International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868
Foundation of Computer Science FCS, New York, USA
Volume 1– No.7, March 2012 – www.ijais.org

Web based Fuzzy Expert System and Its Applications – a Survey

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ABSTRACT
The extensive use of the Internet for data collection, information and knowledge has become a popular activity. Expert system, which provide consultation along with reasoning are more beneficial when made available on the World Wide Web. Expert systems are basically of two types (i) Conventional and (ii) Fuzzy logic based systems. Conventional expert systems are mainly symbolic reasoning engines and very complex in nature while fuzzy expert systems are oriented towards numerical processing which handles even uncertain or imprecise information. The paper presents a comprehensive literature review of recent work in the area of expert systems; precisely web based fuzzy expert systems over the last two decades. This paper discusses application areas of web based fuzzy expert system extensively.

General Terms
Artificial Intelligence, Expert System

Keywords
Web based Expert System, Fuzzy Logic, Symbolic Reasoning, Conventional Expert Systems.

1. INTRODUCTION
Artificial Intelligence is a computer science domain involving the study and development of computer systems that demonstrate some form of intelligence: systems that learn new concepts and tasks, systems that can reason and draw useful conclusions about the world around us, systems that can understand a natural language or perceive and comprehend a visual scene, and systems that perform other types of feats that require human types of intelligence. Irrefutably the AI systems address thought processing and reasoning or the behaviour. Developing functional computer systems that are proficient in executing tasks which require high levels of intelligence is the main objective of AI. It is not essential for the programs emulate human senses and thought processes. The programs may exceed the human abilities if the tasks are performed in a well-organized and particular manner. The important thing is that the systems should be capable of performing intelligent tasks effectively and efficiently. A better understanding of AI can be achieved by looking at the component areas of study.

1.1 Task Domains of AI
AI can be applied for the problem solving in wide variety of task domains as in [5]. For instance, AI can be used in analyzing physical objects and their relationships as well as reasoning about actions and their effects. Such problems can be categorized as commonsense reasoning. Perceptual tasks which include vision and speech are difficult because they involve analog signals, the signals are typically very noisy and usually a large number of things must be perceived at once. AI can also be used in engineering design, scientific discovery, medical diagnosis and financial planning. Such specialized tasks require carefully acquired expertise. The Figure 1 depicts some of the task domains of artificial intelligence. This paper mainly focuses on the expert tasks of artificial intelligence. The second section describes the concept of expert systems in details. The third section denotes the application areas of web based fuzzy expert system. The fourth and final section gives the conclusion of this paper.

2. EXPERT SYSTEMS
The problem areas where AI is now flourishing most as a practical discipline are primarily the domains that require specialized expertise without the assistance of commonsense knowledge. A large number of programs called expert systems are utilized in day-to-day operation throughout almost all the areas – may it be industry or government. Each of these systems attempts to solve part, or whole of the practical, significant problem that previously required scarce human expertise. It has been proved effectively that the expert systems can solve problems in various domains where human expertise is required. Few such domains are law, chemistry, biology, engineering, manufacturing, aerospace, military operations, finance, banking, meteorology, geology and geophysics. An expert system can be defined as a set of programs that use the human expertise as knowledge which is stored in an encoded form and may manipulate it to solve problems in a specialized domain. An expert system's knowledge must be coded and stored in the form which the system can use in its reasoning processes performed by the inference engine. The main sources of expert knowledge are the experts themselves and other sources - such as texts, journals, articles and databases. To obtain this type of knowledge, a lot of training and experience in specialized is required. After obtaining the expert knowledge, it should be encoded and stored in the knowledge base. Thereafter, it should be tested and enhanced continuously throughout the system life.

