A Description of Legal Interpretations in Risk Management with the Use of Ontology Alignment Formalisms

Piotr STOLARSKI [a, 1], Tadeusz TOMASZEWSKI [a], John ZELEZNIKOW [b], Witold ABRAMOWICZ [a]

[a] *Poznan University of Economics, Department of Information Systems, al. Niepodleglosci 10, 60-967, Poznań, Poland*
[b] *Laboratory of Decision Support and Dispute Management, School of Information Systems, Victoria University Room G.03, Land Titles Office, 283 Queen St., Melbourne, Victoria, Australia*

Abstract. The paper has two goals: firstly, we explain how ontology mapping formalisms can be used to denote the many interpretations of a given legal concept; secondly, we provide a short case, justifying the potential need of using such formalisms in modern legal knowledge models. This approach may be especially useful for coding knowledge about specific legal cases.

Keywords. Risk management, legal concepts, semantic modeling, travel insurance, ontology alignment.

Introduction

The key challenge that we are undertaking in this research is to elaborate on how legal information systems become aware of different potential meanings of a legal concept instead of being only aware of the concept's existence.

In this work we meet two main goals. We deal with the problem of interpretation and facts categorization of legal concepts, which constitute agreement provisions. In order to illustrate the problem a specific case is given as an example. The case comes from the insurance industry but the generalized method should be applicable also elsewhere. Apart from the main goals we also insist that the modern legal knowledge models are powerful enough to bring vital information not only about concepts but their interpretations as well.

The context of concepts in the legal ontologies is given by the net of relations and other concepts connected to the one that is being discussed. The definition of such a concept is also supported by instances – if given. Yet such an environment of an entity in the ontology can only hold the knowledge about a single – predefined meaning of

[1] Corresponding Author: Department of Information Systems, Poznan University of Economics, al. Niepodleglosci 10, 60-967, Poznań, Poland; E-mail: P.Stolarski@kie.ae.poznan.pl.

this entity. In real life the meaning (semantics) of an entity may differ, depending on circumstances.

The semantic differences are not only connected and reflecting the changes in the state of knowledge in time (like for instance the number of planets in the Solar system reduced after the 2006 meeting of the International Astronomical Union). The expected meaning of an ontological entity may also depend on other contexts – such as, for example, the subjective point of view of a person or their subjective awareness of the current state of affairs. Such a case is especially important in the legal domain, as the way the provisions are understood is a crucial factor for sustaining the order of law. On the other hand if there is a misunderstanding between parties, then the knowledge about the particular differences about the ways of different interpretations is also vital. This is extremely true in the field of disputes resolution, as we may assume that the starting point of any dispute is when the parties do not share the common semantics of earlier created provisions.

1. Negotiation and Risk Management

One of the principal goals of the law is to reduce risk through the avoidance of litigation. McBurney and Parsons [10] include an excellent coverage of risk assessment; however there is very little application of their work to the domain of law. Zeleznikow [23] provides a detailed discussion of law, negotiation and risk[2].

Whilst there has been extensive research on law and probability, there is a scarcity of reported research on law and risk. Nevertheless, most legal professionals regularly use risk analysis when preparing and indeed avoiding litigation.

Whilst probability and risk are commonly inter-related[3], they are used in quite different ways in the legal domain. Probability and risk have significant differences in how they are utilised in civil law and criminal law[4]. In criminal law, the onus of proof is beyond reasonable doubt. To quote Black [2], this means that the evidence must clearly, precisely and indutiably convict the accused. In criminal law, statistics has been used to analyse evidence (see for example Aitken [1] and Schum [15]). Areas investigated include DNA testing, Fingerprints, Footwear and Ballistics. Kadane and Schum [9] used probability and Wigmore's diagrams of evidence to analyse the trial of the American anarchists Sacco and Vanzetti[5].

[2] Much of the discussion in this section is taken from Zeleznikow [23].

[3] As also is uncertainty.

