Uncertainty Handling Tool For Legal Consultation

A Thesis

Submitted as a Partial Fulfillment

For the Award of Degree of

Masters of Science

By

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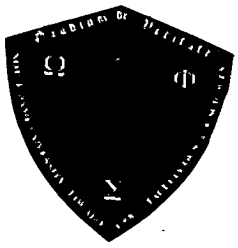

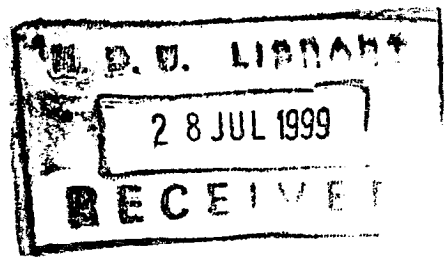

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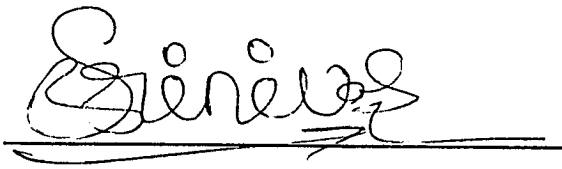

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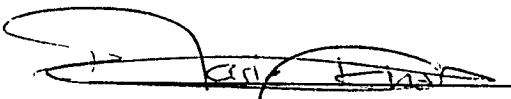

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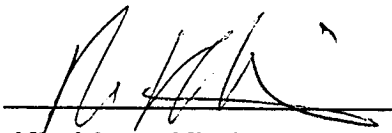

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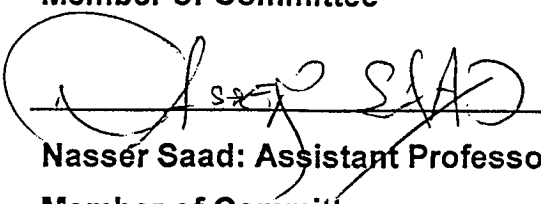

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List of Abbreviations

Artificial Intelligence:	**AI**
Applied Artificial Intelligence:	**AAI**
Bayesian Inference:	**BI**
Data Flow Diagrams:	**DFD**
Dempster Shafer Theory:	**DST**
Evidence Point:	**EP**
Expert System:	**ES**
Knowledge Base:	**KB**
Knowledge Base System:	**KBS**
Knowledge Engineer:	**KE**
Natural Language Processing:	**NLP**

Synopsis

In recent years, it is witnessed that acquisition of knowledge from human sources, taking a challenge tasks as it contains lot of uncertainty. In general, for practical purposes, we reason and solve problems based on insufficient and inadequate information. As a consequence, the knowledge representation in a machine and its subsequent utilization has gained a significant momentum.

Thus, knowledge is subsequently stored in the knowledge base of the system, using an appropriate knowledge representation scheme. Many a times, the knowledge is often defined with respect to a human being. Human knowledge often has gaps, inconsistencies, beliefs and opinions in addition to naked facts whose truth in uninspired.

In this thesis, we broadly categorized the amount of work from two different perspectives:

1. A new approach for handling uncertainty.
2. The application of this approach to legal consultations within the Lebanon Jurisdiction.

We stress more on the application part of it. Part 1 reveals that the uncertainty associated with proposition P in an ordered tuple $(\alpha,\beta) \in [0,1] \times [0,1]$ where α is the total pooled evidence "for" to the proposition and β is the total pooled evidence "against" the same proposition. We adopted this formalism for legal consultation for the purpose of intelligent decision making.

We have developed a software tool using FoxPro for windows 2.6 coupled with Pascal code. This tool is based on procedural design, gives an aid to the judge for the purpose of decision making.

For the purpose of illustration, we practically borrowed certain legal cases in Lebanon from the court.

Contents

Chapter 0

Introduction

0.1 Motivation

Human reasoning is usually approximate in nature and involves various uncertainties. One of the most important capabilities of a human is to deal effectively with imprecise, incomplete and sometimes uncertain information. The term "data" is an unstructured set of numbers, facts and symbols conveying information only by virtue of some structure or decoding mechanism. On the other hand, information is contained within the data, with reference to a particular context, while data may be context free. For example, if we have data regarding the date of birth of a person as 03/09/1964, we can derive the information regarding his age as "35+" in the context of a current date in late 1999. Knowledge has generally been regarded as a direct and infallible acquaintance "reality" (in ancient philosophy) or with "truth" (in modern philosophy).

The very idea of uncertainty may be at several levels namely uncertain data, uncertain information and uncertain knowledge. With reference to a particular domain we can define them as following:

1. **Uncertain Data:** For Example, when we attempt to infer a specific cause from an observed effect we may have to rely on questionable test results. Thus, even when we are certain about the domain knowledge there may be uncertainties in data that describes the external environment.

2. **Uncertain Information:** It is more apt to call this as incomplete information. For example, in an experiment we must make such decisions in the course of processing incriminatingly acquired information. Thus, it is frequently necessary to make decisions based on incomplete information and we must note that this can occur for several reasons.

3. **Uncertain Knowledge:** Frequently a judge will have only heuristics knowledge regarding some aspect of the domain. For example, he may know only that a certain set of evidence probably implies a certain conclusion.

To arrive at a certain decision in the presence of absolute certainty with respect to all the relevant facts and considerations is a luxury rarely afforded to human being. Thereby, assumptions must be made about data values which are not available, about events which may or may not have occurred, and about consequences which are likely to flow from a given decision. This leads to a situation where handling uncertainty is inevitable.

In general, human knowledge takes the form of facts (or valid propositions) and rules. In order to measure the degree of truth of these facts and rules we must rely on the available evidence, which can be in support or against them.

In this piece of work, we have explored the uncertainty representation as a BI-valued ordered tuple (α, β), we call it as an evidence point (EP), where α is the positive evidence in support and β is the negative evidence disagreeing with the same preposition P. Thus, for a perfectly true preposition P we associate an evidence point (1,0) indicating that there is no negative evidence disagreeing with P. Similarly, for a perfectly false proposition we associate an evidence point (0,1). This notion of Evidence Point (EP) we represent in an evidence space as shown in Fig. 1 of Chapter 3. The point (0,0) is an unknowable situation where we don't have any evidence for or against P. The point (1,1) is a highly contradictory situation.

We have developed an algebra constituting the logical operations $\vee$, $\wedge$, and $\neg$ in a particular way as mentioned in our forth coming chapters.

0.2 Organization of the Thesis

We organize this thesis as following:

Chapter 1 and Chapter 2 focus more attention towards an overview of Applied Artificial Intelligence, along with the associated scope for uncertainty and imprecision.

Chapter 3 presents our new approach of handling uncertainty based on the available evidences.

Chapter 4 throws some light on the consistency and correctness of our approach along with its comparison with the other existing techniques of uncertainty handling.

As a part of the application of our uncertainty handling technique we have chosen the domain of legal consultation within the jurisdiction of Lebanon. Thus, we considered some real time legal cases in Lebanon along with their associated intelligent decisions incorporated in our Chapters 5 and 6.

We have developed a small tool using the FoxPro under windows Version 2.6 for an intelligent decision making. The architecture and the functionality of this tool is presented in Chapter 7, along with some of the enumerated legal cases in our Chapter 8

In Chapter 9, we have given the conclusion and some future possibilities in improving our technique for its wider application.

Chapter 1

Overview of Applied Artificial Intelligence

Artificial Intelligence (AI) is a branch of computer science more concerned with the study and creation of computer systems that exhibit some form of intelligence. This include the systems that learn new concepts and tasks, systems that can reason and draw useful conclusions about the world around us and systems that can understand a natural language or pursue and comprehend a visual scene.

To solve a problem an AI program manipulates the symbols used (characters or strings). Thereby, the consequences of this approach is that "knowledge representation" – the choice, the form and interpretation of symbols used.

The main key issue in AI is "Heuristics" – is a rule of thumb facilitate us not to rethink completely what to do every time a similar problem is encountered. Another attempt of AI is to make machines exhibit reasoning capabilities [1]. That is inferencing from facts and rules using heuristics or other search approaches.

1.1 Artificial Intelligence: The Very Idea

Thus, AI is not the study and creation of conventional computer systems, even though one can argue that all programs exhibit some degree of intelligence. An AI program will go beyond this in demonstrating a high level of intelligence to a degree that equals or exceeds the intelligence required of

a human in performing some tasks. We can clearly distinguish the difference between natural and artificial intelligence in the following way:

- Natural intelligence is always creative where as AI is uninspired.
- Natural intelligence enables people to benefit from the use of sensory experience directly, where as most AI systems must work with symbolic input.
- The last but not the least, human reasoning is able to make use at all times of a wide context of experience and bring that to bare on individual problems. On the other hand, AI systems typically gain their power by having a very narrow focus.

AI can also be visualized as a software that permits a computer to duplicate some functions of the human brain in a limited way. To achieve this task some programming languages have been developed especially for AI applications. The two most popular AI programs are LISP and PROLOG.

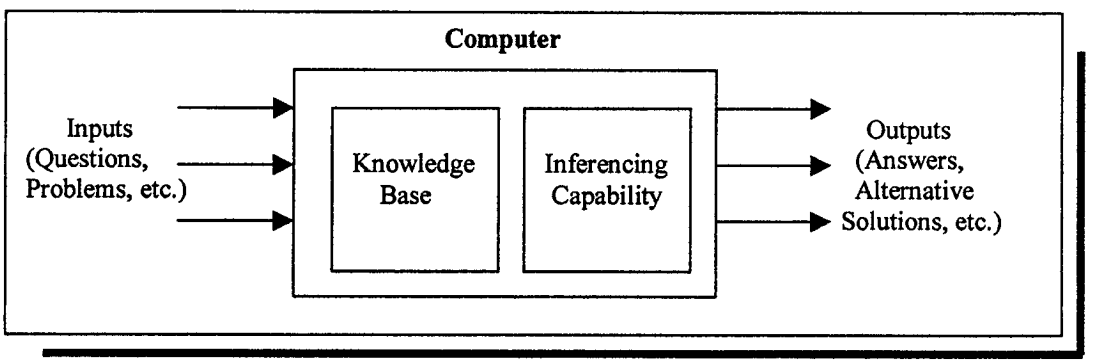
In conventional computing the computer is given data and a step by step program that specifies how the data is to be used to reach a particular solution. In AI, the computer is given knowledge (in the form of facts and rules) about the subject area plus some inferencing capability. This inferencing capability consists of set of all procedure calls. Thereby, the program on its own determines the specific procedure for arriving at a solution.

1.2 Applied Artificial Intelligence

In the past few years we have witnessed a sudden interest in the field of Applied AI (AAI) where we are trying to apply the techniques of AI for various application domains. At this junction, one should realize that AI is concerned with two basic ideas [22] [30]: Studying the thought process of human and representing these processes via machines. The main thrust of

the domain AAI is the symbolic processing where symbol is a string of characters that stands for some real world concept. These symbols can be combined to express meaningful relationships. When these relationships are represented in an AI program they are called symbol structures.

The applied AI can be visualized as the following:



Applying AI Concepts with a Computer

The main thrust of this methodology include: Capability of producing alternative solution in case if the current approach in inapplicable.

There exist many domains under the umbrella of AAI. The most prominent ones include applied expert systems, applied robotics and applied natural language processing. The subtopic, uncertainty handling is intertwined with all these domains but in this work we focus our prime attention towards knowledge based systems (KBS).

A brief description about these prominent fields of AAI can be described as following:

1.2.1 Applied Expert Systems:

These are the true commercial applications of AI which take part in transforming the human knowledge to machines. The design and development of these systems is relatively straightforward. This is due to many of the early-developed software tools to assist AI systems. System developers were targeted at the representation of "IF -THEN"

knowledge, the essence of most ES. It is worth noting that most of these AAI systems are developed only by keeping a particular application domain in mind. There is a rich market value for these systems because of their efficiency and correctness when solving problems of a particular domain. Another significant feature of these systems is that they are capable of invoking the next possible alternative solution method in case if they fail to possess a proper solution with one method.

1.2.2 Applied Natural Language Processing:

It is realized that most of the human knowledge can't be transformed to machines in the form of " IF - THEN " knowledge. Thereby, one started thinking about the representation of knowledge in the form of some structured knowledge representation schemes, such as scripts, frames and networks. Especially in the design of interacting computer systems, the ambiguities of language and the sheer size of the vocabulary of highly developed languages remain formidable obstacles to completely flexible interactive dialogue. Thus, we felt the need for developing human interactive systems with a natural language device. The main advantage of these systems include the permission of users to structure queries in much the same way they might pose to a colleague or assistant.

At this junction, one should notice that these systems are somewhat limited in the number of problem areas in which they are effective.

Any good natural language system must understand the component of the language and represent the knowledge necessary for meaningful interaction with the user.

The introduction of these systems into the market place has lacked behind the development of Expert System not because of less demand or the absence of explicitly requirements, but because of the inherent difficulties of genuine natural language dialogue.

1.2.2 Applied Robotics:

The very idea of the domain of robotics is to merge the computation with mechanics. Thereby, we can take the mechanical advantage of a machine through the application of a software connected to it. Moving our muscles to pick something up and move it around seems effortless to us, but then so does looking at something. In fact, a lot of computation is necessary for each of these skills. Thus, we design a machine called robot to combine sensory systems with mechanical motion to produce machines of widely varying intelligence and abilities. Because of this in built nature we called them as intelligent robots. Under the sensory systems umbrella we can have machines that sense, move and manipulate environment.

The conceptual difference between automatic machines and a robot is that: The robot senses its environment and modifies its behavior as a result of the information gained. Where as in the case of automatic machines we are capable of repeating the same task in the same way for any number of times, without gaining any knowledge each time.

In our next chapter, we describe the occurrence of uncertainty and imprecision in AI

Chapter 2

Uncertainty and Imprecision in Artificial Intelligence

In the field of AI, the term "uncertainty" (also referred to as approximate reasoning or inexact reasoning) refers to a wide range of situations where the relevant information is insufficient in one or more of the following ways:

1. Information is partial.
2. Information is not fully reliable (unreliable observation of evidence).
3. Information comes from multiple sources and is conflicting.

Thus, one of the applications of AI is to focus on reducing the uncertainty. Thereby, the most important capability of a human being and one of the most difficult to faithfully replicate in an expert system (ES) is the ability to deal efficiently with imprecise, incomplete and some times uncertain information [22] [24].

2.1 Uncertainty in Artificial Intelligence

It is difficult to give a unique definition for uncertainty in AI. In many ways, we are just trying to minimize the uncertainty arising from several ways. In general, uncertainty in AI can be treated as a three-step process:

Step 1: An expert provides inexact knowledge, that is, in terms of rules with likelihood values. These can be numeric (a probability value), graphic, or symbolic. Here, we are not quite sure of what is certainty, but we approximate the certainty with a promising candidate.

Step 2: The inexact knowledge of the basic set of events can be directly used to draw inferences in simple cases. In general, these various events are interrelated. Therefor, it is necessary to combine the information provided in Step 1 into a global value of the system. Examples under this category are probability theory of evidence, certainty factors and fuzzy sets. Here, we are sure about what is certainty, but we are lack of sufficient confidence. Thereby, we depend more on the available evidence, and associate an approximate value to it.

Step 3: We propose the KBS to draw inferences. These systems are derived from inexact knowledge of Step 1 or Step 2 and usually they are implemented with an inference engine. Here, we try to explore several alternative methods to meet the required conclusions.

Historically, probability theory has been the primary role for representing uncertainty in mathematical models. Because of this, all uncertainty was assumed to follow the characteristics of random uncertainty. A random process is one where the outcomes of any particular realization of a process are strictly a matter of chance. That is, a prediction of a sequence of events is not possible always. What is possible for a random process is a precise description of the statistics of the long run averages of the process. It is realized that all uncertainty is not random.

Fuzzy set theory is a seminal tool for the kind of uncertainty associated with vagueness, with imprecision and with a lack of information regarding a particular element of the problem at hand. It is also worth noticing that fuzzy set theory uses linguistic variables, rather than quantitative variables to represent imprecise concepts [15] [16] [29]. Thus, fuzzy logic gained its momentum based on its ability to handle two important situations, Viz.,

1. Very complex models where understanding is strictly limited or quite judgmental.

2. It processes the human reasoning, human perception in order to make an intelligent decision-making.

Human understanding of physical processes is largely based on imprecise human reasoning. This imprecision (when compared to the precise quantities required by computers) is nonetheless a form of information that can be quite useful to humans.

