Uncertainty Classification of Expert Systems - A Rough Set Approach

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ABSTRACT

In this paper, we discussed about the un certainity classifications of the Expert Systems using a Rough Set Approach. It is a Softcomputing technique using this we classified the types of Expert Systems. An expert system has a unique structure, different from traditional programs. It is divided into two parts, one fixed, independent of the expert system: the inference engine, and one variable: the knowledge base. To run an expert system, the engine reasons about the knowledge base like a human. In the 80's a third part appeared: a dialog interface to communicate with users. This ability to conduct a conversation with users was later called "conversational". Rough set theory is a technique deals with uncertainty.

Key Words

Expert System, Rough Sets, Lower and Upper approximations, Uncertainity

1. INTRODUCTION

Expert systems are designed to solve complex problems by reasoning about knowledge, like an expert, and not by following the procedure of a developer as is the case in conventional programming. The first expert systems were created in the 1970s and then proliferated in the 1980s. [3, 4, 8, 19]. Expert systems were among the first truly successful forms of AI software.

2. EXPERT SYSTEMS

Inference engine + Knowledge = Expert system

Expert systems are computer programs that are derived from a branch of computer science research called Artificial Intelligence (AI) [7, 17, 22]. AI's scientific goal is to understand intelligence by building computer programs that exhibit intelligent behavior. It is concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented inside the machine. AI programs that achieve expert-level competence in solving problems in task areas by bringing to bear a body of knowledge about specific tasks are called knowledge-based or expert systems. . The area of human intellectual endeavor to be captured in an expert system is called the task domain. Task refers to some goal-oriented, problem-solving activity. Domain refers to the area within which the task is being performed. Typical tasks are diagnosis, planning, scheduling, configuration and design. Expert system have a number of major system components and interface with individuals who interact with the system in various roles. These are illustrated below in fig. 1.

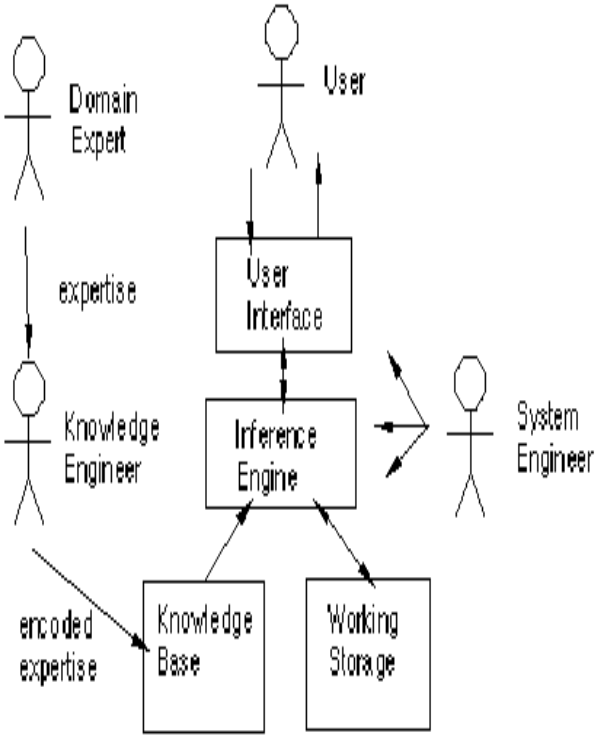

fig: (1) Component of expert systems

Expert systems are designed to facilitate tasks in the fields of accounting, medicine, process control, financial service, production, human resources, among others. Typically, the problem area is complex enough that a more simple traditional algorithm cannot provide a proper solution. The foundation of a successful expert system depends on a series of technical procedures and development that may be designed by technicians and related experts. As such, expert systems do not typically provide a definitive answer, but provide probabilistic recommendations [12].

Expert systems provide an advantage when dealing with uncertainty as compared to decision trees. With decision trees, all the facts must be known to arrive at an outcome. Probability theory is devoted to dealing with theories of uncertainty.

There are many theories of probability – each with advantages and disadvantages.

