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多目標決策理論發展及其應用—系統最適化之演化軟式計算與相關主題(1/3)

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【多目標決策理論發展及其應用—系統最適化之演化軟式計算與相關主題(1/3)】期中成果報告

一、 計畫中文摘要

自從 Kuhn and Tucker (1951) 發表向量最佳化的觀念，Zadeh (1965)發表模糊集合理論，與 Bellman and Zadeh (1970) 發表模糊環境下之決策行為以來，已發展出許多方法及模式以解決具多目標、相互衝突性的決策問題。其後，Yu (1973) 提出多目標決策妥協解的數學驗證，更使得此一學門的方法被廣泛應用在各實務領域，諸如運輸投資與計畫、經濟發展規劃、財務規劃、資本預算、企業經營管理、投資組合選擇、健康與休閒設施規劃、公共工程與土地使用規劃、水資源管理、森林保護、公共政策、環境管理議題等。

本研究計畫為三年期之專案，將廣泛蒐集多目標決策之相關理論的發展，期能在此學門發展新的理論或模式，以解決企業、產業、乃至國家層面之實務問題。除此之外，本計畫擬從模糊多目標規劃出發並聚焦於演化軟式計算之系統最佳化模式之發展，過去已發展的方法諸如基因演算法、類神經網路等，在實證研究方面除了企業與政府的經營管理問題之研究外，同時能針對企業在全球化競爭環境下之永續發展相關議題進行探索。

本研究分為三個主要構面：資料處理面的資料探勘與統計多變量分析方法、規劃／設計面的多目標規劃方法、評估／選擇面的多屬性決策方法等。

1. 資料探勘與統計多變量分析方法—包括資料蒐集與整理的傳統統計方法（例如變異數分析、卡方檢定、迴歸與相關分析、時間序列分析），多變量分析方法（例如主成份分析、因子分析、群落分析、判別分析），資料挖掘，及多目標決策方法（例如 Logit 及 Probit 行為選擇模式）；
2. 多目標規劃模式—此領域起源於 Pareto 最適化及向量最佳化的觀念，可區分為模糊多目標規劃（包括目標模糊、限制式模糊、參數模糊、及其他混合模式），模糊達成度函數之目標規劃，模糊資料包絡(DEA)分析，模糊逆向思考規劃(DeNovo)方法，模糊多階段多階層的目標規劃等主題；
3. 多屬性決策方法—起源於 Bernoulli 的效用理論（強調人類欲求的滿足不在於利益最大化而在於效用最大化的追求），及 Von Neumann and Morgenstern (1947) 所提出的競局理論(Game Theory)。已發展的方法包括分析層級程序法(AHP)、ELECTRE、 PROMETHEE、TOPSIS、 VIKOR、灰色系統理論等。

本研究計畫之主要目標包括上述三個構面之相關理論與模式之探討，為符合實務上之問題與資料特性，在相關理論與模式發展時會依據問題性質將模糊集合、灰朦朧集合、約略集合等納入模式考慮。另外，基於現實環境中，屬性間很少是完全獨立的現象，除了傳統的機率測度外，會針對模糊測度、可能性測度、必然性測度深入探討及考量納入。

關鍵詞：多目標決策，演化軟式計算，系統最佳化，資料探勘，基因演算法

二、 計畫英文摘要

Since Kuhn and Tucker (1951) published one of earliest considerations of multiple objectives using vector optimization concept, Zadeh (1965) originally proposed fuzzy set theory and Bellman and Zadeh (1970) presented the concepts of decision-making in fuzzy environment, increasingly heuristic approaches developed which considering the nature of fuzzy and conflicting in practice, and then Yu (1973) proposed compromise solution method to cope with multicriteria decision-making problems, there have abundant work of multicriteria decision making for applications such as in transportation investment and planning, econometric and development planning, financial planning, capital budgeting, business conducting and investment portfolio selecting, health care planning, land-use planning, water resource management, forest management, public policy and environmental issues, and so on.

The research of this three-year project covered relatively broad area of research methodologies, with an intention to focus on specific methods in the future research. In the domain of decision analysis, the decision makers should consider the viewpoints on different aspects to solve the decision problems. With regard to the development of multiple criteria decision making (MCDM), this project will focus on survey the newly development on MCDM, especially develop the evolutionary soft computing models such as advance Genetic Algorithms and Artificial Neural Networks for system optimization. We also concern how to apply these models to the issues of sustainable development for industries.

