The 11th International Symposium on Operatoins Research and its Applications in Engineering, Technology, and Management (ISORA 2013)

Organizers

Asia-Pacific Operations Research Center
亚 太 运 筹 中 心

公益社団法人 日本オペレーションズ・リサーチ学会
The Operations Research Society of Japan

Sponsors

August 23-25, 2013
Huangshan, China

Schedule & Locations

Date	Time	Conference Room Lianjing 练江厅	Conference Room Shuaishui 率水厅
August 22 Thursday	15:00-23:00	Registration (hotel lobby)	
	18:00-19:00	Supper	
August 23 Friday	08:00-08:30	Registration (hotel lobby)	
	08:30-08:50	Opening Session	
	08:50-10:20	Plenary Session P1	
	10:20-10:50	Coffee break	
	10:50-12:20	Plenary Session P2	
	12:30-13:30	Lunch	
	14:00-15:40	Session A1: Optimization I	Session B1: Emergency Management
	15:40-16:00	Coffee break	
	16:00-17:40	Session A2: Optimization II	Session B2: Combinatorics
	18:00-20:00	Welcome Reception	
August 24 Saturday	08:30-10:10	Session A3: Support Vector Machine	Session B3: Game Theory
	10:10-10:30	Coffee break	
	10:30-12:10	Session A4: Modeling & Algorithms I	Session B4: Modeling & Algorithms II
	12:30-13:30	Lunch	
	14:00-15:40	Session A5: Modeling & Algorithms III	Session B5: Modeling & Algorithms IV
	15:40-16:00	Coffee break	
	16:00-17:40	Session A6: Modeling & Algorithms VI	
	18:00-20:00	Banquet	
August 25 Sunday	09:00-16:00	Meetings of Committees and Discussion about Next ISORA.	
	08:00-18:00	One day tour to Huangshan (Yellow Mountain). Departure at 8:00 from lobby.	

The 11th International Symposium on Operations Research & Its Applications

ISORA2013 Program

August 23-25, Huangshan, China

*The program subjects to revision based on further information and Ad Hoc presentation requests.

August 22 (Thursday) Registration

15:00-23:00	Registration, check in and pick up registration package at hotel lobby.
18:00-19:00	Supper

August 23 (Friday) Technical Sessions

08:00-08:30	Registration for late arrivals (hotel lobby)

Location	Conference Room Lianjing 练江厅
08:30-08:50	Opening Session Chair: Xiang-Sun Zhang & Tatsuo Oyama
08:50-10:20	Invited Speaker Session P1 Chair: Prof. Xiang-Sun Zhang
08:50-09:35	*Study on Complex Networks* **Prof. Peter Scermely,** the Semmelweis University, Budapest, Hungary
09:35-10:20	*Routing in Networks - Optimality vs Equilibrium* **Prof. Xiaodong Hu,** Chinese Academy of Science, President of ORSC
10:20-10:50	Coffee break
10:50-12:20	Invited Speaker Session P2 Chair: Prof. Tatsuo Oyama
10:50-11:35	*The Philosophy of Organization, a Japanese Case* **Prof. Koji Nishimoto,** International Institute for Languages, Waseda University, Japan
11:35-12:20	*The Sparsest Solution of Underdetermined Linear Systems: RSP-Based Theory* **Dr. Yunbin Zhao,** the University of Birmingham, UK

12:30-13:30	Lunch

Location	Conference Room Lianjiang 练江厅	Conference Room Shuaishui 率水厅
14:00-15:40	Session A1: Optimization I Chair: Prof. Suixiang Gao	Session B1: Emergency Management Chair: Prof. Wenguo Yang
14:00-14:25	*#1: The phase 1 simplex algorithm on the objective hyperplane* Pei-Wang Gao, Minjiang University, China	*#43: Investigating Major Factors to Affect Human Casualties of Natural Disasters and Reviewing Recovery Policies* Novia Budi Parwanto and Tatsuo Oyama, National Graduate Institute for Policy Studies, Japan
14:25-14:50	*#19: The Optimization of Natural Gas Pipeline Transmission and End Segment Gas Storage Scheme*	*#18: The Multi-Covering Location Problem of Emergency Service Facilities with Considering Disaster Losses*

	Yanlu Xu, Ningli Zhang, Yan Ma, Xiangfen Zhang and Shunbao Li, Shanghai Normal University, China	Wenfeng Zhou, Zhenping Li, Beijing Wuzi University, China
14:50-15:15	*#40: Joint Pricing and Production Decisions for New and Remanufactured Products* Huayi Li, Xiaosong Ding and Jihong Zhang, International Business School, Beijing Foreign Studies University, China	*#23: Robust p-median Model for Facility Location Problem Based on Scenario Analysis in Emergency Management* Jianming Zhu, Jun Huang and Degang Liu, University of Chinese Academy of Sciences, China
15:15-15:40	*#36: Resource Loading: Applications and Complexity Analysis* Fabrice Talla Nobibon, Roel Leus, Kameng Nip, Zhenbo Wang, Belgium KU Leuven and Tsinghua University, Belgium	*#33: Enumeration of region partitioning for evacuation planning based on ZDD* Atsushi Takizawa, Yasufumi Takechi, Akio Ohta, Naoki Katoh, Takeru Inoue, Takashi Horiyama, Jun Kawahara and Shin-Ichi Minato, Kyoto University, Japan
15:40-16:00	**Coffee break**	
16:00-17:40	**Session A2: Optimization II** **Chair: Dr. Yunbin Zhao**	**Session B2: Combinatorics** **Chair: Prof. Xiaodong Hu**
16:00-16:25	*#32: Integer Linear Programming for Transforming Pairwise Based Results to the Original Ratings* Ping Ji and Jian Jin, The Hong Kong Polytechnic University, HKSAR	*#52: Optimization model and simulation for improving ambulance service system* Hozumi Morohosi and Takehiro Furuta, National Graduate Institute for Policy Studies, Japan
16:25-16:50	*#22: Reliable telecommunication network design problem under node failure* Tie Liu, Wenguo Yang, Ruguo Bu, Jun Huang, University of Chinese Academy of Sciences, Beijing, China	*#9: Optimization Methods on the Planning of the Time Slots in TD-SCDMA System* Zhipeng Jiang, Xiaodong Hu and Suixiang Gao, University of Chinese Academy of Sciencec, China
16:50-17:15	*#46: Method of Centres for Solving Mathematical Programs with Fuzzy Parametric Variational Inequality Constraints* Heng-You Lan, Chang-Jiang Liu and Tian-Xiu Lu, Sichuan University of Science & Engineering, China	*#16: A polynomial-time Algorithm for Edge Coloring a Planar Graph with no Adjacent Short Cycles* Ling Xue, Taishan Polytechnic University, China
17:15-17:40	*#21: Non-negative Matrix Factorization based on Locally Linear Embedding* Congying Han, Guangqi Shao, Hao Yong and Tiande Guo, University of Chinese Academy of Sciences, Beijing China	*#37: Dynamic Traveling Salesman Problem with Deadline based on Traveler's Risk Attitude* Qiang Guo and Jianming Zhu, University of Chinese Academy of Sciences, China

18:00-20:00	**Welcome Reception**

August 24 (Saturday) Technical Sessions

Location	Conference Room Lianjing 练江厅	Conference Room Shuaishui 率水厅
08:30-10:10	**Session A3: Support Vector Machine** **Chair: Prof. Zhenping Li**	**Session B3: Game Theory** **Chair: Prof. Jihong Zhang**
08:30-08:55	*#29: Label-Based Multiple Kernel Learning for Classification* Yang Bing, Qian Li, Lujia Song, Fu Changhe and Jing Ling, China Agriculture University, Beijing, China	*#12: The Effects of Inducing Strategies on Cooperation in Prisoner's Dilemma Games* Fu-Jiang Sun, Qi-Qing Song, College of Science, University of Technology, Guilin, China

08:55-09:20	*#30: Least Squares Support Tensor Machine* Lv Meng, Zhao Xinbin, Song Lujia, Shi Haifa and Jing Ling, China Agriculture University, China	*#15: Design and Analysis of a Maintenance Service Contract* Zhaotong Lian, University of Macau, Macau SAR
09:20-09:45	*#44: Biased Locality-Sensitive Support Vector Machine Based Density for PU learning* Lujia Song, Bing Yang, Ting Ke, Xinbin Zhao and Ling Jing, China Agriculture University, Beijing, China	*#31: Equilibrium strategy in an M/M/1 queue with a single vacation and setup times* Dequan Yue, Ruiling Tian and Wuyi Yue, Yanshan University, China & Konan University, Japan
09:45-10:10	*#49: Twin support vector regression for the determinants of inflation: a comparative study of two periods in China.* Yafen Ye, Xiaojun Liu, Yuanhai Shao and Jiaoyu Yuan, Zhijiang College, Zhejiang University of Technology, China	*#41: Communication Leading to Coalition Nash Equilibrium II -- S4n-Knowledge Case --* Takashi Matsuhisa, Ibaraki National College of Technology, Ibaraki, Japan
10:10-10:30	**Coffee break**	
10:30-12:10	**Session A4: Modeling & Algorithms I** **Chair: Prof. Mingzhe Li**	**Session B4: Modeling & Algorithms II** **Chair: Prof. Wuyi Yue**
10:30-10:55	*#4: The Analysis of Growth and Reproduction of Industrial Clusters Based on View of Ecological Coexistence* Manfeng Liu, Song Ying, Nanchang University, Jiangxi, China	*#47: Color calibration model of skin lesion images for computer-aided diagnostic* Leszek Nowak, Marcin P. Pawlowski, Kasia Grzesiak-Kopec and Maciej Ogorzalek, Jagiellonian University, Krakow Poland
10:55-11:20	*#26: Lower Bounds for the Multislope Ski-Rental Problem* Hiroshi Fujiwara, Yasuhiro Konno and Toshihiro Fujito, Toyohashi University of Technology, Japan	*#42: Research on the Train Ticket Overbooking Strategy for Transportation during the Spring Festival* Zhi-Xin Liang, Shuo Wen and Feng-Wen Yang, Beijing Wuzi University, Beijing, China
11:20-11:45	*#10: Incentive on Knowledge Management in Collaborative Supply Chain with Reciprocal Preference* Lily He, SWUST, China	*#48: Coordination Mechanism of Joint Procurement through Quantitative Discounts* Hongwei Liu, Beijing Wuzi University, China
11:45-12:10	*#51: Using Cellular automata to Model Eolutionary Dynamics of Social Network* Jinshan Li, Zhizuo Chen and Tao Qin, Beijing Forestry University, China	*#35: Performance Evaluation of the Energy Saving Mode for DRX in LTE Systems* Shunfu Jin, Yan Zhang and Wuyi Yue, Yanshan University, China & Konan University, Japan

12:30-13:30	**Lunch**

Location	Conference Room Lianjiang 练江厅	Conference Room Shuaishui 率水厅
14:00-15:40	**Session A5: Modeling and Algorithms III** **Chair: Dr. Lingyun Wu**	**Session B5: Modeling and Algorithms IV Chair: Prof. Degang Liu**
14:00-14:25	*#7: Universal Model with Arithmetic of Twice Turn Angle Shooting for Predetermine Encountering State* Hanquan Dong, Minghua Lu, Changyou Xue, Navy Submarine Academy, China	*#13: A Minimum Cost k-reliable Network Interdiction Model* Jia Zhao, Juyun Wang, Hua Yu, University of Chinese Academy of Sciences, China
14:25-14:50	*#17: A Method of Information Quality Assessment of Ship ASW Operation* Jian Liu, Changyou Xue and Yongjie Wang, Navy Submarine Academy, Qingdao, China	*#28: A hybird algorithm of two kinds of trust region methods* Peipei Zhou, Qinghua Zhou and Yue Yang, Hebei University, China