2.2 Approaches to Handle Uncertainty

Though there are many approaches for uncertainty handling in AI, in this section we provide few techniques. Broadly we can categorize the uncertainty handling techniques as two types:

1. Partial uncertainty inference techniques.
2. Uncertainty structure techniques.

In Method 1, we concentrate more on determining the amount of uncertainty associated with the conclusions (inferences). Here, we don't concentrate on formalizing the uncertainty knowledge, more tend towards resolving uncertainty. The examples of this category include Certainty Factor, Dempster Shafer, Theory of Evidence and Bayesian Probability Theory.

In Method 2, we first attempt to formalize (structure) the uncertain knowledge and then we go for resolving the uncertainty using some techniques. Examples of this category include Fuzzy Logic, Neural Networks and Genetic Algorithm. Here, we stress more on the mathematical consistency of the formalism for handling uncertainty before arriving at a conclusion [16].

We will briefly review two prominent methods for uncertainty handling as following:

2.2.1 Probabilistic Reasoning:

In this method, we use probabilistic presentations for all knowledge which reason by propagating the uncertainties from evidence and assertions to conclusions. Here, the basic assumption of uncertainty is: Uncertainty can rise from inability outcomes due to unreliable, vague, incomplete and inconsistent knowledge. Thus, to each uncertain event A we associate a measure of the degree of likelihood of occurrence of that event – called probability.

A set of all possible events is the sample space S. Thereby, a probability measure is a function T which maps event outcomes E1, E2, E3, ... from S into real numbers that assume the following axioms of probability:

- $0 \leq P(Ei) \leq 1$ for any event $Ei \subseteq S$.
- P (S)=1, a certain outcome.
- For $Ei \cap Ej=0$, for all $i \neq j$ (The outcomes Ei, i=1,2,...are mutually exclusive), P (E1U E2 U E3 U...)=P(E1)+P(E2)+P (E3)+.....

To be precise, the degree of belief of confidence in a premise or a conclusion can be expressed as a probability. This probability is a chance that a particular event occurs (or not occurred). In reality, we come across multiple probability values in many systems. For example, a rule may have 3 parts to its antecedents each with a particular value. Then, the overall probability of the rule can be computed as a part of the individual probabilities if the three parts of the antecedent are independent of one another- let the probability of these antecedent be 0.9, 0.7 and 0.65. Then, the overall probability P is given by:

$P= 0.9 \times 0.7 \times 0.65 = 0.4095$

Thus, the combined probability is about 41%. At this junction, it is worth noting that this is true only if the individual parts of the antecedents don't

affect or interrelate to one another- that can't be insured always. From the practical point of view, the probabilistic reasoning is sometimes used when the outcomes are unpredictable. For example, when a physician examines a patient, the patient history, symptoms, and test results provide some but not conclusive evidence of possible ailments. This knowledge together with the physician's experience on previous patients, improves the likelihood of predicting the unknown (disease) event, but there is still much uncertainty in most diagnosis. Thereby, the level of confidence we place in the hypothesized conclusions is very much depends on the availability of reliable knowledge and the experience of the human prognosticator. This necessitates us to combine the new and existing evidence using the subjective probabilities- precisely the idea of Bayes Theorem [29].

Given two possible events A, B:

$$P(A/B) = (P(B/A) \times P(A)) / (P(B/A) \times P(A) + P(B/\neg A) \times P(\neg A))$$

Where P (A/B)= probability of event A occurring given that B has already occurred (Posterior Probability); P (A)= probability of event A occurring (Prior Probability); P (B/A)=additional evidence of B occurring given A; and P (¬A)= A is not going to occur, but another event is P (A)+P (¬A)= 1.

Consider the following example involving the use of Bayesian rule: Suppose, it is known from previous experience, that the prior (unconditional) probabilities P (D1) and P (E) for randomly chosen patients are P (D1)=0.05, and P (E)=0.15, respectively.

Also, we assume that the conditional probability of the observed symptoms given that a patient has disease D1 is known from experience to be P (E/D1)=0.95.

Then, we easily determine the value of P (D1/E) as:

P (D1/E) = (P (E/D1) × P (D1))/P (E)

= (0.95x0.05)/0.15=0.32.

We can also extend this formula to n events to a generalization

$$P(Ai/B) = \frac{P(Ai) * P(B/Ai)}{P(B/A_1) * P(A) + \ldots + P(B/An) * P(A_n)}$$

Though it is best suited for several domains, there are some limitations of this approach as following:

1. Mutual exclusive hypothesis.
2. Conditional independent evidence.
3. Completely enumerated set of hypothesis.

Thus, we conclude that it has disadvantages in the following two ways:

1. Single probability value doesn't tell us how much about its precision, which maybe very low when the value is derived from uncertain evidence.
2. This single probability value combines the evidence for and against a proposition indicating and how much there is of each.

This forced us to capture the certainty value by an interval approximation, rather than a single number

2.2.2 Dempster Shafer Theory:

In the probabilistic theory the assumption of the conditional independence is probability not warranted in many real time problems.

There are serious drawbacks in using Bayesian theory as a model of uncertain reasoning. At the first sight, the probabilities are represented as a single point value. This can be a distortion of the precision that is actually

available for supporting the evidence. Ultimately, it amounts to overstatement of the evidence giving support to many of our beliefs. For example, we assert with probability 0.8 that the dollar will fall against Japanese yen over the next six month, what we really mean is we have a fairly strong conviction that there is a chance of about 0.6 to 0.9 say that will fall.

Another problem with the traditional probability theory is that there is no way to differentiate between ignorance and uncertainty. These are distinctly different concepts and should be treated as such e.g. suppose we are informed that one of the three terrorist groups A, B or C has planted a bomb in a certain government building. We may have some evidence to believe that C is guilty one and willing to assign a measure of this belief equal to P(A)=0.8. On the other hand, without more knowledge about the other two groups, we wouldn't say that the probability is 0.1 that each one of them is guilty. Even though, traditional probability theory would have us distribute an equal amount of remaining probability to each of the other groups. In fact, we have no knowledge to justify neither the amount of uncertainty nor the equal division of it.

Finally, in classical probability theory we are forced to regard belief and disbelief as functional opposites. That is, if some proposition A is assigned the probability P (A)=0.3, then we must assign P (¬A)=0.7. Since we must have P (A)+P (¬A)=1, we are forced to treat belief and disbelief as interrelated dependent functionals [5] [25]. This forces us to make assignment that may be conflicting since it is possible to belief and disbelief some proposition by the same amount making this requirement awkward.

To overcome all these type of problems, a generalized theory of evidence emerged into the picture. The Dempster Shafer Theory (DST) of evidence originated by Shafer in 1976 and was motivated by Dempster's previous work in 1967 on upper and lower probabilities.

In this theory, we can distinguish between uncertainty and ignorance by introducing belief functions. Belief functions allow us to use our knowledge to bind the assignment of problems when these may be available. Though these methods share some properties of Bayesian theory, it attaches a probability interval instead of single probability value. This approach is especially appropriate for combining experts opinion since expert do differ in their opinion with a certain degree of ignorance. Unfortunately, this theory assumes that the sources of information taken combined are statically independent of each other.

We assume here a universe of discourse U and a set corresponding to n propositions, exactly one of that is true, the propositions are assumed to be exhaustive and mutually exclusive. Let (2^U) denotes all subsets of U including the empty set and U itself (there are 2^n subsets). Let the set function m (also referred to as a basic probability assignment) defined on (2^U) be a mapping to [0,1]

$m : 2^U \longrightarrow [0,1]$ be such that for all subsets $A \subseteq U$

$m(\phi) = 0$

$\sum_{A \subseteq U} m(A) = 1$

The function m defines a probability distribution on 2^U (not just on the singletons of U as in classical theory). It represents the measure of belief committed exactly to A. In other words, it is possible to assign belief to each subset A of U without assigning to anything smaller. A belief function, Bel, corresponding to a specific m for the set A, is defined as the sum of beliefs committed to every subset of A by m. That is, Bel (A) is a measure of the total support or belief committed to the set A and sets a minimum value for its likelihood. It is defined in terms of all belief assigned to A well as to proper subsets of A. Thus,

$$Bel(A) = \sum_{B \subseteq U} m(B)$$

For example, if U contains the mutually exclusive subsets A, B, C and D then:

Bel({A,C,D})=m({A,C,D})+m({A,C})+m({A,D})+m({C,D})+m({A})+m({C})+m({D})

In Dempster-Shafer theory, a belief interval can also be defined for a subset A. It is represented as a subinterval [Bel (A), Pl (A)] of [0,1]. Bel (A) is also called the support of A and Pl (A)=1-Bel (¬A), the plausibility of A.

We define Bel (ϕ) = 0 to signify that no belief should be assigned to the empty set and Bel (A) = 1 to show that the truth is contained within U. the subsets A of U are called the focal elements of the support function Bel when m (A) = 0.

Since Bel (A) only partially describes the beliefs about proposition A, it is useful to also have a measure of the extend one beliefs in ¬A, that is the doubts regarding A. For this, we define the doubt of A as D (A)=Bel (¬A). From this definition, it will be seen that the upper bound of the belief interval noted above, Pl (A), can be expressed as Pl (A)=1-D (A)=1-Bel (¬A). Pl (A) represents an upper belief limit on the proposition A. The belief interval, [Bel (A), Pl (A)], is also sometimes referred to as the uncertainty in A. it can be shown that:

Pl (ϕ)=0,Pl (U)=1

For all A,

Pl (A) $\geq$Bel (A), Bel (A)+Bel (¬A) $\leq$1, Pl (A)+Pl (¬A) $\geq$1 and

For A $\subseteq$ B

Bel (A) $\leq$ Bel (B), Pl (A) $\leq$ Pl (B)

Thus, the uncertain knowledge regarding a phenomenon can be represented only through proposition that can convey support either for or against them. In the DST we visualize the belief in proposition P as the amount of confidence we place for to the proposition. In general, sources of evidence for and against are independent by nature.

In our approach, we consider this fact and proposed a formalism to handle uncertainty. We have also established a link with the above two approaches of uncertainty handling.

Our next chapter throws more light on our approach of handling uncertainty.

Chapter 3

A Technique for Uncertainty Handling

In the field of AI unlike game playing, puzzle solving and theorem proving, many applications often require a "problem solver" to reason with imperfect information [4] [22]. This is mainly due to many different sources of uncertainty providing the information for and against them. Any uncertain knowledge regarding a phenomenon can be represented only through propositions that conveys support either for or against them. This visualization gives us the very notion of "evidence", which is an indication for the validity or otherwise of a proposition.

3.1 Background Literature

In the past, several authors have sighted the uncertainty handling problem in this way [13] [14] [6].

For example, in the work of Edward [7], he considered the Bayesian Logic, and arrived at suitable judgments. This work doesn't throw more light on how to handle the situation where we have both positive and negative evidence together.

Similarly, the work of Familli and Fabrizio [8] and Jacques [10], attempts towards uncertainty handling using a modified version of Dempster-Shafer approach of considering belief functions. This work too doesn't cover the situations having two sources of evidence in the opposite directions

The seminal paper of Bessonet [6] and Garden [11] has contributed a new approach of uncertainty handling based on a two dimensional array. In this work it is also stated that the uncertainty is a bi-directional entity.

Based on the motivation and inspiration from these seniors, we arrived at two open questions:

- How to represent uncertainty as a bi-directional entity.
- How to adopt this uncertainty handling formalism to legal consultation

Thus, we propose our new approach in the following way.

With reference to the design of an Expert System (ES), the knowledge elicited by a Knowledge Engineer (KE) is often characterized by uncertainties. When the KE in unable to establish the truth of the proposition he may have to resort to collect evidences from multiple sources. For Example, consider the following statements:

1. Light travel in straight line.
2. Earth is round.
3. Sugar is a carbohydrate.

To establish the truth of these sentences we need not rely on any sources of evidences [26]. They are already well established both theoretically and experimentally.

Consider another set of propositions:

1. Mr. X got his Ph. D from an institute Y and now working in a place Z.
2. Mr. P got his Ph. D from an institiut Q and now working in a place R.

Now X and P applying for a job in organization O. In order to validate their candidature the organization has to depend on several sources of evidence which gives the information for and against P and X respectively. Under the assumption that the sources of information are reliable, we gather some amount of evidence "for" and some amount of evidence "against" P and

X respectively. Since the sources of evidence are independent we cannot have a way of relating these two quantities of evidence. Now the question here is how do we make an intelligent decision making based on this information.

Once we gathered the maximum possible evidence for and against a proposition. We then represent them in a two dimensional evidence space as described below.

3.2 Evidence Space

In this work, we introduce the representation of uncertainty as an ordered tuple (α,β) [28]. This pair we assign to each proposition P, where α is the quantity of evidence we gathered for to P and β is the quantity of evidence against P. Thus, we define an evidence point $EP(P)= (\alpha,\beta) \in [0,1] \times [0,1]$ located in a two dimensional space, call it an evidence space, as shown in Fig. 1. Though we have taken the range of (α,β) to be a closed interval [0,1], for practical purpose we don't consider the extreme values 0 and 1. We strongly feel that inclusion of 0 or 1 in the EP corresponding to proposition P, makes it certain. Thereby, we consider for a perfectly true proposition T the evidence pair should be (1,0). That is, there is no information against T on the face of it. Similarly, the EP of a false proposition F will be (0,1) and the remaining propositions are all uncertain. In the above evidence space, we call the line $\alpha+\beta=1$ as the "line of demarcation", since it has a close resemblance with the probabilistic sample space. Each point on this line obeys the probabilistic axioms and rules of probability. Similarly, the line $\alpha=\beta$ is suitably named as the "line of contradiction", since each point on it has the equal amount of information for and against to it. The point (0,0) represents an unknowable situation, and the point (1,1) is a highly contradictory situation where decision making is impossible. Thus, we regard them as saddle points in our evidence space. In the rest of our work we are not throwing any light on these points, due to the fact that decision making is quite impossible.

3.3 Evidence Point Algebra

The quantity or state of being true is generally referred to as "truth". If we have a reliable justification for a belief or a fact about a particular proposition (or a statement), we say it is a true proposition. This naturally leads to two questions:

1. How can truth-values be related to evidence points?
2. What are the dependencies between evidence points.

This forced us to define evidence point algebra for logically combining the evidence points as described below. Without loss of generality, we assume that EP(P)= (α1,β1) and EP(Q)= (α2,β2), then we introduce the logical operators (binary and unary) $\wedge$, $\vee$, $\neg$ as described below:

1. EP($\neg$P) = (1-α1, 1-β1) : α1+β1$\leq$1
   = (1-β1, 1-α1): otherwise
2. EP(P$\vee$Q) = (max(α1, α2), max(β1, β2)) : αi+βi>1 i=1,2
   = (max(α1, α2), min(β1, β2)): otherwise
3. EP(P$\wedge$Q) = (min(α1, α2), min(β1, β2)) : αi+βi>1 i=1,2
   = (min(α1, α2), max(β1, β2)) : otherwise

There are certain limitations prevailing in this formalism as described below:

Given any EP(P)=(α,β) we restrict the total evidence m(P)=α+β $\in$ [0,2]. We focus more light on the evidence points for which m(P)>1. We call them as fuzzily oriented evidence points. The set of points which fall below the line of demarcation (α+β=1) can be treated as the points which are lack of sufficient evidence. For more details regarding the consistency, completeness and correctness of this formalism, the reader is urged to refer [26] [27] [28].

In this work of intelligent decision making for legal consultation we are more concerned with the application aspects of this formalism. Thus, we deal with only the cases for which we have sufficient evidence from both sides.

Before we go into details of this approach applied to legal consultation, first we look at its consistency and approach in our next chapter.

