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Rough Set Approach to Development of a Knowledge-Based Expert System

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A B S T R A C T

In this paper we propose to model of a knowledge-based expert systems using the techniques of Rough Sets approach. In the real world problem solving is the process of finding a solution when the path leading to that solution is uncertain. The Expert Systems need to have the ability to handle vague associations, for example by accepting the degree of correlations as numerical certainty factors. When the data is incomplete or missing, the only solution is to accept the value "unknown" and proceed to an approximate reasoning with this missing value. Rough sets provides a framework to model uncertainity, the human way of thinking, reasoning and the perception process. 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.

Introduction:

Knowledge based systems are systems that are designed to emulate human thinking to solve problems and provide advices. One kind of knowledge based systems is Expert System. Although it is widely used in various applications, such systems are not able to model real world problems which are full of ambiguities and vagueness. When Rough Set theory was introduced by *I. Pawlak* at 1991, it did not get the attention of expert system's researchers. According to Pawlak ," a formal approximation of a crisp set (i.e., conventional set) in terms of a pair of sets which give the lower and the upper approximation of the original set.". The idea of rough set was to show that there is a world behind conventional logic. This kind of logic is the proper way to model human thinking. The expert system that uses a collection of rough sets and rules to facilitate reasoning is called a knowledge-based Expert System.

Expert Systems:

Inference engine + Knowledge = Expert system

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. [1, 2]. Expert systems were among the first truly successful forms of AI software.

AI's [10,11] 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.

Expert system has 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.

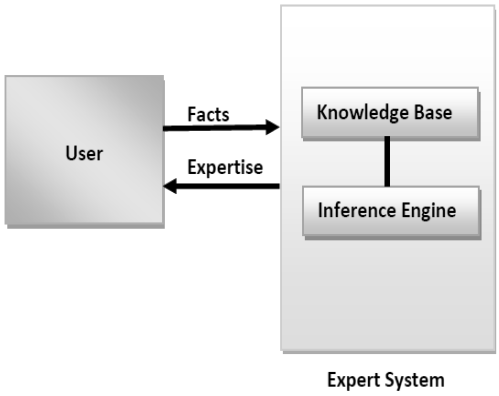

Fig: 1. Basic concept of an Expert System

Knowledge-Based Expert System:

Represent the knowledge in expert systems may be rule-based, the rule-based approach used IF-THEN type rules and it is the method currently used in constructing expert systems. IF-THEN rules take the following form:

IF there is a *flame* THEN there is a *fire*.

The rule-based expert system is their ability to learn by creation of new rules. Probably the first example of a rule-based expert system to rival human experts was DENDRAL, which deduced the molecular strucutre of organic compounds from knowledge.

Development of a Knowledge-Based Expert System:

As we have mentioned, a substantial body of thought, stemming largely from the work of Artificial Intelligence pioneer Allen Newell, contends that much verbal reasoning can be successfully expressed in production rules, called here simply rules. We subscribe to this line of thought. Rules take the form "IF the data available meet certain specified conditions THEN take these specified actions", in which "actions" should be viewed in a very broad context, including drawing conclusions, firm or tentative. A sample simple rule might be "IF the car engine will not turn over when attempting to start THEN check if the battery is discharged". A more complex fuzzy rule might be "IF the pulmonary artery systolic pressure is considerably reduced AND the diastolic pressure is at least normal THEN the pressure reading might be damped".

The explanation facility is an important feature of the rule-based expert sysems, since it provides a mechanism for a human to follow and check the correctness of the solution achieved by the expert system. The process of buiding an expert system is commonly known as knowledge engineering. This implies knowledge acquisition from a human or other source and coding it into the knowledge base of the expert system.

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.

Components of a Knowledge-based Expert System:

The structure of a knowledge-based expert system is solve the problems is contained in the knowledge base in the form of rules [4, 5, 6].

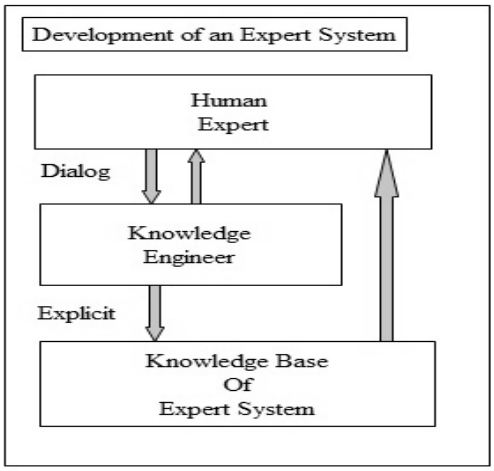

Fig: 2. Development of a K-B Expert system

A Human Experts in the field apply heuristics acquired from years of learning successful techniques for particular circumstances. Their decisions are often based on intangibles, particular circumstances. Their decisions are often based on intangibles, such as patterns or shapes observed in log curves. The implementation of an expert system for log analysis and interpretation requires that the expert system emulate, to some degree, the intuitive behavior of the human expert in searching for an acceptable solution.

