ICSI 2021

July 17-21, 2021

Qingdao, China

PROGRAM

The Twelfth International Conference on Swarm Intelligence

Organized by International Association of Swarm and Evolutionary Intelligence

IASEI

Welcome message from General Chairs

We are warmly welcoming you from all over the world to attend the Twelfth International Conference on Swarm Intelligence (ICSI'2021) in Qingdao of China.

The theme of ICSI'2021 is "Serving Life with Swarm Intelligence". The ICSI'2021 provided an excellent opportunity and/or an academic forum for academics and practitioners to present and discuss the latest scientific results and methods, innovative ideas, and advantages in theories, technologies, and applications in swarm intelligence. The technical program covered a number of aspects of swarm intelligence and its related areas. The ICSI'2021 was the twelfth international gathering in the world for the academias and researchers working on most aspects of swarm intelligence, following successful events in Serbia (ICSI'2020) virtually, ChiangMai (ICSI'2019), Shanghai (ICSI'2018), Fukuoka (ICSI'2017), Bali (ICSI'2016),Beijing (ICSI-CCI'2015), Hefei (ICSI'2014), Harbin (ICSI'2013), Shenzhen (ICSI2012), Chongqing (ICSI'2011), and Beijing (ICSI'2010), which provided a high-level academic forum for participants to disseminate their new research findings and discuss emerging areas of research. It also created a stimulating environment for participants to interact and exchange information on future challenges and opportunities in the field of swarm intelligence research.

Due to the situation of continuous global COVID-19 pandemic, ICSI'2021 provides online and offline presentations together. In one hand, the ICSI'2021 will be normally held in Qingdao, China. On the other hand, the ICSI'2021 technical team provided the ability for the authors of accepted papers who have restrictions on overseas traveling to present their work through an interactive online platform or video replay. The presentations by accepted authors will be made available to all registered attendees onsite and online.

As well known, the host city of the ICSI'2021 is Qingdao of China (also spelled Tsingtao) which is a major sub-provincial city in eastern Shandong province, China. Located on the western shore of Yellow Sea coast, Qingdao is a major nodal city on the 21st Century Maritime Silk Road arm of the Belt and Road Initiative that connects East Asia with Europe, and has the highest GDP of any city in the province. It had jurisdiction over seven districts and three county-level cities till 2019, and As of 2014 had a population of 9,046,200 with an urban population of 6,188,100. Lying across the Shandong Peninsula and looking out to the Yellow Sea to its south, it borders the prefectural cities of Yantai to the northeast, Weifang to the west and Rizhao to the southwest.

The ICSI'2021 will definitely contribute a lot to the enhancement of the research horizons of our delegates in the field of swarm intelligence. Certainly, we are sure that you will have a wonderful experience of visiting Qingdao, China during the ICSI'2021. On behalf of the organizing and technical committees, I wish the ICSI'2021 will be a memorable event for you to stay in Qingdao, China.

Sincerely yours!

General Chairs of ICSI'2021
Ying Tan
Peking University, China
Russell C. Eberhart
IUPUI, USA

Welcome message from Programme Committee Chair

The Twelfth International Conference on Swarm Intelligence (ICSI'2021) is the twelfth international gathering in the world for researchers working on all aspects of swarm intelligence, following the successful and fruitful previous eleven events (ICSI'2020-2016, ICSI-CCI'2015, ICSI'2014-2010), which provided an excellent opportunity and/or an academic forum for academics and practitioners to present and discuss the latest scientific results and methods, innovative ideas, and advantages in theories, technologies, and applications in swarm intelligence. In this year event, the ICSI'2021 will be held at Qingdao of China, promoting transverse fusion, and stimulating innovation. The aim of this important event is to exhibit the state-of-the-art research and development in many aspects of swarm intelligence from theoretical to practical researches.

The ICSI'2021 received 177 submissions and invited submissions from about 392 authors in 32 countries and regions (Algeria, Australia, Bangladesh, Belgium, Brazil, Bulgaria, Canada, China, Colombia, India, Italy, Japan, Jordan, Mexico, Nigeria, Peru, Portugal, Romania, Russia, Saudi Arabia, Serbia, Slovakia, South Africa, Spain, Sweden, Taiwan (China), Thailand, Turkey, United Arab Emirates, United Kingdom, The USA, and Viet Nam) across 6 continents (Asia, Europe, North America, South America, Africa,and Oceania). Each submission was reviewed by at least 2 reviewers, and on average 2.5 reviewers. Based on rigorous reviews by the Program Committee members and reviewers, 104 high-quality papers were selected for publication in this proceedings volume with an acceptance rate of 58.76%. The papers are organized into 16 cohesive sections covering major topics of swarm intelligence research and its development and applications.

On behalf of the Organizing Committee of ICSI'2021, we would like to express our sincere thanks to the International Association of Swarm and Evolutionary Intelligence (IASEI) (iasei.org), which is the premier international scholarly society devoted to advancing the theories, algorithms, real-world applications, and developments of swarm intelligence and evolutionary intelligence. We would also like to thank Peking University, Southern University of Science and Technology, and Ocean University of China for their co-sponsorships, and to Computational Intelligence Laboratory of Peking University and IEEE Beijing Chapter for its technical co-sponsorships, as well as to our supporters of International Neural Network Society, World Federation on SoftComputing, International Journal of Intelligence System, MDPI's Journals:Electronics, Beijing Xinghui Hi-Tech Co., and Springer Nature.

We would also like to thank the members of the Advisory Committee for their guidance, the members of the International Program Committee and additional reviewers for reviewing the papers, and the members of the Publication Committee for checking the accepted papers in a short period of time. We are particularly grateful to the proceedings publisher Springer for publishing the proceedings in the prestigious series of Lecture Notes in Computer Science. Moreover, we wish to express our heartfelt appreciation to the plenary speakers, session chairs, and student helpers. In addition, there are still many more colleagues, associates, friends, and supporters who helped us in immeasurable ways; we express our sincere gratitude to them all. Last but not the least, we would like to thank all the speakers, authors, and participants for their great contributions that made ICSI'2021 successful and all the hard work worthwhile.

Programme Committee Chair of ICSI'2021
Yuhui Shi
Southern University of Science and Technology, China

Contents

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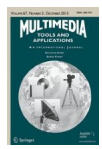


Multimedia Tools and Applications

Beijing Xinghui High-Tech Co.

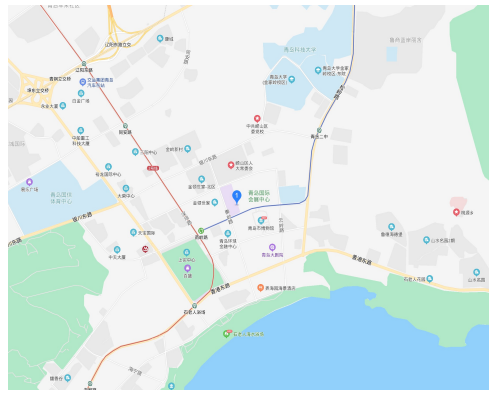
Venue

The 2021 International Conference on Swarm Intelligence (ICSI'2021) will be held in Qingdao Blue Horizon Hotel Laoshan at Qingdao of China.

Blue Horizon Hotel (Qingdao Shilaoren International Exhibition Center store) is affiliated to Shandong Blue Horizon Hotel Group, located in Laoshan District, Qingdao City, and shilao tourist resort in the south. It is an important part of Shandong International Conference and Exhibition Center. The rooms are distributed on the 3rd to 9th floors, with spacious and bright rooms, equipped with complete equipment such as broadband network, satellite TV, international direct dial telephone, small bar, electronic safe, etc., and equipped with transparent toilet and modern home facilities, showing luxury and fashion. It is an ideal choice for you to stay in business and life.

Address: No. 9-2, Miaoling Road, Laoshan District, Qingdao, China

Telephone: 0532-88996666



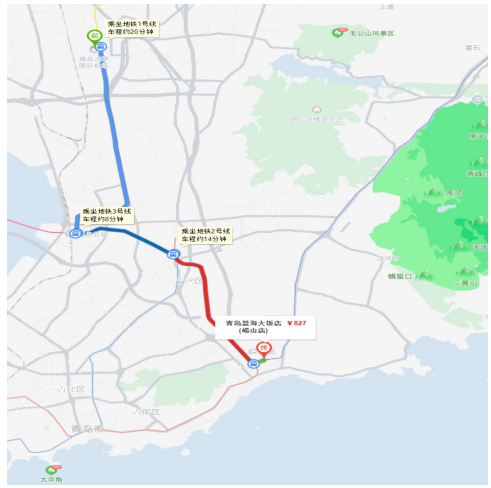
Blue Horizon Hotel (Overview & Map)

Blue Horizon Hotel

Transportation

From Qingdao Liuting International Airport to Blue Horizon Hotel Laoshan

Qingdao Liuting International Airport (IATA: TAO, ICAO: ZSQD) is the main international airport serving the city of Qingdao in Shandong Province, China. It is about 31 km (19 mi) from the city center and serves as a hub for Shandong Airlines, Beijing Capital Airlines and Qingdao Airlines as well as a focus city for China Eastern Airlines. For more information, please visit http://www.qdairport.com/

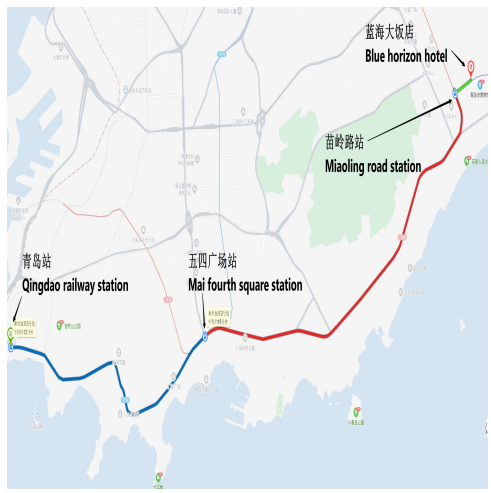


From Liuting International Airport to Blue Horizon Hotel

From railway stations To Qingdao Blue Horizon Hotel Laoshan

Route 1: From Qingdao North Railway Station → Subway line 3 → Li Cun Station → Subway line 2 → Miaoling Road Station → Qingdao Blue Horizon Hotel Laoshan

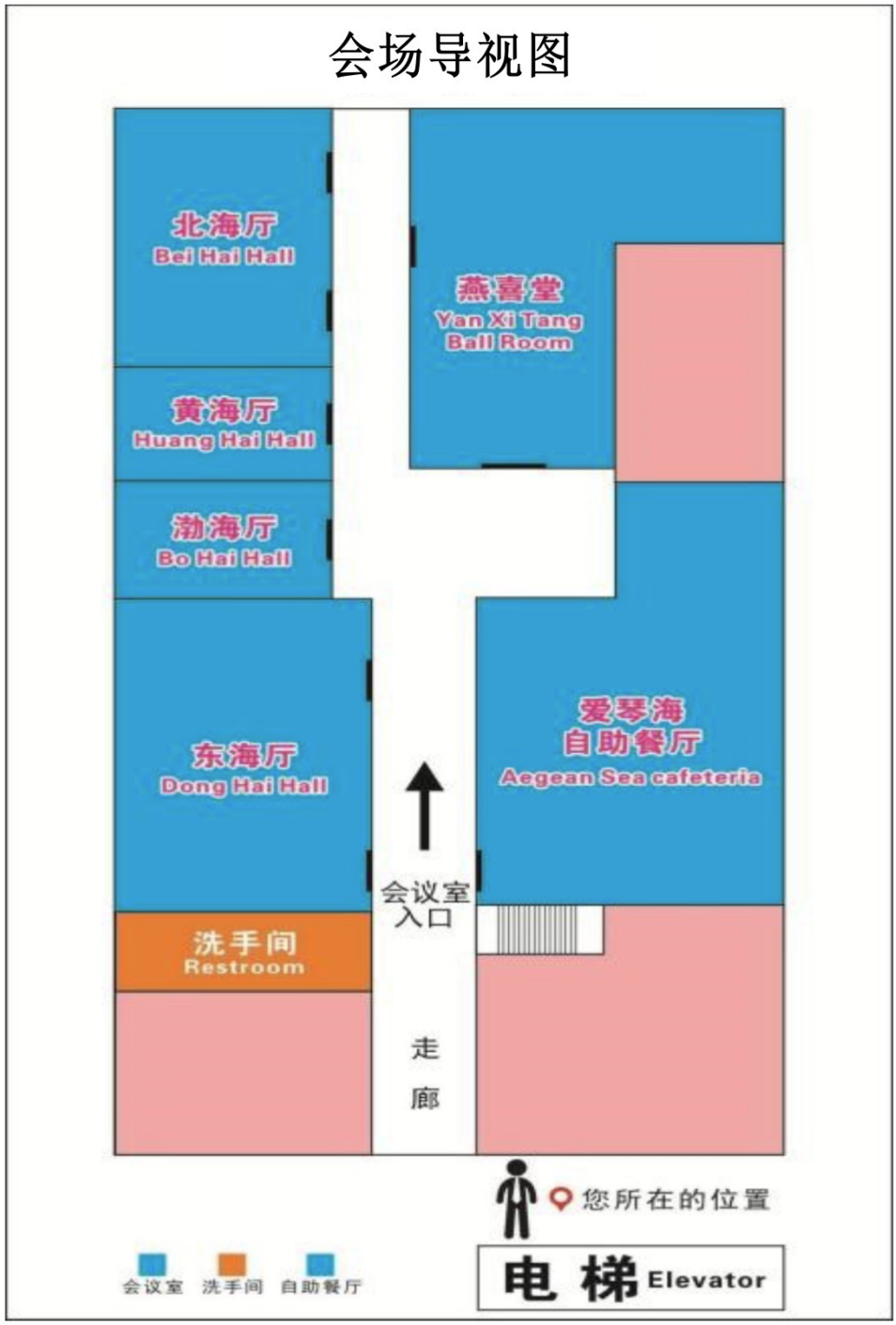
Route 2: From Qingdao Railway Station → Subway line 3 → May Fourth Square Station → Subway line 2 → Miaoling Road Station → Qingdao Blue Horizon Hotel Laoshan



From Railway Stations to Blue Horizon Hotel

Conference Floor Map

The ICSI'2021 will be held on the third floor of the Blue Horizon Hotel.



Social Activities

Beer Festival Reception, Buffet Lunches, and Award Banquet




Beer Festival Reception, Buffet Lunches and Award Banquet are all included in the registration fees.

Beer Festival Reception (JULY 17)
Time: 18:00pm-19:30pm(GMT+8)
Place: Dong Hai Hall (东海厅)

Buffet Lunches (JULY 18 and 19)
Time: 12:00am-13:00pm(GMT+8)
Place: Aegean Sea cafeteria (爱琴海自助餐厅)

Award Banquet (JULY 18)
Time: 18:00pm-20:00pm(GMT+8)
Place: Donghai Hall (东海厅)

Plenary Speech I

Swarm Intelligence and Large-scale Heterogeneous Robotic Swarms

Speaker: Prof. Dr.-Ing. Qirong TANG
Affiliation : Tongji University, China
Location: Yan Xi Tang (zoom: 847 7347 7938)
Time: July 18th 08:40-09:30

Abstract

Swarm intelligence and swarm robotics attract extensive attention for the past few years. However, there are still many questions deserve our questions. For examples, what are the essential mechanisms of swarm intelligence? How to make the robot physical body adapt bidirectionally? How to deal with the increase of the scale of robotic swarms? How to build such large models? This talk will focus on swarm intelligence and swarm robotics, especially large-scale heterogeneous robotic swarms. It will introduce some recent applications of swarm intelligence on swarm robots in speaker's group, such as collaborative operation and confrontation in complex environment with swarm robots under supervision of swarm intelligent algorithms. It will start from the contrast of kinematics and dynamics based modeling methods and machine learning based methods, to the cluster control of swarm robots, indirect communication, and ending with construction as well as application of swarm robotic platforms. The speaker would like to share with you the above recent research from his group.

Biography

Qirong TANG, who obtained his Ph.D. from University of Stuttgart, Germany, and is currently a full professor (with distinguish) at Tongji University Shanghai, China. He is the founding director of the Laboratory of Robotics and Multibody System (RMB), and the leader of the Intelligent Unmanned Systems Group. Meanwhile, he serves as the Vice Dean of School of Mechanical Engineering, and a member of Council of Tongji University. He is the holder of National high-level Talents Program and Shanghai Pujiang Scholar.

Invited Talk I

Improving Metaheuristic Algorithms Using Information Feedback Model

Speaker: Dr. Gaige Wang
Affiliation : Ocean University of China
Location: Yan Xi Tang (zoom: 847 7347 7938)
Time: July 18th 09:30-10:00

Abstract

In most metaheuristic algorithms, the individual update process does not (fully) utilize the individual information generated in previous iterations. If this useful information can be fully utilized in subsequent optimization processes, the quality of the feasible solutions produced by the algorithm will be greatly improved. Based on this, a method of reusing available information of previous individuals to guide subsequent search is proposed. In this method, the previous useful information is fed back to the individual update process, and then six information feedback models are proposed. In these models, the individuals of previous iterations are selected in a fixed or random way, and then the useful information of the selected individuals is applied to the individual update process. Then, based on the individuals generated and selected by the basic algorithm, a simple fitness weighting method is used to generate new individuals. Six different information feedback models are applied to 10 metaheuristic algorithms to generate new algorithms and verify the performance of the proposed information feedback model. Experiments show that these new algorithms are significantly better than the basic algorithms on 14 standard test functions and 10 CEC 2011 real world problems, and further prove the effectiveness of the proposed information feedback model. At the same time, the model is applied to solve many-objective optimization methods (MOEA/D and NSGA-III), and good results are achieved.

