NIRNAY: A HYBRID INTELLIGENT SYSTEM

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Abstract:
This paper exhibits the process of construction of an intelligent system NIRNAY. NIRNAY is a pragmatic approach to Expert system. NIRNAY framework is designed to show that hybrid expert system can be developed to legal reasoning, in law domain. NIRNAY is a design and framework; it can be operated in different legal domains. This paper is a part of research based on the ongoing research project NIRNAY framework. Discussion is presented about legal expert system concept, CBR module and design of NIRNAY.

Keywords: expert system; intelligent system; legal; NIRNAY; Knowledge Engineering; case based reasoning

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1. Introduction

This article presents the design of a legal expert systems and development of experts systems in legal domain. NIRNAY framework is designed to show that hybrid expert system can be developed for legal reasoning, in law domain. NIRNAY is a design and framework of knowledge based system. NIRNAY uses the case based reasoning (CBR) as one of its predictive module for arguments of the legal cases. CBR knowledge is basically represented in frames. The knowledge is acquired from case law and represented as frame object. NIRNAY framework produces its advice by examining, and arguing. The CBR module is developed to find the similar cases and give the advice based on case law according to the Indian Contract Act. The selected domain of CBR is Indian Contract Act, 1872 Ss 1-36. Rule Based Reasoning (RBR) module verifies the cases and contract made between two parties. CBR module uses Nearest Neighbor method, which produces the class of similar cases. All these cases are compared on the basis of conceptual distance. The case which has minimum conceptual distance is selected for producing the legal argument.

The discussion is presented about expert system concept, case-based reasoning module, and design of NIRNAY followed by concluding remarks.

2. Literature survey

2.1 Expert systems

An Expert System is a computer program that reasons using knowledge to solve the complex problems [E. A. Feigenbaum, 1992]. Expert systems have become a popular method for representing large bodies of knowledge for a given field of expertise and solving problems by use of this knowledge. This program exhibits, within a specific domain; a degree of expertise in problem solving that is comparable to that of a human expert [James P. Ignizio, 1990]. Expert system emulates the behavior of a human expert within a well-defined, narrow domain of knowledge [Jay Liebowitz, 1995]. Expert systems offer the possibility of storing and reviving human expertise in a more flexible and adaptable way than is possible with traditional software, by using a declarative programming style in which data and prescripts for manipulating the data are gathered in one base [Lieuwe Sytse de Jong, 1988]. Figure 1 shows the block diagram of Expert System.

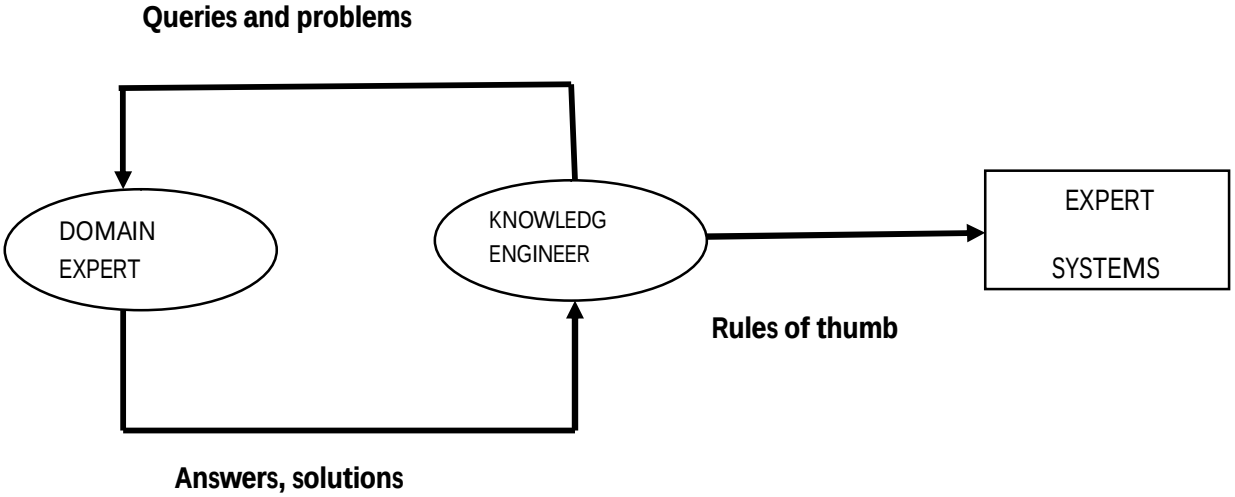

Figure 1: Expert System

Expert systems consist of two principle parts: the knowledge base and reasoning mechanism or inference engine. Knowledge base contains both factual and heuristic knowledge. The factual knowledge contains the facts about the domain collected from expert. The heuristic knowledge is experiential knowledge, the rule-of-thumb and the knowledge about good judgment [E. A. Feigenbaum, 1992].

