessary condition for tortious liability. The notion of causal relation, in brief, constitutes the logical relation that links the conduct as cause with the incurred loss as effect. Legal causation goes beyond the standard of necessary condition (*condictio sine qua non*) searching for an adequate cause (*causa adaequata*), a concept formed on the basis not only of strictly logical but also normative considerations.

Based on the above, Tort can be considered as the intersection of three facts: (i) some wrongful conduct (see points I and II above), (ii) committed by a person at fault (point III above) and (iii) caused economic loss to the victim (point IV). The above are subject to

the condition that the damage directly results from the wrongful act or omission, namely that there exists a causal relationship (point V above) between the cause (conduct) and the end-result (damage).

The above points (i)–(iv) constitute the first three categories of the ontology, namely Wrongful Act, Fault and Damage; whilst the relationship that links the Wrongful Act (ii) with the Damage (iv) constitutes the representation of the causal relation (v).

## 2.2. Semantic Representation of Greek Criminal Law

Any legal provision may be divided into parts. Each provision of the Greek Penal Code consists of at least three parts: (a) The **objective statutory definition of the offence (Illegal Act)**, that is, what constitutes the unlawful conduct (i.e., Theft: to take movable property belonging to another away from another); (b) The **subjective statutory definition of the offence (Fault)**, that is, intent or negligence and their subdivisions; (c) The **penalty threatened** (imprisonment, detention etc.), from which the (d) **gravity of the offence** (Table 2) is also apparent, be it (e) **serious crime** or other (f) **major offence** [28]. An important part of any rule—which must also be reflected in Ontology—is its (g) **title**, i.e., the number identifying the criminal provision which provides for it.

**Table 2. The parts of the criminal rules.**

Gravity of the Offence	Penalty	Time in Prison
Serious crime	Imprisonment	Over 5 years
Major offence	Short-time imprisonment	10 days to 5 years
Minor offence	Detention	1 to 30 days

Therefore, one of the above (a, b, c, d, e, f & g) is considered to be nodes, and the regulation of the relationships between nodes can be the edges of a knowledge network. This network changes as quickly as the corresponding institutional changes take place. In fact, we have a succession of networks with the variable of time (temporal networks).

There are legal rules where it is easy to distinguish between the above parts, but also others where this work becomes more complex. For example, “Homicide with Intent”—Art. 299 ΠΙΚ—is described as follows (Table 3):

1. Anyone who intentionally killed another is punishable with life imprisonment.
2. If the act was decided and executed in the heat of extreme mental disturbance, the penalty of temporary life imprisonment shall be imposed.

Measurement of the Above Order

**Table 3. The analysis of the criminal provision for homicide.**

FEATURE	Measurement
Title	299 ΠΙΚ
Wrongful Act	(§1) Anyone who intentionally killed another person (§2) Whoever—in a state of mental extreme disturbance—killed another person.
Fault	“intentionally”
Penalty	(§1) life imprisonment → serious crime (§2) temporary imprisonment → serious crime

## 2.3. Classes and Properties of Ontology

The following classes and properties of Ontology (Tables 4 and 5) are derived from the above (Sections 2.1 and 2.2):

1. Classes:

**Table 4.** The parts of the civil tort and the criminal law.

	Classes	Subclasses
Civil Tort (Article 914 Greek CC)	Damage	
	Wrongful_Act	Fault
		Intention
		Negligence
	Title	
		Life imprisonment
Criminal Law (BC)	Penalty	Temporary life imprisonment
		Imprisonment
	Gravity_of_the_Offence	Serious crime
		Major offence

As we observe, “Wrongful Act” and “Fault” are common to both civil tort and criminal law, since for the purposes of this study we have limited the scope of wrongful act to the penal domain (a civil wrongful act can generally also take forms other than a penal crime).

“Tort” is also a “Class” of ontology, but it is the condition that it is the intersection between “Damage”, “Wrongful\_Act” and “Fault”.

