第四届数据驱动的复杂系统优化国际前沿论坛

The 4th International Forum on Frontiers of Data-driven Optimization of Complex Systems

(FDOCS2022)

会议程序册

Conference Program

中国 · 成都
Chengdu, China
28 October, 2022

东北大学 Northeastern University　流程工业综合自动化国家重点实验室　四川大学 SICHUAN UNIVERSITY

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Modeling and Control of Dielectric Elastomer Based Soft Robots via Data-In-Loop Approach

Chunyi Su

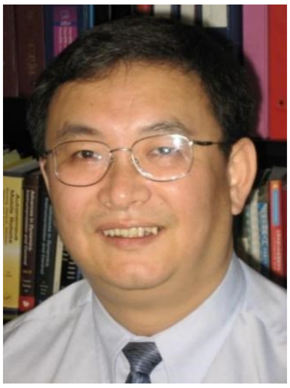
Concordia University, Canada

Abstract:

This talk describes the basic research in the new area of bioinspired soft robotics, with an emphasis on modeling and control. The developments in soft robotics research incorporate smart materials, flexible electronics, and 3D printing to emulate both the physical flexibility and the versatility of animals such as fish, caterpillars, snakes, and worms. Potentially applications include tissue engineering and biology; control engineering; additive manufacturing; biomedical engineering; medical devices.

This talk is intended to discuss a newly proposed data-in-loop approach, showing the status of the art of the current research for modeling and control of the smart-material based soft robots.

Short Biography:



Dr. Chun-Yi Su received his Ph.D. degree in control engineering from the South China University of Technology in 1990. After a seven-year stint at the University of Victoria, he joined Concordia University in 1998, where he is currently a Professor and Honorary Concordia University Research Chair. His research covers control theory and its applications to various mechanical systems, with a recent focus on modeling and control of soft robots. He is the author or co-author of over 500 publications, which have appeared in journals, as book chapters and in conference proceedings. He has been identified as Highly Cited Researchers from Clarivate since 2019.

Dr. Su has served as Associate Editor for several journals, including IEEE Transactions on Automatic Control, IEEE Transactions on Control Systems Technology, IEEE Transactions on Cybernetics, and other journals. He is a Distinguished Lecturer of IEEE RA Society. He served for many conferences as an Organizing Committee Member, including the General Chairs and Program Chairs.

Learning to Drive Autonomously

Zhong-Ping Jiang

New York University, US

Abstract:

This talk presents a new design paradigm, called "learning-based control", that is fundamentally different from traditional model-based control and model-free machine learning. Learning-based control is aimed at learning real-time optimal controllers directly from input-output data, for stability and robustness of dynamical systems in uncertain environments. Novel tools and methods for data-driven control are proposed as an entanglement of techniques from reinforcement learning and control theory. This talk reviews our prior work in learning-based control and presents our recent development of learning-based control algorithms for connected and autonomous vehicles in mixed traffic environments.

Short Biography:

Zhong-Ping JIANG received the M.Sc. degree in statistics from the University of Paris XI, France, in 1989, and the Ph.D. degree in automatic control and mathematics from the Ecole des Mines de Paris (now, called ParisTech-Mines), France, in 1993, under the direction of Prof. Laurent Praly.

Currently, he is a Professor of Electrical and Computer Engineering at the Tandon School of Engineering, New York University. His main research interests include stability theory, robust/adaptive/distributed nonlinear control, robust adaptive dynamic programming, reinforcement learning and their applications to information, mechanical and biological systems. In these fields, he has written six books and is author/co-author of over 500 peer-reviewed journal and conference papers.

Prof. Jiang is a recipient of the prestigious Queen Elizabeth II Fellowship Award from the Australian Research Council, CAREER Award from the U.S. National Science Foundation, JSPS Invitation Fellowship from the Japan Society for the Promotion of Science, Distinguished Overseas Chinese Scholar Award from the NSF of China, and several best paper awards. He has served as Deputy Editor-in-Chief, Senior Editor and Associate Editor for numerous journals. Prof. Jiang is a Fellow of the IEEE, a Fellow of the IFAC, a Fellow of the CAA and is among the Clarivate Analytics Highly Cited Researchers. In 2021, he is elected as a foreign member of the Academy of Europe.

Cyberattack Resilient Control for Cyber-Physical Systems: An Evolutionary Game Approach

Ye-Hwa Chen

Georgia Institute of Technology, US

Abstract:

Cyber-physical systems (CPSs) are a class of systems integrating cyber and physical components. Their network security issues having been receiving a lot of attention recently. We consider the resilience of control of networked dynamical systems.

The system may contain uncertainty. In addition, there can be adversary network environment which may launch cyberattacks.

One most challenging task is to deal with the Denial-of-Service (DoS). This may cause a delay in feedback. So far there are two approaches for DoS. The first is the adversary approach, in which the delayed feedback signal is treated as a hostile attacker. The nominal system is to tolerate the attacker. The second is the cordial approach, which is unique in this presentation, in which one explores as much advantage as possible from the feedback signal. That is, the feedback signal is sorted so that partial useful portion is salvaged.

The control task is for the system to follow pre-planned constraints. We show how to design control for systems under DoS and other attacks. We discuss the optimal choice of a control design parameter in an evolutionary game-theoretic setting, with the designer and the cyberattacker being two players.

Short Biography:

Ye-Hwa Chen received his B.S. in Chemical Engineering from the National Taiwan University in 1979. He then received his M.S. and Ph.D. in Mechanical Engineering from the University of California, Berkeley, in 1983 and 1985, respectively. He served as a faculty in Syracuse University during 1986-1988. Since 1988, he has been with the George W. Woodruff School of Mechanical Engineering of Georgia Institute of Technology where he is currently a professor.

He has been serving as regional editor and associate editor for seven journals. He has published over 300 refereed journal papers. He has received the IEEE Transactions on Fuzzy Systems Outstanding Paper Award, Sigma Xi Best Research Paper Award, and Sigma Xi Junior Faculty Award. A paper of his received the second highest citation in the IEEE Transactions on Industrial Electronics. He received the Passport Award, the Monopoly Award, and the “As Good As It Gets” Award from the Georgia Institute of Technology. He is the recipient of the Campanile Award from the Georgia Institute of Technology, the highest honor of the institute. His research interests include dynamical systems and mechatronic systems modeling and analysis, fuzzy systems, and control.

Neural H2 Control Using Discrete-Time and Continuous-Time Reinforcement Learning Compensation

Wen Yu

National Polytechnic Institute, Mexico

Abstract:

In this talk discrete-time and continuous-time H2 control for unknown nonlinear system are discussed. We use neural networks to model the unknown systems, then apply the H2 tracking control based on the neural models. Since the neural H2 control is very sensitive to the neural modeling errors, we use reinforcement learning to improve the control performance. The stabilities of the neural modeling and the H2 tracking control are proven. Convergences of the approaches are also given. The proposed methods are validated with benchmark control problems.

Short Biography:

Wen Yu received the B.S. degree in automatic control from Tsinghua University, Beijing, China in 1990 and the M.S. and Ph.D. degrees, both in Electrical Engineering, from Northeastern University, Shenyang, China, in 1992 and 1995, respectively. From 1995 to 1996, he served as a lecturer in the Department of Automatic Control at Northeastern University, Shenyang, China. Since 1996, he has been with CINVESTAV-IPN (National Polytechnic Institute), Mexico City, Mexico, where he is currently a professor with the Departamento de Control Automatico. From 2002 to 2003, he held research positions with the Instituto Mexicano del Petroleo. He was a Senior Visiting Research Fellow with Queen's University Belfast, Belfast, U.K., from 2006 to 2007, and a Visiting Associate Professor with the University of California, Santa Cruz, from 2009 to 2010. He also holds a visiting professorship at Northeastern University in China from 2006. Dr.Wen Yu serves as associate editors of IEEE Transactions on Cybernetics and Journal of Intelligent and Fuzzy Systems. He is a member of the Mexican Academy of Sciences.

Smart Big Data in Precision Agricultural Applications: Acquisition, Advanced Analytics, and Plant Physiology-informed Machine Learning

Yangquan Chen

University of California, Merced, US

Abstract:

Big data acquisition platforms, such as small unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), and proximate sensors for precision agriculture, especially for heterogeneous crops, such as vineyards and orchards, are gaining interest from both researchers and growers. For example, lightweight sensors mounted on UAVs, such as multispectral and thermal infrared cameras, can be used to collect high-resolution images. The higher temporal and spatial resolutions of the images, relatively low operational costs, and nearly real-time image acquisition make the UAVs an ideal platform for mapping and monitoring the variability of crops over large acreage. The data acquisition platforms and analytics can create big data and demand fractional-order thinking due to the "complexity" and, thus, variability inherent in the process. Much hope is placed on machine learning (ML). How can an ML model learn from big data efficiently (optimally) and make the big data "smart" is important in agricultural research. The key to the learning process is the plant physiology and optimization method. Designing an efficient optimization method poses three questions: 1.) What is the best way to optimize? 2.) What is the more optimal way to optimize? 3.) Can we demand "more optimal machine learning," for example, deep learning with the minimum or smallest labeled data for agriculture? Therefore, in this seminar talk, the author investigated the foundations of the plant physiology-informed machine learning (PPIML) and the principle of tail matching (POTM) framework. He elucidated their role in modeling, analyzing, designing, and managing complex systems based on the big data in precision agriculture. Plant physiology entails the complexity of growth. The complex system has both deterministic and stochastic dynamic processes with external driving processes characterized and modeled using fractional calculus-based models, which will better inform the complexity-informed machine learning (CIML) algorithms. Data acquisition platforms, such as low-cost UAVs, UGVs, and edgeAI sensors, were designed and built to demonstrate their reliability and robustness for remote and proximate sensing in agricultural applications. Research results showed that the PPIML, POTM, CIML, and the data acquisition platforms were reliable, robust, and smart tools for precision agricultural research in varying situations, such as water stress detection, early detection of nematodes, yield estimation, and evapotranspiration (ET) estimation. The application of these tools has the potential to assist stakeholders in their crop management decisions.

Short Biography:

YangQuan Chen earned his Ph.D. from Nanyang Technological University, Singapore, in 1998. He had been a faculty of Electrical Engineering at Utah State University (USU) from 2000-12. He joined the School of Engineering, University of California, Merced (UCM) in summer 2012 teaching "Mechatronics", "Engineering Service Learning" and "Unmanned Aerial Systems" for undergraduates; "Fractional Order Mechanics", "Linear Multivariable Control", "Nonlinear Controls" and "Advanced Controls: Optimality and Robustness" for graduates. His research interests include mechatronics for sustainability, cognitive process control (smart control engineering enabled by digital twins), small multi-UAV based cooperative multi-spectral "personal remote sensing", applied fractional calculus in controls, modeling and complex signal processing; distributed measurement and control of distributed parameter systems with mobile actuator and sensor networks. He received Research of the Year awards from both USU (2012) and UCM (2020). In 2018, for his cumulative work in drones, Dr. Chen won "Senate Distinguished Scholarly Public Service Award" that recognizes a faculty member who has energetically and creatively applied his or her professional expertise and scholarship to benefit the local, regional, national or international community. He was listed in Highly Cited Researchers by Clarivate Analytics in 2018-2021. His lab website is http://mechatronics.ucmerced.edu/ and his publications are managed by https://scholar.google.com/citations?user=RDEIRbcAAAAJ&hl=en

Learning & Operator Based Nonlinear Position Control of Micro Hands

Mingcong Deng

Tokyo University of Agriculture and Technology, Japan

Abstract:

Learning & operator theory based robust nonlinear control system design for nonlinear systems with uncertainties is shown. The relationship between operator theory and passivity for adaptive control is discussed. Meanwhile, I will introduce support vector regression (SVR) utilized for regression analysis, where the design parameters are selected by using particle swarm optimization (PSO). In order to realize sensorless control, PSO-SVR-based moving estimation with generalized Gaussian distribution (GGD) kernel is employed. That is, learning & operator based sensorless robust adaptive nonlinear control system can be obtained. Further, current results on modeling by ant colony optimization (ACO)-MSVR for 3D actuator are shown. Finally, some experimental results on actuator position control for 2D/3D micro hands are introduced.