2.2 Reasoning

Reasoning is the process of thinking about something in order to make a decision [Cambridge Dictionary]. An expert facing a new problem is usually reminded of similar situations, recalls their results and perhaps the reasoning [L. D. Xu, 1995]. There are two main methods to reach a conclusion, top-down (or deductive) method and bottom-up (or inductive) methods [Fatemeh Zahedi, 1993].

2.3 Rule-Based Reasoning (RBR)

Jackson [1986, page 31] states that rule-based reasoning uses "empirical associations between patterns of data presented to the system [to determine the] actions that the system should perform as a consequence". Systems using rule-based reasoning are referred to as "production systems". Production systems have at least three main components. The first is the rule set. This first component is the representation of the knowledge of an expert in the knowledge domain. The second component is an interpreter. A rule interpreter decides which rules apply, and how and when to apply them. The interpreter determines the outcome for the facts given to the system. These facts are represented in the third component of the system — the "working memory" ("WM").

2.4 Case Based Reasoning (CBR)

Case-based reasoning is the process of predicting an outcome based upon a comparison between the present case and the cases in the case-base. Case-based reasoners store their knowledge of cases by some form of abstraction of the facts of the case, the result, and possibly the reasons for reaching that result.

2.5 Hybrid Intelligent Systems approach

The intelligent systems differ in the way they represent the knowledge, learn the things, and solve the problem. These systems collectively will have features like learning ability, adaption to changes, explanation capability, and flexibility in dealing with the imprecise and incomplete information etc. No single intelligent system has all features. In order to develop the application which requires most of the above features it is necessary to integrate the systems. These systems solve problem like human being. The human combines several knowledge and reasoning methods to solve problem [Agnar Aamodt, Enric Plaza, 1994] that is we are hybrid information processing machines. This hybrid approach is replicated in hybrid intelligent systems. The hybrid intelligent system is combination of more than one technique [Larry Medsker, 1995] to overcome the limitations of individual techniques. These systems represent not only the combination of different intelligent techniques but also integration of intelligent techniques with conventional computing systems such as database systems and spreadsheets [Suran Goonatilake, sukhdev Khebbal, 1995].

3. NIRNAY a Hybrid Intelligent System

The law in India is based on both statutes and cases. For a legal expert system to be of use in most legal domains, it must be able to take account of statute law and case law. To develop an intelligent system which considers the statues and case law, we strongly support the Hybrid approach where we can combine two different methods of reasoning. The Rule based reasoning approach is best suited for acquiring statutory provisions. Case based reasoning is the technique which functions like a Case law is functioned in supporting the arguments. A Hybrid system can be developed which uses these two approaches of reasoning. NIRNAY framework is an integration of two reasoning methods, CBR and RBR. CBR takes care of Ss 1-36 of Contract Act 1872. RBR takes care of Ss 73-75 of Indian Contract Act 1872.

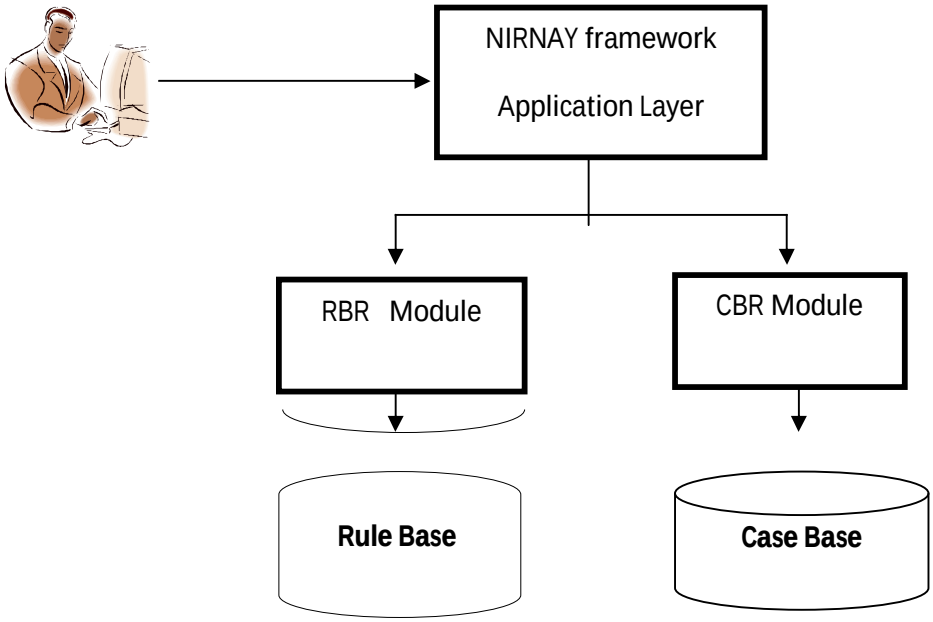

Figure 2: Entity Diagram

Figure 2 shows the working of NIRNAY framework. Application layer is an interactive interface of the system, which interacts between the user and the NIRNAY system. It takes the input from the user and decides which of the two modules to be executed depending upon the response from the user. It asks the questions to the user about the case.