A Knowledge Engineer integrates knowledge into computer systems in order to solve complex problems normally requiring a high level of human expertise. Knowledge engineers interpret and organize information on how to make systems decisions.

A knowledge engineer is required to carry out data collection and data entry, but they must use validation in order to ensure that the data they collect, and then enter into their systems, fall within the accepted boundaries of the application collecting the data. It is important that a knowledge engineer incorporates validation procedures into their systems within the program code. After the knowledge-based system is constructed, it can be maintained by the domain expert.

The Expert System was designed to assess all data available for a particular well through the zone of interest and to give the "best" first-pass interpretation. It "assumes" all available data; log curves, parameters, and depositional environment information are entered before it is used for analysis. Although the expert-system shell is capable of running in a fully interactive mode, the expert system for log analysis was designed to be an assistant for inexperienced log analysts or for computer operators who have no log-analysis background. The design of the "assistant" therefore has concentrated on enabling the expert system to determine the answers to all such questions through examination of the input data.

Rough Sets

Definitions and Notations

Rough set theory is a technique deals with uncertainty. In this section we reintroduce some basic notations of Rough set theory [3, 8, 12].

- $U \quad (\neq \phi)$ 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 $\mathrm{P}(\neq \phi) \subseteq \Re$, the intersection of all equivalence relations in P is denoted by $IND(\mathrm{P})$ 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.

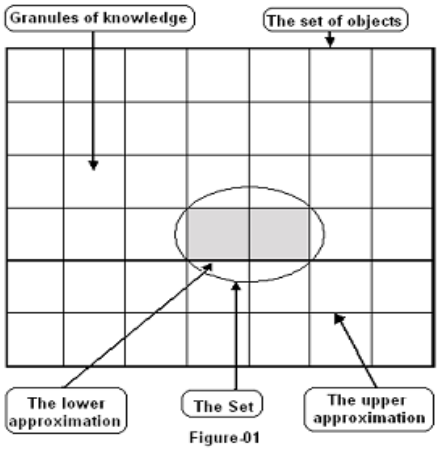

Fig: 3 Rough Set Approaches

- 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 $\overline{R}X = \bigcup\{Y \in U / R : Y \cap X \neq \phi\}$
    $\overline{R}X$ 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, $\overline{R}X - \underline{R}X$. The elements of $\underline{R}X$ are those elements of *U*, which can certainly be classified as elements of X, and the elements of $\overline{R}X$ 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 $\underline{R}X \neq \overline{R}X$, equivalently $BN_R(X) \neq \phi$. X is said to be R-*definable* if and only if $\underline{R}X = \overline{R}X$, or $BN_R(X) = \phi$.

Application of Rough Set:

We briefly highlight few applications of RST [13, 14, 15, 16]. 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.

Rough Set Approach to Design K-B Expert System:

Variety of imperfect information:

We use imperfection as the most general label. Information is perfect when it is precise and certain. Imperfection can be due to imprecision, inconsistency and uncertainty, the major aspects of imperfect data. Imprecision and inconsistency are properties related to the content of the statement:

A rough expert system is an expert system that uses rough logic instead of conventional logic. It uses a collection of knowledge and rules to facilitate reasoning. Since it uses rules, it falls into the category of rule-based expert systems. Rules can easily demonstrate human thinking as they are easily formulated. Rough expert systems are used to provide non experts with some expert's skills.

Uncertainty:

The aspect of informational imperfection, uncertainty, concerns the state of knowledge of an agent (denoted you, but the agent could even be a computer) about the relation between the world and the statement about the world. The statement is either true or false, but your knowledge about the world does not allow You to decide if the statement is true or false. Certainty is full knowledge of the true value of the data. Uncertainty is partial knowledge of the true value of the data. Uncertainty results in ignorance (etymologically not knowing). It is essentially, if not always, an epistemic property induced by a lack of information. A major cause of uncertainty is imprecision in the data. Whether uncertainty is an objective or a subjective property is a still debated philosophical question left aside here [17].

Modeling:

Models for imperfect data can be separated into symbolic-qualitative and numeric-quantitative models. Most quantitative models concern uncertainty. An exception is rough sets theory that addresses imprecision. Symbolic models rather concern deduction based on soft knowledge than data representation but of course one cannot create new deduction models without appropriately adapting the data representation by introducing new operators.

Conclusion:

The Rough Sets theories can be used to investigate imprecise and incomplete information, and to observe, test and reason data. We propose the rules and methods to handel uncertainty and vagus information to solve the problem. We took an initiative to combat new approach is rough sets. It is observed that some theories previously dealing with expert system. We focused a new technique is rough set theory to develop a practically

feasible approach. So the proposed modeling approach may be promising in many applications.

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