Biography

Gai-Ge Wang is an associate professor in Ocean University of China, China. His entire publications have been cited over 8800 times (Google Scholar). Fifteen and sixty-six papers are selected as Highly Cited Paper by Web of Science, and Scopus (till July, 2021), respectively. One paper is selected as "Top Articles from Outstanding S&T Journals of China-F5000 Frontrunner". He was selected as one of "2020 Highly Cited Chinese Researchers" in computer science and technology by Elsevier. He was selected as World's Top 2% Scientists 2020, ranked 3840 in single 2019 (ranked 30762 in 2017), and ranked 88554 in career-long citation impact. One of his papers was selected as "100 Most Influential International Academic Papers in China", One of his paper ranks 1 in the selection of the latest high-impact publications in computer science by Chinese researchers across from Springer Nature in 2019. The latest Google h-index and i10-index are 52 and 103, respectively. He is senior member of SAISE, SCIEI, a member of IEEE, IEEE CIS, ISMOST. He served as Editorial Advisory Board Member of Communications in Computational and Applied Mathematics (CCAM), Associate Editor of IJCISIM, an Editorial Board Member of IEEE Access, Mathematics, IJBIC, Karbala International Journal of Modern Science, and Journal of Artificial Intelligence and Systems. He served as Guest Editor for many journals including Mathematics, IJBIC, FGCS, Memetic Computing and Operational Research. His research interests are swarm intelligence, evolutionary computation, and big data optimization.

Plenary Speech II

New Insights into Nature Inspired Intelligence Methodologies with Applications in Robotics and Autonomous Systems

Speaker: Dr. Chaomin Luo
Affiliation : Mississippi State University, USA
Location: Yan Xi Tang (zoom: 847 7347 7938)
Time: July 18th 10:20-11:10

Abstract

The theme of nature inspired intelligence techniques, swarm intelligence and dynamic evolutionary optimization theory, an important embranchment of series on computational intelligence and machine learning, plays a crucial role for intelligent agents. The autonomous robot and vehicle industry have had an immense impact on our economy and society, and this trend will continue with nature inspired intelligence, swarm intelligence, techniques and dynamic evolutionary optimization theory. A sequence of novel neural dynamics, evolutionary computation algorithms and evolutionary optimization algorithms associated with developed numerical methods, spline-based and vector-driven methods for autonomous robot navigation and mapping are proposed. From biologically motivated neural networks algorithms to evolutionary computation algorithms, nature inspired intelligence techniques and dynamic evolutionary optimization are employed to autonomous system navigation, mapping, path planning, localization and vision, in this research. Automobile accidents account for nearly 34,000 accidental deaths, unfortunately, in the United States yearly; that number is expected to rise by 65% over the next 20 years. The objective of Advanced Driver Assistance Systems (ADAS) is to support drivers through warning to reduce the risk exposure, triggering the protection cycles to prevent from accidents. Sensor fusion, system modeling and development for ADAS by nature inspired intelligence are performed and addressed as well. Simulation, comparison studies and experimental results of nature inspired intelligence, swarm intelligence techniques and dynamic evolutionary optimization algorithms applied for an autonomous robot and a multi-robot system demonstrate their effectiveness, efficiency and robustness of the proposed methodologies.

Biography

Dr. Chaomin Luo received his Ph.D. in Electrical and Computer Engineering from the Department of Electrical and Computer Engineering at University of Waterloo, Canada in 2008, his M.Sc. in Engineering Systems and Computing at University of Guelph, Canada, and his B.Eng. in Electrical Engineering from Southeast University, Nanjing, China. After he received his Ph.D., he was an Assistant Professor and then an Associate Professor, in the Department of Electrical and Computer Engineering, at the University of Detroit Mercy, Michigan, USA. He is currently an Associate Professor, Department of Electrical and Computer Engineering, at the Mississippi State University, Mississippi State, MS 39762, USA. His research interests include biologically inspired intelligence, swarm intelligence, computational intelligence, robotics, autonomous systems and control, and applied machine learning. He was Associate Editor in 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IEEE IROS'2019). He is Tutorials Co-Chair in the 2020 IEEE Symposium Series on Computational Intelligence (IEEE SSCI'2020). Dr. Luo is selected in the Marquis Who's Who in America, 2019-2020 edition. He received the Best Paper Presentation Award at the SWORD'2007 Conference, the Best Paper Award in the IEEE International Conference on

Information and Automation (IEEE ICIA'2017). He was the panelist in the Department of Defense, USA, 2015-2016, 2016-2017 NDSEG Fellowship program and panelist in 2017 NSF GRFP Panelist program. Dr. Luo is active nationally and internationally in his research field. He was the Program Co-Chair in 2018 IEEE International Conference on Information and Automation (IEEE-ICIA'2018). He was the Plenary Session Co-Chair in the 2019 and 2018 International Conference on Swarm Intelligence, and he was the Invited Session Co-Chair in the 2017 International Conference on Swarm Intelligence. He was the General Co-Chair of the 1st IEEE International Workshop on Computational Intelligence in Smart Technologies (IEEE-CIST 2015), and Journal Special Issues Chair, IEEE 2016 International Conference on Smart Technologies (IEEE-SmarTech), Cleveland, OH, USA. Also, he was Chair and Vice Chair of IEEE SEM - Computational Intelligence Chapter and was a Chair of IEEE SEM - Computational Intelligence Chapter and Chair of Education Committee of IEEE SEM. Dr. Luo serves as the Associate Editor of IEEE Transactions on Cognitive and Developmental Systems, Associate Editor of International journal of Robotics and Automation, Associate Editor of International Journal of Swarm Intelligence Research (IJSIR), and the Editorial Board Member of Journal of Industrial Electronics and Applications, and International Journal of Complex Systems – Computing, Sensing and Control. He has organized and chaired several special sessions on topics of Intelligent Vehicle Systems and Bio-inspired Intelligence in reputed international conferences such as IJCNN, IEEE-SSCI, IEEE-CEC, IEEE-CASE, and IEEE-Fuzzy, etc. He has extensively published in reputed journals and conference proceedings, such as IEEE Transactions on Industrial Electronics, IEEE Transactions on Neural Networks and Learning Systems, IEEE Transactions on SMC, IEEE Transactions on Cybernetics, IEEE-ICRA, and IEEE-IROS, etc.

Invited Talk II

Evolutionary Multiparty Multiobjective Optimization

Speaker: Dr. Wenjian Luo
Affiliation : Harbin Institute of Technology
Location: Yan Xi Tang (zoom: 847 7347 7938)
Time: July 18th 11:10-11:40

Abstract

Some real-world optimization problems involve multiple decision makers holding different positions, each of whom has multiple conflicting objectives. These problems are defined as multiparty multiobjective optimization problems (MPMOPs). First, this talk will be focused on a special class of MPMOPs, which have common Pareto optimal solutions. The basic algorithm and the benchmark about MOMOPs having common Pareto optimal solutions are introduced. Second, the real MPMOPs related to distance minimization problems (DMPs) will be introduced. DMPs are a type of multiobjective optimization problems, which demand the nearest position to a set of predefined fixed positions. But the multiparty DMPs mean that there are multiple decision makers, and each decision maker corresponds to one DMP. Two algorithms are tested on the benchmarks, including OptMPNDS and OptMPNDS2. OptMPNDS based on NSGAII changes the nondominated sorting to rank the solutions since multiple parties are involved. OptMPNDS2 further enhances the nondominated sorting to deal with the dominance relation more precisely.

Biography

Wenjian Luo is a professor of School of Computer Science and Technology, Harbin Institute of Technology, Shenzhen, China. He received the BS and PhD degrees from Department of Computer Science and Technology, University of Science and Technology of China, Hefei, China. His research interest is artificial intelligence and applications including swarm intelligence, machine learning and immune computation. He has published over 100 journal and conference papers. He currently serves as an associate editor or editorial board member for several journals including Information Sciences Journal, Swarm and Evolutionary Computation Journal, Journal of Information Security and Applications, Applied Soft Computing Journal and Complex & Intelligent Systems Journal. Currently he also serves as the chair of the IEEE CIS ECTC Task Force on Artificial Immune Systems (2018-). He has been a member of the organizational team of more than ten academic conferences, in various functions, such as program chair, symposium chair and publicity chair.

Program Schedule

Date	Time	Events	Location
July 17th	13:00-18:00	Onsite Registration	Hotel Lobby
	18:00 - 19:30	Beer Festival Reception	Dong Hai Hall
July 18th	08:30 - 08:40	Opening Ceremony	Yan Xi Tang
	08:40 - 09:30	Plenary Speech I	
	09:30 - 10:00	Invited Talk I	
	10:00 - 10:20	Photo Session & Tea/Coffee Break	
	10:20 - 11:10	Plenary Speech II	
	11:10 - 11:40	Invited Talk II	
	13:00 - 17:20	Parallel Sessions (Five parallel onsite/online oral sessions, please refer to the next page for detailed technical program schedule)	Room 1: Bo Hai Hall Room 2: Nan Hai Hall Room 3: Huang Hai Hall Room 4: Zoom I Room 5: Zoom II
		Posters	Hallway
	18:00 - 20:00	Award Banquet	Dong Hai Hall
July 19th	09:00 - 12:00	Parallel Sessions (Three parallel onsite/online oral sessions,please refer to the next page for detailed technical program schedule)	Room 1: Bo Hai Hall Room 2: Zoom I Room 3: Zoom II

Tea/Coffee Breaks for Parallel Sessions: 10:20-10:40, 15:00-15:20

July 20th/21st		Post-event Activities and Tour (Free activities, self-pay, not officially organized)	

Technical Program Overview

Date	Session Time	Room	Topics
July 18th	13:00 - 15:00	Bo Hai Hall (zoom：847 7347 7938)	Data Mining UAV Cooperation and Control
		Nan Hai Hall (zoom：826 7855 8364)	Machine Learning
		Huang Hai Hall (zoom：812 4427 4048)	Evolutionary Computation Multi-Objective Optimization Swarm-based Computing Algorithms
		ZOOM I (826 0784 1667)	Swarm Robotics and Multi-agentSystem Ant Colony Optimization Data Mining
		ZOOM II (859 6443 6186)	Swarm-based Computing Algorithms Differential Evolution MachineLearning
	15:20 - 17:40	Bo Hai Hall (zoom：847 7347 7938)	Swarm Robotics and Multi-agentSystem
		Nan Hai Hall (zoom：826 7855 8364)	Fireworks Algorithms ParticleSwarm Optimization
		Huang Hai Hall (zoom：812 4427 4048)	Brain Storm Optimization Algorithm Swarm Robotics and Multi-agent System
		ZOOM I (826 0784 1667)	Swarm Intelligence and Nature-Inspired Computing Multi-Objective Optimization DataMining
		ZOOM II (859 6443 6186)	Swarm Intelligence and Nature-Inspired Computing Swarm Robotics and Multi-agent System Particle Swarm Optimization
July 19th	09:00 - 10:20	Bo Hai Hall (zoom：847 7347 7938)	Swarm-based Computing Algorithms
		ZOOM I (826 0784 1667)	Swarm Intelligence and Nature-Inspired Computing
		ZOOM II (859 6443 6186)	Other Applications
	10:40 - 12:00	Bo Hai Hall (zoom：847 7347 7938)	Swarm-based Computing Algorithms
		ZOOM I (826 0784 1667)	Data Mining
		ZOOM II (859 6443 6186)	Machine Learning

Technical Program

July 18th

Date: July 18th
Time: 13:00-15:00
Location: Bo Hai Hall (zoom: 847 7347 7938)

13:00-13:20	Mining Neighbor Frames for Person Re-identification by Global Optimal Tracking (onsite) *Chao Zhang*	P27
13:20-13:40	Map Fusion Method Based on Image Stitching for Multi-robot SLAM (onsite) *Qirong Tang, Kun Zhang, Pengjie Xu, Jingtao Zhang , Yuanzhe Cui*	P27
13:40-14:00	Intrusion detection system based on an updated ANN model (onsite) *Xue Yu, Bernard-Marie Onzo , Ferrante Neri*	P27
14:00-14:20	Ensemble Recognition Based on the Harmonic Information Gain Ratio for Unsafe Behaviors in Coal Mines (onsite) *Jian Cheng, Botao Jiao, Yinan Guo , Shijie Wang*	P28
14:20-14:40	Task Allocation Using Particle Swarm Optimization with Dual Update Strategies Collaboration for UAVs (onsite) *Shuang Xia, Xiangyin Zhang, Xiuzhi Li , Tian Zhang*	P28
14:40-15:00	Active Disturbance Rejection Control of Underwater Manipulator (onsite) *Qirong Tang, Daopeng Jin, Yang Hong, Jinyuan Guo , Jiang Li*	P28

Date: July 18th
Time: 13:00-15:00
Location: Nan Hai Hall (zoom: 826 7855 8364)

13:00-13:20	Sequential Stacked AutoEncoder-based Artificial Neural Network and Improved Sheep Optimization for Tool Wear Prediction (onsite) *Fei Ding, Mingyan Jiang, Dongfeng Yuan, Falei Ji , Haiyan Yu*	P29
13:20-13:40	Deep Reinforcement Learning for Dynamic Scheduling of Two-stage Assembly Flowshop (onsite) *Xin Lin , Jian Chen*	P29
13:40-14:00	A Cell Tracking Method with Deep Learning Mitosis Detection in Microscopy Images (onsite) *Di Wu, Benlian Xu, Mingli Lu, Jian Shi, Zhen Li, Fei Guan , Zhicheng Yang*	P29
14:00-14:20	Proof Searching in PVS Theorem Prover Using Simulated Annealing (onsite) *M. Saqib Nawaz, Meng Sun , Philippe Fournier-Viger*	P30
14:20-14:40	Classification of Imbalanced Fetal Health Data by PSO Based Ensemble Recursive Feature Elimination ANN (onsite) *Jun Gao, Canpeng Huang, Xijie Huang, Kaishan Huang , Hong Wang*	P30
14:40-15:00	Exploring the Landscapes and Emerging Trends of Reinforcement Learning from 1990 to 2020: A Bibliometric Analysis (onsite) *Li Zeng, Xiaoqing Yin, Yang Li , Zili Li*	P30

Date: July 18th **Time:** 13:00-15:00	**Location:** Huang Hai Hall (zoom: 812 4427 4048)

13:00-13:20	Biased Random-Key Genetic Algorithm for Structure Learning (onsite) *Baodan Sun , Yun Zhou*	P31
13:20-13:40	A Slime Mold Fractional-order Ant Colony Optimization Algorithm for Travelling Salesman Problems (onsite) *Ziheng Rong, Xiaoling Gong, Xiangyu Wang, Wei Lv , Jian Wang*	P31
13:40-14:00	A Multi-Objective Evolutionary Algorithm Based on Second-order Differential Operator (onsite) *Ruizhi Wan, Yinnan Chen , Xinchao Zhao*	P31
14:00-14:20	Dynamic Multi-objective Optimization via Sliding Time Window and Parallel Computing (onsite) *Qinqin Fan, Yihao Wang, Okan K. Ersoy, Ning Li , Zhenzhong Chu*	P32
14:20-14:40	Real-time Sea Cucumber Detection Based on YOLOv4-tiny and Transfer Learning Using Data Augmentation (online) *Thao Ngogia, Yinghao Li, Daopeng Jin, Jinyuan Guo, Jiang Li , Qirong Tang*	P32
14:40-15:00	Lion Swarm Optimization by Reinforcement Pattern Search (online) *Falei Ji , Mingyan Jiang*	P32

Date: July 18th **Time:** 13:00-15:00	**Location:** ZOOM I (826 0784 1667)

13:00-13:20	Distributed Multi-agent Shepherding with Consensus (online) *Benjamin Campbell, Heba El-Fiqi, Robert Hunjet , Hussein Abbass*	P33
13:20-13:40	Intelligent Intrusion Detection System for a Group of UAVs (online) *Elena Basan, Maria Lapina, Nikita Mudruk, Eugine Abramov , Vitalii Lapin*	P33
13:40-14:00	Ant Colony Optimization for K-Independent Average Traveling Salesman Problem (online) *Yu Iwasaki , Koji Hasebe*	P33
14:00-14:20	Genetic Algorithm Fitness Function Formulation for Test Data Generation with Maximum Statement Coverage (online) *Tatiana Avdeenko , Konstantin Serdyukov*	P34
14:20-14:40	An Improved El Nino Index Forecasting Method Based on Parameters Optimization (online) *Chenxin Shen, Qingjian Ni, Shuai Zhao, Meng Zhang , Yuhui Wang*	P34
14:40-15:00	Stock Market Movement Prediction by Gated Hierarchical Encoder (online) *Peibin Chen , Ying Tan*	P34

Date: July 18th **Time:** 13:00-15:00	**Location:** ZOOM II (859 6443 6186)

13:00-13:20	Success-History Based Position Adaptation in Gaining-Sharing Knowledge Based Algorithm (online) *Shakhnaz Akhmedova , Vladimir Stanovov*	P35

13:20-13:40	An Ant Colony Optimization based Approach for Binary Search (online) *Sreelaja N.K , Sreeja N.K*	P35
13:40-14:00	Two Modified NichePSO Algorithms for Multimodal Optimization (online) *Tyler Crane, Andries Engelbrecht , Beatrice Ombuki-Berman*	P35
14:00-14:20	On One Bicriterion Discrete Optimization Problem and A Hybrid Ant Colony Algorithm for Its Approximate Solution (online) *Yurii Mezentsev , Nikita Chubko*	P36
14:20-14:40	Application of Internet Plus: TCM Clinical Intelligent Decision Making (online) *Jun Xie, Sijie Dang, Xiuyuan Xu, Jixiang Guo, Xiaozhi Zhang , Zhang Yi*	P36
14:40-15:00	The Efficiency of Interactive Differential Evolution on Creation of ASMR Sounds (online) *Makoto Fukumoto*	P36

Date: July 18th **Time:** 15:20-17:40 | **Location:** Bo Hai Hall (zoom: 847 7347 7938)

15:20-15:40	Primitive Shape Recognition Based on Local Point Cloud for Object Grasp (onsite) *Qirong Tang, Lou Zhong, Zheng Zhou, Wenfeng Zhu , Zhugang Chu*	P37
15:40-16:00	Artificial Fish Swarm Algorithm for Mining High Utility Itemsets (onsite) *Wei Song, Junya Li , Chaomin Huang*	P37
16:00-16:20	Multi-UAV Cooperative Path Planning via Mutant Pigeon Inspired Optimization with Group Learning Strategy (onsite) *Yueping Yu, Yimin Deng , Haibin Duan*	P37
16:20-16:40	Robotic Brain Storm Optimization: A Multi-target Collaborative Searching Paradigm for Swarm Robotics (onsite) *Jian Yang, Donghui Zhao, Xinhao Xiang , Yuhui Shi*	P38
16:40-17:00	Adaptive Task Distribution Approach using Threshold Behavior Tree for Robotic Swarm (onsite) *Li Ma, Weidong Bao, Xiaomin Zhu, Meng Wu, Yutong Yuan, Ji Wang , Hao Chen*	P38
17:00-17:20	Immune System Algorithms to Environmental Exploration of Robot Navigation and Mapping (online) *Elakiya Jayaraman, Tingjun Lei, Shahram Rahimi, Shi Cheng , Chaomin Luo*	P38

