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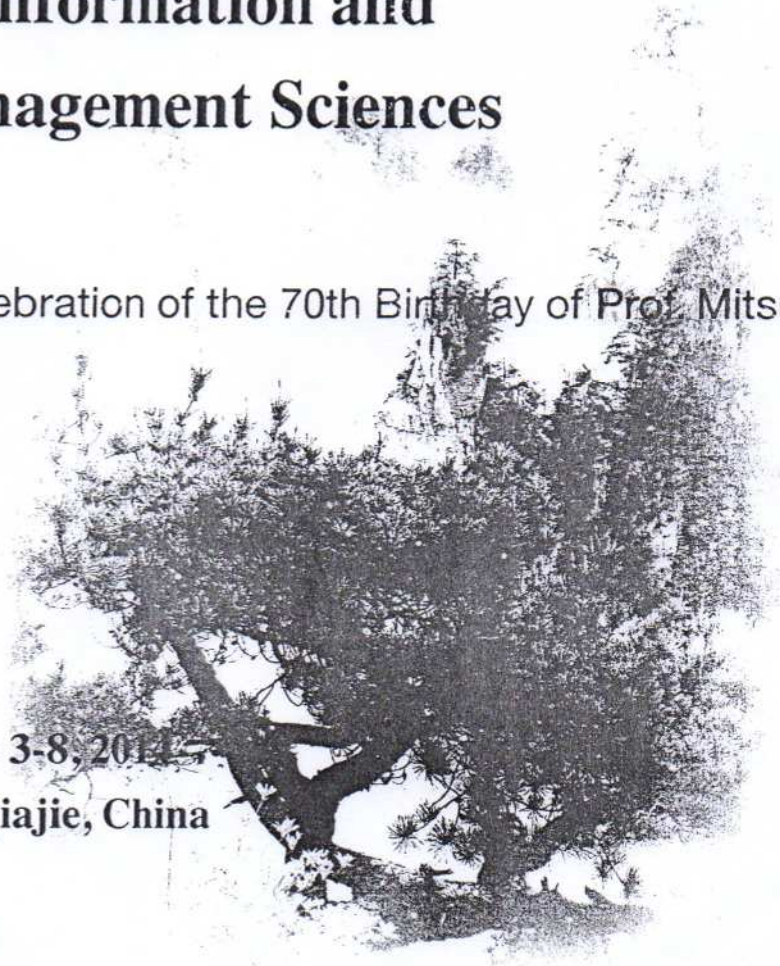
In Celebration of the 70th Birthday of Prof. Mitsuo Gen



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Foreword to the Proceedings of IMS 2014
In Honor of Professor Mitsuo Gen for His 70th Birthday

It is a great honor for me to write this preface to the Proceedings of the Thirteenth International Conference on Information and Management Sciences (IMS 2014) in celebration of the 70th birthday of Professor Mitsuo Gen. The conference IMS2014, sponsored by the International Association for Information and Management Sciences (IMS), will be held during August 3rd to 8th, 2014 at Zhangjiajie, Hunan Province, China. The conference aims to enhance the global competitiveness of the business enterprises through the application of information and management sciences. In addition the conference wishes to foster international collaborations among leading scientists, engineers and scholars from around the world. In fact, IMS conferences have quickly developed into an important forum for the exchange of new ideas among professionals in the theoretical and practical areas related to information and management sciences.

The IMS was founded on July 10, 2005. Now over ten years later, it has more than 50 board members. As the president of IMS Board (2013-2016), Professor Mitsuo Gen has made tremendous contributions to this academic organization. He has been invited to give plenary talks many times in this premier international forum for scientists and researchers presenting state-of-the-art of genetic algorithms and intelligent methods with applications in manufacturing systems design and computers, etc. In addition, he proposed an annual IMS award for best papers rewarding those who have obtained outstanding achievements in scientific research. Due to Dr. Mitsuo Gen's efforts, the excellent papers presented at our conferences can be successfully published in the special issues of famous international journals. Taking the opportunity given by this conference, we are honored to celebrate Professor Mitsuo Gen's 70th birthday.

