# Reasoning and Representation of Legal Cases Through Ontology

**Wajid Ahmed Channa[1], Qamar Uddin Khand[2], Sajid Ahmed Ghanghro[3], Abdul Moiz Ghanghro[4]**

[1,2,3,4]Department of Computer Science Sukkur Institute of Business Administration University Sukkur, Pakistan

**Abstract**

The proposed study is based upon two interchanging concepts; initially to perform case based reasoning with regard to decide matters by relating them with the earlier decisions made in the same area of domain and to explore the idea behind easiness of representation of legal cases, by means of their interpretation in a suggested ontological interface, so also to formulate computational strategies. Whereabouts, the research study is designed for judicial system and to be populated as well as implemented in the said domain, whereas, the sample of practices is taken from judicial district Sukkur. During data collection, it was found that matters (i.e. cases) are main factors of a judicial system. The implementation of proposed study starts from fetching the idea of manual processes adopted by the system, later on going through the identified problems along with their suggested solutions, after that sketching and populating designed fully ontological operational interface.

*Key words:*
*Court Ontology; Perceived Data; Reasoning; Pattern Matching; Judiciary;*

## 1. Introduction

In supporting view of the study, as presented through the abstract level, from the literature, we followed some of the earlier studies conducted over the same nature of areas, reviewed thoroughly and gone through the expert opinions to whether which study suits to this nature of work.

The concept behind the ontological case based reasoning is that all the matters with whole scenario are to be available on the record in the shape of a backlog system or repository, so that the specified ontology can enumerate best results by accessing user oriented terms to generate the results. The basic idea of this ontological case based reasoning is to provide easiness to judicial officers for deciding matters in a short time with effective reasons; which are actually collected from the previous decisions made along with citations to them. The ontology contains different concepts like; case, judge, court, person, etc, where these entities are referring to the major contribution of the study which perform in operating interface.

It is pertinent to mention here that the traditional approach towards the said domain is full of wasting time while making decisions of cases, as there is none precedent strategy to decide cases by enumerating best reasons from the earlier decisions made over the same nature of cases. Now-a-days, the process of searching a case is a traditional one, which emphasizes the use of manual registers to encapsulate a backlog of the cases i.e. regulating the manual cases process into backlog system, so that the study is proposed to modify the process and to improve the strategies by putting ontological schema.

Henceforth, in the initial phase, the study elaborates some real problems which are identified during data collection and analysis in the premises of judicial department and thereafter proposed solutions against to these real problems are also suggested collectively. For the purpose of data collection, sampling and generating results, we follow the processes which are adopted in the judicial department district Sukkur for acquisition of proper ways to come up with a fully ontological operational interface.

Besides it, we must know; ontology is the explicit description of a domain of interest in respect of concepts and the relationships among them, so also the properties and constraints on properties to make them more and more specific. There are many tools for practicing and modeling ontology i.e. Protégé, NeOn, etc and also some of the tools are available to design UML diagrams i.e. Grafoo, etc.

In continuation to support the study, we lately discuss and illustrate the earlier ontological modeling, which actually resembles to the proposed study and helping out users of the ontological schema to understand the best concepts of an ontology in more depth without referring towards others related domains. As there are a number of studies conducted in the same domain of judicial department. Therefore we are going to pick some of the best of them for elaborating their strategies and give a decent comparison to the current study level.

As per literature review, some of the facts needed to be cited and elaborated, are given as under;

"In law, the ontological assumptions reflect an underlying view of what law is made of, what legal knowledge is which knowledge category play a role in law and how they interrelate [Andre Valente, Joost Breuker, 1996]".

According to the cited fact, the current study interprets real aspects found from the domain of judicial department into the ontological interface and enumerates results for case based reasoning on the basis of user oriented terms, which actually provide easiness to the users. An ontology needs input keys to process terms for the purpose of fetching optimal data/results, after that the reasoning from the backlog is chosen for deciding cases.