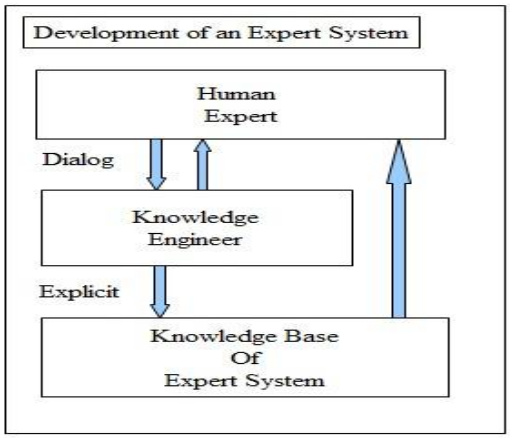

fig: (2) Development of an Expert system

3. ROUGH SETS

3.1 Definitions and Notations

Rough set theory is a technique deals with uncertainty. In this section we reintroduce some basic notations of Rough set theory [1, 2, 13, 18].

- U $(\neq \phi)$ is the universe and be a finite set of objects.
- R is the indiscernibility relation, or equivalence relation over U .
- Indiscernibility is the inability to distinguish between two or more values.
- A= (U, R) an ordered pair is called an approximation space.
- $[x]_R$ denotes the equivalence class or R containing an element $x \in U$.
- For any subset $P(\neq \phi) \subseteq \Re$, the intersection of all equivalence relations in P is denoted by $IND(P)$ and is called the *indiscernibility relation over* P .
- Elementary sets in A – the equivalence classes of R.
- Definable set in A–Any finite union of elementary sets in A.

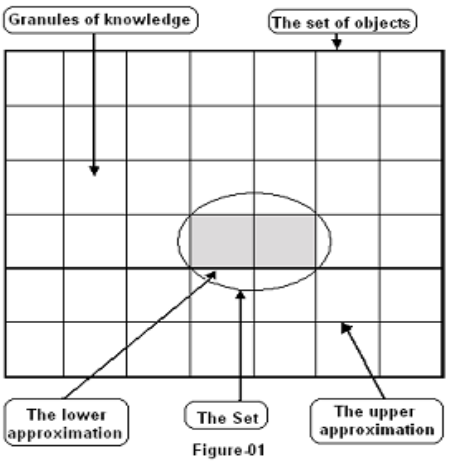

fig: (3) Rough Set Approach

- For any $X \subseteq U$ and an equivalence relation $R \in IND(K)$, there associate two subsets:

- **Lower approximation** of X in A is the set $\underline{R}X = \bigcup\{Y \in U / R : Y \subseteq X\}$
  The elements of $\underline{R}X$ are those elements of U which can be certainly classified as elements of X with the knowledge of R .

- **Upper approximation** of X in A is the set $\bar{R}X = \bigcup\{Y \in U / R : Y \bigcap X \neq \phi\}$
  $\bar{R}X$ is the set of elements of X which can be possibly classified as elements of X employing knowledge of R .

- The boundary of X is, $\bar{R}X - \underline{R}X$.
  The elements of $\underline{R}X$ are those elements of *U*, which can certainly be classified as elements of X, and the elements of $\bar{R}X$ are those elements of U, which can possibly be classified as elements of X, employing knowledge of *R.*

- The borderline region is the undecidable area of the universe.

We say that *X* is *rough* with respect to *R* if and only if $\underline{R}X \neq \bar{R}X$, equivalently $BN_R(X) \neq \phi$. *X* is said to be R-*definable* if and only if $\underline{R}X = \bar{R}X$, or $BN_R(X) = \phi$.

3.2 Application of Rough Set

We briefly highlight few applications of RST [5, 9, 14]. We again feel discussing on various applications will increase the length of paper.

a. Representation of uncertain or imprecise knowledge.
b. Empirical learning and knowledge acquisition from experience.
c. Knowledge analysis.
d. Analysis of conflicts.
e. Evaluation of the quality of the available information with respect to its consistency and the presence or absence of repetitive data patterns.
f. Identification and evaluation of data dependencies.
g. Approximate pattern classification.
h. Reasoning with uncertainty.
i. Information-preserving data reduction.

