

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF INFORMATICS
DEPARTMENT OF INFORMATION SCIENCE

**A RULE-BASED/ NEURAL NETWORK HYBRID LEGAL EXPERT
SYSTEM: A PROTOTYPE FOR PROVIDING LEGAL ADVICE ON
CRIMINAL CASES UNDER ETHIOPIAN LAW**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN
INFORMATION SCIENCE**

BY
SEIFU TATEK
JUNE 2005

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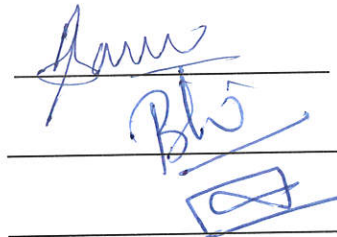
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DEDICATION

To
Tatek Yazhy

ACKNOWLEDGEMENT

I, first of all, acknowledge the guidance and perseverance granted to me from the Lord Jesus Christ during this work and during the whole time I spent at the department.

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ABSTRACT

Expert systems have been applied in various domains in order to solve problems that require expert knowledge. Law is one such domain area that can receive a lot of help from expert systems in the attempt to come up with a faire and efficient judicial system. Legal expert systems contribute to this endeavor by embedding expert knowledge with in them in various forms and providing expert advice.

Approaches abound in the design of legal expert systems ranging from rule based legal expert systems that represent the knowledge acquired from experts in the form of IF-THEN rules to legal expert systems employing neural networks.

The approach adopted in this research in the design of a prototype legal expert system **HyRuNLES** (Hybrid Rule based Neural network Legal Expert System) is a combination of a rule based approach and a neural network model in an attempt to reap the best of each.

The rule based module of the system works with rules that were derived from legal experts regarding a specific domain of criminal law in order to arrive at a judgment. The neural network part of the prototype **HyRuNLES** system is needed to handle a special type of open texture (relating to sentencing discretion) that the rule based part can't handle. The neural network part works based on a model developed through training an ANN using past court cases.

The test result of the performance of the system showed that the model of legal reasoning used in this research and adopted in the design of the prototype legal expert system is functional and could be encouraging to implement in the form of a fully functional legal expert system.

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CHAPTER ONE: INTRODUCTION

PREVIEW:

This chapter is an introductory chapter. It sets out the background to the problem area the thesis tries to tackle, the problems that this work is expected to contribute to solving and the general and specific objectives of the work. It has also got the discussion of the methodologies followed in conducting the thesis work and its scope and limitations. Finally, the chapter outlines the contents of the whole thesis report.

1.1 BACKGROUND

1.1.1 Expert Systems

For years there have been promises to deliver technology that will make computers we can chat to like friends, robots that function as autonomous servants, and one day (for better or worse) even produce conscious machines.

Expert systems represent this desire to come up with computer programs that emulate the reasoning ability of experts in various fields and that eventually act like experts.

The concept of expert systems originated from research in the field of artificial intelligence (AI). Artificial intelligence is the subfield of computer science that attempts to develop machines that are capable of emulating human thought processes.

Expert systems technology has been applied in various fields and professions where experts are vital for the profession's existence. Law is one such area.

Expert systems in law (legal expert systems) have been put to helping lawyers and judges in various ways and are the concern of this paper.

Knowledge engineers (or in a simplistic language expert systems' designers) can use various approaches in designing legal expert systems. A rule-based, case based, neural network, fuzzy logic or a hybrid of any two of these can be used as an approach to designing a legal expert system.

The right approach in the design of legal expert systems depends on the underlying legal system under which these systems are supposed to function. Therefore, it is appropriate to define what a legal system is and the various legal systems that exist in the world that we live in today.

1.1.2 World Legal Systems

The two major legal systems currently in use in the world are civil law and common law systems. Other systems such as Muslim law, customary law or a combination (mixture) of any one or more of these do also exist [URL1].

The common law, which developed in Great Britain after the Norman Conquest, was based on the decisions of judges in the royal courts. It is called judge-made law because it is a system of rules based on "precedent". Whenever a judge makes a decision that is to be legally enforced, this decision becomes a precedent: a rule that will guide judges in making subsequent decisions in similar cases. The common law is unique in the world because it cannot be found in any "code" or "legislation"; it exists only in past decisions. However, this also makes it flexible and adaptable to changing circumstances [URL1].

The tradition of civil law is quite different. It is based on Roman law, which was consolidated by the Roman Emperor Justinian. The law in ancient Rome was scattered about in many places: in books, in statutes, in proclamations. Justinian ordered his legal experts to put all the law into a single book to avoid confusion. Ever since, the civil law has been associated with a "civil code", containing almost all private law [URL2].

So it would be prudent to address what kind of legal system exists in Ethiopia before setting out to design a legal expert system to be used in Ethiopia.

1.1.3 The Legal System in Ethiopia

According to Aberra Jemberie [1998] the law of Ethiopia has its own features. A consideration of features of Ethiopian law could start with the identification of its place in legal families of the world.

Even though Ethiopia had her own civilization, ideologies and cultures, ways of thinking and acting, as well as her own indigenous institutions, she all the same accepted features of Roman-Germanic law (civil law) partly since the fifteenth century via the Fetha Negest (The Law of Kings) which was based on Roman-Byzantine law and via the codification of the Penal Code of 1930 and the other six codes from the second half of this century.

However, the reception of Romano-Germanic law had left some of the original institutions and customary norms intact. Some customary norms and practices were maintained because of the indigenous Ethiopian sense of justice and the value the people attached to ancestral custom.

For example, under the customary law of Ethiopia, marriage prior to the promulgation of the civil Code of 1960 was an alliance between two families rather than a union of two persons. Even now, as the Civil Code gives the same effect to religious, civil and customary marriage, in the case of customary marriage the situation is the same.

Thus we can say that Ethiopia is a predominantly civil law country; however, there are traces of customary law in its legal system.

1.1.4 Dependence of Legal Expert System Design on Prevailing Legal System

Current commercial systems in most part use a fairly standard technology called logic programming. Logic programming systems in law would enable a programmer to put in the constituent parts of a legal rule in a symbolic language and specify logical relationships. Legal rules drawn from statute or case law are written in symbolic language that can be manipulated to produce a solution. A set of 'if condition, then action' rules are compared against a set of facts to reach a logical conclusion. [URL3]

For example, the legal rule of if you drive while drunk you will lose your licence becomes 'drink & drive licence loss'. This representation of the rule can be put into a computer system. The system would ask the user questions based on legal definitions of 'drink' and 'drive' and advise the user on the status of their licence. These sort of expert systems that utilise logic programming to manipulate rules are also known as 'rule-based' expert systems.[URL3]

The rule based legal expert systems have been heavily criticized in common law countries. Capturing legal knowledge using case based reasoning systems has intuitive appeal considering the importance of cases and judge made law contained in cases, in common law legal systems. In applying cases and constructing arguments from cases, case based reasoners appear to incorporate analogical reasoning [Aikenhead, 1995].

As true as what is stated above can be, both rule based and case based expert systems have shortcomings of their own. Rule based systems cannot deal with open texture that is prevalent in any statute (that of a term being open to interpretation). Discretion left for judges in sentencing in a statutory law is an example and a special form of open texture.

On the other hand, case based reasoners or neural networks can emulate the analogy that experts rely on to draw on experience as to the meaning of an open textured term. However, even if experts do implicitly draw on past cases to interpret the meaning of an open textured term, neither lawyers nor judges in Ethiopia can base and present their arguments on precedent set in previous cases, as Ethiopia is not a common law country.

It is in light of these shortcomings of any one paradigm that hybrid systems come in to the scene. Hybrid legal expert systems are a marriage of two paradigms that attempt to exploit the best of each.

In this paper, a hybrid expert system combining a rule based and neural network approach is employed in an attempt to overcome the shortcomings inherent in both paradigms. A rule-based system is used to form arguments based on the criminal law or statute (Penal Code of 1957) in the country and the neural network is used to determine or predict the number of years of imprisonment once the accused is found guilty.

Integration is provided only at a higher level where the user alternately uses the two systems to form legal arguments (or judgments when the user is a judge) and look in to possible areas to research into in forming those arguments.

1.2 PROBLEM DEFINITION AND JUSTIFICATION OF THE STUDY

Donald H Berman et al [1989] in their article “The Potential of Artificial Intelligence to Help Solve the Crisis in Our Legal System” described how legal expert systems can help in building a more faire and efficient legal system. In that article, they quoted Derek Bok who explained the problems prevalent in most legal systems in these words:

The laws that govern affluent clients and large institutions are numerous, intricate and applied by highly sophisticated practitioners. In this section of society, rules proliferate, lawsuits abound, and the cost of legal services grows much faster than the cost of living. For the bulk of the population, however, the situation is very different. Access to the courts may be open in principle. In practice, however, most people find their legal rights severely compromised by the cost of legal services, the baffling complications of existing rules and procedures, and the long, frustrating delays involved in bringing proceedings to a conclusion . . . There is far too much law for those who can afford it and far too little for those who cannot. No one can be satisfied with this state of affairs.

According to the report of the justice sector reform program of Ethiopia, as quoted by Getachew [2004], the machinery of justice is not efficient in Ethiopia. The civil justice system is too costly, complex and unpredictable. The dispositions of criminal cases are so protracted that rights granted by the constitution are not fully operational. This inefficiency has resulted in court congestion and delays, and obstacles in the promotion and protection of human and democratic rights.

Expert systems can help in reducing the time involved in providing legal advice to clients by lawyers and reaching at judgments by judges. Automating the reasoning process based on knowledge captured from vast years of experience of legal experts reduces the time and cost of providing legal advice and passing judgments.

The proposed hybrid legal expert system is meant to illustrate a model of legal reasoning that can be used in designing a full fledged legal expert system. Such a system can be used by judges and

lawyers in Ethiopia to reduce the amount of time required to arrive at a decision or to provide legal advice to clients there by curbing costs involved in this process.

The other problem that the researcher expects to solve through the design of the hybrid legal expert system is the problem of sentencing disparity.

Sentencing disparity happens when different sentences are levied by judges on two individuals who committed the same crime under relatively similar situations. Sentencing disparity results in an unfair judicial system that fosters disrespect and distrust from citizens [Sheriff, 1990].

Judges would have been greatly helped in reaching at fair decisions while at the same time exercising their discretion in an attempt to individualize sentencing if they could be guided by a sort of a benchmark for crimes committed under specified situations.

In conclusion, lawyers and judges alike can thus secure substantial help from a legal advisory system or a legal expert system in terms of saving themselves the time and strenuous labor of drafting legal arguments that are correct in front of a court of law and arriving at just and fair judgments respectively.

1.3 OBJECTIVES OF THE STUDY

The proposed research had the following general and specific objectives.

General Objective:

The general objective of this research has been to investigate the prevailing legal practice in Ethiopia involving criminal cases (specifically that of sexual crimes) and accordingly design and develop a prototype legal expert system that fits it.

Specific Objectives:

The following are the specific objectives necessary to achieve the above general objective:

- To explore the applicability of expert systems in law by conducting a thorough review of relevant literature.
- To build a prototype rule based expert system that forms legal arguments for lawyers and judges regarding sexual crimes by collecting and organizing the necessary knowledge in the domain area.
- To train a neural network model that determines the meaning of an open textured term by way of prediction. More specifically, criminal sentencing involving imprisonment for sexual crimes would be predicted using a sample of crime details as input and the resulting sentences as output.
- To conduct experiments with selected cases to test the performance of the prototype expert system,
- To make conclusions and recommendations based on the test results.

1.4 METHODS

1.4.1 Data Collection

Data for the work has been collected from various sources. These sources can be classified in to primary and secondary sources.

A. Primary Data Sources

Knowledge relevant to the domain has been collected from interviews with legal experts. Seven legal experts working in various capacities have been interviewed to acquire the necessary knowledge for the rule based part of the prototype legal expert system.

The interviews were semi-structured interviews conducted by forwarding open ended pre-specified questions to the legal experts and following on leads and asking for elaborations. Their responses have been transcribed and organized for inclusion in the rule base of the prototype system.

One hundred previous cases related to sexual crimes on which judges have pronounced their decisions have been collected and analyzed. Only those cases where the accused was found guilty were selected as these cases were required for neural network training in an attempt to come up with a model that predicts the number of years of imprisonment once a defendant is found guilty of sexual crimes.

The sentencing decisions by judges and the related suites filed by attorneys were carefully analyzed in order to extract the values of attributes that have been identified as determinant by experts in the sentencing decision of judges.

B. Secondary Data Sources

A review of the relevant literature about legal expert systems, the Ethiopian legal system, the Penal Code of the land and previous work in the area has been reviewed in an attempt to understand the issues leading to the design and development of a legal expert system.

1.4.2 Prototyping

A prototyping approach has been used to design the expert system so that the system would be tested first for its feasibility before taking on the complete task of designing and implementing the system. Thus, a much scaled down version of the expert system was designed and developed before proceeding to developing a system at the level set out to be designed in this study.

1.4.4 Tools

The Knowledge Pro Gold version 3 expert system shell available in the Department of Information Science has been used to design and implement the prototype legal expert system. The use of an expert system shell rather than implementing the system from scratch using specialized programming languages such as LISP or PROLOG is chosen taking in to account the limitation of time the researcher has had to implement the project. The KPWin expert system shell was selected since it is available at the department.

On the other hand, NEUROSOLUTIONS software has been used to train the neural network model in the prototype legal expert system.

The NeuroSolutions software was selected since it has a very user friendly graphical user interface to input data, to train the network and see the performance of the network.

1.5 Scope and Limitations

This paper deals with the design of a prototype legal expert that handles cases related only to sexual crimes. As the prototype system is only meant to demonstrate the model of legal reasoning adopted in this paper, the system doesn't include an interface that integrates the two modules employed in the prototype legal expert system.

At its present form, the system's output can't be presented directly at a court of law in the form of a written legal argument. Rather, the outputs can be used to guide legal experts in their decision making process on a case and in understanding the important dimensions of a case.

1.6 Organization of the Thesis

This chapter has provided the necessary background information to the design of the hybrid legal expert system. The next chapter is a review of the relevant literature related to expert systems in general and legal expert systems in particular. Various approaches to the design of legal expert systems are reviewed.

Chapter three contains the general legal framework in Ethiopia under which the trial of sexual crime cases is conducted. This discussion is relevant in light of the fact that the domain knowledge that the thesis deals with is focused on the trial of sexual crimes.

Chapter four discusses the acquisition of knowledge for the rule based part of the prototype legal expert system. Knowledge elicited from legal experts is structured using the hierarchical tree modeling approach.

Chapter five has got two parts. The first part shows the representation of the knowledge acquired using IF-THEN rules for the rule based part of the prototype system. Part II of the chapter discusses the training and testing of the artificial neural network model.

Chapter six shows the knowledge application phase where the interface for the rule based part and the combined testing of the prototype system is discussed.

Finally, conclusions drawn from the work and recommendations for possible future work are outlined in chapter seven.