"From the point of view of knowledge representation, an ontology delimits what is to be seen in the world and how [Andre Valente, Joost Breuker, 1996]". This aspect focuses on representation of knowledge in an ontological aspect, through which, the current study maps legal case representation into the ontological interface, which points out a factor by delimiting terms and enumerating results from the wide range of choices, not only that but the process of fetching optimal results is also mapped with the case based reasoning from its repository/ backlog of data.

In recent years, it is learnt that the judicial department throughout the province of Sindh has come-up with the idea of converting manual processes into digitalized or computerized form, only for the sake of finding easiness while working in the domain of judiciary. Nevertheless, much of the processes have been found converted from manual processes into the computerized and the significance of these processes have also been identified during data collection and analysis.

It is found that the judicial department of Sindh province has developed and managed the cases (of all type i.e. Criminal, Civil and Family type cases) and their backlog/repository on a Case Flow Management System(CFMS), which highly emphasizes a click away easiness to the users, judicial officers and staff of the domain to make the most of this application. It cannot be avoided that the current efforts taken by the I.T department of judiciary are adequate to remove the barriers of such factors which cause wastage of time, correctness of processes with the easiness and reasoning about cases towards the nature of matter by means of capturing viable circumstances but there is the need of refining them with the help of effective modeling approaches.

It is elaborated in the section of concepts of law and legal documents that justification –which is derived from the term ius (law)– is the domain of epistemology; the study of what we can know and believe. Epistemology is about reasoning, argument and evidence, while ontology is concerned with modeling (understanding) and explaining the world [Breuker, J., et al. 2002]. So, the structure of the ontology of case based reasoning, which is added in the study, is much better to extract the reasoning from the backlog with the help of some specific parameters, which are accessed through user oriented keywords, after extraction, the simplest formatted data will be provided to the user for performing or making decisions by means of citing earlier decisions made on the same sort of data without taking much efforts and loss of time.

The tools followed by the study are discussed, as under;

## A. Protégé

Protégé is an OWL ontology development environment, it contains concepts, relationships between the concepts, properties on them and constraints over the properties (for making them more specific)[9], not only that but SPARQL queries are also implemented in it for the purpose of fetching and extracting meaningful and useful data from a dataset.
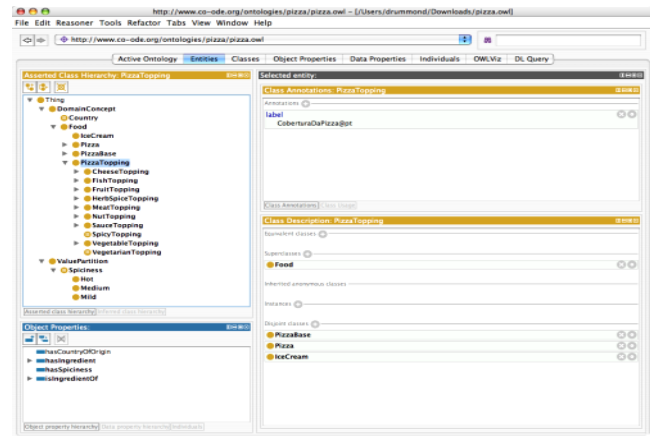


## B. Grafoo

Grafoo is used to draw UML based graphical designs, so that all sketches related to the ontology are presented through Grafoo. It is an open source tool that can be used to present class, properties and restriction with OWL ontology. The advantages of using such a Grafoo diagram are thus that it displays the logical relationships between elements of an ontology, or a sub-section of an ontology, in a manner that is relatively straightforward to understand easily. Once one has grasped the meaning of the different elements of a Graffoo diagram. We use this tool for implementing the design of ontology skeleton of our proposed research paper.
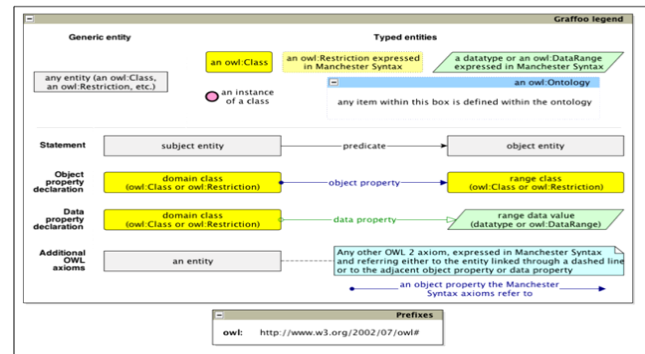


