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Analysis of the job satisfaction index problem by using fuzzy inference

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Abstract

In this study we propose a fuzzy rule-based algorithm to evaluate job-satisfaction in an organization. We collected the effective factors/job facets of job satisfaction through interviews. Through analyzing the interview results we compose fuzzy rules. By using the obtained rules, the value of job satisfaction is computed using the expert system shell ESPLAN. The basic advantage of the used approach is being able to operate with imperfect information for the evaluation of job satisfaction by using fuzzy logic.

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*Keywords:*job satisfaction; fuzzy logic; possibility measure; expert system; fuzzy inference; Minnesota Satisfaction Questionnaire; quality measure- degree of truth

1. Introduction

There is a vast range of studies devoted to job satisfaction in the existing literature. Job satisfaction theories have a strong overlap with theories explaining human motivation. The most common and prominent theories in this area include Maslow's Needs Hierarchy Theory[1], Herzberg's[2] Motivator-hygiene Theory, the Job Characteristics Model[3], and the Dispositional Approach[4]. These theories are popular in the literature related to human motivation[5,8]. Some determinants of job satisfaction are analyzed in[9,12]. In[13]aneffective approach to job satisfaction is described. Job satisfaction indicators and their featuresare described in[14].

Job satisfaction is not only about how much an employee enjoys work. Taber and Alliger[15] analyzed other types of measures such as level of concentration required for the job, level of supervision, and task importance. This study demonstrates that the accumulating enjoyment of work tasks add up to an overall job satisfaction.

Some factors of job satisfaction may be ranked as more important than others, depending on each worker's needs and personal and professional goals. To create a benchmark for measuring and ultimately creating job satisfaction, managers in an organization can employ proven test methods such as the Job Descriptive Index (JDI) or the Minnesota Satisfaction Questionnaire (MSQ)[16]. These assessments help management define job satisfaction adequately.

Five important factors/job facets can be used to measure and influence job satisfaction in the test methods[17]:

1. Pay or total compensation
2. The work itself (i.e., job specifics such as projects, responsibilities)
3. Promotion opportunities (i.e., expanded responsibilities, more prestigious title)
4. Relationship with supervisor
5. Interaction and work relationship with coworkers.

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In[18], the authors propose a fuzzy rule-based algorithm to evaluate the job satisfaction in an organization. First, they collect the effective factors/job facets of job satisfaction through interviews. After analyzing the interview results, they propose questionnaires with respect to categories obtained from interviews. Due to qualitative aspect of satisfaction, they use linguistic choices in the questionnaires. While it is hard to disseminate questionnaires to all employees, sampling is performed based on STRATA technique. The results are used to compose fuzzy rules. After defuzzification of the rules and computing the distance from ideal status, the gaps are determined. The gaps are fulfilled using improvement strategies. Next, they give a brief description of STRATA sampling technique and fuzzy logic. Fuzzy logic is capable of treating this dynamic performance criterion in the uncertain and qualitative environment.

Authors[19] examine how individuals "determine" their job satisfaction based on changes in situational factors. A simulation model, using fuzzy set theory and system dynamics, is used.As Piegat[20] stated "information obtained from people is usually of less precision (large granularity), while information delivered by measuring devices is of higher precision (small granularity)". For the model, the requiredinformation is obtained from people. It measures subjective features of work, consequently making fuzzy set theory a highly applicable technique to evaluate the features. The estimation of an individual's input-output ratio and the impacts of the input-output ratio on changes to the individual's satisfaction level are evaluated using fuzzy set theory. Fuzzy logic is used to get an approximate answer when no exact answer is possible.

The purpose of this study is to determine the level of employee job satisfaction throughthe use of the Minnesota Satisfaction Questionnaire (MSQ) based production rules and the fuzzy expert system shell ESPLAN[21].

The paper is organized as follows. Section 2 discusses description of fuzzy if-then rules and fuzzy inference algorithm. The statement of the problem is described in section 3. Theresults of computer simulation are described in Section 4 and Section 5 concludes the study.

2. Description of fuzzy if-then rules and fuzzy inference algorithm

Knowledge in if-then rules based systems can be described in different ways. Some of the post-modern techniques for representation of knowledge include logical calculus and a structured model. This work is devoted to the rule-based system oriented approaches of knowledge representation. A rule-based system consists of three main parts:1) a set of if-then rules, 2) dynamic database, called the working-storage, 3) control interpreter, which interprets the database using the set of rules. The rule-based system has a wide class of applications in decision making problems, planning problems, business problems, technical problems, and in social sciencessuch as psychology and medicine[21,24].

The shell of ESPLAN provides the following basic abilities:development of expert systems for various applications; building module-oriented structures and knowledge bases segmentation; representation of fuzzy values; compositional inference with possibility measures; arithmetic operations with fuzzy numbers; realization of simple user-machine dialogue (execution of queries) by using special functions; the use of a confidence degree for any rule (in percent); call of external programs; data interchange using file system..

The mathematical description of knowledge in the knowledge base is based on fuzzy interpretation of antecedents and consequents in if-then rules.

For the knowledge representation the antecedent of each rule contains a conjunction of logical connectives like $\begin{Bmatrix} = \\ \neq \end{Bmatrix}$ <linguistic value> named elementary antecedent.

The consequent of the rule is a list of imperatives, among which may be some operator-functions (i.e. input and output of objects' values, operations with segments of a knowledge base, etc). Each rule may be characterized with a confidence degree $Cf \in [0,100]$.

Each linguistic value has a corresponding membership function. The subsystem of fuzzy arithmetic and linguistic values processing provides automatic interpretation of linguistic values like "approximately A", "less than A", "more than A", middle", "much", "high", "low", "near...", "from ... to..." and so on; i.e. for each linguistic value this subsystem automatically computes parameters of membership functions using universes of corresponding variable. The value of linguistic variable are trapezoidal fuzzy numbers, which is described as[21]:

less than $A:(0,I,A-Z,Z)$ *approximately A:* (Z,A,A,Z) *more thanA:* $(Z,A+Z,S,0)$

neutral: $(Z,I,+2*Z,I+3*Z,Z)$ *much:* $(Z,S-Z,S,0)$ etc,

where I and S are respectively minimum and maximum values of universe, Z=(S-I)/5.

The user of the system may define new linguistic values, modify built-in ones and explicitly prescribe a membership function in any place where linguistic values are useful[21]. The fuzzy if-then rules have the following form:

$$R^k\text{: } IF\ x_1\ is\ \tilde{A}_{k1}\ and\ x_2\ is\ \tilde{A}_{k2}\ and \ldots and\ x_m\ is\ \tilde{A}_{km}\ THEN$$

$$u_{k1}\ is\ \tilde{B}_{k1}\ and\ u_{k2}\ is\ \tilde{B}_{k2}\ and \ldots and\ u_{k1}\ is\ \tilde{B}_{k1}\,, \quad k=\overline{1,K}$$

where $x_i, i=\overline{1,m}$ and $u_j, j=\overline{1,l}$ are total input and local output variables , $\tilde{A}_{ki}, \tilde{B}_{kj}$ are fuzzy sets, and k is the number of rules. Note, that inputs $x_1, x_2, \ldots, x_m$ may be crisp or fuzzy variables.

Efficiency of the inference engine considerably depends on the knowledge base internal structure. Theinference mechanism acts as follows. First, current values of objects are given (initial data). Then all rules antecedents of whichoverlapswith these current values are chosen from the knowledge base. For these rules, the truth degrees of the rules are computed (in other words,