CONCLUDING REMARKS:

This chapter outlined the background information for the work and the problems that it tries to solve. It also presented the specific objectives towards the achievement of the general objective set out and the methods employed to achieve them. The next chapter builds on this chapter and discusses information related to the design of legal expert systems based on a review of related literature.

CHAPTER TWO: LEGAL EXPERT SYSTEMS

Preview:

Building on the general introductory background information provided in the previous chapter, this chapter is a conceptual discussion of expert systems in general and their application in law in particular. Various approaches that have been employed so far in the design of legal expert systems are reviewed briefly in light of the approach chosen for this thesis.

2.1 EXPERT SYSTEMS IN GENERAL

2.1.1 Artificial Intelligence and Expert Systems

Artificial Intelligence (AI) is a branch of computer science that has the goal of understanding intelligence by building computer programs that exhibit intelligent behavior. It is concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented inside the machine [Robert et al, 1993].

AI programs that achieve expert-level competence in solving problems in task areas by bringing to bear a body of knowledge about specific tasks are called *knowledge-based* or *expert systems*. Often, the term expert systems is reserved for programs whose knowledge base contains the knowledge used by human experts, in contrast to knowledge gathered from textbooks or non-experts even though the two terms are used synonymously more often than not.

2.1.2 The Anatomy of Expert Systems

Even if the architecture of expert systems may vary based on the approach used, most have a fairly similar anatomy and has been enumerated by Cawsey [1998]:

- The User interface- used by the system to interact with a user through menus, natural language or any other style of interaction.
- An Inference engine- used to reason with both the expert knowledge in the knowledge base and data specific to the particular problem being solved.
- Case-specific data- includes both data provided by the user and partial conclusions based on this data.
- Explanation system- allows the program to explain its reasoning to the user.
- Knowledge base editor-helps the expert or knowledge engineer to easily update and check the knowledge base.
- Knowledge base- where the expert's knowledge is stored

The following figure summarizes the architecture of expert systems.

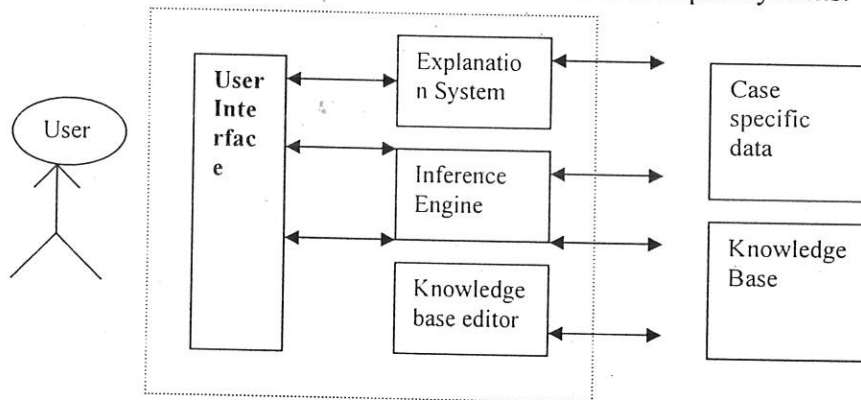


Figure 2.1 The Anatomy of an Expert System

2.2 EXPERT SYSTEMS IN LAW

Computers have long been utilized in the sphere of law. Basic applications such as word processors, spreadsheets and databases have all found their way into legal offices.

Recently, more sophisticated tools such as computerized legal research systems, document-drafting packages, and practice management systems have become increasingly common. Most exciting however, has been the prospect of using artificial intelligence (AI) techniques to create 'automated legal reasoning systems'- computer systems that reason with and apply the law in an effort to resolve legal disputes [Aikenhead,1995].

Examples of such systems include legal expert systems, which are the focus of this research. A beautiful description of what legal expert systems are is found in O'Callaghan's [2003] paper where he states that "legal expert systems are the nexus of artificial intelligence and the law." Thus, legal expert systems have the aim of providing advice similar in form to that which a solicitor might provide [Popple, 1993].

It is important to distinguish these knowledge-based applications in law, or more specifically legal expert systems, from other data based applications stated earlier. For one thing, whereas the primary components of legal databases are the 'raw materials' of legal decisions, cases and statutes, the primary components of knowledge-based systems are representations of legal knowledge, information about the legal system (including cases and statutes) which has been interpreted and structured by the legal 'expert' who created the system [Greenleaf, n.d.].

For another thing, while data-based systems merely retrieve 'raw material' potentially relevant to the particular legal problem, which the user wishes to solve, knowledge-based systems apply that 'raw material' to the problem, producing an outcome such as an advice or a document that deals specifically with the problem [Greenleaf, n.d.].

O'Callaghan [2003] divides legal expert systems in to two on the basis of who they are designed to provide their services for: legal expert systems designed for use by legally trained people and those designed for use by lay-people. He further explains that legal expert systems designed for use by legally trained people aim to provide a method of speeding-up the provision, and improving the accuracy, of legal research undertaken with the aim of advising the client.

These legal expert systems designed for use by legally trained people, may assume general legal knowledge. Consequently the questions asked by the system and the reports returned may be stated at a level appropriate for legally trained people.

The primary benefit of this category of legal expert systems is the reduction of internal cost of legal research. The flow-on benefits for clients results in reductions in the cost of legal services and consequently improved access to quality representation, and reduction of the time taken to resolve a legal question [O'Callaghan, 2003].

The aim of this research work has been to develop a prototype legal expert system for use by legally trained people, as various constraints wouldn't have allowed a system that can be used by lay-people. Such constraints include the fact that legal expert systems for lay people need much more time and effort to build since this category of legal expert systems is more difficult to create. This is because [O'Callaghan, 2003]:

- No legal knowledge by the user can be assumed.
- The discovery of the facts of the case becomes problematic, and
- More research is required in the area of fact elicitation before such systems become viable.

In concluding this section, we can say that legal expert systems are knowledge based applications that try to capture the expertise of lawyers and judges in an attempt to generate legal arguments that would potentially be used by solicitors in providing legal advice to a client. They have the aim of making these services more efficient and expedient.

2.3 APPROACHES TO DESIGNING LEGAL EXPERT SYSTEMS

Various approaches have been used in designing legal expert systems. Legal expert systems that employ a rule-based, case-based, neural network approach or a combination of these are some and these are reviewed in this section.

2.3.1 Rule Based Legal Expert Systems

Jackson as quoted by O'Callaghan (2003) states that rule-based reasoning uses empirical associations between patterns of data presented to the system in order to determine the actions that the system should perform as a consequence. Systems using rule-based reasoning are referred to as production systems.

In a rule based system legal rules drawn from statute or case law are written in symbolic language that can be manipulated to produce a solution. A set of 'if condition, then action' rules are compared against a set of facts to reach a logical conclusion[URL3].

Thus in a rule based legal expert system the law is represented in the form of a series of rules in the form of if-then statements. The rules contain the knowledge of legal experts as to when specific laws should be applied. The relevant rules are fired when the necessary conditions are satisfied.

Two examples of rule based legal expert systems are JUDITH and TAXMAN. The JUDITH system was designed by Popp and Schlink in 1975 at Stanford, for use by a lawyer, and provides two methods of interaction with lawyers: the case option and the specific term option. The case option is used when a comprehensive analysis of a factual scenario is required. The specific term option is used to research the meaning of one or more specific legal terms or concepts[O'Callaghan,2003].

The TAXMAN system is a rule-based legal expert system created by McCarty, with the information for the rules coming from the Internal Revenue Code of the United States[O'Callaghan,2003].

A major short-coming of rule based legal expert systems is that it is difficult for a rule based system to deal with an open textured term that is prevalent in law.

Bench-Capon and Sergot as quoted by Stranieri et al[1998] define an open textured term as one whose extension or use cannot be determined in advance of its application.

Stranieri et al [1998] further enumerate four distinct types of situations that are difficult to resolve because of the open textured nature of law:

- Those that arise as a result of classification ambiguities- there is a term on the statute yet it may be difficult to determine what amounts to that term in real life. This is a classification problem.
- There may also be defeasible rules; rules that can be defeated in various ways such as in the context of exceptional circumstances
- A term may also be open textured merely because it is vaguely defined and can be interpreted in various ways.
- Judicial discretion is also one source of the open textured nature of law. A statute may provide a judicial decision maker (a judge for instance) a list of relevant factors that have to be given weight by the decision maker. The variation in the weights of course results in a range of plausible decisions.

Under such circumstances, Grienke [1994] explains, a legal expert system when presented with the facts of a case, it must decide whether or not a rule applies. Since fact situations do not await us neatly labeled, creased, and folded the difficulty lies in subsuming particular instances under a general rule. A "hard case" is therefore one where the system fails to match the appropriate pattern, thereby preventing a rule from firing. As computer logic relies on pattern matching, knowledge representation necessarily must encounter problems of classification.

2.3.2 Case Based Legal Expert Systems

In a case based legal expert system one or more examples or cases instead of rules are stored in the system. The system, when presented with a new legal case, tries to match the closest similar case in its knowledge base and adopt the solution in this previous case to the legal case at hand or the instant case.

In case based reasoners, the process of similarity determination and analogy formation occurs by breaking down a situation into 'factors'. These factors are pre-determined by the programmer of the case based reasoning system. When presented with a problem situation, the case based reasoning system also breaks it down in terms of these factors. In this way, the case and the problem situation can be compared for the presence or absence of factors. The number of factors shared results in a measure of how similar one case or situation is to another. From here analogies can be created and manipulated. Determining in what ways the cases are similar and in what

ways they differ in turn allows the construction of likely arguments for and against a given proposition [Aikenhead, 1995].

One popular case-based legal expert system is SHYSTER designed by Popple [1993]

SHYSTER'S advice is based upon an examination of, and an argument about, the similarities and differences between cases. The system attempts to model the way in which lawyers argue with cases, but it does not attempt to model the way in which lawyers decide which cases to use in those arguments. Instead, it employs statistical techniques to quantify the similarity between cases. It decides which cases to use in argument, and what prediction it will make, on the basis of that similarity measure.

Ethiopia [2002] developed a case based legal precedent retrieval system specifically for the Ethiopian labor law. Ethiopia's paper was concerned with the development of a case based reasoning precedent retrieval system in the domain of Ethiopian Labor Law. The requirement for the system was to build a knowledge base in which complete decided cases could be entered and then recalled when similar cases arose again. The legal cases had a predefined case structure with a number of weighted features that are used to reflect the important aspects of a legal case.

Case based legal expert systems are more appropriate in a common law environment. Aikenhead [1995] states that capturing legal knowledge by adopting the case based approach has intuitive appeal considering the importance of cases and judge made law contained in cases, in common law legal systems. Popple [1991] also agrees that rules are appropriate for representing statutory law.

As explained in the previous chapter, Ethiopia is a statutory law (civil law country) and judges and lawyers do not cite previous cases to form legal arguments. Thus the appropriateness of case based legal expert systems in our country's legal system is argued against in this research.

It is true, however, that even if legal experts and judges do not cite previous cases to form legal arguments they do implicitly draw on previous cases in order to resolve the meaning of indeterminate terms.

Previous cases can thus be used to determine the meaning of an open textured term.

2.3.3 Legal Expert Systems Employing Neural Networks

A. Nature of Neural Networks

A neural network as described by Haykin [1994] is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects:

- Knowledge is acquired by the network through a learning process
- Interneuron connection strengths known as synaptic weights are used to store the knowledge.

The study of artificial neural networks (ANNs) has been inspired in part by the observation that biological learning systems are built of very complex webs of interconnected neurons. In rough analogy, artificial neural networks are built out of densely interconnected set of simple units, where each unit takes a number of real valued inputs and produces a single real valued output [Mitchell, 1997].

A neuron is a cell in the brain whose principal function is the collection, processing and dissemination of electrical signals. The brain's information processing capacity is thought to emerge primarily from networks of such neurons. For this reason, some of the earliest AI work aimed to create artificial neural networks [Russell et al, 2003].

The following figure shows a simple mathematical model of the neuron. The neuron fires when a linear combination of its inputs exceeds some threshold.

As shown in the figure below neural networks are composed of nodes or units, connected by directed links. A link from unit j to unit i serves to propagate the activation a_j from j to i . Each link also has a numeric weight $W_{j,i}$ associated with it, which determines the strength and sign of the connection. Each unit i first computes a weighted sum of its inputs:

$$m_i = \sum_{j=0}^n W_{j,i} a_j .$$

Then it applies an activation function g to this sum to derive the output:

$$a_i = g(in_i) = g\left(\sum_{j=0}^n W_{j,i}a_j\right).$$

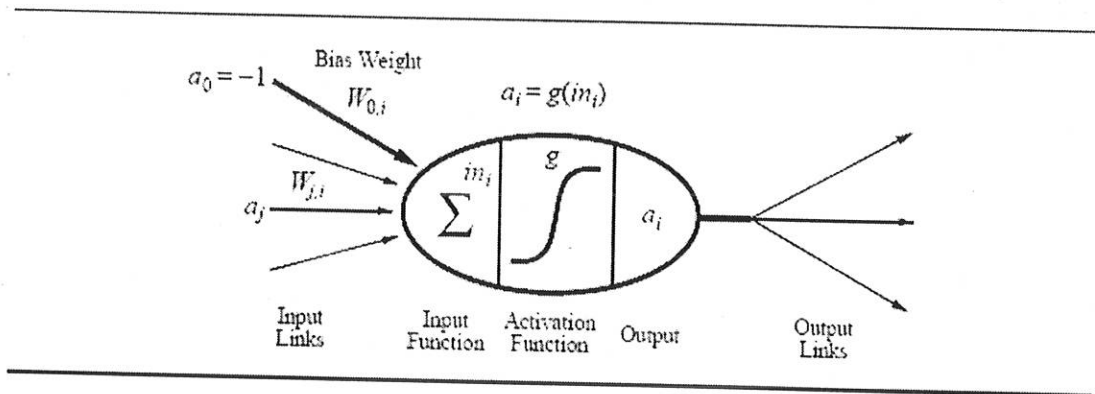


Figure 2.1 from Russell and Norvig a simple mathematical model for a neuron.

B. Architecture of Neural Networks

The type of neural network architecture usually used in most neural network shells is called the feed-forward architecture. Feed-forward ANNs allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. Feed-forward ANNs tend to be straight forward networks that associate inputs with outputs. They are extensively used in pattern recognition. This type of organization is also referred to as bottom-up or top-down [Stergiou et al, 1996].

The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of "input" units is connected to a layer of "hidden" units, which is connected to a layer of "output" units.

- The activity of the input units represents the raw information that is fed into the network.
- The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units.
- The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units.

The feed forward network architecture in neural networks is usually used with the back propagation algorithm.

