

Abstract

The aim of this thesis is to extend the "Fuzzy Decision Maps" (FDM) method so as to be able to adopt linguistic values as link weights among concepts when dealing with "Multi Criteria Decision Making" problems (MCDM). The proposed method allows manipulation of uncertainty at the level of link weights in the form of fuzzy numbers rather than precise crisp values. This allows more suitability for real world application. The proposed method is called the "Linguistic Fuzzy Decision Networks" (LFDN). It incorporates the fuzzy set theory into FDM method for solving multi-criteria decision-making problems in fuzzy environments. It combines the approximate fuzzy eigenvalue method, "Fuzzy Cognitive Maps" (FCM) with linguistic values and fuzzy weighting equation. The proposed method provides both fuzzy local weights and fuzzy global weights. This research shows that the proposed method allows decision makers to make proper decisions based on the vague information in real world. Therefore the proposed LFDN method extends the ability of FDM methods to deal with uncertain MCDM problems. The proposed method is tested using a case study that is also used for testing both of "Analytic Hierarchy Process" (AHP) and FDM methods. The results give the same ranking of alternatives which ensures the validity of LFDN method for solving MCDM problems in all situations of dependence and feedback of criteria.

LIST OF CONTENTS

CHAPTER 1: INTRODUCTION	1
1.1 Problem Definition	1
1.2 Thesis Objectives	2
1.3 Thesis Organization	2
CHAPTER 2: MULTI-CRITERIA DECISION MAKING (MCDM)	4
2.1 Introduction	4
2.2 The decision Making methods	5
2.2.1 Single Objective Decision Making (SODM)	5
2.2.2 Decision support systems (DSS)	6
2.2.3 Multi Criteria Decision Making (MCDM)	6
2.2.3.1 Multi Attribute Decision Making (MADM)	7
2.2.3.2 Multi Objective Decision Making (MODM)	8
2.3 Types of solutions of MADM problems	10
2.3.1 The choice problem	11
2.3.2 The classification/sorting problem	11
2.3.3 The ranking problem	12
2.4 Classification approaches of MCDM	12
2.4.1 First Approach	12
2.4.2 Second Approach	13
2.4.3 Third Approach	14
2.4.4 Fourth Approach	15
2.4.4.1 MAUT Methods	16
2.4.4.2 The outranking methods	17
2.4.4.3 The interactive methods	17
2.5 MCDM methods	19
2.5.1 Analytic Hierarchy Process (AHP)	19
2.5.1.1 The process of the Analytic Hierarchy Process (AHP)	19
2.5.1.2 An illustrative example	21
2.5.1.2 The advantages and disadvantages of AHP	27
2.5.2 Analytic Network Process (ANP)	27
2.5.2.1 The process of the Analytic Network Process (ANP)	28
2.5.2.2 Illustrative Example	32
2.5.2.3 The advantages and disadvantages of ANP	37
2.5.3 Fuzzy Decision Maps (FDM)	38

2.6 Summary	38
CHAPTER 3: FUZZY SET THEORY AND FUZZY COGNITIVE MAPS (FCM)	40
3.1 Introduction	40
3.2 Fuzzy set theory	40
3.2.1 Fuzzy set vs. crisp set	43
3.2.2 Operation on fuzzy Set	44
3.2.3 Fuzzy set characteristics	48
3.2.4 Fuzzy Number	52
3.2.4.1 Types of fuzzy numbers	52
3.2.4.2 Arithmetic operations on fuzzy numbers	54
3.2.5 Linguistic variables	55
3.2.6 Fuzzy hedges	56
3.2.7 Defuzzification	57
3.3 Fuzzy Cognitive Map (FCM)	59
3.3.1 FCM description	59
3.3.2 Mathematical description of FCM	60
3.3.3 The inference of FCM	64
3.4 Summary	66
CHAPTER 4: FUZZY DECISION MAPS (FDM)	67
4.1 Introduction	67
4.2 The process of the fuzzy decision maps	67
4.3 Illustrative example	68
4.4 Advantages and Disadvantages of FDM	73
4.5 Summary	73
CHAPTER 5: THE PROPOSED LINGUISTIC FUZZY DECISION NETWORKS (LFDN)	74
5.1 Introduction	74
5.2 Linguistic Fuzzy Decision Networks (LFDN) steps	74
5.3 Summary	79

CHAPTER 6: TESTING THE PROPOSED APPROACH	80
6.1 Introduction	80
6.2 Case study	80
6.3 Discussions and results	86
6.4 Summary	87
CHAPTER 7: CONCLUSION AND FUTURE WORKS	88
REFERENCES	89

LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
ANP	Analytic Network Process
CMCDM	continuous Multi Criteria Decision Making
COA	Center Of Area
DM	Decision Maker
DMCDM	Discrete Multi Criteria Decision Making
DSS	Decision Support Systems
ELECTRE	ELimination Et Choice Translating REality
Evamix	Evaluation matrix
FCMs	Fuzzy Cognitive Maps
FDMs	Fuzzy Decision Maps
FN	Fuzzy Number
GP	Goal Programming
LFDN	Linguistic Fuzzy Decision Networks
MACBETH	Measuring Attractiveness by a Categorical Based Evaluation Technique
MADM	Multi-Attribute Decision Making
MAUT	Multi Attribute Utility Theory
MCE	Multi Criteria Evaluation
MCD	Multi Criteria Design
MCDA	Multi-Criteria Decision Analysis
MCDA	Multi-Criteria Decision Aid
MCDM	Multi Criteria Decision Making
MF	Membership Function
MODM	Multi- Objective Decision Making
MOP	Multiple Objective Programming
MOLP	Multiple Objectives Linear Programming
MOMP	Multi Objective Mathematical Programming
MOO	Multi Objective Optimization
NAIADE	Novel Approach to Imprecise Assessment and Decision Environments
PROMETHEE	Preference Ranking Organisation METHod of Enrichment Evaluation
SODM	Single Objective Decision Making
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
TFN	Triangular Fuzzy Number