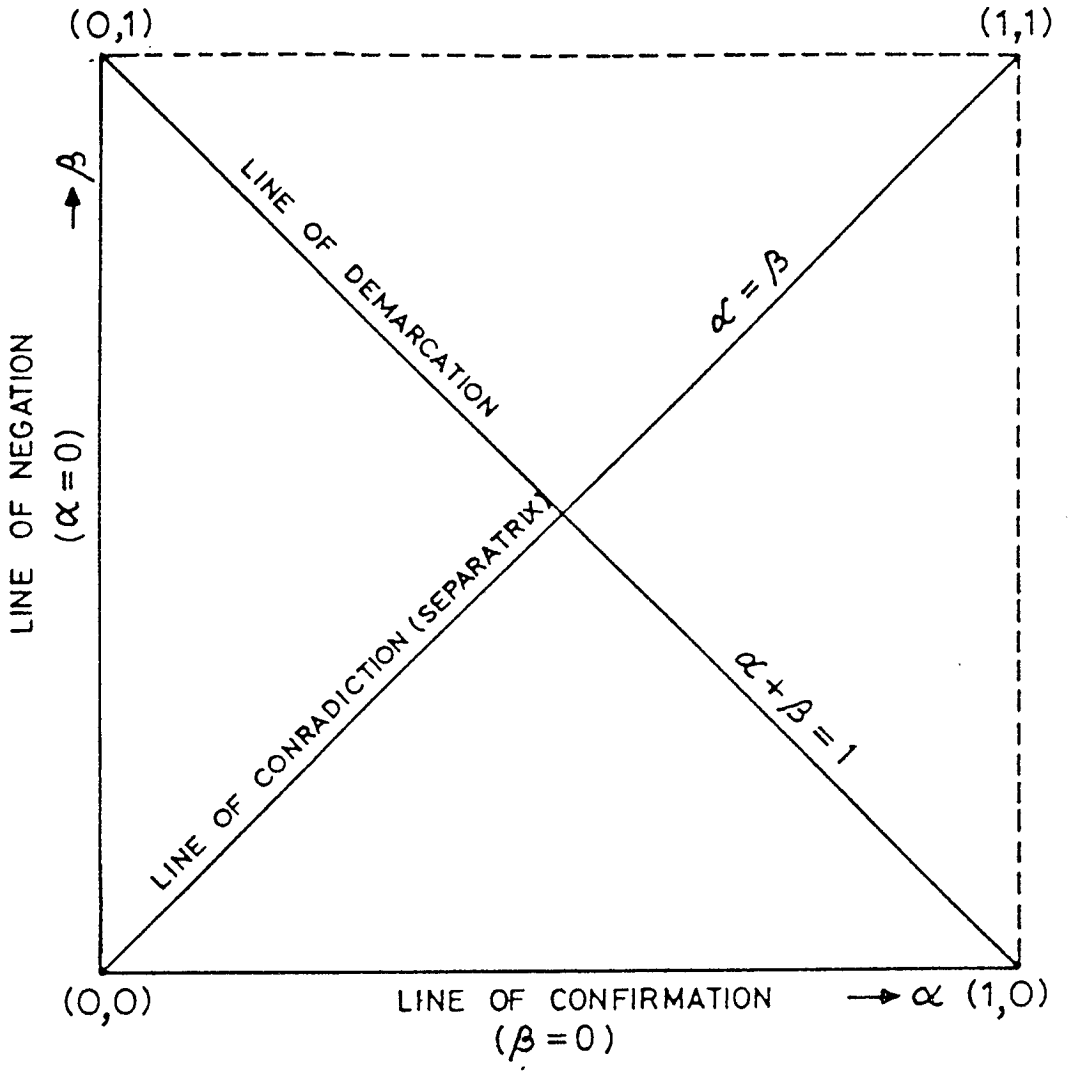


Figure 1 Evidence Space

Chapter 4

Consistency and Correctness of our Approach

In our previous chapter we just stated our new approach and its overview. In this chapter, we will through some more light on the consistency and correctness of this approach. As described before in our previous chapters, the extreme situations EP(1,0) in the sample space represents a perfectly true proposition T. Similarly, the case of EP(0,1) is for a false proposition F.

EP(T)=(1,0) ,EP(F)=(0,1)

Using the earlier mentioned evidence point above algebra, we can easily arrive at these conclusions:

1. $EP(T \wedge F) = EP(F) = (0,1)$
2. $EP(T \vee F) = EP(T) = (1,0)$
3. $EP(\neg T) = EP(F)$
4. $EP(\neg F) = EP(T)$

This shows the conformance of our approach with the Bayesian Bi-Valued logic. More details such as conditional evidence points were not discussed due to the fact that we are more oriented towards the application of this formalism [28].

For a general proposition P with EP(P) = (α,β), with $\alpha+\beta>1$. Using the above algebra we can also deduce the following relations:

1. $EP(P \vee T) = EP(T)$
2. $EP(P \wedge T) = EP(P)$
3. $EP(P \vee F) = EP(P)$
4. $EP(P \wedge F) = EP(F)$

4.1 Deductive Logic Vs Evidence Point approach

It is also observed that De Morgan's laws are valid for any proposition P and Q if they are fuzzily oriented.

According to the deductive logic, the rule of "Modus Ponens" can be defined as:

Given P

$P \longrightarrow Q$

We deduce Q

This looks quite logical since

$P \longrightarrow Q \quad \neg P \vee Q$

This can be realized using our formalism as following:

Let EP(X)=(1,0) and

EP(Y)= (α,β)

Then

$EP(\neg X)=(0,1)$

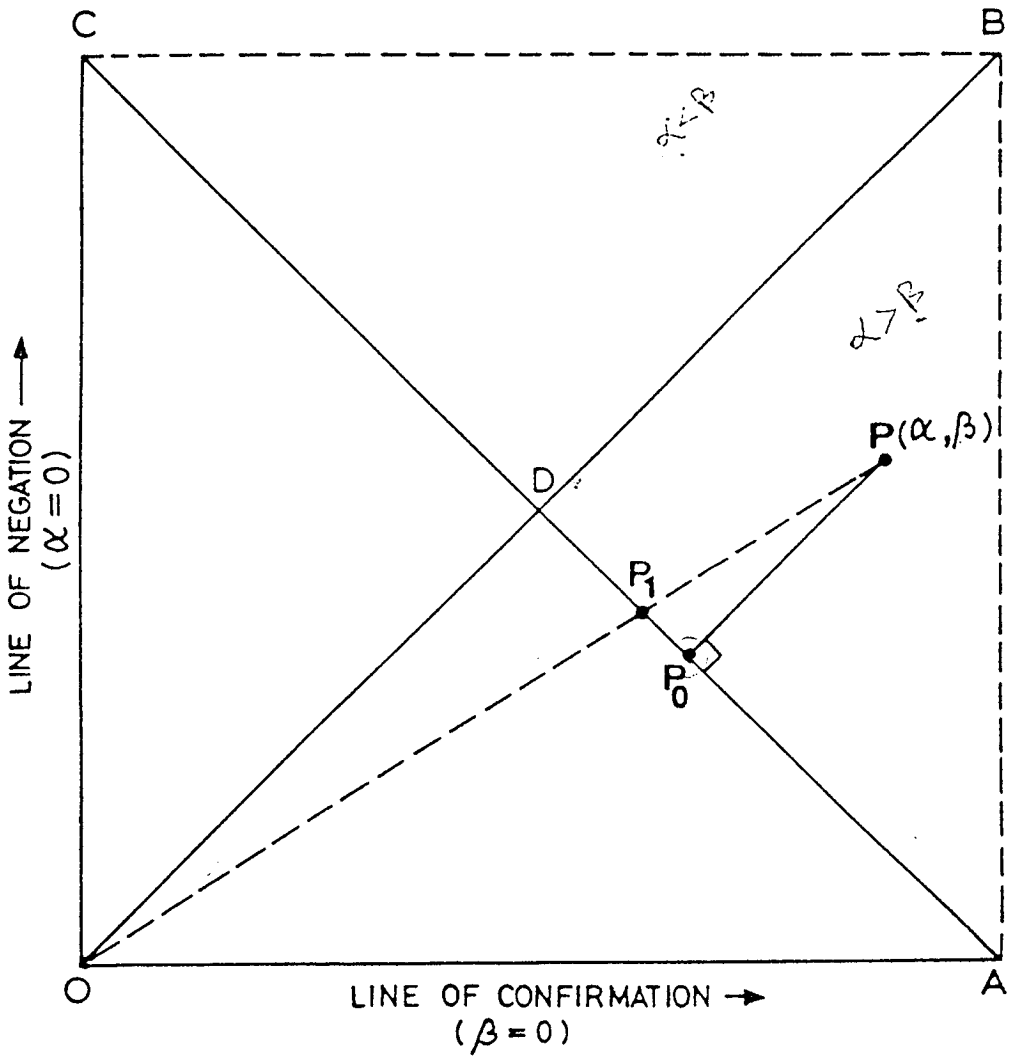
Since $X \longrightarrow Y$ is a true proposition.

We assume that

$$EP(X \longrightarrow Y) = EP(\neg X \vee Y)$$
$$= (0,1) \vee (\alpha,\beta)$$
$$= (Max(0, \alpha), Min(1, \beta))$$
$$= (1,0)$$

4.2 Decision Making:

In this section, we describe the way the decision can be taken based on an EP (α,β). Given an evidence point (α,β) with $\alpha+\beta>1$, the biggest task is to look for an intelligent decision making for its validity. We achieved this task by bringing down this point on the line of demarcations $(\alpha+\beta=1)$. We call this as the process of normalization. Pictorially this idea can be represented as:



$$EP(P) = (\alpha,\beta)$$

$$EP(P_1) = \left(\frac{\alpha}{(\alpha+\beta)}, \frac{\beta}{(\alpha+\beta)}\right) = (\alpha_1,\beta_1)$$

$$EP(P_0) = (\alpha_0,\beta_0)$$

Figure 4.1 Reliability of the Sources of Evidence

Where P0 is the foot of the perpendicular from P to the line of demarcation, P1 is the point of intersection between the line of demarcation and the line joining P with the origin O.

EP (P1)= (($\alpha/\alpha+\beta$),($\beta/\alpha+\beta$))

Which is precisely the normalized evidence point.

Now, a convex combination of the points P1 and P0 help us in arriving at an intelligent decision as briefed below:

(4.2.1) EP(Pi)=($\alpha i,\beta i$)= γ (($\alpha/\alpha+\beta$),($\beta/\alpha+\beta$))+(1-γ)((1+α-β)/2,(1-α+β)/2))

Given any point ($\alpha i,\beta i$) with ($\alpha i+\beta i>1$), i=1..n, we have two classification namely ($\alpha i>\beta i$) and ($\alpha i<\beta i$). It depends on the case we choose the point P0 and P1, with the convex combination as mentioned in Equation (4.2.1). For example:

Let EP (P) = (α,β)

Given $\alpha+\beta>1$, $\alpha>\beta$

Then we can notice that:

EP (P0) = ((1+α-β)/2,(1-α+β)/2))

which is a particular case of the above convex combination with γ = 0. In order to arrive at a decision, we should find maximum and minimum attainable values for positive and negative evidences [28]. This necessitates comparing our logical decision with the computed value. This can be witnessed through the following equation.

(4.2.2) $\alpha i = \gamma (\alpha/\alpha+\beta) + (1-\gamma)((1+\alpha-\beta)/2) > (\alpha/\alpha+\beta)$

In order to measure the deviations (positive and negative) of the calculated value from the actual value we use the following formula:

(4.2.3) $\max(\alpha i-\alpha 1)=((\alpha-\beta) / (2*(\alpha+\beta))) * (\alpha+\beta-1)$

Thus, for a set of fuzzy evidence points we fix the equation as following

(4.2.4) $(\alpha i-\beta i)= \gamma\ (\alpha/\alpha+\beta,\beta/\alpha+\beta)+(1-\gamma)(\ (1+\alpha-\beta)/2,\ (1-\alpha+\beta)/2\ )$

It is equally important to realize the following fact. While maximizing the positive evidence, we should look for minimizing the negative evidence as well. This will enhance the reliability of our decision in the wake of reliable sources of evidence. This viewpoint can be witnessed mathematically as shown below

(4.2.5) $\max(\beta i-\beta) = \max\{\ (1-\gamma)\ (1-\alpha+\beta)/2 + \gamma\ (\beta/(\alpha+\beta)) - \beta/(\alpha+\beta)\ \}$

$= \max\{\ [(1-\gamma)\ (\ \alpha+\beta-1)\ (\beta-\alpha)]\ [2(\alpha+\beta)]\ \}$

Thus, this process of maximizing the positive evidence and minimizing the negative evidence is for two reasons:

1. To reduce the excessive evidence which dragged the uncertainty into the picture.
2. In order to take an intelligent decision-making.

Once we boil down the image of an EP on the line of demarcation, it is easy for us to infer the required decision.

4.3 Dempster Shafer Theory Vs Evidence Point Approach

This is a well known method to represent ignorance about a proposition or inexact rules concerning a proposition in the context of ES. This theory provides a mechanism to handle a conflicting data regarding an uncertain propositions. This theory is mostly based on subjective belief, as opposed to objective but unknown probabilities.

Dempster Shafer theory assumes that the answer to a particular answer lies among finite set X (of propositions) called "frame". The elements of this X are assumed to be mutually exclusive and exhaustive by nature. If m is a mapping from the set of all subsets of X onto the real interval [0,1] that is:

$m: 2^X \longrightarrow [0,1]$ such that

$m(\phi) = 0$ and $\sum m(A)=1$ where $A \subseteq X$

Where m(A) is the weight associated with proposition A which measures the strength of the argument in favor of the prop A. it is also known as basic probability assignment (BPA).

If $m(A) \neq 0$ it is called a focal element of X, then we define the notion of "Belief" in the proposition $A \subseteq X$ is given by the equation:

Belief (A) = Bel (A) = $\sum$ m(B) over all $B \subseteq A$.

In the context of ES, it is to be noted that the m(A) represents belief in A and not in any of its proper subsets. The following set of axioms for belief facts is worth noting:

1. Bel (ϕ) = 0
2. Bel (X) = 1
3. $Bel(B1 \vee B2 \vee ... \vee Bn) \leq \sum (-1)^{|I|+1} Bel(\wedge\{i \in I\} Ai,$
   where $\{I \subseteq \{1,2,...n\}, I \neq \phi\}$.

If we have some belief for the proposition A, then we can deduce the "plausibility" using the following relation:

Pl (A) = 1-Bel ($\neg$A).

Thus, in this case the certainty about the proposition A is represented by an interval [Bel, Pl] under the assumption that Bel < Pl is a subset to [0,1]. Thus, we conclude that Pl (A) is a measure of the extent to which the proposition A is believable to be true [28] [27]. The following are few axioms with respect to belief functions:

1. Bel (A) + Bel ($\neg$A) $\leq$ 1 that is

   Bel (A) $\leq$ 1 - Bel ($\neg$A) = Pl(A).

2. Pl (A) + Pl ($\neg$A) $\geq$ 1.

The interval [Bel (A), Pl (A)] can be regarded as the range of the true probability of A.

From this theory, we can also define the "doubt" about A given by:

Dou (A) = Bel ($\neg$A)

Thus, we can further deduce that:

Pl(A)= 1 – Dou (A)

In the comparison with our evidence point formalism, we conclude that the belief associated with a proposition A is equal to the amount of positive evidence supporting it. Similarly, the plausibility of a proposition A is equal to (1 – negative evidence) disagreeing with A. Thus, we have:

1. Bel (A) = α
2. Pl (A) = 1-β

Where EP (A) = (α,β)

Further, we can also deduce that the doubt associated with A is = 2-(α+β)

After we realize the consistency of this approach, we need to look for an appropriate domain where it is applicable. Before we go into the detailed analysis about our automated tool for legal consultation in Lebanon, we first look for various legal issues within the Lebanon Jurisdiction in our next chapter.

Chapter 5

Legal Issues in Lebanon

In this chapter, we focus our view in pursuing/analyzing the state of art about the legal consultation system within the Lebanon jurisdiction. This chapter exclusively devoted towards our motivation for considering this project of developing an automated tool for the legal consultation in Lebanon. There is an acute need for considering the legal issues within Lebanon, which are rapidly changing from time to time. It is noticed that there are several legal laws which contains many logical gaps, preventing the judges to make any intelligent decision. The judicial legal system in Lebanon derives from the French system with a few amendments due to the English legal system. The Lebanese judge is committed to judge according to the text but the judge has the freedom to follow the precedents declared by the third degree court, the highest law court in Lebanon. We briefly outline certain highlighted issues about the legal consultation within the Lebanon as following [17-21] [1] [2].

5.1 Categories of Courts and the Organization of Cases:

Since each legal case has its own arguments associated within respective judgment and its impact based on the category in which it belong to. Thus, there is a need for categorizing the various courts for dealing with different cases. We have courts that look in the civil cases only (Civil courts), courts that look in the criminal cases (Retributory courts), administrative courts and many exceptions (Military, Sect, Spiritual, Instant) and the councils that masters the work of the state departments (Forensic Supreme Board, Accountancy authority,...).

A. Forensic Courts (عدليه):

This type of court deal with many types of cases and it is divide to two types:

1. Civil Courts (مدنية): It contains three divisions

a. Civil (مدني): This type of courts mainly deal with cases including:

- Private Matters (Death-Property Distribution...)
- Private Royalties (Aggression on individuals...)
- Financial Royalties (Financial Contracts...)

b. Commercial (تجـــاري): It deal with all cases that is related to companies disputes and anything related to traders and what is connected to it

c. Praedial (عقـــاري): It deals with everything related to praedial royalties (Land – Building - ...)