Professor Mitsuo Gen has rich academic experience. He received the B.E., M.E., and Ph.D. degrees in electronic engineering from Kogakuin University, Tokyo, Japan, in the years 1969, 1971, and 1975, respectively, as well as a Ph.D. degree in informatics from Kyoto University, Kyoto, Japan, in 2006.

Dr. Mitsuo Gen is a Senior Research Scientist at Fuzzy Logic Systems Institute, Iizuka, Japan, and a Special Mission Professor at Tokyo University of Science, Tokyo, Japan. He was a Visiting Professor at the Department of Industrial Engineering and Engineering Management at National Tsing Hua University, Hsinchu, Taiwan. He is also Professor Emeritus at the Ashikaga Institute of Technology, Ashikaga, Japan. He was a faculty member at the Ashikaga Institute of Technology, and a professor at the Graduate School of Information, Production and Systems at Waseda University, Kitakyushu, Japan. From 1999 to 2000 he was a visiting professor at the Department of Industrial Engineering and Operations Research at University of California, Berkeley, CA, USA. Likewise at the Department of Industrial Engineering, Texas A & M University, College Station, TX, USA, in 2000, as well as a Hanyang Chair Professor at Hanyang University, Korea, from 2011 to 2012.

Professor Mitsuo Gen is a leading expert in the domain of evolutionary computing. His research interests cover evolutionary algorithms, manufacturing scheduling, logistics network and decision making. He has authored or coauthored more than 400 journal papers on high level international journals, including *IEEE Transaction on Reliability, IEEE Transaction on Automation Sci. Tech., European Journal of Operational Research, Journal of Operational Research Society, OR Spectrum, Networks, Computers & Operations Research, Computers & Industrial Engineering, International Journal of Systems Science, Computers in Industry, International Journal of Production Research, International Journal of Production Economics, Journal of Intelligent Manufacturing, Expert Systems with Applications, Soft Computing, Applied Soft Computing, Applied Mathematics & Computation, etc.* His recent citation index and the h-index of his papers are now 15,458 and 55, respectively. He

is currently serving as Editor-in-Chief of *Industrial Engineering & Management Systems*, the area editor of *Computers & Industrial Engineering* and the associate editor of *OR Spectrum*. Furthermore he also acts as editorial board member of various international journals including *Fuzzy Optimization and Decision Making, International J. of Manufacturing Technology and Management*, and *Journal of Uncertain Systems*.

As a worldwide acknowledged expert, Professor Mitsuo Gen has contributed greatly to the theoretical and experimental genetic algorithms (GA). He has published many books, including *Genetic Algorithms and Engineering Design* by Wiley in 1997, and *Genetic Algorithms and Engineering Optimization* by Wiley in 2000. These two books have been translated into Chinese. He is also a coauthor of other books such as *Introduction to Evolutionary Algorithms* in 2010, *Intelligent and Evolutionary Systems* in 2009, and *Network Models and Optimization: Multiobjective Genetic Algorithm Approach* in 2008 from Springer and others. He is widely regarded as one of the most influential scientists of our time. He is most famous for his GA research, but he also contributed to other areas of intelligent systems such as semiconductor manufacturing systems.

Each birthday is a milestone we reach on the road of life. It represents a new beginning and a new chance to get a foothold on the future. Today we take special pride in all the achievements a wonderful person has made. We look forward to greeting Professor Mistuo Gen and honoring his great work.

This preface is dedicated to Professor Mistuo Gen on the occasion of his 70th birthday. We wish Dr. Mitsuo Gen joyful days filled with friendliness, bright days filled with color, and warm days filled with happiness to last throughout all his life! Have a wonderful birthday!

Prof. Jin Peng
Huanggang Normal University

Welcome Message from the General Chair

With great pleasure and excitement, I welcome you to this Thirteenth International Conference on Information and Management (IMS2014) in Zhangjiajie, Hunan, China. Since its first meeting in 2002 in Xi'an, IMS has continued to hold annual conference in interesting cities all over China. I am delighted to report that 66 papers are accepted, and over 120 attendees are participating. Whether you are a newcomer or a frequent participant, I trust that you will soon experience the unique value and tradition that the IMS conference offers: (1) ample opportunities to share research findings, exchange ideas, and learn from fellow scholars, (2) well-designed tours that give you easy access to the local scenery and attractions, (3) carefully selected venues that offer favorite local foods and cultural displays, and most importantly, (4) a small community atmosphere to meet interesting people and make friends.