The research area of this project includes three aspects from data processing/statistic analysis, multi-objective programming, multi-attribute decision making, and applications to design, planning and management.

1. Data Discovering & Mining: Statistic analysis includes data collection (including fuzzy data), Frequency or Categorical statistic analysis, Principal Component Analysis, Factor Analysis, Analytical Hierarchical Process, Cluster Analysis, Partitioned Hierarchy Fuzzy Integral Multi-criteria Evaluation, Statistical Reasoning, Discriminant Analysis. Logit and Probit model for Choice Behavior, Fuzzy Logit, Fuzzy Neuron, Neuron Fuzzy, Logit and Probit model combined with fuzzy integral, and forecasting models;
2. Multiple Objective Programming is based on the concept of Pareto optimization and vector optimization. This field includes fuzzy multiple objective programming, fuzzy goal programming with achievement function, fuzzy DEA, multi-stage dynamic programming, multi-level linear programming, fuzzy DeNovo programming and many other relevant models for multiple objective decision making problems.
3. Multiple Attribute Decision Making is based on the concept of evaluation system

along with the concept of Utility Theory that introduced by Bernoulli, Von Neumann and Morgenstern (1947) then presented the theory of game and economic behavior model which expanded the studies on human being economic behavior for multiple attribute decision-making (MADM) problems, from that moment on, more and more literature engaged in this field. The developed methods has been applied on many real facets problems such as AHP, ELECTRE, PROMETHEE, TOPSIS, VIKOR methods and Grey theory for decision-making (grey relation analysis, grey prediction models).

The objective of this project is to survey and develop MCDM methodologies in three aspects as mentioned above. In order to meet the nature of problems, we combine the theories of fuzzy set, grey hazy set, rough set, possibility measure and necessity measure, and the evolutionary computation methods such as neural network and genetic algorithm, to develop new methods and useful models and apply them to practical problems. This project especially focuses on developing methodologies and models of evolutionary soft computing and sustainability issues for applying to real problems.

Keywords: MCDM, Evolutionary Soft Computing, System Optimization, Data Discovering, Genetic Algorithms

三、 報告內容

The goal of this project is to survey and develop the decision analysis methodologies from the aspect of statistic analysis, data discovery, multi-objective programming (including fuzzy, multi-stage, multi-level), multi-criteria evaluation and choice (including fuzzy, additive, partitioned hierarchy non-additive model), and application on design, planning and exploring. Combining the theories of fuzzy set, grey hazy set, rough set, possibility measure and necessity measure, and the evolutionary computation methods such as neural network and genetic algorithm, we are trying to develop new methods and useful models and apply them to practical problems.

In this year we finished many research papers, some of them focus on modeling development and some focus on application for industries. Here we list these papers that have been accepted by international journal or international conference as follows.

1. Publications on Journal Papers:

(1) Opricovic, Serafim and Tzeng, Gwo-Hshiung, “Compromise Solution by MCDM Methods: A Comparative Analysis of VIKOR and TOPSIS”, *European Journal of Operational Research*, Vol. 156, No. 2, pp. 445-455. **(SCI)**

(2) Hu, Yi-Chung, Chen, Ruey-Shun, and Tzeng, Gwo-Hshiung, “Assessing Weights of Product Attributes from Fuzzy Knowledge in a Dynamic Environment”, *European Journal of Operational Research*, Vol. 154, No. 1, pp. 125-143. **(SCI)**

(3) Hu, Yi-Chung, Tzeng, Gwo-Hshiung, and Chen, Chin-Mi, “Deriving Two Stage

Learning Sequence from Knowledge in Fuzzy Sequential Pattern Mining", *Information Sciences: An International Journal*, Vol.159, No.1-2, pp.69-86, 2004. **(SCI)**

(4) Cheng, Chih-Chiang, Shyu, Joseph Z., and Tzeng, Gwo-Hshiung, "The Decision/ Evaluation of Civil Aeronautics Administration Public Construction Plan", *Civil Aviation Journal Quarterly*, Vol. 6, No. 1, pp. 37-63, 2004 (in Chinese, Taiwan).

(5) Cheng, Chih-Chiang, Tsai, Li-Min, Shyu, Joseph Z., and Tzeng, Gwo-Hshiung, "Fuzzy Heuristic Algorithm Method for Transport Route-Choice of Low-Radiation Waste Junk", *Chung Hua Journal of Management*, Vol. 5, No. 1, pp.41-56, 2004 (in Chinese, Taiwan).