[4] The findings in this book relate to both Civil Law and Common Law countries. It should be noted that the word 'civil' is used in two different contexts. Civil law may be defined as that legal tradition which has its origin in Roman law, as codified in the Corpus Juris Civilis of Justinian and as subsequently developed in Continental Europe and around the world. Civil law eventually divided into two streams: the codified Roman and uncodified Roman law. Civil law is highly systematised and structured and relies on declarations of broad, general principles, often ignoring the details. Civil law systems are closed, in the sense that every possible situation is governed by a limited number of general principles.

As opposed to criminal law, in which conflict is between the state and the defendant, civil law involves conflict that does not involve the state as a party to the conflict. It involves two equal status parties: the plaintiff and the defendant.

[5] Ferdinando Sacco and Bartolomeo Vanzetti were two Italian-born American laborers and anarchists, who were tried, convicted and executed on August 23, 1927 in Massachusetts for the 1920 armed robbery and murder of two pay-clerks in South Braintree (a Boston suburb), Massachusetts. Their trial attracted enormous international attention, with critics accusing the prosecution and presiding judge of improper conduct, and of allowing anti-Italian, anti-immigrant, and anti-anarchist sentiment to prejudice the jury. Prominent

Zeleznikow and Stranieri [24] stress the software can help with legal interpretation, but not make decisions about facts. They noted that that only a human can make decisions with regard to facts and that humans will disregard information they find inconceivable.

In building legal decision support systems, it is thus better to focus upon interpreting the law rather than making decisions upon facts. Because of the beyond reasonable doubt onus in criminal law, very few decision support systems have been built in criminal law. The exceptions are in the domain of sentencing (see Schild [13], Zeleznikow [22] and Schild and Zeleznikow [14] for a discussion of discretion and sentencing information systems). The burden of proof in civil law is on the balance of probabilities. Hence it easier to provide decision support systems in civil law domains.

Judicial decision-making first involves the determination of the facts of a case. The second step then involves applying the law to the given fact situation. Legal decision support systems have primarily been used in civil law domains to provide an interpretation of the law.

One of the major benefits of decision support systems that advise upon risk assessment is that they help avoid litigation. Ross [12] states the principal institution of the law is not trial; it is settlement out of court. To support this argument, Williams [21] notes that whilst the figures may vary in different jurisdictions, of all the cases listed before the courts only about 5% of the cases are ever heard by the court and only 1% of the cases result in judicial decision-making. He quotes the 1980 Annual Report of the Director- Administrative Office of the United States of America Courts, Washington, D.C. (1980) at pages A-28 and A-20 which states that the average percentage of cases reaching trial verdict is 6.5%. The average for districts varies from a low of 2.0% to a high of 16.1%. By circuits, the differences are less extreme, ranging from a low of 4.0% in the District of Columbia Circuit to a high of 8.4% in the Eighth Circuit.

Further, many disagreements are never even listed before courts. Ross [12] claims that a major study of personal injury/automobile insurance cases in the United States shows that of claimants represented by attorneys who obtained some compensation, 72% filed suit, 6.5% started trial and 2% reached a verdict[6]. Obviously these figures will vary depending on the jurisdiction and type of actions; however what does not vary is that negotiated settlements account for the vast majority of all legally binding decisions.

To avoid the risks of extra costs and an unfavorable outcome, disputants often prefer to negotiate rather than litigate. Whilst investigating how disputants evaluate the risks of litigation researchers are faced with a basic hurdle - outcomes are often, indeed

---

Americans such as Felix Frankfurter and Upton Sinclair publicly sided with citizen-led Sacco and Vanzetti committees in an ultimately unsuccessful opposition to the verdict. Sacco's and Vanzetti's execution elicited mass-protests in New York, London, Amsterdam and Tokyo, worker walk-outs across South America, and riots in Paris, Geneva, Germany and Johannesburg. Sacco's and Vanzetti's actual guilt remains a source of controversy. Significant post-trial evidence cast doubt upon the verdict and the fairness of their murder trial. These include modern ballistics tests, revelations of mishandled evidence, a confession to the crime by convicted bank robber Celestino Medeiros, and statements by numerous participants in the case.

