Washington University in St. Louis

# 8th Midwest Workshop on Control and Game Theory

**April 27-28, 2019**

# Welcome Message from the Workshop Co-Chairs

We are delighted to welcome you all to the 8th Midwest Workshop on Control and Game Theory (MWCGT) at Washington University, St. Louis, Missouri.

We have an exciting and broadly encompassing technical program lined up and would like to thank all the speakers and poster presenters for their contributions. It is our hope that the 17 invited talks and the poster session covering a wide range of research topics in control and systems theory, game theory, mathematics, networks, system science and engineering will stimulate and facilitate a vibrant exchange of ideas between faculty, researchers in industry, as well as postdocs and students.

The success of the workshop could not be possible without the help and support from many people who have worked with us in planning and organizing both the technical program and social activities. In particular, we would like to thank the Organizing Committee (Ali Belabbas, ShiNung Ching, Huazhen Fang), the Advisory Committee (Tamer Basar, Bruno Sinopoli), the Operations & Event Manager (Tammy Haney), and both the NSF and the McKelvey School of Engineering for the financial support.

Finally, we hope that you will enjoy the 8th MWCGT and wish you a pleasant stay in St. Louis!

Jr-Shin Li, Shen Zeng
Workshop Co-Chairs


# Workshop Organizers and Sponsors

**Workshop Co-Chairs**
Jr-Shin Li (Washington University)
Shen Zeng (Washington University)

**Organizing Committee**
ShiNung Ching (Washington University), Program Co-Chair
Shen Zeng (Washington University), Poster Session Chair
Ali Belabbas (University of Illinois at Urbana Champaign), Program Co-Chair
Huazhen Fang (University of Kansas), Publicity Chair

**Advisory Committee**
Bruno Sinopoli (Washington University)
Tamer Basar (University of Illinois at Urbana Champaign)

**Workshop Sponsors**
Financial support through the NSF and the McKelvey School of Engineering is gratefully acknowledged.

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Washington University in St. Louis
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## Scope and History

The 8th Midwest Workshop on Control and Game Theory is part of a series of annual workshops held at Midwestern academic institutions that is aimed at gathering researchers from the Midwest region of the United States working on all aspects of control and game theory.

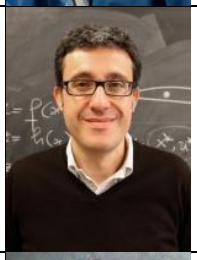
## Previous Workshops

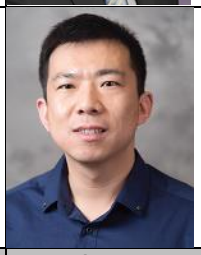
| | | | |
|---|---|---|---|
| 1. | University of Illinois at Urbana-Champaign | April 28 – April 29 | 2012 |
| 2. | University of Notre Dame | April 26 – April 27 | 2013 |
| 3. | Ohio State University | April 26 – April 27 | 2014 |
| 4. | Iowa State University | April 25 – April 26 | 2015 |
| 5. | Purdue University | April 30 – May 1 | 2016 |
| 6. | University of Michigan, Ann Arbor | April 22 – April 23 | 2017 |
| 7. | Michigan State University | April 28 – April 29 | 2018 |

The last workshop was organized by Profs. Vaibhav Srivastava and Xiaobo Tan at Michigan State University.

# Technical Program

## Program: Saturday, April 27th, 2019

| | | |
|---|---|---|
| 8:00am – 9:00am | Breakfast | |
| 8:50am – 9:00am | Opening Remarks | |
| 9:00am – 9:30am |  | **Hassan K. Khalil**<br>Michigan State University<br><br>*High-gain observers as a tool for reducing information requirements in multi-agent control* |
| 9:30am – 10:00am |  | **Andrea Serrani**<br>Ohio State University<br><br>*The disturbance decoupling problem with stability for systems over digraphs: A stratified geometric approach* |
| 10:00am – 10:30am |  | **Wei Lin**<br>Case Western Reserve University<br><br>*$L_gV$ adaptive controllers for non-affine systems with unknown parameters and applications to DC-microgrid with PV and battery* |
| 10:30am-10:45am | Coffee Break | |
| 10:45am – 11:15am |  | **ShiNung Ching**<br>Washington University in St. Louis<br><br>*Functional dynamics in brain networks* |
| 11:15am – 11:45am |  | **Istvan Kiss**<br>Saint Louis University<br><br>*Synchronization engineering: Design of pattern formation with oscillatory chemical reactions using experiment-based phase models* |
| 11:45am – 12:15pm |  | **Indika Rajapakse**<br>University of Michigan<br><br>*Reprogramming on demand* |
| 12:15pm – 1:40pm | Lunch Break | |

| | | |
|---|---|---|
| 1:40pm – 2:10pm |  | **Laurent Lessard**<br>University of Wisconsin–Madison<br><br>*Automating the analysis and design of large-scale optimization algorithms* |
| 2:10pm – 2:40pm |  | **George Yin**<br>Wayne State University<br><br>*Maximum principle for switching diffusions and applications to mean-field controls* |
| 2:40pm – 3:10pm |  | **Mohamed-Ali Belabbas**<br>University of Illinois at Urbana-Champaign<br><br>*Structural Stability of Networked Systems and Graph Theory* |
| 3:10pm – 3:40pm |  | **Shaoshuai Mou**<br>Purdue University<br><br>*Consensus-based distributed computation: Algorithm, scalability & resilience* |
| 3:40pm – 4:30pm | Break | |
| 4:35pm | Group Picture at Brookings Quadrangle | |
| 4:45pm – 5:15pm | Students/Postdocs Poster Lightening Talks | |
| 5:15pm – 7:45pm | Posters: 5:15pm - 6:30pm<br>Bar and Food: 5:30pm – 7:30pm<br>Band/Music: 5:45pm – 7:45pm | |