(6) Ting, Shin-Chan and Tzeng, Gwo-Hshiung, "An optimal containership slot allocation for liner shipping revenue management", *Maritime Policy and Management*, Vol.31, No.2 or 3, 2004 (**Forthcoming**).

(7) Liu, Li-Chen, Lee, Chuan, and Tzeng, Gwo-Hshiung, "DEA Approach of the Current-period and Cross-period Efficiency for Evaluating the Vocational Education", *International Journal of Information Technology and Decision Making*, Vol.3, No.2, June 2004.

(8) Tzeng, Gwo-Hshiung and Chiou, Hua-Kai, "Prequalifying the Public Construction Profect Using Extended VIKOR with Entropy Measure", *Computers & Industrial Engineering* (**Accepted**). **(SCI)**

(9) Tzeng, Gwo-Hshiung and Chiou, Hua-Kai, "Hybrid DEA with Grey Relation Model to Measure the Perforance of Municipal Waste Recycling in Taiwan", *Computers & Industrial Engineering* (**Accepted**). **(SCI)**

(10) Tzeng, Gwo-Hshiung and Lin, Cheng-Wei, "Multi-criteria analysis of alternative-fuel buses for public transportation", *Energy Policy* (**Accepted**) **(SSCI)**

(11) Liu, S.T., Hsieh, T.Y. and Tzeng, G.H. "Decision Support System for Planning and Design Tender Selection in Public Buildings", *Computer-Aided Civil and Infrastructure Engineering* **(Accepted)**. **(SCI)**

(12) Shuai, Jia-Jane, Tzeng, Gwo-Hshiung, and Li, Han-Lin, "The Multi-source Fabless-Foundry Partnership Selection Model", *International Journal of Manufacturing Technology and Management*, Vol. 6, Nos.1/2, pp.137-154.

(13) Ong, Chorng-Shyong, Huang, Jih-Jeng, and Tzeng, Gwo-Hshiung, "Motivation and Resource Allocation for Strategic Alliance through De Novo Perspective", *Mathematical and Computer Modeling* (Accepted). (**SCI)**

(14) Yu, Jing-Rung, Tzeng, Y-C, Tzeng, Gwo-Hshiung, and Sheu, H.J., "Fuzzy Multiple Objective Programming Approach to DEA with Imprecise Data", *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* **(Accepted)**. **(SCI)**

(15) Chiou, Hua-Kai, Tzeng, Gwo-Hshiung and Cheng, Ding-Chou, "Evaluating sustainable development strategies using a fuzzy MCDM approach", *OMEGA: The International Journal of Management Science*. (**Accepted**) **(SCI, SSCI)**

(16) Tzeng, Gwo-Hshiung and Chiou, Hua-Kai, “Prequalifying the Public Construction Project Using a Compromise Optimization Method”, *Computer-Aided Civil and Infrastructure Engineering* **(Accepted) (SCI)**

(17) Hsu, Chi-Sheng; Lee, Zon-Yau; Hung, Chih-Young; Shih, Chintay; Yu, Hsiao-Cheng; Tzeng, Gwo-Hshiung, “Evaluation of R&D Organization Based on Fuzzy Multi-Objective DEA Model: The Case of Industrial Technology Research Institute in Taiwan”, *Computers and Industrial Engineering*. **(Accepted) (SCI)**

(18) Hsu, Chi-Sheng; Lee, Zon-Yau; Hung, Chih-Young; Shih, Chintay; Yu, Hsiao-Cheng; Tzeng, Gwo-Hshiung, “Key Factors in Performance Appraisal for R&D Organizations”, *Journal of Biomedical Fuzzy Systems*. **(Accepted)**

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(20) Tzeng, Gwo-Hshiung and Kang, Tsai-Hua “MADM Approach for Selecting the Consignment Performance with Cooperating the Information Service Company in the Computer Center of Institute of Technology”, *Journal of Information Management.* **(Accepted)** (in Chinese, Taiwan) (**TSSCI)**

(21) Tzeng, Gwo-Hshiung and Kang, Tsai-Hua, “Fuzzy MADM Approach for Evaluating the Consignment Performance with Cooperating the Information Service Company in the Computer Room of Institute of Technology”, *Journal of Information Management.* **(Accepted)** (Chinese, Taiwan) **(TSSCI)**

(22) Hu, Yi-Chung, Chiu, Yu-Jing and Tzeng, Gwo-Hshiung, “Grey Theory and Competence Sets for Multiple Criteria Project Scheduling”, *Chung Yuan Management Review*, Vol. 1, No. 2, pp.257-273, 2003 (in Chinese, Taiwan).