On August 23, 1977, Massachusetts Governor Michael Dukakis signed a proclamation declaring, "any stigma and disgrace should be forever removed from the names of Nicola Sacco and Bartolomeo Vanzetti." Dukakis said, "We are not here to say whether these men are guilty or innocent. We are here to say that the high standards of justice, which we in Massachusetts take such pride in, failed Sacco and Vanzetti." Taken from http://en.wikipedia.org/wiki/Sacco_and_Vanzetti last accessed September 6 2008.

[6] AUTOMOBILE PERSONAL INJURY CLAIMS, U.S. Department of Transportation, Automobile Insurance and Compensation Study, 1970.

usually, kept secret. If the case is litigated, it could be used as a precedent for future cases, which may be a disincentive for one or more of the litigants ([8]). Publicity of cases and the norms resulting from cases makes the public aware of the changing attitudes towards legal issues[7]. The adjudication decision not only leads to the resolution of the dispute between the parties, but it also provides norms for changing community standards ([6]). This latter facet is lost in negotiated settlements.

The secrecy behind negotiated settlements is one of the reasons for the paucity of published material on legal decision support systems dealing with risk. WIRE IQ (Wire Intelligent Quantum) is an Internet delivered decision support system which allows lawyers, insurers and re-insurers access to up-to-the minute quantitative analysis of current claims settlement values for a wide range of personal injuries ([5]). Douglas and Toulson [5] state that analysis and price discovery of tort in un-settled personal injury claims has been conducted using rule-based systems. In such systems, the details of the claim (injury type, claimant's age, sex, earnings, etc.) are entered into the system. The system then applies predefined rules to determine the settlement value of the claim.

WIRE IQ uses a database with thousands of records of settled claims and court wards for a range of personal injury claims. It then uses provides the following analysis services based on the data: trend analysis, comparative analysis, precedent search and forecasts. The forecasts are performed using neural networks.

Avoiding risk is a fundamental goal of insurance agencies. The Rand Corporation built numerous expert systems in the early 1980's [17, 18, 19, 11] to advise upon risk assessment.

One of their early systems, LDS, assisted legal experts in settling product liability cases. Another Rand Corporation decision support system, SAL [17] also dealt with claims settlement. SAL helped insurance claims adjusters evaluate claims related to asbestos exposure. SAL used knowledge about damages, defendant liability, plaintiff responsibility and case characteristics such as the type of litigants and skill of the opposing lawyers.

In this paper we investigate risk avoidance in the domain of travel insurance to demonstrate our approach for developing formalisms, methodologies for the task of interpreting legal knowledge about the insurance industry.

2. The Travel Insurance Case Model

2.1. Case Description

The described case is based on real events. Private details have been removed on account of anonymity sustaining.

The subject was approved by her employer to attend a conference in Portugal and work with a colleague at a university in another European country. Four day's prior to travel being due to commence, the subject's sister, died of breast cancer. Whilst the illness was terminal, at the time the ticket for travel was initially booked and paid for, the subject believed that her sister would survive for at least another year.

[7] In common law countries, changing community values towards issues such as abortion, euthanasia and rape within marriage have been enacted in the legal system through landmark precedents, rather than parliamentary legislation.

At first, cancelling the trip was considered, but the organisers of the conference, where the subject was due to give an invited address, pleaded for her to participate in the conference and offered to reorganise the conference program.

To meet their request, as well as the needs of the subject's family; after much conflict with the airlines, the subject managed to reschedule the departing flight to until a week after her sister's demise. This resulted in her having to repurchase the London to Lisbon leg of her flight, incurring an additional cost of $US270.

The subject was initially confident that the employer's travel insurance would pay the extra cost. Yet, the claim for this amount for reimbursement was refused by the insurance agency.

2.2. Documents

Below we present experts from documents connected to the introduced case. The documents reflect the legal state of affairs.