## Program: Sunday, April 28th, 2019

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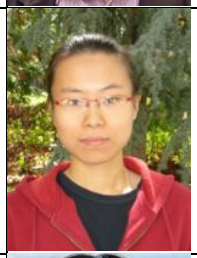
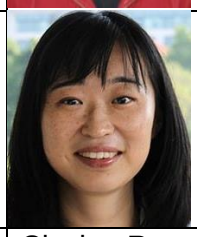
|---|---|---|
| 8:00am – 8:30am | Breakfast | |
| 8:30am – 9:00am |  | **Yevgeniy Vorobeychik**<br>Washington University<br><br>*Machine learning (is not?) in control* |
| 9:00am – 9:30am |  | **Doug Bristow**<br>Missouri University of Science & Technology<br><br>*Large transient growth in iterative learning systems* |
| 9:30am – 10:00am |  | **Erwei Bai**<br>University of Iowa<br><br>*Variable selection in nonlinear nonparametric identification* |
| 10:00am – 10:30am |  | **Umesh Vaidya**<br>Iowa State University<br><br>*Dynamical systems for solving robust optimization* |
| 10:30am-10:45am | Coffee Break | |
| 10:45am – 11:15am |  | **Ankur Mani**<br>University of Minnesota<br><br>*Asymptotically efficient distributed experimentation* |
| 11:15am – 11:45pm |  | **Anqi Li**<br>Washington University<br><br>*The politics of news personalization* |
| 11:45pm – 12:15pm |  | **Ermin Wei**<br>Northwestern University<br><br>*Location-based advertising for vehicle service providers* |
| 12:15pm – 12:30pm | Closing Remarks (Tamer Basar) | |

# Plenary Talks

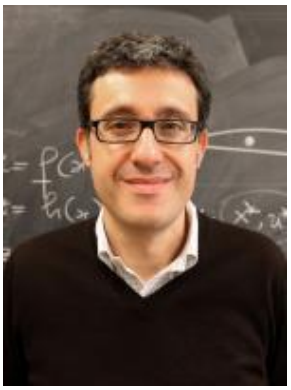
**Title:** High-gain Observers as a Tool for Reducing Information Requirements in Multi-agent Control
**Speaker:** Hassan K. Khalil
**Time and Location:** April 27, 9:00am – 9:30am, Whitaker Hall Auditorium, Room 100

**Abstract:** Control of multi-agent systems has been a topic of increasing interest. In this talk, it is shown that high-gain observers can be used to reduce the information exchange requirements of current designs. The information reduction can take the form of achieving faster convergence with less communication links, or less knowledge of the topology of the network. The talk starts by reviewing the essentials of high-gain and extended high-gain observers. Then, two examples are presented for the use of extended high-gain observers in multi-agent control. In the first example, fast consensus is achieved in a network with star topology. In the second example, practical synchronization is achieved in a network of nonlinear systems.

**Biography:** Hassan K. Khalil is University Distinguished Professor of Electrical and Computer Engineering at Michigan State University. He received B.S. and M.S. from Cairo University and Ph.D. from the University of Illinois. He published over 100 papers on singular perturbation methods and nonlinear control. He is the author of High-Gain Observers in Nonlinear Feedback Control (SIAM 2017), Nonlinear Control (Pearson 2015), Nonlinear Systems (Macmillan 1992; Prentice Hall 1996 & 2002) and coauthor of Singular Perturbation Methods in Control: Analysis and Design (Academic Press 1986; SIAM 1999). Dr. Khalil is Fellow of IEEE and IFAC. He was Associate Editor of the IEEE Transactions on Automatic Control, Automatica, and Neural Networks, and Editor of Automatica. He was Program Chair of the 1988 ACC and General Chair of the 1994 ACC.

**Title:** The Disturbance Decoupling Problem with Stability for Systems over Digraphs: A Stratified Geometric Approach
**Speaker:** Andrea Serrani
**Time and Location**: April 27, 9:30am – 10:00am, Whitaker Hall Auditorium, Room 100

**Abstract:** We consider the Disturbance Decoupling Problem with Stability (DDPS) for switched discrete-time linear systems, where switching occurs within a set of admissible transitions defined via a weighted directed graph. The concept of subspace arrangement, as a collection of linear subspaces, is employed as a main tool for the definition of geometric properties tailored to switched linear systems on digraphs. Stratified geometric concepts are developed as natural extensions of familiar ones in linear systems theory as applicable to the framework of switched discrete-time linear systems. Invariance concepts are specifically characterized when the system is switched from one mode to the next. The consideration of two types of feedback control, namely a mode-dependent piecewise constant control and a graph-based time-varying control, is seen to induce different notions of controlled invariance, leading to strong and weak controlled invariant subspace arrangements, respectively. Sufficient conditions for solvability of DDPS under certain classes of admissible switching signals are expressed in terms of the proposed invariance notions. Conditions for eigenvalue assignment and stabilizability are provided under the assumptions of arbitrary dwell-time and sufficiently large dwell-time switching strategies, respectively. These results specialize previous approaches based on robust controlled invariance, while providing a constructive solution in cases where previous methodologies fail.