This year, we would also like to celebrate the 70th birthday of Professor Mitsuo Gen and to honor the contributions that he has made to IMS and to his field. Dr. Gen is a world-renown scholar in Industrial Engineering and Fuzzy Logic Systems. He has published more than a hundred papers in various research outlets and has directed numerous Ph.D. dissertations. He has been a frequent contributor and participant in past IMS conferences and has seen the President of IMS for the past few years. He is like a magnet that attracts other top scholars to IMS. This year, he has made a tremendous effort to organize a Special Issue in The Journal of Intelligent Manufacturing so that good papers in this Conference will be considered for its publication.

This proceedings contains contributions from a number of leading researchers. They address topics of both current theoretical and applied interest to the scientific community. The plenary talks will be addressed by Mitsuo Gen from Tokyo University of Science and Fuzzy Logic Systems Institute, Andrew Kusiak from the University of Iowa, Xiande Zhao from China-Europe International Business School, Hark Hwang from Korea Advanced Institute of Science and Technology, Dan A. Ralescu from University of Cincinnati, Zhilong Chen from University of Maryland, Hartmut Schwandt from Technische Universität Berlin, Jin Peng from Huanggang Normal University, and Jinwu Gao from Renmin University of China.

This conference is organized by the International Association for Information and Management Science, Tokyo University of Science & Fuzzy Logic Systems Institute, Japan, The Chinese University of Hong Kong, Tsinghua University, China and KAIST, Korea. It is no doubt that organizing and planning for IMS 2014 is a daunting task. Thus, I would like to show my appreciation to those people who have put in countless hours preparing for this gathering. First, we are grateful for the endeavors of the Program Committee (under Dr. Baoding Liu's leadership) and Mr. Kai Yao, the IMS2014 Secretary. There are several other committees that have worked behind the scenes to support many functions of the conference, such as publishing the proceedings selecting the best papers, making local arrangements, and conducting finance and accounting. I would also like to thank all authors for submitting their original scholarly works, as well as the reviewers for their time and effort to uphold the quality of this scholarly conference. To all participants of IMS2014, I wish you and your companions a pleasant and fruitful stay at Zhangjiajie.

Sincerely Yours
Jerry C. Wei
Mendoza College of Business
University of Notre Dame, USA
General Chair, IMS2014

Thirteenth International Conference on Information and Management Sciences

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Implementation of Hybridized Genetic Algorithm for Fuzzy Traveling Salesman Problem

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Abstract: The Traveling Salesman Problem (TSP) is known as one of NP-complete optimization problems that has taken great interest of the researchers. The common objective is to determine route through some cities facilities in order to minimize travel distance. The classic TSP usually assumes that the travel costs are deterministic. In the real-world applications, due to the complexity of social and economic factors, it is often difficult to have deterministic value of travel costs (i.e. travel time). One way of handling such uncertainty in decision making is by introducing fuzzy programming approach.

Since TSP is also usually very large, huge research efforts have been devoted to develop heuristic algorithms for solving TSP. It has also been reported that Genetic Algorithm could give a good solution of TSP within reasonable time.

In this paper, we consider a more realistic model called fuzzy TSP. By assuming that the travel costs between cities are represented by triangular fuzzy number, we examine how the route should be designed. We develop a GA hybridized with local approach to solve the problem. Several numerical experiments are done to show the effectiveness of the proposed method.

Keywords: Fuzzy number, Logistic, Traveling Salesman Problem, Genetic Algorithm, Local Search

I. Introduction

With the development of modern society, engineering design becomes an important part human being's life. How to solve the problems effectively and efficiently will be a great research issue in this century or even further future.