2. Properties

**Table 5.** Properties on ontology.

Property	Domain	Range	Characteristic
hasPenalty	Wrongful_Act	Penalty	Asymmetric
hasFault	Wrongful_Act	Fault	Asymmetric
gravity	Penalty	Gravity_of_the_Offence	Symmetric
providedBy	Wrongful_Act	Title	Symmetric
damageCaused	Wrongful_Act	Damage	Symmetric

#### 2.4. Introduction in Ontology: Four-Indicative—Crime Behaviors

As the offence of Homicide (Section 2.2, Table 3) has been analyzed, nine other provisions of the Penal Code are shared with a view to their parts being incorporated into the ontology. Each part will become a “Subclass” of the corresponding “Class” and within the latter, it will be presented as a separate “Individual”, in order to have an impact with the other parts of the ontology (Tables 6–9).

**Table 6.** Homicide with Intent.

Classes	Subclasses	Subclass + Individual
Title	299	299
Wrongful Act	Homicide_with_Intent	Kill_another_person Kill_another_person_(with_mental_disturbance)
Fault	Intentionally	Intentionally
Penalty	Imprisonment	Imprisonment
Gravity_of_the_Offence	Serious_Crime	Serious_Crime
Damage	False	

**Table 7.** Theft.

Classes	Subclasses	Subclass + Individual
Title	372	372
		Stealing_Part_or_All
Wrongful Act	Theft	Theft_of_High_Value
		Electricity_Theft
Fault	Intentionally	Intentionally
Penalty	Short-time imprisonment	Short-time imprisonment
Gravity_of_the_Offence	Major_Offence	Major Offence
Damage	True	

**Table 8.** Arson.

Classes	Subclasses	Subclass + Individual
Title	264	
		Arson_with_Risk_for_Objects
Wrongful Act	Arson	Arson_with_Danger_to_Humans
		Arson_with_Human_Death
		Arson_with_Human_Physical_Damage
		Arson_in_a_Utility_Installation
		Arson_by_Negligence_with_Risk_for_Objects
		Arson_by_Negligence_with_Risk_to_Man
Fault	Intentionally	Intentionally
	Negligence	Negligence
Penalty	Short-time imprisonment	Short-time imprisonment
	Imprisonment	Imprisonment
Gravity_of_the_Offence	Major_Offence	Major_Offence
	Serious_Crime	Serious_Crime
	False	
	False	
	False	
Damage	True	
	True	
	False	
	False	

**Table 9.** Serious Physical Harm.

Classes	Subclasses	Subclass + Individual
Title	310	310
Wrongful Act	Serious_Physical_Harm	Serious_Physical_Harm_with_Pursuit
		Serious_Physical_Harm_with_Intent
Fault	Intentionally	Intentionally

**Table 9.** Cont.

Classes	Subclasses	Subclass + Individual
Penalty	Imprisonment	Imprisonment
	Short-time imprisonment	Short-time imprisonment
Gravity_of_the_Offence	Serious_Crime	Serious_Crime
	Major_Offence	Major_Offence
Damage	True	
	True	

It should be noted that for the purposes of this study, “Damage” is considered to concern only the direct victims of the acts and no other persons. For example, in homicide there is likely to be financial damage to the victim’s family, but the victim himself has no loss of money, as the dead do not own property.

### 3. The legal ontology

The ontology developed in the present study is presented as Supplementary Material:

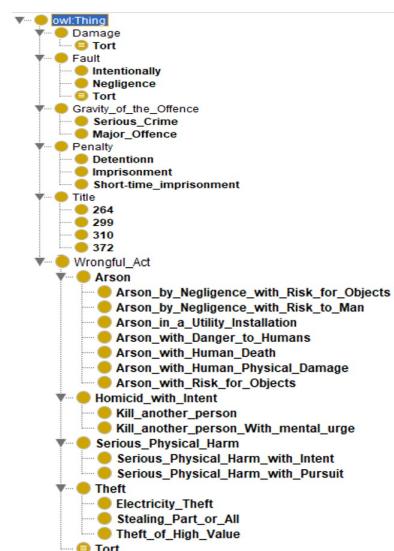
- Supplementary Material: Intersection of Criminal Law & Civil Tort

### 3. Ontology in Pictures

As mentioned earlier “Ontology” is a semantic network, nodes of which are our data on a subject while the connections (links) between nodes relate to the relationships between the data. This semantic network can be captured in charts (graphs) which help users to draw quick conclusions.

Below are a series of images regarding the ontology developed through the Protégé programme.