2. Retributory Courts (جزائية): It contains these divisions

- **Court of Perception** (محكمة الجنايات)
- **Single Retributory Proconsuls** (الحكام المنفردين الجزائيين)
- **Accusable Authority** (الهيئة الاتهامية)
- **Investigation Judges** (قضاة التحقيق)
- **Forensic Officers** (الضابطة العدلية)
- **Public Lawyer** (محام عام)
- **Public Claremont** (مدعي عام)

B. Instant Courts (الأمور المستعجلة)

It deals with cases that the hurry item exists in the case.

C. Military Courts (العسكرية)

It deals with all military type cases. It contains the government commissar in the military court and it is divided as following:

- Discriminated Military Court (محكمة التمييز العسكرية)
- The Permanent Military Court (المحكمة الدائمة العسكرية)
- Single Military Proconsuls (القاضي العسكري المنفرد)
- Military Investigation Judges (قضاة التحقيق العسكريين)

D. Administrative Courts (الإداري)

It consists of مجلس شورى الدولة :

- ✓ It is divided to many chambers
- ✓ Each chamber contains 3 judges
- ✓ It deals with all administrative cases (Contracts with government ministry- the abolishing of decree- ...)
- ✓ Its decision is final – no reconsideration of it.

E. Sect Courts (المذهبية)

- ♦ It is specialized for the Islamic sect cases.
- ♦ It is divided to three parts (shiaa, sunna, durzi).
- ♦ It has two stages (starting – appealing)
- ♦ It's decision can be reconsidered.

F. Spiritual Courts (الروحية)

- ♦ It is specialized for the Christian sect cases.
- ♦ It has two stages (starting – appealing)
- ♦ It's decision can be reconsidered.

G. Supreme Board of Arbitrating (المجلس الأعلى للتحكيم)

It deals with the controversies between the commercial chambers and industrial chambers of different states.

H. Accountancy Authority &Central Inspecting Authority

It deals with inspecting the government administration contracts and work and see if it is done according to law. Also, it controls the money use in all the government administrations.

I. The Common Authority for Discrimination

(الهيئة العامة لمحكمة التمييز)

It considers in the sect and spiritual cases that are relegate to it, and it looks in the exposure staggering of the law. It abolishes the decision taken by other courts, but it doesn't look into the happenings.

J. Forensic Supreme Board (المجلس العدلي الأعلى)

It considers in the crimes that are done against the security of the state. And anything that is relegated to it by the government (politician cases)

5.2 Legal Stages

Basically, the legal stages in courts are done on three stages. But in some cases, the legal procedure consists of two or one stage only. For example, cases of labor and rents consists of two stages only. Also, cases of administrative law consists of one stage only. Here is the three legal stages of courts in Lebanon:

A. First Degree Courts - Forensic Courts

- Single Judge (Under 100 million)
- Chambers :It consists of 3 judges, one president and two advisors (Above 100 million)
- Office Of Execution: It consists of one judge and it looks in the execution of judgements and bonds

B. Second Degree Courts - Appealing:

- It consists of 3 judges, one president and two advisors (above one million).
- It contains many chambers according to the division of cases nature.
- It looks in all cases that can be appealed.

C. Third Degree Courts - Discrimination:

- Many chambers according to the division of cases nature.
- It doesn't look in the happenings but in the law.

5.3 Major Gaps in the Existing Legal System

In this subsection, we mention certain gaps that are existing in the current legal laws. As a result, these days decision making in certain cases is becoming almost impossible. This is mainly due to some of the situation-actions that are not completely adaptable to these laws. As an example for illustration, a few of the gaps in the current legal laws which we come across the literature are:

- Death Penalty: In almost all the world, the death penalty is not being implemented any more. Whereas in Lebanon, the law is still authorizing this kind of penalty.
- Children Penalties: The law being implemented in Lebanon concerning this case needs to be modified in order to take into consideration the new methods of treating and rehabilitation of children.

5.4 A Word About Punishments

In this section, we narrow down our view towards the various punishments imposed by the courts within Lebanon.

It is almost impossible to categorize the number of punishments, but still for the purpose of better understanding, we provide 3 main punishments we come across in a general sense:

1. In the case of controverting (Up to 3 months)
2. In the case of delict (From 6 months to 3 Years)
3. Perpetration (3 years and up to life imprisonment and death penalty)

As a whole, the current situation in Lebanon forcing the courts to verify the implementation aspects of the punishment in the following three ways:

1. The final resolution is executed by the office of execution in the forensic courts.
2. The Retributory resolution is being implemented by the forensic officers.
3. The judgements against the state might take sometime to be implemented.

Further more, the time taken for each case hearing is drastically vary according to its nature and the type of the court. For example, the following is a list of cases and their respective average time period:

- Praedial (5 to 10 years).
- Hurry Matters (2 to 3 years).
- Retributory cases (3 to 7 years).
- Perpetration (5 to 10 years)
- Military (1 year).

The overall legal situation in Lebanon is not very much distinguishing between the educated and uneducated people and their response to the court decisions. This is also reflecting the seminal future of the residents in Lebanon. In general, the quality of judgment will vary for an educated and novice. This clearly shows an excellent opportunity and acute need for doing some qualitative research work in this domain.

In our next chapter, we present the logic involved in decision-making while using our tool.

Chapter 6

Decision Making in Legal Consultation System

As the first commercial applications of AI namely expert systems, were developed with an intuition to capture the expert's knowledge in a particular domain in order to infer context-based conclusions. In general, it is witnessed that these inferences are consistent, complete and correct only with respect to that domain knowledge.

Some ES are significantly changing the manner in which business is being conducted. The introduction of such systems is not easy and the development process is not simple. However, the payoffs to the organization can be extraordinary. Such systems are called mission critical systems because they do provide incomparative advantage in the companies core operations, especially with reference to the intelligent decision making activity. Thus, these systems usually integrated with decision support systems and databases.

At some situations, ES and other AI technologies (e.g. Natural Language Processing) are currently being embedded or integrated with existing computer systems. This clearly shows that there is an immense need for automated support and assistance to the analytical engines underlying decision support systems. Intelligent decision making in the presence of imprecise and incorrect information is an immense capability for human beings. To develop the systems imitating the human decision making process is really a challenging task. The applications of such an intelligent decision

support systems include company management aspects, legal issues, medical diagnosis applications and manufacturing industries. In this chapter, we throw some light on the intelligent decision-making based on the available evidence, in a legal consultation system. This is purely a hypothetical view coupled with the earlier mentioned uncertainty handling formalism. In our next chapter we provide the implementation aspect of this view.

6.1 Evidence Point Normalization

We have broadly categorized the pool of evidence points into two categories namely excess evidence points ((α,β) with $\alpha+\beta>1$) and lack of evidence points ((α,β) with $\alpha+\beta\leq1$). In our entire work, we concentrate more on the evidence points with excess evidence [26] [28]. With the help of the algebra stated in our earlier chapters we arrive at a decision with an evidence point say (X, Y) with X+Y>1. On the face of it, it is impossible to take any decision. Thus, we boil down the reflection of this point onto the line of demarcation as shown in the evidence space (Fig. 4.1) of Chapter 4.

Thus, we adopt a simple normalization technique for intelligent decision making as following:

Say $(\alpha,\beta) = (0.8,0.4)$

In order to make a decision about this point, we convert (α,β) to its numerical equivalent $(\alpha1,\beta1)$ as

$$(\alpha1,\beta1) = (\alpha/\alpha+\beta,\beta/\alpha+\beta)$$
$$= (0.8/1.2,0.4/1.2)$$
$$= (0.67, 0.33).$$

Now, based on a heuristic criterion, such as positive evidence exceeding 65% and negative evidence not exceeding 35%, we arrive at a decision. Mathematically speaking, this EP (0.67,0.33) is a point on the line of demarcation ($\alpha+\beta=1$) (precisely the probabilistic sample space). In case of intelligent decision making with a general (α,β) with ($\alpha+\beta>1$) is already well explained in our earlier chapters (Chapters 3 and 4).

6.2 Logical Steps

With reference to the legal consultation issues we incorporate the above stated logic into our software tool as following:

Step 1: Combining the total pooled positive and negative evidence we arrive at an evidence point (p, q) with p+q>1.

Step 2: Now we normalize this (p, q) as (p1, q1) with obviously (p1+q1=1).

Step 3: We will fix the positive evidence of the normalized pair (p1,q1) to be our belief.

Step 4: Based on a heuristic criteria such as:

1. if $\alpha \geq 0.8$ and $\beta \leq 0.2$ Punishment 1
2. if $\alpha \geq 0.7$ and $\beta \leq 0.3$ Punishment 2
3. if $\alpha \geq 0.6$ and $\beta \leq 0.4$ Punishment 3
4. if $\alpha = 0.5$ and $\beta = 0.5$ Punishment 4
5. if $\alpha \leq 0.4$ and $\beta \geq 0.6$ Punishment 5
6. if $\alpha \leq 0.3$ and $\beta \geq 0.7$ Punishment 6
7. if $\alpha \leq 0.2$ and $\beta \geq 0.8$ Punishment 7

Step 5: Assume that the legal case is hearing between two parties X and Y. In the first three combinations Viz. (1,2,3), there are some chances (but definitely we are not sure) that X will win the case. Similarly, the case with the last three combinations Viz., (5,6,7) favoring Y. In the case of Combination 4, such as equal contradictory point (saddle point), $\alpha = 0.5$ and $\beta=0.5$, the likely judgement could be: Court will adjourn. In such situations we can say that:

1. Some more evidences should be gathered.
2. Already assigned evidence values for the arguments of X and Y should be reviewed.

This process will iterate for a number of times, till the judge gets a satisfactory maximum of α or satisfactory maximum of β. With this basic logical intuition we designed our tool.

In our next chapter we throw more light on the architecture and functionality of the tool.

Chapter 7

Architecture and Functionality of the Tool

This chapter exclusively dedicated to the architecture and functionality of our tool developed for legal consultation within the jurisdiction of Lebanon. This is mainly due to the fact that the Lebanon legal laws were not updated since long time.

The main application of our tool is to provide aid for taking an intelligent decision when the information in incomplete. It is developed using the FoxPro for Windows version 2.6 with a main emphasis on the procedural approach rather than an object oriented approach. Here we have provided the facility for the user to accommodate both sides of the argument for the same case. The logical conclusions and decisions are strictly subject to the evidence point algebra discussed in our earlier chapters. We followed the procedural design [23] for the design of our tool.

I- Scope:

The scope of this tool is limited to single and multi-user facility. Each time the user is supposed to provide the weightage to the arguments for the case as well as the arguments against the case. The customer visible objects include, the argument statements, inference consolidation as well as conclusion, possibly an online help command. Thus, the data objects required for the input are the evidence points (α, β) corresponding to each argument for and against the case.

A. System Objectives:

There are many objectives for this system:

- Automation of some significant legal cases within the Lebanese jurisdiction.
- Make intelligent decisions if the information is imprecise and Incomplete.
- Make a comparative study about the judgement versions of two or more judges.
- Emphasize the computational tractability of our new approach of handling uncertainty.

B. Major Software Requirements:

The software requirements are:

- Microsoft Windows 95 or any later versions.
- Microsoft FoxPro 2.6 for Windows.
- Borland Pascal Ver. 7.0 for Windows.

C. Design Constraints, Limitations:

- ✓ Unlimited number of cases which yields to automatic updating of the knowledge base(KB).
- ✓ Positive and negative values $\in [0,1]$, to signify the 0%-100%.
- ✓ Multi-user facility.
- ✓ Structural design, making use of the entity relations such as Sequence, selection and loop.
- ✓ We have used a static and modular design.
- ✓ Its interface design is capable of recognizing and reorganizing the reusable components.

II- Data Design:

It transforms the information domain model created during analysis into data structures that will be required to implement the software. The data object and relationships defined in the entity- relationship diagram and the detailed data content depicted in the data dictionary provide the basis for data design activity [9] [3].

- ***Data Objects and Resultant Data Structure:***

A data object is a representation of almost any composite information that must be understood by software. It can be an external entity, a thing, an occurrence or event, a role, an organizational unit, a place or a structure. They are related to one another and they encapsulate data only.

1. **Case_f**: This is the main object that contains the general information about the cases contained in the system

Field name	Explanation	Type	Width
Case_num	case #	numeric	8 (key identifier)
Case_spec	problem specification	memo	
Case_query	case query	memo	

2. **Casdet_f**: This is the object that contains the details information about the cases

Field name	Explanation	Type	Width
Cd_csnum	case #	numeric	8
Cd_evnum	evidence #	numeric	8
Cd_evtype	evidence type	character	1
Cd_evexpl	Explanation	character	254
Cd_evexpl1	Explanation	character	254
Cd_evpos	positive value	numeric	5:2
Cd_evneg	negative value	numeric	5:2

3. **Name_f**: This object is used as a parameter file that supports our multi-language interface support.

4. **Ovr_f:** n this object we have the general information that gives the user a general overview of the tool.

5. **Pass_f:** this object is used to save the different users using the tool.

Field name	Explanation	Type	Width
Pass_code	user code	character	2
Pass_user	user name	character	10
Pass_word	password	character	10

6. **Err_f:** This is used to save the error messages that the users may encounter while using the system.

Field name	Explanation	Type	Width
Err_mess	error message	character	50
Err_line	line # of the error	numeric	8
Err_prog	program name	character	20
Err_date	date of error	date	8
Err_time	time of error	character	10

7. **Seq_f:** This is for the sequential # of the cases.

Field name	Explanation	Type	Width
Seq_case	case number	numeric	8

8. **Equation:** This is the file where we save the information about the combinations that the user may choose for the argument that he entered for each case and the result given by the system using the three methods.

Field name	Explanation	Type	Width
Eq_case	case #	numeric	8
Eq_num	equation #	numeric	2
Eq_desc	equation detail	character	254
Eq_desc1	equation detail	memo	
Eq_pos	positive result(α)	numeric	5:2
Eq_neg	negative result (β)	numeric	5:2
Eq_pos1	positive result(α1)	numeric	5:2
Eq_neg1	negative result (β1)	numeric	5:2
Eq_pos2	positive result(α2)	numeric	5:2
Eq_neg2	negative result (β2)	numeric	5:2
Eq_pos3	positive result(α3)	numeric	5:2
Eq_neg3	negative result (β3)	numeric	5:2

9. **Evlist_f**: This file is used as a temperory file in order to transform the equation to the form that it can be calculated using the Pascal progam.

Field name	Explanation	Type	Width
Ev_eqnum	equation #	numeric	2
Ev_num	evidence #	numeric	8
Ev_start	starting pos. of the evid.	Numeric	3
Ev_end	ending pos. of the evid.	Numeric	3
Ev_letter	letter assigned	character	1
Ev_pos	positive point	numeric	5:2
Ev_neg	negative point	numeric	5:2

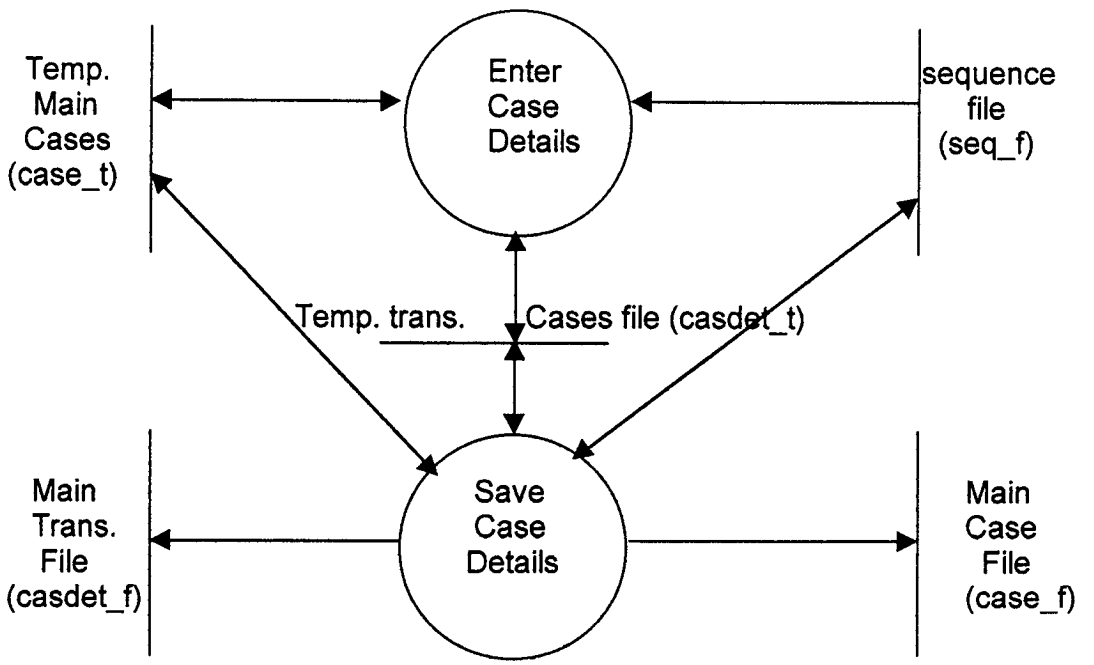
III- Architectural Design:

The primary objective of architectural design is to develop a modular program structure and represent the control relationships between modules.

