Chapter 1

Introduction & Statement of the Problem

In the following sections, a brief introduction and motivation for undertaking the present study is discussed, the problem statement for the thesis and organization of report is also included.

Introduction and Motivation

Artificial intelligence (AI) has been area of active research for many decades, with a central theme of producing machines which have intelligence. For example the mathematician Alan Turing was involved in the development of Manchester mark I computer and in the question how to judge the intelligence of a machine. His speculation on the latter led to which is now called the “Turing Test”. Knowledge-based system is research sub-domain of Artificial Intelligence (AI). The knowledge-based systems have found their way into many application domains such as medicine, law, geographical mappings to name a few. The example application domains of knowledge-based systems / Expert System Applications (1980-Present) are legal support system, prediction and forecasting, power system planning, railway route planning, financial accounting, computer aided design, equipment configuration, crisis management, Other scheduling applications, scheduling railway crew assignment, planning and design in manufacturing etc.

The terms “Expert System” or “intelligent knowledge-based systems” are also used to express the same concept of knowledge-based systems. The expert system receives facts from the user and provides expertise in return. The main components of the expert system (invisible from the outside) are the knowledge-base, the inference engine, explanation system and user interface. The inference engine may infer or draw conclusions (solutions) from the knowledge-base, based on the ‘facts’ supplied by the user. The facts and rule-base interact with the expert system bi-directionally [1].
The expert system was historically, the first term coined. The earliest AI systems were intended as general problem solvers. Later on the emphasis was shifted to research intended to mimic the performance of a human expert in a narrow, well defined domain. Thus successful outcome of the research were first expert systems, such as DENDRAL (an expert system for molecular chemistry) and MYCIN (an expert system for which diagnoses microbial infections and recommended appropriate medical treatment), ANAPRON, EMYCIN, HYPO, CABAERT and many others.

Law and Artificial Intelligence seem to be two disciplines very far apart. One can be traced back thousands of years and the other not past 1950. Nevertheless both disciplines have a lot to learn from each other. The legal domain is very well suited for the application of AI. In contrast to other disciplines like medicine, law is not a natural but a normative science. Therefore reasoning is explicit and in most cases exists in written form. Furthermore law (especially civil law) is mostly adversarial. For this reason we do not only have to deal with the arguments that lead to a certain decision but also with the counter arguments. Other domains do not require such a complex reasoning.

Artificial intelligence and Law (AI and Law) is a sub-domain of artificial intelligence (AI) mainly concerned with applications of AI to legal informatics problems. The main research concern of the field is to contribute in the use of latest technological tools and techniques available to the larger enterprise of AI, there by resulting in automation of the legal informatics domain. The domain of AI & Law is in existence since L. Thorne McCarty's Harvard Law Review article in 1976, "Reflections on Taxman: An Experiment in Artificial Intelligence and Legal Reasoning" [2].

The field of artificial intelligence and law is born as an application of the larger discipline of artificial intelligence. Artificial intelligence, from its very beginning, has favoured the legal domain for its applications. The research was particularly inspired by logic fitting which blended in old philosophical tradition to ground legal reasoning in logical foundations. The idea is that legal rules and reasoning are integrated in a system (Knowledge-based systems) which would help human beings make decisions. This vision is not without problems as it requires models of law that are computable & reduce legal activities so as to rules, to formalize law.

General research in AI can be categorized broadly in six different areas; they are: Knowledge-based systems, Natural language understanding, Pattern recognition, intelligent
computer-assisted learning, Speech recognition, Model of human cognition. The overall structure is represented in onion model shown in figure 1.1[3].

![Figure 1.1: Six Areas of AI Research](image)

Knowledge-based systems

Knowledge-based systems (KBS) are computer based systems which support, or perform automatically, cognitive tasks in a narrow problem domain which are usually only carried out by human experts. KBS are different from traditional computer applications in multiple aspects. First, a KBS represents knowledge explicitly as a set of declarations which is referred to as the knowledge-base. Traditional applications implement knowledge implicitly as procedures and therefore can only apply it in a predetermined way. Furthermore they are hard to maintain as an update of the information is reflected by the modification of a procedure. A KBS provides problem solving capability which is performed by an inferential engine. It is also able to justify its behaviour by expressing the inferential steps that have led to a certain conclusion [4]. The knowledge-based systems are classified mainly in seven types, they are: expert systems, neural networks, case-based reasoning, genetic algorithms, intelligent agents, data mining and intelligent tutoring systems.
Natural language understanding

The problem of human-computer communication (particularly in the direction from human to computers) has existed ever since computers were invented. The standard practice for any computer language to claim that it “uses English-like commands”. A computer should be able to use the restricted version of the human language, and this seems to have been a general goal to most people in computer domain. Till now, the human has always had to adapt (to a greater or less extent) to the needs of computer. AI languages such as LISP and PROLOG have provided a useful vehicle for machine representation of sentences in English or similar natural languages and much progress towards natural language interfaces have been made [5].