Short Biography:

Prof. Mingcong Deng received his BS and MS in Automatic Control from Northeastern University, China, and PhD in Systems Science from Kumamoto University, Japan, in 1997. From 1997.04 to 2010.09, he was with Kumamoto University; University of Exeter, UK; NTT Communication Science Laboratories; Okayama University. From 2010.10, he has been with Tokyo University of Agriculture and Technology, Japan, as a professor. Prof. Deng specializes in three complementary areas: Operator based nonlinear fault detection and fault tolerant control system design; System design on human factor based robot control; Learning based nonlinear adaptive control. Prof. Deng has over 550 publications including 189 journal papers in peer reviewed journals including IEEE Transactions, IEEE Press and other top tier outlets. He serves as a chief editor for Int. J. of Advanced Mechatronic Systems, Int. J. Human Factors Modelling and Simulation, and associate editors of 6 international journals. Prof. Deng is a co-chair of agricultural robotics and automation technical committee, IEEE Robotics and Automation Society; Also a chair of the environmental sensing, networking, and decision making technical committee, IEEE SMC Society. He was the recipient of 2014 & 2019 Meritorious Services Award of IEEE SMC Society, 2020 IEEE RAS Most Active Technical Committee Award (IEEE RAS Society). He is a member of The Engineering Academy of Japan, and a fellow of AAIA.

Inverse Reinforcement Learning for Non-Cooperative Linear-Quadratic Differential Games

Ming Cao

University of Groningen, the Netherlands

Abstract:

Given the data describing the optimal behavior in an environment modeled by a Markov Decision Process or dynamical system, the central aim of Inverse Reinforcement Learning (IRL), also known as Inverse Optimal Control (IOC), is to identify the corresponding hidden unknown reward (cost) functions. In this talk I first review several existing results on solving this class of inverse problems. We then focus on an IRL algorithm for the representative case of infinite-horizon non-cooperative Linear-Quadratic (LQ) differential games, where the optimal behavior are known to be Nash Equilibrium (NE) trajectories; the set of possible cost function parameters can be infinite, and thus there can be infinitely many solutions to this inverse problem. The presented algorithm solves the problem by providing a parameter set that, together with the system’s dynamics, forms an equivalent game such that the observed behavior is an NE of the game. We show the theoretical guarantees for the algorithm and present the characterization of the possible solutions for the inverse LQ differential game. This characterization allows us to find other possible sets of cost function parameters that are the solution to the inverse problem. Possible extensions to a model-free setting are also discussed due to its importance in practice.

Short Biography:

Ming Cao is the director of the Jantina Tammes School of Digital Society, Technology and AI, and a professor of systems and control at the University of Groningen, the Netherlands. He received the Bachelor degree in 1999 and the Master degree in 2002 from Tsinghua University, China, and the Ph.D. degree in 2007 from Yale University, USA, all in Electrical Engineering. From 2007 to 2008, he was a Research Associate at Princeton University, USA. He worked as a research intern in 2006 at the IBM T. J. Watson Research Center, USA. He is the 2017 and inaugural recipient of the Manfred Thoma medal from the International Federation of Automatic Control (IFAC) and the 2016 recipient of the European Control Award sponsored by the European Control Association (EUCA). He is an IEEE fellow. He is a Senior Editor for Systems and Control Letters, an Associate Editor for IEEE Transactions on Automatic Control, IEEE Transactions on Control of Network Systems and IEEE Robotics and Automation Magazine, and was an associate editor for IEEE Transactions on Circuits and Systems and IEEE Circuits and Systems Magazine. He is a member of the IFAC Conference Board and a vice chair of the IFAC Technical Committee on Large-Scale Complex Systems. His research interests include autonomous agents and multi-agent systems, complex networks and decision-making processes.

Robust and Cooperative Formation Control for Multi-Agent Systems

Peng Shi

University of Adelaide, Australia

Abstract:

Inspired by the wild animals that perform teamwork to achieve complex tasks, the concept of multi-agent systems is introduced to build up connections among intelligent and autonomous systems. To generate collaborative behaviour and group intelligence for a multi-robot system, this talk discusses how to design adaptive and cooperative formation control algorithms. The issue of collision avoidance is considered first to ensure safety of the system. Next uncertainty estimation techniques are proposed to increase the formation tracking precision of all agents. The actuator saturation problem is then investigated to assure practicality of the proposed control algorithms. Experimental results regarding a group of self-designed omni-directional robots are provided to show effectiveness of the control algorithms in practice.

Short Biography:

Peng Shi received the PhD degree in Electrical Engineering from the University of Newcastle, Australia, the PhD degree in Mathematics from the University of South Australia, the Doctor of Science degree from the University of Glamorgan, UK, and the Doctor of Engineering degree from the University of Adelaide, Australia. He is now a Professor at the School of Electrical and Electronic Engineering, and the Director of Advanced Unmanned Systems Laboratory, at the University of Adelaide, Australia. His research interests include systems and control theory and applications to robotic and autonomous systems, cyber-physical systems, and multi-agent systems. Currently he serves as the Editor-in-Chief of IEEE Transactions on Cybernetics, and Senior Editor of IEEE Access. His professional services also include as the President of the International Academy for Systems and Cybernetic Sciences, the Vice President of IEEE SMC Society, and IEEE SMC Distinguished Lecturer. He is a Fellow of IEEE, IET, IEAust and CAA, and a Member of the Academy of Europe.

Cybersecurity for Robotics

Danwei Wang

Nanyang Technological University, Singapore

Abstract:

Sensors are critical components in robotics and they generate huge amount of data which are subjected to hostile attacks. Actuators of robots are also vulnerable to cyber-attacks which can cause catastrophic damages. In this presentation, we study autonomous robots and understand vulnerability to cyber-attacks. We propose solution to detect cyber-attacks to its critical sensing and actuation components. Our detection frameworks are described and experiments are illustrated to show the effectiveness. This talk also presents our efforts on development of some technologies for a new generation of autonomous environmental service including autonomous navigation for street sweepers, high-fidelity teleoperation etc.

Short Biography:

Danwei Wang received his Ph.D and MSE degrees from the University of Michigan, Ann Arbor in 1989 and 1985, respectively. He received his B.E degree from the South China University of Technology, China in 1982. Since 1989, he has been with the School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore. Currently, he is a professor and Director, ST Engineering – NTU Corporate Laboratory and deputy director of the Robotics Research Center, NTU. He also served as Head of Division of Control and Instrumentation, School of EEE from 2005 to 2011 and director, EXQUISITUS, Centre for System Intelligence and Efficiency from 2011 to 2016. He has received over research funding over S$20Million and supervised more than 80 researchers and postgraduate students. He has served as general chairman, technical chairman and various positions in international conferences, such as International Conference on Control, Automation, Robotics and Vision (CARCVs), IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) and IEEE International Conference on Robotics and Automation (ICRA). He has served or is serving as an associate editor of Conference Editorial Board, IEEE Control Systems Society, an associate editor of the International Journal of Humanoid Robotics, and an active member of IEEE Singapore Robotics and Automation Chapter. He was a recipient of Alexander von Humboldt fellowship, Germany. His research interests include robotics, control theory and applications. He has published 5 books and more than over 450 technical articles in the areas of robotics, control theories and applications, as well as fault diagnosis and prognosis of complex engineering systems.

My Understanding of Control and Autonomous Systems

Ben M. Chen

The Chinese University of Hong Kong, China

Abstract:

In this talk, it aims to present a personal understanding of control and autonomous systems and personal experiences in utilizing autonomous unmanned systems for industrial applications. Particular attention is paid to the development of infrastructure inspection and information management system with advanced AI and unmanned aerial systems (UAS) technologies, which includes sophisticated unmanned aerial hardware platform and software systems for automatic flight control and task and motion planning, artificial intelligent algorithms and software platform for image and infrared data processing, i.e., crack, spalling, delamination and other defect detections, and building information modeling (BIM) and management system integrated with detailed geographical information systems (GIS) and digital twin techniques.

Short Biography:

Ben M. Chen received his B.Sc. degree in mathematics and computer science from Xiamen University, China, in 1983, M.Sc. in electrical engineering from Gonzaga University, USA, in 1988, and Ph.D. in electrical and computer engineering from Washington State University, USA, in 1991. He is currently a Professor of Mechanical and Automation Engineering at the Chinese University of Hong Kong (CUHK). He was a Provost's Chair Professor in the Department of Electrical and Computer Engineering at the National University of Singapore, before joining CUHK in 2018, and was an Assistant Professor in the Department of Electrical Engineering at the State University of New York at Stony Brook, USA, in 1992 – 1993. His current research interests are in the development of unmanned systems technologies and their industrial applications.

Dr. Chen is an IEEE Fellow, CAA Fellow and Fellow of Academy of Engineering, Singapore. He has authored/co-authored hundreds of journal and conference articles, and a dozen research monographs in control theory and applications, unmanned systems and financial market modeling. He had served on the editorial boards of a dozen international journals including Automatica and IEEE Transactions on Automatic Control. He currently serves as an Editor-in-Chief of Unmanned Systems. Dr. Chen's research team has actively participated in international UAV competitions and won many championships in the contests.

Input Delay Tolerance of Nonlinear Systems: The Current State-of-the-Art

Wei Lin

Case Western Reserve University, US

Abstract:

This lecture presents the current state-of-the-art in the study of input delay tolerance of nonlinear control systems. In the first part of this talk, we focus on the problem of semiglobal input delay tolerance (SGIDT) under smooth feedback. A semiglobal control framework is introduced for the analysis/synthesis of input delay tolerance of nonlinear systems under smooth feedback. Using the converse Lyapunov theorem on global asymptotic local exponential stability (GALES), together with the Razumikhin theorem, we prove that: 1) GALES implies the SGIDT of nonlinear systems under smooth state feedback; 2) GALES and uniform observability imply the SGIDT of MIMO nonlinear systems under smooth output feedback.

In the second part of this talk, we concentrate on the problem of global input delay tolerance (GIDT) under non-smooth feedback for nonlinear systems that are not LES nor smoothly stabilizable. Using the homogeneous systems theory, we further prove that homogeneity degree zero and global stabilizability by homogeneous feedback imply global input delay tolerance. Various examples and counter-examples are also presented to illustrate some fundamental limitations in achieving SGIDT under smooth feedback or GIDT under non-smooth feedback. If time is permitted, I shall also present some latest results on when non-smoothly stabilizable systems are semi-globally tolerant to actuator delay.