A. Data Flow Diagrams (DFD) :

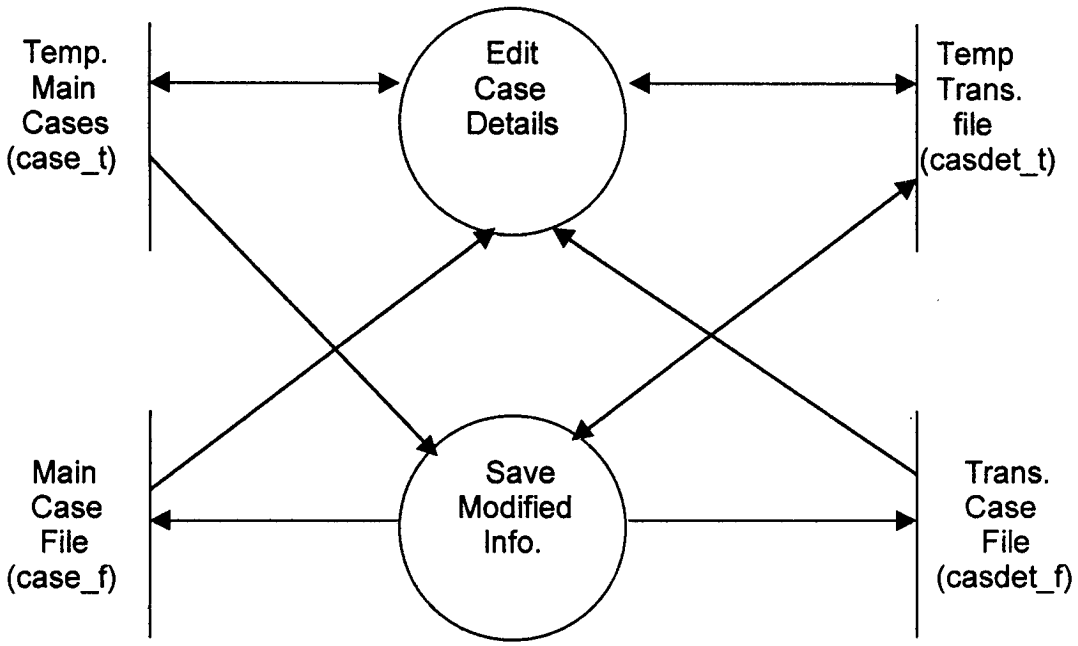
It is a graphical technique that depicts information flow and the transforms that are applied as data move from input to output.

1- Add New Case:



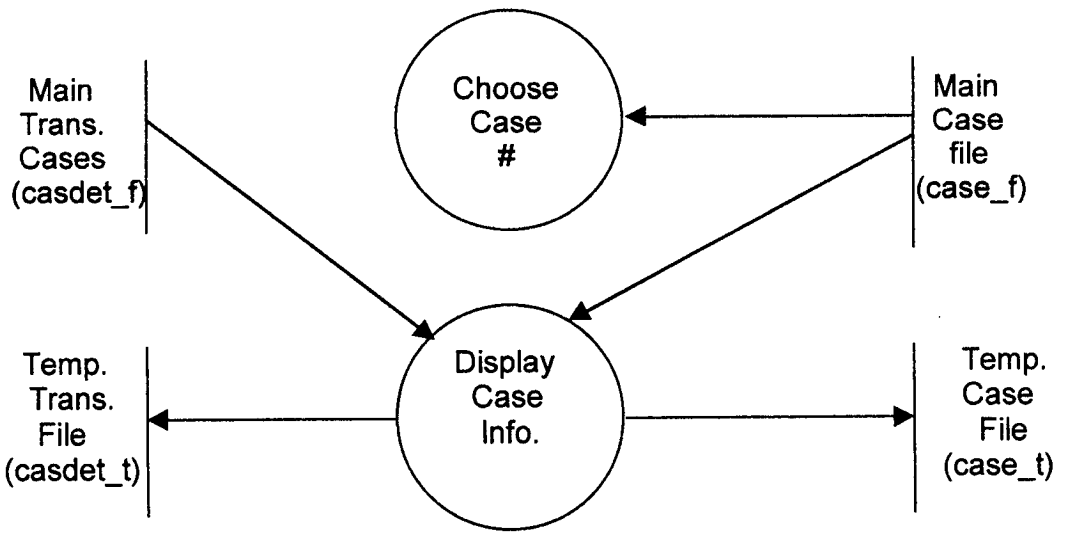
In adding a new case, we have two main modules, "enter case detail" and "save case detail". In the first one, the user is supposed to enter the problem specification, query, arguments for and against, and the combination of the arguments of the new case [23] [3]. During this stage, there is an access to many files. "Seq_f" is referenced for the case sequential #, "casdet_t" and "case_t" files are used to save the information entered by the user. In the second module, if the user wants to save the information, the information is brought from the temperory files ("case_t", "casdet_t") and saved in the main files ("case_f", "casdet_f"), "seq_f" is referenced to take the case # and update it.

2- **Edit Existing Cases:**



In editing a case, we have two main modules, "edit case detail" and "save modified information". In the first one, the user is supposed to modify what he needs. During this stage, data is brought from "case_f" and "casdet_f" and filled in the temperory files "casdet_t" and "case_t". In the second module, if the user wants to save the modified data, the data is brought from the temperory files ("case_t", "casdet_t") and saved in the main files ("case_f", "casdet_f"),

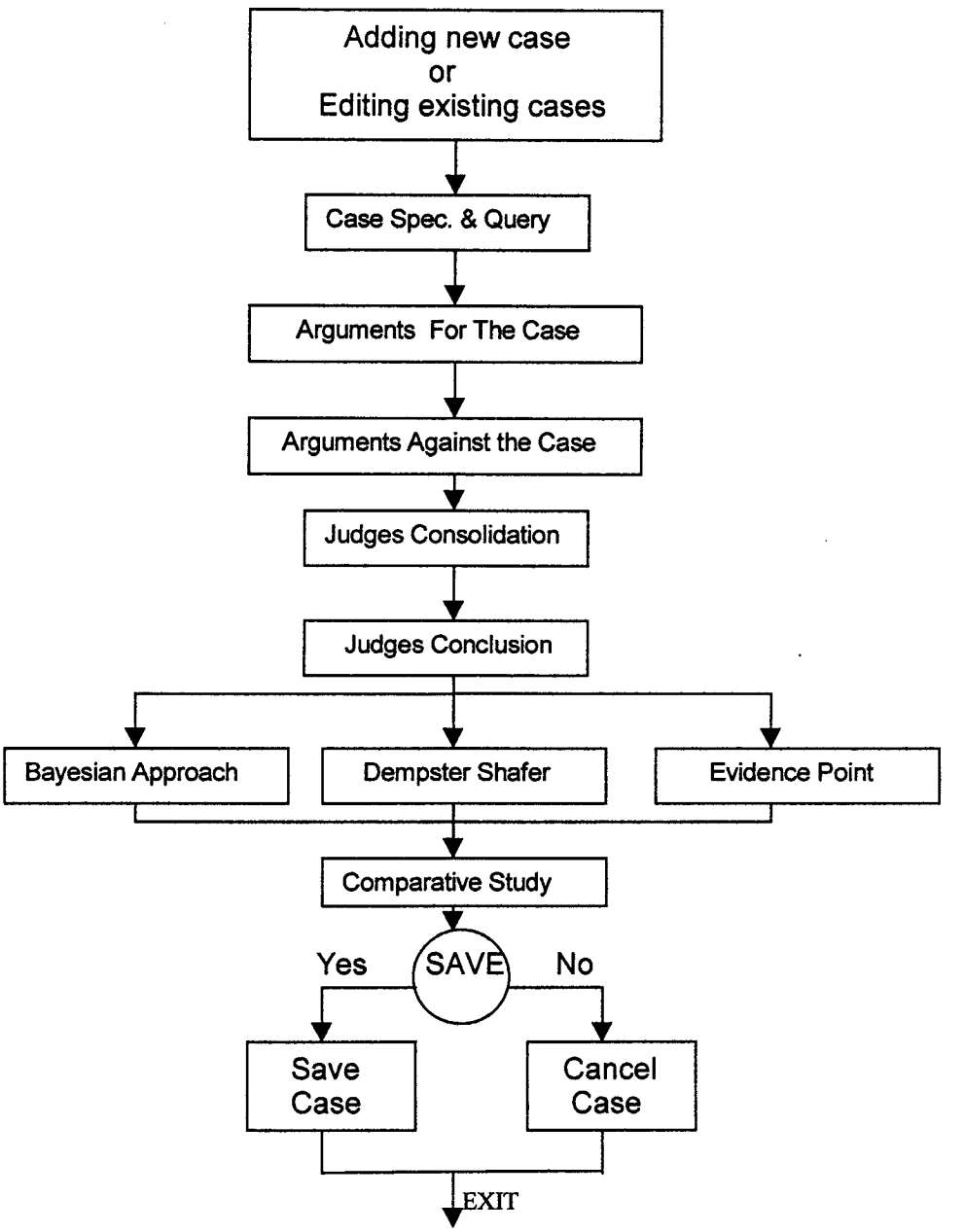
3- View/Search Existing Case:



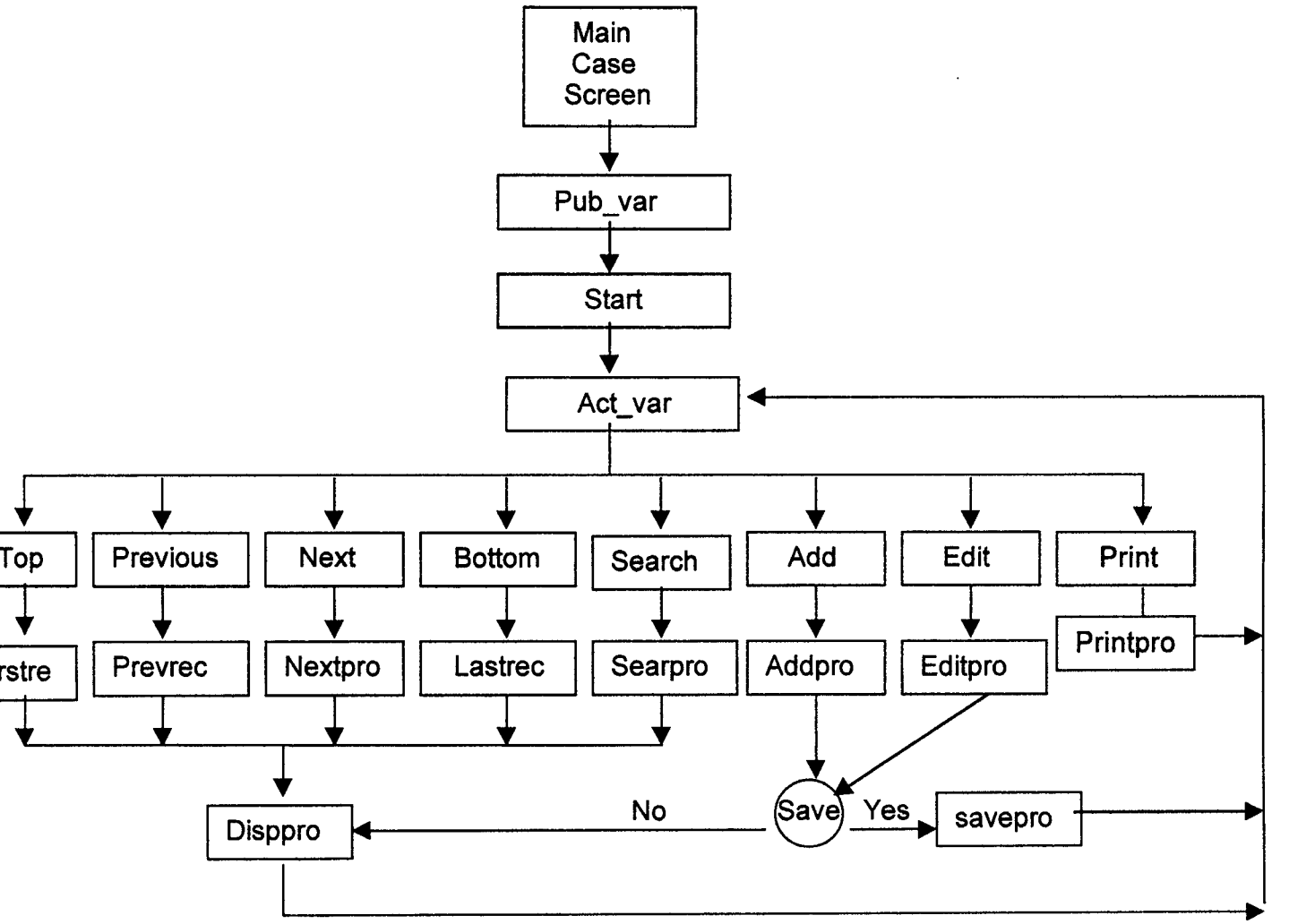
B. Control Flow Diagrams:

There exists a large class of applications that are driven by events rather than reports or displays, and that process information with heavy concern for time and performance [9]. Such applications require the use of control flow modeling in addition to data flow modeling.

1. Overall System Control Flow:

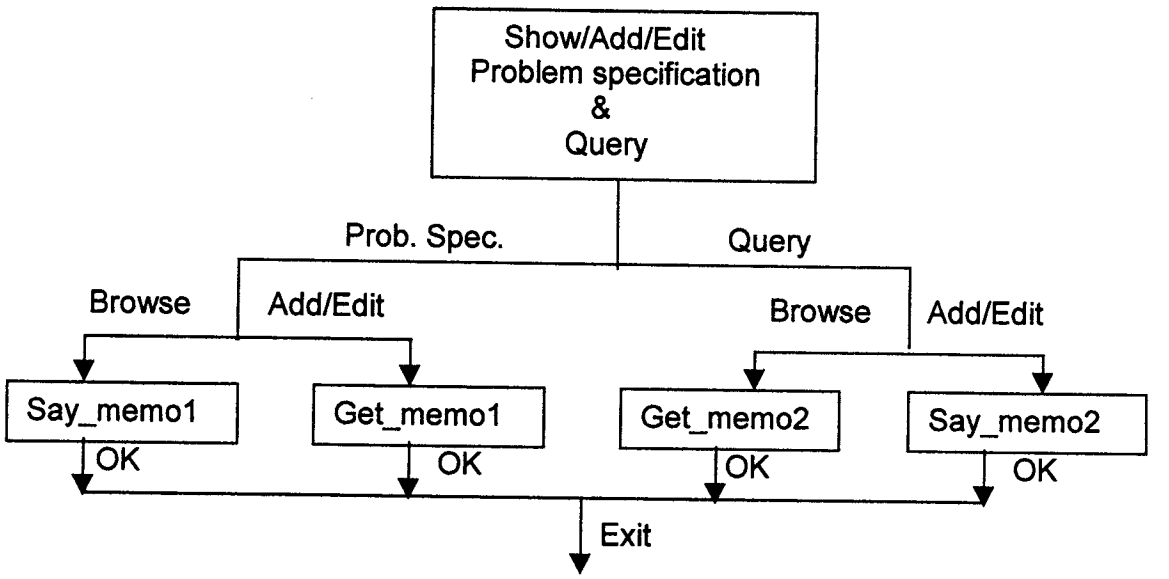


2. Cases:



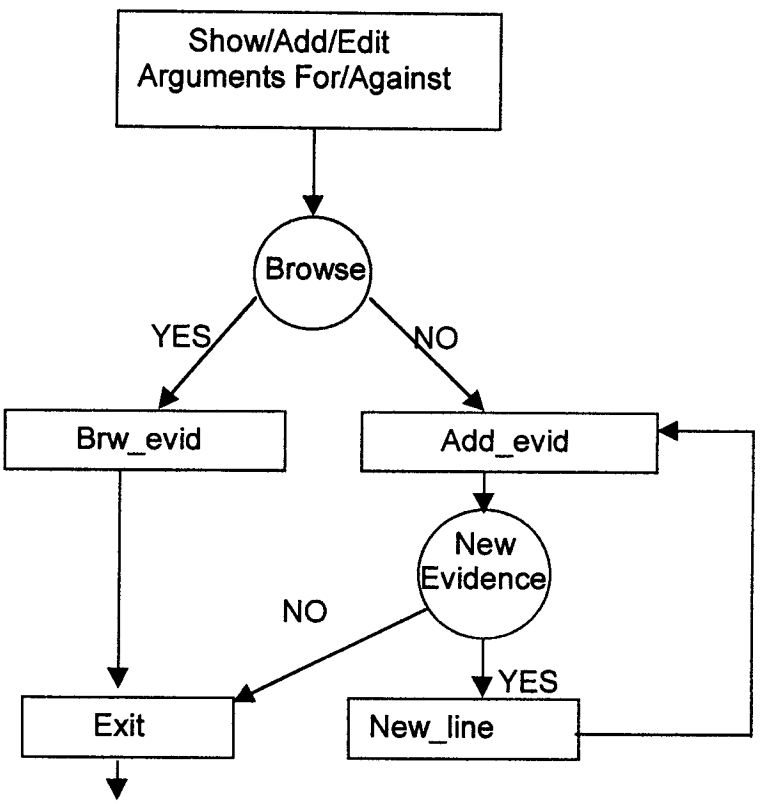
Initially all the needed variable in the program are defined (Pub_var) and data files are opened (start). Then the user has an option to browse/view existing cases (top, previous, next, bottom) in which the record pointer is positioned in the corresponding record (firstrec, prevrec, nextpro, lastrec) and the data is displayed (disppro) in the screen. We can also add a new case (addpro) or edit an existing case, then he can either save what he has done (savepro) or cancel it. Finally, he can print any case with its details (printpro).