1. The Classes and Sub-Classes of Ontology (Figure 1).
2. The Properties of Ontology (Figure 2).
3. The Parties to the Tort (Figure 3).
4. The Penal Rule (Figure 4).
5. Activates the offence of “Homicide with Intent” the “Tort”? (Figure 5).
6. How many of the delinquent behaviors described in “Arson” trigger “Tort”? (Figure 6).

**Figure 1.** The categories on ontology.

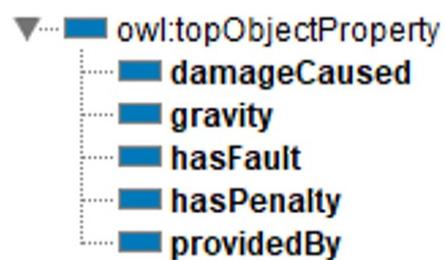


Figure 2. Properties on ontology.

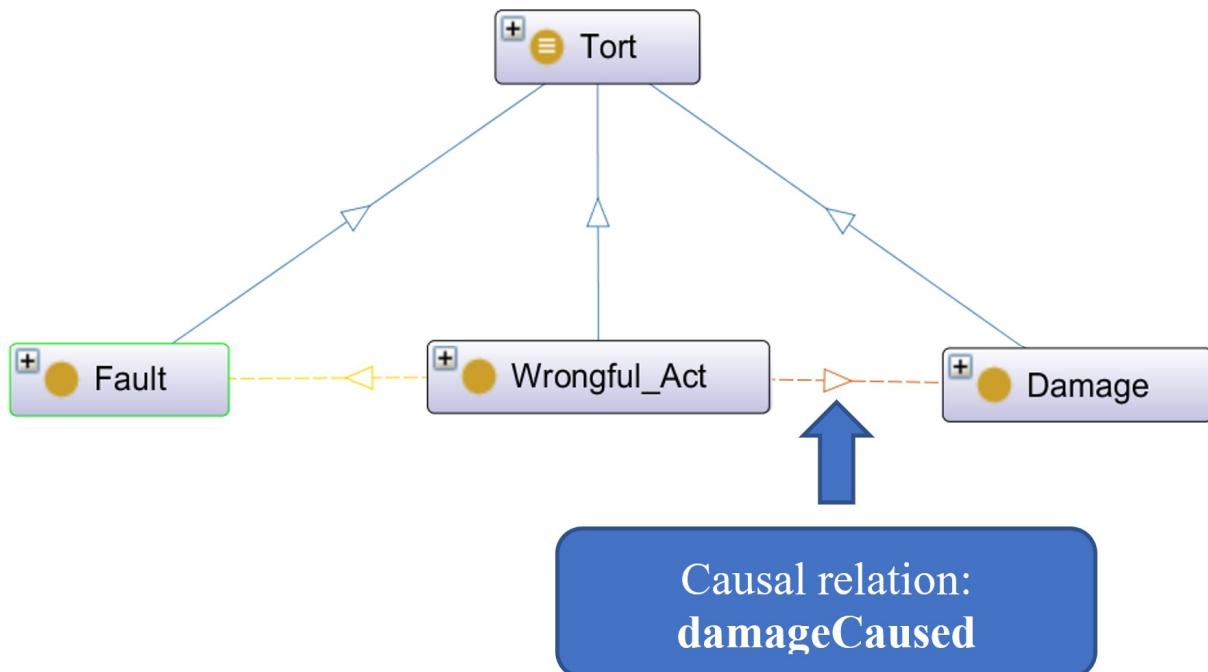


Figure 3. The Parties to the Tort.