Date: July 18th **Time:** 15:20-17:40 | **Location:** Nan Hai Hall (zoom: 826 7855 8364)

15:20-15:40	Fireworks Harris Hawk Algorithm Based on Dynamic Competition Mechanism for Numerical Optimization (onsite) *Wenyu Li, Ronghua Shi, Heng Zou , Jian Dong*	P39
15:40-16:00	Enhancing Fireworks Algorithm in Local Adaptation and Global Collaboration (onsite) *Yifeng Li , Ying Tan*	P39

16:00-16:20	Research on the Latest Development of Particle Swarm Optimization Algorithm for Satellite Constellation (onsite) *Zhang Jiaxu , Yan Xiaopeng*	P39
16:20-16:40	Multi-stage COVID-19 Epidemic Modeling Based on PSO and SEIR (onsite) *Haiyun Qiu, Jinsong Chen , Ben Niu*	P40
16:40-17:00	Optimizing Artificial Neural Network for Functions Approximation using Particle Swarm Optimization (onsite) *Lina Zaghloul, Rawan Zaghloul , Mohammad Hamdan*	P40
17:00-17:20	Performance Analysis of the Fireworks Algorithm Versions (online) *Ira Tuba, Ivana Strumberger, Eva Tuba, Nebojsa Bacanin , Milan Tuba*	P40
17:20-17:40	Region Selection with Discrete Fireworks Algorithm for Person Re-Identification (online) *Xuan Li, Tao Zhang, Xin Zhao , Shuang Li*	P41

Date: July 18th **Time:** 15:20-17:40 | **Location:** Huang Hai Hall (zoom：812 4427 4048)

15:20-15:40	An Improved Brain Storm Optimization Algorithm Based on Maximum Likelihood Estimation (onsite) *Junfeng Chen, Xingsi Xue , Bulgan Ninjerdene*	P41
15:40-16:00	Spiking Adaptive Dynamic Programming with Poisson Process (onsite) *Qinglai Wei, Liyuan Han , Tielin Zhang*	P41
16:00-16:20	The Impact of Wechat Red Packet Feature at Achieving Users Satisfaction and Loyalty: Wechat Users in China (online) *Kamal Abubker Abrahim Sleiman, Juanli Lan, Xiangyu Cai, Yubo Wang, Hongzhen Lei , Ru Liu*	P42
16:20-16:40	Distributed Position-force Control for Cooperative Transportation with Multiple Mobile Manipulators (onsite) *Pengjie Xu, Jun Zheng, Jingtao Zhang, Kun Zhang, Yuanzhe Cui , Qirong Tang*	P42
16:40-17:00	Multi-objective Brainstorming Optimization Algorithm Based on Adaptive Mutation Strategy (onsite) *Yali Wu, Yulong Wang , Xiaoxiao Quan*	P42
17:00-17:20	A New Evolutionary Approach to Multiparty Multiobjective Optimization (onsite) *Zeneng She, Wenjian Luo, Yatong Chang, Xin Lin , Ying Tan*	P42
17:20-17:40	Using Population Migration and Mutation to Improve Loser-out Tournament-based Fireworks Algorithm (online) *Pengcheng Hong , Junqi Zhang*	P43

Date: July 18th **Time:** 15:20-17:40 | **Location:** ZOOM I (826 0784 1667)

15:20-15:40	Traveling Salesman Problem via Swarm Intelligence (online) *Pei-Chen Yen , Frederick Kin Hing Phoa*	P44
15:40-16:00	NiaClass: Building Rule-based Classification Models Using Nature-inspired Algorithms (online) *Luka Pe?nik, Iztok Fister , Iztok Jr. Fister*	P44

16:00-16:20	An Improved Evolutionary Multi-objective Optimization Algorithm Based on Multi-population and Dynamic Neighborhood (online) *Shuai Zhao, Xuying Kang , Qingjian Ni*	P44
16:20-16:40	Applying classification algorithms to identify brain activity patterns (online) *Marina Murtazina , Tatiana Avdeenko*	P45
16:40-17:00	Analysis of Security Problems in Groups of Intelligent Sensors (online) *Elena Basan, Maria Lapina, Massimo Mecella, Karen Grigoryan , Evgeniya Olefirenko*	P45
17:00-17:20	NiaAML2: An Improved AutoML Using Nature-inspired Algorithms (online) *Luka Pe?nik, Iztok Fister , Iztok Fister Jr.*	P45
17:20-17:40	Parallel Random Embedding with Negatively Correlated Search (online) *Qi Yang, Peng Yang , Ke Tang*	P46

Date: July 18th
Time: 15:20-17:40
Location: ZOOM II (859 6443 6186)

15:20-15:40	Metaheuristic Optimization on Tensor-type Solution via Swarm Intelligence and its Application in the Profit Optimization in Designing Selling Scheme (online) *Frederick Kin Hing Phoa, Hsin-Ping Liu, Yun-Heh Chen-Burger , Shau-Ping Lin*	P46
15:40-16:00	Odometry during Object Transport: A Study with Swarm of Physical Robots (online) *Muhanad Alkilabi, Timoteo Carletti , Elio Tuci*	P46
16:00-16:20	Multi-Guide Particle Swarm Optimisation Control Parameter Importance in High Dimensional Spaces (online) *Timothy Carolus , Andries Engelbrecht*	P47
16:20-16:40	Polynomial Approximation Using Set-Based Particle Swarm Optimization (online) *Jean-Pierre van Zyl , Andries Engelbrecht*	P47
16:40-17:00	Particle Swarms Reformulated towards a Unified and Flexible Framework (online) *Mauro S. Innocente*	P47
17:00-17:20	The Experimental Analysis on Transfer Function of Binary Particle Swarm Optimization (online) *Yixuan Luo, Jianhua Liu, Xingsi Xue, Renyuan Hu , Zihang Wang*	P47

July 19th

Date: July 19th **Time:** 09:00-10:20	**Location:** Bo Hai Hall (zoom: 847 7347 7938)

Date: July 19th **Time:** 09:00-10:20	**Location:** Nan Hai Hall (zoom: 826 7855 8364)

Date: July 19th **Time:** 09:00-10:20	**Location:** Huang Hai Hall (zoom: 812 4427 4048)

Date: July 19th **Time:** 10:40-12:00	**Location:** Bo Hai Hall (zoom: 847 7347 7938)

10:40-11:00	An Improved Dragonfly Algorithm Based on Angle Modulation Mechanism for Solving 0-1 Knapsack Problems (onsite) *Lin Wang, Ronghua Shi, Wenyu Li, Xia Yuan , Jian Dong*	P52
11:00-11:20	A Bacterial Foraging Optimization Algorithm Based on Normal Distribution for Crowdfunding Project Outcome Prediction (onsite) *Yingsi Tan, Shilian Chen , Shuang Geng*	P52
11:20-11:40	Reorganized Bacterial Foraging Optimization Algorithm for Aircraft Maintenance Technician Scheduling Problem (onsite) *Ben Niu, Bowen Xue, Tianwei Zhou, Churong Zhang , Qinge Xiao*	P53
11:40-12:00	Brain Storm Optimization Algorithm Based on Formal Concept Analysis (onsite) *Fengrong Chang, Lianbo Ma, Yan Song , Aoshuang Dong*	P53

Date: July 19th **Time:** 10:40-12:00 | **Location:** Nan Hai Hall (zoom：826 7855 8364)

10:40-11:00	Optimization of A High-Lift Mechanism Motion Generation Synthesis Using MHS (online) *Suwin Sleesongsom , Sujin Bureerat*	P53
11:00-11:20	Bayesian Classifier Based on Discrete Multidimensional Gaussian Distribution (online) *Yihuai Wang , Fei Han*	P54
11:20-11:40	Feature Selection for Image Classification Based on Bacterial Colony Optimization (online) *Hong Wang, Zhuo Zhou, Yixin Wang , Xiaohui Yan*	P54
11:40-12:00	An Improved Spatial-Temporal Network Based on Residual Correction and Evolutionary Algorithm for Water Quality Prediction (online) *Xin Yu, Wenqiang Peng, Dongfan Xue , Qingjian Ni*	P54

Date: July 19th **Time:** 10:40-12:00 | **Location:** Huang Hai Hall (zoom：812 4427 4048)

10:40-11:00	Compositional Object Synthesis in Game of Life Cellular Automata Using SAT Solver (online) *Haruki Nishimura , Koji Hasebe*	P55
11:00-11:20	A Knowledge Graph Enhanced Semantic Matching Method for Plan Recommendation (online) *Rupeng Liang, Shaoqiu Zheng, Kebo Deng, Zexiang Mao, Wei Ma , Zhengwei Zhang*	P55
11:20-11:40	Evolutionary Ontology Matching Technique with User Involvement (online) *Xingsi Xue, Chaofan Yang, Wenyu Liu , Hai Zhu*	P55
11:40-12:00	A Hybrid Wind Speed Prediction Model Based on Signal Decomposition and Deep 1DCNN (online) *Yuhui Wang, Qingjian Ni, Shuai Zhao, Meng Zhang , Chenxin Shen*	P56

Abstracts

Day I July 18th 13:00-15:00 Bo Hai Hall (zoom：847 7347 7938)

Mining Neighbor Frames for Person Re-identification by Global Optimal Tracking

Chao Zhang

Abstract. Person re-identification is a challenging task aiming to identify the same person across different cameras. However, most of existing image-based person re-identification methods neglect the spatial and temporal constraint, the information in neighbor frames of each person image is rarely exploited by previous studies. In this paper, we propose a novel neighbor frames mining framework (NFM) to exploit the spatial-temporal information. For each gallery image, we use a dynamic programming-based global optimal tracking method to search images of the same person in its neighbor frames. From those images, the image features extracted by the shared convolutional neural network (CNN) in the constructed neighbor sequence are merged via an attention weighted averaging technology. To this end, a novel supervised attention mechanism is designed for dealing with tracking errors. The final feature with multi-view and robust information is used for matching. Experimental results show the superiority and efficiency of the proposed method on two benchmark datasets including DukeMTMC-reID and PRW.

Map Fusion Method Based on Image Stitching for Multi-robot SLAM

Qirong Tang, Kun Zhang, Pengjie Xu, Jingtao Zhang , Yuanzhe Cui

Abstract. Compared with the single-robot SLAM, the SLAM task completed by a multi-robot system in cooperation has the advantages of more accuracy, more efficiency and more robustness. This study focuses on the map fusion problem in the multi-robot SLAM task, which is to fuse the local maps created by multiple independent robots into an integrated map. A multi-robot SLAM map fusion method based on image stitching is therefore proposed. A single robot uses lidar SLAM to build a local environment map and upload it to a central node. The central node then maps each local map from a two-dimensional occupancy grid map to a grayscale image. The SuperPoint network is used to extract the depth features from the grayscale images, and the transformation relationships between the local maps are calculated via the feature matching. The matching topology graph is used to realize the final map fusion. It carries out experimental verification in the indoor environment on three mobile robots, which were developed by our own, and the experiment proved that the method has good real-time performance and robustness. After obtaining the global map, some new robots were placed in the environment, and realized the task of multi-robot target search by using the relocalization function.

Intrusion detection system based on an updated ANN model

Xue Yu, Bernard-Marie Onzo , Ferrante Neri

Abstract. An intrusion detection system (IDS) is a software application or hardware appliance that monitors traffic on networks and systems to search for suspicious activity and known threats, sending up alerts when it finds such items. In these recent years, attention has been focused on artificial neural networks (ANN) techniques, especially Deep Learning approach on anomaly-based detection techniques; because of the huge and unbalanced datasets, IDS encounters real data processing problems. Thus, different techniques have been presented which can handle this problem. In this paper, a deep learning model or technique based on the Convolutional Neural Network (CNN) is proposed to improve the accuracy and precisely detect intrusions. The entire proposed model is divided into four stages: data collection, data pre-processing, the training and testing stage, and performance evaluation.

Ensemble Recognition Based on the Harmonic Information Gain Ratio for Unsafe Behaviors in Coal Mines

Jian Cheng, Botao Jiao, Yinan Guo , Shijie Wang

Abstract. More than 90% accidents occurred in coal mine are caused by unsafe behaviors of human. How to effectively identify unsafe behaviors and decrease the possibility of their occurrence is the fundamental of avoiding accidents. However, the number of unsafe behaviors is far less than that of safe ones in a behavior dataset of coal mine. Serious imbalance has a negative impact on recognition efficiency and accuracy. To address the problem, the harmonic information gain ratio is defined by introducing the degree of imbalance into traditional information gain, and the corresponding feature selection method is presented. By integrating it into Underbagging, a novel ensemble recognition based on the harmonic information gain ratio for unsafe behaviors is presented, with the purpose of avoiding information loss caused by feature reduction and guaranteeing recognition accuracy. Based on a sub-dataset obtained by undersampling, the optimal features subset is selected by the proposed feature selection method, and employed to train a base classifier built by support vector machine. The weighted sum of all base classifiers output forms final recognition result. Each weight is calculated from the corresponding harmonic information gain ratio. Experimental results on UCI dataset and a behavior dataset for a particular coal mine indicate that the proposed ensemble recognition method outperforms the others, especially for a dataset with high imbalance ratio.

Task Allocation Using Particle Swarm Optimization with Dual Update Strategies Collaboration for UAVs

Shuang Xia, Xiangyin Zhang, Xiuzhi Li , Tian Zhang

Abstract. The task allocation problem is a hot topic in the field of multiple unmanned aerial vehicle (UAV). In this paper, we consider the task allocation in rescue scenarios and establish the optimization model. Then, an improved particle swarm optimization with dual update strategies collaboration (DUCPSO) is proposed to solve it. In order to simplify the solution of the problem, a real vector coding method is adopted. In addition, the ring topology update method and the mutation update method are introduced to enhance the diversity of the population, and the effective collaboration of the two strategies is realized through the adaptive strategy conversion probability. The simulation results show that the proposed algorithm can effectively obtain the optimal task allocation scheme. Compared with other algorithms, the proposed algorithm is more feasible and efficient.

Active Disturbance Rejection Control of Underwater Manipulator

Qirong Tang, Daopeng Jin, Yang Hong, Jinyuan Guo , Jiang Li

Abstract. In this study, a method of active disturbance rejection controller (ADRC) is presented for 2-DOF underwater manipulator. The ADRC basically does not rely on the accurate mathematical model of the object and can decouple the model. This method can eliminate the influence of model errors, time-varying parameters and external interference on the control effect. Firstly, the manipulators is divided into two subsystems. For each joint subsystem, the hydrodynamic force, coupling term between joints and unknown environment disturbances are considered as the total disturbance. Subsequently, an extended state observer (ESO) is designed to estimate and compensate the total disturbance. Moreover, in order to improve the disturbance observation effect of the extended state observer, the inertia matrix of the manipulator system is used to decouple the static part. Finally, the effectiveness of ADRC is verified by simulation and it is demonstrated that ADRC's control effect outperforms PD and CSMC in either accuracy, dynamic characteristics or robustness.

Day I July 18th 13:00-15:00 Nan Hai Hall (zoom：826 7855 8364)

Sequential Stacked AutoEncoder-based Artificial Neural Network and Improved Sheep Optimization for Tool Wear Prediction

Fei Ding, Mingyan Jiang, Dongfeng Yuan, Falei Ji , Haiyan Yu

Abstract. Real-time tool wear prediction is one of the key problems to be solved in the field of intelligent manufacturing. In recent years, with the help of powerful feature extraction capability of AutoEncoder(AE), the Stacked AutoEncoder-based Deep Neural Network(SAE-DNN) model has achieved good results on tool wear prediction. However, the SAEDNN model ignores the time series characteristics between original samples. Besides, training the neural network with a gradient-based algorithm is prone to fall into local optimum. To solve the problems in the SAE-DNN, we propose a new improved model: Sequential Stacked AutoEncoder-based Artificial Neural Network(SSAE-ANN). First, the SSAE-ANN model uses the Sequential Stacked AutoEncoder(SSAE), which can not only fuse the features between different channels of a single sample, but also extract the time series features between adjacent samples. Second, the SSAE-ANN model uses the Improved Sheep Optimization(ISO) algorithm to train the neural network. Compared with the gradient algorithm, the ISO algorithm has stronger robustness and global optimization ability. At the end of the paper, we perform experiments on PHM2010 dataset and verify the superiority of SSAE-ANN model by comparing with other algorithms.

Deep Reinforcement Learning for Dynamic Scheduling of Two-stage Assembly Flowshop

Xin Lin , Jian Chen

Abstract. Dynamic scheduling of jobs is increasingly needed in modern maketo-order manufacturing companies considering various inevitable uncertainties, such as dynamical arrivals or frequent changes of customer orders. To this end, we model a dynamic scheduling of two-stage assembly flowshop (AF) to minimize the total tardiness as a Markov decision process (MDP). Then we propose a deep reinforcement learning (DRL) approach to build a scheduler agent to make real-time decisions of dispatching rules according to current production environment. A proximal policy optimization (PPO) algorithm is developed to efficiently train agent using production data. Numerical experiments show that the trained agent can fully capture the knowledge in historical data so as to make a real-time scheduling quickly and effectively, and the proposed approach is both superior and general to each well-known dispatching rule in different production scenarios. The proposed approach is highly desirable for many practical scheduling situations that requires dynamic and quick decisions.

A Cell Tracking Method with Deep Learning Mitosis Detection in Microscopy Images

Di Wu, Benlian Xu, Mingli Lu, Jian Shi, Zhen Li, Fei Guan , Zhicheng Yang

Abstract. Cell motion analysis plays an important role in biomedical fields such as disease diagnosis and drug development. A crucial step in quantifying cell dynamics is to detect mitosis, which is the process that a mother cell divided into two daughter cells. To gain an accurate analysis of multiple cells, a deep framework combining U-net and convolution LSTM is proposed to simultaneously segment cells and detect mitosis, in which the spatiotemporal information of image sequences is fully utilized to predict the locations of cell and the occurrence of mitosis. With the obtained cell segmentation and mitotic event, a particle filter based tracking method is proposed to estimate individual state of cells, in which a two-step data association strategy is developed to handle the mitotic assignment. Simulation results are presented to show that the proposed method has favorable performance and can track cells effectively with mitosis.