Short Biography:

Wei Lin received the D.Sc. and M.S. degrees in Systems Science and Mathematics from Washington University, St. Louis, in 1993 and 1991. He also received the B.S. and M.S. degrees in Electrical Engineering from Dalian University of Technology (1983) and Huazhong University of Science and Technology (1986), respectively. During 1986 to 1989, he was a Lecturer in the Dept. of Mathematics at Fudan University, Shanghai, China. From 1994 to 1995, he was a Post-doctor and Visiting Assistant Professor in Washington University. Since spring of 1996, he has been a Professor in the Dept. of Electrical, Computer, and Systems Engineering at Case Western Reserve University, Cleveland, Ohio. He has also held visiting positions at several universities in North America, Europe and Asia. Dr. Lin's research interests include nonlinear control, dynamic systems with time-delay, homogeneous systems theory, estimation and adaptive control, stochastic control, under-actuated mechanical systems and robotics, power systems, renewable energy and smart grids. In these areas, he has published a number of papers in peer refereed journals and conferences. More details can be found at http://engineering.case.edu/groups/nonlinear/

Dr. Lin was a recipient of the U.S. NSF CAREER Award, the Warren E. Rupp Endowed Professor, the Robert Herbold Faculty Fellow Award, the JSPS Fellow and IEEE Fellow. He served as an Associate Editor of the IEEE Trans. on Automatic Control (1999-2001), an Associate Editor of Automatica (2003-2005), a Guest Editor of TAC Special Issue on “New Directions in Nonlinear Control” (2003), a Subject Editor of Int. J. of Robust and Nonlinear Control (2005-2010), an Associate Editor of Journal of Control Theory and Applications (2005-2008), Board of Governors of IEEE Control Systems Society (2003-2005), and Vice Program Chair of 2001 IEEE CDC (Short Papers) and 2002 IEEE CDC (Invited Papers).

Decision Making for Minimized Uncertainties Impact Using Probability Density Function Control and Brain-Computer-Interface

Hong Wang
University of Manchester, UK

Abstract:

Decision-making under uncertainties has been a subject of study for many years. In particular, the decision making (optimization) for complex systems such as engineering and economic systems involves human-decision phase. This triggers the occurrences of uncertainties in the decision making phase in addition to the widely-existed inherent uncertainties in the actual systems. In this talk, such challenges will be addressed by summarizing the year's efforts of the presenter when he was with the University of Manchester before 2016. At first, a generic framework on the decision making for uncertainty systems has been formulated into a "closed loop control design problem", where the uncertainties in both decision making phase and the actual systems have been represented by the uncertainty injections to the "controller" and to the "plant to be controlled". The uncertainties in human decision making phase is characterized by their probability density functions (PDF) of the brain-cell's signal collected via brain-computer-interface (BCI). Using such a generic framework, decision making under uncertainties are formulated as a PDF control problem of objective functions and constraints- leading to a total solution for the stochastic optimization for complex systems. Two case studies will be presented together with the rationale and claims that most of the existing stochastic optimizations are special cases of the presented theory. Note that the presentation is based upon the published materials by the author.

Short Biography:

Professor Hong Wang (FIET, FInstMC, SMIEEE) received the master's and Ph.D. degrees from the Huazhong University of Science and Technology, Wuhan, China, in 1984 and 1987, respectively. He was a Research Fellow with Salford University, Salford, U.K., Brunel University, Uxbridge, U.K., and Southampton University, Southampton, U.K., before joining the University of Manchester Institute of Science and Technology (UMIST), Manchester, U.K., in 1992. He was a Chair Professor in process control of complex industrial systems with the University of Manchester (UoM), U.K., from 2002 to 2016, where he originated probability density function control theory in 1996 and was the Deputy Head of the Paper Science Department, the Director of the UMIST Control Systems Centre from 2004 to 2007, which is the birthplace of Modern Control Theory established in 1966. He was a University Senate member and a member of general assembly during his time in Manchester. Whilst he has been an Emeritus Professor of UoM, from 2016 to 2018, he was with the Pacific Northwest National Laboratory (PNNL), Richland, WA, USA, as a Laboratory Fellow and Chief Scientist, and was the Co-Leader and the Chief Scientist for the Control of Complex Systems Initiative. He joined the Oak Ridge National Laboratory in January 2019. His research focuses on stochastic distribution control, fault diagnosis and tolerant control, and intelligent controls with applications to complex system area. He is an associate editor for IEEE Transactions on Neural Networks and Learning Systems and was an Associate Editor of IEEE Transactions on Automatic Control (2002 – 2004), IEEE Transactions on Control Systems Technology (2013 – 2018), and the IEEE Transactions on Automation Science and Engineering. He is also a member for three IFAC Committees for the three areas of his research.

Distributed Nash Equilibrium Seeking for a Class of Uncertain Nonlinear Systems with Disturbance Rejection

Jie Huang

The Chinese University of Hong Kong, China

Abstract:

Non-cooperative games have broad applications to artificial intelligence, communication networks, control systems, etc. A key issue with non-cooperative games is the seeking of Nash equilibrium for networked dynamic systems. Recently, we have presented an approach to deal with the distributed Nash equilibrium for a class of uncertain nonlinear systems over jointly strongly connected switching networks. In this talk, we will further consider the distributed Nash equilibrium seeking for the same class of uncertain nonlinear systems subject to external disturbances over jointly strongly connected switching networks. Our approach is an integration of the adaptive control, distributed estimator, and asymptotic observer.

Short Biography:

Jie Huang obtained his PhD degree from the Johns Hopkins University in 1990. After a year with Johns Hopkins University as a postdoctoral fellow and four years with industry in USA, he joined the Department of Mechanical and Automation Engineering, the Chinese University of Hong Kong (CUHK) in September 1995, and is now Choh-Ming Li Research Professor of Mechanical and Automation Engineering, CUHK. His research interests include nonlinear control, robotics and automation, networked control, game theory, and guidance and control of flight vehicles. He has authored/co-authored four monographs and some papers. He was elected HKIE Fellow in 2017, CAA Fellow in 2010, IFAC Fellow in 2009, and IEEE Fellow in 2005.

Distributed Continuous-time Optimal Resource Allocation with Time-varying Quadratic Cost Functions

Wei Ren
University of California, Riverside, US

Abstract:

In this talk, we introduce distributed continuous-time algorithms to solve the optimal resource allocation problem with time-varying quadratic cost functions for multi-agent systems. The objective is to allocate a quantity of resources while optimizing the sum of all the local time-varying cost functions. Here the optimal solutions are trajectories rather than some fixed points. We consider a large number of agents that are connected through a network, and our algorithms can be implemented using only local information. By making use of the prediction-correction method and the nonsmooth consensus idea, we first design distributed algorithms to deal with the case when the time-varying cost functions have identical Hessians. We further propose estimator-based algorithms relying on distributed average tracking estimators to address the case of nonidentical Hessians. In each case, it is proved that the solutions of the proposed dynamical systems with certain initial conditions asymptotically converge to the optimal trajectories. The effectiveness of the proposed distributed continuous-time optimal resource allocation algorithms are illustrated through simulations.

Short Biography:

Wei Ren is currently a Professor with the Department of Electrical and Computer Engineering, University of California, Riverside. He received the Ph.D. degree in Electrical Engineering from Brigham Young University, Provo, UT, in 2004. Prior to joining UC Riverside, he was a faculty member at Utah State University and a postdoctoral research associate at the University of Maryland, College Park. His research focuses on distributed control of multi-agent systems and autonomous control of unmanned vehicles. Dr. Ren was a recipient of the IEEE Control Systems Society Antonio Ruberti Young Researcher Prize in 2017 and the National Science Foundation CAREER Award in 2008. He is an IEEE Fellow and an IEEE Control Systems Society Distinguished Lecture.

Self-Triggered Adaptive Model Predictive Control for Constrained Nonlinear Systems

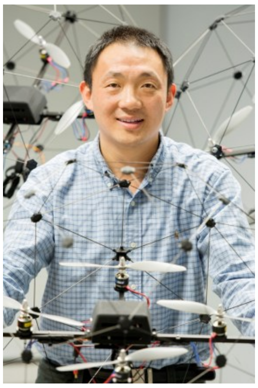
Yang Shi

University of Victoria, Canada

Abstract:

Model predictive control (MPC) is a promising paradigm for high-performance and cost-effective control of complex dynamic systems. Yet, the MPC schemes and the corresponding optimization problem closely rely on the model of the dynamic system under consideration. In real applications, the mathematical model is hard to be precisely known or even varying. This talk will introduce a self-triggered adaptive model predictive control (MPC) method for constrained discrete-time nonlinear systems subject to parametric uncertainties and additive disturbances. Firstly, a real-time zonotope-based set-membership parameter estimator is developed to refine a set-valued description of the time-varying parametric uncertainty based on the available measurements. We leverage this estimation scheme to design a novel self-triggered adaptive MPC (ST-AMPC) approach for uncertain nonlinear systems. Compared with the existing self-triggered robust MPC methods, the proposed ST-AMPC method can further reduce the average sampling frequency while preserving comparable closed-loop performance. Then, we theoretically show that, under some reasonable assumptions, the proposed ST-AMPC algorithm is recursively feasible, and the closed-loop system is input-to-state practical stable (ISpS) at triggering time instants. Finally, some existing challenges and future research directions will be discussed.

Short Biography:



Yang SHI received his B.Sc. and Ph.D. degrees in mechanical engineering and automatic control from Northwestern Polytechnical University, Xi'an, China, in 1994 and 1998, respectively, and the Ph.D. degree in electrical and computer engineering from the University of Alberta, Edmonton, AB, Canada, in 2005. From 2005 to 2009, he was an Assistant Professor and Associate Professor in the Department of Mechanical Engineering, University of Saskatchewan, Saskatoon, SK, Canada. In 2009, he joined the University of Victoria, and now he is a Professor in the Department of Mechanical Engineering, University of Victoria, Victoria, BC, Canada. His current research interests include networked and distributed systems, model predictive control (MPC), cyber-physical systems (CPS), robotics and mechatronics, navigation and control of autonomous systems (AUV and UAV), and energy system applications.

Dr. Shi received the University of Saskatchewan Student Union Teaching Excellence Award in 2007, and the Faculty of Engineering Teaching Excellence Award in 2012 at the University of Victoria (UVic). He is the recipient of the JSPS Invitation Fellowship (short-term) in 2013, the UVic Craigdarroch Silver Medal for Excellence in Research in 2015, the 2017 IEEE Transactions on Fuzzy Systems Outstanding Paper Award, the Humboldt Research Fellowship for Experienced Researchers in 2018. He is a member of the IEEE IES Administrative Committee and the IES Fellow Evaluation Committee during 2017-2019; he is the VP of IEEE IES Technical Committee on Industrial Cyber-Physical Systems. Currently, he is Co-Editor-in-Chief for IEEE Transactions on Industrial Electronics; he also serves as Associate Editor for Automatica, IEEE Transactions on Automatic Control, IEEE Transactions on Cybernetics, etc. He is General Chair of the 2019 International Symposium on Industrial Electronics (ISIE) and the 2021 International Conference on Industrial Cyber-Physical Systems (ICPS). He is a Fellow of IEEE, ASME, CSME, and Engineering Institute of Canada (EIC), and a registered Professional Engineer in British Columbia, Canada.