## C. NeOn ORSD Document

NeOn methodology presented an ORSD document to specify the slots of an ontology for fetching its detail in a narrow way; it means there is a neat and clean way to explain each sprint like phase of ontology[10]. An ORSD comprises of purpose, scope, level of formality, intended

users, intended uses and pre-glossary terms (terms and objects).

## 2. Ontologies and Types of Ontologies

"The term ontology was borrowed from Philosophy, where it meant a description of nature of being a theory of existence". "The meaning of the term in AI is not quite the same and is closer in many ways to an epistemology"[1].

"The most frequently quoted definition is a specification of a conceptualization [1], which are rather vague".

"To do so, we will introduce in this section some basic dimensions through which we can interpret and explain the different types of ontologies and their uses[3]". Notice that while in this article we will apply these concepts to legal applications, the concepts apply to all work with ontologies in AI in general.

### 2.1 Applications of Ontologies

- Used in structuring/organizing information
- Suitable for problem solving and reasoning
- Used for searching and semantic indexing
- Necessary to understanding the domain

It is generally known that Ontology is used for the purpose of structuring and organizing information for the sake of enumerating best results, through which a system can extract meaningful information. Actually, it keeps data in a structured interface and it is commonly found that structured data can easily be populated for extracting information against the unstructured data, besides it, if the data is in structured form, then the process of extraction takes less time. Due to which, we found necessary to pick the ontological schema for assembling backlog of judicial organization data, through which meaningful information can be sorted out and extracted from backlog of domain, which will be utilized for several purposes.

The aspect of problem solving as well as reasoning can also be made available through designing an ontological interface. As we know about an Ontology; the concepts, relationships, properties and constraints are taken as the part of study, through which a problem solving and reasoning is carried out. Whereabouts, one of the dimensions of proposed study is reasoning about the legal cases; the users of this study can make the most of current ontological schema, by retrieving the best reasons for making decisions, which will be a kind of unchallengeable schema.

Mostly, each and every ontological schema presents a good enough method of searching and semantic indexing in the desired domain of interest, just because of containing uniqueness. On the other hand, an ontology also facilitates SPARQL queries; these queries provide results by fetching data from the repository with strong enumeration.

The knowledge about domain can be found straightforward in an ontological schema, just because of the fact that ontology has much strength of encapsulating and organizing the information, through which domain knowledge can easily be extracted. It has become way easy through ontological schema to enumerate information by putting some desired keywords in the specific application.

### 2.2 Ontologies as Knowledge Mangement Tool

"Within Knowledge Management ontologies are primarily used for establishing a common vocabulary and consequently common understanding of a certain knowledge domain"[4]. In other words, the primary function of the ontology is to serve as a shared conceptual model.

"In the process of shared conceptual modeling a group discussion is organized in which the members are invited to express their ideas, beliefs and knowledge about a system is held"[4]. "This representation allows the members of the group to easily adapt their ideas, beliefs and knowledge together"[5]. The modeling discussed here-in-above, can interpret user oriented keywords into the desired and specific representation.

Applied ontologies within Knowledge Management are built with the aims of;

- Knowledge Management ontologies are used for establishing the mental models of the participating individuals[6];

The ontological schema, which is used for the purpose of encapsulating knowledge or information and to act as a knowledge management-Onto, is the source of structured and organized information; which extract information in an organized manner, by putting several roles of ontology in the perspectives of knowledge management. There are many Knowledge Management tools available but ontological schema to render the factors of knowledge management, is most valuable and pursuing. The researchers (particularly from the field of semantic web) found much growing strength of ontological schemas in all fields of knowledge management.