Since it was introduced by Holland (1975), Genetic Algorithm (GA) has been proven to be a valid and robust alternative in optimization fields (Goldberg, 1989; Davis, 1991). GA has been widely and sucessfully used in different area of appications engineering, finance, economics, agriculture, business and so on (Gen and Cheng, 2000; Michalewicz, 1994). For some specific optimization problems, however, we need more efforts to obtain an improvement of GA performance. It includes to combine some local search techniques into GA (Syarif, Yun and Gen, 2002; Syarif and Gen, 2003).

The Traveling Salesman problem refers to a special class of combinatorial optimization problems. Though it is not so clear who first introduced TSP, it has been very popular and taken a great attention of researchers since 1954 (Dantzig, Fulkerson and Johnson; 1954). It has been applied for various real world applications. The classical TSP is usually stated as a problem of finding the shortest possible tour through N "cities" so that each city is only visited at once. It seems to very easy to say, however, for large size problems, it is very difficult to solve. It belongs to the class to NP-Complete problems and cannot be solved exactly in polynomial time (Aarth and Lenstra, 1997). Thus, Solving TSP optimally would take to long and normally one would uses approximation algorithm or heuristic algorithms (Dorigo and Gambardella, 1997; Johnson and McGeoch, 2002). In our previous work, we also have implemanted GA approach for solving TSP (Syarif, Wamiliana and Yasir, 2007).

In real world applications, moreover, we often have more complex of social and economic factors that need to be considered. It includes the difficulty to determine the proper value of travel cost or travel time between cities. One way of handling such uncertainty in decision making is by introducing fuzzy programming approach (Gen and Cheng, 1997).

In this paper, we consider TSP with fuzzy coefficient (fTSP). We represent the travel time between the city by using triangular fuzzy nmber. Our major efforts in this work include the development of GA method and adopt fuzzy ranking technique for handing the objective functions and fuzziness. Numerical experiment results are presented to demonstrate the effectiveness of the proposed method.

II. Mathematical model

In this section, we shall present a comprehensive mathematical model of fuzzy TSP as follows:

Let

$$x_{i,j}\begin{cases}=1 \text{ if the route from citi } i \text{ to } j \text{ is taken}\\ =0 \text{ otherwise;}\end{cases}$$

Proceedings of Thirteenth International Conference on Information and Management Sciences, Zhangjiajie, China, August 3-8, 2014, pp. 6-9.

$$\min \quad z(x) = \sum_{i=1}^{n}\sum_{j=1}^{n} \tilde{t}_{i,j} x_{i,j}, \quad i \neq j \qquad (1)$$

$$\text{s,t.} \quad \sum_{i=1;i\neq j}^{n} x_{i,j} = 1, j = 1,2,...,n \qquad (2)$$

$$\sum_{j=1;j\neq i}^{n} x_{i,j} = 1, \quad i = 1,2,...,n \qquad (3)$$

where n is the number of cities. $\tilde{t}_{i,j}$ is a triangular fuzzy number representing travel time between the city i to city j

In the above model, the objective function captures the total traveling time or total routing cost. The constraint (2) and (3) ensure that each city is only visited at once.

III. Design of the algorithm

1. Ranking Fuzzy numbers

As stated earlier, in this paper, we consider TSP in which the cost values are represented as fuzzy number (triangular fuzzy number) (Gen and Cheng, 1997). A triangular fuzzy number $\tilde{A}$ used in this paper is denoted by (a_1, a_2, a_3) where a_1, a_2, a_3 are real numbers. Its membership function $\mu_{\tilde{A}}$ is given as follows (See also Figure 1 for the illustration of this membership function):

$$\mu_{\tilde{A}}(x) = \begin{cases} (x - a_1)/(a_2 - a_1), a_1 \le x \le a_2 \\ (x - a_3)/(a_2 - a_3), a_2 \le x \le a_3 \\ 0 \quad otherwise \end{cases}$$