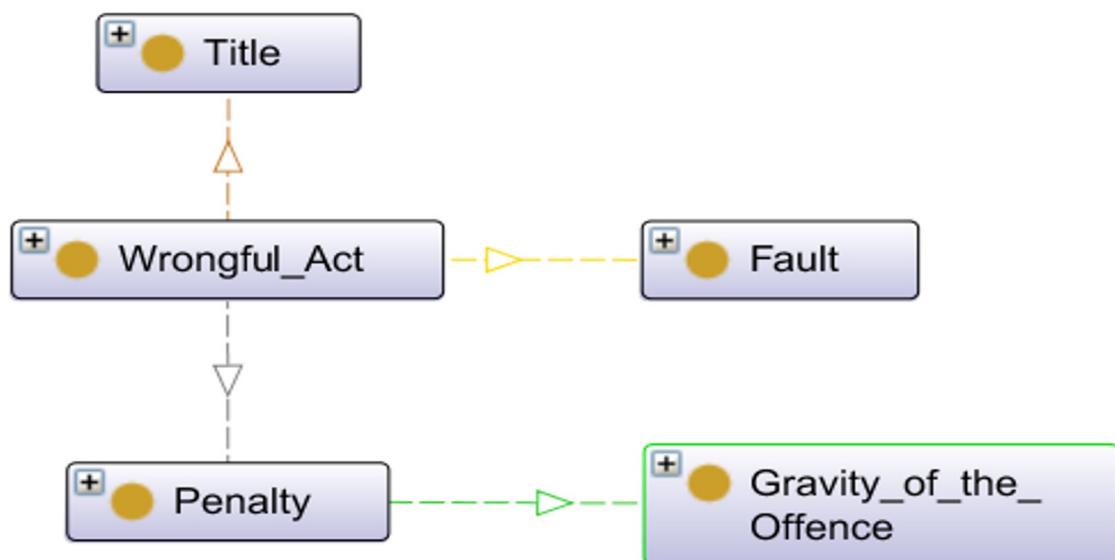
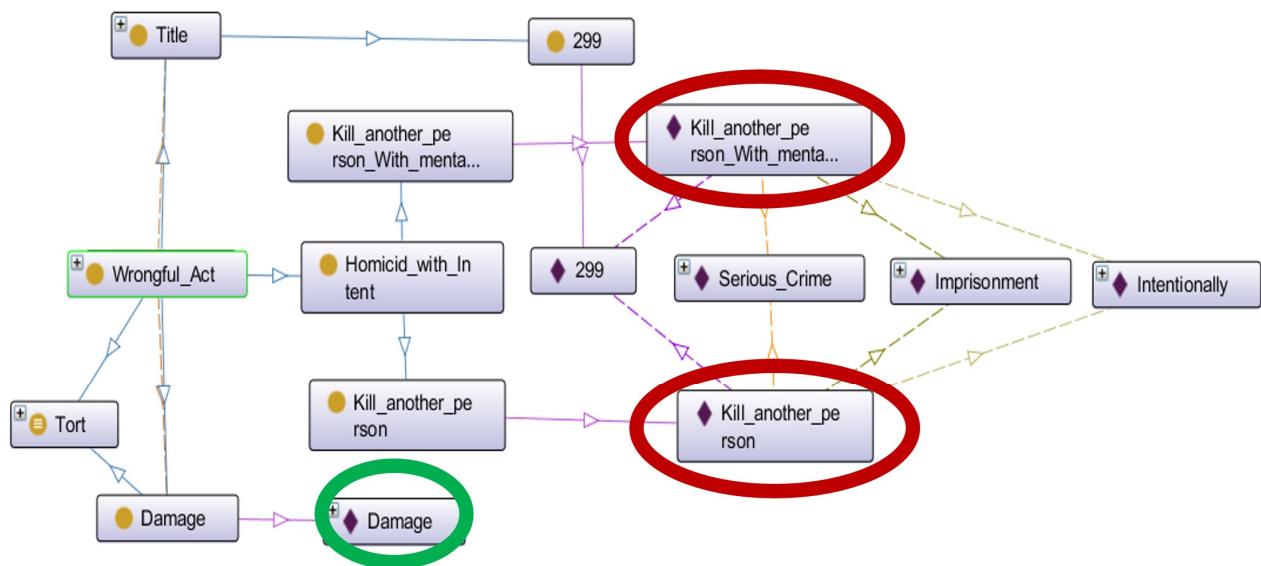
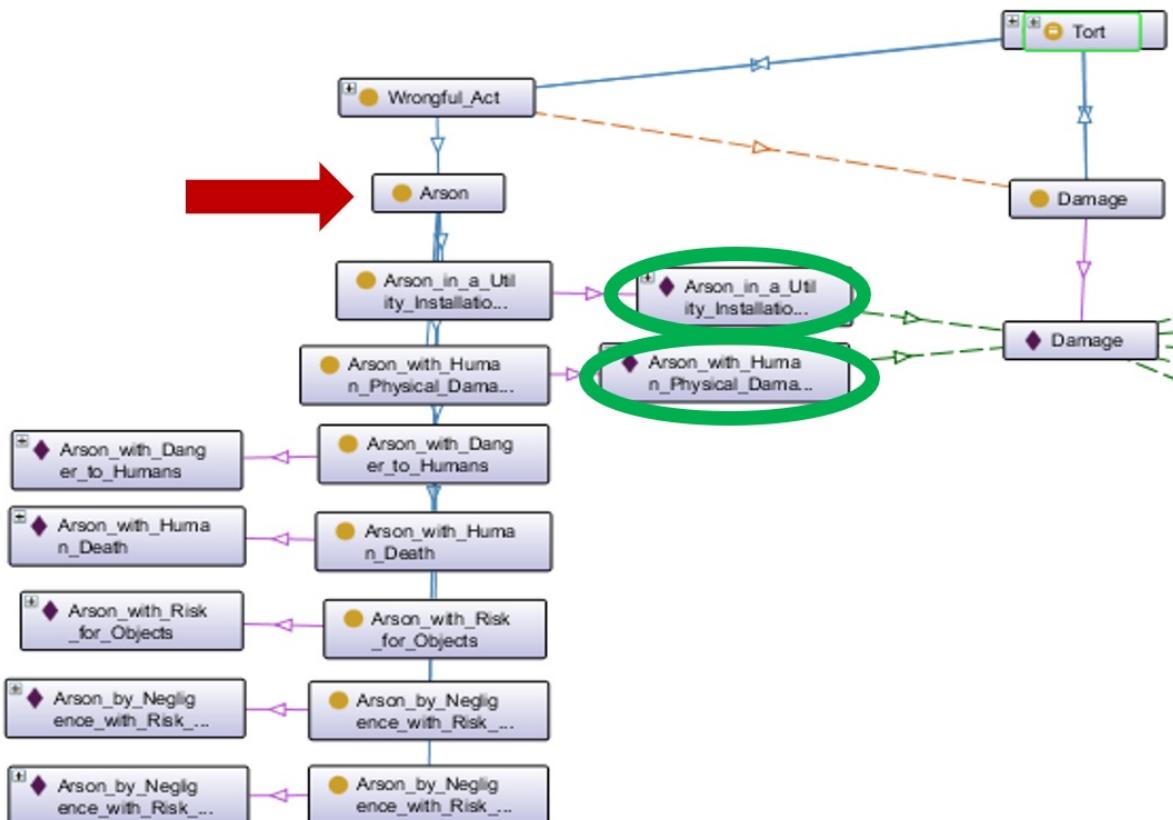