Training a back propagation neural network as described by Gashaw [2004] has three steps:

- The network gets a training instance and, using the existing weights in the network, it calculates the out put for the instance.
- Back propagation then calculates the error by taking the difference between the calculated result and the expected result. In order to train a neural network to perform some task, we must adjust the weights of each unit in way that the error between the desired output and the actual output is reduced. This process requires that the neural network compute the error derivatives of the weights. In other words it must calculate how the error changes as each weight is increased or decreased slightly (Stergion et al, 1996).
- The error is used to adjust the weights. This is feeding the error back through the network.

Using the error measures to adjust the weights is the critical part of any back propagation algorithm. In classic back propagation, each unit is assigned a specific responsibility for the error. For instance, in the output layer, one unit is responsible for the whole error. This unit then assigns a responsibility for part of the error to each of its inputs, which come from units in the hidden layers, and so on, if there is more than one hidden layer.

Training an artificial neural network model also involves setting the number of layers and the number of nodes (units) in each layer. Once the number of layers, and number of units in each layer, has been selected, the network's weights and thresholds must be set so as to minimize the prediction error made by the network. This is the role of the training algorithms. The historical cases that are gathered are used to automatically adjust the weights and thresholds in order to minimize this error. This process is equivalent to fitting the model represented by the network to the training data available.

The error of a particular configuration of the network can be determined by running all the training cases through the network, comparing the actual output generated with the desired or target outputs. The differences are combined together by an error function to give the network error.

C. Using Neural Networks in the Design of Legal Expert Systems

Aikenhead [1995] states that identifying patterns between circumstances and classifying those patterns ostensibly appears to be what is occurring when an analogy is formed. Two cases will only be regarded as similar if they share some sufficiently close pattern of facts. Researchers in AI and law have thus viewed neural nets as a promising technique with which to emulate legal analogical reasoning; their ability to match patterns could be used to match cases with each other and with problem situations.

Aikenhead [1995] argues that the law cannot be regarded purely as a system of rules; analogical reasoning from past cases is extremely important. Neural nets may find application in systems that reason with cases. Warner as quoted by Aikenhead [1995] has stated that a large benefit of neural nets is their ability to classify patterns and so imitate the analogical reasoning process, thereby resolving issues of open texture.

The use of neural nets to mimic this aspect of analogical reasoning has been investigated by producing a neural network 'index' of the Theft Act 1968 (England).

In this index, a factual situation is analyzed by the researchers for the presence or absence of various concepts, the concepts being specified by the wording of the Act.

Other people who employed neural networks to design legal expert systems include Bench Capon and Walker et al [Aikenhead 1995].

Neural networks as a statistical method are suitable for law as long as we are not trying to provide any normative bases for decision making [Hunter,1996]. In this thesis, we are not concerned with modeling how judges should decide cases; rather we want to model how judges do decide cases. This is appropriate if we want to generate a model of adjudication which is consistent with prior decisions and which is an accurate predictor of subsequent decisions.

If we were able to build artificial neural networks which accurately predict the outcome of undecided cases we must first identify the case features that will be important to all the relevant judges. We don't have to assess the importance of these factors as the neural network will do this for us. The neural network can then accurately predict the outcome of new cases [Hunter ,1996].

Since neural networks cannot explain how they arrived at their outcomes Dan Hunter[1996] suggests choosing a domain where explanation is either irrelevant or provided by some other method such as property split in divorce, bail decision or sentencing.

This thesis aims to train a neural network model that can provide important first-pass information to assess a client's chances. This is particularly shown to be relevant where a law firm has a large number of junior lawyers who might not yet have accumulated the experience which makes a good lawyer's "intuition"[Hunter 1996].

Hunter [1996] asserts that an artificial neural network model can also be used as a lawyer's tool to play "what-if" with the network. By changing the value of one attribute, and holding the values of all other attributes the same, if the outcome differs it means there is a strong indication that this attribute is the one which the case may well turn. Hence, intelligent research and argument by the lawyer on that point could well be the difference between a good and a bad result [Hunter,1996].

Stranieri et al [1998] state that the use of knowledge discovery from databases (KDD) techniques such as neural networks in the legal domain can alter the practice of the law by introducing a non-expert mechanism for predicting and analyzing court outcomes.

They further state that legal domains that are well suited to KDD are those in which a high level of judicial discretion exists particularly where the source of the discretion stems from a principle statute that presents a list of factors to be taken in to account without specifying the relative importance of each factor.

In their report Stranieri et al [1998] draw on three classifications of stare decisis: traditional, local and personal stare decisis and assert that the predictability of court outcomes must be the result of local and personal stare decisis.

Here, local stare decisis refers to the fact that the same equivalent or more favorable fact pattern in the same court leads to the same decision. This means there is a desire for judges to exercise discretion in a manner that is consistent with other judges of the court.

Personal stare decisis, on the other hand, refers to the fact that the same or equivalent or more favorable fact pattern found by the same judge in different cases leads to the same decision. This

means that there is a tendency of individual judges to be consistent with the way he or she exercised discretion in past similar cases.

Stranieri et al [1998] thus assert that in discretionary domains if it were possible to expose a large number of judges to the same facts then we can imagine that a mean (average) outcome would emerge and individual judgments would fall on or on either side of the mean. This enables us to set boundary lines between acceptable and unacceptable exercise of discretion on empirical grounds.

All in all, neural networks are preferred to case based reasoners in this researcher's opinion in the legal domain because ascertaining knowledge about how a decision maker weights and combines factors from experts (as what usually happens in building case based reasoning systems) by direct interview is difficult in that a guessed numerical weights is unlikely to represent the actual weight of the factor in the context of a large number of other independent factors.

In contrast, a record of the way the factors have in practice been combined by judicial decision makers exists in the form of a transcript of judgments made by them in typical cases.

2.3.4 Hybrid Systems

Due to the inadequacies observed in each of the above paradigms in building legal expert systems researchers have tried to combine one or more of the above approaches in an attempt to exploit the strength of individual paradigms and to make up for the inadequacies.

O'Calaghan [2003] designed a legal expert system called SHYSTER-MYCIN that combines rule-based reasoning with case based reasoning for legally trained people. The hybrid system enables the case-based reasoner to determine open-textured concepts when required by the rule-based reasoner, MYCIN.

The SHYSTER-MYCIN system "operates on a reduced version of the *Copyright Act 1968*, including cases that define the term "authorization". The Act is reasoned by a system of rules; whereas cases are reasoned by analogy" [O'Callaghan, 2003].

Stranieri et al developed [1996] the Split-Up system which predicts judicial decisions in property proceedings within the Family Law of Australia.

Their System is a rule-based neural network hybrid system. They used rule sets derived from expert heuristics for those units where data was either unavailable or not sufficiently reliable for neural network training. In other words, they decomposed the task into small units, where each unit is implemented using a neural network or a rule set [Stranieri et al, 1996].

In this thesis the researcher has had the objective of building a rule based neural network hybrid legal expert system for providing legal advice on criminal cases under Ethiopian Law.

A hybrid legal expert system can be used to provide help to lawyers and judges in various domains of criminal law in Ethiopia such as sexual crimes, robbery, and homicide or first degree murder.

Various legal experts were consulted on which one of these areas to proceed for the development of the hybrid legal expert system. The experts identified the area of sexual crimes as one where the rules are not too many to be handled within the limited time available for this work.

In addition, the trial of sexual crimes fits with the model of legal reasoning that the researcher set out to experiment with by the design of the prototype legal expert system.

Concepts related to the trial and sentencing of criminal cases under the Penal Code of Ethiopia are discussed in the next chapter.

CONCLUDING REMARKS:

This chapter discussed the concept of expert systems in general and their application in law in particular. The chapter outlined the various approaches available in the design of legal expert systems.

A hybrid approach that combines rule bases with neural networks was selected from these alternative approaches for this work in the hope the shortcomings inherent in these two paradigms. The domain of sexual crimes was selected for the development of the prototype legal expert system from various areas in criminal law. The next chapter is a brief discussion of the framework within which the trial of sexual crimes is conducted.

CHAPTER THREE: THE TRIAL OF CRIMINAL CASES UNDER ETHIOPIAN LAW

Preview:

This chapter discusses the back ground to the general statute governing criminal cases in Ethiopia (the Penal Code) and shows the issues involved in the specific legal domain of sexual crimes chosen for developing the hybrid rule based neural network legal expert System.

3.1 CRIMINAL CASES UNDER THE ETHIOPIAN PENAL CODE

Under Ethiopian law, criminal cases are governed under the Penal Code of 1957. The Penal Code governs all cases that are categorized as a crime.

A crime has been defined in various ways by various authors. R. C. Nigam as quoted by Kassahun Tesfa [1996] pointed out the following three attributes that characterize an offence as crime:

1. A crime is a harm caused by a man and which state desires to avoid or prevent
2. The preventive measures taken by the state appear in the form of threat of punishment
3. Legal proceedings wherein the guilt or otherwise of the accused is determined are a special kind of proceeding governed by special rules.

This definition agrees with the definition of a crime as described under article 2 of the Penal Code.

Article 23(2) of the Penal Code defines a crime by stating that “a criminal offence is only completed when all its legal, material and moral ingredients are present.”

Kassahun [1996] elaborates that this means:

1. the offense must be an act or omission prohibited by law (legal element)
2. the offense must be physical or an external manifestation of human activity or inactivity (material)
3. the offense must encompass the mensrea (the inhibition of an evil intent) or guilt or mental element in the form of intention or negligence (moral element)

The Penal Code provides some exceptions to this general rule. For example, in cases of attempted offence the material element need not exist in its complete form.

3.2 ETHIOPIAN PENAL CODE AND CRIMINAL SENTENCING

The trial of a criminal case has two stages: the conviction stage and the sentencing stage. At the trial stage, the court determines if the accused is guilty or not. If the accused is not found to be guilty, the matter will end there. If he is found to be guilty, on the other hand, the court passes a sentence on him.

A sentence may include penalty, punishment or measures. The basic forms of punishment that the Penal code of Ethiopia provides for are reprimand, apology, fine, corporal punishment, imprisonment, deprivation of civil, family or professional rights, dismissal or reduction of rank in the armed forces and capital punishment.

This paper deals only with those crimes that are punishable by imprisonment by the Penal code.

3.3 DISCRETION OF JUDGES IN SENTENCING UNDER THE PENAL CODE

The 1957 Penal Code of Ethiopia grants discretion for the courts in the determination of penalty. This can be seen from the assigning of alternative punishments to certain offences and providing of the maximum and minimum limits for punishment assigned to certain specific offences [Tsfaye, 1986].

In particular to imprisonment, the Penal Code provides the lower and upper boundaries of the sentences such as rigorous imprisonment from five to twenty years (Article 523), or only one of the boundaries is provided like in Article 530” rigorous imprisonment not exceeding five years” [Sherif,1990].

However, the Ethiopian legislature, under Article 86 of the Penal Code has established the general guiding principle that the court has to assess the sentence in accordance with the degree of guilt of the offender, considering “the dangerous disposition of the offender, his antecedents, motive and purpose, his personal circumstances and his standard of education, as well as the gravity of is offence and the circumstances of its commission.” [Sherif,1990].

Sheriff [1990] observed that courts sometimes pronounce more severe or more lenient sentences on certain offenders even though they have comparable backgrounds and they commit identical, similar or even more or less serious offences than others. This, he suggests, results in sentencing disparity without any reasonable basis.

Sentencing disparity may create a profound disrespect for the law among individuals and casts grave doubt upon the extent to which the goal of individualized correctional treatment can be achieved.

One reason cited by Sheriff [1990] for sentencing disparity is the impact of emotionality because of the very nature of human mind that makes it impossible to make an absolutely rational inquiry and decision.

Another legal expert has also cited the lack of experience among new judges for the sentencing disparity mentioned above.

This research attempts to come up with a legal expert system that not only reasons with the criminal law in Ethiopia and outputs legal arguments for lawyers and judges but also tries to suggest or predict the number of years of imprisonment an offender faces based on similar past decisions.

For the development of the prototype expert system the researcher has seen it important to focus on one small and specific area of criminal law that fits the model of trial and sentencing of criminal cases discussed above and that is definitely punishable by imprisonment. A very good area that fits this description and suggested by legal experts whom the researcher had discussions with is the area of sexual crimes described under articles 589 and 590 of the Penal Code of 1957.

3.4 NATURE AND DEFINITION OF RAPE

The crime of forcing another person to submit to sex acts, especially sexual intercourse is defined as rape. Rape, in law, is the crime of sexual intercourse without the consent of the victim, often through force or threat of violence.

Rape may mean deferent things under various legal systems. In the United Kingdom and the United States common law, "rape" traditionally described a man who forces a woman to have sexual intercourse with him. Forced sex by a husband against his wife was not considered rape, or even a crime, throughout most of history, since as part of the marriage both partners were deemed to have given implicit informed consent in advance to a lifelong sexual relationship. Modern criminal law eliminates this exception and includes acts of sexual violence other than vaginal intercourse, such as forced anal intercourse, which were traditionally barred under sodomy laws [URL 4].

3.5 RAPE AND SEXUAL OUTRAGE UNDER THE PENAL CODE OF ETHIOPIA

The Ethiopian penal code differentiates between rape and sexual outrage, which is a less punishable crime and are discussed below.

A. Rape

Rape is described under article 589 of the Penal Code of Ethiopia of 1957 in the following manner:

Whosoever compels a woman to submit to sexual intercourse outside wedlock; whether by the use of violence or grave intimidation or after having rendered her unconscious or incapable of resistance is punishable with rigorous imprisonment not exceeding ten years.

Rigorous imprisonment shall not exceed fifteen years where the rape is committed:

- a. on a child under fifteen years of age
- b. on an inmate of a hospital, alms house or asylum, or any establishment of education, correction, internment or control of or dependent upon the accused person; or
- c. By a number of persons acting in concert

The conviction of rape depends on the existence of three elements according to Alem Debebe [1998]: sexual intercourse, force and the commission of the act with out the consent or against the will of the victim.

Sexual Intercourse

Sexual intercourse is “an actual penetration of the female sex organ by the male sex organ.” Alem [1998] explains that even the slightest penetration such as that of in to the labia of the female amounts to sexual intercourse and there is no need of the rupture of the hymen in case of a virgin. The sexual intercourse must also be per vagina and any other sorts of intercourse like buggery and fellatio is outside the scope of sexual intercourse in rape.

Force

Force is also a necessary element for a sexual intercourse to amount to rape, Alem explains. There is however no particular amount of force necessary for the commission of rape, there is also no need of reasonable apprehension of death due to the exertion of that force as far as the woman on whom it was committed had reason to believe that resistance is dangerous or even absolutely useless.

The Ethiopian Penal Code doesn't say anything with regards to this issue. How the experts see this issue will be dealt in the next chapter.

Lack of Consent

The consideration of lack of consent can be seen by focusing on the behavior of the prosecutrix at the moment of the crime. It signifies the existence of resistance on the part of the victim due to the employment of force or grave intimidation by the offender to get access to unlawful sexual intercourse.

The need of resistance is necessitated for the establishment of two elements in the crime: sexual intercourse through force by the offender and lack of consent expressed by resistance by the victim.