Proof Searching in PVS Theorem Prover Using Simulated Annealing

M. Saqib Nawaz, Meng Sun , Philippe Fournier-Viger

Abstract. The proof development process in PVS theorem prover is interactive in nature, that is not only laborious but consumes lots of time. For proof searching and optimization in PVS, a heuristic proof searching approach is provided where simulated annealing (SA) is used to search and optimize the proofs for formalized theorems/lemmas in PVS theories. In the proposed approach, random proof sequence is first generated from a population of frequently occurring PVS proof steps that are discovered with sequential pattern mining. Generated proof sequence then goes through the annealing process till its fitness matches with the fitness of the target proof sequence. Moreover, the performance of SA with a genetic algorithm (GA) is compared. Obtained results suggest that evolutionary/heuristic techniques can be combined with proof assistants to efficiently support proofs finding and optimization.

Classification of Imbalanced Fetal Health Data by PSO Based Ensemble Recursive Feature Elimination ANN

Jun Gao, Canpeng Huang, Xijie Huang, Kaishan Huang , Hong Wang

Abstract. Electrocardiogram (CTG) is a simple and low-cost option to assess the health of the fetus. However, the number of normal fetuses is larger than the number of abnormal fetuses, leading to imbalances in CTG data. Existing studies have attempted to optimize the data processing or model training process by integrating machine learning methods with optimization algorithms. However, the effectiveness of features and appropriate selection of machine learning method creates new challenges. This study proposed an comprehensive method that considers the feature effectiveness and data imbalance issue. The proposed method uses the Particle Swarm Optimization (PSO) algorithm to optimize the parameters of the Edited Nearest Neighbours (ENN), Recursive Feature Elimination (RFE), and Artificial Neural Network (ANN) algorithms to find the optimal combination of the parameters of the three algorithms to further improve the accuracy of the fetal health prediction and reduce the cost of tuning. Experimental results show that the algorithm proposed in this paper can effectively solve the imbalance of CTG data, with a classification accuracy of 0.9942 and a kappa measure of 0.9783, which can effectively assist doctors in diagnosing fetal health and improve the quality of hospital visits.

Exploring the Landscapes and Emerging Trends of Reinforcement Learning from 1990 to 2020: A Bibliometric Analysis

Li Zeng, Xiaoqing Yin, Yang Li , Zili Li

Abstract. Reinforcement Learning (RL) becomes increasingly important in recent years as the huge success of AlphaGo and AlphaZero. However, this technique is a not a newly born research topic, which originates from the well-developed dynamic programming method. In this paper, we explore the history of RL from the bibliometric perspective for the last 30 years, to capture its landscapes and emerging trends. We conduct comprehensive assessments of the RL technology according to articles related to RL in SCI database from 1990 to 2020, and extensive results indicate that reinforcement learning research goes up significantly in the past three decades, including a total of 9344 articles covering 96 countries/territories. Top five most productive countries are USA, China, England, Japan, Germany and Canada. There are 4507 research institutes involved in the field of RL and among them the top five productive ones are Chinese Academy of Sciences, University College London, Beijing University of Posts and Telecommunications, Tsinghua University and Northeastern University and Princeton University. Besides, top frequently adopted

Day I July 18th 13:00-15:00 Huang Hai Hall (zoom: 812 4427 4048)

Biased Random-Key Genetic Algorithm for Structure Learning

Baodan Sun , Yun Zhou

Abstract. The structure learning of Bayesian networks is a NP-hard problem, which cannot be easily solved since it is usually a complex combination optimization problem. Thus, many structure learning algorithms using evolutionary techniques are investigated recently to obtain a reasonable result. However, evolutionary algorithms may suffer from a low accuracy and restricts their applications. In this paper, we apply the Biased Random-Key Genetic Algorithm to solve Bayesian network structure learning problem since this framework is novely designed to solve conventional combination optimization problems. Also, we use a local optimization algorithm as its decoder to improve the performance. Experiments show that our method achieves better performances on the real-world networks than other state-of-art algorithms.

A Slime Mold Fractional-order Ant Colony Optimization Algorithm for Travelling Salesman Problems

Ziheng Rong, Xiaoling Gong, Xiangyu Wang, Wei Lv , Jian Wang

Abstract. In this paper, a novel algorithm of slime mold fractionalorder ant colony optimization (SMFACO) for travelling salesman problems (TSPs) is proposed. The newly developed algorithm, SMFACO, takes full use of the long-term memory characteristics of the fractional calculus to balance exploration and exploitation. In addition, it considers the property of the slime mold model, which retains the critical path to avoid trapping into the local optima. To evaluate the performance of the SMFACO, we conduct comprehensive experiments on various data sets. According to the experimental results, the proposed algorithm outperforms its peer algorithms on solution quality, search efficiency and convergence speed.

A Multi-Objective Evolutionary Algorithm Based on Second-order Differential Operator

Ruizhi Wan, Yinnan Chen , Xinchao Zhao

Abstract. Differential evolution (DE) is a swarm intelligence algorithm based on population, which has been used to solve multi-objective optimization problems (MOP). The distribution and convergence of the non-dominated solutions set are often the key indicators to evaluate the merits of MOP algorithms. In this paper, we propose a decomposition multi-objective evolutionary algorithm based on second-order differential operator (MOEA/D-SODE). By selecting the commonly used ZDT, DTLZ and IMOP benchmark functions, comparing with the existing differential evolution MOEA/D-DE, the solutions set obtained by MOEA/D-SODE algorithm has better convergence and distribution. The experimental results verify the effectiveness of MOEA/D-SODE algorithm, which provides a new and effective method for MOP.

Dynamic Multi-objective Optimization via Sliding Time Window and Parallel Computing

Qinqin Fan, Yihao Wang, Okan K. Ersoy, Ning Li , Zhenzhong Chu

Abstract. Tracking changing Pareto front (PF) in the objective space and Pareto set (PS) in the decision space is an important task in dynamic multi-objective optimization (DMO). Similarly, maintaining population diversity and reusing previous evolutionary information are useful to explore promising regions and to find high-quality solutions quickly in time-varying environments. To this end, a sliding time window based on parallel computing (STW-PC) is introduced in the present study. In the STW-PC, obtained time-sequence solution sets aim to preserve the diversity and facilitate a fast convergence since problems in successive time/environments are usually related. The parallel computing method is also employed to reduce the computational time. The STW-PC is incorporated into a multi-objective evolutionary algorithm and is compared with two competitors on 12 dynamic multi-objective optimization problems. The results show that the STW-PC can both improve the tracking performance of the selected algorithm in different degrees of changes, and significantly reduce the calculation time compared with transfer learning.

Real-time Sea Cucumber Detection Based on YOLOv4-tiny and Transfer Learning Using Data Augmentation

Thao Ngogia, Yinghao Li, Daopeng Jin, Jinyuan Guo, Jiang Li , Qirong Tang

Abstract. You Only Look Once version 4 (YOLOv4) model has an outstanding performance in object detection and recognition. However, the YOLOv4 is too complex, requiring high computing resources with a lot of training data, which is difficult in the underwater environment. YOLOv4-tiny is proposed based on YOLOv4 to simplify the network structure and reduce parameters, which makes it be suitable for developing on mobile and embedded devices. In this paper, in order to implement a real-time cultured sea cucumber detector to the autonomous underwater vehicle (AUV), YOLOv4-tiny and transfer learning are applied. The model has a good performance in speed but the accuracy is unsatisfactory while evaluated on the real-world underwater datasets. Therefore, a data augmentation method based on improved Mosaic data augmentation is further proposed to improve the quality of the training dataset. The proposed method is evaluated on the real-world sea cucumber underwater videos and has a good performance.

Lion Swarm Optimization by Reinforcement Pattern Search

Falei Ji , Mingyan Jiang

Abstract. Lion swarm optimization (LSO) is a swarm intelligence algorithm that simulates lion king guarding, lioness hunting, and cub following. However, there are problems that lions are easily out of bounds when the range of activity is large and the position update formulas are not universal, which affect the performance of LSO. Aiming at above problems, a swarm intelligence algorithm, lion swarm optimization by reinforcement pattern search (RPSLSO) is proposed. The algorithm is based on the proposed modified lion swarm optimization (MLSO) and reinforcement pattern search (RPS) algorithm. The former solves above two problems, and the latter enhances the local search capability of MLSO, making the search more directional. In order to test the performance of RPSLSO, RPSLSO was compared with MLSO, LSO and the other two algorithms on the CEC2013 test function set. The experimental results show that the performance of RPSLSO is better, and the modifications to LSO and the proposed RPS in this paper are also effective.

Day I July 18th 13:00-15:00 ZOOM I (826 0784 1667)

Distributed Multi-agent Shepherding with Consensus

Benjamin Campbell, Heba El-Fiqi, Robert Hunjet , Hussein Abbass

Abstract. The field of swarm guidance and control can rely on intrinsic strategies such as a rule-based system within each member of the swarm or extrinsic strategies, whereby an external agent guides the swarm. In the shepherding problem, sheepdogs drive and collect a flock (swarm) of sheep, guiding them to a goal location. In the case of multiple dogs guiding the swarm, we examine how shared contextual awareness of the sheepdog agents improves the performance when solving the shepherding problem. Specifically consensus around the dynamic centre of mass of a flock is shown to improve shepherding performance.

Intelligent Intrusion Detection System for a Group of UAVs

Elena Basan, Maria Lapina, Nikita Mudruk, Eugine Abramov , Vitalii Lapin

Abstract. Today, the creation of UAV groups is becoming a very popular and relevant task. Nevertheless, the use of UAVs is not securely, since they are vulnerable not only to attacks by an intruder, but also to environmental influences. Thus, the occurrence of anomalies must be detected in time. This work is aimed at detecting anomalies in UAV groups and determining the type of attack. To accomplish this task, the authors have developed an experimental stand emulating traffic transmission in a UAV group. The study is based on the investigation of changes in traffic transmission patterns during normal operation and under attacks. Data sets for training a neural network were collected using an developed testbed.

Ant Colony Optimization for K-Independent Average Traveling Salesman Problem

Yu Iwasaki , Koji Hasebe

Abstract. In this paper, we propose a K-independent average traveling salesman problem (KI-Average-TSP) extended from the TSP. This is an optimization problem that minimizes the weighted sum of the average and standard deviation of K circuits' costs, with mutually independent edges. As a method to solve the KI-Average-TSP, we propose K-independent average ant colony optimization (KI-Average-ACO) extended from the original ACO. KI-Average-ACO moves K ants simultaneously using the following two heuristics to prevent different circuits from sharing the same edge. The first heuristic uses a degree of possible options representing the number of vertices that an ant can reach from its current vertex. The destination of ants is stochastically determined by this value to reduce the circuit construction failure rate. The second heuristic, named 2-best-opt, uses a greedy algorithm in reconstructing a better path to obtain K circuits if circuit construction fails. Comparison results between the approximate solution obtained using KI-AverageACO and the solution obtained using a quadratic programming method for a binary search showed that the number of circuits for KI-AverageACO was higher, and KI-Average-ACO obtained a better approximate solution than the quadratic programming method.

Genetic Algorithm Fitness Function Formulation for Test Data Generation with Maximum Statement Coverage

Tatiana Avdeenko , Konstantin Serdyukov

Abstract. In present paper we solve an urgent problem of generating the optimal set of test data that provides maximum statement coverage of the code when it is used in the software white box testing process. Formulation of a fitness function containing two terms, and, accordingly, two versions for implementing genetic algorithm (GA) have been proposed. The first term of the fitness function is responsible for the complexity of the code statements executed on the path generated by the current individual test case (current set of statements). The second term formulates the maximum possible difference between the current set of statements and set of statements covered by the remaining test cases in the population. Using only the first term does not make it possible to obtain 100 percent statement coverage by generated test cases in one population, and therefore implies repeated launch of GA with changed weights of the code statements which requires recompiling the code under test. By using both terms of the proposed fitness function, we obtain maximum statement coverage in one launch of the GA.

An Improved El Nino Index Forecasting Method Based on Parameters Optimization

Chenxin Shen, Qingjian Ni, Shuai Zhao, Meng Zhang , Yuhui Wang

Abstract. El Nino is an important research issue in meteorology. In this paper, we propose a time series model to predict the NINO index. In this model, variational mode decomposition (VMD) is applied to extract multiple sub-signals, the long short term memory network (LSTM) is used to fit these sub-signals. Aiming at the optimization of parameters, we design a K-means neighbor particle swarm optimization (KMPSO) based on comprehensive learning particle swarm optimization (CLPSO), which optimizes the parameters of VMD and LSTM. El Nino data is widely concerned due to its strong relevance to world climate change. We conduct experiments on El Nino data, and put forward a forecast model, which has better forecast skills than other models. Experiments results demonstrate that the proposed method extends forecast time limits, and improves the accuracy prediction.

Stock Market Movement Prediction by Gated Hierarchical Encoder

Peibin Chen , Ying Tan

Abstract. Stock movement prediction is an important but challenging topic in the stock market. Previous methods mainly focus on predicting up or down of one stock, ignoring the significant up and down of the whole stock market that is more related to the final return. In this paper, a novel framework Gated Hierarchical Encoder (GHE) is proposed, which consists of two components: hierarchical feature learning and dynamic gate. Hierarchical feature learning helps the model do prediction from coarse to fine, while dynamic gate dynamically ensembles results from different branches. Experiments show that compared with MLP and LSTM, GHE achieves higher return on multiple stock markets, and predicts more accurately on the significant up and down.

Day I July 18th 13:00-15:00 ZOOM II (859 6443 6186)

Success-History Based Position Adaptation in Gaining-Sharing Knowledge Based Algorithm

Shakhnaz Akhmedova , Vladimir Stanovov

Abstract. This paper introduces a modification of the recently developed Adaptive Gaining Sharing Knowledge (AGSK) algorithm. The AGSK algorithm simulates the process of human gaining and sharing knowledge using two main phases to solve optimization problems: junior and senior. AGSK's efficiency was proved; however, there are still various approaches that can be used to improve its workability. In this study a new technique for generating potential solutions for the AGSK algorithm is proposed. This technique uses a historical memory of successful positions found by individuals stored in the external archive to guide those individuals in different directions and thus to improve the exploration and exploitation abilities of the AGSK algorithm. At first, the size of the external archive was fixed, but later in order to improve the performance of AGSK, a reduction technique was applied to decrease its size during the optimization process. Moreover, three different approaches were used to update the external archive after each algorithm's iteration. The modified algorithm (as well as its original variant) was evaluated on a set of test functions taken from the CEC 2021 competition. The obtained experimental results are presented and compared. It was established that the proposed modification of the AGSK algorithm allows finding better solutions with the same computational effort. Thus, proposed position adaptation technique's usefulness was demonstrated.

An Ant Colony Optimization based Approach for Binary Search

Sreelaja N.K , Sreeja N.K

Abstract. Search is considered to be an important functionality in a computational system. Search techniques are applied in file retrievals and indexing. Though there exists various search techniques, binary search is widely used in many applications due to its advantage over other search techniques namely linear and hash search. Binary search is easy to implement and is used to search for an element in a large search space. The worst case time complexity of binary search is O (log 2 n) where n is the number of elements (search space) in the array. However, in binary search, searching is performed on the entire search space. The complexity of binary search may be further reduced if the search space is reduced. This paper proposes an Ant Colony Optimization based Binary Search (ACOBS) algorithm to find an optimal search space for binary search. ACOBS algorithm categorizes the search space and the key element is searched only in a specific category where the key element can exist thereby reducing the search space. The time complexity of ACOBS algorithm is O (log 2 c) where c is the number of elements in the reduced search space and c ¡ n. The proposal is best suited for real time applications where searching is performed on a large domain.

Two Modified NichePSO Algorithms for Multimodal Optimization

Tyler Crane, Andries Engelbrecht , Beatrice Ombuki-Berman

Abstract. Multimodal function optimization (MMO) has seen a lot of interest and research over the past several years due to its many real world applications, and its complexity as an optimization problem. Several niching techniques proposed in past research have been combined with popular meta heuristic search algorithms such as evolutionary algorithms (EA), genetic algorithms (GA) and particle swarm optimization (PSO). The NichePSO algorithm was one of the first PSO algorithms proposed for utilizing niching methods and parallel swarms to apply PSO to MMO problems effectively. In this paper, two modified versions of the NichePSO algorithm are proposed, the NichePSO-R and NichePSO-S algorithms, in an attempt to improve its performance. Experimental results show that both proposed algorithms are able to locate more global optima on average than the NichePSO algorithm across several popular MMO benchmark functions.

On One Bicriterion Discrete Optimization Problem and A Hybrid Ant Colony Algorithm for Its Approximate Solution

Yurii Mezentsev , Nikita Chubko

Abstract. The bicriteria optimization problem of many projects developments' schedules with many competitive constraints on resources and interval constraints on the execution time and cost of operations is formulated in this article. Optimization is carried out according to the maximizing performance and the total cost of project execution criteria. The problem is NP-hard MILP and an efficient hybrid parametric algorithm that combines the critical path algorithm and ant colony optimization has been developed for its approximate solution. The actual performance and solutions' quality of the hybrid algorithm's software implementation have been compared with the results of IBM CPLEX on test problems. The effectiveness of the toolkit is confirmed experimentally by testing.

Application of Internet Plus: TCM Clinical Intelligent Decision Making

Jun Xie, Sijie Dang, Xiuyuan Xu, Jixiang Guo, Xiaozhi Zhang , Zhang Yi

Abstract. To improve the electronic medical record database for traditional Chinese medicine (TCM) and pass on the experience of distinguished TCM practitioners using artificial intelligence technology for TCM clinical decision making. The clinical intelligent assisted decision-making system independently developed by hospital joint enterprises was used to standardize clinical decision making. To create a decision-making support tool, it adopted the approach of disease and syndrome differentiation of TCM; it also analyzed and modeled the empirical approach of distinguished TCM practitioners. Internet Plus information technology supported TCM clinical decision making and allowed more people to benefit from TCM services. Non-expert doctors can understand the system functions quickly; they can grasp a patient's actual situation more efficiently and issue high-level prescriptions for TCM. Through the development and application of the intelligent decision-making system for TCM, the diagnostic efficiency and ability of doctors has greatly improved. The system has attained its expected goal.