**Biography:** Andrea Serrani received the Ph.D. degree from the University of Ancona, Italy, in 1997, and the D.Sc. degree from Washington University in Saint Louis in 2000. Since 2002, he has been with The Ohio State University, Columbus, Ohio, where he is currently a Professor. His research activity spans the field of control and systems theory, with applications to aerospace and vehicular systems. He is the co-author (with A. Isidori and L. Marconi) of the book Robust Autonomous Guidance—An Internal Model Approach, published by Springer Verlag. Prof. Serrani is a Fulbright Fellow and the recipient of four US Air Force Fellowships. He is currently the Editor-in-Chief for the IEEE Transactions on Control Systems Technology and an Associate Editor for the IEEE CSS and EUCA Conference Editorial Boards and has served in the past on the editorial boards of Automatica and the International Journal of Robust and Nonlinear Control. He is a member of IEEE, AIAA, and IFAC. He is the Program Chair of the upcoming 2019 American Control Conference.

**Title:** $L_gV$ Adaptive Controllers for Non-affine Systems with Unknown Parameters and Applications to DC-Microgrid with PV and Battery
**Speaker:** Wei Lin
**Time and Location:** April 27, 10:00am – 10:30am, Whitaker Hall Auditorium, Room 100

**Abstract:** This talk presents a passivity-based framework for adaptive control of non-affine systems with nonlinear parameterization. Under the assumptions that the system has stable free dynamics and satisfies controllability-like conditions characterized by the Lie brackets of affine vector fields, it is proved that there exist $L_gV$ -type adaptive controllers that not only asymptotically regulate the state of the nonlinearly parameterized system but also guarantee global stability of the closed-loop system. The design of $L_gV$ adaptive controllers is also included. Applications of the proposed adaptive control scheme are presented, including an interesting case of a DC-microgrid with PV and battery system.

**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 a visiting Assistant Professor in Washington University. Since spring of 1996, he has been a Professor in the Dept. of Electrical Engineering and Computer Science, Case Western Reserve University, Cleveland, Ohio. He has also hold visiting positions at a number of universities in North America, Europe and Asia. Dr. Lin's research interests include nonlinear control, time-delay systems, estimation and adaptive control, biologically inspired systems and robotics, power systems, renewable energy and smart grids. In these areas, so far he has published more than 200 papers in peer refereed journals/conferences, and delivered a number of Keynote Addresses and Plenary Lectures at the IFAC, IEEE and international conferences on control, optimization and power systems. Dr. Lin was a recipient of the U.S. NSF CAREER Award, the Warren E. Rupp Endowed Professor, the Robert Herbold Faculty Fellow, the JSPS Fellow and IEEE Fellow. He has served as an Associate Editor of Automatica, Associate Editor of the IEEE Trans. on Automatic Control, Subject Editor of Int. J. of Robust and Nonlinear Control, and Associate Editor of Journal of Control Theory and Applications.

**Title:** Functional Dynamics in Brain Networks
**Speaker:** ShiNung Ching
**Time and Location:** April 27, 10:45am – 11:15am, Whitaker Hall Auditorium, Room 100

**Abstract**: The past decade has witnessed the emergence of engineering and mathematics as indispensable tools in brain and cognitive science research. At the heart of this emergence is a desire to more completely understand the structure and dynamics of brain dynamics and their link to cognitive function. That is, how do brain networks coordinate and produce activity towards supporting how we see, hear and think. In this talk, I will discuss two theory-forward approaches that we are pursuing to answer this question. The first approach involved modeling and analysis of brain circuits in well-defined behavioral contexts. Here, we are taking what is known about neuronal dynamics and network structure and then performing systems-theoretic analysis to uncover the types of input-output, information processing relationships that such networks might mediate. The second approach involves normative synthesis of neural dynamics based on mathematical objectives. Here, we postulate certain goals that we believe neural circuits must achieve, then use optimization strategies to construct candidate neuronal dynamics that enacts the goal in question. If successful, these two approaches converge on a unified set of biophysically compatible neuronal dynamics that are linked to rigorous functional primitives.

**Biography**: ShiNung Ching is the Das Family Career Development Assistant Professor in the Department of Electrical and Systems Engineering at Washington University in St. Louis (St. Louis, USA). His research interests are at the intersection of control theory and systems neuroscience, particularly in using systems and control theoretic concepts to study the link between dynamics and function in neuronal networks. He is also interested in how neuronal dynamics can be manipulated by extrinsic neurostimulation towards both basic neuroscience and clinical endpoints. Dr. Ching completed his B.Eng (Hons.) and M.A.Sc degrees in Electrical and Computer Engineering from McGill University, Canada and the University of Toronto, Canada. He earned his Ph.D. in Electrical Engineering from the University of Michigan in 2009 in the area of systems and control theory. He subsequently completed post-doctoral training in computational neuroscience and anesthesiology at the Massachusetts Institute of Technology and the Harvard Medical School. He is an author on over 70 publications in academic journals and conferences and the textbook 'Quasilinear Control'. Dr. Ching has received the CAREER Award from the US National Science Foundation, the Young Investigator Program award from the US AFOSR, a Career Award at the Scientific Interface from the Burroughs-Welcome Fund.