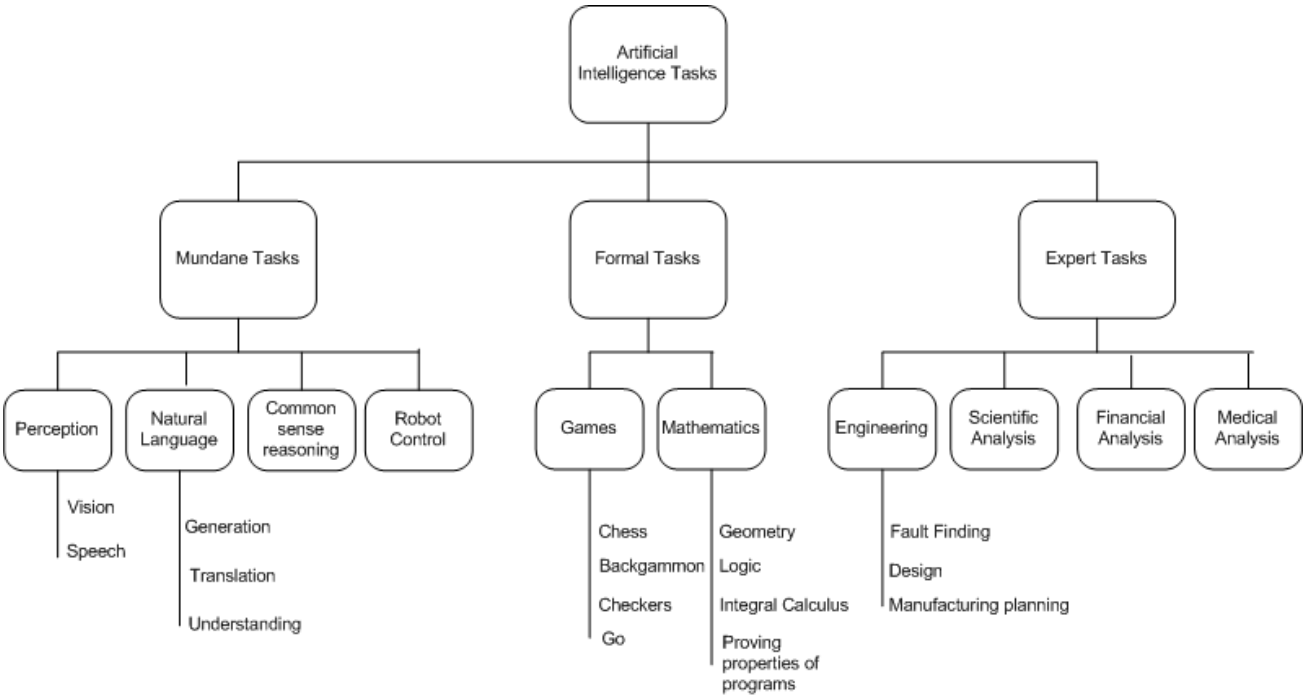

Figure 1: Some Task Domains of AI

2.1 Fuzzy Expert System

A fuzzy expert system is a category of artificial intelligence that is composed of set of membership functions and rules (fuzzy logic instead of Boolean logic) that are used to analyze the data. The rules in a fuzzy expert system are generally delineated as:

if m is low and n is high then p = medium

where m and n are input variables (variables with known data values), p is an output variable (a variable whose value is to be calculated), low is a membership function (fuzzy subset) defined on m, high is a membership function defined on n, and medium is a membership function defined on p. The part of the rule between the "if" and "then" is the rule's "premise" (or antecedent), that describes to what degree the rule is applicable. A typical fuzzy expert system has more than one rule – collectively known as rule-base (or knowledge-base). The part of the rule following the "then" is the rule's "conclusion" (or consequent), that assigns a membership function to each of one or more output variables. Fuzzy expert systems may have more than one conclusion per rule. Unlike conventional expert system, the fuzzy expert systems are centered towards numerical processing

2.2 Web-based Fuzzy Expert System

With the innovative trends in the web technology, its use for information sharing and model analysis is getting more convenient and cost-effective. For instance, internet is being used for data collection (through electronic surveys), analysis and as publishing tool. The fusion of web technology and fuzzy expert system can render thorough information and consultation in interactive and user-friendly approach. More or less, it is open to use by all (unless there is restriction for authorization), even by geographically separated users.