3.3 Equivalence relations of Rough Sets and Classification of Expert Systems

As discussed through the definitions and notations, the rough set philosophy is based upon the notion of equivalence relations. This describes the partitions made of classes of indiscernible objects with common lower and upper approximations. Incomplete information can be analyzed by means of classical approximation spaces. Such spaces consist of a universe and an indiscernibility relation, which is always equivalence relation. Knowledge granules determined by these spaces are equivalence classes.

The equivalence relation divides the universe *U* into pair-wise disjoint subsets, called equivalence classes of objects. That is, for an object $x \in U$, the equivalence class of objects containing *x* is given by: [x] = {x'|xE(V)x'}

In expert system technology, the knowledge base is expressed with natural language rules IF ... THEN ... For examples :

- "IF it is living THEN it is mortal"

- "IF his age = known THEN his year of birth = date of today - his age in years"
- "IF the identity of the germ is not known with certainty AND the germ is gram-positive AND the morphology of the organism is "rod" AND the germ is aerobic THEN there is a strong probability (0.8) that the germ is of type enterobacteriacae".

This formulation has the advantage of speaking in everyday language which is very rare in computer science (a classic program is coded). Rules express the knowledge to be exploited by the expert system [20].

4. UNCERTAINITY WITH EXPERT SYSTEMS AND CLASSIFICATIONS

4.1 What is Uncertainty?

- Uncertainty is essentially lack of information to formulate a decision.
- Uncertainty may result in making poor or bad decisions.
- As living creatures, we are accustomed to dealing with uncertainty – that's how we survive.
- Dealing with uncertainty requires reasoning under uncertainty along with possessing a lot of common sense [6, 10, 11].

4.2 Theories to Deal with Uncertainty

- Bayesian Probability
- Hartley Theory
- Shannon Theory
- Dempster-Shafer Theory
- Markov Models
- Zadeh's Fuzzy Theory

4.3 Dealing with Uncertainty

- Deductive reasoning – deals with exact facts and exact conclusions
- Inductive reasoning – not as strong as deductive premises support the conclusion but do not guarantee it.
- There are a number of methods to pick the best solution in light of uncertainty.
- When dealing with uncertainty, we may have to settle for just a good solution.

4.4 Uncertainty and Rules

There are several sources of uncertainty in rules:

- Uncertainty related to individual rules
- Uncertainty due to conflict resolution
- Uncertainty due to incompatibility of rules

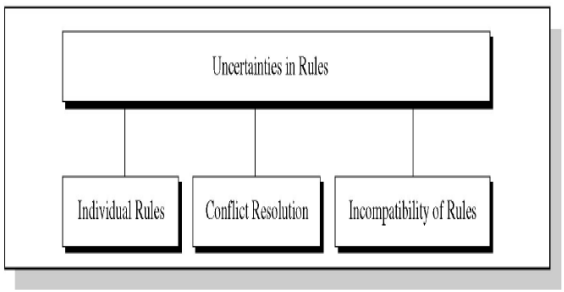

fig: (4)Uncertainity and Rules

Often the Knowledge is imperfect which causes uncertainty. To work in the real world, Expert systems must be able to deal with uncertainity[16].

One simple way is to associate anumeric value with each piece of information in the system. The numeric value represents the certainity with which the information is known. There are different ways in which these numbers can be defined, and how they are combined during the inference process [15, 21].

An important features of expdrt systems is their ability to explain themselves. Given that the system knows which rules were used during the inference process, the system can provide those rules to the user as means for explaaining the results.

By looking explanations, the knowledge engineer can seen how the system is behaving, and how the rules and data are inteacting. This is very valueable diagnositc tool during development.

5. CONCLUSIONS

In this paper, we have reviewed Expert Systems and rough set theory. We discussed the classifications and uncertainity in Expert Systems data, and took an initiative to combat new approach is roughsets. It is observed that some theories previously dealing with uncertainity classifications. We focused a new technique is rough set theory to clasify the Expert Systems systematically and developed a practically feasible approach. For future work, we believe that the discussed approach will become suitability for classify the expert systems.

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