14:50-15:15	*#3: Wake Homing Torpedo Confronts with Warship Based on Game Theory* Sun Zhufeng, Zhu Weiliang and Xue Changyou, Navy Submarine Academy, Qingdao, China	*#34: Fuzzy Portfolio Selection with Transaction Costs based on Decision Making* Hongwei Liu, Beijing Wuzi University, China
15:15-15:40	*#45: The study of release immunization strategy in weighted complex network* Hui-Jia Li, Chi Zhang and Xiang-Sun Zhang, Chinese Academy of Sciences, China	*#11: Inverse DEA model with considering return to scale and elesticity* Xiaoya Li and Jinchuan Cui, Chinese Academy of Sciences, China
15:40-16:00	**Coffee break**	
16:00-17:40	**Session A6: Modeling and Algorithms VI** **Chair: Dr. Yong Wang**	
16:00-16:25	*#14: Competitive Facility Location Problem with Geographical Interdiction and Aggregation Effect* Zhenping Li, Jieqiong Hu, Beijing Wuzi University, China	
16:25-16:50	*#2: Mathematical Models for the Best Water Usage Strategy* Zhenping Li, Jieqiong Hu and Fei Zhao, Beijing Wuzi University, China	
16:50-17:15	*#38: A new support vector machine for the classification of positive and unlabeled examples* Junyan Tan, Ling Zhen, Naiyang Deng and Chunhua Zhang, China Agriculture University, Beijing, China	
17:15-17:40	*#27: On the use of hybrid models in wedge trust region* Yue Yang, Qinghua Zhou and Fengxia Xu, Hebei University, China	

18:00-20:00	**Banquet**

August 25 (Sunday) Meetings of Committees/Tour

09:00-16:00	**Meetings of Committees and Discussion about Next ISORA**
08:00-18:00	One day tour to Yellow Mountain (One-day-tour-tickets are needed)
08:00-09:00	Gathering in front of the hotel and depart to Yellow Mountain
09:00-10:00	Take park bus and cable car to the top of mountain
12:30-13:30	Lunch
16:00-17:00	Down to the park gate
17:00-18:00	Take bus back to the hotel
18:00-19:00	**Supper at the hotel**

Note: Those who leave Huangshan on August 25 may check out the hotel before 8:00 and deposit luggage at the reception desk. Do not leave your luggage in bus because the buses may be used by other passengers during the day.

Influential nodes and plasticity/rigidity transitions of complex networks

Peter Csermely

(Semmelweis University, H-1094 Budapest, Hungary)

Abstract:

There is an increasing recognition that complex systems are shifting their structure and behavior between two major states: a more plastic and a more rigid state. Network plasticity increases the learning potential of the system. However, a highly plastic system will be unable to keep changes: will not have memory. An increase in system rigidity increases the memory storing ability of the system. Alternating changes of plasticity and rigidity emerge as a highly efficient optimization strategy. Importantly, rapidly dividing cells have more plastic networks than differentiated cells. As an example of this, the community structure of the protein-protein interaction network of yeast cells became more condensed upon stress (PLoS Comput. Biol. 7, e1002187). Plastic networks are dissipating perturbations well. (Actually, too well...) Therefore, plastic networks need to be attacked at their most rigid segments, i.e. at their most central nodes. Importantly, this is the drug targeting strategy of rapidly growing cancer cells or parasites. On the contrary, if rigid networks are attacked at their most central nodes, they easily become over-saturated, over-excited. This may lead to increased side-effects and toxicity. Therefore, rigid networks need to be attacked at their most plastic segments, which are in the neighborhood of the most central network nodes. Importantly, this is the drug targeting strategy of differentiated cells in all other diseases (Pharmacology & Therapeutics, 138, 333-408).

Earlier several node-types, such as hubs, bridges, bottlenecks have been proposed as key actors of cellular processes. Our group developed the ModuLand program package, which is a novel method-family detecting pervasively overlapping communities, as well as their core-node(s), bridges and 'creative nodes' connecting multiple modules at the same time (www.linkgroup.hu/modules.php). Inter-community nodes play a critical role in the regulation of networks, such as our high-confidence signaling network, www.SignaLink.org. Recently we defined two novel centrality measures based on the excellence in perturbation propagation (perturbation-centrality; www.linkgroup.hu/Turbine.php), or on the ability of a node or edge to establish or break cooperation in repeated social dilemma games (game-centrality; www.linkgroup.hu/NetworGame.php). Both dynamic centrality types defined influential network nodes with higher biological relevance than conventional network centrality measures. These algorithms are important novel tools in finding influential nodes of networks.

Key words:

creative nodes; learning; memory formation; network dynamics; network modules; perturbation centrality; plasticity; rigidity; social dilemma games; stress

Routing in Networks - Optimality vs Equilibrium

Xujin Chen, Xiaodong Hu

Academy of Mathematics and Systems Science, CAS, Beijing 100190, China
xchen@amss.ac.cn, xdhu@amss.ac.cn

Keywords: Routing, Congestion Game, Optimality, Nash Equilibrium

Abstract

Routing is one of the most important topics in not only operations research but also computer and communication technologies. As one of the classic optimization problems, researchers focus on how to route all traffic in an optimal and efficient way in terms of some objective functions. In the past decade, researchers began to consider routing, particularly in large scale networks, as a game where each user routes his/her own traffic individually and selfishly for the interest of his/her own. Under such a setting, the routings achieved reach a stable state, called Nash equilibrium, from which no user would deviate unilaterally. In this talk we will present our recent study on selfish routing on ring networks. We will give the analysis of inefficiency of Nash equilibrium for minimizing maximum latency and show how to improve the inefficiency of Nash equilibrium for minimizing maximum load via cooperation among only a small number of users.

1 Introduction

Routing in computer and communication networks is the process of selecting paths/trees along which to send traffic. For decades, it has been the responsibility of network designers to route traffic and all network users are assumed to obey the protocol. Our work focuses on rings which are frequently encountered in communication networks. For examples, seven self-healing rings form the EuroRings network, the largest, fastest, best-connected high-speed network in Europe, spanning 25,000 km and connecting 60 cities in 18 countries. As its name suggests, the Global Ring Network for Advanced Applications Development (GLORIAD) [22] is an advanced science internet network constructed as an optical ring around the Northern Hemisphere. The global ring topology of the network provides scientists, educators and students with advanced networking tools, and enables active, daily collaboration on common problems. It is therefore worthwhile to study this topology in particular. Indeed, considerable research has already gone into studying rings in the context of designing approximation algorithms for combinatorial optimization problems (e.g., [16, 35, 36]).

However, modern networks usually operate at a scale that makes the use of centralized protocols challenging. Thus, recent trends in the design and analysis of network routing take into account the rational behaviors of selfish network users. Among many others, *selfish routing* [34] models network routing from a game-theoretic perspective, in which network users are viewed as self-interested strategic *players* participating in a competitive game. Each player, with his/her own pair of source and destination nodes in the network, aims to establish a communication path (between his/her source and destination) along which he/she experiences latency or bottleneck congestion as low as possible. We are interested in both in our recent work [14, 15].

In the absence of a central authority which can impose and maintain globally efficient routing strategies on network traffic, network designers are often interested in a stable outcome that is as close to the system optimum as possible. The most popular solution concept of *Nash Equilibrium* (NE) refers to the stable state from which no individual would deviate unilaterally. Given a certain social cost that measures the network performance (e.g., the overall maximum link load in SRL), the efficiency of NE is often quantified by *Price of Anarchy* (PoA) and *Price of Stability* (PoS), which are the worst-case ratio and the best-case ratio, respectively, between the social costs in a NE and in a globally optimal solution [4].

Most of the existing research has focused on the price of anarchy for minimizing the total latency of all the players [33, 1]. In most cases, a symmetric setting was considered where all players have the same source node and the same destination node, and hence the same strategy set. It was proved [17, 7] that the PoA of the atomic congestion game (symmetric or asymmetric) with linear latency is at most 2.5. This bound is tight. The bound grows to 2.618 for weighted demands [7], which is again a tight bound. In non-atomic congestion games with linear latencies, the PoA is at most 4/3 [34]. This is witnessed by two parallel links. The same paper also extended this result to polynomial latencies.

In one of our recent work [14], we regard as social cost function the maximum latency a player experiences. While this cost function was suggested already in [28], it seems much less understood. For general topologies, the maximum PoA of atomic congestion games with linear latency is 2.5 in single commodity networks (symmetric case, all player choose paths between the same pair of nodes), but it grows to $\Phi(\sqrt{k})$ in k-commodity networks (asymmetric case, k players have different nodes to connect via a path) [17]. The PoA further increases with additional restrictions

to the strategy sets. It was showed [21] that when the graph consists of n parallel links and each player's choice can be restricted to a particular subset of these links, the maximum PoA lies in the interval $[n-1, n)$.

For non-atomic selfish routing, it was showed [30] that the PoA of symmetric games on n-node networks with arbitrary continuous and non-decreasing latency functions is $n-1$, and exhibited an infinite family of asymmetric games whose PoA grows exponentially with the network size. In our recent work [14], we have shown that the PoA for minimizing the maximum latency on rings is exactly 2.

In another one of our recent work [15], we study *selfish routing in ring networks on maximum load* (referred to as SRL) in which both individual players and the central authority wish to minimize their own maximum link loads. Our study on SRL is inspired by the end-to-end packet delivery in communication networks, where each packet is to be delivered along a path greedily selected by its corresponding player without considering the system-wide criteria. In heavily congested networks, the delay of a packet is governed by the bottleneck congestion (the maximum link load) the packet experiences [10]. From a systemic perspective, the performance of a communication network is closely related to the performance of its most congested link [9, 18, 32], especially when robustness to bursty traffic [8] or to growing demand [37] is a priority.

Although the *selfish routing in general networks on maximum load* (referred to as SL) always admits NE, its PoA can grow linearly with the size of network; the known worst case of SL appears in ring networks [10]. This suggests a natural starting point – SRL, for improving SL games. Good resolution for SRL may provide insights for pursing nice outcomes in SL.

While NE is a powerful tool for predicting outcomes in competitive environments, its notion of stability applies only to unilateral deviations under the assumption that users (players) are completely non-cooperative, isolated entities in networks (games), acting not only selfishly but also independently. However, in numerous competitive situations, given today's communication infrastructure, a group of selfish users may and does coordinate a joint deviation if it is profitable to all the members of the group [31]: businesses agree to cooperate for mutual benefits, and agents contract bilaterally or multilaterally to take joint actions for common efficiency [5]. In these more realistic situations that allow some level of coordination, the NE is not necessarily sustainable in that it may not reflect rational behaviors of players.

To address the issue of coordination in competitive games, the concept of *Strong Equilibrium* (SE) was introduced in [6], which ensures stability against deviations by *every* possible coalition of players, namely, no coalition of any size can cooperatively deviate in a way that *strictly* benefits *all* the group members, taking the actions of the players outside the coalition as given. The resilience to deviations by all coalitions turns out a very robust and appealing notion of stability, motivating extensive research on SE [2, 3, 19, 26]; but this stronger equilibrium concept suffers from a major criticism: it is too strong in the sense that SE rarely exists. Even if in some cases we can prove SE exists in theory, or even more luckily, find a SE in polynomial time, it is usually very hard for a distributed system to reach such a strong equilibrium by self-organized players. As pointed out by [25], players may not all cooperate for the greater good because of communication and/or computation difficulty in large networks (see also [3, 27, 29]). On the other hand, we must recognize that, in many cases, players will form small coalitions to improve their well-being [25]. Unfortunately, in some settings small coalitions do not necessarily help a lot, or even worse, harm the social welfare [25, 29] in comparison with the corresponding coalition-free game.