3. Problem Specification and Query:



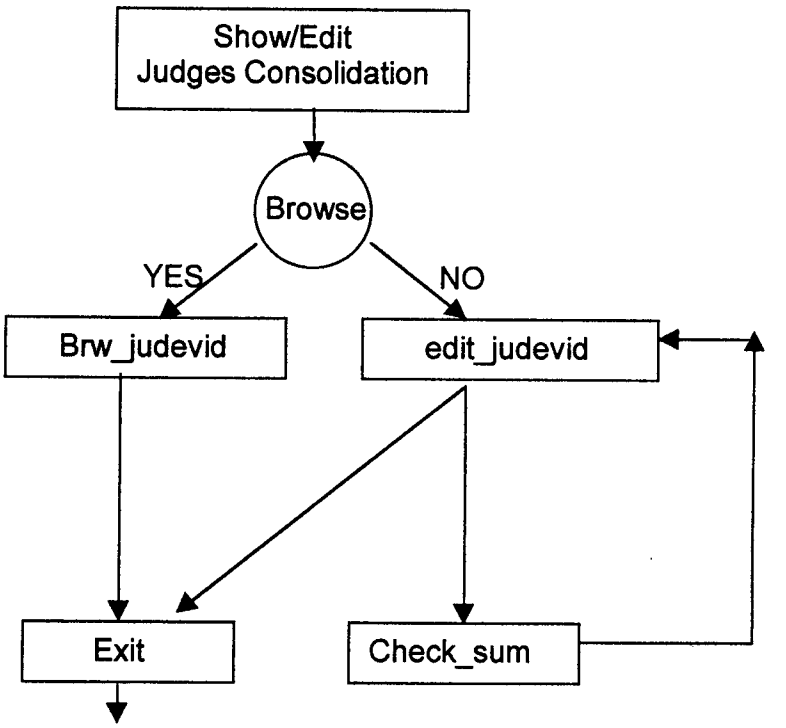
Here, the user can either browse (say_memo1, say_memo2), edit or add (get_memo1, get_memo2) the problem specification or query according to the parameters passed to it.

4.Arguments For/Against the Case:



The user can browse the arguments for and against the case (brw_evid) and then exit, or he can add new evidence or edit existing evidence (add_evid, new_line) as many as he wants and then return to the calling program.

4. Judges Consolidation:



The user can browse the judges consolidation of the arguments for and against the case (brw_judevid) or he can enter the positive and negative points of each argument (edit_judevid) and the computer will check if the sum of the positive and negative point ig greater than one.

IV- Interface Design:

It describes how the software communicates within itself, to systems that interpolate with and with humans who use it. The three areas of concern are divided as following:

1. Design the interface between software modules.
2. Design the interface bet the software and other non human producers and consumers of information (external entities)
3. Interface between a human and the computer.

Initially, the design of internal program interfaces, sometimes called intermodular interface design, is driven by the data that must flow between modules and the characteristics of the programming language in which the software is implemented [23]. This is illustrated in the data flow diagrams that is shown previously in detail in the architectural design.

Further, the external interface design begins with an evaluation of each external entity represented in data flow diagrams. This type of interface design is not applicable to our type of software tool we are developing [9].

Finally, as for the design of the user interface, it evolves five common design issues:

- **System Response Time:** The system should have a very good response time especially in evaluating the equations (combinations of evidences) that the user enters, and giving the answer to the three techniques and the comparative study.

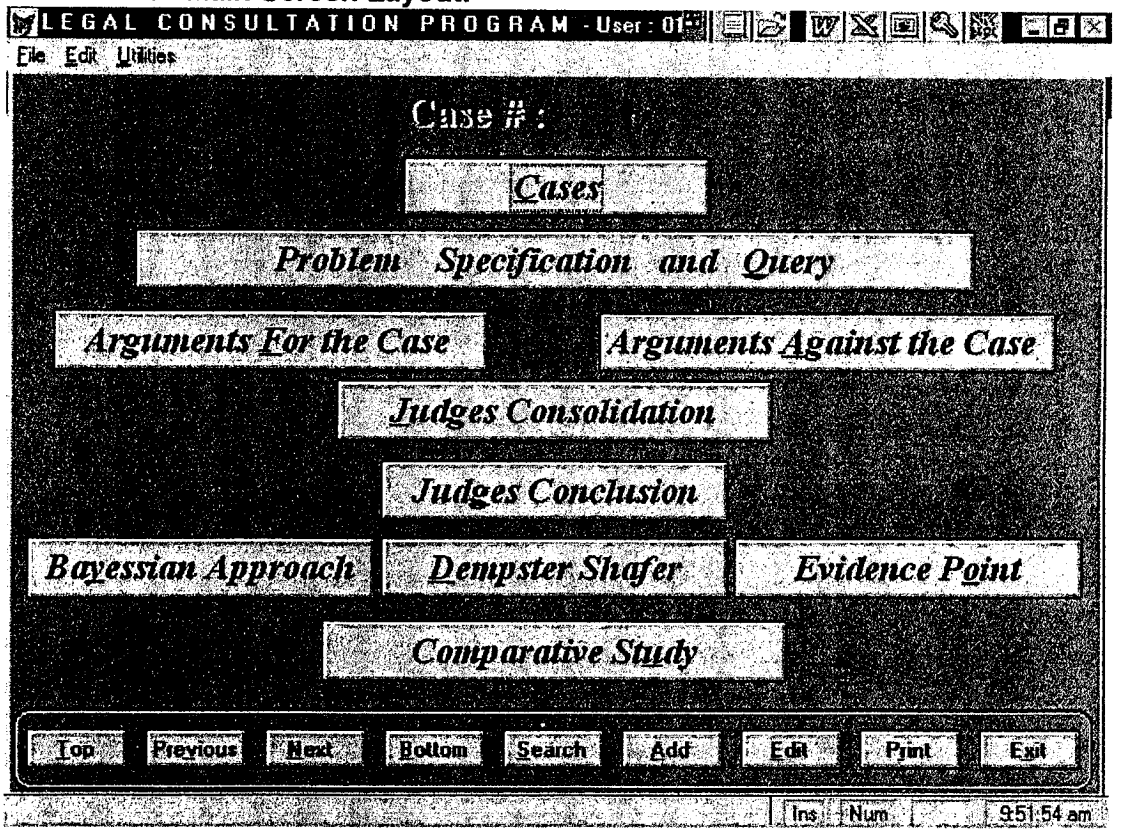
- **User Help Facilities:** This is a very important issue, since if the user doesn't understand what is in front of him, he can't use the tool efficiently. That's why, we will provide the user with a help facility (by pressing F1) for each screen in which we will show the needed information that enable him to use the tool efficiently and easily.

- **Error Information Handling:** We will provide the user with a good interface with the computer when any type of error occurs specifying the cause and the type of recovery that should be applied. Also, the access to the data inside the tool will be done through temporary files when browsing, adding or editing the original data. By this, we will protect the data from user misuse or any sudden system error. With the main tool, we will provide some utilities that will help the user in recovering from errors such as a program that will fix any error in the index files that might be corrupted due to electricity failure while the system is working.

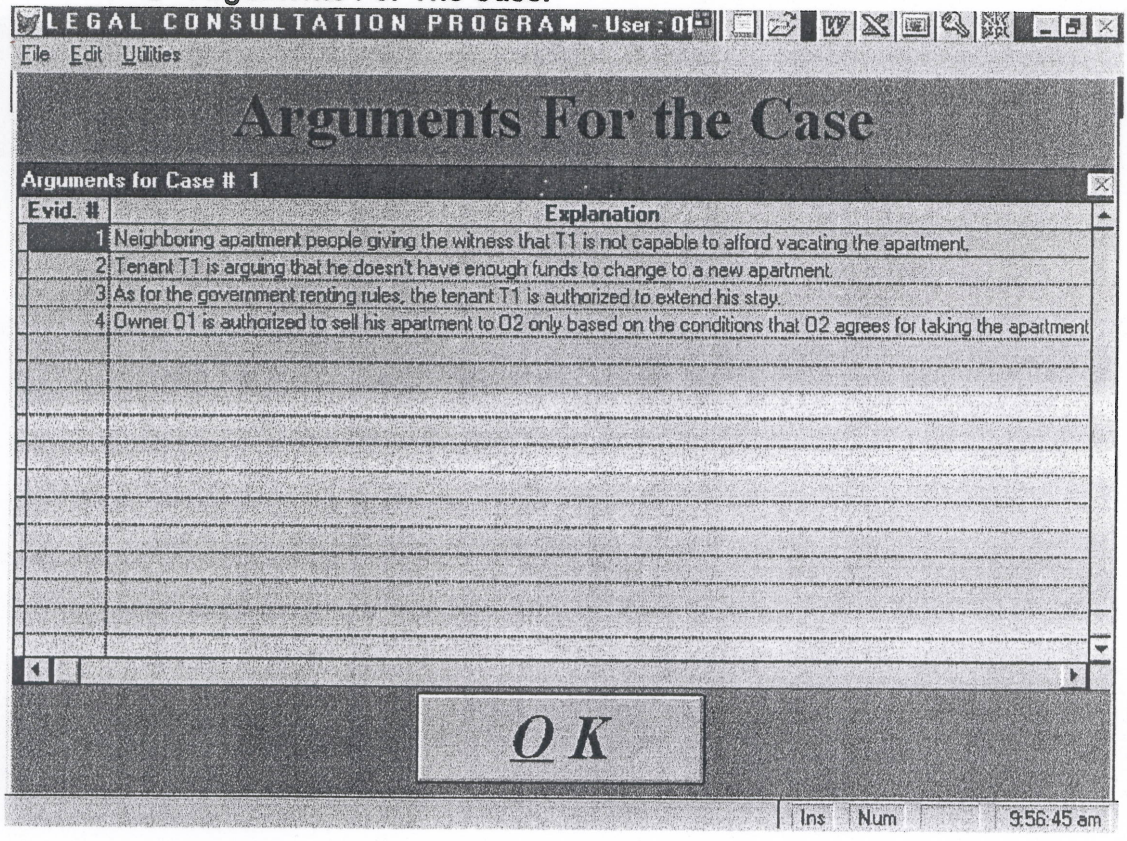
- **Command Labeling:** Consistency in names and commands used throughout all stages of the tool is a very important issue. The user should find no difficulty in applying the commands during the use of the tool. So, these type of commands and shortcut keys should be consistent, small in number and easy to implement. These characteristics or specifications are shown in the screen layouts that are shown below.

- **Screens Layout:**

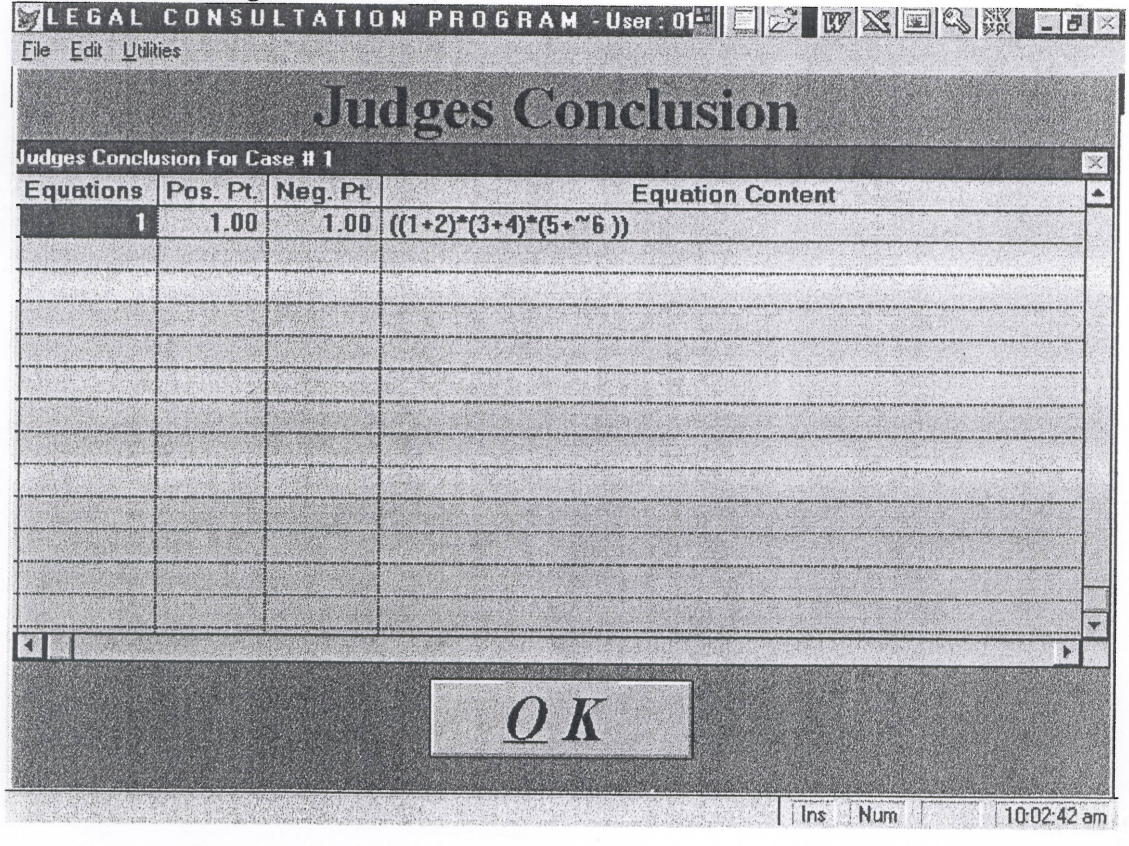
  - **Main Screen Layout:**



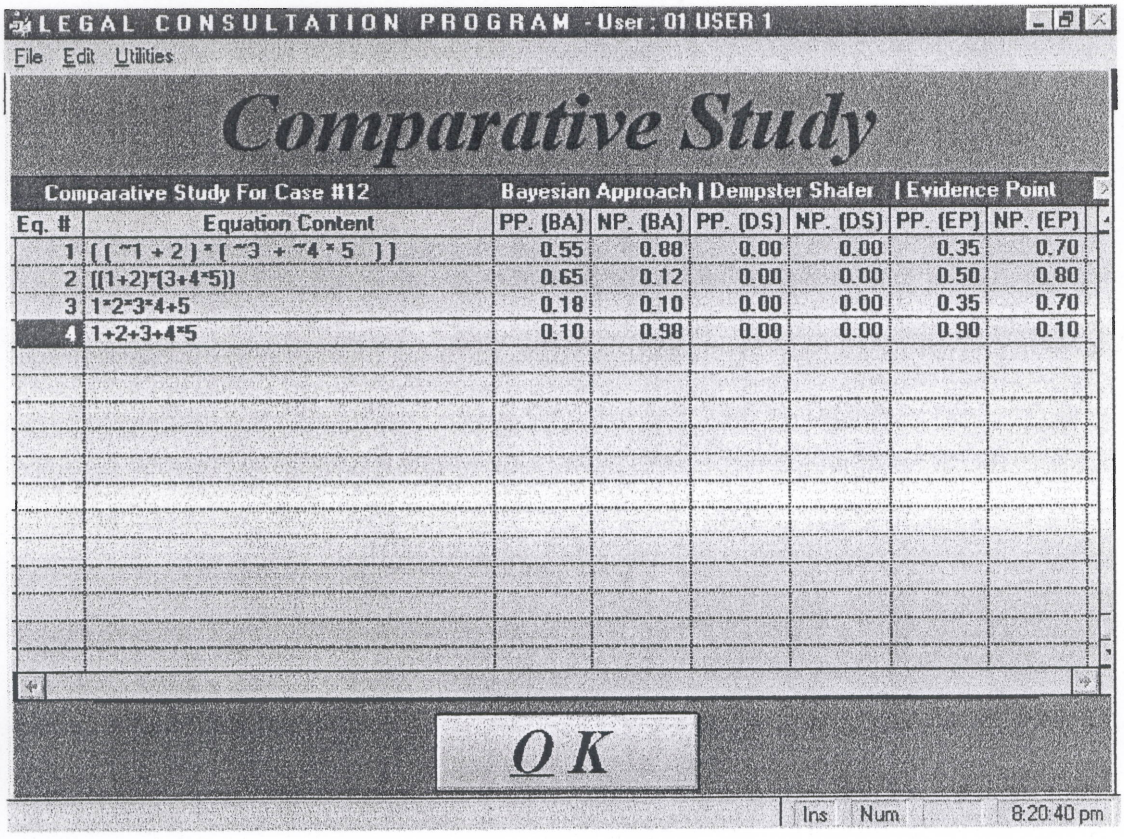
- **Arguments For The Case:**



- **Judges Conclusion:**



- **Comparative Study:**



V- Procedural Design:

In this part we explain the processing narrative, interface description, comments, restrictions and limitations of our tool. Our process start with either invoking an old case or generating a new case as specified in the architectural design. At Step 1 we are providing the problem specification and the query details for the user to have an overview about the case. In Step 2, we look for the list of arguments for and against the case. At Step 3, the user is supposed to provide the appropriate weight for both positive and negative evidences against all the arguments specified in Step 2. At this junction, it is assumed that the user is providing these weights based on the insight and his

understanding about the case. In Step 4, we provide the conclusion based on some/all arguments. At this junction, we arrive at a consolidated evidence point (X, Y) to the respective case under consideration. In order to take an intelligent decision making, we go for normalizing this EP(X, Y) by replacing with (X / X+Y,Y / X+Y). In the final step, we give a comparative study about decision making based on Bayesian Inference, Dempster Shafer theory and Evidence Point approach.

With respect to the design language, I have used FoxPro under windows 2.6 [31] and Borland Pascal 7.0 [32]. In FoxPro, I have designed mainly screens and reports taking benefit of the visual objects in the language (push buttons, edit and browse windows). Also, I have used data files and indexes to accelerate the access time and response time of the system. I have used Pascal Language to evaluate the equations entered by the user by using stacks, arrays and text files mainly. The communication between FoxPro and Pascal is done through file that are shared by both of them. With respect to the internal data structure, I have used data files, text files, arrays, stacks, variables and many other structures.

In our next chapter we discussed at length some of the enumerated legal cases of Lebanon. We did our survey across several varieties of legal cases and enumerated ten cases of different cross section.

Chapter 8

Enumerated Cases

Our survey about the legal cases in Lebanon has revealed few seminal points as described below [17-21]:

- The existing legal laws are of out dated, there is an acute need for their modification.
- Due to the war in Lebanon, hearing of each case is taking enormous time due to the non-availability of sufficient evidence.
- Categorization of each legal case is very slow, due to different categories of courts.

Here, are some illustrated legal cases.

- **Case # 1: Renting Problem**

Summary: A house owner O1 has given his house for rent to a tenant T1. After some time, T1 extended his stay based on the existing rental laws of the government which are supporting him. Further, owner O2 wanted the tenant T1 to vacate the apartment.

Now, the issue here is the tenant T1 opposing O2.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. Neighboring apartment people giving the witness that T1 is not capable to afford vacating the apartment.

2. Tenant T1 is arguing that he doesn't have enough funds to change to a new apartment.
3. The argument from O2 is that as for the rental contract the tenant T1 should vacate as the time of the contract expires.
4. As for the government renting rules, the tenant T1 is authorized to extend his stay.
5. Owner O2 is unaware of the fact that the apartment is given for rent at the time of purchasing. Therefor, O2 claims that T1 should vacate.
6. Owner O1 is authorized to sell his apartment to O2 only based on the conditions that O2 agrees for taking the apartment if the tenant is agreeing to vacate after the date of the contract.
7. The tenant is also supported by O1 based on the existing law of tenants.
8. Since the tenants were out of station during the war period of 1985 to 1992, the O1 taken advantage of the situation and sold the apartment to O2. This made the misconception for O2 that the tenants are going to vacate soon after their return.

- **Case # 2: Naming Confusion**

Summary: Bank X has a name N1 was funding number of companies. A company Y adopted the same name N1 and started funding some more companies after a gap of 45 years. Since that, bank X is a senior one, having a very good reputation in the society. Now, because of adopting the same name as of X, Y is also getting a more popularity. X and Y are meeting in the court.

The court has given a decision to change the name of Y, will be fined in case if it disobeys the court decision.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. X argues that his popularity has come down because of imitating his name.

2. X became defamed and conflicted in the society due to duplication of his name.
3. Y argues that he has not interfered in the policies and management of X.
4. As for the company's act, one should not duplicate the name of others.
5. Y argues that if he change the name now he will incur heavy losses, who is going to pay those losses in case he decides to change the name.
6. X argues that if Y is having a financial litigation problem that will defame him (X).
7. Y argues that name of the company doesn't matter much as of the domain of business of X (Banking) is quite different from that of Y (Traveling).
8. Y argues that the duplication of the name as an alphabetical string doesn't matter much as long as its translation in Arabic leading to different names.
9. Y argues that duplicating the name of X is not his sole intention, but he did it under the pressure from his parent organization situated outside Lebanon.

- **Case # 3: Architect and Owner Dispute**

Summary: This is a case between an architect A and the owner of the building O. Architect A has given the design and plan of construction of the building and hand it over to the owner O. At the time of signing the necessary documents, architect A has clearly explained about a few minor defects in the building construction.

At the time of signing, the architect A also suggested certain maintenance work to be done to the owner O. Owner O has not given his ear for the written given points about the building by the architect A.

Now, owner O proceeded to the court against A because of certain leakage problems in the building.

The final judgement of the court is supporting A.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. Architect A argues that he has writtenly committed about certain defects and their remedy at the time of handing over the building.
2. The owner O argues that he has been not explained enough regarding certain leakage problem in that building, at the time of handing over.
3. As for the handing over the document evidence, it clearly says that all the minor issues are exemplified by the architect A.
4. It is realized that the architect A has done a minor modifications to the building plan given by the owner O. this results in the above mentioned leaking problems.
5. Owner O declares that certain defects A mentioned only orally, not keeping it on paper.
6. Architect A has a written proof about the owner O acceptance in spite of certain minor problems specified in writing.
7. As a reply to Argument 2, the architect A submitted a proof of certain document indicating the owners awareness about the size and cost of repairing certain minor problems.

- **Case # 4: Murder**

Summary: This is a case under murder. X has a daughter and a divorced wife Z. X is staying in Lebanon doing some business. Y is staying with Z in Switzerland. A third person P knows X since several years and is a close intimate of X. P is also taking care of X's business in Lebanon.

Here is a situation that requires more concentration.

In 1995, when X returned to Lebanon from Switzerland, realized that P is responsible for some theft in the X's business. So, X had an attempt to kill P, meanwhile P has opened a fire against X and killed him.

Court has given a verdict of death sentence to P or life long imprisonment. Now, the evidence clue are as following:

1. P has an unlicensed gun through which he fired X.
2. P owes a little amount of money to X.
3. Since X has attempted to kill P, P has opened a fire in order to defend his life, not with an intention to kill.
4. It is true that P has a handicapped leg, can't move very fast. Thus, he first opted to gun down X.
5. In spite of the long time friendship, X has not understood the reasoning and explanations of P in resolving the conflict between them.
6. Several times in the past P has taken the responsibility of the business of X, in the absence of X.
7. Due to the close friendship with X, several times P has interfered in the personnel matters of X. This makes P to estimate the period of stay of X in Switzerland.
8. As for a responsible person for the business of X in Lebanon, P started posting the business updates to X, time to time. P unable to provide the business updates for some period due to his poor health. This leads to the misconception to X about P, whereas P declaring that he was sick.
9. Due to stingent personnel problems, X got enough disturbed psychologically in Switzerland. Thus, he started blaming on P for certain silly causes.
10. Through certain investigation and rade into the vicinity of the house of P, it is surfaced that the gun through which he committed murder and the dead body of X were all hidden in some remote places.
11. X is supporting his argument for having a gun only to transfer the money from house to bank and Vice Versa.

- **Case # 5:Renting Case**

Summary: In this case, a tenant Y is staying in an apartment of X. Y left the apartment during the war. But still X is getting the rent amount for his apartment, from two people viz., Z an outsider and P the father of Y. After the

completion of the war, the tenant Y likes to come back to his apartment, for which the owner X not agreeing.

Court giving decision that X has no right to occupy the apartment and legally Y is authorized to take back his apartment.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. As for the law, if the tenant has not returned after six month, X has the right to break the contract, but he should inform the tenant. In this case, the owner has not informed to the tenant.
2. Though Y has given his whereabouts during the war to X, X is claiming that he doesn't know.
3. X is getting the rental amount every month and still claiming that he doesn't know the tenants whereabouts.
4. The tenant Y has left the apartment during war, by leaving certain personnel belongings inside the apartment.
5. The tenant Y has incurred in many losses due to run away of the apartment during the war. Thus, after the war, he may need some more time in order to stabilize, before apting/shifting to a new apartment.

- **Case # 6:Renting Problem**

Summary: This is again a case of renting. An apartment owner X has given his apartment for rent to a person P. Along with the P, his siblings Q, R, S were also staying in the same apartment. The contract between the owner X and the tenant was signed by P alone.

The person P has purchased a new apartment, but still want to retain the apartment of X.

The court has given the final decision that P should vacate the apartment of X.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. Because the renting contract is written by P alone, as for the renting law, P should vacate soon after he owns apartment on his name.
2. Though Q,R,S are siblings of P were not authorized to stay in the apartment of X, since they were not mentioned in the contract.
3. P argues that his siblings are non income minors, cannot vacate the apartment. His newly owned apartment is still under the lease with a bank.
4. In the renting contract, P hasn't mentioned the residency of his siblings Q, R, S. thus, X claims that he can't give the apartment to Q, R, S at the old rate, which he has given to P.
5. During the stay of P,Q,R, and S in X's apartment, he has observed their poor maintenance. Thus X appeals to give his apartment to Q, R, S and so P should vacate.

- **Case # 7:Buisness Partnership Case**

Summary: A husband H and a wife W started a company, having a hold on the entire shares of the company. The H has brought a person X into his business without consulting his business/life partner. Without informing to W, H has sold some shares to X. it is surfaced that H has sold the shares to X, without W's signature.

The W has realized about this point after 8 years and appealed to the court against H that the sold shares are invalid.

Court has given decision that what W is saying is right.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. W being a partner in the business to X, not knowing the fact that x has sold the shares 8 years ago doesn't look reasonable.

2. Being a joint partner, the H has no authorization to sell the shares without informing to W.
3. Being a husband and wife and the partners of the company, selling the shares without informing to wife is illegal.
4. While H selling the shares of the company to X, he hasn't taken the signature of his partner, instead he has forged the signature of his partner W which is illegal.
5. In response to court questions, H has defended his action stating that ha has taken the concern with W orally (telephoning conversation) for selling the shares to X, as she was out of station.
6. W is appealing to the court that X is a highly unreliable person, back stabbed H in several occasions which H couldn't realize.
7. After due investigation, it is realized that there was no contract between the husband H and the middle name X.

- **Case # 8:Organizational Dispute**

Summary: A company C and an Employer E has Signed a contract stating that the employee E shouldn't work in the same area for next 3 years within/outside Lebanon, in case if E resigns from C. After signing this contract with C, E started working with another company D in the same field.

C went to the court against E for Breaking the contract.

Court given decision that E should resign from the new company

The amount of positive and negative evidences should be pooled based on the following reasons:

1. E is appealing to the court that company D doesn't exists, still only a survey is conducting for its establishing.
2. E is working and producing the products in C. Though E is working with D, so far there is no production in D.
3. Expert reports says that D has not yet produced any product, it is still in a location survey.
4. C is appealing to the court that E may release certain confidential issues to D during its survey.

5. E is appealing to the court that he was forced to sign with C due to some unavoidable circumstances.
6. C is appealing to the court that E is redirecting some of its customers to D.
7. Before completing the contract period of 3 years with company C, the employee E has resigned. As for the company loss, he is not authorized to work in any similar company within the next three years. This point E has violated and joint in a company D within 8 month of his resignation of C.

- **Case # 9:Social Security Problem**

Summary: A husband H work nature wasn't included in the law of Social Security (SS), whereas his wife W work nature is included. They have a few kids as part of their family. As for the SS law a women can't take money on behalf of her husband and kids.

Since the SS in not paying any money to wife and children, the wife W proceeded to the court against the law of SS.

The court given decision that the SS should pay money to her family allocation and motherhood.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. As for the law of SS if the husband work nature is not included in the SS law, he is not authorized to cover his wife and children, being he himself not covered.
2. Since the children are minor, can stay only with the mother, not with husband. Thus, W appeals to the court that SS should pay the money through medical insurance and motherhood.
3. Expert study reveals that the work nature in the law of SS is not clear. It reveals that there is no provision given for the male employees whose work nature is not included in the law of SS.
4. W appeals to the court that she is paying the installment money to the

5. SS, like any other employee(male). Thus, she declares that whether she pays the money or her husband pay the money doesn't make any difference.
6. The social security is arguing that there is no written document stating that her husband H work nature is not included in the SS. Thus, there could be provisions that both wife W and husband H may be drawing the money from SS.

- **Case # 10:Intent Killing**

Summary: In a family, father F has killed his daughter D for producing an illegal child C. in this case, father F has given enough evidence to the court about her daughters illegal mating with he boyfriend and thus he killed her and hand over to the police. He has done this in order to keep up his family prestige.

The court has given its decision that F should be given imprisonment seven years executive jail.

The amount of positive and negative evidences should be pooled based on the following reasons:

1. The father F has evidentially admitted that he has killed his daughter.
2. It was reported from the friend of D that D did such a work based on the assurance from her boyfriend that he will marry her.
3. Right from the beginning. The father F has a wrong opinion about D's boyfriend.
4. There is another version saying that the boyfriend has threatened D that he will come and suicide if she doesn't allow him the materialistic pleasure.
5. The boyfriend doesn't have any job at hand. Though H repeated request to D to wait till he get a job, D has not given her ear.

At the end of the thesis, we provided an appendix where we compared our approach with the other existing methods of uncertainty handling Viz., Dempster Shafer reasoning and Bayesian logic.

Chapter 9

Conclusion and Future Possibilities

In this thesis, we have attempted to provide a software tool for intelligent decision making in the domain of legal consultation within the Lebanon Jurisdiction. Based on the survey conducted while analyzing the several legal cases in Lebanon, we realized that some of the existing legal laws are out dated. There is an acute need for an automated system for legal consultation, in order to process the pile up cases.

This motivated us for the design of a legal consultation tool using FoxPro under windows 2.6 coupled with Borland Pascal 7.0 code.

After analyzing some of the practical legal cases in Lebanon using our tool we arrive at the following conclusions.

1. In most of the cases, the sources of evidence (both positive and negative) are of highly reliable.
2. In spite of the outdated existing legal laws, our tool able to provide a clear vision for an intelligent decision-making.
3. The law of renting in some cases giving an undue advantages to the tenant.

Though our automated tool throw some light on the existing legal cases for intelligent decision making, our intuition says the following future possibilities:

1. Subject to the pooled evidences (both positive and negative) we can classify the punishments as well.
2. At any point of time, if we find the sources of evidences (positive or negative) unreliable, there should be a mechanism to update the respective evidence points.
3. There is a scope for extending the capability of this tool by integrating with the Internet. This is with a view to see the consistency and completeness of our tool among the different legal laws in several countries around the world.

