International Journal of Advancements in Communication Technologies – IJACT
Volume 1 : Issue 1 [ISSN : 2374-1511]
Publication Date : 25 June 2014

Some aspects of Soft Computing Approach in Information Technology

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***Abstract*—Soft computing (SC) techniques are rapidly emerging as an important contributor to effective management. One of the greatest growth areas lies in the use of fuzzy logic for supporting managerial decision making processes. Fuzzy set theory, a major branch of SC has only recently begun to be applied to industry problems. Although SC has scarcely touched by today's managers, it will begin to have dramatic and widespread impacts on their activities over the next few years. The application of SC plays a major role in reshaping traditional notions to take decisions. It will lead to tremendous increase in the productivity of organizations. Those organizations in the forefront of applying SC methods to aid in management will have distinct competitive advantage over those that lag. The present paper discusses some aspects of soft computing approach and its limitations in industry.**

***Keywords*—Fuzzy-Logic, Neural networks, Expert systems, Decision making, Artificial intelligence.**

I. Introduction

Soft computing techniques endeavor to make machines such as computers capable of displaying intelligent behavior. This means behavior that would reasonably be regarded as intelligent if it is observed in humans. Two corner stones of intelligence are the ability to understand natural language and the ability to reason. This research has led to the discovery of practical techniques from building software that enables the computer to understand natural language and solve problems by reasoning.

Like human intelligence, soft computing approach (SCA) has many aspects. One of the most significant is the ability to reason. The SC mission able to display expert behavior to assist in the present day engineering and several software tools are now being offered commercially. The application of the SC approach for management, change the very nature of decision-making process, managerial practice and an organization itself. SC approach will revolutionalise the nature of organization and management.

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It will affect all types of business such as construction, manufacture, commerce, banking, and government. SC techniques offer expert's advice about the problem posed by their users. SC system makes use of expertise that has been gathered from a human expert about how to solve a specific problem or class of related problems. These are systems intended to mimic the performance of a human expert. The present paper discussed some aspects of SPA in engineering applications.

A. *Potential benefits of Soft Computing Approach*

The following are some of the benefits of Soft computing Approach

- Soft computing system is able to provide timely advice when a human expert is unavailable. Unlike its human counterpart, it can operated round the clock, all the seven days in a week and every day of the year. It does not get sick, take holidays, go on vacations or resign. It is not tied up in meetings, away in business.

- It can be readily replicated and used simultaneously in many sites across the country or around the world. Once an SC system has been constructed, it is relatively inexpensive to distribute.

- The advice has a very positive impact on the human expert. It can reduce the demands on the human expert's time. They can focus on most challenging problems on new creative activities. Human experts are normally a scarce resource. Their productivity can be increased by off loading consultation activity thus, human resources can be more effectively utilized.

- It provides consistent, uniform advice. It is thorough and methodical and does not have lapses that cause it to overlook important factors, slip steps or forget. It is not politically motivated, temperamental or biased.

- Like a human expert, it is able to explain the line of reasoning uses for each problem it solves. A user can study the rationale on which the advice is based and is free to accept or reject it.

- New expertise can be added by simply adding new rules or modifying existing rules.

B. Limitations of SC systems

The following are some of the limitations

(i) The over-importance of one individual expert in establishing the knowledge base, gives too strong a personal stamp.
(ii) Complete absence of any learning capability. SC system does not improve itself by using its past experience, and except in a very few cases, cannot add to its knowledge base.
(iii) The restricted coverage of the field being studied.
(iv) The limited ability to provide explanation.
(v) Inadequate interaction with the external world.

II. Soft computing approach

Because of their characteristic attributes of combining factual knowledge with judgment, being able to handle incomplete and uncertain data, and communicating with their users in the natural language like English, SC systems have a special appeal for the engineering profession. The following typical features of today's environment show the need for an SC like technology for improving quality and productivity.

(i) Each project being of different design, layout, and material used, ready algorithmic solutions are therefore not applicable to the day-to-day problems.
(ii) The environments are full of uncertainties in respect of market forces, material availability and changes. Algorithmic computer programs cannot handle such uncertainties.
(iii) So far, not enough knowledge in the field of engineering and management has been formalized and encoded in textbooks. The industry runs on conventional knowledge and experience based judgment.
(iv) In many situations, there is not enough time to make a detailed analysis of all the influencing factors. Such decisions are often made on the spot so that the process is not interrupted. SC systems can provide quick decisions in such situations.
(v) Many decisions like safety management, labor relations, evaluation and risk management are qualitative and subjective in nature, needs heuristic approaches.
(vi) On a project, all the necessary information on a subject is almost never completely known and the decisions have to be taken on the basis of incomplete information.
(vii) SC system requires domain experts and there are highly knowledgeable experts in the industry who have successfully completed several projects and who are widely recognized in the profession.