- It is used for creating a representation or conceptual model[6];

Entities and their representation along with the proposed logics, in a kind of conceptual model is the abstract way of retrieving information from the backlog of data, which actually refers to the model towards specific parameters. The significance of ontology in a conceptual model can be found through the retrieval method-used to create representation or conceptual model, which is provided by

the schema possessing all desired techniques of an ontology.

- Main aim is to "creating a situation in which information about the mental models of participating individuals can be exchanged[6]" (i.e. creating a shared conceptual model);

The concept behind the shared conceptual model is as undergone as the concept of structured and organized model; contains useful information, which is always ready to retrieve information from the backlog of data and a user finds it much convenient to compose queries, repeatedly with the intention of fast track of data to get travelled in an easy manner, just because of the fact of information retrieval towards a user. Mostly, designed datasets are partitioned in a logical way, to response a user immediately, whereas, an ontological schema retrieves and extracts information without setting priority of logics in between the entities or concepts.

## 2.3 Roles and Uses of Ontologies in Law

We propose five main uses or roles of ontologies can be recognized[3]; Organizing and structuring information; Problem solving;   Searching and semantic indexing; Semantics integration and interoperation; and Understanding of domain. Some ontologies are referenced here-in-below.

Table 1: Summary of legal ontologies in the literature, their types and roles

| Ontology or Project | Application | Type | Role |
|---|---|---|---|
| "Valente and Breuker's Functional Ontology of Law"[6] | "General architecture for legal problem solving" | Knowledge base in Ontology, highly Structured | Understand a domain, reasoning &problem solving |
| "Mommer's Knowledge based Model of Law"[7] | "General language for expressing legal knowledge" | Knowledge base in English, very lightly structured | Understand a domain |
| "Van Kralingen and Visser's Frame Ontology"[7] | "General language for expressing legal knowledge, legal KBSs" | Knowledge representation, moderately structured (also as a knowledgebase in Ontology) | Understand a domain |
| "Benjamin et. al.'s ontologies of professional legal knowledge"[3] | "Intelligent FAQ system (information retrieval) for judges" | "Knowledge base in Protégé, moderately Structured"[8] | Semantic indexing &Search |
| "Lame's ontologies of French Codes" [2] | "Legal information Retrieval" | "NLP-oriented (lexical) knowledge base, lexical, lightly structured"[8] | Semantic indexing &Search |
| "Leary, Vanden berghe & Zeleznikow's Financial Fraud Ontology"[5] | "Ontology for representing Financial fraud cases" | "Knowledge base(schema) in UML, lightly structured"[8] | Semantic indexing & Search |
| "Gangemi, Sagre and Tiscornia's Jur-Wordnet"[1]` | "Extension to the legal domain of Wordnet" | "Lexical knowledge base in DOLCE (DAML), lightly structured"[9] | Organize and structure information |
| "Asaro et. al.'s Italian Crime Ontology"[5] | "Schema for representing crimes in Italian law" | "Knowledge base(schema) in UML,lightly structured" | Organize and structure information |
| "Boer, Hoekstra & Winkels' CLIME Ontology" [2] | "Legal advice system for maritime law" | "Knowledge base in Protégé & RDF, moderately structured"[9] | Reasoning and problem solving |
| "Zeleznikow and Stranieri's Argument Developer" [1] | "Several legal knowledge based systems" | "Knowledge representation, moderately structured"[9] | Reasoning and problem solving. |

The modern growing field of ontology has several ways of expanding the concepts in semantic web search, where a user depends on such keywords-interpretation of different sort of inputs given by a user of the system, which emphasizes a system to retrieve and extract meaningful information with the help of strengthening schema.

