

**Some Investigations In
Knowledge Representation And Reasoning
In Legal Domain**

by

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Mrs. and Mr. M.G. Srivastava

for teaching me the importance of education.

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Certified that the thesis entitled, '**Some Investigations in Knowledge Representation and Reasoning in Legal Domain**', which is being submitted by **Mr. Sunil K. Srivastava** for the award of the degree of **Doctor of Philosophy** of the Indian Institute of Technology, Delhi, is a record of the student's own work carried out by him under my supervision and guidance at the Indian Institute of Technology, Delhi.

To the best of my knowledge, the matter embodied in this thesis has not been submitted elsewhere for the award of any other degree.



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**Some Investigations in
Knowledge Representation and Reasoning
in Legal Domain
(Abstract)**

Artificial Intelligence (AI) is concerned with understanding the nature of human intelligence and designing intelligent artifacts which can perform the tasks which, when performed by humans, are said to require intelligence. A variety of domains and tasks have been attempted ranging from medical diagnosis to manufacturing process planning. Some of these are in the area of law which challenges AI on many fronts. The researchers have investigated both statutory and case law models. But, though some have come a long way with these efforts, several problems still remain unsolved.

The work embodied in this thesis addresses some of the research issues in modeling reasoning in legal domain. We suggest an approach in which a case is represented as a tree of influences among the entities of the domain. The nodes of the influence tree represent the domain concepts - issue and factual predicates. A node is connected to other nodes by influences which indicate how the value of the predicate corresponding to the node depends on the values of the predicates represented by other nodes. The normative relationship knowledge of the domain is contained in 'domain influence tree' which shows how an issue predicate is related to various other issue and factual predicates of the domain. This has been collected from the analysis of the domain as given in the treatises. The factual predicate nodes also contain procedures to determine applicability of the predicates and to compute the value of the

associated strength.

A precedent case is represented as an influence tree with the root node corresponding to the main issue involved in the case. The leaf nodes represent the factual predicates of the case and branching nodes represent the intermediate conclusions established by the decision-maker in deciding the case. The incoming influences toward a node indicate that the value of the predicate was decided based on the values of the predicates connected by the influences. Similarly, an outgoing influence from a predicate indicates that the predicate was a factor in the determination of the value of the predicate connected by the influence.

Cases are indexed by influences present in the influence tree of the case. When a case contains intermediate conclusions reached by the court, the precedent parts corresponding to these conclusions are indexed separately. These can be used as independent entities in matching and reasoning.

The facts of a new dispute are processed to get the applicable influences using the 'domain influence tree' corresponding to the claim involved in the case. This gives an influence tree where the factual predicates at the leaf nodes have been assigned values but the root node and the intermediate nodes do not have any value as they are disputed at this stage. The applicable influences are used to retrieve the relevant precedent parts. Out of these, a set of most similar precedent parts are selected. The similarity between a dispute part and a precedent part is assessed in terms of shared and unshared influences. The most similar precedents and sets of most similar precedent parts are used in arguments.

We also address the issue of involving the human user in the problem solving process so that the strengths of both computer and human may be combined. This is important for the development of practical systems in the domains such as law which requires the ability to represent and reason with commonsense knowledge for which AI, at present, does not

have a good solution. Using this approach, the system attempts to find values for the predicates which could not be determined using the domain knowledge available with the system. The system supports the user in making decisions on assigning values to the predicates. It provides the user with the relevant information such as the precedents where the predicate was decided applicable or inapplicable, the values of the influencing predicates in the current dispute, etc. This helps the user in assessment of the situation.

We demonstrate how the precedents and precedent parts represented in this way can be used to formulate arguments about deciding a new dispute. The system generates arguments for both the sides. It uses a precedent or precedent part to make a point if the final influence of at least one of the shared predicate suggests a favourable value for the side. The final influence is computed using the directions of influences from the predicate to the disputed predicate.

Algorithms have been developed to generate arguments about a new dispute using precedents and sets of precedent parts. The arguments are generated in a hierarchical fashion. When an issue predicate depends on other issue predicates, the values of influencing lower level issue predicates are established using arguments before arguing about the higher level issue predicate. Once an argument is posed to the system, the system generates a response on behalf of the other side. For generation of response, it identifies the weak points in the argument posed. These are located by finding the influences which suggest a different value for the issue predicate i.e. other than the one being argued by the opposite party.

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