So in [15], we generalizes the model to so-called SRL with collusion (SRLC) which allows coordination within any coalition of up to k selfish players on the condition that every player of the coalition benefits from the coordination. We prove that, for m-player game on n-node ring, the PoA of SRLC is $n-1$ when $k \leq 2$, drops 2 when $k = 3$, and is at least $1 + 2/m$ for $k \geq 4$. Our study shows that on one hand, the performance of ring networks, in terms of maximum load, benefits significantly from coordination of self-interested players within small-sized coalitions; on the other hand, the equilibrium routing in SRL might not reach global optimum even if any number of players can coordinate.

The rest of this extended abstract is organized as follows. We summarize our recent work on selfish ring routing for minimizing maximum latency [14] and maximum load [15] in Sections 2 and 3, respectively, where all details are omitted (but available upon request). We conclude the extended abstract in Section 4 with some problems for future study.

2 Selfish Ring Routing for Minimizing Maximum Latency

In our study on selfish routing for minimizing maximum latency in rings [14], we analyze the PoA of a maximum latency network congestion game for ring networks. As in most previous work, we assume that traffic may not be split, because this causes the problem of packet reassembly at the receiver and is therefore generally avoided. Furthermore, we assume that the edges (links) have linear latency functions. That is, each link e has a latency function $l_e(x) = a_e x + b_e$, where x is the number of players using link e and a_e and b_e are nonnegative constants.

For the problem of minimizing the maximum latency, even assuming a central authority, the question of how

to route communication requests optimally is nontrivial; it is not known whether this problem is in P. It is known for general (directed or undirected) network topologies that already the PoS is unbounded for this goal function even for linear latency functions [12, 13]. However, this is not the case for rings. It has been shown that for any instance on a ring, either its PoS equals 1, or its PoA is at most 6.83, giving a universal upper bound 6.83 on the PoS for the selfish ring routing [12]. The same paper also gave a lower bound of 2 on the PoA. Recently, an upper bound of 16 on the PoA was obtained [13].

In this work [14], we show that the PoA for minimizing the maximum latency on rings is exactly 2. This improves upon the previous best known upper bounds on both the PoA and the PoS [13, 12]. Achieving the tight bound required us to upper bound a high-dimensional nonlinear optimization problem. Our result implies that the performance loss due to selfishness is relatively low for this problem. Thus, for ring routing, simply allowing each agent to choose its own path will always result in reasonably good performance.

Our proof consists of two main parts: first, we analyze for NE the maximum ratio of the latency of any player to the latency of the entire ring, and then we analyze the ratio of the latency of the entire ring in a NE to the maximum player latency in an optimal routing. In the first part we show that this ratio is at most roughly 2/3; the precise value depends on whether or not every link of the ring is used by at least one player in the NE. For the second ratio, we begin by showing the very helpful fact that it is sufficient to consider only instances where no player uses the same path in the Nash routing as in the optimal routing. For such instances, we need to distinguish two cases. The first case deals with instances for which there exists a link that in the NE is not used by any player. For such instances we use a structural analysis to bound the second ratio from above by $2 + 2/k$, where k is the number of agents in the system.

For the main case in which the paths of the players in the NE cover the ring, we show that the second ratio is at most 3. We begin by using the standard technique of adding up the Nash inequalities which state that no player can improve by deviating to its alternative path. This gives us a constraint which must be satisfied for any NE, but this does not immediately give us an upper bound for the second ratio. Instead, we end up with a nonlinear optimization problem: maximize the ratio under consideration subject to the Nash constraint. The analysis of this problem was the main technical challenge of this paper. We use a series of modifications to reach an optimization problem with only five variables, which, however, is still nonlinear. It can be solved by Maple, but we also provide a formal solution.

3 Selfish Ring Routing for Balancing Load via Coalitions

In our work on selfish routing for balancing load via coalitions in rings [15], we refer *SRL with Collusion* (SRLC) to the SRL game that allows dynamic coalitional cooperations. Our results show that *small-sized* coalitions do improve the network performance in SRL *significantly*, leading to outcomes with nearly optimal efficiency. Without bothering with exponentially many possible coalitions as an SE has to consider, the SRL with small coalition is easy to form and therefore very practical from an algorithmic point of view.

Our SRLC model generalizes the SRL game, which is the restriction of SL to ring networks. The PoA of SL for general networks is smaller than $2(\ell+n)$, where ℓ stands for the length of the longest path a player may select and n stands for the number of network nodes [10]. The worst case of SL discovered so far occurs in rings, where the PoA can be both as high as $n-1$. We also conjecture that the matching upper bound on the PoA of SL in general networks equals the length of the longest cycle in the network minus 1, which equals both $n-1$ and $\ell-1$ for ring networks.

Because cooperation among autonomous players may be mutually beneficial even if the players selfishly try to optimize their own objectives, the PoA and PoS arguably conflate the effects of selfishness (which is still reserved in SE) and lack of coordination (which disappears in SE). For this reason, the measures to be *k-Strong Price of Anarchy* (k-SPoA) and *k-Strong Price of Stability* (k-SPoS), with respect to the so called *k-Strong Equilibrium* (k-SE), were refined in [3] where they are strategy profiles in which no coalition of size at most k have any joint deviation beneficial to all members. To be precise, the k-SPoA (resp. k-SPoS) is defined as the ratio of the social cost in the worst (resp. best) k-SE to that in a global optimum. The concept of k-SE generalizes both NE (which is a 1-SE) and SE (which is an m-SE in m-player games). Following convention, the "k-" is often omitted from the notions when integer k equals the number of players in the game.

Employing k-SE has a potential to reduce the PoA, since every k-SE is a NE but not vice versa. In the extreme case of SE where k equals the number of players, it has been shown that the SPoA is significantly lower than the PoA in many settings of competitive games (see, e.g., [2, 3]). Nevertheless, SE mainly make sense in small networks where players have substantial information about the overall structures and can coordinate their actions [27]. Emergent efforts have been devoted to investigating k-SE for general k. It was shown that the k-SPoA falls in

$$\left[\frac{(l-1)(m-l+1)}{k-l+1}, \frac{2l(n-l+1)}{k-l+2}\right]$$

for job scheduling game with $l(\leq k)$ unrelated machines

and m jobs [3, 20], and falls in

$$\Big[\max\{\frac{m}{k}, \sum_{i=1}^{m}\frac{1}{i}\}, \frac{m}{k}\sum_{i=1}^{k}\frac{1}{i}\Big]$$

for fair connection game with m players [2, 19]. Albeit these efforts, for small k the existing results on k-SE are not so attractive in the aspect of practical applications. Even worse situations happen in some network creation games [3] where no k-SE exists for any $k \geq 3$.

Concerning the major downside of the demanding SE, various works have studied its existence in particular families of games [2, 3, 19, 26]. Closely related to our SRLC model is the recent introduction of π-*Lexicographic Improvement Property* (π-LIP) [23]. They showed that games of π-LIP always possess SE, and identified so called *bottleneck congestion games*, which enjoy the π-LIP and include job scheduling [3], SL [10] and hence SRLC (this paper) as special cases.

While our SRLC model, as well as k-SE, works with *dynamic* coalitions, other different approaches have been taken to study the effect of coalition formation in network games based on *static* coalitions which are formed according to an exogenous partition over the set of players [24, 25]. Under certain settings, the quality of the solution can deteriorate by an arbitrarily high factor in the presence of static coalitions.

In addition to the number of coalition members, other natural restrictions have been imposed to admissible coalitions in efforts to improve the quality of outcomes in the decentralized setting. It was studied in [29] how the PoA and PoS of network formation games with Sharpley cost allocation are affected by allowing locally coordinated coalitions of players, where a group of players can form a coalition if they share a link. This kind of local cooperation does not necessarily lead to better PoA, and increases PoS from $\Theta(\log m)$ to $\Theta(m)$ in m-player games. Along a different line of network formation, the pairwise stability was proposed in [27], which is a variant of 2-SE for investigating the (in)compatibility of overall societal welfare with incentives of self-interested individuals to form and sever network links. Some connection between pairwise stability and 2-SE was recently established in [11].

In our recent work [15], we restrict our attention to SRLC, and will often omit the reference to SRLC in our presentation. We prove that when coordination within coalitions of size up to 3 is allowed, the PoA of equilibrium outcomes drops from $n-1$ (linear in the ring size n) to constant 2. More specifically, we establish 3-SPoA $= 2$ against PoA $\geq$ 2-SPoA $= n-1$. Hence, using coordination in 2- and 3-player coalitions, we achieve a significant improvement in terms of the PoA, compared to noncooperative and pairwise coordination environments. Few selfish routing models in literature enjoy such an interesting property as SRLC: small-sized coalitions can greatly improve not only the gains of individual players but also the performance of the whole network.

We also show that the m-SPoA $\in [1+\frac{2}{m}, 2]$ is strictly greater than 1, and the k-SPoA $\in [\frac{k-1}{k-2}-\varepsilon, 2]$ is at most 2, where $k \geq 3$ and $\varepsilon > 0$ can be arbitrarily small.

We strengthen the existence of SE [23] by showing that every optimal routing in SRLC is a SE. Since an optimal routing for SRLC is derivable in polynomial time [36], an immediate algorithmic corollary says that a SE in SRLC can be found in $O(m \log m)$ time and in $O(m)$ time when $m \geq n$.

4 Conclusions

As summarized in Section 2, we have shown [14] that the PoA of the network congestion game is two, when the network is a ring and the link latencies are linear. It is left open whether the PoA is exactly 2^d for polynomial latency functions of degree d.

As summarized in Section 3, we have studied the selfish ring routing game for load balancing that allows coalitions among self-interested players (SRLC). Our main results show [15] that the k-SPoA of SRLC is bounded above by 2 for all $k \geq 3$, in contrast to its unbounded PoA $=$ 2-SPoA $= n-1$. This significant improvement on global efficiency is highly realizable in decentralized environments since players themselves are able to easily determine (say by enumeration) coalitions of size at most three whose deviation can make every member better off. This approach is particularly useful for large scale competitive games, where only small-scale communication and computation are realizable. For future work, it is interesting to explore the weighted version of SRLC, where atomic selfish ring routing has to carry nonuniform traffic between different source-destination pairs. We believe that k-SPoA of SRLC with nonuniform traffic could also be upper bounded by some constant for all $k \geq 3$. Our preliminary study shows that 3-SPoA is at most 6 when there are only two different weights. Other challenging direction is to investigate if the method could be extended to general networks, making good global balance via small coalitions and some other techniques.

Of course, a more challenging task is to analyze what happens in more complicated network topologies.

Acknowledgments

Our work on selfish ring routing was finished by jointly working with B. Chen, B. Doerr, C. Doerr, J. Hu, W. Ma, R. van Stee, and supported in part by NNSF of China under Grant No. 11021161 and 11222109, 973 Project of China under Grant No. 2011CB80800.

References

[1] Aland S., Dumrauf D., Gairing M., Monien B., and Schoppmann F., Exact price of anarchy for polynomial congestion games, Lect Notes Comput Sci, 2006, 3884, pp. 218–229.

[2] Albers S., On the value of coordination in network design. SIAM J Comput, 2009, 38, pp. 2273–2302.

[3] Andelman N., Feldman M., Mansour Y., Strong price of anarchy, Games Econom Behav, 2009, 65, pp. 289–317.

[4] Anshelevich E., Dasgupta A,, Kleinberg J., Tardos É., Wexler T., Roughgarden T., The price of stability for network design with fair cost allocation, SIAM J Comput, 2009, 38, pp. 1602–1623.

[5] Arcaute E., Johari R., Mannor S., Network formation: bilateral contracting and myopic dynamics, IEEE Trans Automat Control, 2009, 54, pp. 1765–1778.

[6] Aumann R., Acceptable points in general cooperative n-person games. Contributions to the Theory of Games 4. Princeton University Press, Princeton, N.J., 1959, pp. 287–324.

[7] Awerbuch B., Azar Y., Epstein A., The price of routing unsplittable flow, Proc of STOC 2005, pp. 57–66.