## 3. Environmental Variables

It has been noticed during data collection and capturing real life scenario in the judicial department that there is acute need of adopting technical activities and reasoning towards cases. However, the following Research Questions are proposed and discussed in detail;

i. Focusing on less time consumption techniques by avoiding lengthy manual processes
ii. Avoiding extraordinary efforts while making decisions through extracting the depth of reasoning

While working over the data in judicial domain, the processes to maintain their standards were found in the form of manual processes-manual registers and kind of books to encapsulate different entries for tracking their status, which consume plenty of time for completing their tasks. To defend the Research Questions, general problems captured from real environment, identified within premises of judiciary, are discussed with their proposed solutions, as below;

## 3.1 Problems (Identified In The Domain)

i. The Judicial Officers (also referred to as Judge) of judicial department face a lot of challenges while making decisions, as there is no reasoning available which is made earlier to follow situation by keeping the same circumstances in his mind
ii. 3.1.2 The rank system of the judicial officers; the performance of the judicial officers(officers working as Judge in the judicial department) is

measured by the help of units earned by them on cases, instead of collecting major factors of all other necessary parameters

    iii.     3.1.3 There is a big problem with the parties of cases, as they don't even know their particulars of the cases. Their matters are actually managed by Advocates from initial to the last stage, which also emphasizes the need of adopting effective processes to remove the barriers affecting them

By keeping in mind that a single research study cannot answer all three problems identified in this particular domain of judicial department, we pick the first problem and elaborate its proposed and optimal solutions-ontological operational interface, as under;

## 3.2 Solutions (Proposed for the Domain)

    i.     Ontology modeling to enumerate the reasoning from backlog with the same scenario along with the resembled circumstances is the best way to come-up with the reasonable decision, which can easily be decided without any challenges

Nevertheless, an ontological schema has enough strength of enumerating 'reasoning as well as problem solving'; as elaborated in the Section-II, the proposed study implements ontological modeling, through which reasoning is possible, not only that but also trying to simplify representation of legal cases in the perspectives of judicial department, by which the practitioners can easily find the significance of ontology.

While, in the essence of decision making, there is an acute need of extracting information to sort out and to capture reasoning of legal cases, whereas, to confirm the potential of reasoning, we put constraints to ensure the rhythm of modeling with accurate aspects of the provision of such data. The basic idea of reasoning and representation is optimized in an ontological schema, the study transforms suggested entities in the form of UML design-diagrammatically presentation of concepts, their properties, relationships among them and applying constraints over the properties for their uniqueness.

## 3.3 Entities For Ontology Development

The purpose of Legal case ontology is to retrieve and extract information along with case based reasoning[9]. The ontology contains elements representing the cases i.e. Case (decided and undecided cases), Judges (judicial officers), and Public (parties of a case).

A Legal case ontology encompasses different entities, which are brought-up during data collection from the domain of judicial department, discussed as under;

### A. Case

    i.     Undecided(Pending) / Decided(Disposed of)
    ii.     Types: Criminal, Civil and Family cases/matters

### B. Case elements

    iii.     Case institution date, date of hearing, diary (detail of case), date of disposal[9]
    iv.     Name of court, judge, advocate, parties (along with gender in siblings)

### C. Judges/Judicial Officers

    v.     District Judge (D.J)
    vi.     Additional District Judge (ADJ)
    vii.     Senior Civil Judge (Sr.C.J)
    viii.     Civil Judge (C.J)

### D. Advocate

    ix.     Public Prosecutors⊗advocate engaged by needy persons through Govt. sources, which freely defends cases of pubic)
    x.     Advocates: (advocate engaged privately by the public)

### E. Public

    xi.     Plaintiff
    xii.     Defendant

The Legal case ontology may also encompass the backlog of cases from a certain period of time for the purpose of tracing them to extract information related to the tasks arising out of the current study. Their representation is helpful to extract reasoning about the cases, through organizing data in a manner, so that an ontological interface can look into such repository and fetch desired results within short time. No doubt, the data being specific after applying constraints is beneficial for fetching reasoning without mapping it in a local manner.