Pattern recognition

The natural language could be considered as form of pattern recognition, but it is a far more general activity of visual recognition of patterns, sometimes called “machine vision”. This is important for robotics, search engines and many more practical applications of today. The algorithms of pattern recognition generally aim to provide a reasonable answer for all possible inputs and to do "fuzzy" matching of inputs. This is opposed to pattern matching algorithms, which look for exact matches in the input with pre-existing patterns. A regular expression matching, an example of a pattern-matching algorithm looks for patterns of a given type in textual data and is included in the search capabilities of many text editors and word processors. In contrast to pattern recognition, pattern matching is generally not considered a type of machine learning, although pattern-matching algorithms (especially with fairly general, carefully tailored patterns) can sometimes succeed in providing similar-quality output of the level provided by pattern-recognition algorithms [6].

Intelligent computer-assisted learning

The domain of Computer-assisted instruction (CAI), is based on extensive application of artificial-intelligence (AI) techniques, is feasible, and demonstrates some of its major capabilities. CAI system is based on the utilization of an information network of facts, concepts, and procedures; it can generate text, questions, and corresponding answers. The difference between a Computer assisted learning (CAL) and Intelligent Computer assisted
learning (ICAL) is that in CAL, an automated version of a programmed learning text, is used although with a potential for much better human interface, ICAL is intended to be adaptive. The alternative phrase “intelligent tutoring systems” perhaps conveys a little more to favour of ICAL systems, even if it gives a misleading impression of their abilities. One particular advantage of ICAL is that as a system it is actually capable of performing a certain task as well as just “teaching” [7].

Speech recognition

The field of Speech recognition adds another dimension to the problem of natural language understanding. The problems include the background noise, changes in pronunciation according to whether words are spoken in isolation or in sentence and in variations of accent between individuals. The biggest problem is that everyday speech is not grammatical, as attempts to transcribe an interview or conversation often reveal. In domain of Computer Science, speech recognition is the translation of spoken words into text. It is also recognized as "automatic speech recognition", "ASR", "computer speech recognition", "speech to text", or just "STT". Speech recognition (SR) is technology that can translate spoken words into text. Some SR systems use "training" where an individual speaker reads sections of text into the SR system. The systems analyse the person's specific voice and use it to fine tune the recognition of that person's speech, resulting in more accurate transcription. These systems that do not use training are called "Speaker Independent" systems. The systems that use training are called "Speaker Dependent" systems. Speech recognition applications include voice user interfaces such as voice dialling, call routing, domestic appliance control, search, simple data entry, speech-to-text processing (e.g., word processors or emails), and aircraft (Direct Voice Input). The phrase voice recognition refers to finding the identity of "who" is speaking, rather than what they are saying. Recognizing the speaker can simplify the task of translating speech in systems that have been trained on specific person's voices or it can be used to authenticate or verify the identity of a speaker as part of a security process [8].

Models of human cognition

A cognitive model is an approximation to animal cognitive processes (predominantly human) for the purposes of comprehension and prediction. Cognitive models can be developed within or without a cognitive architecture, though the two are not always easily
distinguishable. In contrast to cognitive architectures, cognitive models tend to be focused on a single cognitive phenomenon or process (e.g., list learning), how two or more processes interact (e.g., visual search and decision making), or to make behavioral predictions for a specific task or tool (e.g., how instituting a new software package will affect productivity). Cognitive architectures tend to be focused on the structural properties of the modeled system, and help constrain the development of cognitive models within the architecture. Model development, like wise helps to inform limitations and shortcomings of the architecture. Some of the most popular architectures for cognitive modeling include ACT-R and Soar [9].

**AI & Law**

The Artificial Intelligence and Law (AI and Law) domain is attractive for AI research for several reasons. First, the law has a tradition of examining its own reasoning process. Second, much legal knowledge is readily accessible and relatively well structured, codified and indexed. The Lawyers' today are tech savvy and have interest in AI techniques and software. Lawyers’ offices use tools that gather, filter, and/or structure legal arguments in a cost-effective manner. The earlier works in the field such as LEXIS and WESTLAW are essentially keyword based [10].

In the domain of AI to law the researchers have encountered interesting and difficult problems of both the fields. The domain of AI and law is much more than an applications area. The field touches upon issues at the very heart of AI reasoning, representation, and learning. Topics like negotiation, decision-making, e-commerce, natural language, information retrieval, extraction and data mining AI and Law is a rich source of problems and motivation for the interested researchers. Hajime Yoshino, in 1994 had stated that “Legal information is becoming more enormous and complicated as laws, precedents and theories have accumulated. Nevertheless the application of scientific methods to legal field has not always made progress in comparison with other fields. On the other hand with advances in Artificial Intelligence research, the field of law has become the most favourable field of applied research” [11]. There are works in past about tackling legal arguments which have not only created programs that produce legal arguments but also led to insights and advances in the logic of argumentation. The application oriented works have often provided insights into the limitations of existing techniques. There is always collaboration, not only between Law and AI, but also between AI & AI [12].
Work on Artificial intelligence and law has been particularly fruitful in the last decade. Besides providing advanced computer applications for the legal domain such as knowledge-based systems and intelligent information retrieval, research on AI and law has developed innovative interdisciplinary models for understanding legal systems and legal reasoning, which are highly significant for philosophy of law and legal theory. Today there is a strong need for not only integrating research in AI and law within legal theory, but also to encompass the different branches of research in AI and law [13].