[8] Banerjee A., Yoo J., Minimizing maximum logical link congestion in packet switched optimal networks, Proc of ICC 1997, 3, pp. 1298–1302.

[9] Banner R., Orda A., Bottleneck routing games in communication networks, IEEE J Sel Areas Commun, 2007, 25, pp. 1173–1179.

[10] Busch C., Magdon-Ismail M., Atomic routing games on maximum load, Theoret Comput Sci, 2009, 410, pp. 3337–3347.

[11] Calvó-Armengol A., İlkılıç R., Pairwise-stability and Nash-equilibria in network formation, Int J Game Theory, 2009, 38, pp. 51–79.

[12] Chen B., Chen X., Hu X., The price of atomic selfish ring routing, J Comb Optim, 2010, 9(3), pp. 258–278.

[13] Chen B., Chen X., Hu J., Stability vs. optimality in selfish ring routing, to appear at Acta Mathematica Sinica, 2013.

[14] Chen X., Doerr B., Doerr C., Hu X., Ma W., Stee R., The price of anarchy for selfish ring routing is two, submitted to ACM Trans Econom and Comput, 2013.

[15] Chen X., Hu X., Ma W., Balancing load via small coalitions in selfish ring routing game, submitted to WINE 2013.

[16] Cheng C.T., Improved approximation algorithms for the demand routing and slotting problem with unit demands on rings, SIAM J Discrete Math, 2004, 17, pp. 384–402.

[17] Christodoulou G., Koutsoupias E., The price of anarchy of finite congestion games, Proc of STOC 2005, pp. 67–73.

[18] Cole R., Dodis Y., Roughgarden T., Bottleneck links, variable demand, and the tragedy of the commons, Proc of STOC 2006, pp. 668-677.

[19] Epsteina A., Feldmanb M., Mansour Y., Strong equilibrium in cost sharing connection games, Games Econom Behav, 2009, 67, pp. 51–68.

[20] Fiat A., Kaplan H., Levy M., Olonetsky S., Strong price of anarchy for machine load balancing. Lect Notes Comput Sci, 2007, 4596, pp 583–594.

[21] Gairing M., Lucking T., Marios Mavronicolas, and Burkhard Monien, The price of anarchy for restricted parallel links, Parallel Process Lett, 2006, 16(1), pp. 117–132.

[22] GLORIAD, Global ring network for advanced applications development, http://www.gloriad.org.

[23] Harks T., Klimm M, Möhring H., Srong Nash equilibira in games with the lexicographical improvement property. Lect Notes Comput Sci, 2009, 5929, pp 463–470.

[24] Harks, T., Stackelberg strategies and collusion in network games with splittable flow, Lect Notes Comput Sci, 2009, 5426, pp. 133–146.

[25] Hayrapetyan A., Tardos É, Wexler T., The effect of collusion in congestion games, Proc of STOC 2006, pp. 89–98.

[26] Holzman R., Law-yone N., Network structure and strong equilibrium in route selection games, Math Social Sci, 2003, 46, pp. 193–205.

[27] Jackson M.O., A survey of models of network formation: stability and efficiency. Group Formation in Economics: Networks, Clubs and Coalitions, Cambridge Univ Press, Cambridge, UK, 2012.

[28] Koutsoupias E., Papadimitriou C.H., Worst-case equilibria, Lect Notes Comput Sci, 1999, 1563, pp. 404–413.

[29] Leonardi S., Sankowski P., Network formation games with local coalitions, Proc of PODC 2007, pp. 299–305.

[30] Lin H., Roughgarden T., Tardos É., Walkover A., Stronger bounds on Braess's paradox and the maximum latency of selfish routing, SIAM J Discrete Math, 2011, 25(4), pp. 1667–1686.

[31] Procaccia A.D., Rosenschein J.S., The communication complexity of coalition formation among autonomous agents, Proc of AAMAS 2006, pp, 505–512.

[32] Qiu L., Yang Y.R., Zhang Y., Shenker S., On selfish routing in internet-like environments, IEEE ACM Trans Networking, 2006, 14, pp. 725–738.

[33] Roughgarden T., The price of anarchy is independent of the network topology, Proc of STOC 2002, pp. 428–437.

[34] Roughgarden T., Tardos É., How bad is selfish routing? J ACM, 2002, 49(2), pp. 236–259.

[35] Schrijver A., Seymour P.D., and Winkler P., The ring loading problem, SIAM J Discrete Math, 1998, 11(1), pp. 1–14.

[36] Wang B.-F., Linear time algorithms for the ring loading problem with demand splitting, J Algorithms, 2005, 54(1), pp. 45–57.

[37] Wang Y., Wang Z., Explicit routing algorithms for Internet traffic engineering, Proc of ICCCN 1999, pp. 582–588.

The top of a cliff, here too is an invite of the Moon

When the late Master (=Basho*) came up to the capital (=Kyoto), Kyorai** said to him: "Master, Shudo (=a friend of Kyorai's & member of of Basho's haiku-circle) said he would rather put 'monkey of the Moon'*** (in lieu of 'invite of the Moon'). I retorted, houever, that invite would be better. What is your judgement on this point?"

The late Master said: "What on earth has a 'monkey' got to do here?! You, when you composed this haiku, what intent had you in mind?"

Kyorai 's answer was: "One evening of bright moonshine, off I went in the countryside, wandering & meditating aloud one verse or another. And there, perched on top of a cliff, I saw a haiku poet-extravagant (like myself)."

The late Master said: "Put yourself forward and say: 'Here am I, an invite of yours, Mistress Moon!', thus making the poem talking about yourself. That will bring forth some poetic fantasy. You should by all means make this poem talk of yourself. Prizing it very highly, I have already included this haiku in my (circle's) anthology 'Oi-no-Kobumi ' (=Opuscule in the Rucksac)."

My initial intent in comosing the poem, then, was indeed twice or even thrice inferior! Interpreting it after the late Master's manner, its author emerges doned with a certain air of poetic extravagance! Setting myself aback and now considering the haiku talking exclusively of its author invested with an air of poet-fantaisit, the poem's interest grew tenfold more than in its original intent . Verily author himself didn't know of its real value!

* Matsuo Bashyo (=松尾芭蕉, 1644-94)

** Mukai Kyorai (=向井去来, 1651-1704)

*** Mu-Xi (=牧渓, 北宋仏僧・画人, Buddhist monk & painter, Northern Sung Dynasty (13th c,) 『猿猴図』, & 長谷川等伯, Japanese painter (16th c.) 『猿猴捉月図』(A monkey trying to catch Moon)

（2） *Liu Ting－Zhi*（劉 廷之、別伝曰、宋 之問*(Sung Zhi-Men)*作之）:
『代悲白頭翁』(= *"Lamentation on behalf of white haired old man"*）

「年年歳歳花相似、 歳歳年年人不同」
（＝ Year in and year out, flowers bloom idenntical,
Year out and year in, men are't the same.）

（3） Paul Valery （1871－1945）, French poet of Symbolist School :
"J'avais pense et naivement note, peu de temps aupravant, cette opinion en forme de voeu: que si je devais ecrire, j'aimerais infinimentmieux ecrire en toute conscience et dans une entiere lucidite quelque chose de

faible, que d'enfanter a la faveur d'une transe et hors de moi-meme un chef-d'oeuvre d'entre les plus beaux.″

(= I have thought and naively noted, a little while ago, this opinion in the form of a vow: that should I ever write (poems), I would infinitely prefer to write in the fullest awareness and lucidity (of mind) something feeble, than to give birth , thanks to a trance and beside myself, to a masterpiece, (even) among the most beautiful ones.)

(3') Stephan Mallarme (1842-93), founder of French symbolist poetic school:

″ *Un coup de de', JAMAIS n'abolira le HASARD !* ″ *(Igitur)*

(= A throw of dice, NEVER will it eliminate the CHANCE !)

THE SPARSEST SOLUTION OF UNDERDETERMINED LINEAR SYSTEMS: RSP-BASED THEORY

Yunbin Zhao[1]

[1]*School of Mathematics, University of Birmingham, Edgbaston, Birmingham B15 2TT, United Kingdom*
Email: y.zhao.2@bham.ac.uk

Keywords: Sparsest solutions, linear system, ℓ_1-minimization, cardinality minimization, sparse signal recovery, compressed sensing.

Abstract

Many data types arising from signal and image processing and other engineering fields can be sparsely represented, and various data processing tasks such as compression, reconstruction, transmission and separation can formulated as the so-called cardinality minimization problem

$$\min\{\|x\|_0 : Ax = b\},$$

where $A \in R^{m\times n}$ $(m < n)$ is a matrix, and $b \in R^m$ is a vector, and $\|x\|_0$ is the cardinality of x, i.e., the number of nonzero components of x.

The aim of this problem is to locate a sparsest solution to the linear system $Ax = b$. This is a NP-hard problem, to which even the profound linear algebra do not efficiently apply. However, this problem lies in the core of the newly developed Compressed Sensing theory pioneered by Donoho [2], Candés, Tao [1], etc. One of the heuristic method for cardinality minimization is the ℓ_1-minimization

$$\min\{\|x\|_1 : Ax = b\}.$$

which, in signal and imaging literature, is called the Basis Pursuit method.

A fundamental question addressed over the past a few years is: *When does ℓ_1-minimization solve the cardinality minimization problem?* However, various sufficient conditions developed so far remain very restrictive. This stimulates us to further examine the relationship between the cardinality minimization and ℓ_1-minimization problems. Thus it is necessary to introduce the following concepts:

Definition 1 (Zhao [4]) (i) *Cardinality-minimization and ℓ_1-minimization problems are said to be strongly equivalent if the unique solution to cardinality minimization coincides with the unique solution to ℓ_1-minimization.* (ii) *Cardinality-minimization and ℓ_1-minimization problems are said to be equivalent if there exists a solution to cardinality minimization that coincides with the unique solution to the ℓ_1-minimization problem.*

It is evident that the *equivalence* does not require that the cardinality problem have a unique solution, but the *strong equivalence* does. In general, the system $Ax = b$ may have multiple sparsest solutions, and does not meet the *strong equivalence* condition. At present, most of the existing conditions (sufficient conditions) for the relationship of cardinality minimization and ℓ_1-minimization are largely developed for the strong equivalence. The main incentive of such development is the newly developed compressed sensing theory. This theory builds some conditions under which sparse signals can be exactly recovered by certain decoding methods, including the ℓ_1-minimization method.

While extensive researches have been undertaken over the past a few years, many fundamental questions remain open or not adequately addressed. For instance,

- Can the numerical performance of basis pursuit method be more efficiently explained by a new theory than the current theory?
- When the linear system has multiple sparsest solutions, under what condition the ℓ_1-method can guarantee to find a sparsest solution?
- How to deterministically interpret the limit of basis pursuit method for finding a sparsest solution?
- Can we further develop a new theory for sparsity recovery based on some new matrix property rather than existing ones?

To address these questions, we introduce the new property: range space property (RSP), motivated very naturally from optimization theory itself and from the practical needs of further development of sparse signal recovery theory and applications.

Our RSP-based theory goes beyond the existing recovery theory. It turns out to be a new angle for the study of sparsity recovery theory. We can apply this theory to deal with a wider range of linear systems than the existing theory. This theory can successfully interpret the strong equivalence and equivalence

of caridnality-minimization and ℓ_1-minimization, even when the existing theory fails.