A. Application areas of Soft Computing

(i) Project planning, scheduling and control: Time-cost estimates of activities, generation of schedules, critical path analysis, resource allocation, time and cost control, diagnosing reasons for time, cost and resource overruns, prescribing remedial actions, cost estimating, and process monitoring.

(ii) Temporary facilities layout: Optimal layout of temporary facilities that can have significant effect on productivity such as access roads, parking areas, change rooms, material lay-down areas, fabrication shops, site office and hoisting equipment.

(iii) Project Management: Choice of project-delivery strategy, selection of contract type, design checking and management of design changes, contract formulation, project financing options, prequalification of contractors, bidding strategies, bid evaluation, evaluating process payment, evaluating climes, management of risks.

(iv) Material Management: Choice of material, movement of materials, handling, testing-use of explosives.

(v) Legal Issues: Generation of contract documents, maintaining historical data bases of settled cases and matching them with the current situation, settlement of claims and disputes, generating negotiating strategies, and changing conditions of management.

III. Membership Functions of Soft Computing Tools

Fuzzy sets, neural networks, and expert systems are tool of soft computing. Let X be a universe, or a set of elements, x's, and let A be a subset of X. Each element, x, is associated with a membership value to the subset A, UA (x). A is an ordinary, non-fuzzy, or crisp set, then the membership function is given by

$$\mu_A(x) = \begin{cases} 1 \text{ if x belongs to A} \\ 0 \text{ if x does not belong to A} \end{cases} \quad (1)$$

In the above Eq. 1 there are only two possibilities for an element x, either being a member of A, i.e., $\mu A(x) = 1$, or not being a member of A, i.e., $\mu A(x) = 0$. In this case, A has sharp boundaries. On the other hand, if the membership function is allowed to take values in the interval (0,1), A is called a fuzzy set.

Thus, a fuzzy set is a set whose elements are imprecise or fuzzy and with a certain degree of membership. The fuzzy set is represented as

$$A = [x_1/\mu_A(x_1), x_2/\mu_A(x_2) \ldots x_m/\mu_A(x_m)] \quad (2)$$

In Eq. 1, A is a fuzzy set for which the values of membership $\mu_A(x)$ for different levels of the element (x) belonging to the set is defined. Qualitative factors or linguistic variables (terms) are routinely used in construction industry. These linguistic measures add to the overall uncertainty in the final outcome of any decision process.

Therefore, A does not have sharp boundaries and the membership of x to A is fuzzy. For example, let x be the level of experience of labor which may range from excellent experience, i.e., x =**1.0**, to "*never been to a construction site*," i.e., x = **0**. By dividing the range of labor experience into increments of 0.1. "*Short experience*," A, as a linguistic variable, can be defined as

Short experience

$$A = [x_1=1/\mu_A(x_1)=0,\ x_2=0.9/\mu_A(x_2)=0,\ x_3=0.8/\mu_A(x_3)=0,\ x_4=0.7/\mu_A(x_4)=0,\ x_5=0.6/\mu_A(x_5)=0,\ x_6=0.5/\mu_A(x_6)=0,\ x_7=0.4/\mu_A(x_7)=0.1,\ x_8=0.3/\mu_A(x_8)=0.5,\ x_9=0.2/\mu_A(x_9)=0.7,\ x_{10}=0.1/\mu_A(x_{10})=0.9,\ x_{11}=0/\mu_A(x_{11})=1.0] \quad (3)$$

To define the subset of very experienced contractors, a satisfactory answer is difficult one as the class of "Very experienced" contractors is not a set in the classical sense, but belongs to a fuzzy, not crisply defined type. The definition of very experienced may involve a spectrum of human perceptions and the class of very experienced contractors and is therefore said to represent a fuzzy set. Or, in short, it can be expressed as

Short/small/bad experience,

$$A = (0.4/0.1, 0.3/0.5, 0.2/0.7, 0.1/0.9, 0.0/1.0) \quad (4)$$

Similarly, Quiet small & very small experience can be expressed as

Quiet Small (A) = $\{x/(\mu_{A(x)})^{1.25}\}$; and

Very small, A = $\{x/(\mu_{A(x)})^2\}$.