Data-Driven Charging Strategy of PEVs under Transformer Aging Risk

Tingwen Huang

Texas A&M University, Qatar

Abstract:

Big data analytics and plug-in electric vehicle (PEV) are the important elements of smart grids in the future. A data-driven charging strategy for PEV-based taxis is introduced and driving behaviors of taxis and load profiles of buildings are characterized by data analysis to make the risk- averse decision on PEV charging. First, the framework of data driven risk-averse PEV charging is introduced, where a stochastic game model is proposed. Second, the big data analysis of the statistical information about PEV-based taxis and the load profile of buildings are presented by applying various data process techniques. Finally, the performance of the method is numerically illustrated by the case study via real global positioning system information of 490 PEV-based taxis and the smart meter data from local commercial buildings.

Short Biography:

Tingwen Huang is a Professor at Texas A&M University at Qatar. He received his B.S. degree from Southwest University, China, 1990, his M.S. degree from Sichuan University, China, 1993, and his Ph.D. degree from Texas A&M University, College Station, Texas, 2002. After graduated from Texas A&M University, he worked as a Visiting Assistant Professor there. Then he joined Texas A&M University at Qatar as an Assistant Professor in August 2003, then he was promoted to Professor in 2013. Dr. Huang's research areas include neural networks, chaotic dynamical systems, complex networks, optimization and control, smart grid. He a Fellow of IEEE and IAPR.

Dynamic Data Stream Clustering Based on Ant Colony Behaviour

Shengxiang Yang
De Montfort University, UK

Abstract:

Data stream mining is a natural and necessary progression from traditional data mining. However, it presents additional challenges to batch analysis, including strict time and memory constraints and dynamic changes in the stream. In a dynamic data stream, the underlying concepts may drift and change over time. It is challenging to recognise and track the change in a stream. This talk presents our recent work to evaluate unsupervised learning as the basis for clustering dynamic data streams. A novel stream clustering algorithm based on the collective behaviour of ants, called Ant Colony Stream Clustering (ACSC), is present. A Multi Density Stream Clustering (MDSC) method is also presented for finding and tracking multi-density clusters in dynamic data streams. Furthermore, to address the "curse of dimensionality" problem, a Dynamic Feature Mask (DFM) method is presented for improving distance based data stream clustering methods for clustering high-dimensional data streams. Experimental results demonstrate that the proposed methods can efficiently cluster dynamic data streams.

Short Biography:

Shengxiang Yang (http://www.tech.dmu.ac.uk/~syang/) got his PhD degree in Control Theory and Control Engineering from Northeastern University, China in 1999. He is now a Professor of Computational Intelligence (CI) and Deputy Director of the Institute of Artificial Intelligence (IAI), School of Computer Science and Informatics, De Montfort University, UK. He has worked extensively for many years in the areas of CI methods, including evolutionary computation, artificial neural networks, data mining and data stream analysis, and their applications for real-world problems. He has over 360 publications with an H-index of 64 according to Google Scholar. His work has been supported by UK research councils, EU FP7 and Horizon 2020, and industry partners. He serves as an Associate Editor or Editorial Board Member of several prestigious international journals, including IEEE Transactions on Evolutionary Computation, IEEE Transactions on Cybernetics, Information Sciences, and CAAI Transactions on Intelligence Technology, etc. He was the founding chair of the Task Force on Intelligent Network Systems (TF-INS, 2012-2017) and the chair of the Task Force on EC in Dynamic and Uncertain Environments (ECiDUEs, 2011-2017) of the IEEE Computational Intelligence Society. He has given around 30 invited keynote speeches and tutorials at international conferences.

Towards Accurate Human Pose Estimation from Images Using Deep Learning

Chunhua Shen

University of Adelaide, Australia

Abstract:

In this talk I will present two recent works on human pose etimation from monocular images. The first work proposes a fully convolutional multi-person pose estimation framework using dynamic instance-aware convolutions, termed FCPose. Different from existing methods, which often require ROI (Region of Interest) operations and/or grouping post-processing, FCPose eliminates the ROIs and grouping post-processing with dynamic instance-aware keypoint estimation heads. The dynamic keypoint heads are conditioned on each instance (person), and can encode the instance concept in the dynamically-generated weights of their filters. Moreover, with the strong representation capacity of dynamic convolutions, the keypoint heads in FCPose are designed to be very compact, resulting in fast inference and making FCPose have almost constant inference time regardless of the number of persons in the image.

In the second work, we propose a direct, regression-based approach to 2D human pose estimation from single images. We formulate the problem as a sequence prediction task, which we solve using a Transformer network. This network directly learns a regression mapping from images to the keypoint coordinates, without resorting to intermediate representations such as heatmaps. This approach avoids much of the complexity associated with heatmap-based approaches. To overcome the feature misalignment issues of previous regression-based methods, we propose an attention mechanism that adaptively attends to the features that are most relevant to the target keypoints, considerably improving the accuracy. Importantly, our framework is end-to-end differentiable, and naturally learns to exploit the dependencies between keypoints.

Short Biography:

Chunhua Shen is a Professor at School of Computer Science, The University of Adelaide. Prior to that, he was with the computer vision program at NICTA (National ICT Australia), Canberra Research Laboratory for about six years. His research interests are in the intersection of computer vision and statistical machine learning. He studied at Nanjing University, at Australian National University, and received his PhD degree from the University of Adelaide. From 2012 to 2016, he held an Australian Research Council Future Fellowship. His Google scholar citation is 28,000 with H-index 84.

Perception and Localization of Unmanned Systems in Dynamic Environments

Lihua Xie
Nanyang Technological University, Singapore

Abstract:

Unmanned systems have applications in many areas such as surveillance, transport, structure inspection, logistics, etc. Perception and localization are essential capabilities of unmanned systems. There have been a lot of studies on perception and localization based on various sensors such as camera and LiDAR. Each type of sensor has its pros and cons. Different application scenario will require different sensors and there is no one-size-fits-all solution. Existing SLAM technology can only be applicable in static environments. To achieve accurate and reliable localization in complex dynamic environments, heterogeneous sensor fusion has been a recent trend and attracted significant interest. In this talk, we shall present some recent development and discuss possible future directions of the area.

Short Biography:

Lihua Xie is a professor with School of Electrical and Electronic Engineering, Nanyang Technological University and Director, Center for Advanced Robotics Technology Innovation (CARTIN). He has served as Head of Control and Instrumentation Division and Director of Delta-NTU Corporate Laboratory for Cyber-Physical Systems. His research areas include control engineering, indoor positioning, and unmanned systems. He has authored and co-authored 10 books, over 500 journal and 380 conference articles, and 20 patents/technical disclosures. He was listed as a highly cited researcher. He has secured over $90M research funding. He is currently an Editor-in-Chief of Unmanned Systems and has served as an Editor of IET Book Series on Control and Associate Editor of IEEE Transactions on Automatic Control, Automatica, IEEE Transactions on Control Systems Technology, IEEE Transactions on Control of Network Systems, etc. He was an IEEE Distinguished Lecturer (2011-2014). Professor Xie is Fellow of Academy of Engineering Singapore, Fellow of IEEE, Fellow of IFAC, and Fellow of CAA.

Wind Turbine Fault Detection: A Dynamic Model Sensor Method

Zi-Qiang Lang
University of Sheffield, UK

Abstract:

Fault detection based on data from the supervisory control and data acquisition (SCADA) system, which has been installed in most MW-scale wind turbines, has brought significant benefits for wind farm operators. However, the changes in the features of hardware sensor measurements, which are used in current SCADA systems, often cannot provide reliable early alarms. In order to resolve this problem, a novel dynamic model sensor method is proposed for the SCADA data-based wind turbine fault detection. A dynamic model representing the relationship between the generator temperature, wind speed, and ambient temperature is derived following the first principles and used as the basic structure of the model sensor. When the model sensor is applied for fault detection, its parameters are updated regularly using the generator temperature, wind speed, and ambient temperature data from the SCADA system. Then, from the updated model, the fault sensitive features of wind turbine system are extracted via performing system frequency analysis and used for the turbine fault detection. The frequency analysis is based on the concept of Nonlinear Output Frequency Response Functions (NOFRFs) and associated approaches uniquely proposed by the speaker and his research team. This novel model sensor method is applied to the SCADA data of a wind turbine currently operating in Spain. The results show that the proposed method can not only detect the turbine generator failure but also reveal the trend of ageing with the wind turbine components, demonstrating its capability of prognosis of faults in wind turbine system and components.

Short Biography:

Prof Z Q Lang holds the position of Chair Professor of Complex Systems Analysis and Design in the Department of Automatic Control and Systems Engineering at the University of Sheffield, UK. His research fields are the theories and methods of nonlinear system modelling, analysis, design and signal processing and their applications in different science and engineering areas. He has published one monograph and more than 100 journal papers and filed three patents on innovative applications of his theorical research outcomes. Recently, as the principal investigator, he has led £3.5M cross-disciplinary research projects supported by UK Engineering and Physical Science Research Council (EPSRC) and Innovate UK to apply nonlinear system analysis and design approaches he has proposed to address engineering and scientific challenges ranging from digital manufacturing to medical diagnosis. He is an Associate Editor of International Journal of Systems Science and an Associate Editor of the Frontiers in Built Environment. He was a Japan Society for the Promotion of Science (JSPS) Invitation Fellow for Research. His research works on Nonlinear Output Frequency Response Functions (NOFRFs) have been regarded as an outstanding and internationally leading project by UK EPSRC.

Latent State Space Modeling of High-Dimensional Time Series

S. Joe Qin

City University of Hong Kong, China

Abstract:

A novel latent state space (LaSS) analytics algorithm is presented for the latent dynamics modeling of high-dimensional data, where subspace identification is embedded in dimension reduction to form alternating optimization of the latent state space dynamics. Compared with latent VAR models, the proposed algorithm is more general and efficient in capturing latent dynamics. LaSS with a canonical correlation objective prevails in scenarios where the data has reduced-dimensional dynamics. Experiment results with performance indexes, eigen plots, and parameter parsimony demonstrate the model prediction accuracy and dimension reduction capability.

Short Biography:

Dr. S. Joe Qin obtained his B.S. and M.S. degrees in Automatic Control from Tsinghua University in Beijing, China, in 1984 and 1987, respectively, and his Ph.D. degree in Chemical Engineering from University of Maryland at College Park in 1992. He is currently Chair Professor, Dean of the School of Data Science, and Director of Hong Kong Institute for Data Science at City University of Hong Kong. In his prior career he worked as the Fluor Professor at the Viterbi School of Engineering of the University of Southern California, Professor at the University of Texas at Austin, and Principal Engineer at Emerson Process Management.

Dr. Qin is a Fellow of the U.S. National Academy of Inventors, the International Federation of Automatic Control (IFAC), AIChE, and IEEE. He is the recipient of the 2022 CAST Computing in Chemical Engineering Award by the American Institute of Chemical Engineers (AIChE), the U.S. National Science Foundation CAREER Award, the 2011 Northrop Grumman Best Teaching award at Viterbi School of Engineering, the DuPont Young Professor Award, Halliburton/Brown & Root Young Faculty Excellence Award, NSF-China Outstanding Young Investigator Award, and recipient of the IFAC Best Paper Prize for a model predictive control paper published in Control Engineering Practice. He has served as Senior Editor of Journal of Process Control, Editor of Control Engineering Practice, Member of the Editorial Board for Journal of Chemometrics, and Associate Editor for several journals. He has published over 400 international journal papers, book chapters conference papers and presentations. His h-indices for Web of Science, SCOPUS, and Google Scholar are 63, 70, and 81, respectively. He received over 35,000 Google Scholar citations. Dr. Qin's research interests include data science and analytics, machine learning, process monitoring, model predictive control, system identification, smart manufacturing, smart energy systems, and predictive maintenance.