The Efficiency of Interactive Differential Evolution on Creation of ASMR Sounds

Makoto Fukumoto

Abstract. Autonomous Sensory Meridian Response (ASMR) is a popular movie content among Internet users. It is a kind of entertainment content, and the users enjoy positive feelings caused by its binaural sounds in terms of reality. By referring to previous proposals creating ASMR sounds based on Interactive Evolutionary Computations (IECs), this study constructed a system of the Interactive Differential Evolution (IDE) creating ASMR sounds suited to the preference of each user. The purpose of this study is to investigate the efficiency of the IDE, which is one of IEC: its subjective evaluation is based on the user's paired comparison of the ASMR sounds. A listening experiment was conducted to fundamentally investigate the efficiency of the IDE. The ASMR sounds were composed of six natural sounds. Each of the nine subjects participated in the listening experiment, and they repeatedly compared two ASMR sounds afforded by the IDE system. As a result of the search process, a shrink in the search space was observed in accordance with generations. After the repetitive comparisons, the subjects scored two representatives ASMR sounds picked up from the 0th and the 10th generations respectively. With statistical analysis, a marginal increase in the fitness values was observed.

Day I July 18th 15:20-17:40 Bo Hai Hall (zoom：847 7347 7938)

Primitive Shape Recognition Based on Local Point Cloud for Object Grasp

Qirong Tang, Lou Zhong, Zheng Zhou, Wenfeng Zhu , Zhugang Chu

Abstract. Object recognition and grasping are important means of interaction between robot and environment, and also two of the main tasks of robot. Due to the rich information provided by depth sensors, it has paved the way for the object recognition. The geometric information is more conducive to the primitive recognition of the object, and the primitive shape information is used as the input information for the robot to grasp. This study proposes a primitive shape recognition method using local point cloud. First, 900 sets of point cloud data including three primitive shapes was created. Then the PointNet network using the point cloud data to recognize the primitive shape of the objects was trained. Experiments in simulation and physical world shows our recognition method can effectively recognize the primitive shape of the object.

Artificial Fish Swarm Algorithm for Mining High Utility Itemsets

Wei Song, Junya Li , Chaomin Huang

Abstract. The discovery of high utility itemsets (HUIs) is an attractive topic in data mining. Because of its high computational cost, using heuristic methods is a promising approach to rapidly discovering sufficient HUIs. The artificial fish swarm algorithm is a heuristic method with many applications. Except the current position, artificial fish do not record additional previous information, as other related methods do. This is consistent with the HUI mining problem: that the results are not always distributed around a few extreme points. Thus, we study HUI mining from the perspective of the artificial fish swarm algorithm, and propose an HUI mining algorithm called HUIM-AF. We model the HUI mining problem with three behaviors of artificial fish: follow, swarm, and prey. We explain the HUIM-AF algorithm and compare it with two related algorithms on four publicly available datasets. The experimental results show that HUIM-AF can discover more HUIs than the existing algorithms, with comparable efficiency.

Multi-UAV Cooperative Path Planning via Mutant Pigeon Inspired Optimization with Group Learning Strategy

Yueping Yu, Yimin Deng , Haibin Duan

Abstract. This paper proposes a mutant pigeon-inspired optimization algorithm with group learning strategy (MGLPIO), for multi-UAV cooperative path planning. The group learning strategy is introduced in map and compass operator to reduce computation complexity and enhance the global search ability. At the same time, the triple mutations strategy is employed in landmark operator to enhance swarm diversity. What's more, in order to synchronize multi-UAV, the time stamp segmentation technique is designed to prove waypoints, which can simplify the cost function by reducing the number of independent variables. Besides, we geometric the threat sources to quantify their dangerous level. The coordination costs can guarantee collision-free flight and real-time communication. Finally, the proposed method is applied to path planning in set scenarios. The simulation results indicate that our model is feasible and effective, and the MGLPIO algorithm can have a good balance between exploration and exploitation by comparing with other four algorithms.

Robotic Brain Storm Optimization: A Multi-target Collaborative Searching Paradigm for Swarm Robotics

Jian Yang, Donghui Zhao, Xinhao Xiang , Yuhui Shi

Abstract. Swarm intelligence optimization algorithms can be adopted in swarm robotics for target searching tasks in a 2-D or 3-D space by treating the target signal strength as fitness values. Many current works in the literature have achieved good performance in single-target search problems. However, when there are multiple targets in an environment to be searched, many swarm intelligence-based methods may converge to specific locations prematurely, making it impossible to explore the environment further. The Brain Storm Optimization (BSO) algorithm imitates a group of humans in solving problems collectively. A series of guided searches can finally obtain a relatively optimal solution for particular optimization problems. Furthermore, with a suitable clustering operation, it has better multi-modal optimization performance, i.e., it can find multiple optima in the objective space. By matching the members in a robotic swarm to the individuals in the algorithm under both environments and robots constraints, this paper proposes a BSO-based collaborative searching framework for swarm robotics called Robotic BSO. The simulation results show that the proposed method can simulate the BSO's guided search characteristics and has an excellent prospect for multi-target searching problems for swarm robotics.

Adaptive Task Distribution Approach using Threshold Behavior Tree for Robotic Swarm

Li Ma, Weidong Bao, Xiaomin Zhu, Meng Wu, Yutong Yuan, Ji Wang , Hao Chen

Abstract. Online task distribution is a typical problem for the cooperation of robotic swarm. However, there exist several challenges such as the distributed system, large-scale swarm and limited communication. Therefore, this paper proposes an adaptive task distribution approach based on the threshold behavior tree, which solves the task distribution problem of the large-scale robotic swarm. Through observation and perception towards outside, the robot obtains information of targets and neighboring robots in the field of view. In the condition of lacking communication, each robot makes its own decision on which kind of tasks to perform according to its threshold behavior tree. Finally, the robotic swarm can achieve the expected task distribution ratio which equals to that of the targets.

Immune System Algorithms to Environmental Exploration of Robot Navigation and Mapping

Elakiya Jayaraman, Tingjun Lei, Shahram Rahimi, Shi Cheng , Chaomin Luo

Abstract. In real-world applications such as rescue robots, service robots, mobile mining robots, and mine searching robots, an autonomous mobile robot needs to reach multiple targets with the shortest path. This paper proposes an Immune System algorithm (ISA) for real-time map building and path planning for multi-target applications. Once a global route is planned by the ISA, a foraging-enabled trail is created to guide the robot to the multiple targets. A histogram-based local navigation algorithm is used to navigate the robot along a collision-free global route. The proposed ISA models aim to generate a path while a mobile robot explores through terrain with map building in unknown environments. In this paper, we explore the ISA algorithm with simulation studies to demonstrate the capability of the proposed ISA in achieving a global route with minimized overall distance. Simulation studies demonstrate that the realtime concurrent mapping and multi-target navigation of an autonomous robot is successfully performed under unknown environments.

Day I July 18th 15:20-17:40 Nan Hai Hall (zoom：826 7855 8364)

Fireworks Harris Hawk Algorithm Based on Dynamic Competition Mechanism for Numerical Optimization

Wenyu Li, Ronghua Shi, Heng Zou , Jian Dong

Abstract. Harris Hawk Optimizer (HHO) is a new algorithm based on population, because of the diversity of its plunder strategy, it has good exploration ability, but there is still room for further improvement of exploitation ability. Because of its unique "explosion" mechanism, Fireworks Algorithm (FWA) has good exploitation ability. In order to make up for the shortcomings of HHO algorithm, this paper proposes an improved HHO algorithm, fireworks Harris hawk algorithm based on dynamic competition mechanism (DCFW-HHO). In the iterative process, taking the escape energy function of HHO algorithm as an index, different competition mechanisms and fireworks explosion operations are performed in different stages of the algorithm. In order to verify the performance of the proposed algorithm, the benchmark function of CEC2005 is optimized by DCFW-HHO, and compared with the marine predator algorithm (MPA), whale optimization algorithm (WOA), lightning search algorithm (LSA), water cycle algorithm (WCA), FWA and HHO, experiments show that the proposed DCFW-HHO algorithm has strong optimization ability.

Enhancing Fireworks Algorithm in Local Adaptation and Global Collaboration

Yifeng Li , Ying Tan

Abstract. In order to improve the performance of fireworks algorithm, this paper carries out a comprehensive enhancement for its framework. Locally, the basic explosion operator is replaced by an efficient adaptation method in CMA-ES. Globally, the explosion range of all fireworks is effectively collaborated by search space partition. On the one hand, the proposed algorithm can quickly adapt to local landscape and improve the local exploitation efficiency significantly. On the other hand, it can collaborate the search ranges of multiple fireworks to form a seamless and non-overlapping partition of the search space, thereby ensuring the global search ability. Since the proposed framework evaluates one batch of a fixed large number of solutions in each iteration, it also achieves better computational efficiency in modern parallel hardware. The proposed algorithm is tested on the CEC 2020 benchmark functions with three different dimensions. The experimental results prove that those strategies improve fireworks algorithm significantly.

Research on the Latest Development of Particle Swarm Optimization Algorithm for Satellite Constellation

Zhang Jiaxu , Yan Xiaopeng

Abstract. As a huge space system, satellite constellation is developing rapidly. Satellite constellation design is a basic problem in the design of multi spacecraft space system. It is the premise of building constellation of earth observation, satellite navigation, satellite communication and various scientific exploration satellites. According to the characteristics of modern satellite constellation design,this paper investigates the design and application of particle swarm optimization algorithm in satellite constellation, and the latest research progress of various research institutions in satellite constellation maintenance and control, autonomous navigation and space real-time monitoring, and discusses the latest strategies and technical methods of satellite constellation operation and management.

Multi-stage COVID-19 Epidemic Modeling Based on PSO and SEIR

Haiyun Qiu, Jinsong Chen , Ben Niu

Abstract. In this study, based on the characteristics and the transmission mechanism of COVID-19, SEIR epidemiological model is employed for modeling and analysis, utilizing the data of Hubei Province. To optimize the key epidemic parameters of the proposed SEIR model, a stochastic computational intelligence approach, the Particle Swarm Optimization (PSO) is introduced. To better analyze the epidemic, the data between January 20, 2020 to March 25, 2020 is selected and divided into four stages. The parameters are dynamically changeable at different stages of the epidemic, which shows the effectiveness of public health prevention and control measures. Moreover, the Genetic Algorithm (GA) and the Bacterial Foraging Optimization (BFO) are also executed for comparison. The experimental results demonstrate that all swarm intelligence algorithms mentioned above can help forecast COVID-19, and PSO shows the advantages of faster convergence speed and the capability of finding a better set of solutions in fewer iterations, particularly.

Optimizing Artificial Neural Network for Functions Approximation using Particle Swarm Optimization

Lina Zaghloul, Rawan Zaghloul , Mohammad Hamdan

Abstract. Artificial neural networks (ANN) are commonly used in function approximation as well as classification problems. This paper shows a configurable architecture of a simple feed forward neural network trained by particle swarm optimization (PSO) algorithm. PSO and ANN have several hyperparameters that have impact on the results of approximation. ANN parameters are the number of layers, number of neurons in each layer, and neuron activation functions. The hyperparameters of the PSO are the population size, the number of informants per particle, and the acceleration coefficients. Herein, this work comes to spot the light on how the PSO hyperparameters affect the ability of the algorithm to optimize ANNs weights in the function approximation task. This was examined and tested by generating multiple experiments on different types of input functions such as: cubic, linear, XOR problem. The results of the proposed method show the superiority of PSO compared to backpropagation in terms of MSE.

Performance Analysis of the Fireworks Algorithm Versions

Ira Tuba, Ivana Strumberger, Eva Tuba, Nebojsa Bacanin , Milan Tuba

Abstract. In the last decades, swarm intelligence algorithms have become a powerful tool for solving hard optimization problems. Nowadays numerous algorithms are proved to be good for different problems. With the overwhelming number of algorithms, it became hard for a common user to choose an appropriate method for solving a certain problem. To provide guidelines, it is necessary to classify optimization metaheuristics according to their capabilities. Deep statistical comparison represents a novel method for comparing and analyzing optimization algorithms. In this paper, the deep statistical comparison method was used for comparing different versions of the widely used fireworks algorithm. The fireworks algorithm was developed and improved in the last ten year, and this paper provides a theoretical analysis of five different versions, a cooperative framework for FWA, bare bones FWA, guided FWA, loserout tournament based FWA, and dynamic search FWA. Based on the obtained results, the loser-out tournament based FWA has the best performance in the term of the solution quality, while the dynamic search FWA is the best in term of the solutions distribution in the search space.

Region Selection with Discrete Fireworks Algorithm for Person Re-Identification

Xuan Li, Tao Zhang, Xin Zhao , Shuang Li

Abstract. Various hand-crafted features with metric learning methods have improved the person re-identification (Re-ID) accuracy. Metric learning methods for person Re-ID mean to match the features acquired from different persons. However, not all information of the features is valid for metric learning. Compared to these metric learning methods, the region selection with discrete fireworks algorithm (RS-DFWA) is proposed in this paper for hand-crafted feature designing. RS-DFWA uses the fireworks algorithm after discretization to select the effective regions of the feature maps at the metric learning stage. RS-DFWA has a faster convergence speed and a better optimization accuracy so that the noise regions such as background features would be ignored. RS-DFWA optimizes the fitness of the discrete fireworks algorithm while training the deep networks for person feature learning. The method we proposed is validated on the CUHK03 dataset, region selection with discrete fireworks algorithm for the deep features achieve favorable accuracy. For example, on the CUHK03 dataset in single query mode, an improvement of mAP= +4.6% is obtained by RS-DFWA compared to the Baseline model.

Day I July 18th 15:20-17:40 Huang Hai Hall (zoom: 812 4427 4048)

An Improved Brain Storm Optimization Algorithm Based on Maximum Likelihood Estimation

Junfeng Chen, Xingsi Xue , Bulgan Ninjerdene

Abstract. Brain Storm Optimization (BSO) is a relatively new swarm intelligence algorithm. It employs clustering, creating, and selecting operators, all connected and significantly impacting the optimization performance. However, with the increase of the problem dimension and the offset of the optimal value, the performance of the basic BSO algorithm becomes worse. This paper designs the double grouping operator, which employs k-means clustering in the horizontal and differential grouping in the vertical. A new creating operator is designed based on maximum likelihood estimation for the mean and variance of the Gaussian distribution. The numerical experiments are carried out to amplify and highlight the performance of the proposed algorithm artificially. Experimental results show that the proposed algorithm achieves satisfactory results on shifted and rotated benchmark functions.

Spiking Adaptive Dynamic Programming with Poisson Process

Qinglai Wei, Liyuan Han , Tielin Zhang

Abstract. A new iterative spiking adaptive dynamic programming (SADP) algorithm based on the Poisson process for optimal impulsive control problems is investigated with convergence discussion of the iterative process. For a fixed time interval, a 3-tuple can be computed, and then the iterative value functions and control laws can be obtained. Finally, a simulation example verifies the effectiveness of the developed algorithm.

The Impact of Wechat Red Packet Feature at Achieving Users Satisfaction and Loyalty: Wechat Users in China

Kamal Abubker Abrahim Sleiman, Juanli Lan, Xiangyu Cai, Yubo Wang, Hongzhen Lei , Ru Liu

Abstract WeChat has become an essential social media platform in China. This research investigates the importance of the WeChat Red packet as a motivator at achieving user's satisfaction and loyalty in China. To investigate its impact, and factors that attribute to its popularity and acceptability, we extended technology acceptance model (TAM), in addition to the main model factors, "perceived usefulness and perceived ease of use" our proposed model include, perceived trust, perceived security, and perceived entertainment. The questionnaire was designed, and SPSS was used for the analysis. The research results provide insight into how WeChat Red Packet can motivate users and build their satisfaction to improve their loyalty which in turn increases WeChat users'. These results have future implication and practice for research.

Distributed Position-force Control for Cooperative Transportation with Multiple Mobile Manipulators

Pengjie Xu, Jun Zheng, Jingtao Zhang, Kun Zhang, Yuanzhe Cui , Qirong Tang

Abstract. This paper presents a distributed position-force control framework for multiple mobile manipulators in charge of achieving a tightly cooperative transportation task. Since the effect of each robot is different in the whole system, a three-layer control framework is designed. For the first layer, mobile bases run distributed observer which uses global states. At the second layer, the position deviation is adopted to improve the accuracy of general manipulators. Then, position control works in combination with force to ensure that the most important manipulator achieves cooperative transportation accurately and compliantly. The designed controller is extensible, which suits not only for pure transportation tasks but can also be exploited in those cases where a closed kinematic chain is generated by multi-robots manipulations. An analysis of the proposed controller is validated by simulation with three UR5 manipulators mounted on differential driven mobile bases separately.

Multi-objective Brainstorming Optimization Algorithm Based on Adaptive Mutation Strategy

Yali Wu, Yulong Wang , Xiaoxiao Quan

Abstract: Multi-objective Problems(MOP) is a classic combinatorial optimization problem. A brainstorming optimization algorithm based on multiple adaptive mutation methods in multiple regions of the population (DE_MOBSO) is proposed in this paper to solve the MOP. Firstly, the algorithm uses differential mutation to evolve the population, which can improve the diversity of population. Secondly, an adaptive mutation learning factor is introduced on the mutations to enhance the search efficiency of the algorithm considering the characteristics of the MOP. The effectiveness and practicability of the algorithm are verified by a set of simulation example. The results show that the proposed algorithm has better performance in solving large-scale MOP.

A New Evolutionary Approach to Multiparty Multiobjective Optimization

Zeneng She, Wenjian Luo, Yatong Chang, Xin Lin , Ying Tan

Abstract. Multiparty multiobjective optimization problems (MPMOPs) are a type of multiobjective optimization problems (MOPs), where multiple decision makers involve, different decision makers have different objectives to optimize, and at least one decision maker has more than one objective. Although evolutionary multiobjective optimization has been studied for many years in the evolutionary computation field, evolutionary multiparty multiobjective optimization has not been paid much attention. To address the MPMOPs, the algorithm based on a multiobjective evolutionary algorithm is proposed in this paper, where the non-dominated levels from multiple parties are regarded as multiple objectives to sort the candidates in the population. Experiments on the benchmark that have common Pareto optimal solutions are conducted in this paper, and experimental results demonstrate that the proposed algorithm has a competitive performance.