3. APPLICATIONS OF WEB-BASED FUZZY EXPERT SYSTEM

Reference [9] shows a tool, ClonEx, which integrates web and expert system technologies, allowing internet accessible expert systems for multiple problem domains. The tool provides the capability to develop applications to interact with other expert applications for problem solution. It is based in quick application development without technical knowledge, using the expert mental model, and optimizing the components for internet access and is compatible with mobile devices. Moreover, ClonEx is a domain independent tool: it can be used for industrial applications, e-commerce and so on. Since the knowledge acquisition tool dispossesses the web interface, the tool can be enhanced in future for collaborative web interface for expert communities.

There are many uncertain risk factors for the heart disease, which makes it difficult for the physicians to analyze and diagnose patient. A fuzzy expert system has been developed and described in [3] to deal with patient diagnosis. The system can be beneficial to identify the presence of heart disease.

Reference [13] shows that the author has developed Diabetes Diagnosis System, a medical diagnosing system that can

diagnose the diabetes disease. The system is implemented using Fuzzy Expert system and Sungeno's inference technique. Based on the user answers to the questionnaire of diabetes risk factors and symptoms, the system generates an estimated result giving some recommendations to prevent or lower the risk, which may in turn be interconnected with the user life style and medication.

The authors in [10] have presented a paper designing a fuzzy rule-based expert system to alleviate asthma, a chronic lung disorder by diagnosing it at initial stages. The knowledge representation is based on patient perception and is organized into modular structure. The knowledge was presented as production rules and Meta rules were used to present relevant questions for patients in the user interface. In context with the knowledge representation, the fuzzy inference engine was designed involving the modules of symptoms. The final result of every system is de-fuzzified in order to provide the assessment of the possibility of asthma for the patient, considering verification and validation criteria throughout the life-cycle.

Reference [21] is a paper that explores the potential of artificial intelligence techniques particularly for web-based medical applications. In addition, a model for web-based medical diagnosis and prediction is proposed with the main features as medical diagnosis and prediction using artificial intelligence techniques will make the consultation to be more interactive. As clinical decision making inherently requires reasoning under uncertainty, expert systems as in [16] and fuzzy logic as in [12] will be suitable techniques for dealing with partial evidence and with uncertainty regarding the effects of proposed interventions. For the prediction tasks, Neural Networks have been proven to produce better results compared to other techniques (such as statistics) as in [16], [11]. Such techniques are worth to explore and integrate in the system for medical diagnosis and prediction. The authors also propose that the Internet would be used not only to provide tele-healthcare to people but the centralized databases over the WWW may also aid in knowledge and expertise sharing. Also, researchers in medical applications can use the data for investigating new medical solution and treatment [19], [20].

The International Statistical Classification of Diseases and Related Health Problems (ICD) provides codes to classify diseases and a wide variety of signs, symptoms, abnormal findings, complaints, social circumstances and external causes of injury or disease. Authors in [14] have developed an ICD10 based Medical Expert System that provides advice, information and recommendation to the physician using fuzzy temporal logic. The paper is more focused on the use of ICD code, temporal rule into management and fuzzy logic based decision making. The system provides the possible disease conditions based on the modifications in Elders algorithm using the fuzzy severity scale for symptoms and rules on diseases. The system can be enhanced by narrowing the domain to a particular part of human body to get accuracy in decision making.

In [7], a paper has been presented on a web-based intelligent education system to help students and tutors in the context of an AI course. The authors developed a rule-based expert system for student evaluation furnishing valuable information to the tutor. The key aspects of the system were knowledge management and student evaluation. The knowledge management aspect referred to test questions construction and management and the student evaluation was focused to the evaluation of the knowledge level of a student with regards to the concepts that were taught.

Expert system have been used in the field Applied Mechanics and Materials especially aeronautics. Reference [8] shows a paper proposing the design and implementation of a web-based fuzzy expert system focused on the monitoring and fuzzy fault diagnosis of aero-engine. The paper presents the detail process of system implementation and practical applications to illustrate and prove the system's applicability. The results of the system prove the feasibility and reliability of the framework. Also, the results aid to integrate the aero-engine diagnosis knowledge and improve the diagnosis efficiency and decrease the diagnosis cost.