Figure 4. The Penal Rule.



**Figure 5.** Activates the offence of “Homicide with Intent” the “Tort”.



**Figure 6.** How many of the delinquent behaviors described in “Arson” trigger “Tort”?

As we observe in Figure 6, two [green circles] of the seven illegal behaviors that describe “Arson” [red arrow] are involved in “Damage” and therefore activate “Tort”.

#### 4. Reasoning & Description Logic on Legal Ontology

##### 4.1. Reasoning

Reasoners are software programs that run on ontologies and detect possible logical errors, examine whether the relationships within the ontology are consistent and at

the same time check whether the affiliation relationships between classes and properties work correctly.

This paper uses the “HermiT” reasoner in version 1.4.3.456. It is open-source software, and available from LGPL [35].

#### 4.2. Scenario Example

As shown in Section 3, graphs can offer a direct view of an ontology. For complex questions or ontologies, such as the one proposed, the examination of graphs seems to be more difficult. The Protégé program in conjunction with the HermeT reasoner enables the users to ask questions of the ontology.

Scenario:

As stated in the introduction, the field of civil law is not intertwined with the field of criminal law in the Greek penal system (but also in Europe). It is assumed that a judge searches in the first instance for wrongful acts (of those recorded in the ontology) which, with the appropriate attribution of fault, also cause damage and thus trigger the civil tort rule of civil law.