Using Population Migration and Mutation to Improve Loser-out Tournament-based Fireworks Algorithm

Pengcheng Hong , Junqi Zhang

Abstract. The fireworks algorithm (FWA) is a newly proposed swarm intelligence algorithm inspired by the phenomena of fireworks explosion and has solved many real-world optimization problems successfully. A loser-out tournament-based fireworks algorithm (LoTFWA) is a new baseline in the development of FWA due to its outstanding independent framework and competition mechanism for multimodal optimization. Under this framework, each firework calculates its expected fitness improvement compared with the best fitness to determine whether to be reinitialized. Although LoTFWA achieves the best performance among the variants of FWA, it lacks of comprehensive consideration of the fireworks' cooperation and hence weakens the algorithm's power. This paper improves the cooperation of fireworks in LoTFWA based on the idea of population migration and mutation in biogeography-based optimization (BBO). The proposed mechanism not only promotes fireworks' exploration ability but also enhances their exploitation ability greatly. Experimental results show that the proposed algorithm attains superior performance than the state-of-the-art fireworks algorithm in both unimodal and multimodal functions.

Day I July 18th 15:20-17:40 ZOOM I (826 0784 1667)

Traveling Salesman Problem via Swarm Intelligence

Pei-Chen Yen , Frederick Kin Hing Phoa

Abstract. Traveling Salesman Problem (TSP) is one of the most classic combinatorial optimization problems. It can be widely applied in many real-world applications. In this paper, we propose an efficient method via swarm intelligence to handle the traveling salesman problem, which may not be suitable for the standard particle swarm optimization due to its domain's discrete nature. Compared to the classic Ant Colony Optimization method, the SIB method performs well in terms of efficiency and accuracy in the TSP problem. For TSP with cities size between 15 to 25, SIB has a significantly lower average executing time to obtain an adequate solution with close distance.

NiaClass: Building Rule-based Classification Models Using Nature-inspired Algorithms

Luka Pe?nik, Iztok Fister , Iztok Jr. Fister

Abstract. Searching for a set of rules, with which the knowledge hidden in data is extracted, can also be applied for multi-class classification. In line with this, a collection of nature-inspired algorithms are selected for determining the set of rules capable of classifying the samples into three or more classes. This set is encoded into representation of individuals and undergoes acting as variation operators. The results of various nature-inspired algorithms, obtained after their application on more UCI classification databases, are compared with each other, and revealed that some of them can be potential candidates for real-world applications.

An Improved Evolutionary Multi-objective Optimization Algorithm Based on Multi-population and Dynamic Neighborhood

Shuai Zhao, Xuying Kang , Qingjian Ni

Abstract. In the field of meteorology, atmospheric duct has important implications for the transmission of electromagnetic wave. When the electromagnetic wave signal is received by the signal receiving antenna of the global navigation satellite system (GNSS), the propagation loss and phase delay of the electromagnetic wave in the actual propagation process can be recorded, and the predicted values of the atmospheric dust parameters can be obtained through the inversion process. Atmospheric duct inversion problem can be modeled as a multi-objective optimization problem. Based on the classic MOEA/D algorithm, this paper designs an evolutionary multi-objective optimization algorithm for a single GNSS received signal, which introduces multiple population strategy and dynamic neighborhood mechanism. This paper also compares and analyzes the proposed algorithm with the classical evolutionary optimization algorithms through experiments. The experimental results show that the algorithm has higher accuracy and can better solve the atmospheric duct inversion problem.

Applying classification algorithms to identify brain activity patterns

Marina Murtazina , Tatiana Avdeenko

Abstract. The paper examines the applicability of classification algorithms to identify brain activity patterns according to EEG data using the example of determining the state of eyes. In this area of research, the following main subareas can be distinguished: search for a features' set that can be extracted from EEG data using a minimum number of electrodes, preprocessing techniques development for EEG data, classification techniques comparison and development of new ones, recommendations development for the selection of suitable classification algorithms. Particularly relevant is the question of how accurately classifiers can work with data coming in real time from the EEG neuroheadsets. The paper compares basic classification algorithms implemented in the Weka machine learning tool. For the experiment, six data sets were designed from the "EEG Motor Movement / Imagery" corpus. In the first stage of the experiment, 20 algorithms were investigated on one dataset. The best results were obtained by the IBk, RandomForest and RandomTree algorithms. In the second stage of the experiment, these three algorithms are compared on five additional data sets. The best result on four datasets was obtained for IBk, and one dataset best showed on the RandomForest. The study clearly demonstrated that using a simple data preprocessing procedure it is possible to obtain a classification model that works with an accuracy of 73% – 93% even if one applies well-known machine learning algorithms. This preprocessing procedure consists of applying a bandpass filter and excluding outliers from data whose values are greater than three standard deviations from the median.

Analysis of Security Problems in Groups of Intelligent Sensors

Elena Basan, Maria Lapina, Massimo Mecella, Karen Grigoryan , Evgeniya Olefirenko

Abstract. Today, the creation of intelligent sensors became possible due to the development of the hardware base, the use of small boards, where the processor, memory, and network interfaces can be placed. Examples of such cards can be Raspberry Pi, Arduino, and others. These devices can be used to connect various sensors to them depending on the tasks. Today, there are many protocols for the exchange of messages between such sender devices, which ultimately leads to the creation of distributed networks with distributed functionality. Such systems can be decision-making and are like swarm intelligence, where each device performs its functions, but together they are a single system. This study will examine the information security issues of such systems. An analysis of threats and vulnerabilities for intelligent sensor systems was carried out. Demonstrated an attack on the secure ZigBee protocol, which is often used to create a network between smart sensors. The use of lightweight cryptography to minimize risks is proposed.

NiaAML2: An Improved AutoML Using Nature-inspired Algorithms

Luka Pe?nik, Iztok Fister , Iztok Fister Jr.

Abstract. Using machine learning methods in the real-world is far from being easy, especially because of the number of methods on the one hand, and setting the optimal values of their parameters on the other. Therefore, a lot of so-called AutoML methods have emerged nowadays that also enable automatic construction of classification pipelines to users, who are not experts in this domain. In this study, the NiaAML2 method is proposed that is capable of constructing the classification pipelines using nature-inspired algorithms in two phases: pipeline construction, and hyper-parameter optimization. This method improves the original NiaAML capable of this construction in one phase. The algorithm was applied to four UCI ML datasets, while the obtained results encouraged us to continue with the research.

Parallel Random Embedding with Negatively Correlated Search

Qi Yang, Peng Yang , Ke Tang

Abstract. Evolutionary algorithm (EA) is proved to be a promising way for parameter optimization in deep reinforcement learning (RL) in recent years. However, it still suffers from the curse of dimensionality when dealing with high-dimensional inputs. Based on experiments, we observe that only a few variables contribute significantly to the performance of large-scale RL policy. Intuitively, we propose a parallel random embedding framework to optimize strategies on multiple parameter subspaces to incorporate classical Evolution algorithms and techniques for the million-scale RL policy optimization. Experiments show that our approach has outperforming performance with Negatively Correlation Search (NCS) in the framework.

Day I July 18th 15:20-17:40 ZOOM II (859 6443 6186)

Metaheuristic Optimization on Tensor-type Solution via Swarm Intelligence and its Application in the Profit Optimization in Designing Selling Scheme

Frederick Kin Hing Phoa, Hsin-Ping Liu, Yun-Heh Chen-Burger , Shau-Ping Lin

Abstract. Nature-inspired metaheuristic optimization has been widely used in many problems in industry and scientific investigations, but their applications in designing selling scheme are rare because the solution space in this kind of problems is usually high-dimensional, and their constraints are sometimes cross-dimensional. Recently, the Swarm Intelligence Based (SIB) method is proposed for problems in discrete domains, and it is widely applied in many mathematical and statistical problems that common metaheuristic methods seldom approach. In this work, we introduce an extension of the SIB method that handles solutions with many dimensions, or tensor solution in mathematics. We further speed up our method by implementing our algorithm with the use of CPU parallelization. We then apply this extended framework to real applications in designing selling scheme, showing that our proposed method helps to increase the profit of a selling scheme compared to those suggested by traditional methods.

Odometry during Object Transport: A Study with Swarm of Physical Robots

Muhanad Alkilabi, Timoteo Carletti , Elio Tuci

Abstract. Object transport by a single robot or by a swarm of robots can be considered a very challenging scenario for odometry since wheel slippage caused by pushing forces exerted on static objects and/or by relatively frequent collisions with other robots (for the cooperative transport case) tend to undermine the precision of the position and orientation estimates. This paper describes two sets of experiments aimed at evaluating the effectiveness of different sensory apparatuses in order to support odometry in autonomous robots engaged in object transport scenarios. In the first set of experiments, a single robot has to track its position while randomly moving in a flat arena with and without an object physically attached to its chassis. In the second set of experiments, a member of a swarm of physical robots is required to track its position while collaborating with the group-mates to the collective transport of a heavy object. In both sets, odometry is performed with either wheel encoders or with an optic-flow sensor. In the second set of experiments, both methods are evaluated with and without gyroscope corrections for angular displacements. The results indicate that odometry based on optic-flow sensors is more precise than the classic odometry based on wheel encoders. In particular, this research suggests that by using an appropriate sensory apparatus (i.e., an optic-flow sensor with gyroscope corrections), odometry can be achieved even in extreme odometry conditions such as those of cooperative object transport scenarios.

Multi-Guide Particle Swarm Optimisation Control Parameter Importance in High Dimensional Spaces

Timothy Carolus , Andries Engelbrecht

Abstract. This article presents an investigation into the effects of the search space dimension on the control parameter importance of the multiguide particle swarm optimization (MGPSO) algorithm over time. The MGPSO algorithm is a multi-objective optimization algorithm that uses multiple swarms, each swarm focusing on an individual objective. This relative control parameter importance of the MGPSO is identified using functional analysis of variance (fANOVA). The fANOVA process quantifies the control parameter importance through analysing variance in the objective function values associated with a change in control parameter values. The results indicate that the inertia component value is the most influential control parameter to tune when optimizing the MGPSO throughout the run time. The relative importance of the inertia weight remains dominant with an increase in the search space dimensions.

Polynomial Approximation Using Set-Based Particle Swarm Optimization

Jean-Pierre van Zyl , Andries Engelbrecht

Abstract. This paper introduces a new approach to solving regression problems by using a particle swarm optimization algorithm to find optimal polynomial regressions to these problems. Polynomial regression is defined as a multi-objective optimization problem, with the goals to find both an optimal combination of terms in the polynomial and optimal values of the coefficients of the terms, in order to minimize the approximation error. This paper shows that a set-based PSO works well to find the optimal term structure of the target polynomials in low dimensions, and holds promise for improved performance in higher dimensions. The results of the set-based PSO are compared to the results of a Binary PSO on the same problems. Finally, this paper explores possible solutions to create a hybrid algorithm that can find both the optimal term structure and the coefficients of the found terms.

Particle Swarms Reformulated towards a Unified and Flexible Framework

Mauro S. Innocente

Abstract. The Particle Swarm Optimisation (PSO) algorithm has undergone countless modifications and adaptations since its original formulation in 1995. Some of these have become mainstream whereas others have faded away. A myriad of alternative formulations have been proposed raising the question of what the basic features of an algorithm must be to belong in the PSO family. The aim of this paper is to establish what defines a PSO algorithm and to attempt to formulate it in such a way that it encompasses many existing variants. Therefore, different versions of the method may be posed as settings within the proposed unified framework. In addition, the proposed formulation generalises, decouples and incorporates features to the method providing more flexibility to the behaviour of each particle. The closed forms of the trajectory difference equation are obtained, different types of behaviour are identified, stochasticity is decoupled, and traditionally global features such as sociometries and constraint-handling are re-defined as particle's attributes.

The Experimental Analysis on Transfer Function of Binary Particle Swarm Optimization

Yixuan Luo, Jianhua Liu, Xingsi Xue, Renyuan Hu , Zihang Wang

Abstract. Binary Particle Swarm Optimization (BPSO) has extended the capacity of the conventional particle swarm optimization (PSO) for optimizing the discrete combinational optimization problems. The transfer function of BPSO is key for its capacity to search solution. This paper discuss the weight setting of two variants called the S-Shaped and the V-Shaped transfer functions in BPSO. The experimental results indicate that the increasing weight setting is beneficial to the performance of BPSO with the S-shaped transfer function, while the decreasing weight setting is flavorful for that of BPSO with the V-shaped transfer function. The Multi dimension Knapsack Problem (MKP) are used in the experiment for testing the discussable conclusions. The experimental results illustrate that the transfer function can be adjusted to improve the performance of BPSO, and the recommended weight setting is obtained, accordingly.

Day II July 19th 09:00-10:20 Bo Hai Hall (zoom: 847 7347 7938)

Fuzzy Clustering Algorithm Based On Improved Lion Swarm Optimization Algorithm

Haiyan Yu, Mingyan Jiang, Dongfeng Yuan , Miaomiao Xin

Abstract. Aiming at the shortcomings of fuzzy C-means (FCM) clustering algorithm that it is easy to fall into local minima and sensitive to initial values and noisy data, this paper proposes a fuzzy clustering algorithm based on improved lion swarm optimization algorithm. Aiming at the problem that lion swarm optimization(LSO) algorithm is easy to fall into the local optimum, this paper improves lion swarm optimization algorithm by introducing sin cos algorithm and elite opposition-based learning. In addition, the introduction of a supervision mechanism enhances the lions' ability to jump out of local optimum and improves the local search ability of lion swarm optimization algorithm. The optimal solution obtained by improved lion swarm optimization algorithm is used as the initial clustering center of FCM algorithm, then FCM algorithm is run to obtain the global optimal solution, which effectively overcomes the shortcomings of FCM algorithm. The experimental results show that, compared with original FCM clustering algorithm, FCM clustering algorithm based on improved lion swarm optimization algorithm has improved the algorithm's optimization ability and has better clustering results.

Sparrow Search Algorithm for Solving Flexible Jobshop Scheduling Problem

Wu Mingliang, Yang Dongsheng, Yang Zhile , Guo Yuanjun

Abstract. With the global development of the third industrial revolution, intelligent manufacturing has received attention from many countries and regions since it was first proposed. In the next ten years, intelligent manufacturing has become an important factor in determining international status, and it is imminent for traditional manufacturing to switch to intelligent manufacturing. Flexible job-shop scheduling is a key research problem in the field of intelligent manufacturing. In this paper, we uses a novel swarm intelligence optimization algorithm-Sparrow Search Algorithm to solve the problem of the longest processing time of workshop scheduling. The experimental results show that compared with other advanced meta-heuristic algorithms, the Sparrow Search Algorithm (SSA) can not only achieve ideal optimization accuracy in the test function, but also can achieve acceleration effects and solving capabilities that other algorithms do not have in actual shop scheduling problems.

An Intelligent Algorithm for AGV Scheduling in Intelligent Warehouses

Xue Wu, Min-Xia Zhang , Yujun Zheng

Abstract. In today's intelligent warehouses, automated guided vehicles (AGVs) are widely used, and their scheduling efficiency is crucial to the overall performance of warehouse business. However, AGV scheduling is a complex problem, especially when there are a large number of tasks to be undertaken by multiple AGVs in a large warehouse. In this paper, we present a problem of scheduling multiple AGVs for order picking in intelligent warehouse, the aim of which is to minimize the latest completion time of all orders. After testing a variety of algorithms, we propose a hybrid water wave optimization (WWO) and tabu search (TS) algorithm for efficiently solving the problem. We test the algorithm on a set of problem instances with different sizes, and the results show that the proposed algorithm exhibits significant performance advantages over a number of popular intelligent optimization algorithms.

A Novel Physarum-Based Optimization Algorithm for Shortest Path

Dan Wang , Zili Zhang

Abstract. As a new bio-inspired algorithm, the Physarum-based algorithm has shown great performance for solving complex computational problems. More and more researchers try to use the algorithm to solve some network optimization problems. Although the Physarum-based algorithm can figure out these problems correctly and accurately, the convergence speed of Physarum-based algorithm is relatively slow. This is mainly because many linear equations have to be solved when applying Physarum-based algorithm. Furthermore, many iterations are required using Physarum-based algorithm for network optimization problems with large number of nodes. With those observations in mind, two new methods are proposed to deal with these problems. By observing the traffic network data, there are many redundant nodes, which dont need to be computed in practical applications. The calculation time of the algorithm is reduced by avoiding these special nodes. The convergence speed of Physarum-based algorithm can then be accelerated. Two real traffic networks and eighteen random sparse connected graphs are used to verify the performance of the proposed algorithm.

Day II July 19th 09:00-10:20 Nan Hai Hall (zoom：826 7855 8364)

Liminal Tones: Swarm Aesthetics and Materiality in Sound Art

Mahsoo Salimi , Philippe Pasquier

Abstract: The application of swarm aesthetic in music composition is not new. Artistic swarm application has resulted in complex soundscapes and musical compositions. However, sound composition using physical swarm agents has not been extensively studied. Using an experimental approach, we create a series of sound textures know as Liminal Tones (B/ Rain Dream) based on swarming behaviours. We study the influence of different materials and emergent patterns and evaluate the acoustic properties of different materials such as wood, ceramic or granite, and effect of imperfections of the physical agents on the overall aesthetic quality. Finally, we consider the historical and theoretical foundation of swarm music, the role of materiality and actions in sound, and challenge the traditional perception of sound as an immaterial art form.

Natural Emergence of Heterogeneous Strategies in Artificially Intelligent Competitive Teams

Ankur Deka , Katia Sycara

Abstract. Multi agent strategies in mixed cooperative-competitive environments can be hard to craft by hand because each agent needs to coordinate with its teammates while competing with its opponents. Learning based algorithms are appealing but they require a competitive opponent to train against, which is often not available. Many scenarios require heterogeneous agent behavior for the team's success and this increases the complexity of the learning algorithm. In this work, we develop a mixed cooperative-competitive multi agent environment called FortAttack in which two teams compete against each other for success. We show that modeling agents with Graph Neural Networks (GNNs) and training them with Reinforcement Learning (RL) from scratch, leads to the coevolution of increasingly complex strategies for each team. Through competition in Multi-Agent Reinforcement Learning (MARL), we observe a natural emergence of heterogeneous behavior among homogeneous agents when such behavior can lead to the team's success. Such heterogeneous behavior from homogeneous agents is appealing because any agent can replace the role of another agent at test time. Finally, we propose ensemble training, in which we utilize the evolved opponent strategies to train a single policy for friendly agents. We were able to train a large number of agents on a commodity laptop, which shows the scalability and efficiency of our approach. The code and a video presentation are available online † .