Introduction to Process Data Analytics and Statistical Feature Extractions

Biao Huang

University of Albert, Canada

Abstract:

Modern industries are awash with a large amount of data. Extraction of information and knowledge discovery from data for process design, control and optimization, from day by day routine process operating data, is especially interesting but also challenging. Process data analytics is an emerging area of great interest among both data scientist and practicing engineers to extract meaningful features that are representatives of data and their underlying processes. Unlike neural networks learning based approaches that typically extract features without clear physical meanings, most statistical feature extractors have physical interpretations. This presentation will give a historical overview of process data analytics along with illustrative examples related to some popular statistical feature extraction methods.

Short Biography:

Biao Huang received his Ph.D. degree in Process Control from the University of Alberta, Canada, in 1997. He held MSc degree (1986) and BSc degree (1983) in Automatic Control from the Beijing University of Aeronautics and Astronautics. He joined the University of Alberta in 1997 as an Assistant Professor in the Department of Chemical and Materials Engineering and is currently a Full Professor. He is an IEEE Fellow, Fellow of the Canadian Academy of Engineering, and Fellow of the Chemical Institute of Canada. He is currently the Editor-in-Chief for IFAC Journal Control Engineering Practice, Subject Editor for Journal of the Franklin Institute, and Associate Editor for Journal of Process Control.

Nonlinear Robust Tracking Control: A Multi-Objective Complementary Approach

Xiang Chen

University of Windsor, Canada

Abstract:

In this talk, a nonlinear multi-objective complementary control (MOCC) design is presented. In particular, an MOCC for linear systems is first introduced and then is extended for nonlinear systems subject to disturbances with an extra gain factor added to Youla-type parameter Q. A robust tracking control for the nonlinear system is presented as a design example to show how the nonlinear MOCC is conducted. In this tracking control case, the added parameter is tuned to optimize a cost function through off-line extremum seeking algorithm with data generated from simulation on the nonlinear model of the system. The proposed method is validated with experiment placed on an inverted pendulum. The results show that the MOCC designed on linearized model of the nonlinear system can be further enhanced with the extra gain factor, hence, pointing to a meaningful approach for tracking control of nonlinear systems.

Short Biography:

Xiang Chen received his Ph. D. and M. Sc. degrees from Louisiana State University in 1998 and 1996, respectively, and B. Eng. degree from Huazhong University of Science and Technology in 1985. Since 2000, he has held cross-appointed faculty position with Department of Electrical and Computer Engineering and Department of Mechanical, Automotive and Materials Engineering at the University of Windsor, Canada, and is currently a Professor in the Department of Electrical and Computer Engineering. He has made fundamental contribution to the theory of Gaussian filtering and control, control of nonlinear systems with bifurcation, optimization of field sensing networks, and multi-objective complementary control theory and applications. He has also made significant contributions to the industrial applications of control and optimization to automotive systems, robotic and machine visions in manufacturing systems, through profound and extensive collaboration with automotive, manufacturing, and robotics industries in both Canada and USA. He is the major developer of several patented technologies delivered to relevant companies' product lines or applied in practical operations. He is currently a Senior Editor for the IEEE/ASME Transactions on Mechatronics, an Associate Editor for SIAM Journal on Control and Optimization, International Journal of Intelligent Robotics and Applications, Control Theory and Technology (English Version), and Unman Systems. He received the Award of Best Paper Finalist from 2017 IEEE/ASME International Conference on Advanced Intelligent Mechatronics, the Award of Best Student Paper Finalist (as supervisor author) from 2015 ASME DSCC, the New Opportunity Awards from the Canadian Foundation of Innovation and from the Ontario Centre of Excellence-- Materials and Manufacturing Ontario, as well as 4 times Research Awards from the University of Windsor. He is the Principal Investigator or Co-Principal Investigator of multi-million dollars research projects funded by Canadian Government Agencies and Industries in Canada and USA. He has published over 140 papers in high quality journals and conferences. His current research interests include multi-objective complementary control, field sensing networks for autonomous systems, modelguided data-driven control and optimization, and control of networked autonomous vehicular systems. He is a registered Professional Engineer in Ontario, Canada.

Guiding the AI Models to Better Explain Themselves

Liang Zhao

Emory University, US

Abstract:

Explainable Artificial Intelligence focuses on "opening the box" of blackbox deep neural networks. It is becoming more and more important in explaining the predictions in critical domains such as cancer diagnosis in medical imaging and showed promise in other areas such as fault detection in industrial processes. Despite the fast development of explanation techniques where the main focus is handling "how to generate the explanations", research questions like "whether the explanations are accurate", "what if the explanations are inaccurate", and "how to adjust the model to generate more accurate explanations" are still relatively under-explored by the research body. To guide the model toward better explanations, explanation supervision techniques which add supervision signals to the model explanation have started to show promising effects on improving both the generalizability as well as intrinsic interpretability of Deep Neural Networks (DNNs), especially on the text and attributed data where the human annotation labels can be assigned accurately on each feature of the data. However, the research on supervising visual explanations (e.g., explanation represented by saliency maps) is still under-explored and in its nascent stage, due to many challenges such as "inaccuracy of the human explanation annotation boundary", "incompleteness of the human explanation annotation region", "inconsistency of the data distribution between human annotation and model explanation maps", and "geometric properties of various data types such as image and network data". This talk will cover our recent progress in addressing these challenges and other preliminary results on promising and critical applications in the areas such as medical imaging.

Short Biography:

Dr. Liang Zhao is an assistant professor at the Department of Compute Science at Emory University. Before that, he was an assistant professor in the Department of Information Science and Technology and the Department of Computer Science at George Mason University. He obtained his Ph.D. degree as Outstanding PhD student in 2016 from Computer Science Department at Virginia Tech in the United States. His research interests include data mining and machine learning, with special interests in spatiotemporal and network data mining, deep learning on graphs, nonconvex optimization, and interpretable machine learning. He has published over a hundred papers in top-tier conferences and journals such as KDD, TKDE, ICDM, ICLR, NeurIPS, Proceedings of the IEEE, TKDD, CSUR, IJCAI, AAAI, and WWW. He won NSF Career Award in 2020 and Jeffress Trust Award in 2019. He also won Amazon Research Award in 2020 and CIFellow Mentor in 2021. He was ranked as "Top 20 Rising Star in Data Mining" by Microsoft Search in 2016. He won several the Best Paper Award and Candidates such as Best Paper Award in ICDM 2019, Best Paper Candidate in ICDM 2021, and Best Paper Award Shortlist in WWW 2021. He is an IEEE senior member.

Graph Signal Processing Approach to QSAR/QSPR Model Learning of Compounds

Jingxin Zhang

Swinburne University of Technology, Australia

Abstract:

Quantitative relationship between the activity/property and the structure of compound is critical in chemical applications. To learn this quantitative relationship, hundreds of molecular descriptors have been designed to describe the structure, mainly based on the properties of vertices and edges of molecular graph. However, many descriptors degenerate to the same values for different compounds with the same molecular graph, resulting in model failure. To overcome this difficulty, we design a multidimensional signal for each vertex of the molecular graph to derive new descriptors with higher discriminability. We treat the new and traditional descriptors as the signals on the descriptor graph learned from the descriptor data and enhance descriptor dissimilarity using the Laplacian filter derived from the descriptor graph. Combining these with model learning techniques, we propose a graph signal processing based approach to obtain reliable new models for learning the quantitative relationship and predicting the properties of compounds. We also provide insights from chemistry for the boiling point model. Several experiments are presented to demonstrate the validity, effectiveness and advantages of the proposed approach.

Short Biography:

Jingxin Zhang received the M.E. (1983) and Ph.D. (1988) degrees in electrical engineering from Northeastern University, Shenyang, China. Since 1989, he has held research and academic positions in Northeastern University, China, the University of Florence, Italy, the University of Melbourne, the University of South Australia, and Monash University, Australia. He is currently associate professor of electrical engineering, Swinburne University of Technology, and adjunct associate professor of electrical and computer systems engineering, Monash University, Melbourne, Australia. His research interests include signals and systems and their applications to biomedical and industrial systems. He was the recipient of the Fok Ying Tong Educational Foundation for the Outstanding Young Faculty Members in China, and China National Education Committee Award for the Advancement of Science and Technology.

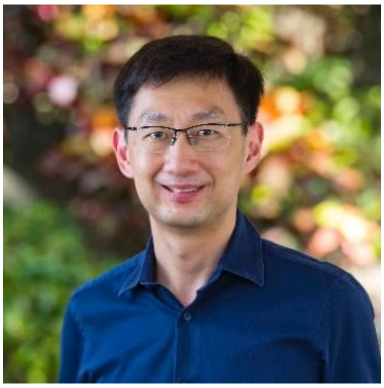
Does Optimization Experience Always Help? An Empirical Study on Evolutionary Sequential Transfer Optimization

Tan Kay Chen
Hong Kong Polytechnic University, China

Abstract:

In recent years, evolutionary transfer optimization (ETO), which aims to improve the performance of evolutionary search via knowledge transfer across tasks, has been receiving increasing research attention. Evolutionary multitasking, evolutionary sequential transfer optimization, and evolutionary multiform optimization are a few representative conceptual realizations of ETO. Despite the technical differences, these conceptual realizations face the same three central issues of knowledge transfer: what to transfer, when to transfer, and how to transfer. Advances made in any of these issues are expected to benefit a wide range of ETO paradigms. Taking this clue, we attempt to address the issues in the context of solution-based evolutionary sequential transfer optimization. This talk will analyze relationships among the three issues and conduct an empirical study to evaluate various knowledge transfer methods under the topic of when and how to transfer. The results will show that the performance of many existing algorithms is highly problem-dependent and suggest the necessity of designing more effective ETO algorithms. Lastly, a few promising future research directions will be presented to stimulate the development of ETO.

Short Biography:



Kay Chen Tan is currently a Chair Professor (Computational Intelligence) of the Department of Computing, The Hong Kong Polytechnic University. He has co-authored 7 books and published over 200 peer-reviewed journal articles.

Prof. Tan is currently the Vice-President (Publications) of IEEE Computational Intelligence Society, USA. He was the Editor-in-Chief of IEEE Transactions on Evolutionary Computation from 2015-2020 (IF: 11.169) and IEEE Computational Intelligence Magazine from 2010-2013 (IF: 9.083). Prof. Tan currently serves as an Associate Editor of various international journals, such as IEEE Transactions on Artificial Intelligence, IEEE Transactions on Cybernetics, and IEEE Transactions on Games.

Prof. Tan has been invited as a Plenary/Keynote speaker for many international conferences, including the 2020 IEEE World Congress on Computational Intelligence, the 2016 IEEE Symposium Series on Computational Intelligence, etc. He has served as an organizing committee Chair/Co-Chair for many international conferences, including the General Co-Chair of 2019 IEEE Congress on Evolutionary Computation, and the General Co-Chair of 2016 IEEE World Congress on Computational Intelligence, etc.