**Title:** Synchronization Engineering: Design of Pattern Formation with Oscillatory Chemical Reactions Using Experiment-Based Phase Models
**Speaker:** István Z. Kiss
**Time and Location:** April 27,11:15am – 11:45am, Whitaker Hall Auditorium, Room 100

**Abstract**: Complex system responses can emerge from interactions among nonlinear rhythmic components. External signals can be used to control the behavior of complex rhythms, both to tune essential behavior, such as by heart pacemakers, or to alter pathological behavior, such as by deep-brain "antipacemakers" in tremors or Parkinson's disease. In such applications, a mild control is desired so that the system can be tuned to a desired behavior without destroying its fundamental nature. In the presentation, a methodology is presented that applies phase models to describe and tune complex dynamic structures to desired states; weak, nondestructive signals are used to alter interactions among nonlinear rhythmic elements. Applications are made to the tuning the phase difference between two oscillators, and the design of cluster and chimera (spatially organized partial synchronization) states. The control methodologies are demonstrated in experiments with electrochemical oscillators. Implementations are highlighted for control of neuronal spiking and circadian rhythms.

**Biography**: István Kiss is an Arts and Sciences Professor of Chemistry in the Department of Chemistry at Saint Louis University. Before joining St. Louis University in 2007, Dr. Kiss completed his Postdoctoral training at the University of Virginia from 2000 to 2004 where he then worked as a Research Associate from 2004 to 2007. Dr. Kiss received his Diploma in Chemistry in 1995 from Kossuth Lajos University, Debrecen, Hungary and his PhD in 2000 from University of Debrecen, Inst. Physical Chemistry, Debrecen, Hungary. Dr. Kiss is a recipient of multiple awards including: Pro Scientia Medal (National Undergraduate Academic Achievement Award) (1995), Outstanding Thesis Award of the Hungarian Chemical Society (1995), Fulbright Fellowship, University of Virginia, Dept. Chem. Eng., Charlottesville, Virginia, USA (1997-98), Richard M. Noyes Scholar (2004) Cottrell College Science Award, Research Corporation for Science Advancement (2008), National Science Foundation CAREER Award (2010), Grant winner Award for Excellence in Research, Saint Louis University (2012), Cottrell Scholar (Class of 2008) by Research Corporation for Science Advancement. His research interests include: Physical chemistry, electrochemistry, nonlinear dynamics, synchronization, circadian rhythms.

**Title:** Reprogramming on Demand
**Speaker:** Indika Rajapakse
**Time and Location:** April 27,11:45am – 12:15pm, Whitaker Hall Auditorium, Room 100

**Abstract**: In 2007, a remarkable discovery was made that with just four external inputs (transcription factors), it was possible to change human cells into what very closely resembled an embryonic stem cell. In addition, only a small number of other cellular reprogramming strategies were known, and this motivated our construction of a universal template for reprogramming. I will present our work on an algorithm for cellular reprogramming, which uses basic biology, data from advanced genomics technologies and control theory.

**Biography**: Indika Rajapakse is an Associate Professor in the Departments of Computational Medicine & Bioinformatics (Medical School), Mathematics, and Biomedical Engineering, University of Michigan. Indika is a co-founder and the Chief Scientific Officer at iReprogram, LLC.

**Title:** Automating the Analysis and Design of Large-Scale Optimization Algorithms
**Speaker:** Laurent Lessard
**Time and Location:** April 27,1:40pm – 2:10pm, Whitaker Hall Auditorium, Room 100

**Abstract**: Most complicated optimization problems, in particular, those involving a large number of variables, are solved in practice using iterative algorithms. The problem of selecting a suitable algorithm is currently more of an art than a science; a great deal of expertise is required to know which algorithms to try and how to properly tune them. Moreover, there are seldom performance guarantees. In this talk, I will show how the problem of algorithm selection can be approached using tools from robust control theory. By solving simple semidefinite programs (that are small, independent of problem size), we can derive robust bounds on convergence rates for popular algorithms such as the gradient method, proximal methods, fast/accelerated methods, and operator-splitting methods such as ADMM. The bounds derived in this manner either match or improve upon the best-known bounds from the literature. The bounds also lead to a natural energy dissipation interpretation and an associated Lyapunov function. Finally, our framework can be used to search for algorithms that meet desired performance specifications, thus establishing a principled methodology for designing new algorithms.

**Biography**: Laurent Lessard is an Assistant Professor of Electrical and Computer Engineering at the University of Wisconsin–Madison and faculty member of Wisconsin Institute for Discovery. Laurent received the B.A.Sc. in Engineering Science from the University of Toronto and received the M.S. and Ph.D. in Aeronautics and Astronautics at Stanford University. After completing his doctoral work, Laurent was an LCCC Postdoc at Lund University in Sweden, and a postdoctoral researcher at the University of California, Berkeley. Laurent was the recipient of the 2013 Hugo Schuck Best Paper Award and an NSF CAREER award. His research interests include: decentralized control, robust control, optimization, and machine learning.