NIRNAY is designed to make a prediction about the likely result in a case. This prediction is based upon statute and previously decided (historical) cases, assuming (as must any legal case-based expert system) the application of the doctrine of precedent. NIRNAY also produces legal argument, the predicted outcome. A legal expert system's predictive ability and its ability to construct legal argument are both important: prediction is a valuable component of legal advice, but the nature of the adversarial system requires that a lawyer be able to argue a case, and be prepared to respond to counter-arguments.

A prediction is merely be a statement about the likely outcome—a statement about the relative strengths of the arguments that are constructed.

3.1 Application for Development

The application for which this Framework has been developed relates to the determination of validity of a contract within the Indian Contract act and the breach of contract. Some characteristics of Nirnay Framework which were perceived as making it a suitable project for development as an expert system are discussed below.

- ***Domain***

The NIRNAY Framework is highly domain specific in the issue of validation and breach of contract.

- ***Operation***

There are ultimately only two possible outcomes from this application, with the contract can be valid and void. For this reason the application appeared to be amenable to use of a backward chaining model, where facts can be established to prove or disprove a hypothesis of contract being Void.

- ***Rule-based***

In common with other areas of law, rules may be derived from legislation and case law. In the area of Contract Act, there are statutory provisions defining the validity, and decided cases examining the issues.

- ***Case-based***

The way lawyers use the historical cases for citation, the case-base can be created to formulate the argumentation of the new case.

3.2 Design principle

NIRNAY is designed to help common men, lawyers and judges. It is an interactive system which interacts with user and gives the solution to the user of the system about the case. It uses two reasoning methods for giving the solution to the user. The methods for reasoning used are Rule Based Reasoning method and Case Based Reasoning method. The RBR reasoning produces the prediction using the rule base in the system. The RBR module runs the VIDWAN an open source inference engine. The output is displayed on the screen and stored in a file as well. The formation of rule base and reasoning is explained in detail in following topics. The CBR reasoning produces the prediction using case based system. CBR is developed using java. The previously decided cases of the act are stored in case base. The case is represented in a frame. All the cases together form a case-base, which is stored on secondary storage device using a database. Objects are used to internally representing the frames of the case base. The java object has member variables to store the data (i.e. history of the case) and methods to write the functionality of the object. The objects are stored in a file 'CB'. This file can be stored permanently and can be retrieved at the time of reasoning. The representation of case and retrieval procedure is explained in following topics.

3.3 CBR Module

This module asks the question to the user. The answers of the questions are mainly of YES-NO-Unknown type. If answer is unknown then user can specify U as answer. The parameters which are dependant are in the first part of substring and independent parameters are at 2nd part of string.

The matching process matches exactly the dependant parameters and selects the cases from case base. These cases are now selected for further process of matching or finding the most appropriate case that is nearest – neighbor. In the second stage of matching the new case parameters are compared with the cases which are found in the 1st stage. The conceptual distance is calculated for all the cases within the block. The case which has less conceptual distance with the new case is selected for adapting the decision. The argument is considered and decision is adapted to solve the new case.

Case based reasoning uses the knowledge which is stored in case base for the reasoning purpose. This case base is mainly formed using case law. The previously decided cases and cited cases are used to form case base. Sections Ss 73-75 of Indian Contract Act were firstly interpreted with the help of human expert i.e. a lawyer who is practicing in the area of Contract Act. A case is actually a record or history of previous cases and stored in the case base. It is the knowledge, which comprises problem, solution and outcome. Reasoning by re-using past cases is a powerful and frequently applied way to solve problems for humans [Agnar Aamodt, Enric Plaza, 1994]. NIRNAY uses the solutions and outcomes of selected cases for forming the argument of current case. In CBR module, cases similar to the current problem are retrieved, and the best match is selected and adapted to fit the current problem. A problem solving system focuses on the construction of solutions suited to the new case by modifying previous case solutions.

3.4 Knowledge Representation in CBR

A case in CBR contains the information about the case Typically a case comprises: the problem, the parties involved in the case, judgments, arguments and the detail information about the case.

Cases which comprise problems and their solutions can be used to derive solutions to solve new case. If, in addition, such cases contain solutions they can be used to evaluate the outcome of proposed solutions. Cases can be represented in a variety of forms using the full range of AI representational formalisms including frames, objects, predicates, semantic nets and rules – the frame/object representation currently being used by the majority of CBR software. There is a lack of consensus within

the CBR community as to exactly what information should be in a case. Case storage is an important aspect in designing efficient CBR systems in that, it should reflect the conceptual view of what is represented in the case and take into account the indices that characterize the case. The case-base should be organized into a manageable structure that supports efficient search and retrieval methods. A balance has to be found between storing methods that preserve the semantic richness of cases and their indices and methods that simplify the access and retrieval of relevant cases.