Enterprise Information Systems (EIS) are collections of hardware, software, data, people and procedures that work together to manage organizational information resources, to enhance decision making and strategic advantage. Determination of value of investment in such systems is the one of the main issues in acquisition and utilization of EIS. A framework has been presented through [6] to propose the adoption of a hybrid intelligent technique (fuzzy-expert system) in carrying out a cost benefit analysis of EIS investment. The study takes high cognizance of intangible variables and vagueness / imprecision in human group decision making that requires a good level of consensus. The framework identifies a comprehensive list of intangible costs and benefits associated with acquisition, utilization and maintenance of EIS, recognizes the distortion towards qualitative variables, and suggests the qualification of the same using fuzzy linguistic variables. This provides an evidence of use of fuzzy expert system for organizational decision making.

Fuzzy theory can be of great assistance to solve challenges in agricultural systems, which occur due to the uncertainties and dynamic interaction between farmer decision and agricultural events. A web based fuzzy expert system is an expert system that uses fuzzy logic instead of Boolean logic on the internet. A prototype web based fuzzy expert system in [15] has been developed for controlling the Groundnut insect pests. The system accepts the observable symptoms to identify the actual inset pest and recommends the appropriate control measures.

A web-based expert system has been proposed in [18] for diagnosis of plant macro and micronutrients disorders in crops, considering diagnosis and remedies as critical components of crop productivity. The system is developed using virtual diagnosis framework to aid identification and solution to nutrient deficiency in crops and disorders in various parts of a plant. The system is focused in mineral aspects and would contribute to improve the quality and productivity in agricultural sector research. Development of adaptable diagnosis models for nutritional deficiency symptoms in plants confining the application domain can be done in future.

Web based applications can be very beneficial in case of real-time applications. Reference [4] shows that a prototype web-based flood forecasting system has been developed to perform on-line analysis for model-based flood forecasting by rendering hydrological models. The system also makes data available to stakeholders and experts involved, eventually offering an efficient medium for transferring and sharing information, knowledge and experiences among them.

A web-based expert system for vehicle registration fee computation has been implemented in [2]. The paper illustrates that the rule-base organization and rule tracing is less complicated by following the business driven methodology. Engineering skills like ability to translate business documentation into rules and to reduce them to their atomic state and communication skills with business and technical personnel are required for development of such a system. The paper also demonstrates the need of tools and development environments and the practicing methods for the system. The system can be enriched by focusing on the complete vehicle registration procedure.

Authors in [17] have presented a web-based Software Engineering Measurement Expert System Tool (SEMEST). SEMEST has been designed as a multi-layer web-based expert system with a rule-based inference engine and a knowledge-base to support goal, process and category oriented measurement and analysis in software engineering. It also performs measurement analysis and benchmarking for software engineering projects. SEMEST provides multiple users for software measurement services via the Internet and has enabled the software industry to practice quantitative software engineering in a consistent and efficient way. The further work would be to adapt the expert system for a wide range of application domain and business contexts.

In [1] a web based fuzzy expert system has been proposed to present tourism information focusing on arts, culture, recreational and hospitality centers, hotels, natural and artificial objects that are available in a community, peculiar to the Nigerian communities.

4. CONCLUSIONS

The innovative trend of web technology and increasing demand of fuzzy logic has created birth of web based fuzzy expert systems. The essence of an expert system is to distribute knowledge into the hands of any non-expert personnel. This paper described all taxonomies related to expert system so any novice user can also understand the concept of expert system very effectively. The fusion of web technology and fuzzy expert system can render thorough information and consultation in interactive and user-friendly approach and that point is effectively described in this paper by means of web based fuzzy expert systems. All important applications areas of web based fuzzy expert systems are clearly described by paper with the appropriate reference so any researcher can get detail information of specific application area of his interest for further study. Thus this paper is very useful for novice or expert personnel to get detail about relevant topic of expert system.

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