**Title:** Maximum Principle for Switching Diffusions and Applications to Mean-Field Controls
**Speaker:** George Yin
**Time and Location:** April 27, 2:10pm – 2:40pm, Whitaker Hall Auditorium, Room 100

**Abstract:** We study stochastic maximum principles for switching diffusions. The motivation stems from controls involved mean-field interactions. As an example, we examine LQG with Markovian switching and mean-field interactions. This is a joint work with Son Luu Nguyen and Dung Tien Nguyen.

**Biography:** George Yin received the B.S. degree in mathematics from the University of Delaware in 1983, and the M.S. degree in electrical engineering and the Ph.D. degree in applied mathematics from Brown University in 1987. He joined Wayne State University in 1987, became a Professor in 1996, and University Distinguished Professor in 2017. He is Editor-in-Chief of SIAM Journal on Control and Optimization and on the editorial board of many journals; he also served on many technical committees. He is a Fellow of IEEE, a Fellow of IFAC, and a Fellow of SIAM.

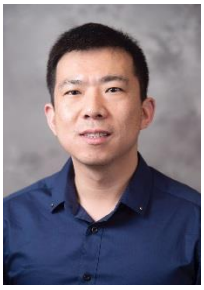
**Title:** Structural Stability of Networked Systems and Graph Theory
**Speaker:** Mohamed-Ali Belabbas
**Time and Location:** April 27, 2:40pm – 3:10pm, Whitaker Hall Auditorium, Room 100

**Abstract**: Understanding which system structure can sustain stable dynamics is a fundamental step in the design and study of large-scale systems made of interconnected agents. The language of graph theory is particularly well-suited to address this question. In this talk, we introduce the basic graph theoretic notions needed to analyze structural stability, and present necessary and sufficient conditions. We also briefly address the case of random system structure and algorithmic issues.

**Biography**: M.-A. Belabbas obtained his PhD degree in applied mathematics from Harvard University and his undergraduate degree from Ecole Centrale Paris, France, and Universite de Louvain, Belgium. He is currently an associate professor in the Electrical and Computer Engineering department at the University of Illinois, Urbana-Champaign and at the Coordinated Science Laboratory. His research interests are in Networked Control System and Geometric Control Theory, with their applications in robotics, social dynamics and data science. He was a recipient of the 2014 NSF Career Award.

**Title:** Consensus-based Distributed Computation: Algorithm, Scalability & Resilience
**Speaker:** Shaoshuai Mou
**Time and Location:** April 27, 3:10pm – 3:30pm, Whitaker Hall Auditorium, Room 100

**Abstract**: In this seminar, we will introduce our recent progress in consensus-based distributed algorithms for solving linear equations in multi-agent networks, in which each can only communicate with its nearby neighbors. We suppose information known to each agent is only part of the overall equation, other than the whole equation. Such information could one or several rows, or even just one entry for better scalability. We will present a distributed algorithm for solving linear equations, which is applicable to all types of linear equations as long as solution exists, do not involve any sufficiently small step size that needs to be shared by all agents in the network, and works asynchronously. Applications of the algorithm includes large content delivery across vehicular networks, distributed network localizations, and so on. We will also introduce a distributed algorithm for achieving the least square solutions. A method to achieve resilience of consensus-based distributed algorithms under malicious attacks with unknown locations will also be discussed.



**Biography**: Shaoshuai Mou received his bachelor and master degree in Harbin Institute of Technology in 2006 and 2008, respectively. He completed his Ph.D. study at Prof. A. Stephen Morse's group in Electrical Engineering at Yale University in 2014. Then he worked as a post-doc at MIT for a year. During his Ph. D. study, he also held a position of visiting scholar at Australian National University and worked part-time for Yale Law School. Since 2015, Shaoshuai Mou has been working as an assistant professor at School of Aeronautics and Astronautics at Purdue University. His research interests include distributed algorithms and control, multi-agent networks, formation control, collaborations of multiple UAVs, cyber-security & resilience.

**Title:** Machine Learning (is not?) in Control
**Speaker:** Yevgeniy Vorobeychik
**Time and Location:** April 28, 8:30am – 9:00am, Whitaker Hall Auditorium, Room 100

**Abstract**: The broad success of machine learning (ML) has made it inevitable that it would come to be used in CPS, particularly in the context of automated control. However, machine learning techniques exhibit a number of vulnerabilities, the most visible of which have been exhibited recently in computer vision. A number of such vulnerabilities have implications for control settings, such as autonomous driving, but to date these have been explored by taking ML out of the control loop. I will discuss some of our recent work on the use of ML in CPS where ML vulnerabilities have direct implications for control. The first problem will be in using supervised learning for anomaly detection in sensor measurements, where we consider stealthy (undetectable) attacks, as well as defenses. The second problem will consider vulnerabilities in deep learning for end-to-end control in autonomous driving, where we exhibit (in simulation) a novel class of simple physically realizable attacks.

**Biography**: Yevgeniy Vorobeychik is an Associate Professor of Computer Science & Engineering at Washington University in Saint Louis. Previously, he was an Assistant Professor of Computer Science at Vanderbilt University. Between 2008 and 2010 he was a post-doctoral research associate at the University of Pennsylvania Computer and Information Science department. He received Ph.D. (2008) and M.S.E. (2004) degrees in Computer Science and Engineering from the University of Michigan, and a B.S. degree in Computer Engineering from Northwestern University. His work focuses on game theoretic modeling of security and privacy, adversarial machine learning, algorithmic and behavioral game theory and incentive design, optimization, agent-based modeling, complex systems, network science, and epidemic control. Dr. Vorobeychik received an NSF CAREER award in 2017, and was invited to give an IJCAI-16 early career spotlight talk. He also received several Best Paper awards, including one of 2017 Best Papers in Health Informatics. He was nominated for the 2008 ACM Doctoral Dissertation Award and received honorable mention for the 2008 IFAAMAS Distinguished Dissertation Award.