The Policy:

SECTION 5 – LOSS OF DEPOSITS AND CANCELLATION CHARGES

EXTENT OF COVER

We will indemnify You and any Insured Person for loss of travel and accommodation expenses paid in advance by You or the Insured Person and for the loss of which You, he or she is legally liable and which are not recoverable from any other source, consequent upon the cancellation of travel occurring between the date of payment of those expenses and the date of commencement of the Insured Travel caused only by:

1. The Unexpected Death, Injury or Sickness, compulsory quarantine or jury service of an Insured Person or any person with whom the Insured Person intended to travel;

RELATIVE means […]

SERIOUS INJURY OR SICKNESS is a […]

UNEXPECTED DEATH means death which occurs fortuitously and does not include the death of a terminally ill person unless the death is caused by any other reason.

EXCLUSIONS

We shall not be liable for loss of expenses caused by:

4. Death of relative with a known short life span as a consequence of a Sickness.

The Death Certificate:

The document certifying the death indicated that

"the claimant sister's condition was terminal and has been known for some time".

2.3. Conceptualization

The conceptual diagram of the case is contained in Figure 1. The diagram shows that we treat knowledge of the parties about the case as separate pieces of ontology. The conceptualization reflects information and categories gathered during the analysis of documents as presented above. The conceptualization phase is a fundamental element of ontology development process. We deal more with legal ontologies in other papers (i.e. [16]).

3. Legal Concepts Interpretations Modeling

In the process of interpretation there may be a divergence between different notions about the classification of certain events or facts into given categories. Such divergences typically become apparent at the time of classification rather at the time of creation or when negotiating definitions about the general meaning of symbols.

Theoretically the fuzzy nature of definitions is a matter of economy of information. The trade off between the cost of preparing sufficiently precise provisions and the cost of potential dispute marks the nearly optimal point of precision of agreements' resolutions.

In terms of ontologically modelling such cases, the mentioned economy of information is represented by the richness of additional properties, attributes and axioms specifying given concepts. The more such entities exist, the less is the risk that parties will misclassify instances in the processes of categorization.

On the other hand the definitions may be demonstrated by the examples. For instance, an event concept may be introduced by any potential real-life event that by the agreement of parties should be recognized as the kind of event. In reality this is not possible to realize, so only approximate approaches are used.

If the concept definition is well-tailored and there is still place for disagreement between parties then three situations are possible:

- The definition does not cover all the relevant facts known about the object of classification.
- Parties interpret some parts of the definition in different ways.
- Parties share the meaning of a concept but have different knowledge about the facts at a given moment.

In the first case only the clear-cutting post ante redefinition is possible. Another two possibilities are – in contrast – a quite interesting matter for modelling.

We propose a way of modelling such situations by assuming that in fact there exists more than one ontology, each of which is in effect at the same time. If this is true, than we further expect that concepts from such parallel ontologies may be aligned to picture the relations between different understandings of the concepts of different parties. For the ontology alignments, the developed formalisms may be used.

3.1. Ontology Alignments

A comprehensive proposition of how an ontology alignment should be defined is given in [3]. The definition provides an information structure that allows representing alignment in such a way that it can be (re)used in many contexts and situations.

Assuming that two ontologies: O1 and O2 are given, each containing entities of certain meta-types (classes, instances, relations, formulas, axioms, etc.), alignment is a set of correspondences between pairs of such entities <e1, e2> where e1 belongs to O1 and e2 to O2. The entities may be either simple instances of meta-types or complex structures made of simple entities[8].

Such correspondences may be viewed as quadruple:

<e1, e2, R, n>

where:

[8] Definition is based on [4].

- e1 and e2 are the entities between which a relation is asserted by the correspondence;
- R is the relation, between e1 and e2, asserted by the correspondence. For instance, this relation can be a simple set-theoretic relation (applied to entities seen as sets or their interpretation seen as sets), a fuzzy relation, a probabilistic distribution over a complete set of relations, a similarity measure, etc.
- n is a degree of confidence in that correspondence (this degree does not refer to the relation R, it is rather a measure of the trust in the fact that the correspondence is appropriate – "I trust n% the fact that the correspondence is correct/ reliable/…").

The degree of trust represented by n may be computed in many ways (for instance: users' feedback or log analysis). The alignment description should be made up of at least the below given items:

- a level used for characterizing the type of correspondence;
- a set of correspondences which express the relation holding between entities of the first ontology and entities of the second ontology.;
- an arity (default 1:1) Usual notations are 1:1, 1:m, n:1 or n:m. We prefer to note if the mapping is injective, subjective and total or partial on both side.