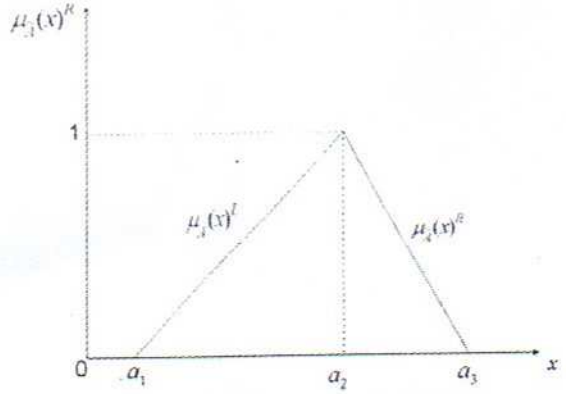


Figure 1. The membership function

When considering the optimization problem that its coefficients are represented with fuzzy numbers, the objective values of the problem will also be fuzzy numbers. One way to handling fuzzyness is the ranking fuzzy numbers with integral value technique proposed by Liou and Wang (1992). The basic concept of this technique is to rank the fuzzy numbers based on its total integral value. The left and right integral values are used to reflect the pessimistic and optimistic viewpoint of decision maker respectively. The total integral value is the n computed based on this degree of optimism and each objective function values. A parameter $\alpha \in [0,1]$ is given to adjust the degree of optimism.

Since it is clear from the above membership function that the left membership function $\mu_{\tilde{A}}(x)^L$ is continuous and strictly increasing, its inverse function $g_{\tilde{A}}(x)^L$ would exist and continuous on interval [0,1]. Thus it would be integrable on that interval. Similarly for the right membership function $\mu_{\tilde{A}}(x)^R$. Both the left and right integral values can be computed as follows:

$$I(\tilde{A})^L = \int_0^1 g_{\tilde{A}}(x)^L dy = \frac{1}{2}(a_1 + a_2)$$

$$I(\tilde{A})^R = \int_0^1 g_{\tilde{A}}(x)^R dy = \frac{1}{2}(a_2 + a_3)$$

Thus, the total integral value for triangular fuzzy number $\tilde{A}$ is

$$I_T^{\alpha}(\tilde{A}) = \alpha I(\tilde{A})^R + (1-\alpha) I(\tilde{A})^L$$

$$= \frac{1}{2}[\alpha a_3 + a_2 + (1-\alpha) a_1]$$

2. Genetic Algorithm For Fuzzy TSP

2.1. Chromosome representation

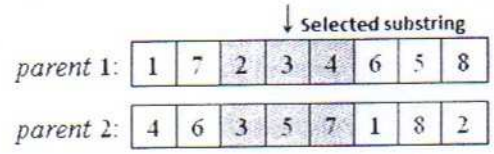
It is well known that the success of GA depends on several factors including an efficient design of the chromosome, genetic operator and so on. For TSP, one of the classical chromosome representations that can be used is permutation representation. Each chromosome represents the tour that is developed. An important issue here is how to generate chromosome that would bring us to a good solution. Instead of using random algorithm, in this research, we adopt Nearest-Neighborhood (NN) algorithm that is known to be better tour construction procedure. The NN algorithm is done by first selecting a node randomly. The next node in the tour is selected by selecting a node with nearest distance.

2.2. Genetic Operation

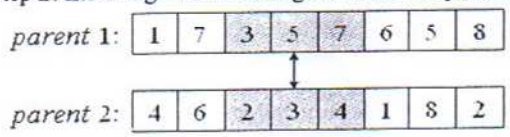
Crossover:

We employed **PMX** operation. This type of crossover is accomplished by selecting two parents of solutions and randomly taking a component from one parent to form the corresponding component of the offspring (Goldberg dan Lingle, 1985.). The procedure of PMX is given as follows:

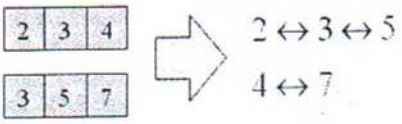
Step 1: Select substring of chromosome randomly



Step 2: Exchange the substring between two parents



Step 3: Determine the map bet gen in the substring



Step 4: Repair the chromosome using the information given by Step 3

Mutation:

To increase the variability of the population, mutation operation is done. We used here inversion mutation that can guarantee to generate feasible chromosome when the parents are feasible (Gen and Cheng, 1997).

Evaluation and Selection:

In our GA implementation, the evaluaton is done by calculating fuzzy objective for a given alpha value. We adopt the elitist selection strategy to keep the best chromosome from the current generation to the next generation.