Again how sex with an unconscious woman such as when asleep or intoxicated is seen will be judged by legal experts since the Penal Code doesn't clearly put this out.

B. Sexual Outrage

Sexual outrage as provided for in the Penal Code is different from rape. It is a crime which manifests itself when a male person has compelled a person of the opposite sex outside wedlock, to perform or to submit to an act corresponding to the sexual act or any other indecent act or with a woman who is unconscious, deluded or incapable of resisting or by misrepresentation or with a woman who is an inmate of hospital, an alms house or any other establishment of education, internment or detention by taking advantage of her distress or dependence on him, or with or in the presence of a minor (other than his child) who is under fifteen years of age or with a minor whose age is above fifteen but under eighteen years or with a minor who is above fifteen but under eighteen years of age by promise of marriage or trickery or otherwise.

CONCLUDING REMARKS:

The domain of knowledge for the design of the prototype legal expert system in this paper is that of sexual crimes. General background information in the trial of criminal cases and the specific domain selected has been outlined in this chapter. The following chapter discusses the knowledge acquisition phase for the rule based part in the design of the prototype legal expert system.

CHAPTER FOUR: KNOWLEDGE ACQUISITION

Preview:

The previous chapter dealt with the general framework under which the trial of sexual crimes is carried out. This chapter reports on the knowledge acquisition phase in the design of the rule based part of the hybrid legal expert system.

4.1 NATURE AND MEANING OF KNOWLEDGE ACQUISITION

The process of seeking out the knowledge required by an expert system is referred to as knowledge acquisition [Parseye, 1988].

The first thing knowledge engineers do when designing a knowledge based system is to make a commitment to become “mini-experts” so that they could talk intelligently to the experts and not slow down the expert’s work. This allows the knowledge engineers not only to help identify key concepts of a problem and to understand the expert’s explanation, but also to ask good questions [Wendy, 1988].

The knowledge acquisition task is often complicate by the fact that human experts have not analyzed the contents of their thoughts, so that they are not explicitly aware of the structure of their knowledge. As a result the intermediate steps in their reasoning seem obvious to them and they cannot eloquently provide an overall account of how their decisions are made at the level of detail required by a machine reasoning process.

4.2 STEPS IN KNOWLEDGE ACQUISITION

Two major steps in knowledge acquisition have been cited by Samir [2001]: knowledge elicitation and knowledge structuring.

4.2.1 Knowledge Elicitation

Knowledge elicitation involves extracting knowledge from human experts to build an expert system.

The knowledge required to build the prototype expert system was elicited from experts through unstructured interviews. Seven experts participated in the knowledge acquisition phase for the interviews. These experts were identified and selected based on their educational qualification, the nature of relation of their job position to the domain area and year of experience. The experts identified and explained the interpretation of the relevant articles that govern the trial of sexual crimes. From the above experts, two are judges who work in a court at Lideta special court which is established to decide on sexual crimes.

The experts also identified the relevant attributes (aggravating and mitigating factors) that are usually considered by judges when passing a sentence. These factors and their values for each defendant are stated in the final sentencing decision judges write once an accused person is found guilty of a sex crime.

These attributes and their values were collected from past judgments for the neural network part of the system from the Lideta and Arada courts for careful analysis and extraction of the attributes identified by experts and their values.

4.2.2 Knowledge Structuring

Knowledge structuring involves using concepts discovered during the knowledge elicitation session to build a model or representation of the expertise [Samir, 2001].

The knowledge structuring for prototype legal expert system has been carried out using the hierarchical tree structure. This model puts a goal at the highest level of the hierarchy and factors leading to that decision (goal) are represented down the hierarchy, with the primary parameters nearer to the top [Anteneh,2004].

Anteneh [2004] further explains that the symbols used in representation in the hierarchical tree modeling: an ellipse represents the concepts while arrows connect nodes to each other. The direction of the arrows moves from the higher to lower level. Nodes keep on giving rise to other nodes depending on the concept represented till they have no successor at which time they are called n^{th} level node or a Leaf.

4.3 MODELING OF CONCEPTS IN THE TRIAL OF SEXUAL CRIMES

Concepts used in the judgment of a sex crime case are discussed below. These concepts appear in the Penal Code. However, what is discussed here and embodied in the legal expert system is the interpretation of these concepts by judges or legal experts as retrieved from the result of the interview by the researcher with them. What makes any legal expert system an *expert* system is not just the fact that it embodies the rules stated in the related statutes; the system also has in its rule base how these statutes are interpreted in front of the law by legal experts.

Input Parameters	Output Parameters
Relation with victim	Conviction for Sexual Outrage(590)
Sex Act	Conviction for Rape (589-1)
Force or Lack of Consent	Conviction for Rape (589-2)
Age of victim	Attempt (27+ 589-1)
	Attempt (27+ 589-2)
	Acquittal

Table 4.1 Input and Output parameters of Judgment

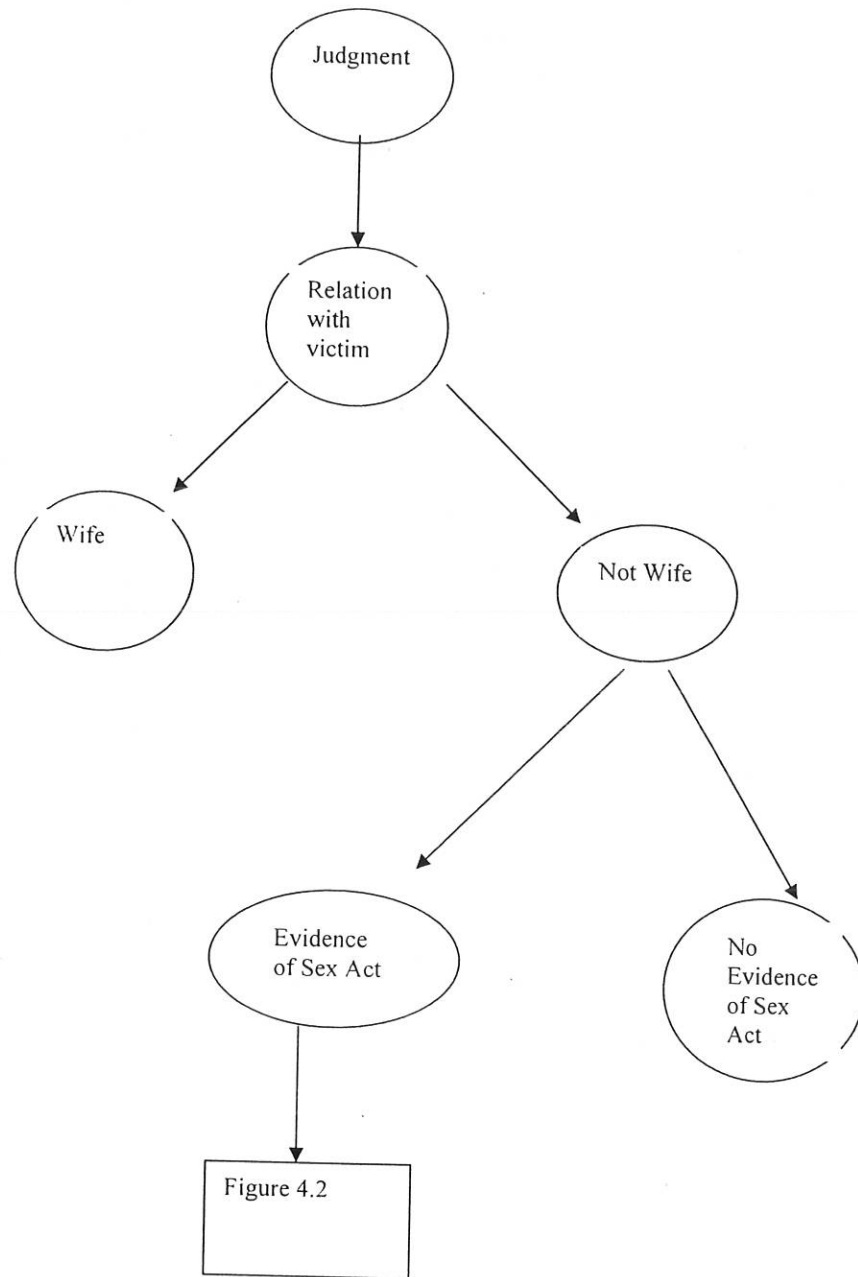


Figure 4.1 Concepts in Sexual Crimes Judgment

4.3.1 Relation with Victim

In the trial of a sex crime the judge first decides if the victim is the offender's wife or not. The law stipulates that a sexual act amounts to rape or sexual outrage or any other sex crime when committed outside of wedlock. A marriage performed under any of the three alternatives of a civil marriage, a religious marriage or a traditional marriage is taken as a valid marriage and a sex act done by an individual with in such marriage is deemed to be performed in wedlock.

The interviewed legal experts also explained that any sex acts even among people who live together for a long time with out being married are categorized with a sex act not "out side of wedlock". Therefore, any sex act performed with in wedlock according to the Penal Law and the interviewed legal experts is not taken as a crime even if there is violence, intimidation or lack of consent.

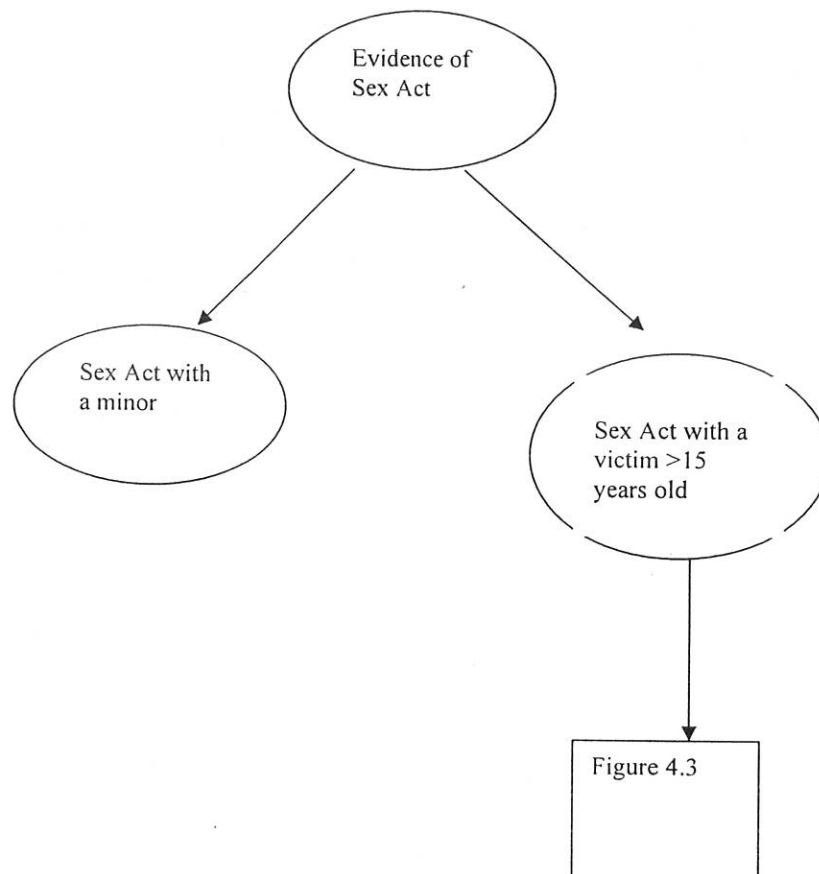


Figure 4.2 Concepts in Evidence of Sex Act

4.3.2 Force or Lack of Consent

For a sexual act to be taken as rape or any other sexual crime it should be accompanied by violence. The violence, however, need not be explicitly manifested in the form of bodily injury. Even grave intimidation that makes the victim to reasonably expect harm in the future if she doesn't conform to the requests of the offender amounts to violence.

Another concept used in determining if a sex act amounts to rape of sexual outrage is lack of consent. If the victim was unconscious of the nature of the act she was performing at the time of the sex act or incapable of resistance for various reasons such as intoxication, this shows that there is lack of consent.

What amount of force is necessary? How is sex with an already intoxicated person or with a woman asleep seen?

The existence of force during the sex act can not be directly established according to the experts. Therefore, the existence of force is established through circumstantial evidence such as from witnesses who saw such force or circumstantial evidence before or after the sex act. For example witnesses may say that they have seen the accused taking the victim by force to a secluded place.

A sex act committed with a minor (a girl of age less than 15 years) is punishable by law as per Article 594 of the Penal Code.

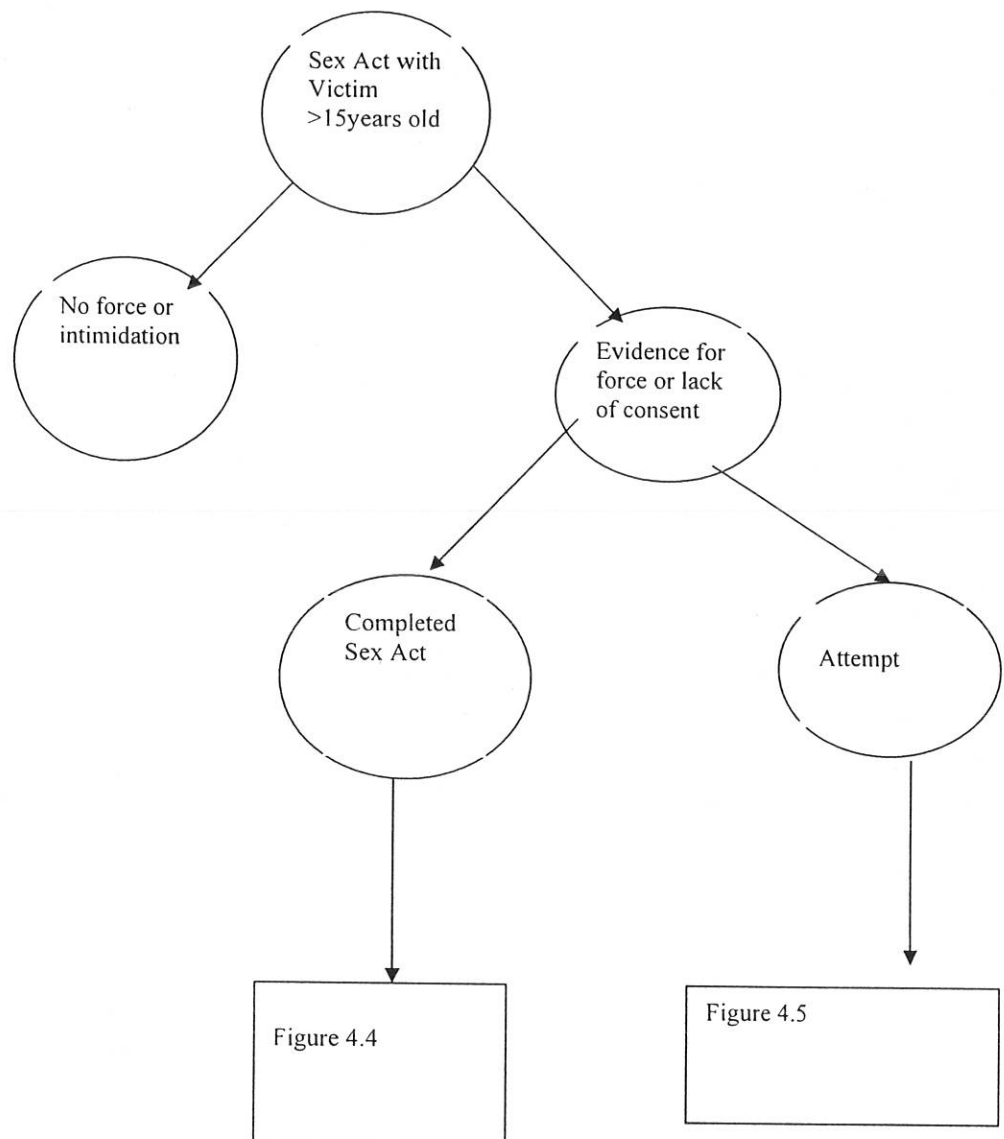


Figure 4.3 Concepts in Sex Act with a Non-Minor Victim

4.3.3 Sex Act

For an offence to be deemed as rape or sexual outrage what matters is the nature of the sex act. Both rape and sexual outrage involve violence and are crimes against the will of a woman. For a sex act, however, to be seen as rape there should be sexual intercourse between the offender and the victim. From this, we can see that rape is a more serious crime than sexual outrage.