More advanced way of alignment descriptions are possible, but they are out of scope of the paper.

The relation holding between the two entities is by default equivalence. Nevertheless, it is not restricted to this type of relation, but can be more sophisticated - e.g., subsumption or incompatibility [7]. Even some fuzzy relations are possible. The strength denotes the confidence held in this correspondence. Since many alignment methods compute the strength of the relationship between entities, this strength can be provided as a normalised measure. The measure should belong to an ordered set M with maximum and minimum elements. Currently, this value is normally restricted to be a float value between 0 and 1.

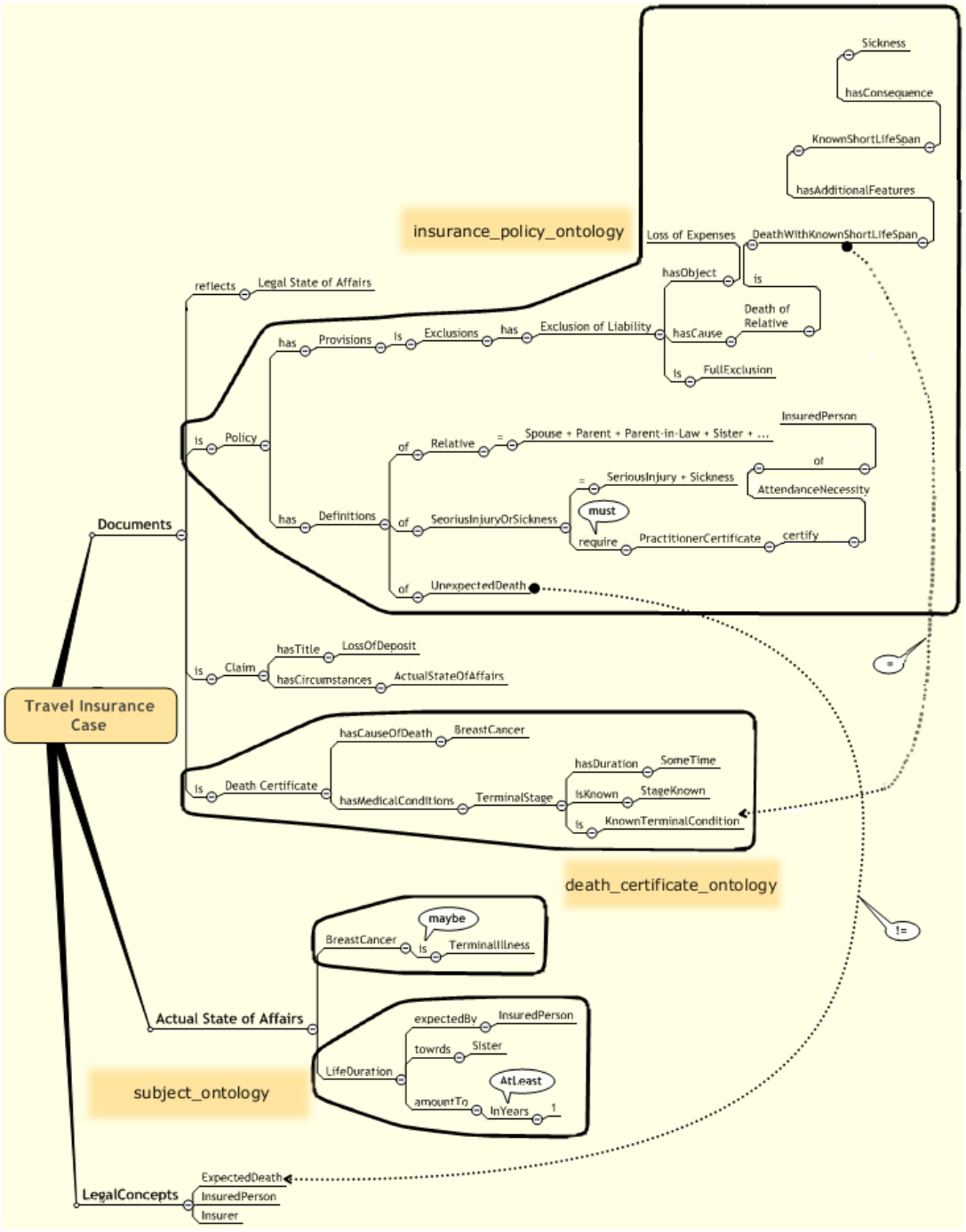

Figure 1. The case model

```
<rdf:RDF
xmlns="'http:"//knowledgeweb.semanticweb.org/heterogeneity/alignment'
    xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'
    xmlns:xsd='http://www.w3.org/2001/XMLSchema#'>
    <Alignment>
      <xml>yes</xml>
      <level>0</level>
      <type>**</type>
      <onto1>http://www.example.org/subject_expectations_ontology</onto1>
      <onto2>http://www.example.org/insurance_policy_ontology</onto2>
      <onto3>http://www.example.org/death_certificate_ontology</onto3>
      <map>
        <Cell>
          <entity1 rdf:resource="'http:"//www.example.org/
death_certificate_ontology#KnownTerminalCondition'/>
          <entity2 rdf:resource="'http:"//www.example.org/ insurance_policy_ontology#
DeathWithKnownShortLifeSpan'/>
          <measure rdf:datatype="'"&xsd;float'>0.75</measure>
          <relation>equal</relation>
        </Cell>
        <Cell>
          <entity1 rdf:resource="'http:"//www.example.org/ #SisterHealthStateAxiom'/>
          <entity2
rdf:resource="'http:"//www.example.org/insurance_policy_ontology#ClaimantRelative
ConditionAxiom'/>
          <measure rdf:datatype="'"&xsd;float'>1.0</measure>
          <relation>notEqual</relation>
        </Cell>
      </map>
    </Alignment>
    </rdf:RDF>
```

Figure 2. Example of the use of the formalism.