2.3 Local Search

In order to obtain a good solution, we include local search techniques called *2-opt* into our GA process. this algorithm based on the idea that a good tour must not have crossing arcs. Thus, it is designed to omit the crossing arc in tour. The tour improvent is done by checking the following situation:

$$t(a, next(a)) + t(b, next(b)) > t(next(a), next(b)) + t(a, b). \quad (4)$$

As an example, consider the tour given in Figure 2. It is clear that arc (3,9) crosses arc (4,10). and $t(3,9) + t(4,10) > t(3,4) + t(9,10)$. Thus using *2-opt* algirthm we get a better tour as given in Figure 3.

IV. Numerical Experiment

In order to show its effectiveness, the proposed GA approach has been implemented in visual C language. Numerical experiments are done by modifying two benchmark test problems (mod-kroa150 and mod-eil76) given in the literatiure (Reinelt, 1991). The coefficients of the objectives are represented as triangular fuzzy numbers. Those represent three different speeeds (30 km/hour, 50 km/hour and 70 km/hour). We fixed the GA parameter as follows: crossover probability $p_C = 0.4$ and mutation probability $p_M = 0.2$, pop_size = 20 and max_gen =1000.

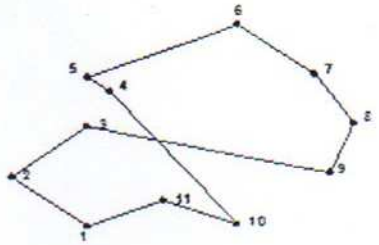


Figure 2. Tour with crossing arcs

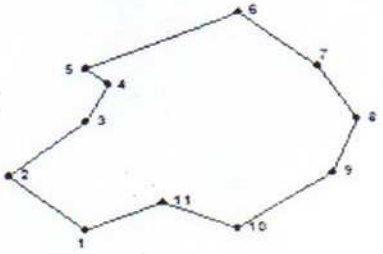


Figure 3. Improved tour with *2-opt*

For our numerical experiments, we run our program by varying the values of α between 0 and 1. These values represent different degree of optimism. The results of our experiments are summarized in Table 1. For $\alpha = 0.5$, the heuristic solution for those test problems can be seen in Figure 4. The results show that the smallest objective value can be obtained when we determine the problem based on optimistic degree ($\alpha = 0$). On the other hand, the highest objective function value is when based on the pessimistic degree ($\alpha = 1$). Thus with this situation, the decision makers can determine the range of objective value based on his/her degree of optimism. This would be very important for decision support system in the real world applications.

V. Conclusion

In this paper, we consider a TSP with fuzzy coefficient. We develop a Genetic Algorithm (GA) approach to find the best heuristic solution to the problem. The proposed method adopt the concept of the ranking fuzzy numbers with integral value for the evaluation. With this technique, the decision maker can determine his/her decision by giv-

ing flexible value for the degree of optimism. The experimental results show the effectiness of the proposed method. Thus this technique would be suitable for decision support system.

Table 1. Computational results

	Alpha										
Test Problem	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
mod-kroa150	455,41	494,39	518,83	522,09	556,59	581,52	606,89	632,25	675,03	682,97	729,43
mod-eil76	10,29	10,71	11,56	11,84	11,99	12,89	13,65	14,29	14,86	16,01	16,6

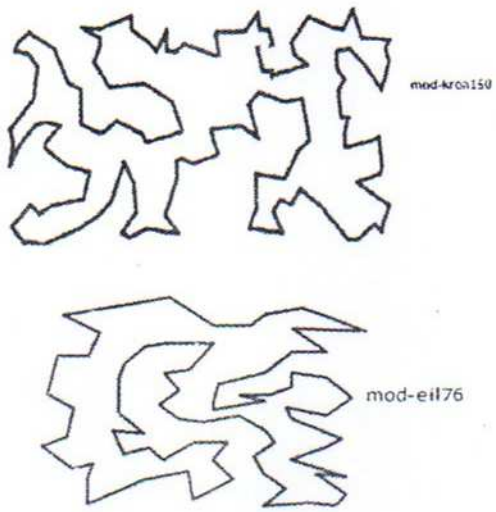


Figure 4 The best heuristic route for mod-kroa150 and mod-eil76 ($\alpha = 0.5$).