**Title:** Large Transient Growth in Iterative Learning Systems
**Speaker:** Douglas Bristow
**Time and Location:** April 28, 9:00am – 9:30pm, Whitaker Hall Auditorium, Room 100

**Abstract**: Many systems, particularly automated manufacturing systems, perform the same operation repeatedly. Iterative learning control (ILC) is a framework that leverages the repetition to improve performance by batch-updating a feedforward control signal between repetitions. The utility of this framework has been well demonstrated with implementation across a broad range of industrial applications, often improving tracking performance by an order of magnitude or more. One challenge in the design of ILC is that of large transient growth, a dynamic in which provably stable ILC systems can exhibit large oscillations characteristically similar to that of an unstable system. This unusual behavior arises because of the high-order and particular structure of the dynamics in the iterative, rather than temporal, domain. This talk will present an introductory background of the ILC method, a mathematical understanding of large transient growth in iterative systems, and robust design methods.

**Biography**: Dr. Douglas A. Bristow is currently an Associate Professor in the Department of Mechanical and Aerospace Engineering at the Missouri University of Science and Technology (Missouri S&T). He received his B.S. in Mechanical Engineering from Missouri S&T in 2001. He received his M.S. and Ph.D., also in Mechanical Engineering, from the University of Illinois at Urbana-Champaign in 2003 and 2007, respectively. Dr. Bristow is the Director of the Center for Aerospace Manufacturing Technologies, an industry consortium that currently includes eleven member companies. He has more than 80 peer-reviewed publications and his research interests include precision motion control, repetitive and iterative process control, additive manufacturing process control, atomic force microscopy, and volumetric error compensation in machine tools and robotics. Dr. Bristow's research is currently funded by the National Science Foundation, the Department of Energy, the Digital Manufacturing and Design Innovation Institute, and multiple companies. He is an Associate Editor at the ASME Journal of Dynamic Systems, Measurement and Control.

**Title:** Variable Selection in Nonlinear Nonparametric Identification
**Speaker:** Erwei Bai
**Time and Location:** April 28, 9:30am – 10:00am, Whitaker Hall Auditorium, Room 100

**Abstract:** The importance of discovering significant variables from a large candidate pool is now widely recognized in many fields. This talk will present some of our recent work in the context of nonlinear system identification.

**Biography:** Er-Wei Bai received his education from Fudan University, Shanghai Jiaotong University, both in Shanghai, China, and the PhD degree from the University of California at Berkeley, Berkeley, CA, USA, in 1987.,He is the College of Engineering Distinguished Professor and the Chair of Electrical and Computer Engineering, and a Professor of Radiology at the University of Iowa where he teaches and conducts research in identification, control, signal processing, and their applications in engineering and life science.,Dr. Bai also held the rank of World Class Research Professor, Queen's University, Belfast, U.K. He received the President's Award for Teaching Excellence and the Board of Regents Award for Faculty Excellence.

**Title:** Dynamical Systems for Solving Robust Optimization Problem
**Speaker:** Umesh Vaidya
**Time and Location:** April 27, 10:00pm – 10:30pm, Whitaker Hall Auditorium, Room 100

**Abstract**: We propose a dynamical system-based approach for solving robust optimization problems. The dynamical system is derived from the saddle point property of the robust optimization problem and is different than the primal-dual dynamical system used for solving a non-robust optimization problem. We call this new dynamical system saddle point dynamics. For a general class of robust optimization problem, where the cost function is convex in decision variable and concave in the uncertain variable, we show that the robust optimal solution can be recovered as a globally asymptotically stable equilibrium point of the saddle point dynamical system. Furthermore, the dynamical system is also used to determine the worst instantiation of the uncertainty, as the uncertain variable arises as one of the states of this dynamical system. The new saddle point dynamics is attractive as it allows for the distributed implementation of a robust optimization problem. Convergence results for the discrete-time algorithm based on the discretization of continuous time saddle point dynamics will also be discussed. Simulation results are presented to demonstrate the capability of this new dynamical system to solve various robust optimization problems. We also compare our proposed approach with existing methods based on robust counterpart and scenario-based random sampling.

**Biography**: Dr. Umesh Vaidya is Associate Professor in the Department of Electrical and Computer Engineering at Iowa State University, Ames IA, USA. He received the Ph.D. degree in Mechanical Engineering Department from University of California Santa Barbara, CA, USA in 2004. He was Research Engineer at United Technologies Research Center (UTRC) East Hartford, CT, USA from 2004-2005. He is a recipient of 2012 National Science Foundation CAREER award. He is an associate editor for IEEE Transactions on Power Systems, and Journal of Dynamic Systems, Measurement, and Control. His research interest is in the area of ergodic theory of dynamical systems, network-controlled systems, robust optimization, and learning with applications to cyber-physical systems, power systems, and building systems.

