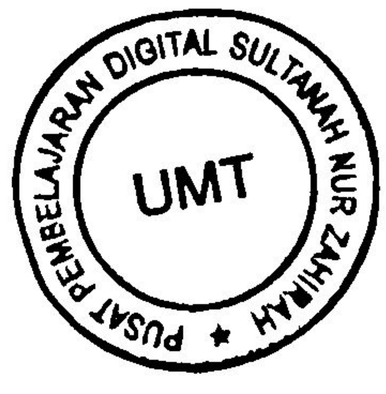

Lihat Sebelah

A Type-2 Fuzzy Logic Approach for Multi-Criteria Group Decision Making

Nur Syibrah Muhamad Naim

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University of Essex

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Abstract

Multi-Criteria Group Decision Making (MCGDM) is a decision tool which is able to find a unique agreement from a group of decision makers (DMs) by evaluating various conflicting criteria. However, the current multi-criteria decision making with a group of DMs (MCGDM) techniques do not effectively deal with the large number of possibilities that cause disagreement between different judgments and the variety of ideas and opinions among the decision makers which lead to high uncertainty levels. There is a growing interest to investigate techniques to handle the faced uncertainties in many decision making applications. Studies in fuzzy decision making have grown rapidly in the utilisation of extended fuzzy set theories (i.e., Type-2 Fuzzy Sets, Intuitionistic Fuzzy Sets, Hesitant Fuzzy Sets, Vague Sets, Interval-valued Fuzzy Sets, etc.) to evaluate the faced uncertainties.

In recent years, there has been a growing interest in developing MCGDM using type-2 fuzzy systems which provide a framework to handle the encountered uncertainties in decision making models. In addition, fuzzy logic is regarded as an appropriate methodology for decision making systems which are able to simultaneously handle numerical data and linguistic knowledge. In this thesis, we will aim to modify the fuzzy logic theories based multi-criteria group decision making models to employ a suite of type-2 fuzzy logic systems in order to provide answers to the problems that are encountered in the real experts' decision.

The presented suite of type-2 fuzzy MCGDMs will employ various type-2 fuzzy sets to deal with the various levels of encountered uncertainties. In the

proposed framework, we will present the application of interval type-2 fuzzy sets based MCGDM for handling the linguistic uncertainties among the various experts. In addition, we will present a MCGDM method based on interval type-2 fuzzy logic combined with intuitionistic fuzzy evaluation (from intuitionistic fuzzy sets). This combination handles the linguistic uncertainties by the interval type-2 membership function and simultaneously computes the non-membership degree from the intuitionistic evaluation. In addition, the interval type-2 fuzzy values are extended into intuitionistic values to evaluate the hesitation values which is lacking in type-2 fuzzy systems.

However, the interval values with hesitation index cannot fully represent the uncertainty distribution (in the third dimension) associated with the decision makers. Hence, we will present a final component of our framework employing general type-2 fuzzy logic based approach for MCGDM which is more suited for higher levels of uncertainties. In order to optimally find the type-2 fuzzy sets parameters (including interval type-2 and general type-2), we have employed the Big Bang Big Crunch (BB-BC) optimisation method, which has low computation overhead and fast convergence.

In order to validate the efficiency of the proposed systems in handling various DMs' behaviour and opinion, we will present comparisons which were performed on three different real world decision making problems. The first problem was a medical decision problem for umbilical acid-base balance assessment from 5 clinicians. The second decision problem involved employing intelligent decision making systems to select the preferred lighting level during reading where we carried out various experiments in the intelligent apartment (iSpace) located at the University of Essex involving 15 users. The third

decision problem concerned the assessment of the best location for postgraduate study where the evaluation involved 10 candidates who were asked to determine their preferred location of postgraduate study.

As will be shown in the various experiment sections, we found that the proposed type-2 MCGDM based system better agrees with the users' decision compared to type-1 fuzzy expert system and existing type-1 fuzzy MCDMs including the Fuzzy Logic based TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution). In addition, we will show how the different type-2 fuzzy logic based MCGDM systems compare to each other when increasing the level of uncertainties where the general type-2 MCGDM will outperform the MCGDM based interval type-2 fuzzy logic combined with intuitionistic fuzzy evaluation which will outperform the MCGDM based on interval type-2 fuzzy sets.

Hence, this work can be regarded as a step towards producing higher ordered fuzzy logic approach for MCGDM (HFL-MCGDM) which could be applied to complex problems with high uncertainties to produce automated decisions much closer to the group of human experts.