The above can be written with descriptive logic:

Civil tort is defined as:

$$\begin{aligned} \text{CivilTort} \equiv \\ \exists \text{wrongfulAct}. \text{Act} \sqcap \exists \text{hasFault}. \text{Fault} \sqcap \exists \text{damageCaused}. \text{Damage} \end{aligned}$$

The criminal offence is defined:

$$\begin{aligned} \text{CriminalLaw} \equiv \\ \exists \text{wrongfulAct}. \text{Act} \sqcap \exists \text{hasFault}. \text{Fault} \sqcap \exists \text{timeImprison}. \text{Days} \sqcap \forall \text{damageCaused}. \text{Damage} \end{aligned}$$

Qualifying criminal offences and civil torts are defined as:

$$\begin{aligned} \text{CriminalandTort} \equiv \\ \text{CivilTort} \sqcap \exists \text{timeImprison}. \text{Days} \end{aligned}$$

The question can be asked in Protégé as shown in Figure 7 and take as an answer the seven criminal acts depicted.

The screenshot shows the Protégé query interface. The top section is titled "Query (class expression)" and contains the following SPARQL-like query:

```
hasFault some Fault and damageCaused some Damage
```

Below the query are two buttons: "Execute" and "Add to ontology". The bottom section is titled "Query results" and displays the following output:

Instances (7 of 7)

- Arson\_in\_a\_Utility\_Installation
- Arson\_with\_Human\_Physical\_Damage
- Electricity\_Theft
- Serious\_Physical\_Harm\_with\_Intent
- Serious\_Physical\_Harm\_with\_Pursuit
- Stealing\_Part\_or\_All
- Theft\_of\_High\_Value

**Figure 7.** Wrongful acts (of those recorded in the ontology) which, with the appropriate attribution of fault, also cause damage and thus trigger the civil tort rule of civil law.

In addition, the judge of the scenario could ask which of the above seven wrongful acts is major offence, that is, an offense that carries a prison sentence of 10 days to 5 years (1825 days).

$$\begin{aligned} \text{MajorTort} \equiv \\ \text{CivilTort} \sqcap \geq 30 \text{ time Imprison} \sqcap \neg (\geq 1825 \text{ time Imprison}) \end{aligned}$$

The question can be asked in Protégé as shown in Figure 8 and take as an answer the four criminal acts depicted.

The screenshot shows the Protégé interface. In the top section, there is a 'Query (class expression)' input field containing the following SPARQL-like query:

```
hasFault some Fault and damageCaused some Damage and hasPenalty some Short-time_imprisonment
```

Below the query are two buttons: 'Execute' and 'Add to ontology'. The 'Execute' button is highlighted with a light blue background. In the bottom section, titled 'Query results', it says 'Instances (4 of 4)' and lists four items, each preceded by a purple diamond icon:

- Electricity\_Theft
- Serious\_Physical\_Harm\_with\_Intent
- Stealing\_Part\_or\_All
- Theft\_of\_High\_Value

**Figure 8.** Major offence wrongful acts (of those recorded in the ontology) which, with the appropriate attribution of fault, also cause damage and thus trigger the civil tort rule of civil law.

## 5. Conclusions

An analysis of the existing legal ontologies (Section 1.1.2) shows that the constructed legal ontology differs in the following points:

1. It codifies legal knowledge differently compared to the legal ontologies presented in (Section 1.1.2), because we use the parts of the legislation as categories, instead of simple legal indexing.
2. Sharing the content of criminal provisions in such a way that it is interoperable with different pillars of Greek law (interoperability).
3. The above codification offers the possibility of reasoning beyond the limitations of indexing.
4. At the same time, comparison and “communication” with the legal systems of other states with appropriate ontology alignment is possible.
5. It allows easy, immediate integration of changes through the consequences, as well as the resulting effects of changes throughout the ontology.
6. The ability to integrate changes allows the evolution of ontologies to be monitored through temporal networks. This possibility will lead to more complete constantly updating analysis of a legal and social nature, which are very difficult to perform in traditional ways due to the exponential increase of editorial data.
7. Ontology is adapted by design (HermeT software, Protégé) to operate with learning machines and to be integrated into intelligence networks. The involvement of artificial intelligence (A.I.) in the administration of justice is increasing [13]. Legal ontologies are expected to be used to train machine learning algorithms to support judgments by judges [36].

Our ontology is a first attempt at an interdisciplinary approach to the development of legal ontologies in Greece. At the same time, it could be the starting point for the creation of tools that could be used by out-of-court settlement organizations or even by the judges themselves for the faster administration of justice.