Semantic net is one way of storage representation but it is difficult for implementation as it involves the entities and their relations. We propose the frames to store the knowledge about the case as it can be simulated using objects in the same sense they are defined.

3.4.1 Frames

Frames were proposed by Marvin Minsky in his 1974 article "A Framework for Representing Knowledge." A frame is an artificial intelligence data structure used to divide knowledge into substructures by representing "stereotyped situations." Frames are connected together to form a complete idea [Marvin Minsky 74]

The frames are used to store the knowledge of cases of law. The case base basically is the collection of previously decided cases of the courts under the law of Contract Act 1872. Each case represented in one frame. All the frames share same structure and associated to each other. The frame stores the complete information about the case, which includes the decision of the case, the court name which gave the decision, year of the decision made, parties involved in the case, sections referred for the case, citation of the case, the argument made for the case etc. Case base

3.4.2 Retrieval rules for cases

For deciding a new case, we consider the similar kind of previously decided cases stored in the case base. The most similar case is considered for analysis. The decision of relatively closed case is adapted for giving the decision of the new case.

The relatively closed case is selected using the algorithm Nearest Neighbor. This algorithm finds the conceptual distance between the relatively closed cases which are stored in cases base with the new case. The case which has minimum conceptual distance is a nearest neighbor of the new case. Such a case is called candidate case. The decision of candidate case analyzed and then adapted for the new case. Such a decision is given to the user as a report and a decision of the NIRNAY Framework decision.

The well known methods for case retrieval are 1) Nearest Neighbour, 2) Induction, 3) Knowledge guided induction and 4) Template retrieval.

These methods can be used alone or combined into hybrid retrieval strategies. The NIRNAY framework uses the Nearest Neighbour method as the retrieval method for cases stored in the case-base. Generally the decision of new case is based on the similar cases in the history. Nearest Neighbour method provides the same approach to retrieve the similar cases stored in the case-base of NIRANY which is not possible with the other methods of case retrieval.

3.4.3 Nearest Neighbour Method for Case Retrieval

This approach involves the assessment of similarity between stored cases and the new input case, based on matching a weighted sum of features. The biggest problem here is to determine the weights of the features. The limitation of this approach includes problems in converging on the correct solution and retrieval times. In general the use of this method leads to the retrieval time increasing linearly with the number of cases. Therefore this approach is more effective when the case base is relatively small. Several CBR implementation have used this method to retrieve matching cases, for example: BROADWAY [Skalk, 92] for selection of car models, the Compaq SMART System [Acorn & Walden, 92] for a customer product support help desk. The algorithm finds the similar cases (n) in the case-base and retrieve it in the temporary storage of the algorithm. The conceptual distance (CD) is calculated for all the cases which are retrieved by the Nearest Neighbour method. The conceptual distance (CD) of i^{th} case is calculated using following formula

$$\mathbf{CD_i = (W_i * P_i) / n}$$

W_i is the weight of the i^{th} case, Pi the parameter of i^{th} case and n is the total parameters defined for the cases.

The minimum CD is found out by comparing all the CD_i's and the respective case is used to generate the argument for new case of the user.

4. Concluding Remarks

The discussion is presented about expert system concept and development process of NIRNAY. Process of designing experts systems is an exhaustive process as it involves active participation of domain expert. In case of NIRNAY the domain expert is a lawyer practicing in the area of Contract Act. The law domain is such a domain where the outcome may vary for same type of cases.

This article presents the process of construction of legal expert systems and development of experts systems in legal domain. Various important factors are specified regarding CBR module of legal expert system which is helpful for researchers who want to work in legal domain.

In framing the NIRNAY, important and extensive task was Knowledge Engineering process. A case base was created to reflect the relevant provisions of the contract Act 1872 after the successful KE process. The system was designed in three versions. The final version goes close to providing predictions similar to the legal experts in terms of validity, conciseness and correctness.

It is concluded that the results of the system, arguments and question answering of the CBR module is highly dependent on the output of the KE process.

The goal of NIRNAY framework is to develop a system that provides legal arguments to users' cases than usually provided by an Expert system and with a more precise sense of relevance than provided by traditional Information Retrival systems. In our Hybrid Intelligent approach, knowledge-intensive case-based reasoning is performed on cases represented in a CBR module, and important cases selected from this analysis are used to form an argument to support the decision for the case.

The quality of an ES is measured on how similarly it works like a human expert, the human expert basically use a hybrid way to draw the inference hence we strongly support the hybrid approach for designing of the Expert System.

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