## 4. Methodology

The proposed study is designed and structured by using ontology development tool i.e. Protégé and graphically diagram sketching tool i.e. Grafoo. No doubt, these both the tools are referred commonly for designing diagrams and creating ontology based models for implementing structures in i.e. semantic search, etc. Herein-forth, the research study is also followed by Ontology Requirement Specification Document (ORSD) document, which is used for making it meaningful to the readers as well as practitioners and to give an easy way to initiate it for the future work.

It is more explained that the ontological structure of the current study is based on advanced information retrieval; a single ontology structure is not enough to enumerate results from the backlog as a whole and to satisfy in all aspects, so we have sketched many ontologies, each of which maps a part of the research study.

It is learnt that law is highly entangled with common sense views, so we include specific terms to describe the structures for avoiding any incorrect information being fetched and enumerated by the system. The entities of the proposed study are mapped and sorted out in the initial phase, later on these are sketched over the desired interface by using protégé, which is discussed and shown as under;

Here, a case, name of a person, name of a Court are designed as the major concepts of the study, these are followed by sub-concepts for the purpose of inheriting data in a sorted manner, which is in the favor of an ontological schema. Besides it, another structure is also designed, which contains case (type of cases), name, date, nature, decision and age of cases, this structure helps out the inherited structure by propagating its data after extraction in a sorted manner.
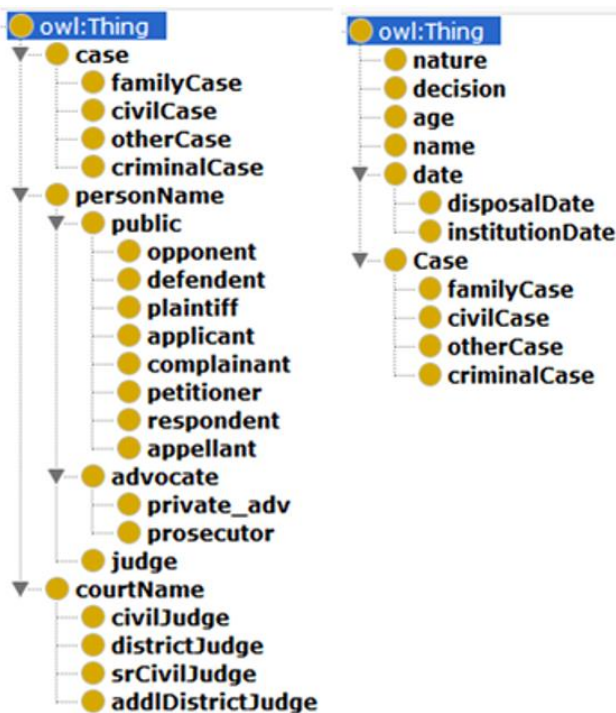
| | Table 2: Research Study Representation Through An Orsd Document |
|---|---|
| 1 | Purpose: The study is to make the sense of reasoning of cases in the domain of judicial department, so also to suggest interchanging and adopting computational strategies against the manual processes, which are time wasting |
| 2 | Scope: The study is designed to be implemented in the judicial department (also referred to as judiciary), whereas, it followed the practices reflected in the judicial district Sukkur |
| 3 | Level of formality: The aspects of study are developed by using Protégé (an ontology development tool) and Grafoo (a model designing tool)[10] |
| 4 | Intended users: Judicial officers(Judges), Staff members (working in judicial department), and the Public (having matters for decision or else) |
| 5 | Group of competency questions: What cases are treated situation based? Which decisions are made potentially? How to adopt easiness in processes? |
| 6 | Pre-Glossary of terms: Terms: Court ontology; perceived data; reasoning; pattern matching; judiciary; Objects: Computational devices |

After discussing an ORSD with different slots, now there is the need of mapping a case with its major factors or including more contribution to the research.

