

Expert system application in law: A review of research and applications

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Abstract

Artificial intelligence (AI) is the intelligence exhibited by machines or software. Expert systems are one of the common applications of artificial intelligence. Legal expert systems are programs which can reason and think like lawyers. There is an urgent need to develop a legal expert system for the people to solve their legal troubles in order reduce problems to people frequently arising legal solutions or legal queries, there is a need legal lawyer is mandatory, so there is an urgent need for the use of practical AI solutions in many of areas for problems which people encounter in their daily lives. This research paper introduces the introduction, structure, applications or review of a legal expert system. This paper also discusses the advantages, new tools and various research aspects in low expert systems. This paper intends to outline current research trends which are found in low expert systems literature.

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1 Introduction

Artificial intelligence is the knowledge of making intelligent machines or programs. Artificial intelligence is a branch of computer science that examines computational requirements and actions such as perception, reasoning, and learning and provides a system to perform such actions [14]. One of the most controversial aspects of the interaction between artificial intelligence and legal science, which has developed in the last few decades, is the attempt to develop programs that simulate the work of a lawyer or judge. Among the programs that try to imitate human behavior are expert systems. An expert system is a computer system that mimics the decision-making ability of a human expert [6]. Legal expert systems create a kind of link between artificial intelligence and law. A legal expert system is also called a computerized legal advisor or an automatic producer of legal documents [1]. The main purpose of this research is to examine the work that has been done at the world level in relation to the connection between artificial intelligence and law.

2 Applications of artificial intelligence in law

Legal artificial intelligence systems are divided into legal retrieval systems and legal analysis systems [3, 7, 16, 20].

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2.1 Legal recovery systems

Legal retrieval systems allow lawyers to search databases that contain various details of laws. Artificial intelligence techniques may make this work easier. For example, by searching for keywords that the user did not enter but that are related to the topic that the user is looking for results [12, 22].

2.2 Legal analysis systems

Analysis systems also take information about a set of facts and determine the branches that may be created from these facts in a certain area of law. The use of expert systems in law is part of the second category [4, 12]. This system itself is divided into two areas: judgment machines and legal expert systems.

2.3 Judgment machines

Such machines are a substitute for human judges. The first judgment machine was created in 1959. Later in 1977, D’Amato proposed that a machine could be built to replace the judge. His proposed machine receives the relevant events as input and finally provides us with a number between -1 and +1, where +1 indicates the plaintiff’s victory. He believed that if there are many factors and events, the possibility of obtaining a zero number is very low and a non-zero number is always obtained [11].

3 Legal expert system

A legal expert system is a system that acts like a lawyer. Systems that only help lawyers in legal conclusions or prepare legal arguments are not considered part of this category. A legal expert system must have some kind of legal expertise. This definition does not include systems that are used only by legal experts. Some systems such as SHYSTER have been developed only for the use of lawyers. Legal expert systems are also divided into three categories: rule-based systems, case-based reasoning systems, and hybrid systems.

In the legal analysis system developed by humans, the person in question must be an expert in the field of law. But on the contrary, legal recovery systems can be produced by people who do not have expertise in the field of law. In Figure 1, you can see the general classification of legal artificial intelligence systems.

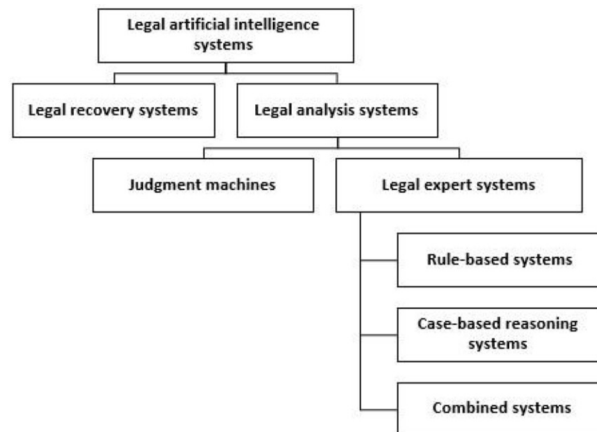


Figure 1: Classification of legal artificial intelligence systems

The following formulas are used to analyze and evaluate issues related to the liquidity of legal expert systems:

$$\text{Currant Ratio} = \frac{\text{Currant Asset}}{\text{Currant Liabilities}}$$

$$\text{Net Profit Ratio} = \frac{-\text{Net Profit after tax}}{\text{Net sales}} \times 100$$

$$\text{Quick Ratio} = \frac{(\text{Total Currant Ratio} - \text{Inventory})}{\text{Total Currant Liabilities}}$$

$$\begin{aligned} \text{Gross Profit Ratio} &= \frac{\text{Gross Profit}}{\text{Net sales}} \times 100 \\ \text{Operating Ratio} &= \frac{\text{Operating Cost}}{\text{Net sales}} \times 100 \\ \text{Inventory Turnover Ratio} &= \frac{\text{Cost of Goods Sold}}{\text{Average Inventory}} \\ \text{Earnings per share} &= \frac{\text{Net Income} - \text{Preferred Dividend}}{\text{Weighted Average Number of Shares Outstanding}} \\ \text{Debt Equity Ratio} &= \frac{\text{Total Liabilities}}{\text{Stakeholder's Equity}} \\ \text{Proprietary Ratio} &= \frac{\text{Stakeholder's Equity}}{\text{Total Assets}} \times 100 \end{aligned}$$

3.1 Systems based on legal rules

Rule-based approaches use if-then rules. You can see an example of these rules in Figure 2.

In this type of reasoning, the condition part must be fulfilled in order to achieve the result part. This is one of the limitations of this type of reasoning because the real world is fuzzy and contingent. Therefore, a number of other arguments are derived from this argument, which has a fuzzy state and can adapt to a partial degree of conformity. The case-based reasoning structure consists of at least two components, the knowledge base (here the rule base) and the inference engine. The knowledge base contains domain knowledge that is stored in the form of rules. The inference engine also includes the reasoning strategy to search for rules in the knowledge base, which enables the system to find the right answer for the new problem. There are many examples of rule-based expert systems in the field of law, which will be reviewed below.

<p>IF (<i>Sam has a driving license</i>) AND (<i>Sam is drunk</i>) AND (<i>Sam is driving a car</i>) AND (<i>Sam is stopped by police</i>) THEN (<i>Sam's driving license will be revoked by the transport authority.</i>)</p>
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Figure 2: An example of if-then rules.

3.1.1 TAXMAN

McCarthy is known as the father of legal artificial intelligence. TAXMAN project is related to the development of a computer theory of legal reasoning developed in the field of corporate tax law. TAXMAN takes the description of the corporate reorganization as input and, upon request from the user, determines whether the transactions qualify for tax-exempt activities under specific provisions of the Internal Revenue Code. First, the system processes the input facts in order and expands them into a series of high-level details using forward chaining rules, and then uses backward chaining to determine whether the developed facts Does the regulation satisfy the domestic regulations?

One of the limitations of TAXMAN is that all its abstractions are defined by rules. This work for some simple inferences, such as determining whether someone is a shareholder or not? It is suitable. Like other fields of corporate tax law, they also have open-text concepts. Important concepts that are not defined in the statute. McCarthy found that the TAXMAN rules were insufficient to represent these concepts.

McCarthy believed that presenting the facts in the legal system is much more difficult than other expert systems in other fields. Because the facts of the case usually include all the complexities of daily life, i.e. human actions, beliefs, desires, motives, etc. He also stated that even if the events can be shown, the rules often become problematic. Some laws, which are usually set out in statutes, have a precise logical structure that makes them easily subject to artificial intelligence techniques, yet it is common among lawyers. Most laws do not have such a form and such laws are called open text and their boundaries are not fixed [17]. McCarthy also claimed that the easiest problems for first-year law students are the hardest problems for an AI system, because students use innate human experience and reasoning. He

chose tax laws because commercial abstractions are, in fact, artificial and formal systems derived from the material of the normal world and well-structured by legal standards. According to him, the field of corporate tax law is very close to the top of the hierarchy of commercial abstractions.