In a sexual outrage the accused uses violence and commits “an act pertaining to the sexual act”.

The experts explain that in rape there is sexual intercourse and for a sex act to amount to sexual intercourse it has to be performed per vagina.

An act pertaining to the sexual acts, on the other hand, means any sex act that is not sexual intercourse.

In Ethiopia, there is no reliable and direct way of medical evidence for the commission of sexual intercourse on the victim. The judges rely on medical evidence for a recent defloration of the hymen if the victim was a virgin. If the victim is not a virgin all the judges rely on is on the words of the victim and of witnesses for the existence of violence.

This may sound inappropriate but that is how things are according to the experts and this system takes it as is since our objective is not to model how the law should be; rather how the law is.

The law stipulates that sexual intercourse with a minor, with a dependent or in concert with others is punishable by a more serious sentencing, one that reaches to 15 years.

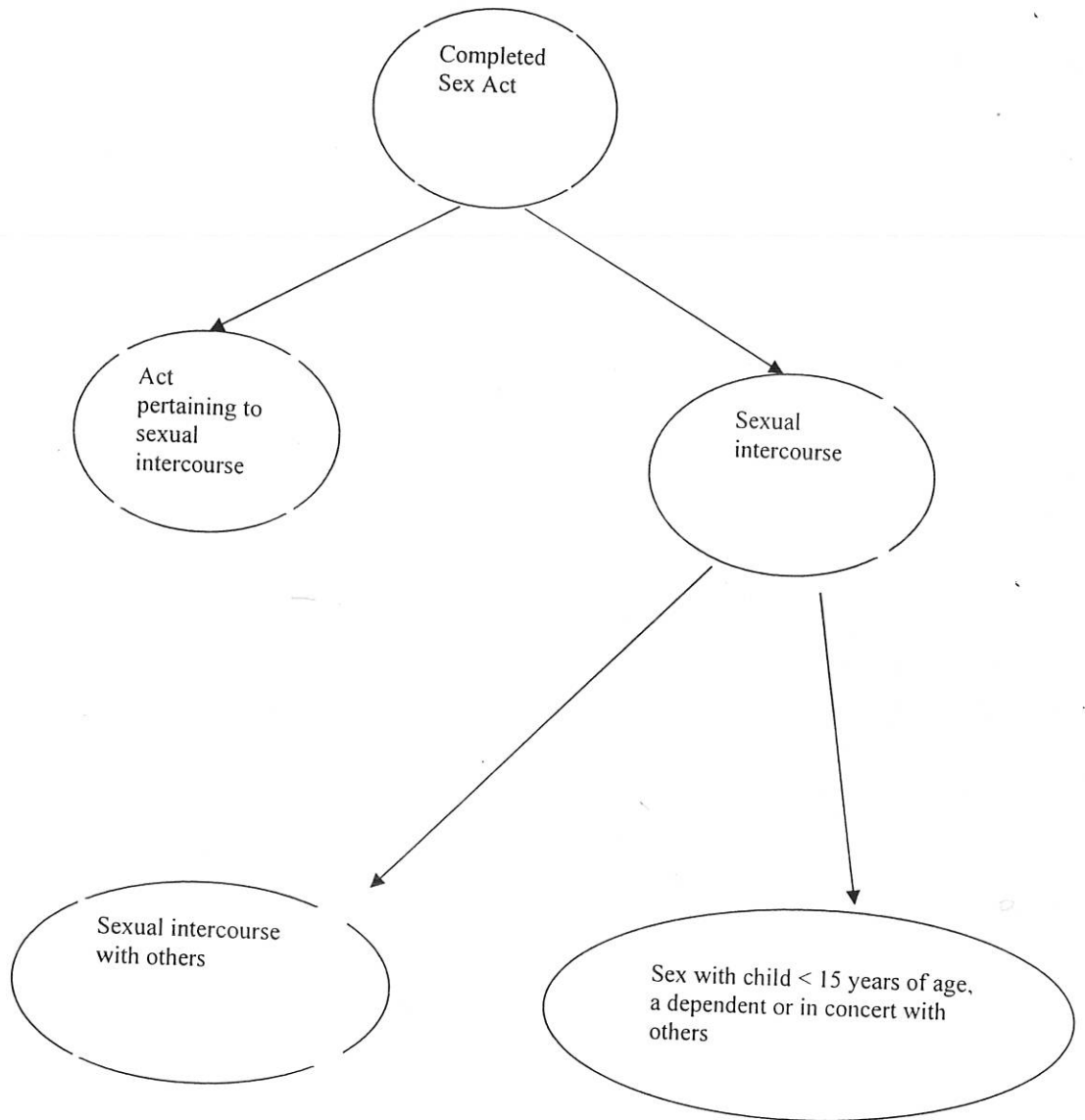


Figure 4.4 Concepts in Completed Sex Act

4.3.4 Attempt

A sex offense that has been started but not completed is prosecuted as per article 27 of the Penal Code. This article stipulates that:

1. Whoever intentionally begins to commit an offence and does not pursue or is unable to pursue his criminal activity to its end or who pursues his criminal activity to its end without achieving the result necessary for the completion of the offence shall be guilty of an attempt.

The offence is deemed to be begun when the act performed clearly aims, by way of direct consequence, at its commission.

2. An attempt offence is always punishable save as is otherwise provided by law. A mere attempt to instigate or participate in an offence doesn't come within the provisions of the law unless it is expressly provided to the contrary.

3. In the case of an attempted offence the offender is liable to the punishment attaching to the offence he intended to commit:

Provided that if circumstances so justify, the court may reduce the punishment within the limits provided by law.

The attempt may be of an attempt to commit any of the sexual offences but mostly the experts see it as an attempt of rape since such attempt usually includes violence.

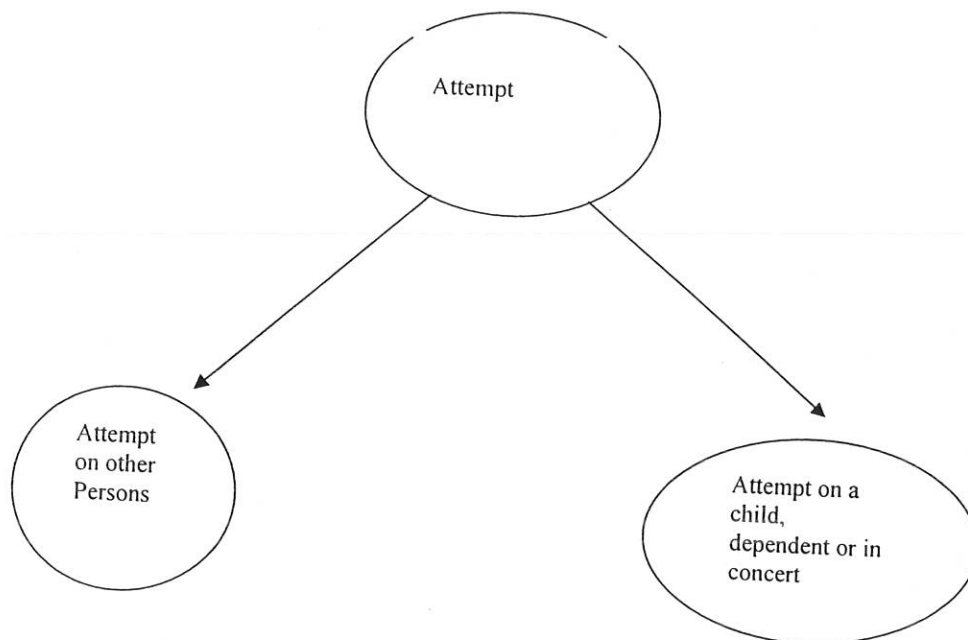


Figure 4.5 Concepts in Attempt

CONCLUDING REMARKS:

This chapter outlined the important concepts in the decision of the acquittal or conviction of a sex crime defendant and how these concepts are structured. The next chapter describes the knowledge representation for the rule based part of the legal expert system. The chapter outlines the derivation of various rules based on the concepts discussed in this chapter and their representation according to the syntax of the selected expert system shell for the rule based part. The chapter does also show the training of the neural work model to be used in the sentencing module of the prototype legal expert system.

CHAPTER FIVE: KNOWLEDGE REPRESENTATION AND NEURAL NETWORK MODEL BUILDING

Preview:

The previous chapter presented the acquisition of knowledge needed for the rule based part of the hybrid legal expert system. As the prototype legal expert system has got two modules (that of a rule based module and a neural network module) this chapter has got two parts. The chapter in its part I shows the representation of the knowledge acquired from experts, in the form of IF-THEN rules, the reasoning strategy chosen and the explanation facility of the prototype legal expert system.

Part two of this chapter describes the data set and the artificial neural network model developed from it for use in predicting sentencing decisions.

PART I: KNOWLEDGE REPRESENTATION FOR THE RULE BASED MODULE

5.1 THE RULE BASE

The rule base of the prototype HyRuN-LES is a collection of IF-THEN rules which represent the knowledge acquired from experts in the syntax of the selected expert system shell.

The expert system development shell selected and used in the implementation of the hybrid legal expert system is the Knowledge Pro for Windows (KP Win) expert system shell.

Knowledge Pro for Windows (KP Win) is a tool for rapid application development under Windows or DOS. Interactive design tools and a rich, object-oriented language combine with

hyper-text and expert systems technology to make KP Win the most complete development tool available for both beginners and professional programmers.

There are five different goals to be reached by the system. These goals can be reached through various routes. The five different goals correspond to the five kinds of decisions (judgments) the system can give.

Goal 1: Judgment being acquittal

An accused person is acquitted or set free of the charges that were brought against him when there was no condition satisfied to render him guilty of the judgments in the other goals.

Goal 2: Judgment being "guilty of Rape (Art.589-1)"

This judgment is given when the accused has been found guilty of a rape crime.

Goal 3: Judgment being "guilty of Rape (Art.589-2)"

This judgment is reached when the accused has been found guilty of raping a minor, a dependent or in concert with others. The sentencing is more sever (or imprisonment is prolonged) for this than in the case of number two.

Goal 4: Judgment being "guilty of attempt of Rape (Art.27 +589-1)"

This decision is made when the rape was an attempt and not completed.

Goal 5: Judgment being "guilty of attempt of Rape (Art.27 +589-2)"

This decision means the same as in number 5 but the attempt was on a minor, a dependent or in concert with others.

Goal 6: Judgment being "Guilty of Sexual Outrage (Art.590)"

The accused is guilty of a lesser evil crime of forcing someone to have an act pertaining to sexual intercourse.

These goals are located at the root node of the hierarchical tree used to model the concepts in the sexual crime trial in chapter four. The goals are achieved when the conditions in the leaf nodes are satisfied.

Stated in another way, there are various possible routes to reach at any one of the above goals. Each one of these routes constitutes a rule that can be stored in the rule base of the expert system to be fired when the necessary conditions are satisfied.

A few of the rules derived from the hierarchical tree structuring of the knowledge in the previous chapter that show when and how the above goals are reached appear below.

IF 'Wedlock' is 'yes'
THEN judgment is 'Goal 1'.

IF ? 'Wedlock' is 'no'
And? 'Evidence of sex act' is 'no'
Then judgment is 'Goal 1'.

IF ? 'Wedlock' is 'no'
And? 'Evidence of sex act' is 'yes'
And ? 'Victim age is less than 15' is 'yes'
Then judgment is 'Goal 3'.

IF ? 'Wedlock' is 'no'
And? 'Evidence of sex act' is 'yes'
And ? 'Victim age is less than 15' is 'no'
And? 'Force or lack of consent' is 'no'
Then judgment is 'Goal 1'.

IF ? 'Wedlock' is 'no'
And? 'Evidence of sex act' is 'yes'
And ? 'Victim age is less than 15' is 'no'
And? 'Force or lack of consent' is 'yes'
And ? 'sex act' is 'attempt'
Then judgment is 'Goal 4'.

IF ? 'Wedlock' is 'no'
And? 'Evidence of sex act' is 'yes'
And ? 'Victim age is less than 15' is 'no'
And? 'Force or lack of consent' is 'yes'
And ? 'sex act' is 'completed sex act'
And ? 'completed sex act' is 'act pertaining to sexual intercourse'
Then judgment is 'Goal 6'.

5.2 REASONING STRATEGY ADOPTED

The reasoning strategy adopted in the rule based module of HyRuNLES is a backward chaining strategy. In this strategy, a judgment is seen as a goal. The system functions as a diagnosis of the symptoms input by the user to recommend the appropriate remedies (judgment).

The control structure of the system is such that it starts with a goal to achieve and works "backward" through the inference rules stored in the rule base.

This strategy was adopted to the problem at hand as opposed to a forward chaining strategy since suggesting a judgment involves ascertaining the existence or nonexistence of some parameters (or symptoms to use a medical term) by asking questions. The answers to these questions are worked back to the goal based on the rules stored in the rule base.

To illustrate this through an example, it is good to see the rules organized in this form:

1. Judgment = 'Goal 3' if
'Wedlock' = 'no' and
'Victim age is less than 15' = 'yes' and
'Evidence of sex act' = 'yes'

2. Judgment = 'Goal 1' if

'Wedlock' = 'no'

'Force or lack of consent' = 'no'

'Victim age is less than 15' = 'no'

We can continue likewise listing the goals and the conditions they will be satisfied under. In a backward chaining strategy the system starts from one goal and it asks if the first condition is satisfied or not for that goal. If yes then the other conditions are ascertained. If not it moves to the other goal.