For contributing easiness to the readers, the diagrammatical aspects of the study paper are best way that ontology concepts and the attachments will be a basis of following the strategies as presented. The shareable thing regarding this research paper and attachments shown in both the figures is that, I.T department of Sindh High Court has initiated to convert manual processes into the computerized format, for that purpose, the data is being inputted and collected in a repository form but is still under process. Therefore, the current study will get populated and implemented on the basis of such repository available in the record of judicial department.

The mapping point is made through the use of Grafoo tool, in which a clear dimension of a case and relationships in between the entities are shown for further discussion.
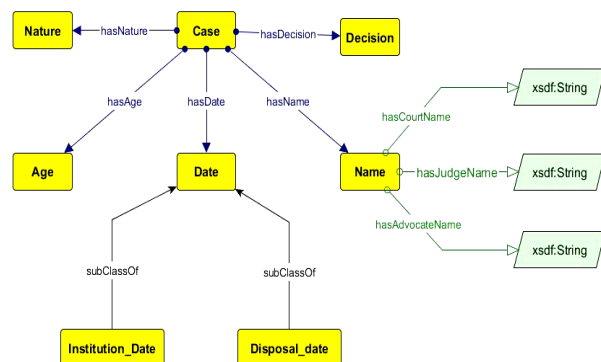


Fig. 1  Ontological model in Protégé



Fig. 2 case representation in an ontology

## 5. Conclusion

The study presented in this research paper is based upon the strategies reflected in the real environment of the judicial district Sukkur and pointed out some of the real problems and after that proposed solutions towards each of the problem along with their possible aspects of the computational strategies.

There were two discussion-based aspects; the case-based reasoning, in which a case (matter) of the court is traced by its nature and some other parameters and replied by some type of same situation-based results in terms of detail or information, whereas the other aspect reflects the case search by means of its backlog[10]. There is no doubt that a backlog in the shape of big data with having un-mannered storage policies will cause to occur sensitive problems.

## 6. Future Work

The study can be extended with some more aspects by means of keeping in mind that all the cases heard in the Court room are not of same nature and sometimes are referred to be perused by different ranked judicial officers i.e. sometimes referred to the Additional District Judges rather than Senior Civil Judges or else. So, there must be a sensing environment which automatically generates fair reasons to address and/or locate the cases towards the optimal Court room.

## References

[1] Breuker, J., et al. Ontologies for legal information serving and knowledge management. in Legal Knowledge and Information Systems, Jurix 2002: The Fifteenth Annual Conference. 2002.

[2] Shaheed, J., A. Yip, and J. Cunningham. A top-level language-biased legal ontology. in ICAIL Workshop on Legal Ontologies and Artificial Intelligence Techniques (LOAIT). 2005. Citeseer.

[3] Van Engers, T., et al., Ontologies in the legal domain, in Digital Government. 2008, Springer. p. 233-261.

[4] Mommers, L., Ontologies in the legal domain, in Theory and Applications of Ontology: Philosophical Perspectives. 2010, Springer. p. 265-276.

[5] Breuker, J., A. Valente, and R. Winkels, Use and reuse of legal ontologies in knowledge engineering and information management, in Law and the Semantic Web. 2005, Springer. p. 36-64.

[6] Valente, A. and J. Breuker, A functional ontology of law. Towards a global expert system in law, 1994: p. 112-136.

[7] Gangemi, A., Design Patterns for Legal Ontology Constructions.LOAIT, 2007. 2007: p. 65-85.

[8] Valente, A., Types and roles of legal ontologies, in Law and the semantic web. 2005, Springer. p. 65-76.

[9] Wyner, A., An ontology in OWL for legal case-based reasoning. Artificial Intelligence and Law, 2008. 16(4): p. 361.

[10] Wyner, A. and R. Hoekstra, A legal case OWL ontology with an instantiation of Popov v. Hayashi. Artificial Intelligence and Law, 2012. 20(1): p. 83-107.

[11] Andre Valente and Joost Breuker, A functional ontology of law, Article. October 1996. p.1