Swarm Unit Digital Control System Simulation

Eugene Larkin, Aleks,r Privalov , Tatyana Akimenko

Abstract: Physical swarm unit, as an object under digital control is analyzed. It is shown, that Von Neumann digital controller, as a physical device, has new properties in comparison with analogue controllers, namely due to sequentially interpretation of control algorithm there are time delays between quests to sensors and actuators, that cause influence on a swarm unit performance as a whole. Flowchart of digital control system is worked out and closed loops transfer function, which takes into account real properties of Von Neumann digital controller, is obtained. The method of time lags estimation, based on notion the interpretation of arbitrary complexity cyclic algorithm as semiMarkov process, is proposed. Theoretical postulates are confirmed by simulation of two-loop digital control system functioning. Results of simulation emphatically show how data skew and feedback lag affect on swarm unit control dynamics.

Performance Analysis of Evolutionary Computation Based on Tianchi Service Scheduling Problem

Jun Yu, Yuhao Li, Tianwei Zhou, Churong Zhang, Guanghui Yue , Yunjiao Ge

Abstract. We choose the well-known evolution strategy (ES) in the evolutionary computation (EC) community to solve the large-scale scheduling problem provided by Alibaba cloud services. Since the problem is accompanied by multiple strong constraints, we design two additional strategies for improving the search efficiency with a given limited computational cost. Compared with widely used numerical benchmark test suits, this problem arises from the requirements of real-world applications and has strict constraints that cannot be violated, such as processing time, response timeout, load balance, and so on. The main contribution of this paper is to establish a bridge between EC algorithms and the characteristics of real-world problems so that EC algorithms can solve real-world problems more effectively and smoothly. Based on the difficulties encountered in the experiment, we summarize some of our experiences and insights, and hope that they may bring new enlightenment to the latecomers.

Day II July 19th 09:00-10:20 Huang Hai Hall (zoom：812 4427 4048)

Bacterial Foraging Optimization with Leader Selection Strategy for Bi-Objective Optimization

Hong Wang, Yixin Wang, Yikun Ou , Ben Niu

Abstract. Multi-objective problem (MOP) has long been a challenging issue. Many novel Swarm Intelligence (SI) method like Bacterial Foraging Optimization (BFO) has been extended to tackle MOPs recent years. To further improve the efficiency of BFO in multi-objective optimization, this paper proposes a novel BFO for Bi-objective optimization (abbreviated as BIBFO) with enhanced leader selection strategy. The leader selection strategy incorporating with the Density-Based Spatial Clustering of Applications with Noise (DBSCAN) method in comprehensive learning mechanism can direct evolution and enhances the search efficiency. Besides, the strategies of reproduction and elimination are improved using elitism strategy to enhance the collaboration between search group and the external archive, which can speed up the convergence and improve the search efficiency. In addition, the external archive control strategy is further applied to balance the convergence and the solution diversity. The effectiveness of BIBFO is demonstrated on six frequently used benchmarks, and comparative studies have been conducted among bacterial-based multi-objective optimization algorithms. Experimental results indicate that the proposed BIBFO performs well in generation distance (GD) and diversity () metrics of obtained Pareto front.

Toward Swarm Robots Tracking: A Constrained Gaussian Condensation Filter Method

Shihong Duan, Hang Wu, Cheng Xu , Jiawang Wan

Abstract. Real-time high-precision navigation has a wide range of applications in scenarios. In practice, the measurement models are often non-linear, and sequential Bayesian filters, such as Kalman and particle filter, suffer from the problem of accumulative errors, which cannot provide long-time high-precision services for localization. To solve the problem of arbitrary noise distribution, this paper proposes a Gaussian condensation filter to achieve high-precision localization in a nonGaussian noise environment. To this end, we proposed an error-ellipse re-sampling-based Gaussian condensation (EER-GCF) filter, which establishes error-ellipses with different confidence probabilities and implements a re-sampling algorithm based on the sampling points' geometrical positions. Furthermore, a cooperative Gaussian condensation filter based on error-ellipse re-sampling (CEER-GCF) is proposed to enhance information fusion in the swarm robots network. This study accomplishes swarm robots tracking based on spatial-temporal constraints to enhance tracking accuracy. Experiment results show that the accuracy of EERGCF reaches 0.80m, while CEER-GCF achieves a localization accuracy of 0.27m.

Designing a Mathematical Model and Control System for the Makariza steam boiler

Taha Ahmadi , Sebastian Soto

Abstract.This study provides a method to perform the dynamic analysis of sugarcane bagasse boiler owned by Makariza Company in Colombia. In this method, the values of Makariza industrial boiler has been taken as a reference, which allow to calculate the real values of enthalpy of sub-processes, boiler mass and energy balances. In the proposed dynamic model, the Differential-Algebraic Equations (DAE's) will be used, and the drum steam pressure and flow of the system are controlled using PI controllers. After describing the thermodynamic and mathematical processes, the effect of different operating conditions on system outputs will be examined and compared together considering the existence of the controller and without its use.

Automatic Detection of Type Ⅲ Solar Radio Burst

Shicai Liu, Guowu Yuan, Chengming Tan, Hao Zhou , Ruru Cheng

Abstract. With the accuracy improvement of radio telescopes, massive amounts of solar radio spectrum data are received every day. It is inefficient to detect solar radio burst by astronomers, and it is also difficult to meet the realtime requirements of space weather, aerospace and navigation systems and etc. In order to reduce the workload of astronomers and improve the detection accuracy and efficiency, we propose an algorithm for automatic real-time detection of solar radio bursts based on density clustering in this paper. The algorithm firstly uses channel normalization to remove the interference of horizontal stripe in the image. Then, the normal distribution model is used for binarization, and then the DBSCAN clustering algorithm is used to cluster detection of the binarized solar radio burst area. Finally, the Canny operator is used to detect the edge and the time parameter of burst is extracted. Experiments show that the proposed method improves the detection efficiency and accuracy compared with some traditional clustering detection algorithms.

Day II July 19th 10:40-12:00 Bo Hai Hall (zoom: 847 7347 7938)

An Improved Dragonfly Algorithm Based on Angle Modulation Mechanism for Solving 0-1 Knapsack Problems

Lin Wang, Ronghua Shi, Wenyu Li, Xia Yuan , Jian Dong

Abstract. Dragonfly Algorithm (DA) is a new intelligent algorithm based on the theory of dragonfly foraging and evading predators. DA exhibits excellent performance in solving multimodal continuous problems. To make DA work in the binary spaces, this paper introduces an angle modulation mechanism on DA (called AMDA) to generate bit strings, that is, to give alternative solutions to binary problems. Instead of running on the original high-dimensional binary spaces, the original AMDA utilizes the four-dimensional trigonometric function. However, the original AMDA has certain limitations, such as poor algorithm stability and slow convergence speed. Therefore, an improved AMDA called IAMDA is proposed. Based on the original generating function, a variable coefficient is added to control the vertical displacement of the cosine function. In this paper, seven high-dimensional zero-one knapsack problems are considered. Experimental results prove that IAMDA has superior convergence speed and quality of solution as compared to AMDA, BDA and BPSO.

A Bacterial Foraging Optimization Algorithm Based on Normal Distribution for Crowdfunding Project Outcome Prediction

Yingsi Tan, Shilian Chen , Shuang Geng

Abstract. Crowdfunding is a concept that raising fund for different individual or organization to conduct creative projects and it has gained more and more popularity during these years. Fund used for projects can reach to billions of dollars, so it's very significant to perfectly predict multiple crowdfunding ads. To improve the accuracy of crowdfunding project outcome prediction, a modified Bacterial Foraging Optimization Algorithm(NBFO) through population initialization, reproduction and elimination-dispersion was proposed to cooperate with Light Gradient Boosting Machine (LightGBM). This paper used normal distribution through the period of population initialization and elimination-dispersion. Moreover, during reproduction, selective probability was introduced to enhance the performance of bacteria. Experiments used 5561 valid data collected from Kickstarter from June 2017 to February 2018, and compared the predictive power of LightGBM incorporated with Particle Swarm Optimization (PSO), Bee Colony Optimization (BCO) and Evolutionary Strategy (ES). Results showed that the performance of NBFO surpasses all comparative algorithms. The performance of LightGBM incorporated with other swarm intelligent algorithms and evolutionary algorithm are discussed. Findings in this study contribute to the study of crowdfunding, Light Gradient Boosting Machine, swarm intelligent algorithm and evolutionary algorithm.

Reorganized Bacterial Foraging Optimization Algorithm for Aircraft Maintenance Technician Scheduling Problem

Ben Niu, Bowen Xue, Tianwei Zhou, Churong Zhang , Qinge Xiao

Abstract. This paper studies the problem of aircraft maintenance technician scheduling problem. Aircraft maintenance companies often need to allocate aircraft maintenance technicians in advance according to maintenance orders before carrying out maintenance work, with the aim of maximizing the company's benefits. In order to solve the aircraft maintenance technician scheduling problem, we propose a reorganized bacterial foraging optimization algorithm (RBFO), which introduces the individual information transmission mechanisms among each individual in the bacterial swarm, and reorganizes the structure of the original bacterial foraging algorithm. The experimental results verify the applicability of the proposed algorithm in the specific con-structed model, and give the optimal task-technician allocation scheme based on the numerical example data. The performance of RBFO is high-lighted through comparative experiments.

Brain Storm Optimization Algorithm Based on Formal Concept Analysis

Fengrong Chang, Lianbo Ma, Yan Song , Aoshuang Dong

Abstract. The brain storm optimization (BSO) algorithm is an excellent swarm intelligence paradigm, inspired from the behaviors of the human process of brainstorming. The design of BSO is characterized by the clustering mechanism However, this mechanism is inefficient to deal with complex large-scale optimization problems. In this paper, we propose a high-dimensional BSO algorithm based on formal concept analysis (FCA), called HBSO, for dealing with large-scale optimization problems. In HBSO, two new procedures are developed, i.e., relationship analysis of individuals and adaptively determine the number of clusters. Relationship analysis is used to judge the similarity of individuals in the population. The FCA is used to determine the size of k in the original clustering algorithm, in order to alleviate the evolution stagnation of clusters. Experiments are conducted on a set of the CEC2017 benchmark functions and the results verify the effectiveness and efficiency of HBSO on the benchmark problems.

Day II July 19th 10:40-12:00 Nan Hai Hall (zoom：826 7855 8364)

Optimization of A High-Lift Mechanism Motion Generation Synthesis Using MHS

Suwin Sleesongsom , Sujin Bureerat

Abstract. The purpose of this paper is to synthesize a high-lift mechanism (HLM) of a transportation aircraft. In the past still lack in studying to synthesize of the HLM using a very recent technique. The device is an important mechanism to generate an addition lift to the wing of aircraft in take-off and landing condition. The crucial designing problem is to minimize the error between actual flap motion and target points. The optimum target points are positions and angles of flap at the take-off and landing condition. Designing constraints include the possibility of four-bar mechanism to work well, limiting position and includes workplace of mechanism. The optimizers are selected to tackle the problem is in a group of metaheuristics (MHs). The results show the propose method and MHs can synthesize the flap mechanism meet with the design targets.

Bayesian Classifier Based on Discrete Multidimensional Gaussian Distribution

Yihuai Wang , Fei Han

Abstract. Bayesian classifier has become one of the most popular classification methods due to its flexible probability expression and good classification performance. However, in the classification of multidimensional discrete data, the assumption of data independence in naive Bayes classification is unrealistic, the Bayesian network structure is complex and the classification performance is sometimes unstable. In order to more effectively consider the correlation of data in the Bayesian classifier, this paper proposes a Bayesian classifier with multidimensional Gaussian distribution based on discrete data. This classifier uses the moment estimation of the training data to obtain the covariance matrix of the classification model, and reflects the correlation of the data through the covariance matrix. In view of the mathematical model problem caused by the non-positive definite covariance, the largest linearly independent group after feature sorting is selected as a new sample to estimate the covariance matrix, and then the optimized Bayesian classification model is obtained. The classification simulation experiments on several datasets verify the effectiveness and stability of the proposed classifier.

Feature Selection for Image Classification Based on Bacterial Colony Optimization

Hong Wang, Zhuo Zhou, Yixin Wang , Xiaohui Yan

Abstract. Image classification is an important issue in pattern recognition, the high dimension features is a challenging task since only a few number of them are effective in classification. To improve the classification efficiency, it is necessary to reduce the dimensionality of image features before classification. This study provides a novel image classification application based on Bacterial Colony Optimization, which can decreases the computation burden and improves the classification's efficiency. Specifically, the elimination strategy in original algorithm is removed, and the communication, chemotaxis, migration, and reproduction strategies are kept. Additionally, the communication and chemotaxis step size of the Bacterial Colony Optimization are modified for feature selection in image classification. Several comparision experiments on two public image datasets are conducted to verify the effectiveness of the method. Experimental results prove that the method can greatly improve the classification accuracy and efficiency.

An Improved Spatial-Temporal Network Based on Residual Correction and Evolutionary Algorithm for Water Quality Prediction

Xin Yu, Wenqiang Peng, Dongfan Xue , Qingjian Ni

Abstract. Water quality prediction is of great significance for the supervision of water environment. At present, artificial intelligence method has been tried to be introduced into this field. In this paper, a novel spatial-temporal convolutional attention network based on residual correction and parameter optimization, is proposed for water quality prediction. The model can be divided into three parts. The first part is convolutional attention network in spatial-temporal domain, which uses an one-dimensional convolutional network to extract temporal and spatial information of water quality monitoring station, and adds attention mechanism; the second part is TCN residual correction module, which corrects the residual of the first part; the third part is the parameter optimization module, which introduces PSO algorithm to optimize the model parameters of the first two parts to obtain better results. Based on the real water quality data of a river in South China, this paper carries out relevant comparative experiments, and the experimental results show that the water quality prediction model proposed in this paper is better than other models.

Day II July 19th 10:40-12:00 Huang Hai Hall (zoom：812 4427 4048)

Compositional Object Synthesis in Game of Life Cellular Automata Using SAT Solver

Haruki Nishimura , Koji Hasebe

Abstract. Conway's Game of Life is a two-dimensional cellular automata known for the emergence of objects (i.e., patterns with special properties) from simple transition rules. So far, various interesting objects named still-life, oscillator, and spaceship have been discovered, and many methods to systematically search for such objects have been proposed. Most existing methods for finding objects have comprehensively search all patterns. However, attempting to obtain a large object in this way may cause a state explosion. To tackle this problem and enhance scalability, in this study, we propose a method to generate objects by synthesizing some existing objects. The basic idea is to arrange multiple pieces of existing objects and compose them by complementing the appropriate patterns. The problem of finding complementary patterns is reduced to the propositional satisfiability problem and solved using SAT solver. Our method can reduce the object generation time compared to the case where a large object is generated from the beginning. We also demonstrate the usefulness of our proposed method with an implementation for automatic object generation.

A Knowledge Graph Enhanced Semantic Matching Method for Plan Recommendation

Rupeng Liang, Shaoqiu Zheng, Kebo Deng, Zexiang Mao, Wei Ma , Zhengwei Zhang

Abstract. In order to solve the problem of rapid matching and optimization of the plan, a semantic feature-based smart matching method of the plan is proposed, which can be used to solve the problem of the typical small sample date for recommendation of the best plan in the military field. In this method, the semantic feature of the battle plan is established to describe the combat scenario through a military knowledge graph. The semantic feature annotation of the plan is constructed based on the military knowledge map too. So the semantic features corresponding to each matching target plan object are described, which realize the explicit definition of the hidden knowledge of the combat plan. Based on knowledge enhancement technology, the similarity measurement of semantic features is calculated, realizing the intelligent semantic matching of combat plans, so as to solve the problem of low matching efficiency and accuracy based on pragmatic level features such as index or

Evolutionary Ontology Matching Technique with User Involvement

Xingsi Xue, Chaofan Yang, Wenyu Liu , Hai Zhu

Abstract. Ontology matching is able to identify the entity correspondences between two heterogeneous ontologies, which is an effective method to solve the data heterogeneous problem on the Semantic Web. Traditional fully-automatic ontology matching techniques suffers from the limitation of similarity measure, whose alignment's quality can not be ensured. To overcome this drawback, in this work, an Evolutionary Ontology Matching technique with User Involvement (EOM-UI) is proposed, which utilizes both the Compact Evolutionary Algorithm and user knowledge to improve the algorithm's performance and the alignment's quality. In addition, an optimization model is established to formally define the ontology entity matching problem, and an efficient interacting strategy is proposed to reduce the user's workload and maximize his working value. The experiment uses Ontology Alignment Evaluation Initiative (OAEI)'s benchmark to test our proposal's performance. The experimental results show that our approach is able to make use of the user knowledge to improve the alignment's quality, and it also outperforms OAEI's participants.

A Hybrid Wind Speed Prediction Model Based on Signal Decomposition and Deep 1DCNN

Yuhui Wang, Qingjian Ni, Shuai Zhao, Meng Zhang , Chenxin Shen

Abstract. Wind speed prediction is a typical time series prediction and is of great importance in power generation. In order to deal with those problems of heavy resource consumption and complex hyperparameter selection in traditional methods, we propose a multidimensional prediction method based on decomposition methods. However, using a model to fit all subseries may lead to the model's performance degradation and error increasing, which is called "preference" error. To solve this problem, a one-dimensional CNN (1DCNN) is used to capture the relationships between subseries. As to better explore this problem and enhance the stability of the CNN model, the generative adversarial network (GAN) method is tried to generate and generalize this "preference" error and expand training samples for 1DCNN. This paper combines multiple methods including the decomposition method, RNN model, CNN model, and GAN method in order, and chooses the best combination in different datasets. The experiments on two real-world wind datasets demonstrate that this method can achieve excellent performance in wind speed prediction with the help of combining the above methods.

Posters

Study on The Random Factor of Firefly Algorithm

Yanping Qiao, Feng Li, Cong Zhang, Xiaofeng Li , Zhigang Zhou

Abstract. The firefly algorithm (FA) is a swarm intelligence algorithm that mimics the swarm behaviour of the firefly in nature. The idea is simple, and FA is easy to realize. To improve its performance, a new method to control the random factor in FA is proposed in this paper, based on the design idea and mathematical model of FA and a simple experiment. Under the new method, the value of the random factor decreases according to a geometric progression sequence. Twenty common ratios of geometric progression sequences are used to optimize nine standard benchmark functions. The experimental results are analysed by the ANOVA and step-up methods. The analysis shows that the performance of FA improves under the new method to control the random factor.