This way the backward chaining embedded in the selected expert system shell enables the system to know what question to ask and when to ask them.

5.3 EXPLANATION FACILITY

One aspect that separates expert systems from other conventional programs is their ability to reason with knowledge and to explain the solution they provide to the user. The explanation facility in the prototype legal expert system has got two aspects.

The user can inquire **why** a specific question is being asked when interacting with the system. This "why" facility is provided for each question in the prototype system in a separate window that pops up at the touch of an appropriate button. This aspect not only convinces the user about the validity of the question but points them the various issues involved in deciding the answer for each question.

For instance, the first question that the system asks when deciding if an accused person is guilty of a sex crime or not is whether the accused person lives with in wedlock with the victim or not. The following explanation is provided when the user asks "why"?

The Penal Code of Ethiopia provides that any sex act is to be taken as a possible crime if and only if committed out of wedlock. Sexual intercourse or an act pertaining to sexual intercourse performed, with or without the plaintiff's consent, doesn't constitute a crime if performed between two individuals that live in wedlock.

Please notice here that wedlock refers to marriage performed in any one of the three alternatives: civil marriage, religious marriage or traditional marriage. Some legal experts also hold that irregular union (living for a long time together without being married) may amount to being taken as living in wedlock for the purpose of determining if the sex act between such people is a crime or not.

The other aspect of the explanation facility of the prototype legal expert system is in the form of providing answers to the user's question of **how** a specific judgment is arrived at. After a series of questions, the system determines whether the accused person is guilty of a sex crime or not and if yes under which article. The user may at this point want to know how the system drew that conclusion.

The system gives this explanation by taking in to account the answers provided by the user for the various questions that were asked before arriving at the judgment.

The outputs of the rule based module of the prototype legal expert system are used as an input in an artificial neural network model in an attempt to predict the number of years of imprisonment a person already convicted of a sex crime faces to complete the trial of a sex crime.

It should be obvious that the neural network is used only if an accused person is convicted since no sentencing is needed in the case of acquittal.

The rule based module outputs under which article the person is convicted as discussed before. The number of years of imprisonment a convicted person faces depends, among other things, on under which article the person is found guilty. The neural network module is thus fed with this value as one input in addition to other factors discussed in part two of this chapter in an attempt to predict the number of years of imprisonment the person faces.

The data set used to train the Artificial Neural Network model and the training and testing of the model is discussed next.

PART II: THE NEURAL NETWORK MODULE

5.4 INTRODUCTION

Part I of this chapter described the knowledge representation phase for the rule based module of the prototype legal expert system. The rule based part of the system decides whether an accused person is guilty of a sex crime and if yes under which articles of the Penal Code of Ethiopia.

Part II of this chapter reports on the training of a neural network model that deals with the sentencing part of the judgment once an offender is found guilty. Once trained, the neural network model can be used to predict the number of years of imprisonment the convicted person faces.

The advantages and functionality of this part of the system briefly are the following.

- The output of the module can be used as a benchmark for inexperienced judges when deciding sentences. It is needless to say however that such a system can never replace the discretion of any judge as the individualization of punishment requires for every case to be seen as different.
- Lawyers can use this part of the module to answer what if questions by changing the values of the attributes described below. This will help them discover what areas need to be further researched. Since we can't derive clear rules from the neural network model from its very nature a significant change in the number of years of imprisonment following a change in one input variable shows that that input variable is important for the outcome of this case and has to be given serious work by the lawyers.

5.5 DESCRIPTION OF THE DATA SET

The data used for the training of the neural network model to predict the number of years of imprisonment as output has the following attributes as input. These attributes have been identified by legal experts interviewed as important in the determination of the sentencing decisions of judges.

The only relevant attributes for the training of the model and their possible values are:

Attribute	Possible Values
Name of Judge	Name of 5 judges
Age	1-120
Occupation	Student, unemployed, manual labor, office work, military, business man
Article	589(1),27+589(1), 589(2), 27+589(2),590
Prior case	Yes,no
Concurrence	Yes,no
Regret	Yes, no
Gravity	Yes, no
Family responsibility	Yes, no
Years imprisonment	1-15

Table 5.1 Attributes and values used for ANN model training

An explanation of what each attribute and its value represent is given below.

Name of Judge

Name of judge refers the judge who makes the sentencing decision. Taking in to account the value of this attribute helps to incorporate the concept of personal stare decisis discussed in chapter two.

Age

Age refers to the age of the offender.

Occupation

Occupation refers to the job of the offender. A more appropriate category would have been the educational status according to the Penal Code. However, instead of the educational status of the offender the occupation of offenders is found in the records. The whole purpose of considering the educational status of the offender is to consider the knowledge the person had of the criminality of the offence. The researcher concluded that a more general category of occupation would show indirectly the educational standard of the offender.

Article

Article refers to the specific article of the Penal Code under which the offender was found guilty. The severity of the sentence is not similar for all sexual crimes dealt with in this prototype system.

For instance, raping a child or a dependent is a more punishable crime than raping any other person. While ordinary rape is covered under article 589-1 rape of the later type is covered under Article 589-2.

Prior Case

Prior Case tells if the offender had a prior rape case or any other criminal case that he had been found guilty and convicted of before.

Concurrence

Concurrence has got a value of 'yes' when the accused commits a sexual crime in addition to committing another crime at the same time. Such as that of killing the victim after raping her. for instance!

Gravity

Gravity shows the evil conviction of the offender. Even if all sexual crime is a crime some are graver than others in their commission.

Family Responsibility

According to the legal experts the fact that a convicted person has got family responsibility may not always be a mitigating factor to assign a reduced sentence. In any case, whether the offender has got a family responsibility that he supports almost always affects the judgment.

The values for the above attributes have been collected from past cases and the decisions of judges on these cases at Arada and Lideta First Instance Courts. The suite filed by the Prosecutor General and the corresponding sentencing decisions of five judges were carefully examined to extract the values for the above dependent and independent variables (attributes). From a bulk of sexual crime cases, only those cases (100 of them) that resulted in the defendant's conviction were selected for training the artificial neural network model.

The neural network software used to train, test and evaluate the outputs of the model was the NeuroSolutions evaluation edition from NeuroDimensions Incorporated. The software has got a Microsoft Excel add-in that enables one to develop a neural network model in an Excel environment.

5.6 STEPS IN BUILDING THE MODEL

5.6.1 Preprocessing the Data Set

The following preprocessing tasks were carried out on the data set before using it for the training of the model.

Discretization

The ages listed for the defendants were categorized in to one of five categories as the neural network can handle only a limited number of columns of data upon training.

Randomizing Rows

In many cases the data may be ordered such that similar inputs may be grouped together. This can cause a problem when training a neural network in that the network may be trained on one group of input data and then tested on a group of data that has little similarity to the training data. In order for the training data to be representative of the entire data set NeuroSolutions for Excel randomizes the rows of the data set before training.

Translating Symbolic Columns

Neural networks require that they be fed numeric input and desired output data. In the data set the textual values such as “yes” “no” “unemployed”.....had to be translated in to columns of 0’s and 1’s.

5.6.2 Tagging the Data

Before training the neural network using NeuroSolutions, it was necessary to partition the columns and the rows of the data set in the Excel spreadsheet. All the columns except the last were tagged as an input and the last column was tagged as a desired output. The rows were then segmented into one or more of the following four groups:

- **Training** - Data used by the neural network to learn from.

- **Cross Validation** - Data used to evaluate the performance during the learning process to avoid over-training.
- **Testing** - Data used to evaluate the performance after the training is complete.
- **Production** - Input data to feed into the trained neural network to produce an output.

The data looks like below after all the above preprocessing activities and after the necessary tagging.

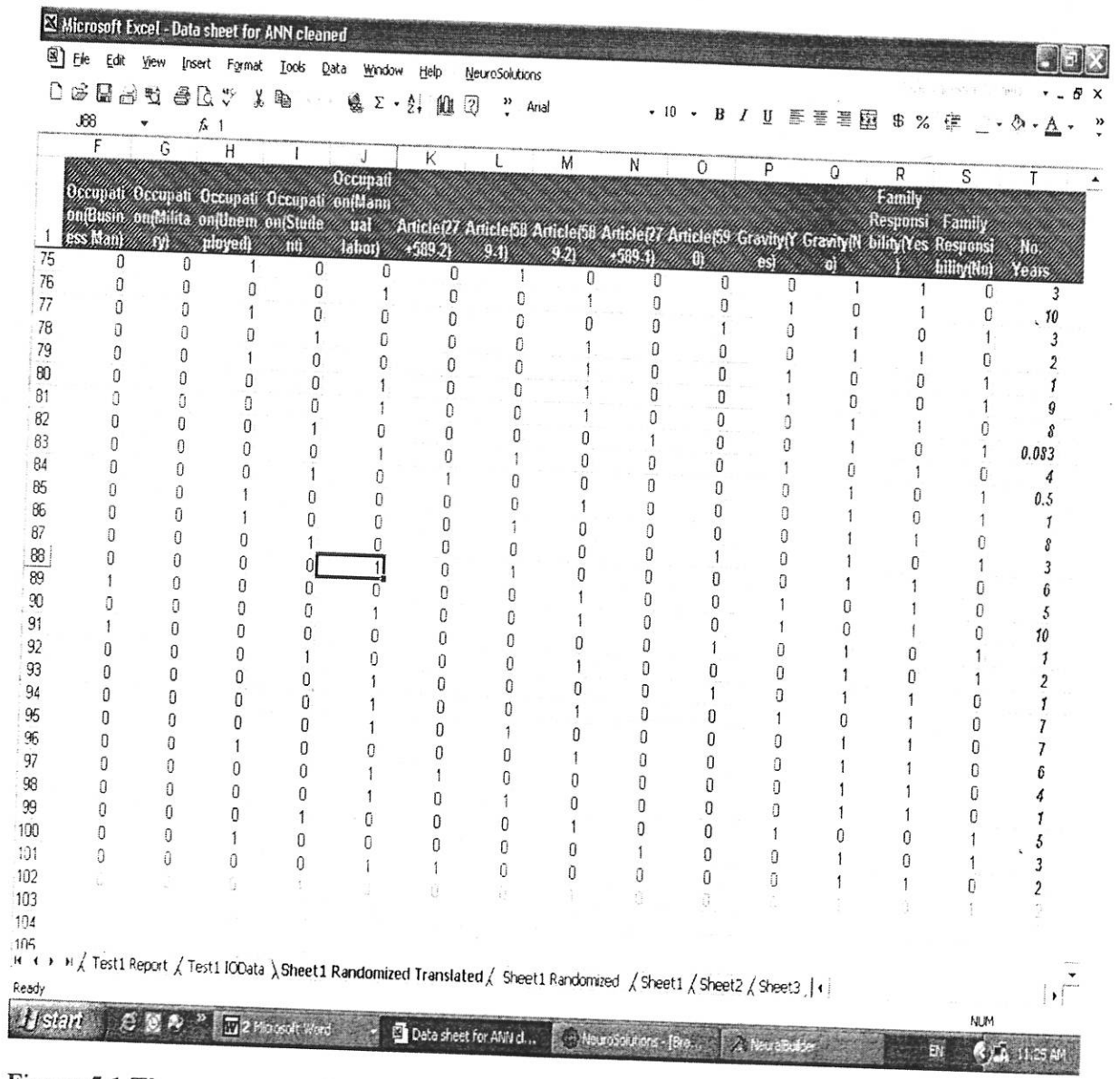


Figure 5.1 The preprocessed data set used for experimentation

5.6.3 Creating the Neural Network

After selecting the data to be fed to the neural network, the type of neural network to be used to model that data was specified. NeuroSolutions for Excel is integrated with the NeuralBuilder, one of the neural network construction utilities included with NeuroSolutions.

An MLP (MultiLayer Perceptron) with one input, one hidden and one output layer was created. The neural network created uses the feedforward backpropagation algorithm in training with the data and building a model.

5.6.4 Training the Neural Network

The next task was to specify to NeuroSolutions for Excel how many epochs (passes through the data) to train for and let NeuroSolutions do the work of training the network weights.

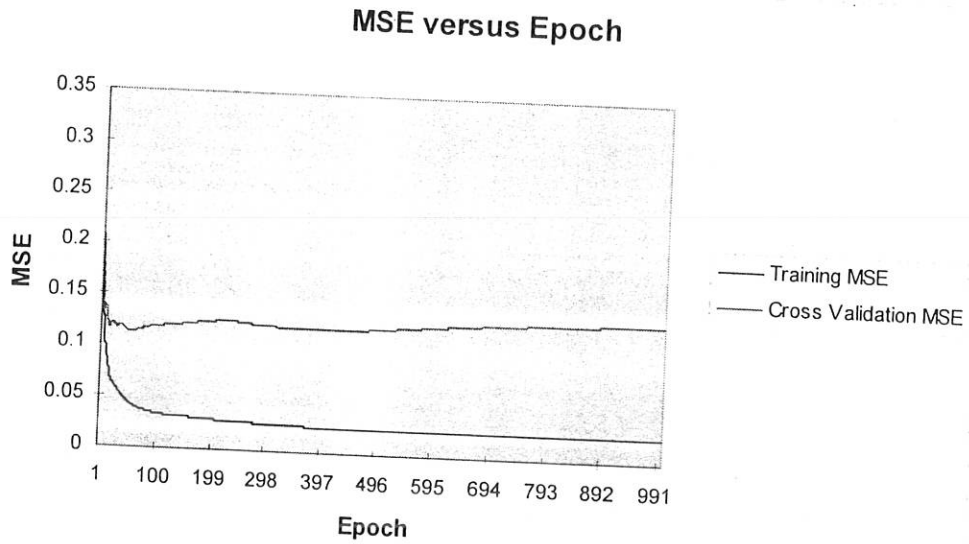
First the default set up of the software was used to train the MLP network. The default set up has 1 hidden layer with four processing units. The network has also got 16 processing elements in its input layer and 1 processing element on its output layer. The transfer function used was the TanAxon function and the learning rule was Momentum. The maximum epoch for which the network iterates was specified at 1,000 while the weight update was batch.

The termination criteria was to stop the training when the MSE (mean squared error) of the cross validation set starts to increase.

The data set was classified in to a first group of 60 % of records for training, the next 20 % of records of the cross validation group and the final 20% records (cases) for testing.

Shown below is the report generated by the software at the end of the training session. It shows the learning curves for both the training and cross validation data sets as well as the mean squared

error (MSE) achieved during the training. The network weights are automatically saved at the point where the cross validation error is at its lowest.