Prof. Tan has received a number of research awards, such as the 2020 IEEE Transactions on Cybernetics Outstanding Paper Awards, the 2019 IEEE Computational Intelligence Magazine Outstanding Paper Awards, the 2016 IEEE Transactions on Neural Networks and Learning Systems Outstanding Paper Awards, the 2012 Outstanding Early Career Award presented by the IEEE Computational Intelligence Society.

Prof. Tan is an IEEE Fellow, an IEEE Distinguished Lecturer Program (DLP) speaker since 2012, and an Honorary Professor at University of Nottingham in UK. He is also the Chief Co-Editor of Springer Book Series on Machine Learning: Foundations, Methodologies, and Applications since 2020.

Predictive Modelling for Data-driven Optimization in Manufacturing Complex Injection Moulding Process

Xiang Li

Singapore Institute of Manufacturing Technology, Singapore

Abstract:

Manufacturing shop floor is facing the challenges on process optimization to minimise product scrap rate. The traditional practice of process parameter tuning is based on "try-and-error" and heavily depends on engineers' knowledge. It is time consuming and high cost for man power, materials and machine time. Manufacturing complex process is lack of intelligent learning capability for identifying major factors and quality predictive models for in-situ process parameter tuning and process optimization. Machine learning and AI techniques provide solutions to identify key process parameters, prediction modelling and be capable of product quality control through in-situ process optimization. This talk aims to introduce SIMTech research works on feature selection and predictive modelling for product anomaly pattern discovery and process optimization in injection moulding. A case study will be illustrated to show how AI to solve real industrial problems in process optimization.

Short Biography:

Dr Xiang Li received her B. Eng. and M. Eng. from the Northeastern University, Shenyang, China, and PhD from Nanyang Technological University, Singapore. She taught at the Northeastern University in 1982-87. In 1987-1989, she did research work at Tohoku University, Japan. She joined Singapore Institute of Manufacturing Technology (SIMTech), Agency for Science, Technology and Research (A*STAR) in 1992 and currently she is Senior Scientist and Senior Technical Lead in SIMTech.

Dr Li has more than 20 years of experience in research on machine learning, data mining and artificial intelligence. She has led many research projects as PI with local and overseas universities such as Nanyang Technological University (NTU), National University of Singapore (NUS), Carnegie Mellon University(CMU), etc and supervised many PhD and Master Students. She has been awarded A*Star research grants as PI and Co-PI since 2004. She has led the team in the research areas of process monitoring and quality control in manufacturing shopfloor. Dr Li has also led many industrial projects by using data mining and machine learning algorithms such as multivariate anomaly detection in semiconductor testing process , tool degradation detection in milling machining process, smart recipe tuning in coating process, handling imbalanced and unlabelled data for classification for Aerospace MRO, major factor identification and root cause analysis in OLED processes, Semiconductor production data warehousing, etc. She has trained more than 500 Singapore industrial directors, managers and engineers in the areas of data mining and data analytics since 2016. She is an IEEE and IE member.

Data-Driven State Estimation of Li-Ion Batteries Assisted with Machine Learning and Fbg Sensors

Kang Li
University of Leeds, UK

Abstract:

The global economy will be greatly shaped by the transformed energy landscapes. Battery storage systems play an important role in decarbonizing the whole energy chain from accepting renewable generations to electrification of transport and other sectors. The talk presents some recent studies in the data-driven state estimation of Li-ion battery systems assisted with machine learning and novel fobre optial sesnors.

Short Biography:

Kang Li: Prof Kang Li holds the Chair of Smart Energy Systems at University of Leeds. His primary research interest lies on the development of advanced modelling, control and optimization technologies and machine learning methods with substantial applications in the areas of energy and power systems, transport decarbonization, and energy management in energy intensive manufacturing processes. His work on the development of minimal-invasive cloud-based energy and condition monitoring platform (Point Energy Technology) to support digitalization of SMEs in their transition to industry 4.0 has been successfully trialled in food processing and polymer processing industries, winning InstMC ICI prize 2015 and Northern Ireland INVENT 2016 award and was included in the finalist of the Sustainable Energy Awards 2016 from Sustainable Energy Authority of Ireland. He has been a strong advocator of transport decarbonization and societal transition to low carbon economy for a number of years within the international research community, leading large scale international research collaboration forums and consortiums on energy, winning Springer Nature "China New Development Award" in 2019 in recognition of the "exceptional contributions to the delivery of the UN Sustainable Development Goals". He has worked closely with industries in energy and power, and manufacturing, and with key stakeholders in railway and road systems and with local communities in developing microgrids. He is strongly advocating the synergies of different sectors to achieve overall system flexibility for net zero. Prof Li has published over 200 international journal papers and edited 19 international conference proceedings in his area, winning over 20 prizes and awards.

Meta-Learning for Robot Control via Bilevel Optimization

Lin Zhao

National University of Singapore, Singapore

Abstract:

Robot estimation, planning, and control are often solved via optimization problems. Their solutions depend on various hyperparameters including weighting matrices, reference waypoints, horizon lengths, etc. Real-time adaptation of these hyperparameters is crucial for autonomous operations in complex and dynamic environments. We develop efficient algorithms for meta-learning these hyperparameters modeled by deep neural networks (DNNs), achieving fast online adaptation in challenging robot control tasks. They are essentially solving a bilevel optimization problem, with the inner optimization problem subject to dynamic constraints. We present two interesting quadrotor control tasks solved in this way. One is robust flight control, where we developed a neural moving horizon estimator for accurate disturbance/model uncertainties estimation. The other is SE(3) path planning, where DNNs are trained to generate a reference waypoint to facilitate agile maneuvers. Both tasks demonstrate effective online adaptation and superior control performance.

Short Biography:

Lin Zhao is currently an Assistant Professor with the Department of Electrical and Computer Engineering, National University of Singapore. He received the B.S. and M.S. degrees in automatic control from the Harbin Institute of Technology, Harbin, China, in 2010 and 2012, respectively, and the M.S. degree in mathematics and the Ph.D. degree in electrical and computer engineering from The Ohio State University, Columbus, OH, USA, in 2017. From 2018 to early 2020, he was a Research Scientist with the Aptiv Pittsburgh Technology Center (now Motional), Pittsburgh, PA, USA. His current research focuses on control and reinforcement learning with applications in robotics.

Surrogate-Based Distributed Optimization for Energy and Power Systems

Zhengtao Ding
University of Manchester, UK

Abstract:

There are huge challenges in reducing CO2 emission while maintaining energy supply. Renewable energy resources play an ever increasingly important role in power systems. Different from coal fired power plants, renewable energy resources are more distributed geographically. New power management and control methods are needed. In the meantime, there are significant developments in internet of things, big data, machine learning etc. in the area of network-connected systems and control applications, in particular, in the areas relating to distributed optimization and decision making from various data. Surrogate-based optimization provides a systemic way to achieve optimality directly from data collected, and the development of distributed algorithms of this data-driven optimization method is important for energy and power systems. This talk will cover some recent activities in relation to the development of distributed algorithms for Surrogate-based optimization and their applications to renewable energy systems carried out in the speaker's group. It also covers some recent advances in optimization of electrical power systems relating to data driven mechanisms with the effort to integrate optimization and control for power systems.

Short Biography:

Zhengtao Ding received B.Eng. degree from Tsinghua University, Beijing, China, and M.Sc. degree in systems and control, and the Ph.D. degree in control systems from the University of Manchester Institute of Science and Technology, Manchester, U.K. After working in Singapore for ten years, he joined the University of Manchester in 2003, where he is currently Professor of Control Systems and the Head of Control, Robotics and Communication Division.
He is the author of the book: Nonlinear and Adaptive Control Systems (IET, 2013) and has published over 300 research articles. His research interests include nonlinear and adaptive control theory and their applications, more recently network-based control, distributed optimization and distributed learning, with applications to power systems and robotics. Prof. Ding has served as the Subject Chef Editor of Nonlinear Control for Frontiers, and Associate Editor for Scientific Reports, IEEE Transactions on Automatic Control, IEEE Transactions on Circuit and Systems II, IEEE Control Systems Letters, Transactions of the Institute of Measurement and Control, Control Theory and Technology, Unmanned Systems and several other journals. He is a member of IEEE Technical Committee on Nonlinear Systems and Control, IEEE Technical Committee on Intelligent Control, and IFAC Technical Committee on Adaptive and Learning Systems.

Adaptive Control and String Stability for a Class of Autonomous Vehicle Platoons

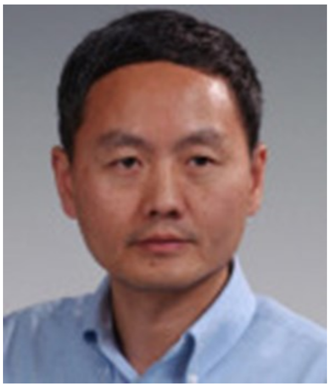
Guoxiang Gu

Louisiana State University, US

Abstract:

We study platoon control for a class of autonomous vehicles. Different from the majority of the existing work, two adaptive control laws are proposed to tackle the feedback stability of the nonlinear vehicle dynamics under both position and velocity controls, and to achieve the string stability of the vehicle platoon for the linearized vehicle models. The results show that the proposed adaptive control laws are capable of dealing with the nonlinear dynamics in the presence of unknown vehicle parameters in achieving the speed consensus for multiple autonomous vehicles in platoons and the required safety spacing between each neighboring vehicle pair asymptotically. In combination with the classic proportional and derivative control, the proposed adaptive control method mitigates parameter uncertainties and model nonlinearities. The control performance of the vehicle platoon can be further improved if the operating equilibrium points of all the vehicles are known, leading to linear time-invariant control laws for individual vehicles under both position and velocity controls and for the vehicle platoon under control. Simulation studies illustrate the effectiveness of the proposed control method, validating the results obtained for the class of vehicle platoons.

Short Biography:



Guoxiang Gu received the Ph.D. degree in Electrical Engineering from University of Minnesota, Minneapolis, MN, USA, in 1988. From 1988 to 1990, he was with the Department of Electrical Engineering, Wright State University, Dayton, OH, USA, as a Visiting Assistant Professor. Since 1990, he joined Louisiana State University, Baton Rouge, LA, USA, where he is currently a Professor of Electrical and Computer Engineering. He has authored two books, over 80 archive journal papers, and numerous book chapters and conference papers. His research interests include networked feedback control, system identification, and statistical signal processing. Dr. Gu served as an Associate Editor for IEEE Transactions on Automatic Control from January 1998 to December 2001 and from January 2018 to December 2022, SIAM Journal on Control and Optimization from 2006 to 2009, and Automatica from 2006 to 2012. He is currently the F. Hugh Coughlin/CLECO Distinguished Professor of Electrical Engineering at LSU, and Fellow of IEEE.