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(24) Opricovic, Serafim and Tzeng, Gwo-Hshiung, “Defuzzification for a Fuzzy Multicriteria Decision Model”, *International Journal of Uncertainty, Fuzziness and Knowledge-based Systems*, Vol. 11, No. 5, pp.635-652, 2003. **(SCI)**

(25) Hu, Yi-Chung, Chen, Ruey-Shun, and Tzeng, Gwo-Hshiung, “Finding Fuzzy Classification Rules Using Data Mining Techniques”, *Pattern Recognition Letters*, Vol. 24, No. 1-3, No. 1-3, pp. 509-519, 2003. **(SCI)**

(26) Hu, Yi-Chung, Chen, Ruey-Shun, and, Tzeng, Gwo-Hshiung, “Discovering Fuzzy Association Rules Using Fuzzy Partition Methods”, *International Journal of Uncertainty, Fuzziness and Knowledge-based Systems*, Vol. 16, No. 3, pp. 137 – 147, 2003. **(SCI)**

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Post-Earthquake Land-Use Planning", *Natural Hazards Review*, Vol. 4, No. 2, pp. 59-64, 2003. **(SCI)**

(28) Hsu, C. S., Lee, Z.Y., Shi, C.S., Hung, C.Y., and Tzeng, G.H. "The Clustering and Performance Efficiency of ITRI's R&D Units, *Journal of Technology Management*, Vol. 8, No. 2, 2003 (in Chinese, Taiwan).

(29) Chen, Ting-Yu and Tzeng, Gwo-Hshiung, "Exploring the Public Attitude Using Fuzzy Integrals", PanPacific Management Review, Vol. 6, No. 1, pp. 45-58, 2003.

(30) Hsu, Yeou-Geng, Shyu, Joseph Z., and Tzeng, Gwo-Hshiung, "Policy Tools on the Formation of New Biotechnology Firms in Taiwan", *Technovation* (**Accepted**). **(SCI)**

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(32) Shee, Daniel Y., Tzeng, Gwo-Hshiung and Tang, Michael T., "AHP, Fuzzy Measure and Fuzzy Integral Approaches for the Appraisal of Information Service Providers in Taiwan", *Journal of Global Information Technology Management*, Vol. 6, No. 1, pp. 8-30, 2003.

(33) Hu, Yi-Chung and Tzeng, Gwo-Hshiung, "Elicitation Of Classification Rules by Fuzzy Data Mining", *Engineering Applications of Artificial Intelligence*, Vol.16, No. 7-8, pp. 709-716, 2003. **(SCI)**

(34) Cheng, Hsin-Jung and Tzeng, Gwo-Hshiung, "Multiobjective Planning for Relief Distribution Systems", *Transportation Planning Journal*, Vol.32, No. 3, pp. 561-580, 2003. **(TSSCI)**

(35) Hu, Yi-Chung, Chen, Ruey-Shun, Tzeng, Gwo-Hshiung, and Chiu, Yi-Jing "Acquisition of Compound Skills and Learning Costs for Expanding Competence Sets", *Computers and Mathematics with Applications*. Vol. 46, No. 5-6, pp. 831-848, 2003. **(SCI)**

(36) Chen, Mei-Fang and Tzeng, Gwo-Hshiung, "Combining Grey Relation and TOPSIS Concepts for Selecting an Expartriate Host Country", Mathematical and Computer Modelling (Accepted, MCM4563, 10/23/03) **(SCI)**

2. International Conference Papers:

(1) Hua-Kai Chiou and Gwo-Hshiung Tzeng, "Prequalifying the Public Construction Project Using Extended VIKOR with Entropy Measure", Accepted to present on *The 32nd International Conference on Computers and Industrial Engineering* (*ICC&IE 2003*), Limerick, Ireland, August 11-13, 2003, pp.170-175.

(2) Hua-Kai Chiou, Chin-Huan Liao, Yen-Fang Chu and Gwo-Hshiung Tzeng, "Applied Hybrid DEA Model to Measure the Performance of Municipal Waste Recycling in Taiwan", Accepted to present on *The 32nd International Conference on Computers and Industrial Engineering* (*ICC&IE 2003*), Limerick, Ireland, August 11-13, 2003,

pp.584-589.