The realization of the proposed ontology is expected to lead to the semantic relief of users of legal science from the unwieldy editorial complexity, which is exponentially increasing due to the diversified human activity.

In our future work we intend to improve our ontology using SWRL (semantic web rule language), thus improving the implementation.

**Supplementary Materials:** The following supporting information can be download at: <https://www.mdpi.com/article/10.3390/data7120176/s1>, The developed legal ontology is published as Supplementary Material “Supplementary Material—Intersection of Criminal Law & Civil Tort.owl”.

**Author Contributions:** Conceptualization, A.Z.S. and A.K.; Methodology, A.Z.S., A.K. and G.C.M.; Software, A.Z.S.; Supervision of Legal Domain, A.K.; Supervision of Development Domain, G.C.M. and C.B.; Writing—original draft, A.Z.S. and A.K.; Writing—review & editing, A.Z.S., A.K. and G.C.M.; supervision, V.T. and I.A. All authors have read and agreed to the published version of the manuscript.

**Funding:** This article received no external funding. Published free of charge by invitation of MDPI.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. McCampbell, A.S.; Clare, L.M.; Gitters, S.H. Knowledge management: The new challenge for the 21st century. *J. Knowl. Manag.* **1999**, *3*, 172–179. [[CrossRef](#)]
2. Christensen, T.; Lægreid, P. Complexity and Hybrid Public Administration—Theoretical and Empirical Challenges. *Public Organ. Rev.* **2010**, *4*, 407–423. [[CrossRef](#)]
3. Almeida, F.L.F. Benefits, Challenges and Tools of Big Data Management. *J. Syst. Integr.* **2017**, *8*, 4. [[CrossRef](#)]
4. Cloud Computing: The Future of Big Data Management: Computer Science & IT Journal Article | IGI Global. Available online: <https://www.igi-global.com/article/cloud-computing/127105> (accessed on 30 December 2020).
5. Orchard, S. Molecular interaction databases. *Proteomics* **2012**, *12*, 1656–1662. [[CrossRef](#)] [[PubMed](#)]
6. Wang, Y.R.; Madnick, S.E. *The Inter-Database Instance Identification Problem in Integrating Autonomous Systems*; ICDE: Salt Lake City, UT, USA, 1989; pp. 46–55.
7. Fitzpatrick, P. Law and Societies. *Osgoode Hall Law J.* **1984**, *22*, 115–138.
8. Sōtēropulos, D.A.; Christopoulos, L. *Over Regulation and Bad Legislation in Greece (Trans: Polynomia Kai Kakonomia Stēn Ellada: Ena Schedio gia ena Kalytero Kai Apotelesmatikotero Kratos)*; Dianeosis: Athen, Greece, 2017.
9. Ontologies in the Legal Domain | SpringerLink. Available online: [https://link.springer.com/chapter/10.1007/978-0-387-71611-4\\_13](https://link.springer.com/chapter/10.1007/978-0-387-71611-4_13) (accessed on 1 January 2021).
10. Prakken, H.; Sartor, G. Law and logic: A review from an argumentation perspective. *Artif. Intell.* **2015**, *227*, 214–245. [[CrossRef](#)]
11. Griffó, C.; Almeida, J.P.A.; Guizzardi, G. A systematic mapping of the literature on legal core ontologies. In Proceedings of the Brazilian Seminar on Ontologies (ONTOBRAS 2015), São Paulo, Brazil, 8–11 September 2015; CEUR-WS; p. 12.
12. Bex, F.; Villata, S. (Eds.) *Legal Knowledge and Information Systems: JURIX 2016: The Twenty-Ninth Annual Conference*; IOS Press: Amsterdam, The Netherlands, 2016.
13. Bex, F.; Prakken, H.; Van Engers, T.; Verheij, B. Introduction to the special issue on Artificial Intelligence for Justice (AI4J). *Artif. Intell. Law* **2017**, *25*, 1–3. [[CrossRef](#)]
14. Campbell, R.W. Artificial Intelligence in the Courtroom: The Delivery of Justice in the Age of Machine Learning. *Colo. Technol. Law J.* **2020**, *18*, 323.
15. Rizer, A.; Watney, C. Artificial Intelligence Can Make Our Jail System More Efficient, Equitable, and Just. *Tex. Rev. Law Polit.* **2018**, *23*, 181. [[CrossRef](#)]
16. Legal Ontologies and How to Choose Them: The InvestigatiOnt Tool | Semantic Scholar. Available online: <https://www.semanticscholar.org/paper/Legal-Ontologies-and-How-to-Choose-Them%3A-the-Tool-Leone-Caro/42f9d88bb77b2c7a9ad7e814fe298345f71afdd0?p2df> (accessed on 2 January 2021).
17. Athan, T.; Governatori, G.; Palmirani, M.; Paschke, A.; Wyner, A. LegalRuleML: Design principles and foundations. In *Reasoning Web International Summer School*; Springer: Cham, Switzerland, 2015; p. 11.
18. Benjamins, V.R.; Casanovas, P.; Breuker, J.; Gangemi, A. (Eds.) *Law and the Semantic Web: Legal Ontologies, Methodologies, Legal Information Retrieval, and Applications*; Springer: Berlin/Heidelberg, Germany, 2005; pp. 1–17.
19. Normative Requirements Vocabulary. Available online: [http://ns.inria.fr/nrv/v1/nrv\\_v1.html](http://ns.inria.fr/nrv/v1/nrv_v1.html) (accessed on 2 January 2021).
20. ODRL Information Model 2.2. Available online: <https://www.w3.org/TR/odrl-model/> (accessed on 2 January 2021).
21. Creative Commons Rights Expression Language. Available online: <https://creativecommons.org/ns> (accessed on 2 January 2021).
22. L4LOD Vocabulary Specification. Available online: [http://ns.inria.fr/l4lod/v2/l4lod\\_v2.html](http://ns.inria.fr/l4lod/v2/l4lod_v2.html) (accessed on 2 January 2021).
23. OpenScience. Available online: <https://openscience.adaptcentre.ie/> (accessed on 2 January 2021).
24. Public Procurement Ontology. Available online: <http://contsem.unizar.es/def/sector-publico/pproc.html> (accessed on 2 January 2021).