McCarthy sees the development of legal expert systems as an opportunity to help the development of jurisprudence. McCarthy identified problems with TAXMAN I. One of these problems, as mentioned earlier, was the problem of displaying open text rules. Because of these issues, TAXMAN II was created by McCarthy to overcome these problems [12].

TAXMAN II uses prototypes and transformations to represent a legal concept. This representation by determining the prerequisite conditions for that concept, a set of cases (real or hypothetical) that concept includes or does not include, and a set of transitions to convert from one case to another, are possible. If the designated case (which represents a legal concept) can be turned into an instant case while it has the prerequisite conditions for the concept, then that case can be used as an example of the intended concept in the argument.

3.1.2 JUDITH

The JUDITH system was developed in 1975 by Popp and Schlink at Stanford University, where MYCIN was developed [10]. There were many similarities between JUDITH and MYCIN, so that the authors claimed that it is possible to create a legal knowledge base for MYCIN, and on the other hand, it is possible to create a therapeutic knowledge base for JUDITH, so that Only very few modifications are needed. JUDITH system is designed to help lawyers and provides two methods of interaction. The first is related to the "case option". This mode is used when a comprehensive analysis of real scenarios is required. The second mode is "specific term option" and is used when research is needed on the meaning of one or more specific legal terms or concepts. The authors of this article claimed that the most powerful mode of using JUDITH is in "case option" mode. This situation is raised when a question is created for the lawyer and the lawyer believes that more questions are needed to give an adequate answer to the initial question. When a question is raised in the JUDITH environment, direct questions are asked related to the answer to the initial question. These questions use case-based reasoning to give an appropriate answer to the initial question. Another feature of the JUDITH system is the automatic generation of keywords. This list is created when the system is implemented and the lawyer is connected to an information retrieval system to view the case and articles related to the desired subject. The authors of the article believe that the searches generated by JUDITH's keywords are very relevant to the topic searched by the lawyer.

3.1.3 LDS

The Latent Damage System or LDS is a rule-based expert system that comprises a small part of UK construction law [15]. This expert system is the first system that has been widely published and made available. From this system, it can be seen that legal expert systems are considered more as an assistant for lawyers and not a legal tool that can be made available to the public.

3.1.4 Split-up

Split-up is a legal expert system that makes predictions about the distribution of property during divorce between the parties [21]. This system is designed to help judges in the family court as well as lawyers. It is a rule-based system that also takes help from neural networks in its reasoning. Neural network has been used to generate decisions under uncertain conditions. In this system, the prototype process is used to distribute the property between the parties. The prototyping process includes the construction of an experimental system that quickly and at low cost shows the reasons and how to evaluate so that users can determine the information they need.

3.1.5 DataLex

DataLex software consists of three parts. Expert system, hypertext and text recovery section. DataLex combines these three parts into one general-purpose tool. This software is developed as a commercial application and is used in the field of privacy law [5].

DataLex software has three engines that process legal knowledge and data in different ways. These engines include: an inference engine, a hypertext engine and a text retrieval engine, each of which communicates with the user using a user interface. You can see the architecture of DataLex in Figure 3. Rule-based reasoning is used in the inference part, concordance is used in the text retrieval part, and a hypernet (a collection of nodes and edges) is used in the supertext part.

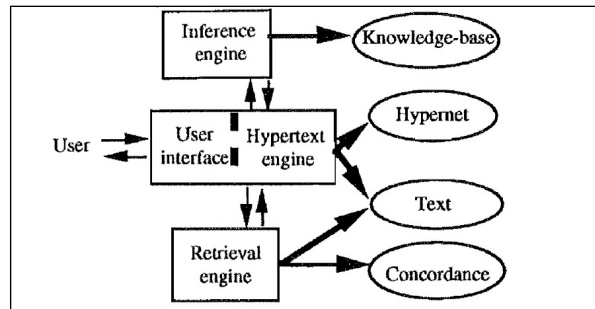


Figure 3: DataLex software architecture [5].

3.2 Case-based reasoning systems

Case-based reasoning systems is a process in which the desired file is compared with the files in the database and an output is predicted. This system stores the knowledge related to its cases in its database by summarizing the facts of the case, the result and the reasons for reaching the result. Arguments based on the case that is examined in this research are: FINDER and SHYSTER.