(3) Gwo-Hshiung Tzeng, Hua-Kai Chiou and Yen-Fang Chu, “Imprecise Data Envelopment Analysis for Evaluating the Performance of R&D Project in Taiwan”, Accepted to present on *The 33rd International Conference on Computers and Industrial Engineering* (*ICC&IE 2004*), Jeju, Korea, March 25-27,2004.

(4) Hua-Kai Chiou, Yu-Yuan Tsou and Gwo-Hshiung Tzeng, “Fuzzy Multiple Objective Programming with Bounded Method for Evaluating the Performance of Accounting & Statistics Departments of Taiwan Air Force”, Accepted to present on *The 6th International Conference on Multiple Objective Programming and Goal Programming* (*MOPGP 2004*), Hammamet, Tunisia, April 14-16, 2004.

(5) Hua-Kai Chiou, Gwo-Hshiung Tzeng, Gia-Shie Liu and Chih-Kang Cheng, “GM(1,1) Model for Forecasting the Intermittent Demand of Spare Parts in Navy of Taiwan”, Accepted to present on *The 6th International Conference on Multiple Objective Programming and Goal Programming* (*MOPGP 2004*), Hammamet, Tunisia, April 14-16, 2004.

(6) Hua-Kai Chiou and Gwo-Hshiung Tzeng, “Evaluating the Performance of R&D Project in Taiwan Using Data Envelopment Analysis with Imprecise Data”, Accepted to present on *The 6th International Conference on Multiple Objective Programming and Goal Programming* (*MOPGP 2004*), Hammamet, Tunisia, April 14-16, 2004.

(7) Hua-Kai Chiou, Gwo-Hshiung Tzeng, Chih-Kang Cheng and Gia-Shie Liu “Grey Prediction Model for Forecasting the Planning Material of Equipment Spare Parts in Navy of Taiwan”, Accepted to present on *The 5th World Automation Congress*(*WAC 2004*), Seville, Spain, June 28 – July 1, 2004.

(8) Hua-Kai Chiou, Gwo-Hshiung Tzeng, Benjamin J.C. Yuan and Chien-Pin Wang, “Fuzzy C-Means Clustering for the Optimal Portfolio of Machinery Industrial Sustainable Development Strategies in Taiwan”, Accepted to present on *The 5th World Automation Congress*(*WAC 2004*), Seville, Spain, June 28 – July 1, 2004.

(9) Hua-Kai Chiou, Gwo-Hshiung Tzeng and Wen-Han Tang, “Imprecise DEA with FMOP method for Evaluating the Performance of R&D Projects in Taiwan”, Accepted to present on *The 5th World Automation Congress*(*WAC 2004*), Seville, Spain, June 28 – July 1, 2004.

(10) Lee, Hong-Yuh, Tzeng, Gwo-Hshiung, and Yu, Hsiao-Cheng, “Fuzzy Multi-Criteria Decision-Making (FMCDM) for Evaluating IC Design House System on Chip Capability Strategy in Taiwan”, Portland International Conference on Management of Engineering and Technology, July 20-24, 2003, Portland, Oregon USA.

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(12) Lo, Mei-Chen, Chang, Chun-Yen, and Tzeng, Gwo-Hshiung, “Headcount Requirement Forecast Model for Wafer Fab Operation”, Portland International Conference on Management of Engineering and Technology, July 20-24, 2003, Portland, Oregon USA.
(13) Chen, Mei-Fang, Tzeng, Gwo-Hshiung, and Ding, Cherng G., “Fuzzy MCDM Approach to Select Service Provider”, The IEEE International Congerence on Fuzzy System, May 25-28, 2003, St. Louis Missouri, USA.
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四、 計畫成果自評

多評準決策為跨領域之整合性多面向思考的決策邏輯，相關理論及方法已被廣泛應用於公共政策、交通運輸、都市計畫、企業經營與管理、環境保護議題、競局理論等領域。過去一年來，本研究群的研究成果相當豐碩，未來將持續致力於此相關領域之研究，一方面開發新的理論模式，一方面深入產業及企業之實證研究，除了將研究成果發表於國際期刊外，並利用國際學術研討會之參與，與國際上知名學者專家進行學術交流，同時能將最新的理論思維引進國內，以提昇國內在此相關領域之研究水準，盡知識份子之社會責任。