To largely address the afore-mentioned open questions, we first prove the following theorem:

Theorem 1 (Zhao [4]) *x is the unique least ℓ_1-norm solution to the linear system $Ax = b$ if and only if the so-called range space property (RSP) and a full-rank property hold at x.*

This theorem completely characterized the condition for the uniqueness of ℓ_1-minimizer. Based on this theorem, we may further addressed the afore-mentioned questions, and we may develop a new sparse signal recovery theory. For instance, together with a Fuchs [3]'s theorem, we may prove the following result:

Theorem 2 (Zhao [4]) *A sparsest solution to a linear system is the unique least ℓ_1-norm solution of the system if and only if it satisfies the range space property (irrespective of the multiplicity of sparsest solutions).*

The RSP-based analysis enables us to go beyond the existing theory and to deal with the linear system with multiple sparsest solutions, and this new analysis can efficiently interpret the numerical performance of Basis Pursuit method, better than most of the existing theory. As a result, a new recovery theorem for compressed sensing can be developed, based on the so-called RSP of order K. For instance, we obtained the following theorem:

Theorem 3 (Zhao [4]) *Any K-sparse signal can be exactly recovered by ℓ_1-method if and only if A^T has the RSP of order K.*

Finally, we briefly discuss the partial-information-based recovery problems. The theory and methods for such problems have been recently discussed by several authors. In practice, some information for target vectors is known. For instance, the cardinality $\|x\|_0 = k$ is known, or even part of the support of vectors is known. The problem is to recover its full support and associated values. We take such a case as an example to show how the concept of Weak-RSP can be easily adapted to cope with such recoveries. We may define the following more relaxed concept than the RSP of order K.

Definition 2. (i) (PRSP of order K) *A^T is said to satisfy the partial range space property (PRSP) of order K if for any disjoint subsets S_1, S_2 of $\{1, ..., n\}$ with $|S_1| + |S_2| = K$, the range space $\mathcal{R}(A^T)$ contains a vector η such that $\eta_i = 1$ for all $i \in S_1$, $\eta_i = -1$ for all $i \in S_2$, and $|\eta_i| < 1$ otherwise.* (ii) (PWRSP of order k) *A^T is said to have partial weak range space property (PWRSP) of order K if for any disjoint subsets $S_1, S_2 \subseteq \{1, ..., n\}$ such that $|S_1| + |S_2| = K$ and $\begin{pmatrix} A_{S_1} & A_{S_2} \end{pmatrix}$ has full column rank, the range space $\mathcal{R}(A^T)$ contains a vector η such that $\eta_i = 1$ for all $i \in S_1$, $\eta_i = -1$ for all $i \in S_2$, and $|\eta_i| < 1$ otherwise.*

Based on the above definition, we can prove the following result.

Theorem 4 *Assume that the measurements of the form $y = Ax$ are taken.*

(i) *Any x with $\|x\|_0 = K$ can be exactly recovered by the ℓ_1-method if and only if A^T satisfies the PRSP of order K, where $K < Spark(A)$.*

(ii) *Any x with $\|x\|_0 = K$ and $\begin{pmatrix} A_{J_+} & A_{J_-} \end{pmatrix}$ being full-column-rank can be exactly recovered by the ℓ_1-method if and only if A^T has the PWRSP of order K, where $K \leq m$.*

Of course, tailored to different types of available information, we would like to seek for sensing matrices with other specific RSPs, other than the Definition 2. We now give a simple example of partial-information-based recovery via partial RSPs.

Example 1. Suppose that $\|x\|_0 = 2$ and $\text{Supp}(x) \subset \{1, 2, 3\}$ are known information for vector $x \in R^4$. Clearly, there are infinitely many such 2-sparse vectors in R^4. Can we recover all such sparse vectors? Consider the 3×4 matrix

$$A = \begin{pmatrix} 1 & 0 & 0 & 1/\sqrt{3} \\ 0 & 1 & 0 & 1/\sqrt{3} \\ 0 & 0 & 1 & 1/\sqrt{3} \end{pmatrix}.$$

By checking the possible vectors in $\mathcal{R}(A^T)$, it is easy to verify that A^T satisfies the following PWRSP of order 2: For any two disjoint subsets S_1, S_2 of $\{1, 2, 3\}$ with $|S_1| + |S_2| = 2$, the matrix $\begin{pmatrix} A_{S_1} & A_{S_2} \end{pmatrix}$ has full column rank, and $\mathcal{R}(A^T)$ contains a vector satisfying that $\eta_i = 1$ for $i \in S_1$, $\eta_i = -1$ for $i \in S_2$, and $|\eta_i| < 1$ for else components. Thus, by Theorem 4(ii), all sparse vectors with $\|x\|_0 = 2$ and $\text{Supp}(x) \subset \{1, 2, 3\}$ can be exactly recovered by ℓ_1-minimization using this sensing matrix. Note that not all 2-sparse vectors with $\|x\|_0 = 2$ can be exactly recovered by this matrix. In fact, some 2-sparse vectors with $x_4 \neq 0$ does not satisfy the RSP and thus cannot be recovered by ℓ_1-minimization. Also, it is not difficult to check that A^T satisfies certain PWRSP of order 3, and hence a proportion of 3-sparse vectors (which are the vectors with highest sparsity for this example) can be exactly recovered by the above matrix as well.

References

[1] E. Candès, Compressive sampling, *International Congress of Mathematicians*, Vol. III, 2006, pp.1433–1452.

[2] D. Donoho, Compressed sensing, *IEEE Trans. Inform. Theory*, 52 (2006), pp. 1289–1306.

[3] J.J. Fuchs, On sparse representations in arbitrary redundant bases, *IEEE Trans. Inform. Theory,* 50 (2004), pp.1341–1344.

[4] Y.B. Zhao, RSP-Based Analysis for Sparsest and Least ℓ_1-Norm Solutions to Underdetermined Linear Systems, Tech Report, School of Mathematics, University of Birmingham, 2012 (Revised 2013).

Parallel Sessions

#1

The Phase 1 Simplex Algorithm On The Objective Hyperplane

Pei-Wang Gao

Department of Mathematics, Minjiang University, Fuzhou 350121, China
pwgao640328@yahoo.com

This paper presents a new phase 1 simplex algorithm for solving linear programming problems. In the algorithm, first, the equation with the auxiliary objective function at the optimality as a new constraint is added to phase 1, and then a pivot is performed to generate one vertex on the associated objective hyperplane. This vertex may be feasible or not feasible. If it is feasible, the phase 1 sim-plex algorithm ends. Otherwise, proceed with the succes-sive iterations fixed on the objective hyperplane. Next, three variants are presented to achieve a feasible vertex or the conclusion that the original problem is infeasible. Var-iant 1 is a dual simplex algorithm without the row ratio test. In variants 2 and 3, the ideas of the bounding hyper-plane method and MBU dual simplex algorithm are ap-plied, respectively. Finally, computational study is done to test the efficiencies of three variants comparing to the ordinary simplex algorithm on some standard test prob-lems from NETLIB and MIPLIB, showing that variant 1 is simple in pivot rule, and variant 2 generally uses fewer iterations to solve those problems, and variant 3 generally spends less executive time at each iteration in the solution process.

#2

Mathematical Models For The Best Water Usage Strategy

Zhenping Li[1], Jieqiong Hu[2], Fei Zhao[2]

School of Information, Beijing Wuzi University, Beijing 101149, China; 2 Department of Postgraduate, Beijing Wuzi University, Beijing 101149, China. lizhenping66@163.com

In this paper, we investigate the best water usage strategy problem of China. Firstly, based on the historical date from 2004 to 2012, we forecast the fresh water supply and demand in each province in the near future by GM(1,1) model. Then we calculate the supply-demand gap and the pure fresh water surplus in each province, and partition all provinces into water supplying provinces and water-demanding provinces according to their signs of pure fresh water surplus. We formulate the problem into a linear programming model and a mix integer linear programming model respectively. The total costs in each model are calculated by the data of 2012. The total costs obtained from the mix integer linear programming model are 18680.59 billion yuan, which are 51883.53 billion yuan less than that obtained by the linear programming model. The results show that we can reduce the total costs of water usage by using multiple methods including pipeline transportation, desalinization and conservation etc.

#3

Wake Homing Torpedo Confronts With Warship Based On Game Theory

Sun Zhufeng, Zhu WeiLiang, Xue Changyou

Navy Submarine Academy，QingDao 266071, China Sun_zf@163.com

The process of wake homing torpedo attacking the target warship is a typical antagonized chase & evade problem. We have developed a two person zero sum game model to describe this problem and used LINGO to find out the optimal strategies for each players based on linear programming. We divide the strategies of the WHT as well as the target into several typical situation and construct the reward matrix of the game. The results show that there is no saddle point in common situation. Both sides of the game can receive the optimal results if the optimal mixed strategies are followed. Compared with traditional torpedo attacking method, this paper has revealed more possibilities for the submarine torpedo attacking results under sophisticated sea battle environment.

#4

The Analysis of Growth and Reproduction of Industrial Clusters Based on View of Ecological Coexistence

Liu Man-feng[1] Song Ying[2]

1.Cluster and Enterprise Development Research Center of Jiangxi University of Finance & Economics, Nanchang, Jiangxi, 330013; 2. Economic & Management School of Nanchang Hangkong University, Nanchang, Jiangxi, 330063 liumangfeng@sina.com, 362612807@qq.com

The behavior of industrial cluster is similar to the behavior of biological population, that is, the industrial cluster is seemed to be an ecological symbiotic system. The relationship between economic organizations in the industrial cluster is similar to the relationship of species in ecological system, and symbiotic reciprocity, competition and cooperation are the basic. The ecological development is mainstream and direction of industrial cluster. In this paper, firstly, we studied the ecological symbiosis growth model of industry cluster, and found it being according to logistic growth model; secondly, we studied the growth and reproduction of economic organizations in industrial cluster in three different cases, which with only competition relations, only beneficial relations, and both competition and beneficial cooperation relationship between economic organizations, and finally, we determined the number of economical organizations when the industrial cluster attained ecological equilibrium.

#7

A Universal Model With Arithmetic Of Two Turn Angle Shooting For Predetermined Encountering State

Han.-Quan.Dong, Ming.-Hua. Lu and Chang.-You.Xue

Navy Submarine Academy, Qingdao 266071, China powerd7868@163.com

For solving the problem of calculating two turn angle shooting parameter with predetermined encountering state, by considering with possible process of special trajectory and shifting torpedo velocity, a universal model which satisfied the requirement of different shooting mode was constructed, and a formulas concerning Newton iteration arithmetic was given. The correctness of the model and arithmetic was validated by numerical experiment; some conclusion indicated that the model and arithmetic could satisfy the requirements to calculate shooting parameter for straightforward, sound auto-guiding, wake-homing, salvo and target selection, etc.

#9

Optimization Methods on the Planning of the Time Slots in TD-SCDMA System

Z.-P. Jiang[1], S.-X. Gao[2]

1 Academy of Mathematics and Systems Science, CAS, Beijing 100190, China; 2 School of Mathematical Sciences, UCAS, Beijing 100049, China lstjzp07@aliyun.com, sxgao@ucas.ac.cn

TD-SCDMA is the third-generation mobile communication standard of our country that adopts time slot duplex and code division multiple access (CDMA). Time slots planning, i.e. the division of uplink and downlink time slots, is critical in TD-SCDMA. Most existing algorithms and strategies are greedy algorithm, which can't ensure the optimality or approximate optimality of the result. In this paper, some optimization models on the planning of the time slots for single channel problem and multiple channel problem are proposed. The simulation result show that our method can get a good result.

#11

Inverse Dea Model With Considering Returns To Scale And Elasticity

X.-Y. Li[1], J.-C. Cui[1]

1 Academy of Mathematics and Systems Science, CAS, Beijing 100190, China xyli@amss.ac.cn, cjc@amss.ac.cn

This paper discusses a new kind of inverse data envelopment analysis (DEA) model with considering returns to scale and elasticity of decision making unit (DMU). An inverse DEA model can be used for a DMU to estimate its input/output levels when some or all of its input/output entities are revised. Different from original inverse DEA model, the new model allows the efficiency score being changed, which is more of economical background. Under this hypothesis, by finding most production scale size of

the observed DMU, we propose a function to compute the approximate change of efficiency score, and then we construct an algorithm to solve the new inverse DEA model. Numerical example is discussed at last.