The xml code given in Figure 2 presents two alignments. The first one of concepts: KnownTerminalCondition from the ontology representing the death certificate with DeathWithKnownShortLifeSpan (taken from the insurance policy ontology). The concepts are recognized the same with the strength weight of 0.75. The second alignment match two axioms: SisterHealthStateAxiom and ClaimantRelativeConditionAxiom form the claimant's and insurer's ontologies respectively. As can be seen, the two axioms do not match and are considered unequal with the highest degree of certainty (1.0).

4. Case Generalization

The presented approach is in our view independent of any contextual details. This means that the very similar method of model creation should possibly be deployed in other domains (not only in cases connected to travel insurance or even the insurance

sector) where disagreement modelling using overlapped ontologies can be useful as a starting point in resolving disputes.

Such models may also be helpful in remembering knowledge about past cases or legal precedents. It also creates space for more robust search techniques in knowledge bases. Such search may also be used in order to project provisions of agreement by approaching a merged version of resolutions from initial differentiated ideas on legal qualifications.

5. Conclusion

This paper deals with modeling risk in the domain of travel insurance.. The risk of insurance companies may manifest in many forms. One of the forms is the legal risk and risks associated with it. In order to avoid (or reduce) such a risk the companies of the sector should preclude the possibilities of misunderstanding between policy parties as the shared comprehension of provisions is generally always of mutual interest when it comes to legal agreements (disregarding the cases of bad will). The presented approach sketch a method of representing disputes taking its root from different interpretation of legal concepts or facts. The representation assumes that parties' subjective knowledge may be modelled by overlapping ontologies. The ontology alignment formalisms can be used to indicate similarities and differences in those ontologies.

References

[1] Aitken, C. 1995. Statistics and the Evaluation of Evidence for Forensic Scientists. John Wiley and Sons, Chichester, UK.

[2] Black, H. C. 1990. Black's Law Dictionary, West Publishing Company, St. Paul, Minnesota.