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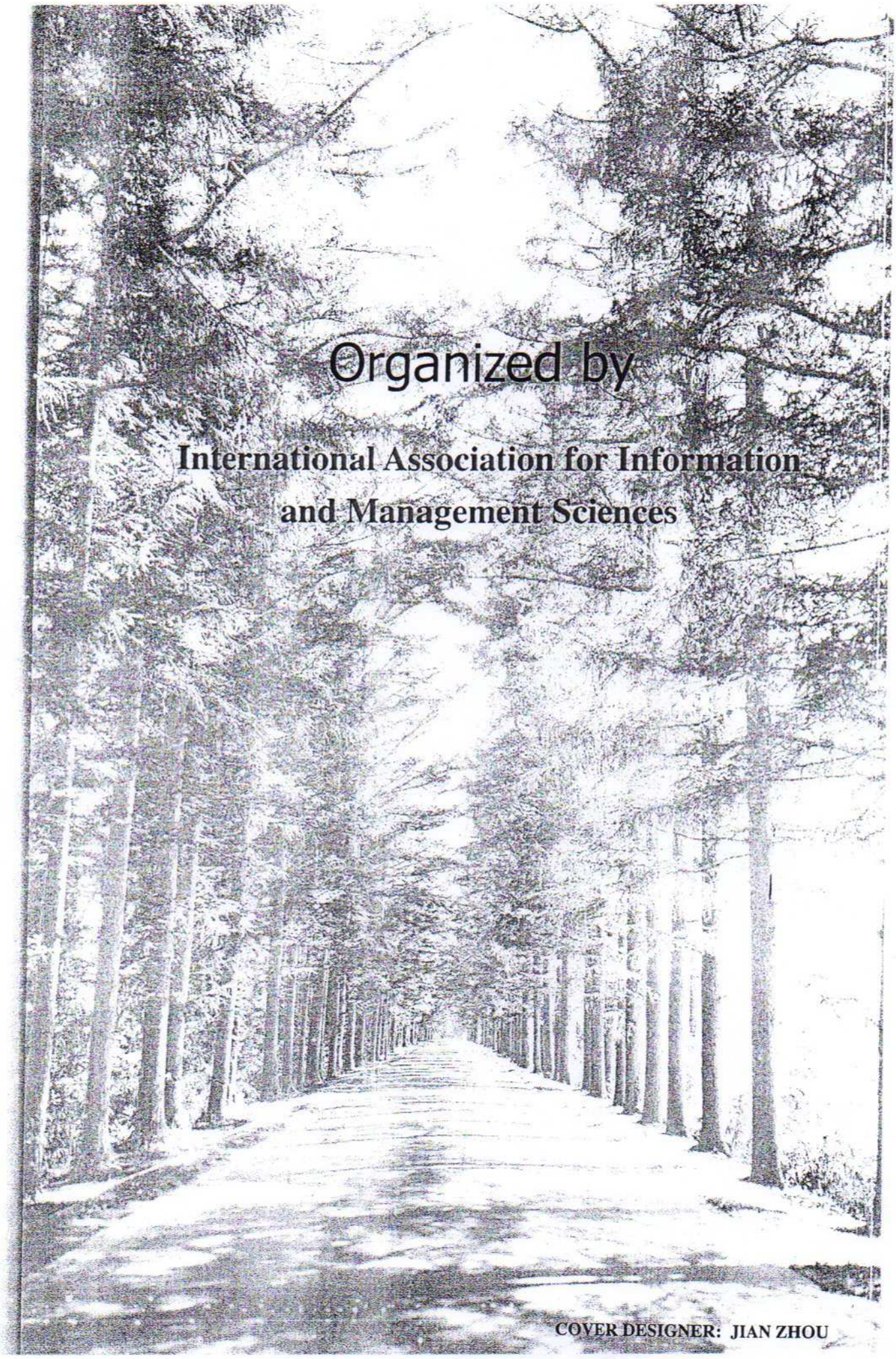

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