#13

A Minimum Cost k-reliable Network Interdiction Model

J. Zhao[1], J.-Y. Wang[2], H. Yu[1]

1 University of Chinese Academy of Sciences, Beijing 100049, China; 2 Communication University of China, Beijing 100024, China zhaojia11b@mails.ucas.ac.cn, wangjuyun@cuc.edu.cn, yuh@ucas.ac.cn

This paper proposes a model, ”named a minimum cost k-reliable network interdiction”, which minimizes the cost of setting sensors on arcs for preventing any potential threat into a protected area. Mathematically, given any directed graph with a source and a sink, several arcs need to be selected such that any path from source to sink contains at least k arcs in selected arcs with as few resources as possible. The original model is transferred to a bilevel formulation because it is nearly impossible to be exhibited explicitly, even for the network of a moderate size. This paper also proposes an approach for resolving a bilevel program where the lower level program is a mixed integer program. A small numerical example illustrates the feasibility of our model.

#14

Competitive Location Problem With Geographical Interdiction And Aggregation Effect

Zhenping Li[1], Jieqiong Hu[2]

1 School of Information, Beijing Wuzi University, Beijing 101149, China; 2 Department of Postgraduate , Beijing Wuzi University, Beijing 101149, China lizhenping66@163.com

When multiple competitive facilities are located in the same place, they will attract more customers to use them, this phenomenon is called aggregation effect. The competitive location problem (CLP) with aggregation effect (AE) is investigated in this paper. Meanwhile, the geographical interdiction (GI) is considered. A new mathematical model for CLP with AE and GI is constructed. The objective function of the model is to maximize the profits. A method for solving the model is given. The aggregation effect is quantified by two parameters, which are the growth rate of demand and the discount rate of distance. The geographical interdiction can be eliminated by adding special nodes. We also do simulations on an example. The results show that when considering aggregation effect, more profits can be obtained by setting the competitive facilities in the same candidate point than setting them decentralized. By analyzing the relationships between the optimal solution and two parameters, we give some meaningful conclusions.

#15

Design and analysis of a maintenance service contract

Zhaotong Lian[1], Jinbiao Wu[1;2]

1 Faculty of Business Administration, University of Macau, Macau SAR, China; 2 School of Mathematics and Statistics, Central South University, Changsha 410075, China lianzt@umac.mo, wujinbiao@ymail.com

This paper studies a novel maintenance model with service contracts. We use a non-cooperative game formulation in which both parties, agent and unit owner, take the decisions by maximizing their expected profits to determine the agent’s optimal pricing strategy, the length of warranty and the number of repairmen for a monopolist service agent providing the maintenance service. We find that the optimal length of warranty and the number of repairmen are independent of the warranty price functions. Furthermore, for fixed lifetime of the unit, the number of customers hardly affects the optimal length of warranty.

#16

A Polynomial-Time Algorithm For Edge Coloring A Planar Graph With No Adjacent Short Cycles

Ling Xue[1]

1 Dept. of Information Engineering, Taishan Polytechnic, Taian, 271000, Shandong, China

Let G be a planar graph such that $\Delta\geq 5$ and any 4-cycle is not adjacent to a 3-cycle.

In the paper, we prove that G is of class 1. The proof is constructive and supplies a polynomial-time algorithm to color the edges of G with $\Delta(G)$ colors.

#17

A Method Of Information Quality Assessment Of Ship ASW Operation

Jian-Liu[1], Chang-You Xue[1], Yong-Jie Wang[1]

1 Academy of Navy Submarine, Qingdao 266071 navystrong@163.com

As it is difficult to assess quality of information of ship anti submarine warfare (ASW) operation by traditional methods, this paper gives a new method to solve the problem and builds a model of information quality assessment based on information entropy. Further, ASW ship operation information quality assessment database is given to offer a way to acquire the quality of information (QoI) in time indexed by the operation situation and operation time in the database. The method gives a beneficial way to evaluate the ship ASW operation efficiency and offers an aid for ship operation decision.

#18

The Multi-Covering Location Problem Of Emergency Service Facilities With Considering Disaster Losses

Wenfeng Zhou[1], Zhenping Li[2]

1 Deans Office, Beijing Wuzi University, Beijing 101149, China; 2 School of Information, Beijing Wuzi University, Beijing 101149, China lizhenping66@163.com

The multi-covering location problem of emergency services facilities with considering disaster losses is investigated in this paper. The total costs of emergency service facilities and the losses caused by disasters are considered. The relationship between the losses caused by an accident disaster and the disaster's duration is analyzed. The relationship between the losses caused by a disaster and the distance (time) from the emergency services facility point to the disaster site (demand point) is formulated into a function. And the costs of the emergency services facility are divided into the fixed operating costs and the facility rescuing costs. We propose a new mathematical model for multi-covering location problem of emergency service facilities. The objective function of our model is to minimize the sum of disaster losses and the total costs of emergency services facilities. We give a method for solving the model, do simulations on an example, analyze the results and give some discussions.

#19

The Optimization Of Gas Pipeline Transmission And End Segment Storage In Gas Network

Yanlu Xu[1], Yan Ma[1], Xiangfen Zhang[1], Shunbao Li[2], Yushan Wang[1], Ningli Zhang[1]

1 Department of Information Mechanical and Electrical Engineering, Shanghai Normal University, Shanghai200234, China; 2 Department of Mathematic & Science, Shanghai Normal University, Shanghai200234, China xu.yanlu@163.com, ma-yan@shnu.edu.cn, xiangfen@shnu.edu.cn, lsb@shnu.edu.cn, amywang@shnu.edu.cn, ningli_2@126.com

This paper describes a mathematical model for natural gas pipeline network which could help the sales company achieve maximum economic profits. In this paper, we analyze the pipeline network and consider many factors, including the end segment of pipeline for storage. Then we choose the feasible direction optimized algorithm for constrained nonlinear programming to solve the model. Finally, we give an example and come to a conclusion on that end segment storage in natural gas transmission has its own rationality and economic advantages.

#21

Non-Negative Matrix Factorization Based On Locally Linear Embedding

C.-Y. Han, G.-Q. Shao, Y. Hao, Y. A, T.-D. Guo

School of Mathematical Science, UCAS, Beijing 100049, China hancy@ucas.ac.cn, shaoguanqi09@mails.ucas.ac.cn, hyang0722@gmail.com, ayong08@mails.ucas.ac.cn,tdguo@ucas.ac.cn

In this paper, we proposed a novel method called Nonnegative Matrix Factorization based on Locally Linear Embedding (LLE-NMF). This idea is to factorize the nonnegative matrix considering the intrinsic geometric structure of the high dimensional

data. Instead of the need to estimate pairwise distances between widely separated data points, LLE-NMF is able to find a compact representation recovering the global nonlinear structure from locally linear fits. We proposed updating rules and simulation results. In the experiments, we show the encouraging results of the method in comparison to the state-of-the-art algorithms on face image clustering.

#22

Reliable Telecommunication Network Design Problem Under Node Failure

Tie Liu[1], Wenguo Yang[2], Ruguo Bu[1], Jun Huang[1]

1 College of Engineering, University of Chinese Academy of Sciences, Beijing, China, 100049; 2 School of Mathematics Sciences, University of Chinese Academy of Sciences, Beijing, 100049 yangwg@ucas.ac.cn, liutie_@126.com

The design of telecommunication network with capacity constraints of links, routers and ports of routers is considered in this paper. Specially, we limit each demand flow traversed through within a pre-specifed number of links (called hops) under node failure scenarios in IP layer net-work. Such a design must be the most cost-effective and ensure that feasible flows continue to exist even when any relay node of the network fails. We propose a reliable mixed-integer programming (MIP) model with multi-scenario constraints to optimally design a minimum-cost survivable IP network that continues to support a good communication under any node failure scenario. Then transform the MIP model to many single scenario models containing simplified MIPs, nonlinear programming (NLP) models and MIP models under Benders decomposition. Three heuristic methods are proposed to solve these models including branch-and-bound algorithm, global algorithm for NLP, and heuristic algorithm based on benders decomposition.

#23

Robust P-Median Model For Facility Location Problem Based On Scenario Analysis In Emergency Management

Jianming Zhu[1], Jun Huang1, De-Gang Liu[2]

1 College of Engineering and Information Technology, University of Chinese Academy of Sciences, Beijing 100049; 2 Academy of Mathematics and Systems Science, CAS, Beijing 100190, China jmzhu@ucas.ac.cn, junh@ucas.ac.cn, dliu@amt.ac.cn

Uncertainty of disaster districts is an important character in emergency response, which brings great challenge for facility location decision before disasters. Many kinds of resources are reserved in these facilities in order to satisfy the requirement of affected districts. Careful deployment of facilities can decrease the response time and improve the ability of emergency management. In this paper, scenario analysis is proposed for forecasting disaster districts under uncertainty. In order to make robust decision, a robust p-median model is presented for facility location problem in dealing with the specified percent of affected districts. Since the robust model is NP-hard, an approximation algorithm is designed and theoretical ratio is analyzed. Finally, sensitivity analysis and performance evaluation for the proposed model and algorithm are shown by computational instances.

#26

Lower Bounds For The Multislope Ski-Rental Problem

Hiroshi Fujiwara[1], Yasuhiro Konno[1], and Toshihiro Fujito[1]

1Toyohashi University of Technology, 1-1 Tenpaku-cho, Toyohashi, 441-8580 Japan

The multislope ski-rental problem is an extension of the classical ski-rental problem, where the player has several options of paying both of a per-time fee and an initial fee, in addition to pure renting and buying options. Damaschke gave a lower bound of 3.62 on the competitive ratio for the case where arbitrary number of options can be offered. In this paper we propose a scheme that for the number of options given as an input, provides a lower bound on the competitive ratio, by extending the method of Damaschke. This is the first to establish a lower bound for each of the 5- or-more-option cases, for

example, a lower bound of 2.95 for the 5-option case, 3.08 for the 6-option case, and 3.18 for the 7-option case. Moreover, it turns out that our lower bounds for the 3- and 4-option cases respectively coincide with the known upper bounds. We therefore conjecture that our scheme in general derives a matching lower and upper bound.

#27

A Hybrid Model In Wedge Trust Region

Y. Yang[1], Q.-H. Zhou[1], F.-X. Xu[1], P.-P.Zhou[1]

1College of Mathematics and Computer， Hebei University, Baoding 071002, Hebei Province yangyue1104@126.com, qinghua.zhou@gmail.com, xiafengxu3@163.com, zhoupei6011@126.com

In this paper, we have constructed a new algorithm for unconstrained optimizations based on the wedge trust region method. It is designed for solving problems in which the gradient of the object function is not available and the number of variables is moderate. After reviewing the separate contributions of the linear models and the quadratic models, here we propose a hybrid model to update the wedge trust region radius. Comparison of the new algorithm with both version of interpolation methods are reported in this paper. Numerical results show the applicability of our new algorithm to practical problems.

#28

A Hybird Algorithm Of Two Kinds Of Trust Region Methods

Pei-Pei Zhou Qing-Hua Zhou Yue Yang Yue Wang

College of mathematics and Computer Science, Hebei University, Baoding, 071002, Hebei Province, China zhoupei6011@126.com, qinghua.zhou@gmail.com, yangyue1104@126.com

In this paper, we propose an algorithm for nonlinear optimization problem that employs both traditional trust region methods. When solving trust region sub-problem, the traditional trust region algorithm is within the trust region centered at the current iteration point, the two improved trust region algorithms are within the trust region centered at one point located in the direction of the negative gradient. When the norm of the gradient k g is less than or equal to 10^2, we use the traditional trust region method, otherwise use the two improved trust region methods. Numerical results are given to show that the algorithm is efficient for the proposed method.