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Appendix A

Results of The Enumerated Legal Cases

Legal Consultation System

Date : 02/07/1999

Case # 1

Page : 1

Problem Specification

A house owner O1 has given his house for rent to a tenant T1. After some time, T1 extended his stay based on the existing rental laws of the
government which are supporting him. Further, Owner O2 wanted the tenant T1 to vacate the apartment.
Now, the issue here is the tenant T1 opposing O2.

Query From X

Owner O2 wanted the tenant T1 to vacate the apartment.

Evidences

Number	Type	Explanation	Positive	Negative
1	For	Neighboring apartment people giving the witness that T1 is not capable to afford vacating the apartment.	0.90	0.37
2	For	Tenant T1 is arguing that he doesn't have enough funds to change to a new apartment.	0.78	0.42
3	For	As for the government renting rules, the tenant T1 is authorized to extend his stay.	0.90	0.40
4	For	Owner O1 is authorized to sell his apartment to O2 only based on the conditions that O2 ag rees for taking the apartment if the tenant is agreeing to vacate after the date of the contract.	0.87	0.40
5	For	The tenant is also supported by O1 based on the existing law of tenants.	0.90	0.30
6	Against	The argument from O2 is that as for the rental contract the tenant T1 should vacate as the time of the contract expires.	0.92	0.38
7	Against	Owner O2 is unaware of the fact that the apartment is given for rent at the time of purcha sing.	0.95	0.40
8	Against	Since the tenants were out of station during the war period of 1985 to 1992, the O1 taken advantage of the situation and sold the apartment to O2. This made the O2 a misconception	0.67	0.72

Equations

Number	Explanation								
1	((1+2)*(3+4)*(5+6 +7+8))								
	Bayesian Inference	0.70	0.30	**Dempster Shafer**	0.70	0.76	**Evidence Point**	0.75	0.25
2	((1*2)+(3*4)+(5*6 *7*8))								
	Bayesian Inference	0.69	0.31	**Dempster Shafer**	0.69	0.70	**Evidence Point**	0.75	0.25
3	1+2+3+4+5+6+7+8								
	Bayesian Inference	0.64	0.36	**Dempster Shafer**	0.64	0.96	**Evidence Point**	0.65	0.35

Legal Consultation System

Case # 2

Date : 02/07/1999

Page : 1

Problem Specification

Bank X has a name N1 was funding number of companies. A company Y adopted the same name N1 and started funding some more companies after a gap of 45 years. Since that bank X is a senior one, having a very good reputation in the society. Now, because of adopting the same name as of X, Y is also getting a more popularity. X and Y are meeting in the court.

Query From X

The bank X is asking Y to change it's name .

Evidences

Number	Type	Explanation	Positive	Negative
1	For	As for the company's act, one should not duplicate the name of others.	0.90	0.34
2	For	X argues that if Y is having a financial litigation problem that will defame him (X).	0.75	0.35
3	For	X argues that his popularity has come down because of imitating his name.	0.87	0.33
4	For	X became defamed and conflicted in the society due to duplication of his name.	0.50	0.90
5	Against	Y argues that he has not interfered in the policies and management of X.	0.90	0.20
6	Against	Y argues that if he change the name now he will incur heavy losses, who is going to pay th ose losses ?	0.88	0.30
7	Against	Y argues that the domain of business of X (Banking) is quite different from that of Y (Tr aveling).	0.70	0.40
8	Against	Y argues that the duplication of the name as an alphabetical string doesn't matter much as long as its translation in Arabic leading to different names.	0.90	0.22
9	Against	Y argues that duplicating the name of X is not his sole intention, but he did it under the pressure from his parent organization situated outside Lebanon.	0.78	0.30

Equations

Number	Explanation
1	((1+6)*(4+2)+(3*5)*(7+8+9))

Bayesian Inference	0.75	0.25	**Dempster Shafer**	0.75	0.82	**Evidence Point**	0.79	0.21

Legal Consultation System

Date : 02/07/1999

Case # 3

Page : 1

Problem Specification

This is a case between an architect A and the owner of the building O. Architect A has given the design and plan of construction of the building and hand it over to the owner O. At the time of signing the necessary documents, architect A has clearly explained about a few minor defects in the building construction.
At the time of signing, the architect A also suggested certain

Query From X

The owner O proceeded to the court against A because of certain leakage problems in the building.

Evidences

Number	Type	Explanation	Positive	Negative
1	For	The owner O argues that he has been not explained enough regarding certain leakage problem in that building.	0.82	0.55
2	For	As for the handing over the document evidence, it clearly says that all the minor issues are exemplified by the architect A.	0.70	0.45
3	For	It is realized that the architect A has done a minor modifications to the building plan gi ven by the owner O. this results in the above mentioned leaking problems,	0.64	0.50
4	For	Owner O declares that certain defects A mentioned only orally, not keeping it on paper.	0.77	0.30
5	Against	Architect A has writtenly committed about certain defects and their remedy at the time of handing over the building.	0.88	0.45
6	Against	Architect A has a written proof about the owner O acceptance inspite of certain minor pro blems specified in writing.	0.65	0.50
7	Against	Architect A submitted a proof of certain document indicating the owners awareness about th e size and cost of repairing certain minor problems.	0.50	0.76

Equations

Number	Explanation
1	1+(2*4)+(3*5)+(6*7)

Bayesian Inference	0.59	0.41	**Dempster Shafer**	0.59	0.90	**Evidence Point**	0.60	0.40

Legal Consultation System

Case # 4

Date : 02/07/1999

Page : 1

Problem Specification

This is a case under murder. X has a daughter and a divorced wife Z. X is staying in Lebanon doing some business. Y is staying with Z in Switzerland. A third person P knows X since several years and is a close intimate of X. P is also taking care of X's business in Lebanon.
Here is a situation that requires more concentration.

Query From X

Death sentence to P .

Evidences

Number	Type	Explanation	Positive	Negative
1	For	P has an unlicensed gun through which he fired X.	0.90	0.33
2	For	P owes a little amount of money to X.	0.35	0.85
3	For	Several times in the past P has taken the responsibility of the business of X, in the absence of X.	0.88	0.22
4	For	Several times P has interfered in the personnel matters of X. This makes P to estimate the period of stay of X in Switzerland.	0.89	0.35
5	Against	Since X has attempted to kill P, P has opened a fire in order to defend his life, not with an intention to kill.	0.77	0.40
6	Against	It is true that P has a handicapped leg, can't move very fast. Thus, he first opted to gun down X.	0.60	0.70
7	Against	In spite of the long time friendship, X has not understood the reasoning and explanations of P in resolving the conflict between them.	0.85	0.20
8	Against	As for a responsible person for the business of X in Lebanon, P started posting the business updates to X, time to time. P unable to provide the business updates for some period due to	0.90	0.30
9	Against	Due to stingent personnel problems, X got enough disturbed psychologically in Switzerland. Thus, he started blaming on P for certain silly causes.	0.70	0.40

Equations

Number	Explanation
1	(1+2*3+4*5+6*7+8*9)

Bayesian Inference	0.73	0.27	**Dempster Shafer**	0.73	0.79	**Evidence Point**	0.78	0.23

Legal Consultation System

Case # 5

Date : 02/07/1999

Page : 1

Problem Specification

In this case, a tenant Y is staying in an apartment of X. Y left the apartment during the war. But still X is getting the rent amount for his apartment, from two people viz., Z an outsider and P the father of Y. After the completion of the war, the tenant Y likes to come back to his apartment, for which the owner X not agreeing.

Query From X

THE TENANT WANTS TI TRETURN BACK TO HIS APARTMENT

Evidences

Number	Type	Explanation	Positive	Negative
1	For	As for the law, if the tenant has not returned after six month, X has the right to break t he contract, but he should inform the tenant. In this case, the owner has not informed to the	0.88	0.35
2	For	Though Y has given his whereabouts during the war to X, X is claiming that he doesn't know .	0.90	0.45
3	For	X is getting the rental amount every month and still claiming that he doesn't know the ten ants whereabouts.	0.70	0.50
4	For	The tenant Y has left the apartment during war, by leaving certain personnel belongings in side the apartment.	0.80	0.40
5	For	The tenant Y has incurred in many losses due to run away of the apartment during the war. Thus, after the war, he may need some more time in order to stabilize, before apting/shifting to	0.78	0.25

Equations

Number	Explanation
1	(1+5)*(2+4)* 3

Bayesian Inference			Dempster Shafer			Evidence Point		
	0.62	0.38		0.62	0.70		0.65	0.35

Number	Explanation
2	(1*2)+(5*~4)+3

Bayesian Inference			Dempster Shafer			Evidence Point		
	0.61	0.39		0.61	0.85		0.63	0.38

Legal Consultation System

Date : 02/07/1999

Case # 6

Page : 1

Problem Specification

This is again a case of renting. An apartment owner X has given his apartment for rent to a person P. Along with the P, his siblings Q, R, S were also staying in the same apartment. The contract between the owner X and the tenant was signed by P alone.
The person P has purchased a new apartment, but still want to retain the apartment of X.

Query From X

BRINGING DOWN OF AN EXTENSION RIGHT BECAUSE OF OWNING

Evidences

Number	Type	Explanation	Positive	Negative
1	For	Renting contract is Signed by P alone, as for the renting law, P should vacate soon after he owns apartment on his name.	0.40	0.90
2	For	Though Q,R,S are siblings of P, were not authorized to stay in the apartment of X, since t hey were not mentioned in the contract.	0.30	0.80
3	For	In the renting contract, P hasn't mentioned the residency of his siblings Q, R, S. thus, X claims that he can't give the apartment to Q, R, S at the old rate, which he has given to P.	0.55	0.80
4	For	During thier stay in X's apartment, he has observed their poor maintenance. Thus X appeal s not to give his apartment to Q, R, S.	0.35	0.69
5	Against	P argues that his siblings are minor by age, cannot vacate the apartment. His newly owned apartment is still under the lease with a bank.	0.40	0.80

Equations

Number	Explanation
1	(1+3)*(2+4)+5

Bayesian Inference		Dempster Shafer		Evidence Point	
0.33	0.67	0.33	0.80	0.70	0.30

Number	Explanation
2	(1*4)+(2+5*3)

Bayesian Inference		Dempster Shafer		Evidence Point	
0.27	0.73	0.27	0.90	0.75	0.25

Legal Consultation System

Date : 02/07/1999

Case # 7

Page : 1

Problem Specification

A husband H and a wife W started a company, having a hold on the entire shares of the company. The H has brought a person X into his business without consulting his business/life partner. Without informing to W, H has sold some shares to X. it is surfaced that H has sold the shares to X, without W's signature.
The W has realized about this point after 8 years and appealed to the

Query From X

W appealed to the court against H that the sold shares are invalid.

Evidences

Number	Type	Explanation	Positive	Negative
1	For	Being a joint partner, the H has no authorization to sell the shares without informing to W.	0.70	0.91
2	For	Being a husband and wife and the partners of the company, selling the shares without infor ming to wife is illegal.	0.60	0.80
3	For	H hasn't taken the signature of his partner, instead he has forged the signature of his pa rtner W which is illegal.	0.55	0.88
4	For	W says that X is a highly unreliable person, back stabbed H in several occasions which H c ouldn't realize.	0.90	0.40
5	Against	W being a partner in the business to X, not knowing the fact that x has sold the shares 8 years ago doesn't look reasonable.	0.77	0.55
6	Against	H has defended his action stating that he has taken the concern with W orally (telephoning conversation) for selling the shares to X, as she was out of station.	0.66	0.55

Equations

Number	Explanation
1	((1+4)*(3+2)+5*6)

Bayesian Inference	0.56	0.44	Dempster Shafer	0.56	0.75	Evidence Point	0.58	0.43

Legal Consultation System

Date : 02/07/1999

Case # 8

Page : 1

Problem Specification

A company C and an Employer E has Signed a contract stating that the employee E shouldn't work in the same area for next 3 years within/outside Lebanon, in case if E resigns from C. After signing this contract with C, E started working with another company D in the same field.
C went to the court against E for Breaking the contract.

Query From X

THE BANNING OF THE WORKER FROM WORKING IN A RIVALLING COMPANY.

Evidences

Number	Type	Explanation	Positive	Negative
1	For	C is appealing to the court that E may release certain confidential issues to D during its survey.	0.90	0.50
2	For	C is appealing to the court that E is redirecting some of its customers to D.	0.75	0.65
3	Against	E is appealing to the company that company D doesn't exists, still only a survey is conducting for its establishing.	0.65	0.70
4	Against	E is working and producing the products in C. though E is working with D, so far there is no production in D.	0.87	0.55
5	Against	Experts reports says that D has not yet produced any product, it is still a location survey.	0.76	0.88
6	Against	E is appealing to the court that he was forced to sign with C due to some unavoidable circumstances.	0.88	0.44

Equations

Number	Explanation
1	1+2+3+4+5+6

Bayesian Inference	0.60	0.40	**Dempster Shafer**	0.60	0.91	**Evidence Point**	0.61	0.40

Legal Consultation System

Date : 02/07/1999

Case # 9

Page : 1

Problem Specification

A husband H work nature wasn't included in the law of Social Security (SS), whereas his wife W work nature is included. They have a few kids as part of their family. As for the SS law a women can't take money on behalf of her husband and kids.
Since the SS in not paying any money to wife and children, the wife W proceeded to the court against the law of SS.

Query From X

The wife W proceeded to the court against the law of SS in order to pay her what she deserves.

Evidences

Number	Type	Explanation	Positive	Negative
1	For	Since the children are minor, can stay only with the mother, not with husband. Thus, W appeals to the court that SS should pay the money through medical insurance and motherhood.	0.40	0.80
2	For	Expert study reveals that the work nature in the law of SS is not clear. It reveals that there is no provision given for the male employees whose work nature is not included in the law	0.90	0.40
3	For	W is paying the installment money to the SS, like any other employee(male). Thus, she declares that whether she pays the money or her husband pay the money doesn't make any	0.50	0.80
4	Against	As for the law of SS if the husband work nature is not included in the SS law, he is not authorized to cover his wife and children, being he himself not covered.	0.76	0.35
5	Against	The social security is arguing that there is no written document stating that her husband H work nature is not included in the SS. Thus, there could be provisions that both wife W and	0.67	0.44

Equations

Number	Explanation
1	((1+4)*(2+5)*3)

Bayesian Inference	0.66	0.34	Dempster Shafer	0.66	0.98	Evidence Point	0.66	0.34

Legal Consultation System

Case # 10

Date : 02/07/1999

Page : 1

Problem Specification

In a family, father F has killed his daughter D for producing an illegal child C. in this case, father F has given enough evidence to the court about her daughters illegal mating with he boyfriend and thus he killed her and hand over to the police. He has done this in order to keep up his family prestige.

Query From X

THE DEATH PENATY

Evidences

Number	Type	Explanation	Positive	Negative
1	For	The father F has evidentially admitted that he has killed his daughter.	0.75	0.35
2	For	Right from the beginning. The father F has a wrong opinion about D's boyfriend.	0.88	0.77
3	For	The boyfriend doesn't have any job at hand. Though H repeated request to D to wait till he get a job, D has not given her ear.	0.44	0.77
4	Against	It was reported from the friend of D that D did such a work based on the assurance from he r boyfriend that he will marry her.	0.88	0.33
5	Against	There is another version saying that the boyfriend has threatened D that he will suicide i f she doesn't allow him the materialistic pleasure.	0.80	0.22

Equations

Number	Explanation								
1	1*(2+3)+(4*5)								
	Bayesian Inference	0.69	0.31	**Dempster Shafer**	0.69	0.92	**Evidence Point**	0.71	0.29
2	(1+2)*(3+4)*5								
	Bayesian Inference	0.70	0.30	**Dempster Shafer**	0.70	0.85	**Evidence Point**	0.73	0.28
3	(5*4)+(3*2)*1								
	Bayesian Inference	0.73	0.27	**Dempster Shafer**	0.73	0.79	**Evidence Point**	0.78	0.23

Installation of the Software Tool

STEP 0: CHECK THE WINDOWS DIRECTORY NAME (e.g. WIN95 OR WINDOWS)
------ - IT SHOULD CONTAIN A SUB-DIRECTORY CALLED "DESKTOP"

Step 1: PUT DISKETTE # 1 IN THE DISKETTE DRIVE (a:)

Step 2: EXIT TO DOS

STEP 3: GO TO THE ROOT DIRECTORY (C:\)

STEP 4: TYPE "RESTORE A: C:/S"

STEP 5: TYPE "A:\INSTALL.BAT (WIN95 OR WINDOWS)"
------ REMARKS: - YOU SHOULD WRITE ONE DIRECTORY ONLY
(ACCORDING TO THE RESULT OF STEP 0)
- DON'T INCLUDE THE BRACKETS
- DISKETTE # 2 SHOULD BE IN THE DISKETTE DRIVE