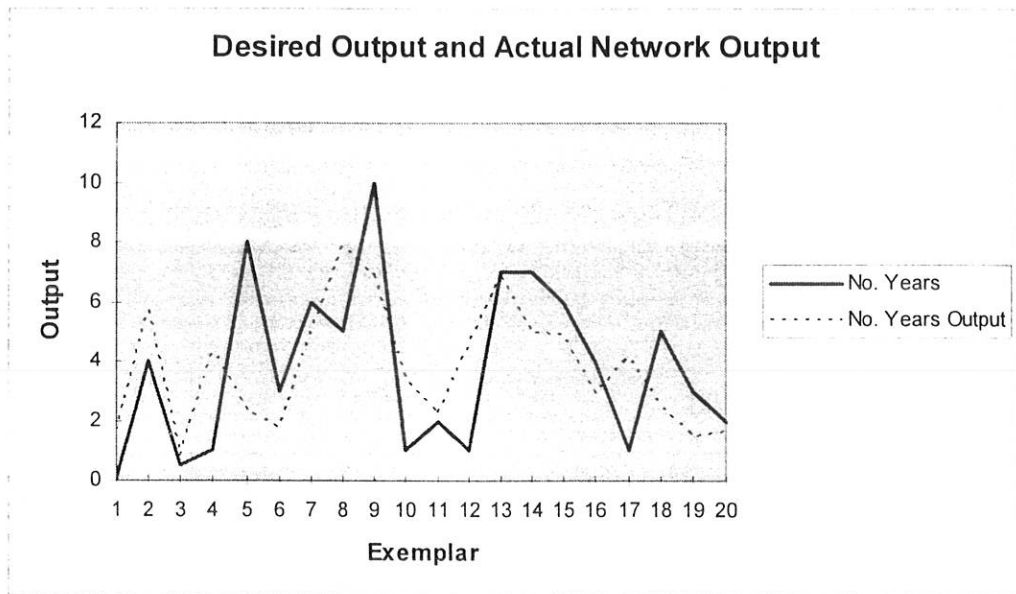


<i>Best Networks</i>	<i>Training</i>	<i>Cross Validation</i>
Epoch #	1000	50
Minimum MSE	0.023472579	0.112685718
Final MSE	0.023472579	0.133463994

Figure 5.2 Performance report of first training experiment

5.6.5 Testing the Network Performance

Testing the network involves seeing how well the neural network performs on data that it has not yet "seen". NeuroSolutions for Excel automatically fed the data tagged as "Testing" into the trained neural network and then generated the report shown in figure 5.3.



<i>Performance</i>	<i>No. Years</i>
MSE	5.660239439
NMSE	0.739856613
MAE	1.947827649
Min Abs Error	0.130391598
Max Abs Error	5.699724436
r	0.540427639

Figure 5.3 Performance report of the ANN model trained in the first experiment

As this was a regression problem the report chosen was typical of such types of problems. Regression problems are those where the goal is to determine a numeric value given a set of inputs.

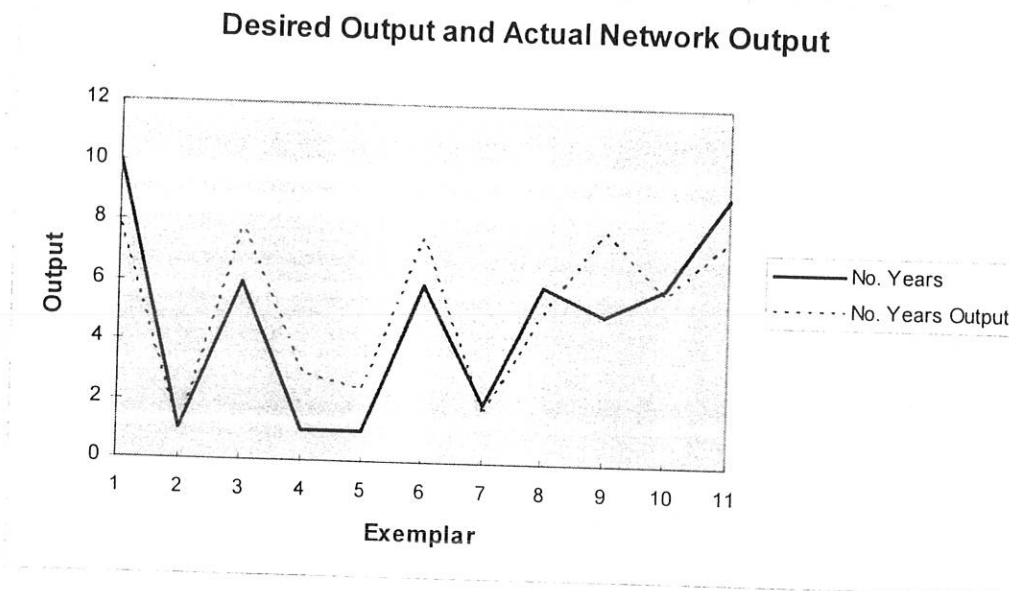
Figure 5.3 shows how close the network output is to the desired output. In this case the performance of the network was not so good. The experiment was repeated several times by changing the default parameters discussed under section 5.6.4. Some examples of these several experiments carried out appear in table 5.2.

Experiment	2	3	4	20
Parameters				
Network Type	MLP	MLP	MLP	MLP
Hidden Layer	1	2	2	1
Hidden Layer nodes	4	4 each	8	4
Transfer function	SigmoidAxon	TanhAxon	SigmoidAxon	TanhAxon
Learning rule	Momentum			Momentum
Maximum epochs	1000	100	10000	10000
Termination	MSE increase on CV	Epochs	MSE incremental CV	Minimum CV MSE
Weight update	Batch	Online	Batch	Batch
Test MSE	4.5	7	9.6	3.2

Table 5.2 Sample parameter in various experiments done

Finally, the performance of the best training experiment done is shown in figure 5.4. The MLP had the same parameters as in experiment 20 but this time around the data was classified in to a first group of 80% of records of training and two groups of 10 % of the records each for cross validation and training respectively. In addition, the number of epochs was 1000 and the termination criterion was upon increase of cross validation MSE.

The mean squared error was the least (2.4 years) obtained form several experiments conducted before and after this one by changing the fore mentioned parameters.



<i>Performance</i>	<i>No. Years</i>
MSE	2.464801269
NMSE	0.266762932
MAE	1.3477699
Min Abs Error	0.121273994
Max Abs Error	2.806681633
r	0.864786405

Figure 5.4 Performance of the best ANN model trained

Concluding Remarks:

This chapter discussed the design of both the rule based and neural network module of the system. The outputs of the rule based part are whether the accused is guilty of a sex crime or not and if yes under which article of the Penal Code. This output is used as an input in the neural network module among other additional values of attributes of the conviction for use in predicting the number of years of imprisonment the person faces. The next chapter shows the knowledge application phase for the hybrid legal expert system.

CHAPTER SIX: KNOWLEDGE APPLICATION

Preview:

The previous chapter discussed the design of the rule based module of the hybrid legal expert system and the training of the neural network model for the ANN module.

This chapter wraps up the design of the prototype system by discussing and demonstrating the interface of the rule based module, the combined evaluation of the hybrid legal expert system, and other design requirements for future use.

6.1 THE USER INTERFACE OF HYRUNLES

The rule based module of the prototype **HyRuNLES** (Hybrid Rule Neural network Legal Expert System) has got various windows that help the system to communicate with the user.

Figure 6.1 below shows the main window of the system that welcomes the user when the program is first initialized. This window introduces the system to the user and provides additional information in a separate window upon the click of the "About **HyRuNLES**" button.

The user can then continue to using the system by clicking "Next" or quit at this point by clicking the "Exit" button as shown in figure 6.1.

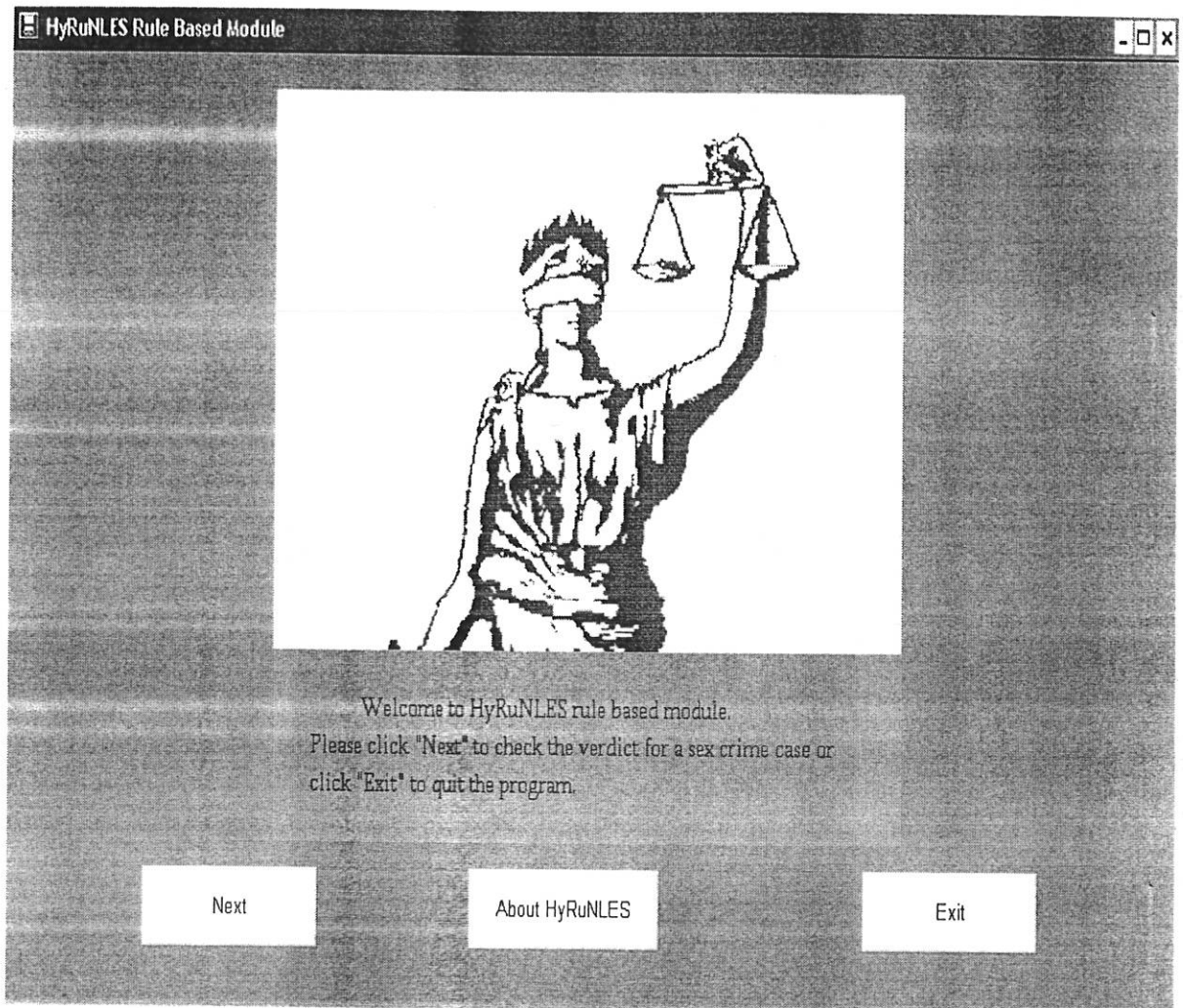


Figure 6.1 The Main Window of HyRuNLES

Clicking the "Next" button on this window leads to another working window that describes the use of the rule based part of the prototype system and if the user wants to check a case he/she is told to proceed by clicking "Next" on this second window(see figure 6.2).

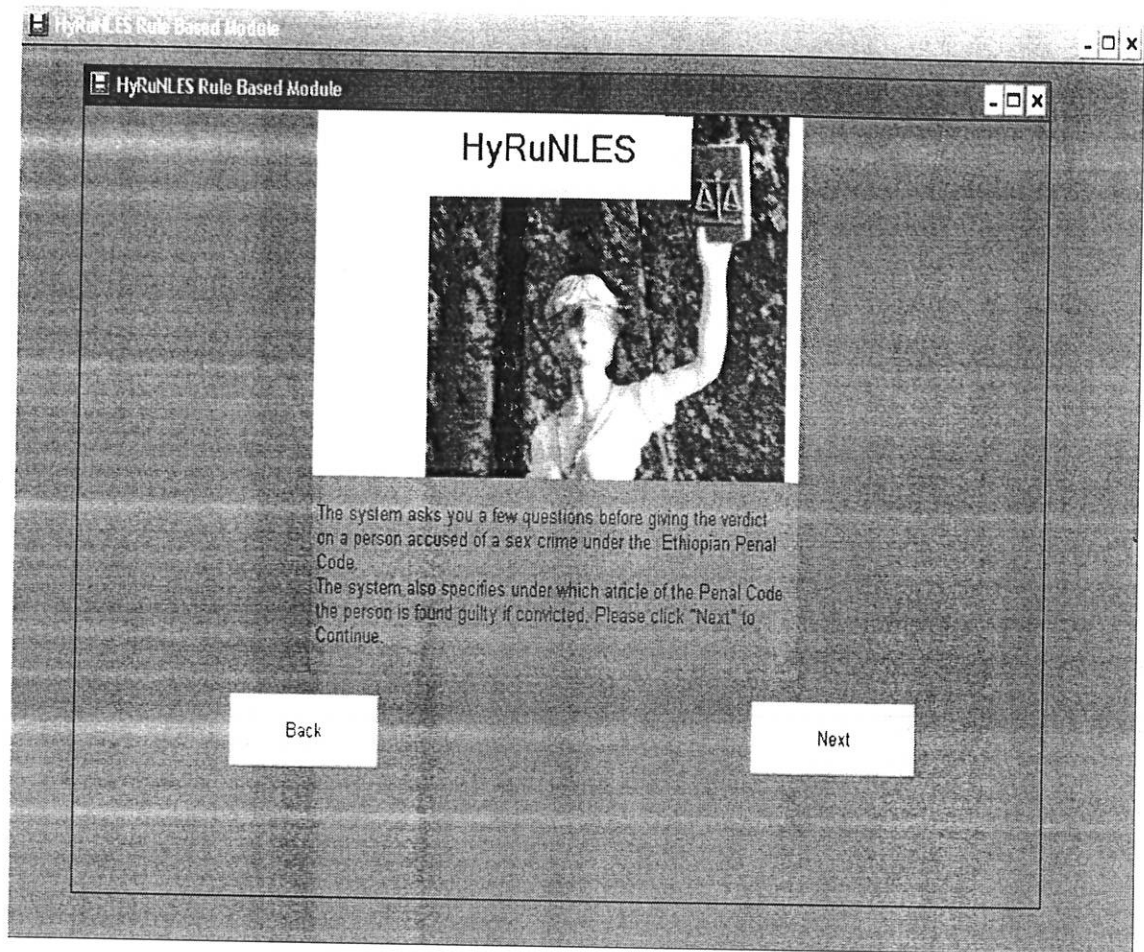


Figure 6.2 The working window of HyRuNLES

If the user proceeds by clicking “Next” on the window shown in figure 6.2 he/she is asked several questions until a decision is reached. The verdict is displayed with in the system as shown in figure 6.4. The point at which the system gives a verdict depends on the case type. If for instance, the user answers “yes” for the first question of whether the accused lives with in wedlock with the victim or not as shown in figure 6.3, the verdict of “acquittal” is immediately displayed with out the need to investigate other facts about the case since under the Penal Code of Ethiopia no sex act can constitute a sex crime irrespective of the prevailing situations as long as the victim and the accused live in wedlock.