#29

Label-Based Multiple Kernel Learning For Classification

Bing Yang[1], Qian Li[1], Lujia Song[1], Changhe Fu[1], Ling Jing[1]

1 College of Science, China Agricultural University, Beijing 100083, P.R. China jingling@cau.edu.cn

This paper provides a novel technique for multiple kernel learning within Support Vector Machine framework. The problem of combining different sources of information arises in several situations, for instance, the classification of data with asymmetric similarity matrices or the construction of an optimal classifier from a collection of kernels. Often, each source of information can be expressed as a similarity matrix. In this paper we propose a new method in order to produce a single optimal kernel matrix from a collection of kernel (similarity) matrices with the label information for classification purposes. Then, the constructed kernel matrix is used to train a Support Vector Machine. The key ideas within the kernel construction are twofold: the quantification, relative to the classification labels, of the difference of information among the similarities; and the linear combination of similarity matrices to the concept of functional combination of similarity matrices. The proposed method has been successfully evaluated and compared with other powerful classifiers on a variety of real classification problems.

#30

Least Squares Support Tensor Machine

M. Lv, X.-B. Zhao, L.-J. Song, H.-F. Shi, L. Jing

Department of Applied Mathematics, College of Science, CAU, Beijing 100083, China lvmeng0122@163.com, zhaoxinbin1986811@163.com, biggirlsong@126.com, shihaifa@163.com, jingling_student@163.com

Least squares support vector machine (LS-SVM), as a variant of the standard support vector machine

(SVM) operates directly on patterns represented by vector and obtains an analytical solution directly from solving a set of linear equations instead of quadratic programming (QP). Tensor representation is useful to reduce the over-fitting problem in vector-based learning, and tensor-based algorithm requires a smaller set of decision variables as compared to vector-based approaches. Above properties make the tensor learning specifically suited for small-sample-size (S3) problems. In this paper, we generalize the vector-based learning algorithm least squares support vector machine to the tensor-based method least squares support tensor machine (LS-STM), which accepts tensors as input. Similar to LS-SVM, the classifier is obtained also by solving a system of linear equations rather than a QP. LS-STM is based on the tensor space, with tensor representation, the number of parameters estimated by LS-STM is less than the number of parameters estimated by LS-SVM, and avoids discarding a great deal of useful structural information. Experimental results on some benchmark datasets indicate that the performance of LS-STM is competitive in classification performance com-pared to LS-SVM.

#31

Equilibrium Strategies In An M/M/1 Queue With Setup Times And A Single Vacation Policy

Dequan Yue[1], Ruiling Tian[1], Wuyi Yue[2], Yaling Qin[3]

1 College of Sciences, Yanshan University, Qinhuangdao 066004, China 2 Department of Intelligence and Informatics, Konan University, Kobe 658-8501, Japan 3College of Liren, Yanshan University, Qinhuangdao 066004, China ydq@ysu.edu.cn, tianrl@ysu.edu.cn, yue@konan-u.ac.jp, 16963906@qq.com

We consider equilibrium strategies in a Markovian queue with setup times and a single vacation policy. Arriving customers decide either to enter the system or to balk based on their desire for service and their unwillingness for waiting. We derive equilibrium strategies for both cases of fully observable queue and fully unobservable queue. Then, for fully unobservable queue, we consider socially optimal strategy and illustrate the effects of several parameters on equilibrium strategy and socially optimal balking strategy using numerical examples.

#32

Integer Linear Programming For Transforming Pairwise Based Results To The Original Ratings

P. Ji[1,2], J. Jin[1,2]

1 Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hong Kong; 2 The Hong Kong Polytechnic University Shenzhen Research Institute, Shenzhen 518057, China p.ji@polyu.edu.hk, jinjian.jay@connect.polyu.hk

Many pairwise models are proposed for ranking problems in the field of information retrieval. Classification problems in the field of data mining also use pairwise comparison. However, conventionally, these pairwise approaches are evaluated based evaluation metrics. The original rating for a single document or instance is not explained faithfully, which makes these algorithms cannot be evaluated by standard evaluation metrics, such as Mean Average Precision and Normalized Discounted Cumulative Gain for ranking models. In this research, the focus is on how to transform pairwise based results to the original ratings. Particularly, an integer linear programming model is formulated for this problem. In this algorithm, the objective is to minimize the number of conflicts for the predicted pairwise based relationship between instances by the assignment of rating values. An example is presented in order to clarify the proposed integer linear programming method. It validates the possibility to transform pairwise based results to the original ratings, which make them to be evaluated by standard evaluation metrics.

#33

Enumeration Of Region Partitioning For Evacuation Planning Based On Zdd

Atsushi Takizawa[1], Yasufumi Takechi[2], Akio Ohta[2], Naoki Katoh[2], Takeru Inoue[3], Takashi Horiyama[4], Jun Kawahara[5], Shin-ichi Minato[3, 6]

1 Department of Architecture and Building Engineering, Osaka City University, Japan; 2 Department of Architecture and Architectural Engineering, Kyoto University, Japan; 3 Minato Discrete Structure Manipulation System Project, ERATO, Japan Science and Technology Agency, Sapporo, Japan; 4 Graduate School of Science and Engineering,

Saitama University, Japan; 5 Graduate School of Information Science, Nara Institute of Science and Technology, Japan; 6 Graduate School of Information Science and Technology, Hokkaido University, Sapporo, Japan

Japanese cities always have risks of large-scale earth-quakes. Thus, it is very important to establish crisis management systems against large-scale disasters such as big earthquakes, and tsunamis to secure evacuation centers for evacuees. In this respect, it is extremely important to provide sufficient evacuation centers and to appropriately partition the whole region into small areas, such that a unique evacuation center is located in each area and the people living in the area can easily evacuate to the center. However, it is hard to find an optimal region partitioning, due to the uncertainty, such as a fire or collapsed buildings. In this research, we propose a method to enumerate all partitioning patterns using Zero-suppressed Binary Decision Diagram (ZDD) that satisfy several conditions. We apply the proposed method to Kamigyo Ward of Kyoto City, Japan.

#34

Optimal Portfolio Selection Based On Satisfaction Index

Hong-Wei Liu

School of Information, Beijing Wuzi University, Beijing 101149, China ryuhowell@163.com

In this paper, optimal portfolio selection with uncertain returns is studied, and corresponding model based on the satisfaction index is proposed. In the model, the risk is taken as the sum of the absolute deviation of the risky assets instead of covariance, the transaction cost is taken as v-shaped function of the difference between the existing and new portfolio. An efficient way is given to transform a non-linear problem into a linear problem, which alleviate the computational difficulty greatly. Numerical result showed that the proposed method is capable of helping investor to find efficient portfolios according to his/her preference.

#35

Performance Evaluation for the Energy Saving Mode for DRX in LTE Systems

S. Jin[1], Y. Zhang[1], W. Yue[2]

1College of Information Science and Engineering Yanshan University, Qinhuangdao 066004, China; 2Department of Intelligence and Informatics Konan University, Kobe 658-8501, Japan jsf@ysu.edu.cn, zy419Lab@163.com, yue@konan-u.ac.jp

In this paper, we aim to evaluate the system performance of the energy saving mode for Discontinuous Reception (DRX) in Long Term Evolution (LTE) systems. We consider the digital nature of modern communications, and build a discrete-time queuing model with a two-stage vacation. By using the method of an embedded Markov chain, we analyze the system model in the steady-state, and derive the formulas for the handover ratio, the energy saving ratio and the response time of data frames. Moreover, we present numerical results to show how the system performance measures change with the system parameters. Finally, we demonstrate the influence of system parameters on the system performance, and investigate the trade-off between different performance measures.

#36

Resource Loading: Applications And Complexity Analysis

F. Talla Nobibon[1], R. Leus[1], K. Nip[2], Z. Wang[2]

1ORSTAT, Faculty of Economics and Business, KU Leuven, 3000 Leuven, Belgium; 2Department of Mathematical Sciences, Tsinghua University, Beijing 100084, China Fabrice.TallaNobibon@kuleuven.be, Roel.Leus@kuleuven.be, njm11@mails.tsinghua.edu.cn, zwang@math.tsinghua.edu.cn

This paper studies the resource loading problem, which consists of a set of jobs that must be scheduled within a given time horizon that is organized into consecutive time periods, where each period is associated with a fixed number of available workers. The objective is to find a feasible schedule that minimizes the number of additional workers needed to execute all the jobs. We describe how this problem arises in industry, and we study six special cases. We present polynomial algorithms for the easy cases and pseudo-polynomial algorithms for weakly NP-hard cases, and we study

the approximation of the strongly NP-hard sub-problems.

#37

Dynamic Traveling Salesman Problem with Deadline Based on Traveler’ s Risk Attitude

Qiang Guo[1], Jianming Zhu[1]

1University of Chinese Academy of Sciences, Beijing 100049, China
guoqiang111@mails.ucas.ac.cn, jmzhu@ucas.ac.cn

In this paper we take dynamic traveling salesman problem with deadline based on traveler’s risk attitude (DTSPD_TRA) as an example to show Behavioral Operational Research (BOR) in advancing the practice of OR. We present the optimal tour model based on the cumulative prospective theory (CPT), where utility functions are nonlinear in probability and thus the salesman’s flexible attitude toward risk in a real-time traffic network can be captured. Finally, a numerical example is presented to indicate the value of considering the salesman’s risk attitude for the optimal tour determination. The optimal tour is different for the same deadline based on expected utility theory (EU) and CPT.

#38

A New Support Vector Machine For The Classification Of Positive And Unlabeled Examples

Junyan Tan[1], Ling Zhen[1], Naiyang Deng[1], Chunhua Zhang[2]

1College of Science, China Agricultural University, Beijing 100083, China; 2 Information School, Renmin University of China, Beijing 100872, China
tanjunyan0@126.com, zhangchunhua@ruc.edu.cn

In this paper, we propose a new version of support vector machine named biased p-norm support vector machine (BPSVM) involved in learning from positive and unlabeled examples. BPSVM treats the classification of positive and unlabeled examples as an imbalanced binary classification problem by giving different penalty parameters to positive and unlabeled examples. Compared with the previous works, BPSVM can not only improve the performance of classification but also select relevant features automatically. Furthermore, an effective algorithm for solving our new model is proposed. BPSVM can be used to solve large scale problem due to the effectiveness of the new algorithm. Numerical results show BPSVM is effective in both classification and features selection.

#40

Joint Pricing And Production Decisions For New And Remanufactured Products

Hua-Yi Li[1], Xiao-Song Ding[1, 2], Ji-Hong Zhang[1]

1 International Business School, Beijing Foreign Studies University Beijing, People's Republic of China, 100089; 2 DECIDE, Department of Computer and Systems Sciences, Stockholm University Forum 100, SE-164 40, Kista, Sweden corresponding author, xiaosong.ding@gmail.com

This paper considers a two-period model in which a monopolistic manufacturer can offer new and remanufactured products. In the first period, the manufacturer can only sell new products. In the second period, the manufacturer may recovery the used products sold in the first period and sell their remanufactured products while he continues to sell new products. Here, the market size is fixed and the market segmentation is realized by the consumer's net utility. Before the selling season, a monopolistic manufacturer has to decide the supply quantity of new products in the first period, as well as the selling price and quantity of re- manufactured products in the second period. We focus on the competition between new and remanufactured products and analyze the manufacturer's optimal production and pricing strategies.