3.2.1 FINDER

FINDER was developed by Tyree, Greenleaf and Mowbray in 1988 [18]. FINDER's area of expertise is trover law. This law is a common law that is about the rights of those who found cattle. FINDER stores its knowledge of reference files in a vector of attribute values. Attributes have a yes or no value and answer questions about facts that are legally important in the reference case.

FINDER finally determines whether the finder should keep the quadruped or not? The reasoning program reports based on the closest case (using nearest neighbor analysis) and the closest case with a photo result. In 1996, Popple took the approach used in FINDER and built SHYSTER.

3.2.2 SHYSTER

Popple (1996) developed SHYSTER as his doctoral thesis at the Australian National University and advanced legal-statistical reasoning through it [12]. SHYSTER is considered as a hybrid system that uses rule-based reasoning in parliamentary activities and case-based reasoning in decision cases. But in general, SHYSTER acts as a case-based reasoner in the current state.

SHYSTER stores the knowledge related to his cases in the facts vector. The facts in the vector are indicated by using the words yes, no or uncertain. When the user interacts with SHYSTER, the program asks him questions to create a vector for each fact. In the conclusion phase, SHYSTER compares the facts vector of the current case (entered by the user) with its existing case database. This comparison is done by nearest neighbor analysis in the N-dimensional space where the facts vector is located. The legal argument used by SHYSTER is called analogy. When the closest file is selected, the report is generated. This report specifies why the particular case was selected and what the results of using the case will be.

SHYSTER has four separate file databases. One of these databases has a name license and is about the copyright law. The other is related to the classification of workers as employees or independent contractors. The third one is related to the observance of justice and finally the fourth base is the Finder simulation.

3.3 Combined systems

Hybrid expert systems are systems that combine more than one reasoning method to answer a legal problem. And in a general way, they combine two methods of case-based reasoning (CBR) and rule-based (RBR). There are two popular methods that are combined. The first method is known as "blackboard architecture". This method has a number of knowledge modules that cooperate with each other using a common database. ("Blackboard") There is a control mechanism called scheduler that determines the most appropriate knowledge module in each reasoning process. Two examples of the blackboard system are called CABARET and PROLEXS, which are introduced below.

Another hybrid method is known as distributed artificial intelligence. This method allows different AI systems to be executed simultaneously on their knowledge base and each of them will propose an answer and respond to them.

This approach has been used in the IKBALS project, which is discussed below. The developers of IKBALS have used distributed AI because they believed that the blackboard architecture is very limited in cases that inevitably have heterogeneous files. Another reason for using serial distributed AI was to make the blackboard system work on parallel files. But distributed AI could be executed simultaneously on parallel files and quickly answer their questions and answers. According to the explanations that will follow, it can be seen that the task of the RBR part of the combined systems is to acquire the knowledge of the two parts of the statute and the law. CABARET and GREBE have used RBR to extract the knowledge of the two mentioned sectors. However, PROLEXS is somewhat against the trend and uses RBR to get knowledge in the statute section and CBR for the database. These approaches also have problems. Among these problems, from a lawyer's point of view, is that the only information that can be obtained by reasoning by the RBR is that found in the statute.

3.3.1 CABARET

CABARET is an expert system that deals with the United States income tax law [13]. To determine the concept of a section, CABARET has a case database with 23 lawsuits and six hypothetical cases. In addition, it also has another key knowledge base of 14 dimensions which is obtained based on records, legal research analysis and commercial tax materials. CABARET also has a rule base that includes deduction rules obtained from 10 bureaus, as well as production rules extracted from reading tax service files and contracts. After the section concept is determined using a case-based reasoner, some knowledge about other rules is also stored in the rule set. These rules are taken from the so-called clear cases.