Data Driven Approaches in Process Analytics and Health Monitoring: New Development and Challenges

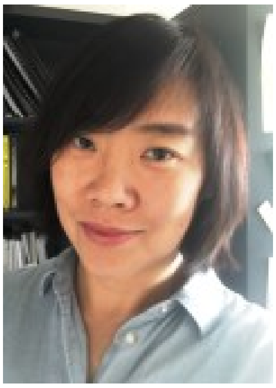
Qing Zhao

University of Alberta, Canada

Abstract:

In manufacturing and process industries, applications of distributed control systems (DCS) and supervised control and data acquisition (SCADA) systems have created a data-rich environment. How to learn from multiple sources of data has attracted great attention from industries and research communities. Recent development will be reported on data driven methods for system health monitoring, anomaly detection and fault root cause diagnosis. Furthermore, recognizing that there are still several challenges in the data-driven paradigm, the following research topics will be discussed 1) uncertainty and robustness issues in datacentric modeling; and 2) Intelligent fault detection and diagnostics via learning from both knowledge and data.

Short Biography:



Qing Zhao received her BSc degree in control engineering from Northeastern University, P. R. China, attended the graduate program of Department of Mathematics, Shandong University, and received the PhD degree in Electrical and Computer Engineering from the University of Western Ontario, Canada, respectively. Since September 2000, she has been with the Dept. of Electrical & Computer Engineering, Univ. of Alberta, Canada, where she is currently a professor and the Electrical Engineering program director. During her sabbatical leave from Aug. 2008 to Sept. 2009, Dr. Zhao has visited 2 institutes in Europe. From Aug. 2008 to Dec. 2008, she was a visiting professor of the Control Engineering Department at Université Libre de Bruxelles, Brussels, Belgium. From Jan. 2009 to July 2009, she held the Alexander von Humboldt Fellowship for Experienced Researchers and was a visiting professor at Univ. of Duisburg-Essen, Duisburg, Germany. During her sabbatical leave from 2019 to 2020, she visited the Key Laboratory of Synthetical Automation for Process Industries (SAPI), Northeastern University, China. She has been a member of IEEE, AIAA, ISA and she is a registered professional engineer in Canada. She also serves several technical and professional boards/committees. She is currently a Member-at-Large of the Canadian Engineering Qualification Board (CEQB) serving the Syllabus Committee and the Admission Committee; a member of the Board of Examiner for Association of Professional Engineers and Geoscientists of Alberta (APEGA), Canada; an international committee member of China Automation Association (CAA) Technical Committee on Fault Diagnosis and Safety of Technical Processes. She is currently a panel member of Grant Selection Panel of the Natural Sciences and Engineering Research Council (NSERC) of Canada. Her current research interests are fault diagnosis, fault tolerant control, machine condition monitoring and industrial data analytics.

Inherent Privacy for Distributed Optimization and Learning

Yongqiang Wang
Clemson University, US

Abstract:

Distributed (stochastic) optimization is the basic building block of modern collaborative machine learning, distributed estimation and control, and large-scale sensing. Since involved data usually contain sensitive information like users' locations, healthcare records, or financial transactions, privacy protection has become an increasingly pressing need in the implementation of distributed optimization and learning algorithms. However, existing privacy solutions usually incur heavy communication/computation overhead or sacrifice optimization/learning accuracy. We propose to judiciously embed stochasticity on the algorithmic level to enable privacy without incurring heavy communication/computation overhead or accuracy loss. Besides rigorous theoretical analysis, simulation results as well as numerical experiments on a benchmark machine learning dataset confirm the effectiveness of the proposed approach.

Short Biography:

Yongqiang Wang received the dual B.S. degrees in electrical engineering & automation and computer science & technology from Xi'an Jiaotong University, Xi'an, Shaanxi, China, in 2004, and the Ph.D. degree in control science and engineering from Tsinghua University, Beijing, China, in 2009. From 2007-2008, he was with the University of Duisburg-Essen, Germany, as a visiting student. He was a project scientist at the University of California, Santa Barbara before joining Clemson University, SC, USA, where he is currently an Associate Professor. His current research interests include distributed control, optimization, and learning, with an emphasis on privacy protection. He currently serves as an associate editor for IEEE Transactions on Automatic Control, IEEE Transactions on Control of Network Systems, and IEEE Transactions on Signal and Information Processing over Networks.

AI-enabled Micro Motion Sensors for Revealing the Random Daily Activities of Caged Mice

Wen Jung Li

City University of Hong Kong, China

Abstract:

More than 120 million mice and rats are used yearly for scientific research purposes. While tracking their motion behaviors has been an essential research issue for the past decade, present techniques, such as video-tracking and IMU-tracking have considerable problems, including requiring a complex setup for video-tracking devices or relatively large IMU modules that cause stress to the animals. Here, we present our development of an AI-enabled and lightweight (i.e., weighs ~6% of typical laboratory mice) wireless μIMU sensing device to collect their motion data over several days continuously. To overcome the shortcomings of using fixed time-windows for data analysis, a new combined segmentation method is introduced, consisting of fixed-window segmentation, adaptive-window segmentation, and a preliminary status classifier for mouse behavior recognition. By applying this new method to generate segmented slices of eight caged mice random behaviors (i.e., resting, walking, rearing, digging, eating, grooming, drinking water, and scratching), the classification accuracy is significant improved from the traditional fix-window segmentation method. Thus, by applying machine learning algorithms to process the motion data collected by these new class of micro “Internet of Things” (IoT) sensors, we envision a new paradigm shift for tracking and recognizing small animal motions, i.e., the AI-enabled micro motion sensors could supplement or replace vision-based tracking in the near future due to their small size, light weight, low-cost, and increased functionality in providing real-time motion recognition results for multiple animals simultaneously without considering ambient lighting conditions.

Short Biography:

Wen Jung LI (BS/MS Aerospace Eng., Univ. of Southern California; PhD Aerospace Eng., UCLA) is currently a Chair Professor and concurrently serving as Associate Provost (Resources Planning) of the City University of Hong Kong (CityU). He was with the Dept. of Mechanical and Automation Engineering of The Chinese University of Hong Kong (CUHK) from 1997 to 2011. Before joining CUHK, he held R&D positions at the NASA/Caltech Jet Propulsion Laboratory (Pasadena, USA), The Aerospace Corporation (El Segundo, USA), and at Silicon Microstructures Inc. (Fremont, USA). His academic honors include IEEE Fellow, ASME Fellow, AIAA (Asia-Pacific Artificial Intelligence Association) Fellow, and 100 Talents of the Chinese Academy of Sciences. He served as the President of the IEEE Nanotechnology Council (2016 and 2017) and as the Founding Editor-in-Chief of the IEEE Open Journal on Nanotechnology (2019-present) and IEEE Nanotechnology Magazine (2007-2013). His research areas are tied by diverse engineering disciplines including electrical engineering, mechanical engineering, biomedical engineering, and artificial intelligence. He has published more than 400 technical papers related to MEMS, Nano-sensors, and Robotics; some of his research results are published in prestigious journals such as Nature Communications, Science Advances, Nature Methods, Advanced Functional Materials, Advanced Energy Materials, Advanced Science, IEEE Internet of Things J., etc. He has also held adjunct/guest professorships at the University of Toronto, Peking University, Huazhong University of Science and Technology, Beijing Institute of Technology, Hong Kong Polytechnic University, Xiamen University, Changchun University of Science and Technology, Northeastern University, and the Shenyang Institute of Automation, Chinese Academy of Sciences.

Accuracy Improvement of Industrial Robot Using Adaptive Neuro-PID Controller

Wenfang Xie
Concordia University, Canada

Abstract:

Nowadays, industrial robots are widely used in many fields. With the wide range of applications, the accuracy of robots has become an issue of concern. In some path following tasks, the accuracy of existing robots does not yet meet the industry standard. The purpose of this research is to propose a novel dynamic path tracking (DPT) method to solve the aforementioned accuracy problem. This method uses the C-Track from Creaform to measure the real-time pose information of the end-effector of the robot Fanuc M-20iA. To remove the noise transmitted from the camera, a robust Kalman filter (RKF) is proposed to improve the performance of the standard Kalman filter under disturbance by correcting the state variable error covariance (P). Then, a position-based visual servoing (PBVS) strategy is proposed to correct the position and orientation of the end-effector, which is implemented through dynamic path modification (DPM) function, in conjunction with real-time data acquired by C-Track. Next, adaptive neuro-PID (ANPID) controller is developed as the PBVS scheme for DPM correction. Such control strategy has a strong adaptive and self-learning capability, which enables online tuning of the PID controller parameters, resulting in better performance in robot control. Finally, extensive experiment tests have been carried out and the results show that the accuracy of path following reaches ±0.08mm, compared with the accuracy ±0.2mm achieved by conventional PID controller.

The effect of supplementing the baseline PID controller with the proposed RL-based controller is assessed. Qualitatively, transient performance is improved in overshoot attenuation, but steady-state performance is not affected. For the line following (position) experiment in the transient phase, the RLbased controller reduces MAE and maximum errors by 10.5% and 20.1%, respectively. The resulting position path accuracy is 0.1026 mm. In contrast, the MAE is not significantly affected for the (full pose) experiment, while the maximum errors deteriorate by 4.2% in position but improve by 9.2% in orientation. The resulting path accuracy is 0.2982 mm / 0.0682 .

Short Biography:

Dr. Wen-Fang Xie is a full Professor with the Department of Mechanical, Industrial & Aerospace Engineering at Concordia University, Montreal, Canada. She was an Industrial Research Fellowship holder from Natural Sciences and Engineering Research Council of Canada (NSERC) before she joined Concordia University as an assistant professor in 2003. She was promoted to Associate Professor in 2008 and full professor in 2014. She received her Ph.D from the Hong Kong Polytechnic University in 1999. Her research interests include identification and control in mechatronics, artificial intelligent control, advanced process control and robotic visual servoing. She has published over 200 journal and conference papers and has graduated over 14 Ph.D and 28 M.A.Sc students. She has received various grants including NSERC Discovery grant (since 2003), Discovery Accelerator Supplements (Discovery Grants) in 2020, FQRNT (principal investigator), MDEIE International Research and Innovation Initiatives, NSERC CRD grant (twice), CFI leading edge. She has been an active member of many IEEE conference organizing committees. She is a CSME fellow and IEEE senior member. She is an Editorial Board member of Journal of Mechatronics and International Journal of Advanced Robotic Systems.

Temporal Community Mining, Computation and its Applications

Jianxin Li

Deakin University, Australia

Abstract:

Searching for local and global communities is an important research problem that supports advanced data analysis in various complex networks, such as social networks, collaboration networks, cellular networks, etc. The evolution of such networks over time has motivated several recent studies to identify temporal communities in dynamic networks. At this tutorial, A/Prof Jianxin Li will first provide a big picture to overview the diversified types of communities investigated in recent years. After that, he will introduce a set of representative works focusing on temporal community mining, efficient computational algorithms, and the emerging applications to be supported. Furthermore, he will share his team's recent paper accepted by PVLDB 2022 – "reliable community search in dynamic networks". In this work, the authors proposed a novel (σ, k)-core reliable community (CRC) model in the weighted dynamic networks, and defined the problem of most reliable community search that couples the desirable properties of connection strength, cohesive structure continuity, and the maximal member engagement. By taking this as an example, A/Prof Jianxin Li will discuss some new types of temporal communities that should pay more attention in the near future. The main goal of this tutorial is to help audiences to know and understand the different applications of community discovery in need, how the community models are devised, the existing research challenges and the state-of-the-arts in this topic. This tutorial is suitable to broad audiences who have interest in database, social data analytics, data mining and AI-driven decision making.