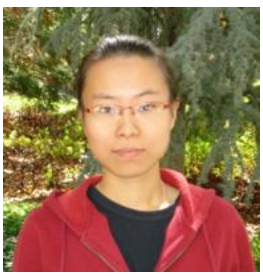
**Title:** Asymptotically Efficient Distributed Experimentation
**Speaker:** Ankur Mani
**Time and Location:** April 28, 10:45am – 11:10am, Whitaker Hall Auditorium, Room 100

**Abstract:** We study the sequential experimentation problem in a distributed setting. In many real situations a central planner is unable to control experimentation decisions of independent agents due to strategic, informational or ethical issues. The agents, often working in their self-interest, are interested in exploitation rather than experimentation. We model this system in a continuous time multi-armed bandit framework and explore the problem of the central planner that interacts with the bandits through a set of independent myopic agents. We identify novel characterization results that give insight into the dynamics of this system. These results help compare the distribution of efforts on different bandits. We first provide the limits of performance under any policy that the central planner can use. This provides a benchmark and the cost of decentralization. We then introduce a policy that mitigates the cost of distributed experimentation and surprisingly provides performance equivalent to the optimal performance of centralized experimentation. If the firm utilizes a policy of dropping products determined to be suboptimal with enough confidence, it can generate a near-optimal amount of experimentation for the firm. However, the firm needs logarithmically many agents (in the length of the time horizon) in order to achieve the optimal regret. This policy distributes the burden of experimentation across the agents, thus utilizing the size of the agent population to speed up learning.

**Biography:** Ankur Mani is an assistant professor in the Industrial and Systems Engineering Department at the University of Minnesota. He received his Ph.D. from the Massachusetts Institute of Technology and undergraduate degree in Electrical Engineering from the Indian Institute of Technology, Delhi. Before coming to the University of Minnesota he was a Research Scientist in the Operations Management Group at NYU Stern School of Business. His research interests lie at the intersection of social networks, distributed experimentation and learning with applications in revenue management, healthcare and modern supply chains. Over the years, his research has been supported by a Martin Family Fellowship, IBM Research, Intel Research, Microsoft Research, Yahoo Research, Transdev, C. H. Robinson, Natura, European Research Commission, Digital Technology Center at UMN, Net Institute, and NSF's Institute for Mathematics and its Applications.

**Title:** The Politics of News Personalization
**Speaker:** Anqi Li
**Time and Location:** April 28, 11:15am – 11:45am, Whitaker Hall Auditorium, Room 100

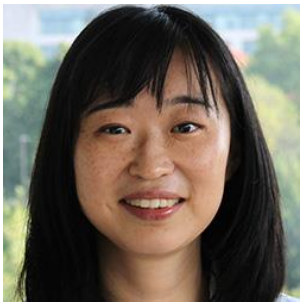
**Abstract:** We study the effect of news personalization on politics. The cornerstone of our model is a market for personalized news, in which contents about political uncertainties are dispersed among myriads of sources that voters may not be familiar with or even aware of. A profit-maximizing news intermediary segments voter based on political predispositions and aggregates contents on their behalves. The result is personalized news, which voters pay costly attention to and generate eyeballs, or profits, to the intermediary. Personalized news simultaneously fosters confirmatory biases and challenges the voters' predispositions with big occasional surprises. In an electoral competition model where the uncertainty concerns the candidates' fitness to hold office, the latter create pessimism among voters when the fitness of the candidate they prefer policy-wise is criticized. To increase winning probabilities, candidates must appeal to voters who least prefer their policies. When these voters are less susceptible to policy deviations than the median voter hearing broadcast news, news personalization elevates policy polarization. News personalization creates new voter coalitions which, if won by candidates, can increase the latter's winning probabilities. These coalitions consist of marginal voters, and they can be more responsive to policy deviations than the median voter, who is found to be increasingly ``apathetic and indifferent'' by some political scholars. If so, then redistributing voters' population from the center to the margin lessens policy polarization. Thus, mass polarization may not be the immediate cause of elite polarization, and a deep understanding of its nature is essential for making the correct equilibrium predictions.



**Biography:** I am assistant professor of economics at Washington University in St. Louis. I am a theorist with broad interests. My recent research develops theoretical models of media and politics.

**Title:** Location-Based Advertising for Vehicle Service Providers
**Speaker:** Ermin Wei
**Time and Location:** April 28, 11:45am – 12:15am, Whitaker Hall Auditorium, Room 100

**Abstract**: Vehicle service providers can display commercial ads in their vehicles based on passengers' origins and destinations to create a new revenue stream. In this work, we study a vehicle service provider who can generate different ad revenues when displaying ads on different arcs (i.e., origin-destination pairs). The provider needs to ensure the vehicle flow balance at each location, which makes it challenging to analyze the provider's vehicle assignment and pricing decisions for different arcs. For example, the provider's price for its service on an arc depends on the ad revenues on other arcs as well as on the arc in question. To tackle the problem, we show that the traffic network corresponds to an electrical network. When the effective resistance between two locations is small, there are many paths between the two locations and the provider can easily route vehicles between them. We characterize the dependence of an arc's optimal price on any other arc's ad revenue using the effective resistances between these two arcs' origins and destinations. Furthermore, we study the provider's optimal selection of advertisers when it can only display ads for a limited number of advertisers. If each advertiser has one target arc for advertising, the provider should display ads for the advertiser whose target arc has a small effective resistance. We investigate the performance of our advertiser selection strategy based on a real-world dataset. Joint work with Haoran Yu and Randy Berry



**Biography**: Ermin Wei is currently an Assistant Professor at the EECS Dept of Northwestern University. She completed her PhD studies in Electrical Engineering and Computer Science at MIT in 2014, advised by Professor Asu Ozdaglar, where she also obtained her M.S.. She received her undergraduate triple degree in Computer Engineering, Finance and Mathematics with a minor in German, from University of Maryland, College Park. Wei has received many awards, including the Graduate Women of Excellence Award, second place prize in Ernst A. Guillemen Thesis Award and Alpha Lambda Delta National Academic Honor Society Betty Jo Budson Fellowship. Wei's research interests include distributed optimization methods, convex optimization and analysis, smart grid, communication systems and energy networks and market economic analysis.