3.3.2 GREBE

In creating GREBE, Brenting used a combination of flat-black architecture and distributed AI. Unlike the pure blackboard system, GREBE does not have a scheduling factor and instead, the selection between arguments created by reasoners is done after they are made. This means that RBR and CBR are executed simultaneously - the distributed AI aspect of the system - and the best generated report is selected in the final report. The scope of GREBE is the Texas Workers' Compensation Act. GREBE rules base has 47 rules, which include codified law, common law and common sense rules. The GREBE case database also includes 25 sample cases, 21 of which are hypothetical. In GREBE, files are displayed in two ways: rules and file database.

3.3.3 PROLEXS

PROLEXS is a Dutch expert system that focuses on the area of landlord and tenant law [9]. The authors of this project believe that all knowledge should be displayed only once and multi-level knowledge is used to measure the importance and priority of a part of knowledge. The four groups of knowledge used in PROLEXS are: law making, legal doctrine, specialized knowledge and subject law. The reasoning used in each of the four areas is different. RBR is used for the knowledge of the law, CBR is used for the knowledge of the subject law, and blackboard is used for other fields of knowledge. RBR uses both backward and forward chains to establish the rule. In PROLEXS, cases use case-based reasoner, and RBR is used for statutes.

3.3.4 IKBALS

The IKBALS project uses a distributed artificial intelligence approach [19]. IKBALS operates in the field of credit laws. The authors of this article believe that the desired approach is better for solving expert systems that have a parallel nature and achieve better results. Because CBR and RBR have completely independent agents and theoretically can run simultaneously on parallel processors and wait for messages from each other. Anyway, the authors of IKBALS decided to model this project in such a way that for the questions asked by the lawyer, first RBR is used and then CBR is used.

3.3.5 SHYSTER-MYCIN

SHYSTER-MYCIN is derived from two expert systems SHYSTER and MYCIN and is mostly used in the field of copyright law [8]. As discussed in previous chapters, MYCIN is a medical expert system that has been modified for use in this method. SHYSTER is also a legal expert system and is used in this method without any changes. In SHYSTER-MYCIN, the safety factor that is present in MYCIN is not used. And the reason for that is the difficulty of scientific extraction of the certainty of a fact in the legal field. In the field of medicine, the confidence factor can be obtained by calculating the measurement error or by calculating the possible confidence of the test results, while

in law, the importance of a result cannot be shown by scientific methods. In SHYSTER-MYCIN, the MYCIN part is used only in the argument section of the parliamentary rules. This hybrid system enables the case-based reasoner to determine open-text concepts when required by the rule-based reasoner. This expert system is created for those people who have knowledge in the field of law. In Table 1, the legal expert systems mentioned above are summarized.

Table 1: Summary of developed legal expert systems

Expert system name	Way of reasoning		Legal field	Year of production
	Case-based reasoning	Rule-based reasoning		
TAXMAN		*	Corporate tax law	1997
JUDITH		*	civil law	1975
Latent Damage System		*	Construction law	1989
DataLex		*	Privacy Act	1991
Split-Up		*	Property distribution in divorce	1996
FINDER	*		Law of misappropriated property	1988
SHYSTER	*		All fields	1996
CABARET	*	*	Income tax area	1998
GREBE	*	*	Payment of workers' compensation	1991
PROLEXS	*	*	Landlord and Tenant Law	1987
IKBALS	*	*	Compensation for accidents	1991
SHYSTER-MYCIN	*	*	Copyright law	2003
DRExM		*	Resolving construction project disputes in Egypt	2015
DSpace [1]		*	Legal issues in Romania	2015
FunGramKB [2]		*	Criminal law in Spain	2015

4 Conclusion

In this article, legal expert systems were investigated. Systems designed for use by legal professionals are used to speed up arguments and improve the accuracy of legal research performed to advise clients. In addition to these systems, which are designed for public use, it increases people's access to the law. Among the benefits of using expert systems in the field of law are: faster provision of legal advice; conducting legal research and giving advice; Increase Productivity; reducing dependence on fleeting human expertise; Potential savings in staff costs and reduction in human error. Despite the importance of these systems, very few works have been done in the field of legal expert systems in the world and especially in Iran, and therefore the literature in this field was very little and had many gaps. Therefore, it is necessary to pay more attention to this field, and to design and implement systems in various legal fields, including the field of inheritance, legal disputes, taxes, etc.

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