The fuzziness in the definition of short experience is obvious. It is clear from that different values of x; or grades of experience have different membership values, $\mu_A(x)$, to the fuzzy set A, short experience. The values of x are 0.4, 0.3, 0.2, 0.1, and 0, and the corresponding membership values are 0.1, 0.5, 0.7, 0.9, and 1.0, respectively. Other values of x have zero membership values to the fuzzy set A. These membership values are generally assigned based on subjective judgment with the help of experts and can be updated with more applications of the method in various projects. If crisp set were used in this example, the value of x would be 0.0 with a membership value of 1.0.

Similarly, long experience, B, can be defined as

$$\text{Long/good/high} = \{1.0/1.0, 0.9/0.8, 0.8/0.7\} \quad (5)$$

The "medium experience" can also be defined as,
Medium/Moderate/Middle/Central Experience,

$$A = (0.7/0.2, 0.6/0.7, 0.5/1, 0.4/0.7, 0.3/0.2) \quad (6)$$

IV. Basic Set Theoretic Operations for fuzzy sets

In order to use fuzzy sets in practical problems, some operational rule similar to those used in classical set theory are defined and these are

Fuzzy Union ($\cup$)

The union, $\cup$ of fuzzy sets A and B of a universe, X corresponds to the connective "or" and its membership function is

$$\mu_{A\cup B}(x) = \max [\mu_A(x), \mu_B(x)] \quad (7)$$

Fuzzy Intersection ($\cap$)

The intersection, $\cap$ of fuzzy subsets A and B correspond to the connective "and" and its membership function is

$$\mu_{A\cap B}(x) = \min [\mu_A(x), \mu_B(x)] \quad (8)$$

For example, consider "superintendent experience" as a linguistic variable, to be expressed by the fuzzy subset

$$C = (1.0/1.0, 0.9/0.8, 0.8/0.6, 0.7/0.4, 0.6/0.2\} \quad (9)$$

And '*long labor experience* is represented by Eq. 14. then, the labor or superintendent experience can be expressed by the union of the fuzzy subsets B and C, and is given by

$$B \cup C = [1/1, 0.9/0.9, 0.8/0.7, 0.7/0.4, 0.6/0.2] \quad (10)$$

On the other hand, the labor and superintendent experience can be expressed by the intersection of the fuzzy subsets B and C, and is given by

$$B \cap C = [1/1, 0.9/0.8, 0.8/0.6, 0.7/0.2, 0.6/0.1] \quad (11)$$

Fuzzy Complement ($\mu_A(x)$)

The complement of a fuzzy subset A is denoted by A, and its membership function is

$$\mu_A(x) = 1-\mu_A(x) \quad (12)$$

Fuzzy Relation

A fuzzy relation, R, or Cartesian – product, A×B, between two fuzzy subsets A (subset of a universe X) and B (subset of a universe Y) has the following membership function

$$\mu_R(x_i, y_j) = \mu_{AxB}(x_i, y_j) = \min(\mu_A(x_i), \mu_B(y_j)) \quad (13)$$

The relation is usually expressed in matrix form as

$$\mu_{R0S}(x_i, y_j) = \min(\mu_R(x_i, y_j), \mu_S(s_i, y_j)) \quad (14)$$

Fuzzy Composition

If R is a fuzzy relation from X to Y, and S is a fuzzy relation from Y to Z, the composition of R and S is a fuzzy relation that is described by the following membership function.

$$\mu_{RoS}(x_i, z_k) = \max(\min(\mu_R(x_i, y_j), \mu_S(y_j z_k)))) \quad (15)$$

Eq. 15 basically evaluates a fuzzy relation between the fuzzy subsets X and Z using the fuzzy relations of X and Z to the common fuzzy subset Y.

v. Conclusions

The paper presented some aspects of soft computing approach to accommodate qualitative and quantitative data. Since the industry is developing at a fast rate, there are lots of qualitative factors involved that can affect the outcome of a project. The risks are relatively vague in nature, since exact values cannot be given. This paper provides a contribution to the area of decision making as it gives the project manager a simple yet powerful tool that allows him to discard projects that are associated with high amount of risk. This approach can be applied during various phases of a project and thus helps the companies save large percentages of time, money, and effort.

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