25. Encoding Ontology/Greek Ministry of Interior. Available online: <http://www.opengov.gr/ypes/?p=3885> (accessed on 5 January 2021). (In Greek)
26. 2016\_06\_29ontology.pdf. Available online: [http://www.opengov.gr/ypes/wp-content/uploads/downloads/2016/07/2016\\_06\\_29ontology.pdf](http://www.opengov.gr/ypes/wp-content/uploads/downloads/2016/07/2016_06_29ontology.pdf) (accessed on 19 February 2021).
27. Kolinkova, E. European Legislation Identifier (ELI). ISA2—European Commission. 15 November 2018. Available online: [https://ec.europa.eu/isa2/solutions/european-legislation-identifier-eli\\_en](https://ec.europa.eu/isa2/solutions/european-legislation-identifier-eli_en) (accessed on 5 February 2021).
28. Billis, E. The Greek Penal Code. Social Science Research Network. SSRN Scholarly Paper ID 2963659. 2017. Available online: <https://papers.ssrn.com/abstract=2963659> (accessed on 1 January 2021).
29. Agallopoulou, P.; Masry, Y.K. *Basic Concepts of Greek Civil Law*; Sakkoulas: Athens, Greece; Stämpfli: Berne, Switzerland, 2005.
30. Protégé. Available online: <https://protege.stanford.edu/> (accessed on 5 February 2021).
31. OWL Web Ontology Language Semantics and Abstract Syntax. Available online: <https://www.w3.org/TR/owl-semantics/> (accessed on 5 February 2021).
32. Kischel, U. *Comparative Law*; Oxford University Press: Oxford, UK, 2019.
33. Taliadoros, C.; Ellas. *Greek Civil Code*; Athens-Komotini: Antens, Greece, 2000.
34. Stathopoulos, M.; Karampatzou, A.G. *Contract Law in Greece*; Kluwer Law International B.V.: Anthens, Greece, 2017.
35. Hermit Reasoner: Home. Available online: <http://www.hermit-reasoner.com/> (accessed on 5 February 2021).
36. Doan, A.; Madhavan, J.; Domingos, P.; Halevy, A. *Ontology Matching: A Machine Learning Approach. Handbook on Ontologies*; Staab, S., Studer, R., Eds.; Springer: Berlin/Heidelberg, Germany, 2004; pp. 385–403.