Short Biography:

Dr Jianxin Li is an A/Professor of Data Science in the School of IT, Deakin University. His research interests include social computing, query processing and optimization, and big data analytics. He has published 130 high quality research papers in top international conferences and journals, including SIGMOD, PVLDB, ICDE, ACM WWW, SIGKDD, ACM CIKM, IEEE TKDE, TII, IS, etc. His professional service can be identified by different roles in academic committees, e.g., Editor-in-Chief in Array Journal, Associate Editors in Knowledge-based Systems, World Wide Web Journal, IEEE Signal Processing Letters, Information Systems; the PC co-chairs in DASFAA 2023, WISA 2022, BESC 2022, ADMA 2019; the General co-chairs in IEEE ISPA-2020, CIT-2021; guest editors and invited reviewers in many top international journals and technical program committee members in most world leading database and data mining international conferences like PVLDB, ICDE, WSDM, ICDM, AAAI, IJCAI.

Sequential Adaptive Switching Time Optimization Technique for Optimal Control Problems

Kok Lay Teo

Sunway University, Malaysia

Abstract:

The control parameterization method used together with time-scaling transformation is an effective approach to transform optimal control problems into optimal parameter selection problems. The approximate problems can then be solved by gradient-based optimization methods. However, the conventional time-scaling transformation requires that all the control component functions switch simultaneously, which can be undesirable in practice. In this paper, we introduce a novel technique where the switching times for each of the control component functions can be adaptively selected. To demonstrate the effectiveness and flexibility of the proposed approach, two example problems with control input and terminal state constraints are solved using the method proposed. Numerical results show that the new method achieves much better objective values with some increase in computation time compared to the conventional time-scaling transformation technique.

Short Biography:

Kok Lay Teo (Life Senior Member, IEEE) received the Ph.D. degree in electrical engineering from the University of Ottawa, Canada. He was with the Department of Applied Mathematics, University of New South Wales, Australia; the Department of Industrial and Systems Engineering, National University of Singapore, Singapore; and the Department of Mathematics, The University of Western Australia, Australia. In 1996, he joined the Department of Mathematics and Statistics, Curtin University of Technology, Australia, as a Professor. He then took up the position of the Chair Professor of applied mathematics and the Head of the Department of Applied Mathematics, The Hong Kong Polytechnic University, China, from 1999 to 2004. He returned to Curtin University as a Professor and the Head of the Department of Mathematics and Statistics from 2010 to 2015. He was a John Curtin Distinguished Professor at Curtin University from 2011 until his retirement in November 2019. He is a John Curtin Distinguished Emeritus Professor at Curtin University. Currently, he is a Professor and the Associate Dean (Research and Postgraduate Studies) with the School of Mathematical Science, Sunway University, Malaysia. He is also associated with the Tianjin University of Finance and Economics as the Visiting Distinguished Chair Professor with the Coordinated Innovation Center for Computable Modeling in Management Science.

Receding Horizon Control with Disturbance Preview: Integrated Optimisation and Stability

Wen-Hua Chen

Loughborough University, UK

Abstract:

With ever increasing capability of sensing and data prediction methods, it is possible to have not only past data but also near future data for improving performance. Sensing techniques like cameras and LIDAR can preview environment information to a certain range while, with the advances of data collection and analysis techniques such as disturbance observer techniques, we are able to model so as to predict future disturbance or demand to a certain accuracy. This talk is to explore the potential of these data in the context of optimal control/decision making where on-line optimisation is employed to achieve best possible performance with updated information in a receding horizon fashion. Rather than treating future reference tracking and disturbance rejection separately, we propose an integrated optimisation framework for model predictive control with disturbance preview capability. It is assumed that disturbance information is known within the predicted horizon, but unknown (possible randomly changing within a certain bound) outside the horizon. The optimal control/decision sequence is generated by online recursively solving an integrated optimisation problem with a defined cost function or reward function where future reference and disturbance preview information are incorporated. This approach can not only improve the disturbance rejection capability so achieve a better performance, but also, more importantly, make use unexpected opportunity created by disturbances or environment uncertainty. This reflects a feature of goal-oriented control systems since some disturbance and uncertainty may be good for achieving a specific goal so shall not be rejected. Theoretic study such as stability analysis will be presented. The proposed framework is illustrated by wave energy generation and other examples.

Short Biography:

Dr Wen-Hua Chen holds Professor in Autonomous Vehicles in the Department of Aeronautical and Automotive Engineering at Loughborough University, UK. He received his MSc and PhD in Industrial Automation from Northeastern University, Shenyang, China., in 1989 and 1991 respectively. Prof. Chen has a considerable experience in control, signal processing and artificial intelligence and their applications in aerospace, automotive and agriculture systems. In the last 15 years, he has been working on the development and application of unmanned aircraft system and intelligent vehicle technologies, spanning autopilots, situational awareness, decision making, verification, remote sensing for precision agriculture and environment monitoring. He is a Chartered Engineer, and a Fellow of IEEE, the Institution of Mechanical Engineers and the Institution of Engineering and Technology, UK. Recently Prof Chen was awarded an EPSRC (Engineering and Physical Science Research Council) Established Career Fellowship in developing control theory for next generation of control systems to enable high levels of automation such as robotics and autonomous systems.

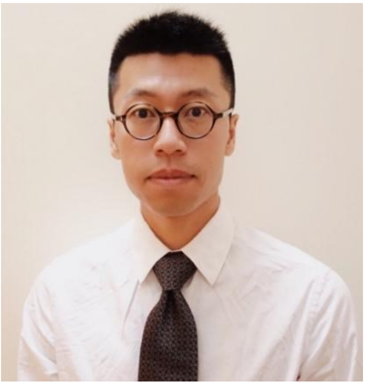
Data-driven Control Design for Non-Gaussian Stochastic Systems via Moment-generating Functions

Qichun Zhang
University of Bradford, UK

Abstract:

As an important branch of stochastic systems research, non-Gaussian stochastic systems have been widely investigated in terms of the randomness properties and dynamics. Based on the recent advances, this presentation shares the recent results regarding to data-driven stochastic control systems using kernel estimation and moment-generating functions. Based on the theorical analysis of the proposed framework, an energy system example will be adopted to validate the performance of the presented method. As the last part, the future perspectives and potential studies will be discussed to enrich the visibility and the understanding of this research topic.

Short Biography:



Qichun 'Kit' Zhang is Assistant Professor in Computer Science at University of Bradford, UK. He received PhD degree in Electrical and Electronic Engineering from University of Manchester, UK, in 2016. He also received MSc in Control Theory and Control Engineering in 2010 and BEng in Automation in 2008, both from Northeastern University, China. Before joining Bradford, he was a Senior Lecturer in Dynamics and Control at De Montfort University, a Senior Research Officer in Neural Engineering at University of Essex, and an Academic Visitor at Control Systems Centre, University of Manchester. He serves over 20 international journals as an active reviewer and currently he is Associate Editor of IEEE Access, Journal of Intelligent Manufacturing, Cluster Computing, and others. He is Academic Editor for PLoS ONE and PeerJ Computer Science. He is Topic Editor for Electronics and Entropy at MDPI while he is editorial board member for other 10 journals. He is a Chartered Engineer UK, Member of EPSRC Peer Review College, Senior Member IEEE. His research interests include stochastic dynamic systems, non-linear control, probabilistic coupling analysis, adaptive decoupling control, performance optimisation and human-computer interaction.

Some Advances on Long-tailed Data Classification

Yiuming Cheung
Hong Kong Baptist University, China

Abstract:

Although deep learning has made great progress, a good model often requires a large amount of artificially balanced and annotated data. Unfortunately, real-world data are often unbalanced, typically exhibiting a long-tailed distribution, which refers to a small number of classes with abundant training samples but the remaining large number of classes only with very few training instances. Under the circumstances, the performance of deep learning models trained on long-tailed data declines sharply in the tail classes. However, tail classes cannot be ignored in various situations such as rare disease diagnosis, and anomaly detection. Subsequently, long-tailed data is still very challenging to deep learning. In this talk, the impact of long-tailed data on deep learning models will be first analyzed. Then, the research progress in this area will be reviewed, including some representative methods in the literature. Furthermore, some of our recent work for long-tail learning will be introduced. Lastly, the critical challenges and potential research directions in this field will be discussed.

Short Biography:

张晓明(CHEUNG, Yiu-ming)为香港浸会大学（浸大）人工智能讲席教授、浸大研究院副院长、深圳研究院院长以及计算和理论科学研究所副所长，是 IEEE Fellow、AAAS Fellow、IET Fellow、英国计算机学会 Fellow，以及教育部长江学者(讲座教授)，列入 2020 及 2021 年史丹福大学所发表的人工智能与图像处理专业领域世界顶尖科学家排名前 1%。张教授是 IEEE 计算智能学会香港分会始创者及前任主席、IEEE 计算机学会智能信息学委员会（TCII）现任主席以及 IEEE Transactions on Emerging Topics in Computational Intelligence 候任主编。张晓明教授长期从事机器学习与视觉计算以及其在数据科学、模式识别、多目标优化及信息安全等应用领域的研究，在相关国际著名期刊及学术会议上，如 IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Information Forensics and Security, IEEE Transactions on Image Processing, IEEE Transactions on Knowledge and Data Engineering, IEEE Transactions on Neural Networks、IEEE Transactions on Circuits and Systems for Video Technology、CVPR、IJCAI、AAAI、MM 等已发表论文逾 250 篇，其中三篇合著论文被选为《 ESI 高被引论文》（即在相应学科中全球排名前 1%）。张教授曾多次获国际会议最佳论文奖，以及 WI-IAT2020 最佳理论论文奖。此外，张教授分别于 2011 及 2021 年二度获得香港浸会大学计算机科学系最佳研究奖，于 2020 年获选为 IEEE 计算智能学会杰出讲师。他已负责主持及承担包括香港研究资助局(RGC)、国家自然科学基金(NSFC)以及 NSFC-RGC 联合基金等科研项目三十余项。张教授作为第一发明人现拥有三项发明专利。曾于 2017 年在瑞士日内瓦举行的第 45 届日内瓦国际发明展上（该发明展吸引了超过 700 个来自 40 个国家的参展商，合共展出超过 1000 件创新发明及产品）荣获计算机科学组别优异金奖（即金奖中的最高级别）及瑞士汽车会大奖二项国际大奖，并获 2017 年第七届香港创新科技成就大奖香港创新发明奖金牌。此外，于 2018 年再次荣获第 46 届日内瓦国际发明展评判嘉许特别金奖（即金奖中的最高级别）以及罗马尼亚优异奖。他曾担任包括 IJCAI、ACML、ICIP、ICPR、ICDM 以及 WI 在内的多个国际著名会议的程序委员会主席、组织委员会主席、领域主席等。张教授是 IEEE 智能计算学会 Fellow 委员会评委、香港研究资助局优配研究金工程学科评委，以及国家基金委、深圳科创委项目评审专家。他担任若干国际著名期刊的副主编，如: IEEE Transactions on Neural Networks and Learning Systems （2014-2020） IEEE Transactions on Cybernetics、IEEE Transactions on Emerging Topics in Computational Intelligence、IEEE Transactions on Cognitive and Developmental Systems、Pattern Recognition 以及 Neurocomputing 等。