#41

Communication Leading To Coalition Nash Equilibrium Ii (S4n-Knowledge Case)

Takashi Matsuhisa

Department of Natural Science, Ibaraki National College of Technology Nakane 866, Hitachinaka-shi, Ibaraki 312-8508, Japan
mathisa@ge.ibaraki-ct.ac.jp

In this paper the new concept of coalition Nash equilibrium of a strategic game is introduced, and it is shown that a communication among the players

in a coalition leads to the equilibrium through messages. A coalition Nash equilibrium for a strategic game consists of (1) a subset S of players, (2) independent mixed strategies for each member of S, (3) the conjecture of the actions for the other players not in S with the condition that each member of S maximizes his/her expected payoff according to the product of all mixed strategies for S and the other players' conjecture. However, this paper stands on the Bayesian point of view as follows: The players start with the same prior distribution on a state-space. In addition they have private information which is given by a reflexive and transitive binary relation on the state space. Each player in a coalition S predicts the other players' actions as the posterior of the others' actions given his/her information. He/she communicates privately their beliefs about the other players' actions through messages among all members in S according to the communication network in S, which message is information about his/her individual conjecture about the others' actions. The recipients update their belief by the messages. Precisely, at every stage each player communicates privately not only his/her belief about the others' actions but also his/her rationality as messages according to a protocol and then the recipient updates their private information and revises her/his prediction. In this circumstance, we show that the conjectures of the players in a coalition S regarding the future beliefs converge in the long run communication, which lead to a coalition Nash equilibrium for the strategic game.

#42

Research On The Optimal Train Ticket Overbooking Strategy For Transportation During The Spring Festival

Zhi-Xin Liang[1], Shuo Wen[2], Feng-Wen Yang[2]

1School of Information, Beijing Wuzi University, Beijing, 101149, China
2 Beijing No.4 high school, Beijing, 100034, China
liangzhixin@sina.com, wenyan4002@sina.com, yfw@bhsf.cn

This paper studies a train ticket overbooking rule and strategy for transportation during the Spring Festival. We determine the expected revenue of train operation by the probability theory. According to the principle which maximizes the expected revenue of the railway sector, we construct a mathematical model to determine the number of overbooking sleeper and seat tickets. Using the optimal solution of the model, the railway sector can find some tactics to reduce the waste of transport resources and improve the train operation efficiency.

#43

Investigating Major Factors To Affect Human Casualties Of Natural Disasters And Reviewing Recovery Policies

Novia Budi Parwanto[1, 2], Tatsuo Oyama[1]

1 National Graduate Institute for Policy Studies (GRIPS), Minato-ku, Tokyo 106-8677, Japan; 2 BPS, Statistics Indonesia, Jl. Dr. Sutomo 6-8 Jakarta 10710, Indonesia noviabudi@bps.go.id, oyamat@grips.ac.jp

The timing and magnitude of natural disasters are unpredictable, and thus are stochastic. Number of death and missing people (D&M) caused by natural disasters are often used to measure the magnitude of the disasters. By using statistical analysis, we investigate the relationship between the D&M inflicted and some parameters of natural disasters with case studies of earthquakes and tsunamis occurred in Japan and Indonesia from 1900 to 2012. The parameters under investigation are the epicenter location, earthquake magnitude, depth of hypocenter, and water height. We found that the earthquake magnitude and water height are positively affect the D&M inflicted, while the epicenter location and hypocenter depth have significant and negative effect. In addition, we also review the recovery process from the 2004 Aceh tsunami and the 2011 Tohoku tsunami, especially in the agriculture sector.

#44

Biased Locality-Sensitive Support Vector Machine Based On Density For Positive And Unlabeled Examples Learning

Lujia Song, Bing Yang,Ting Ke, Xinbin Zhao, Ling Jing*

*Department of Applied Mathematics College of Science, China Agricultural University 100083, Beijing, P.R. China *Corresponding: jingling@cau.edu.cn (L.Jing)*

Learning from positive and unlabeled examples (PU learning) has been a hot topic for classification in machine learning. The key feature of this problem is that there is no labeled negative training data, which makes the traditional classification techniques inapplicable. According to this feature, we propose an algorithm called biased locality-sensitive support vector machine based on density (BLSBD-SVM) for PU learning which takes unlabeled examples as negative examples with noise. Our approach as the variant of Locality-Sensitive support vector machine (LSSVM) not only has a lot of advantages of local learning, but also makes good use of the prior information of training examples by adding the relative density degrees of training points. The experimental results on bioinformatics data show the effectiveness of our algorithm.

#45

A Study Of Inflammation Immunization Strategy In Weighted Complex Network

Hui-Jia Li[1], Chi Zhang[4], Xiang-Sun Zhang[2;3]

1School of Management Science and Engineering, Central University of Finance and Economics, Beijing 100080, China; 2Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing 100190, China; 3National Center for Mathematics and Interdisciplinary Sciences, Chinese Academy of Sciences, Beijing 100190, China; 4School of Computer Science, Sichuan University, Chengdu 610021, Sichuan, China zxs@amt.ac.cn, zigonline@126.com

The problem of epidemic spreading has been widely studied by scientists from various fields, so the corresponding immunization strategy is also been extensively concerned. But the traditional immunization behaviors are performed by deleting edges in the network, which causes changes of the network structure and then possibly severe damage to the network efficiency. In this paper we studied a novel inflammation immunization strategy in weighted network by reducing the edge weight to suppress the spreading of the epidemic while maintain necessary network efficiency. It likes the situation when one place of our body is infected, inflammation occurs around the infected point to prevent the infection going widely, but it does not damage the body function. So we call the new strategy as “inflammation immunization strategy”. Using the SI epidemic spreading model, we set the transmission rate to be in proportion to the edge weight. Further we give the detailed dynamic evolution for the infected nodes which facilitates an effective epidemic control. The theoretical analysis and simulation results show that the inflammation immunization strategy can effectively prevent epidemic spreading while maintain a high efficiency of the network.

#46

Method Of Centres For Solving Mathematical Programs With Fuzzy Parametric Variational Inequality Constraints

Heng-you Lan, Chang-jiang Liu, Tian-xiu Lu

Institute of Nonlinear Science and Engineering Computing, Sichuan University of Science & Engineering, Zigong, Sichuan 643000, PR China hengyoulan@163.com, liuchangjiang@189.cn, lubeeltx@163.com

In this paper, using a new smoothing approach based on a version of the \method of centers with entropic regularization techniques", we construct an iterative algorithm for finding a solution of a class of mathematical program problems with fuzzy parametric variational inequality constraints. Finally, by applying quasi- Newton line search of MATLAB software, the main results presented in this paper are illustrated via a numerical example.

#47

Color Calibration Model Of Skin Lesion Images For Computer-Aided Diagnostic

Leszek A. Nowak, Marcin P. Pawłowski, Katarzyna Grzesiak-Kopeć, Maciej J. Ogorzałek

Department of Information Technologies at Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, Reymonta 4, 30-059 Kraków, Poland leszek.nowak@uj.edu.pl, marcin.pawlowski@uj.edu.pl, katarzyna.grzesiak-kopec@uj.edu.pl, maciej.ogorzalek@uj.edu.pl

Computer-aided diagnostic is developing rapidly and is being introduced in multiple fields of medicine. One of those fields is dermatology where various types of equipment are used for image acquisition. Those images can be processed in order to assist diagnostic by giving comparative examples, initial

image enhancement or automated evaluation. In our research we concentrate on creation of computer-aided methods for skin lesion diagnostics, especially Malignant Melanoma screening based on ABCD evaluation rule. While preparing these methods a number of issues appeared over and over again. The problems are due to the fact that we work with datasets that were obtained from equipment with different characteristics. The methods giving excellent results on one set of images may not perform as well on the others. Solving this problem usually requires manual fine-tuning of a set of parameters. In this paper we introduce a method of automated image adjustment based on color calibration model for calculating the Total Dermoscopy Score (TDS) of the ABCD rule. First we describe the general problem of skin lesion diagnostic and our motivation for the research. Next we will introduce the idea behind the method and its implementation. Finally the practical usage will be shown and discussed.

#48

Coordination Mechanism Of Joint Procurement Through Quantitative Discounts

Hong-Wei Liu

School of Information, Beijing Wuzi University, Beijing 101149, China
ryuhowell@163.com

Coordination mechanism under the optimal quantitative discounts provided by the supplier as well as the economic order quantity (EOQ) procurement policy employed by heterogeneous retailers with various costs and demand parameters are investigated. Compared to fixed wholesale price policy, quantitative discounts policy eliminates integrated supply chain cost to some extend and among supplier and retailers are able to share system cost saving benefits. If retailers' order quantity and supplier's order processing cost are more reduced, channel coordination effectiveness can be achieved at a higher level and system cost can be further eliminated. With the two sufficient but not necessary conditions being fulfilled, independent replenishment model is dominated by the joint replenishment strategy. The results show that the quantitative discounts provided by the supplier can achieve channel coordination depends intimately upon the replenishment model applied by the retailers and these could be advantageous in many environments.

#49

L1-ε-Twin Support Vector Regression For The Determinants Of Inflation: A Comparative Study Of Two Periods In China

Ya-Fen Ye[1], Xiao-Jun Liu[1], Yuan-Hai Shao[1], Jiao-Yu Yuan[2]

1 Zhijiang College, Zhejiang University of Technology, Hangzhou 310024, China 2 Hualong Bishui Kindergarten, Binjiang, Hangzhou 310052, China
yafenye@163.com

To do the feature selection by ε - twin support vector regression for inflation problem, a well-known L0 norm optimal problem is introduced and approximated by L1 to get the solutions, which called L1-ε-twin support vector regression (L1-ε-TSVR). L1-ε-TSVR explores and compares the important determinants of the inflation in China between the periods 2001:01 to 2005:12 and 2006:01 to 2012:12.Compared with ε-TSVR, our L1-ε-TSVR not only fits function well, but also does feature selection efficiency. Our experimental results show that Chinese Yuan exchange rate and the interest rate have no effect on the inflation during the period 2001:01 to 2005:12. However, with the reform of the exchange rate flexibility and interest rate rule in China, the interest rate and the exchange rate are the most significant explanatory factor for the Chinese inflation over the period 2006:01 to 2012:12. Besides, ferrous metals price index is three as high in the latter period as in the first period, which indicates that the cost driven inflation may appear in China.

#51

Using Cellular Automata To Model Evolutionary Dynamics Of Social Network

J.-S. Li[1], Z.-Z. Chen[1], T. Qin[2]

1College of Science, Beijing Forestry University, Beijing 100083, China
2School of Economics and Management, Beijing Forestry University, Beijing 100083, China lijinshan@gmail.com, duckingchen@163.com, qintao415@126.com

Social networks usually serve as critical medium for in-formation transmission, diffusion of epidemics, and spread of behavior through sharing activities or similarities between individuals. A great interest in studying social influence and spread dynamics in social networks are witnessed recently. The related social network models are usually used for simulating and validating real social systems by using simulation data. But most of these social network models are built on existing nodes to study their edge statistical characteristics, such as degree distribution, clustering coefficient, community structure and etc., little consideration of evolutionary dynamics of social net-works are involved, which are the physical base of various social networks and also an important research topic. In this paper, we consider one issue that what kind of factors is beneficial or harmful to the growth of nodes in a social network. Cellular automaton model is applied in this paper to attempt to study this issue, which can be seen as an evolutionary dynamics of a social network. Three kinds of factors named selfishness, reciprocity, and altruism, which are essential for constructing a social network, are introduced in the paper to analyze how they affect the growth of the virtual social network. A conclusion is obtained that reciprocity and altruism promote growth of nodes in the social network, on the other hand, selfishness inhibits the growth. We think it is interesting and significant to study this issue.

#52

Optimization Model And Simulation For Improving Ambulance Service System

Hozumi Morohosi[1], Takehiro Furuta[2]
1National Graduate Institute for Policy Studies, Tokyo, Japan 106-8677
2Nara University of Education, Nara, Japan, 630-8528
morohosi@grips.ac.jp, takef@fw.ipsj.or.jp

This paper presents a brief survey of operations research works for ambulance service design, focusing on two mainstreams, i.e., facility location and simulation methods. Then we show some application examples of those methods using actual ambulance dispatch data.