[3] Bouquet, P., Euzenat, J., Franconi, E., Serafini, L., Stamou, G., and Tessaris, S. (2004). Specification of a common framework for characterizing alignment.

[4] Deliverable 2.2.4, KnowledgeWeb. See http://dit.unitn.it/~p2p/RelatedWork/Matching/kweb-221.pdf last accessed September 27, 2008.

[5] Douglas, R. and Toulson, D. 1999. WIRE Intelligent Quantum (WIRE IQ) – Tort Evaluation by Precedent instead of 'Rules'. Proceedings of Twelfth International Conference on Legal Knowledge Based Systems,, GNI, Nijmegen, Netherlands: 127-128.

[6] Eisenberg, M.A., 1976. Private Ordering Through Negotiation: Dispute Settlement and Rulemaking, Harvard Law Review, 89: 637-681.

[7] Giunchiglia and Shvaiko, 2003 Fausto Giunchiglia and Pavel Shvaiko. Semantic matching. In Proc. IJCAI 2003 Workshop on ontologies and distributed systems, Acapulco (MX), pages 139–146, 2003

[8] Goldring, J., 1976, Australian Law and International Commercial Arbitration. Columbia Journal of Transnational Law, 15: 216-252.

[9] Kadane, J. B. and Schum, D. A. 1996. A Probabilistic Analysis of the Sacco and Vanzetti Evidence, John Wiley and Sons

[10] McBurney, P. J. and Parsons, S. 2002. Determining Error Bounds for Hypothesis Tests in Risk Assessment: A Research Agenda, Law, Probability and Risk, 1(1): 17-36.

[11] Peterson, M. and Waterman, D. A. 1985. evaluating civil claims: An expert systems approach to evaluating liability cases, In Walter, C. (ed.) Computer Power and Legal Reasoning, St. Paul, West Publishing Company: 627-659.

[12] Ross, H. L., 1980, Settled Out of Court, Aldine

[13] Schild, U. 1998. Decision Support for Criminal Sentencing. Artificial Intelligence and Law, 6(4): 151-202.

[14] Schild, U. and Zeleznikow 2009. A comparative study of decision support systems for the sentencing of criminals. To appear in Journal of Decision Systems.

[15] Schum, D. A. 1994. The Evidential Foundation of Probabilistic Reasoning. John Wiley and Sons
[16] Tomaszewski T. and Stolarski P. Legal Framework for eCommerce Tax Analysis, In Luis M. Camarinha-Matos and Willy Picard (Eds.) Pervasive Collaborative Networks, IFIP TC 5 WG 5.5 Ninth Working Conference on Virtual Enterprises, Poznan, Poland, Springer 2008.
[17] Waterman, D. A., Paul, J. and Peterson, M. 1986. Expert systems for legal decision making, Expert Systems 3 (4): 212-226.
[18] Waterman, D. A. and Peterson, M. 1980. Rule-based models of legal expertise, In the Proceedings of the First National Conference on Artificial Intelligence, Stanford University, AAAI: 272-275.
[19] Waterman, D. A. & Peterson, M.A. 1981 Models of Legal Decisionmaking, Technical Report, R-2717 - 1CJ, Rand Corporation, Santa Monica, California.
[20] Waterman, D. A. and Peterson, M. 1984. Rule-based models of legal expertise, In the Proceedings of the First National Conference on Artificial Intelligence, Stanford University, AAAI: 272-275.
[21] Williams, G.R., 1983, Legal Negotiation and Settlement, West Publishing Co., St. Paul, Minnesota
[22] Zeleznikow, J. 2000. Building Judicial Decision Support Systems in Discretionary Legal Domains. International Review of Law, Computers and Technology 14(3): 341-356.
[23] Zeleznikow, J. 2002. Risk, Negotiation and Argumentation – a decision support system based approach. Law, Probability and Risk, 1: 37-48.
[24] Zeleznikow, J. and Stranieri, A. 1998. Split Up: The use of an argument based knowledge representation to meet expectations of different users for discretionary decision making. Proceedings of IAAI'98 — Tenth Annual Conference on Innovative Applications of Artificial Intelligence, AAAI/MIT Press: 1146-1151.