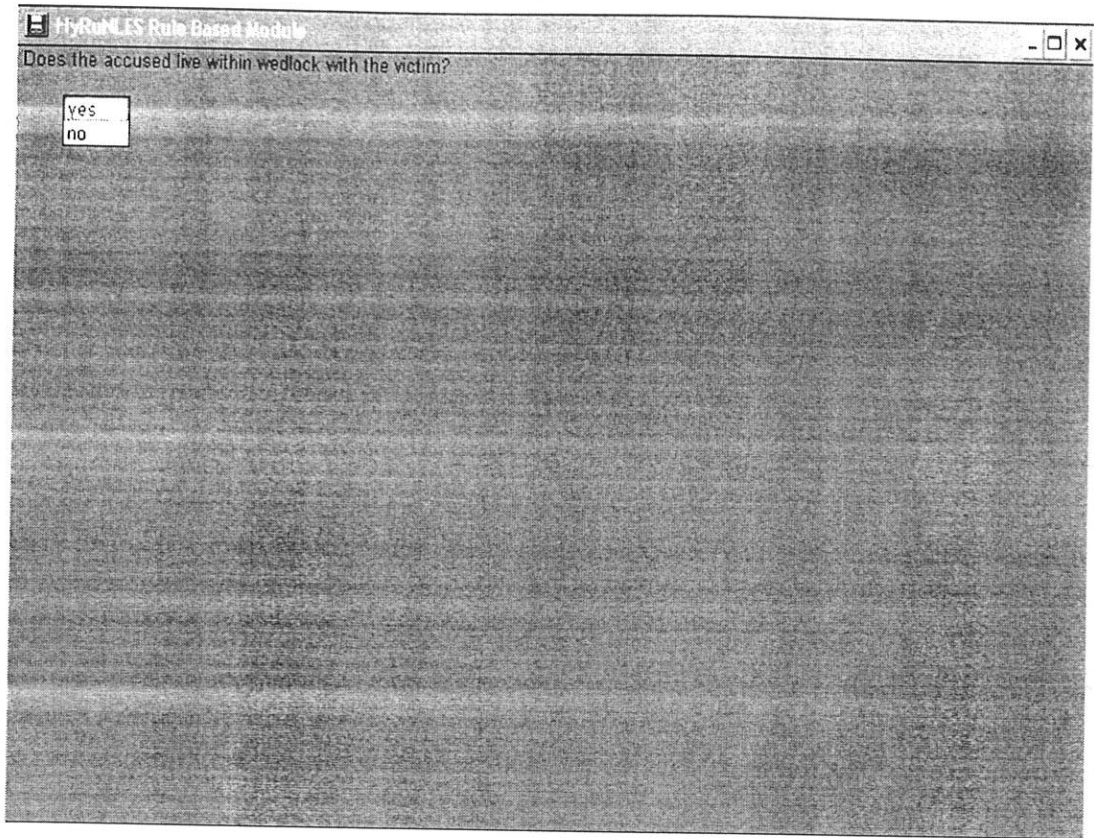
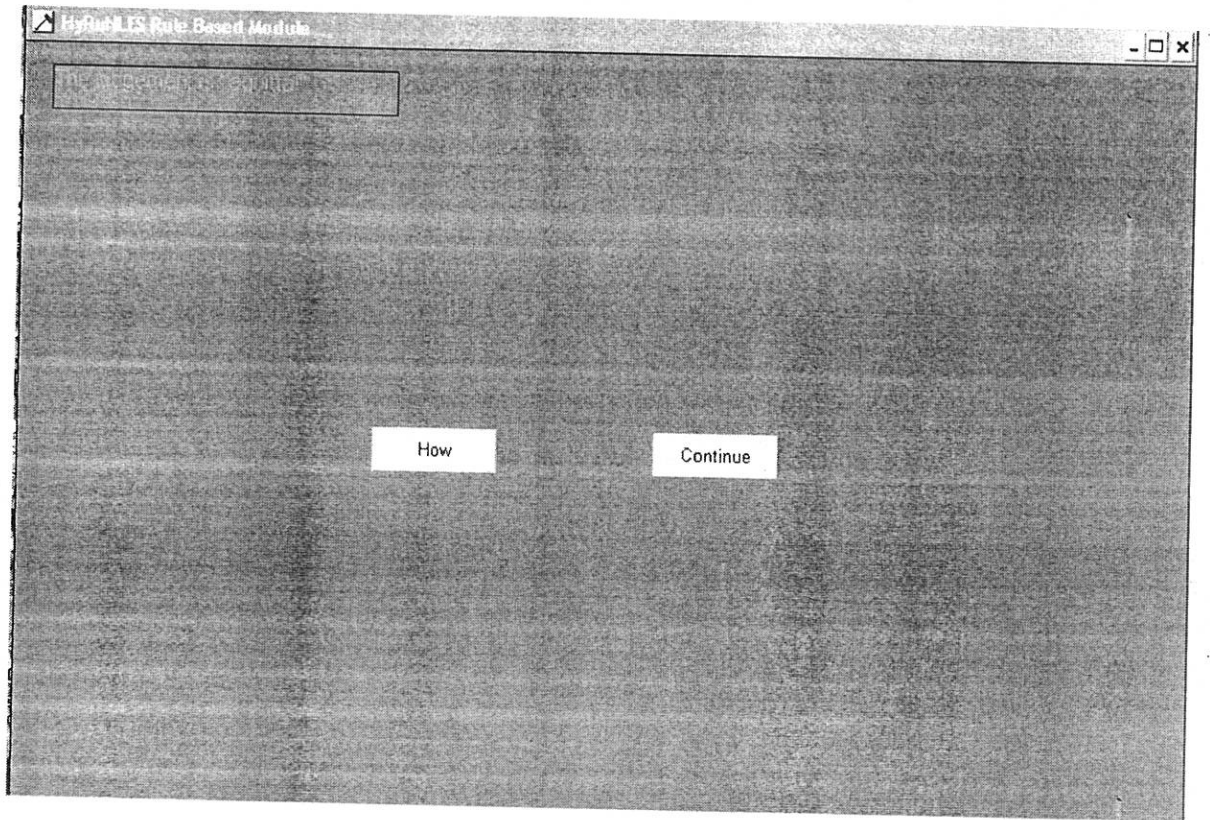


Figure 6.3 The first question in HyRuNLES before a verdict

Once the judgment is displayed in the format shown in figure 6.4 the user is asked if they want to check another case or not. Answering yes to this question takes the user to the first window shown in figure 6.1. The user can continue the process several times in like manner until they exit the program.

The output from the rule based module tells the user whether the accused person is found guilty of one of five sex crimes and if yes under which article of the Penal Code of Ethiopia of 1957. This fact can then be entered in to the artificial neural network model trained using NeuroSolutions with additional data of necessary parameters such as age, occupation, prior case, etc. to predict the number of years of imprisonment the offender is expected to face. It is to be remembered that one of the attributes used in training the ANN model to enable it to predict the number of years of imprisonment was Article. "Article" refers to under which article of the Penal Code the offender is found guilty.



6.4 The final output of the rule based module of HyRuNLES

6.2 TESTING THE SYSTEM

In order to test the performance of the system four separate cases on which judges already pronounced a decision were presented to the system. A description of one of the cases follows.

The Public Prosecutor's charge shows that Mr. X (the name is kept anonymous for privacy reasons) followed the 10 year old victim on a specified date in the premises of Meskerem Hulet School and raped her after rendering her incapable of objecting by putting his hands on her mouth so as to choke her.

Witnesses on the defendant's side contended upon the hearing of the case that it is true that the accused and the victim attend the same school but are in different shifts. However, they have also indicated that students can stay with in the school such as when using the library after their regular class shifts.

On the other hand the victim herself described the scene on the date she was raped and a medical certificate from a hospital by the Public Prosecutor confirmed that the victim's hymen was damaged.

From the above case description the following facts could be extracted and fed in to HyRuNLES as answer to its questions:

- The accused doesn't live with in wedlock with the victim.
- Evidence of sex act was presented in the form of medical certificate
- The victim's age is less than 15
- There was circumstantial evidence in the form of the victim's account of the rape with in the school's premises

Based on the above fact HyRuNLES decided that the accused is guilty of rape under the category of Article 589 sub article 2 of the Penal Code of Ethiopia. The neural network part of the system was fed this data in addition to the values for other attributes of this case described below.

The "Article" column of the data for this record or case was thus filled with the value "Guilty of Rape (article 589-2)".

Additional values extracted from the case description in the file by the judge and the charges of the Public Prosecutor are given below.

- The value of "Name of Judge" was Mihret H/Mariam
- The value of "Age" of convicted person was "<18" from the Prosecutor General's file
- The value of "occupation" was daily laborer
- The value of "Prior case" was no
- The value of "Concurrence" was no
- The value of "Gravity" was no
- The value of "family responsibility" was no

HyRuNLES' neural network module was used by inserting the above parameters in the model trained using the NeuroSolutions software and tagging the above case as "production" raw. The system predicted 7.8 number of years of imprisonment.

A comparison of the output of the system for this and other additional three cases with the actual decision of judges is given below.

Case	System Verdict	Judges' Verdict	System's sentencing prediction	Judges' actual sentencing decision
1	Guilty under Art 589-2	Guilty under Art 589-2	7.8 years	5 years
2	589-2	589-2	3.6 years	6 years
3	589-2	589-2	7.3 years	5 years
4	589-2	27+589-2	1.6 years	4 years

Table 6.1 Test result of HyRuNLES' output

6.3 Hardware and Software Requirements

The Knowledge-Pro for Windows (KPWin) shell version 3.0 is needed to run HyRuNLES. To work on this version of KPWin, there is a need for at least the latest versions of Microsoft C/C++ (V7.0) or Borland C++ (V3.1), or the Windows version of C++, i.e. Microsoft Visual C++.

In the network environment, the new system requires a network operating system, preferably Windows NT 4.0 and at least Windows 95 operating system on client PCs.

According to KPWin (1991), Knowledge-Pro for Windows (KPWin) could be used in PCs having at least 4MB system memory and processor speed of 133 MHz. However, 8 MB memory at least for use with Visual C++ environment is recommended.

CONCLUDING REMARKS:

This chapter showed the application of knowledge phase for HyRuNLES. In addition the combined performance of the two modules of the system was tested. The test result shows that the model of legal reasoning followed in designing and developing HyRuNLES is functional to handle cases on sexual crimes. The performance of the neural network module of the system is not as accurate as is expected from such a system.

The individualization of judgment requires that every individual get fair punishment for their crimes taking in to account the circumstances under which the crime was committed. The amount of error observed in the neural network part is not tolerable in this case as the number of years here refers not only to just numbers but the number of years one has to spend in prison.

The artificial neural network model thus needs to be improved by facilitating mechanisms through which ample data can be collected on previous cases and the related sentencing decisions by judges.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATIONS

Preview:

The previous chapters have brought to light some issues of importance in the design of legal expert systems. These issues have been outlined in the previous chapters. This chapter concludes the work and gives recommendations for future work in the area.

7.1 CONCLUSION

The problem of an inefficient and unfair judicial system is prevalent in a society where justice is delayed and sometimes denied. Legal expert systems can help in the attempt to improve the judicial system in a country by improving the quality and speed of service lawyers give to their clients and the amount of time judges take to decide on a case.

The design of a legal expert system has been discussed in this research using a hybrid approach. Two paradigms, the rule based approach and an artificial neural network model were used to design a prototype legal expert system.

These paradigms were chosen in an attempt to make up for the problems inherent in each one of these paradigms. The rule based approach though appropriate to a civil law legal system such as that exists in Ethiopia can't handle open texture.

A special type of open texture, that of discretion given to judges in sentencing was handled by a neural network model trained based on past judgments collected from courts to supplement the rule based module in this aspect. The parameters that were used as an input in training the network were identified by experts as important in the sentencing decisions of judges.

The results of the endeavor to build HyRuNLES suggest that it is encouraging to invest in a work of designing a full fledged system that emulates the model of legal reasoning adopted in this work.

7.2 RECOMMENDATIONS

An attempt to improve the scope and performance of the legal expert system that the researcher tried to come up with would be interesting. There are a lot of areas that can be worked on and improved in the future in the work of coming up with a functional legal expert system. Some are listed out below.

1. The output of the rule based part is displayed to the user as it is. Instead, it would be interesting to produce a legal argument from the decision (or judgment) and explanations the system produces. In addition, future work would hopefully integrate the two modules so that the user can use one interface to interact with both modules while the rule based part and the ANN model run in the background.
2. The results of the neural network training have not been found pretty accurate. This researcher presumes that this was due to the problems in getting access to a large collection of past cases and their sentencing decisions. A possible future work in this area would use a large amount of records if access to such files is facilitated.
3. The outputs of the neural network module of HyRuNLES can not be explained as to how they were arrived at. It would be helpful both to appreciate which attributes contribute a lot to the sentencing decision and to provide an explanation to the users of the system if rules could be extracted from the model for future work.
4. Including all the rules in the Penal Code is a huge task that requires interviewing a large group of experts and reading a lot of material. Instead, adding one other domain at a time in to the system with in criminal law could be a good approach on the road to designing a full fledged system.
5. In the design of a legal expert system, there is always the issue of the law being updated subsequently. Looking in to how this can be handled is appropriate. The system should be provided with a capability to learn via a facility to accept additional rules to include in its rule base when it comes up with a case it can't decide on based solely on the rules it incorporates.

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URL 4: www.answers.com

Appendices

APPENDIX I: INTERVIEW QUESTIONS FOR LEGAL EXPERTS

1. Which articles in the Penal Code govern crimes related to sex?
2. Can you identify the factors that are to be looked in to before deciding on a sex crime case?
3. What do each one of these concepts or factors mean? Why are they important?
4. How do you determine about the presence or absence of these factors?
5. What evidence is required to conclude that sexual intercourse has actually occurred?
6. What evidence is required to conclude that an act pertaining to sexual intercourse occurred?
7. How do you differentiate an attempt of rape from a completed act?
8. How do you decide if there was lack of consent when no force is used to acquire sexual intercourse?
9. How is a sex crime by a female offender handled?
10. What amount of force is necessary to amount to violence in rape?
11. What are the important factors that judges take in to account when making a sentencing decision on an offender already convicted of a sex crime?

DECLARATION

This thesis is my original work, has not been presented for a degree in any other university and all sources of material used for the thesis have been duly acknowledged.

Seifu Tatek Yazhy

June, 2005

The thesis has been submitted for examination with my approval as university advisor

Dr. B. L. Desai

June, 2005