Simon Kendal and Malcolm Creen, state that “Knowledge Engineering is the process of developing knowledge-based systems (KBS) in any field, whether it is in public or private sector, in commerce, law or in industry. Given a knowledge-intensive task normally performed by knowledgeable human problem solvers, the knowledge engineer attempts to model the domain knowledge and problem solving techniques of the human problem solver, and uses this model to implement a KBS capable of performing the knowledge-intensive task. However it should be clear that data, information and knowledge are not static things in themselves but are stages in the process of using data and transforming it into knowledge” [14].

The field of Artificial Intelligence and Law has matured considerably and its achievements are viewed comprehensively. The approaches to the development of Legal Knowledge-Based Systems (LKBS) such as the use of rule-based Systems, case-based systems, or logics have obtained theoretical and practical results. The central premise, of any development process of LKBS should be centred on the elaboration of explicit models of law, in the theoretical foundations of AI and law and knowledge representation in particular [15].

Michael Negnevitsky in the book “Artificial Intelligence: A guide to Intelligent Systems” says that “the development of expert system created knowledge engineering: the process of building intelligent systems. Today it deals not only with expert systems but also with neural networks and fuzzy logic. Knowledge engineering is still an art rather than engineering, but attempts has already been made to extract rules automatically from numerical data through neural network technology” [16]. The legal expert’s role is gradually shifting from decision making to setting uniform decision making policies for the KBS, i.e. producing (decision making) knowledge instead of decisions. Considering the discussion and significance of field of Artificial Intelligence and Law, the researcher is motivated to take up research work in this field.
The motivation of this study is significant as it will provide the common man with a representation of the legal world in a form, which he/she can understand. The Transfer of Property Act, 1882 is the most important statute that governs all kinds of property transactions taking place within the boundaries of the Indian Territory. English law principles have made quite a significant contribution in the inception of this statute.

Thus the major area of importance in the act is the governance of various forms of ownership, title, transfer and alienation of property. Property, in the context of this act includes “Immovable” or common/ fixed property as well as “Movable” or personally possessed property. The goal of study is not to replace a human advocate, but to provide a tool to help a common man who intends to purchase an immovable property. This system can verify the prima facie title to the property and absence of any encumbrances thereon. Once he is satisfied with these facts, he can approach the advocate for final confirmations. This can save a lot of time and money. Hence, it is felt that this research study will act as tool to a common man and can help a human legal expert for making better & productive decision making. A tutor is also developed for common man, to help him, in understanding the finer details of the transfer of property act and to know about the buying and selling process.

Statement of the problem

The problem statement for the present work can be stated as follows:

“The overall objective of the thesis is to develop and implement a Hybrid/composite model of legal reasoning for transfer of property act of the Indian Legal domain called TPA-EXPERT (Transfer of Property act – Expert Systems). This problem can be divided into following sub problems”.

- To develop a prototype model
- To develop rule-based reasoning system.
- To develop case-based reasoning system
- To develop Hybrid reasoning System.
- To develop tutoring model.
- To evaluate the performance of proposed system and relate the performance through the case study.
Organization of the Thesis

The body of this thesis is divided into Seven Chapters: The details are as below.

CHAPTER 1: INTRODUCTION AND STATEMENT OF THE PROBLEM

Introduces domain of AI and Law and motivation of research problem is discussed. This chapter also gives statement of problem of this thesis. Finally chapter states the organization of this thesis report.

CHAPTER 2: REVIEW & GENERAL CONSIDERATIONS

Discusses knowledge-based system and its development and also give the historical review of legal knowledge-based systems. It also gives brief overview of rule-based and case-based reasoning. The research gaps are identified and chapter finally discusses about the transfer of property act.

CHAPTER 3: DEVELOPMENT OF PROTOTYPE

This chapter discusses about designing of an expert system prototype in general. The expert system shell used in the development of prototype is discussed. Finally the Steps in the implementation of prototype are listed and results and observations are highlighted.

CHAPTER 4: DESIGN & IMPLEMENTATION OF RULE BASED ANS CASED BASED EXPERT SYSTEM

Technology used for implementation is discussed at length. The rule-based reasoning implementation and case-based reasoning implementation is discussed in detail. The implementation of hybrid/composite model is discussed finally.

CHAPTER 5: OBSERVATION PERFORMANCE AND EVALUATION
Observation by the evaluators of system / knowledge-based system is listed and later the performance evaluation steps are discussed. Sample cases used for evaluation are discussed at length. The chapter ends with a conclusion.

CHAPTER 6: DEVELOPMENT OF A TUTORING SYSTEM

This chapter discusses the introduction to tutor for transfer of property act. The development and Implementation process of the web-based tutor is discussed. The chapter highlights about the tutor's importance to common man. Finally concludes with a case study of Information Computer Technology (ICT) in legal domain in Indian courts.

CHAPTER 7: CONCLUSION & SCOPE FOR FUTURE WORK

The chapter discusses conclusion of the thesis work with specific findings. Finally the Scope for future work is presented.