# Poster Session

Jiali Huang, Ankur Mani, Zizhuo Wang.
*The Value of Price Discrimination in Large Random Networks*

Chuan Yan, Huazhen Fang.
*Distributed Leader-Follower Tracking Control for Multi-Agent Systems Subject to Disturbances*

Pranay Thangeda, Melkior Ornik.
*Safety-Guaranteed, Accelerated Learning in MDPs with Local Side Information*

Ning Tian, Huazhen Fang.
*A new equivalent circuit model for lithium-ion batteries*

Amir Daneshmand, Gesualdo Scutari, Vyacheslav Kungurtsev.
*Second-order Guarantees of Distributed Gradient Algorithms*

Dhrubajit Chowdhury, Hassan K. Khalil.
*Scalable Consensus in Networks of Multi-agent Systems Using High-Gain Observers*

Theodoros Mamalis, Subhonmesh Bose, Lav R. Varshney.
*Business-to-Peer Carsharing Systems with Electric Vehicles*

Jinlong Lei, Uday V. Shanbhag.
*Gradient-Response and Best-response Schemes for Stochastic Nash Games and their Distributed Variants*

Pratap Bhanu Solanki, Shaunak Bopardikar, Xiaobo Tan.
*Cooperative Optimization for a Non-Communicating Two-agent System with Parallel Updates*

Xuan Wang, Shreyas Sundaram, Shaoshuai Mou.
*Resilience for Consensus Algorithms in Fully Distributed Scenarios*

Wei Miao, Jr-Shin Li.
*A Geometric Approach to Ensemble Control Analysis and Design*

Paulo Heredia, Shaoshuai Mou.
*Distributed State Estimation for Nonlinear Systems with Unknown Parameters*

Paul Griffioen, Raffaele Romagnoli, Bruce H. Krogh, Bruno Sinopoli.
*Secure Networked Control via Software Rejuvenation*

Erik Miehling, Roy Dong, Cédric Langbort, Tamer Başar.
*The Private Sampling Game*

Muhammed O. Sayin, Tamer Basar.
*Dynamic Deceptive Signaling of Multivariate Distributions Over Finite/Infinite Horizon*

Mingyu Cai, Baike She, Zhen Kan.
*Linear Temporal Logic Path Planning for Mobile Robots*

Manash Chakraborty, Dr. Ryan J. Caverly.
*Synthesis of a Conic Controller with Gain-Scheduled Internal Models for Robust Trajectory Tracking*

Ali Reza Pedram, Takashi Tanaka.
*Linearly-Solvable Mean-Field Approximation for Multi-Team Road Traffic Games*

Khaled Alshehri, Mariola Ndrio, Subhonmesh Bose, Tamer Basar.
*The Impact of Aggregating Distributed Energy Resources on Electricity Market Efficiency*

Juntao Chen, Quanyan Zhu.
*Dynamic Contract Design for Systemic Cyber Risk Management of Interdependent Enterprise Network*

Lucas Buccafusca, Carolyn Beck.
*An Application of Nested Control Synthesis for Wind Farms*

Minh Vu, Shen Zeng.
*Iterative Optimal Control for Nonlinear Systems*

Raghavan Krishnan, Sarangapani Jagannathan, V.A. Samaranayake.
*A Minimax Approach to Classification*

# Danforth Campus Map

# Things to do in St. Louis
## April 27-28

The top 25 Things to Do in St. Louis: https://explorestlouis.com/25-things-to-do-in-st-louis/

**Traveling with Family:**
City Museum (https://www.citymuseum.org)
St. Louis Science Center (https://www.slsc.org)
St. Louis Zoo (https://www.stlzoo.org/visit/zooservices)
Gateway Arch (https://www.gatewayarch.com)

**Sports:**
St. Louis Blues vs Dallas (https://www.nhl.com/blues/schedule/2019-04-01/CT)
St. Louis Cardinals vs Cincinnati Reds (https://www.mlb.com/cardinals/schedule/2019-04)
Saint Louis FC Soccer Match (https://www.saintlouisfc.com/single-game-tickets)

**Arts & Entertainment:**
Cirque Du Soleil at Chaifetz Arena (https://www.cirquedusoleil.com/usa/st-louis/corteo/buy-tickets)
Miss Saigon at the Fabulous Fox (https://www.fabulousfox.com/events/detail/miss-saigon)

**Music Venue's:**
Blueberry Hill (https://blueberryhill.com)
Delmar Hall (https://www.delmarhall.com)
The Pageant (https://www.thepageant.com/calendar)

Visit Explore St. Louis for a complete list of things to do in St. Louis this weekend!
(https://explorestlouis.com/things-to-do)