VaCSO: A Multi-objective Collaborative Competition Particle Swarm Algorithm Based on Vector Angles

Libao Deng, Le Song, Sibo Hou , Gaoji Sun

Abstract. Recently, particle swarm algorithm (PSO) has demonstrated its effectiveness in solving multi-objective optimization problems (MOPs). However, due to rapid convergence, PSO has poor distribution when processing MOPs. To solve the above problems, we propose a multi-objective collaborative competition particle swarm algorithm based on vector angles (VaCSO). Firstly, in order to remove the influence of global or individual optimal particles, the competition mechanism is used. Secondly, in order to increase the diversity of solutions while maintaining the convergence, the population is clustered into two groups which use different learning strategies. Finally, a three-particle competition and co-evolution mechanism is proposed to improve the distribution and diversity of particle swarms. We set up comparative experiments to test the performance of VaCSO compared with the current popular multi-objective particle swarm algorithm. Experimental results show that VaCSO has excellent performance in convergence and distribution, and has a significant effect in optimizing quality.

Initializing Ant Colony Algorithms by Learning from the Difficult Problem's Global Features

Deng Xiangyang, Zhang Limin , Zhu Ziqiang

Abstract. Deception, which stems from the tackled problem instance and algorithmic structure, has a tremendous negative impact on the algorithmic performance. An improved ACO called GFL-ACO with a global feature learning strategy is proposed to process the algorithmic initialization. The strategy consists of two parts: a greedy random walking of ant colony and a mean value approach. With the former part, some initialized ants are launched to step forward by a greedy rule till finished a tour. A statistical manner of edge-based relative frequency is used to initial pheromone trails and ants' starting positions. With the latter part, a mean value calculated from edge-based relative frequency is used to generate ant population size. The experiments on the TSPLIB benchmark show that GFL-ACO can achieve a rather better performance on the standard benchmark.

Inferring Small-Scale Maximum-Entropy Genetic Regulatory Networks by Using DE Algorithm

Fu Yin, Zexuan Zhu, Jiarui Zhou, Weixin Xie , Xaoliang Ma

Abstract. Maximum-entropy genetic regulatory networks (GRNs) have been increasingly applied to infer pairwise gene interactions from biological data. Most maximum-entropy GRNs inferring methods estimate the inverse covariance matrix based on the assumption that the network is sparse and the problem can be approximated via convex optimization. However, the assumption might not be true in reality. To address this issue, in this paper, we propose an adaptive differential evolution (DE) algorithm to directly infer the maximum-entropy GRNs, which is formulated as a constrained optimization problem with the maximum entropy being the objective function and the first and second moments being two penalty terms. A GRN inferred by DE is a fully connected network that can reflect the gene regulatory relations. The experimental results on both simulated and real data suggest that the proposed method is robust in inferring the smallscale maximum-entropy GRNs.

Variable Fragments Evolution in Differential Evolution

Changshou Deng, Xiaogang Dong, Yucheng Tan , Hu Peng

Abstract. The crossover operator plays an important role in Differential Evolution. However, the choice of proper crossover operator and corresponding parameters is dependent on the features of the problems. It is not easy for practitioners to choose the right crossover operator and associated parameter value. In the newly proposed method, a novel evolution scheme called Variable Fragments Evolution was presented. During the evolution, the roughly fixed fragments of genes of all individuals were selected in a population for directional variation. Variable Fragments Evolution was compared with commonly used binomial crossover. Experimental results show that Variable Fragments Evolution exhibits better performance than the binomial crossover. Thus it can serve as an alternative evolution scheme for Differential Evolution.

A Genetic Algorithm-based Ensemble Convolutional Neural Networks for Defect Recognition with Small-Scale Samples

Yiping Gao, Liang Gao, Xinyu Li , Cuiyu Wang

Abstract. In modern manufacturing, defect recognition is an important technology, and using recent advances, such as convolutional neural networks (CNNs) to help defect recognition have addressed many attentions. However, CNN requires large-scale samples for training. In industries, large-scale samples are usually unavailable, and this impedes the wide application of CNNs. Ensemble learning might be a feasible manner for the small-scale-sample problem, But the weight for different CNNs needs explicit selection, and this is complex and time-consuming. To overcome this problem, this paper proposes a genetic algorithm (GA)-based ensemble CNNs for small-scale sample defect recognition problem. The proposed method uses an ensemble strategy to combinate several CNN models to solve the small-scale-sample problem in defect recognition, and use GA to optimize the ensemble weights with 5-fold cross-validation. With these improvements, the proposed method can find the optimal ensemble weight automatically, and it avoids the complex and explicit parameter selection. The experimental results with different trainable samples indicate that the proposed method outperforms the other defect recognition methods, which indicates that the proposed method is effective for small-scale sample defect recognition tasks. Furthermore, the discussion results also suggest that the proposed method is robust for noise, and it indicates that the proposed method has good potential in defect recognition tasks.

Stability and Hopf Bifurcation Analysis of DNA Molecular Oscillator System Based on DNA Strand Displacement

Tao Sun, Hui Lv , Qiang Zhang

Abstract. DNA molecular technology has gradually matured and has been widely used in the design of nanomaterials and chemical oscillators. In order to ensure the correct setting of DNA molecular oscillator, it is necessary to thoroughly study the dynamic behavior of system. This paper studies the dynamics system of DNA molecular oscillator based on DNA strand displacement. Modeling the reaction process transforms the reaction process into a specific mathematical model. The research results show that the influence of time delay is not considered in an ideal state. Stability near the equilibrium point of system is determined by initial reaction substrate concentration and reaction rate. Considering the time delay of separation of DNA double-stranded molecules in the reaction process, the time delay parameter is added to the system model. As the time delay increases, the system changes from a stable state to an unstable state and Hopf bifurcation occurs. At the same time, the study found that both Hopf bifurcation direction and the periodic solution are closely related to the time delay parameter. The result of numerical simulation proves the correctness of our conclusion.

Dynamic Behavior Analysis of DNA Subtraction Gate with Stochastic Disturbance and Time Delay

Huiwen Li, Hui Lv , Qiang Zhang

Abstract. As one of the basic arithmetic gates of DNA circuits, the DNA subtraction gate plays an important role in the design and optimization of circuits. A nonlinear system with stochastic perturbations and delays is constructed to accurately describe the reaction process of DNA subtraction gates and comprehensively analyze the system dynamics. At the same time, enzyme recognition sites are added to the original basis of the DNA subtraction gate to increase the reaction rate. According to the law of conservation of quality, the dimensionality reduction of the system model with stochastic perturbation and time delay is performed, which greatly reduces the computational complexity. The properties of the solution of a DNA subtraction gate system are discussed, and the Lyapunov analysis proves that the model solution is global and unique. The properties of the solutions indicate that the constructed DNA subtraction gate system with stochastic perturbations and time delays is of practical significance. Through systematic ergodic analysis, it is found that the DNA subtraction gate system is distributed smoothly, which provides a theoretical basis for the realization of the DNA subtraction function. The results of numerical simulation show that the DNA subtraction gate can be implemented successfully under the influence of stochastic disturbance and time delay.

Modeling and Analysis of Nonlinear Dynamic System with Lévy Jump Based on Cargo Sorting DNA Robot

Hao Fu, Hui Lv , Qiang Zhang

Abstract. In this paper, a model of nonlinear dynamic system with Lévy jumps based on cargo sorting DNA robot is studied. Firstly, nonlinear biochemical reaction system based on cargo sorting DNA robot model is established. Considering the influence of external disturbances on the system, nonlinear biochemical reaction system with Lévy jump is built and its dimensionality is reduced. Secondly, in order to prove that the built system conforms to the actual meaning, the existence and uniqueness of the system solution is verified. Next, the sufficient conditions for the completion of cargo pick-up of cargo sorting DNA robot and the continued sufficiency are introduced, and the progress of cargo sorting DNA robot under different noise intensities is analyzed. Then, it is proved that the positive recursion of the reaction can better describe and show the persistence of the system. Finally, numerical simulations verify the correctness of the theoretical results. The results show that the end of cargo pick-up with DNA robots for cargo sorting is closely related to the intensity of noise.

Stability and Hopf Bifurcation Analysis of Complex DNA Catalytic Reaction Network with Double Time Delays

Wei Chen, Hui Lv , Qiang Zhang

Abstract. DNA specific fragments are required in DNA computing. The fragments are usually obtained through DNA catalytic reactions. For achieving accurate regulation of DNA catalytic reaction network, toehold has been added into it. Due to the inevitable transcriptions and translations of DNA strands, the outcome of DNA catalytic reaction network using toehold may be affected by these operational delays. Based on this, a nonlinear differential model of complex DNA catalytic reaction network using toehold is proposed. Double time delays characterize delays of two DNA strands transcription in the reaction process. By assigning reactant concentrations and reaction rates, the stability of complex DNA catalytic reaction network system with double time delays is analyzed. The Hopf bifurcation at the equilibrium point is studied and the results of mathematical analysis are obtained. Finally, the correctness of theoretical analysis is verified by numerical simulation.

A Multiobjective Memetic Algorithm for Multiobjective Unconstrained Binary Quadratic Programming Problem

Ying Zhou, Lingjing Kong, Lijun Yan, Shaopeng Liu , Jiaming Hong

Abstract. This study introduces a multiobjective memetic algorithm for multiobjective unconstrained binary quadratic programming problem (mUBQP). It integrates multiobjective evolutionary algorithm based on decomposition and tabu search to search an approximate Pareto front with good convergence and diversity. To further enhance the search ability, uniform generation is introduced to generate different uniform weight vectors for decomposition in every generation. The proposed algorithm is tested on 50 mUBQP instances. Experimental results show the effectiveness of the proposed algorithm in solving mUBQP.

A Hybrid Algorithm for Multi-objective Permutation Flow Shop Scheduling Problem with Setup Times

Cuiyu Wang, Shuting Wang , Xinyu Li

Abstract. This paper studies the multi-objective permutation flow shop scheduling problem (PFSP) with setup times. Firstly, the mathematical model of multiobjective PFSP with setup time is established, then based on the theory of Pareto, Genetic algorithm and Variable Neighborhood Search, a new hybrid algorithm is proposed, named as Multiple Objective Hybrid Genetic algorithm (MOHGA). Finally, a set of benchmark instances with different scales are used to evaluate the performance of MOHGA. Experimental results show that the MOHGA obtains some solutions better than those previously reported in the literature, which reveals that the proposed MOHGA is an effective approach for the optimization of multi-objective PFSP with setup time.

Non-Singular Finite-Time Consensus Tracking Protocols for Second-Order Multi-Agent Systems

Yao Zou, Wenfu Yang, Zixuan Wang, Keping Long , Wei He

Abstract. This paper surveys non-singular finite-time consensus tracking issues for second-order multi-agent systems subject to external disturbance. The consensus tracking protocol utilizes the sliding mode control methodology. Firstly, a novel non-singular sliding mode manifold is designed for each agent dynamics, and it ensures the finite-time convergence once the error trajectory reaches it. Further, two non-singular consensus protocols are developed so as to drive the error trajectory towards the assigned sliding mode manifold in finite time. However, the settling time with the first protocol scheme cannot be assessed due to its dependence on transient states. To overcome this dilemma, another protocol scenario is exploited, with which the settling time is assignable off-line using available initial information states and control parameters. Finite-time consensus tracking results are demonstrated based on Lyapunov stability theorems. Eventually, simulations verify the performance of the developed protocols.

UAV Path Planning Based on Variable Neighborhood Search Genetic Algorithm

Guo Zhang, Rui Wang, Hongtao Lei, Tao Zhang, Wenhua Li , Yuanming Song

Abstract. This study proposed a new genetic algorithm with variable neighbourhood search (GAVNS) for UAV path planning in three-dimensional space. First, an 0-1 integer programming mathematical model is established by inspired from the vehicle routing planning model with time window (VRPTW), and then a heuristic rule based on space vector projection is designed to quickly initialize high-quality solutions that meet constraints of upper error limit and minimum turning radius. Second, it improves mutation operator with a reselected mutation strategy, and incorporates Variable Neighborhood Search strategy based on adding and deleting route during the search process; Finally, GAVNS is compared with general Genetic Algorithm on a set of experiments. It is demonstrated that GAVNS algorithm is both effective and efficient. Moreover, the introduction of variable neighborhood search strategy enhances the local search ability of Genetic Algorithm.

Value-based Continuous Control without Concrete State-action Value Function

Jin Zhu, Haixian Zhang , Zhen Pan

Abstract. In the value-based reinforcement learning continuous control, it is apparent that actions with higher expected return (state-action value, also as Q) will be selected as the action decision. But limited by the expression of deep Q function, researchers mostly introduce an independent policy function for approximating the preference of Q function. These methods, named actor-critic, implement value-based continuous control in an effective but compromise way. However, the policy function and the Q function are highly correlated in Maximum Entropy Reinforcement Learning, so that these two have a close-form solution on each other. By this fact, we propose to implement a value-based continuous control algorithm without concrete Q function, which infers a temporary Q function from policy when needed. Compare to the current maximum entropy actor-critic method, our method saves a Q network needing training and a step of policy optimization, which results in an advance in time efficiency, while remains state of art data efficiency in experiments.

Local Binary Pattern Algorithm with Weight Threshold for Image Classification

Zexi Xu, Guangyuan Qiu, Wanying Li, Xiaofu He , Shuang Geng

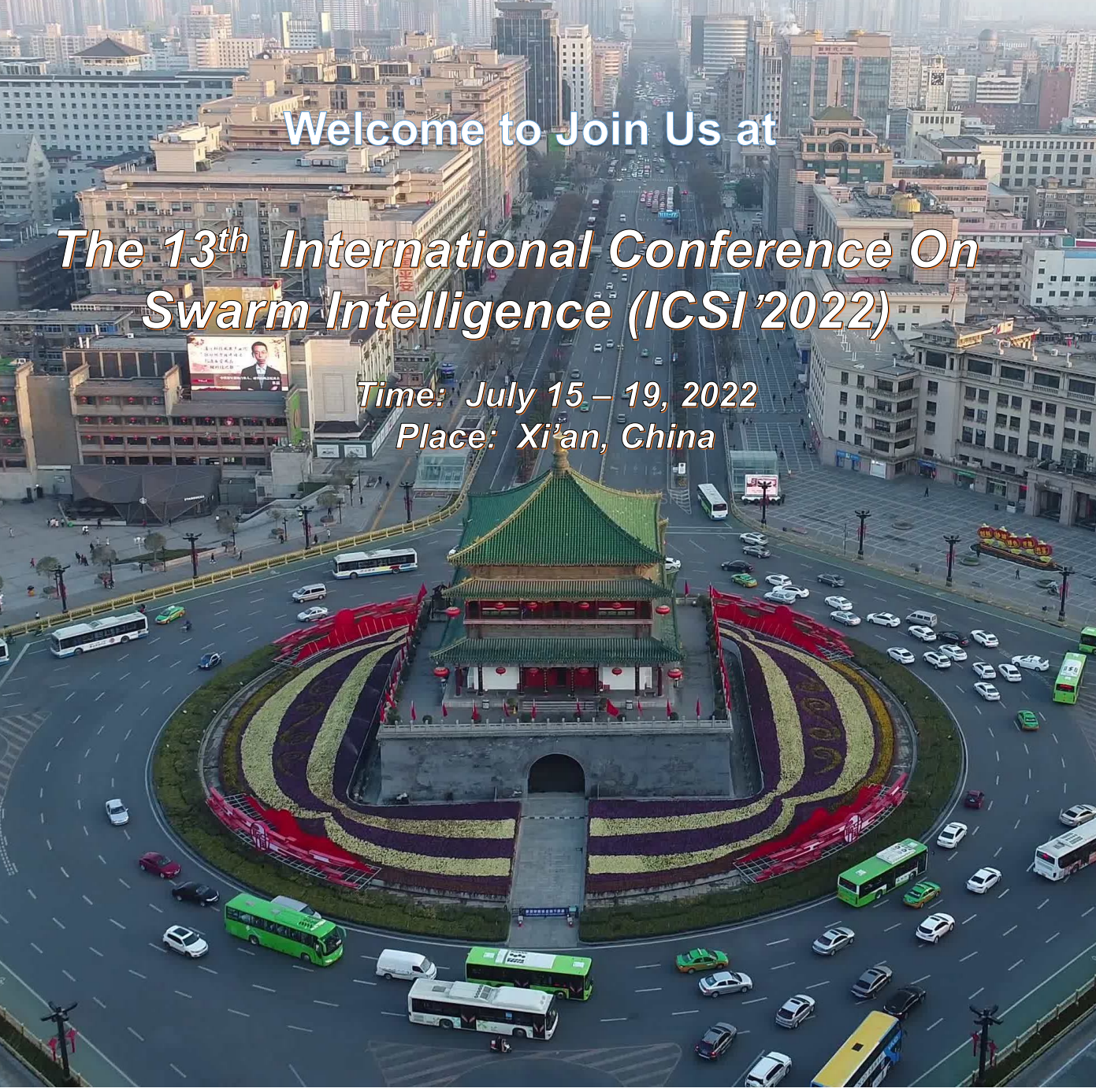
Abstract. Image classification has attracted the attention in many research field. As an efficient and fast image feature extraction operator, LBP is widely used in the Image classification. The traditional local binary pattern (LBP) algorithm only considers the relationship between the center pixel and the edge pixel in the pixel region, which often leads to the problem of partial important information bias. To solve this problem, this paper proposes an improved LBP with threshold, which can significantly optimize the processing of texture features, and also be used to address the problems of multi-type image classification. The experimental results show that the algorithm can effectively improve the accuracy of image classification.

Can Argumentation Help to Forecast Conditional Stock Market Crisis with Multi-agent Sentiment Classification?

Hao Zhiyong , Sun Pengge

Abstract. It is well known that investors in stock market making financial decisions are often affected by certain events, like the coronavirus disease pandemic. However, it is very hard to perceive stock market crisis by making use of variety information. In this paper, we investigate whether it is possible to exploit arguments from investor sentiment expressed through financial news and posts, to forecast conditional stock market crisis. Thus, an argumentation enriched multi-agent sentiment classification method is proposed to make full use of variety tone and proliferation under certain events. In particular, the conditional stock market is investigated in our experiment to compare the predictive performance of the argumentation enriched multi-agent sentiment classification system with the existing multiple classifier system for the variance of CSI 300 Index. We find that the proposed argumentation enriched system outperforms the existing popular multiple classifier systems, while giving argumentative explanations through preliminary empirical evaluation.

Index (a=abstract)



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