WENQI CUI

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EDUCATION

University of Washington, Seattle, WA *Sept.2019 - Jun.2024 (expected)*
Ph.D. Candidate in Electrical and Computer Engineering
Graduate Fellow in Clean Energy Institute
Advisor: Prof. Baosen Zhang

Zhejiang University, Hangzhou, China *Sept. 2016 - Jun. 2019*
Master of Science in Electrical Engineering
Advisor: Prof. Yi Ding

Southeast University, Nanjing, China *Aug. 2012 - Jun. 2016*
Bachelor of Engineering in Electrical Engineering and Automation

INDUSTRY EXPERIENCE

Microsoft Research, Redmond, WA *Jun.2022 -Sept.2022*
Research Intern at Microsoft Research Special Projects at Remond Lab Mentor: Weiwei Yang
We proposed sample-efficient reinforcement learning algorithms for the control of largescale physical systems, including power systems and traffic networks. The proposed methods overcome the challenges of partial observability, sample complexity and the lack of real-time communication capability in real-world applications.

Microsoft Research, Redmond, WA *Jun.2021 -Sept.2021*
Research Intern at Microsoft Research Special Projects at Remond Lab Mentor: Weiwei Yang
We proposed a novel framework for predicting power system dynamics and transients in the frequency domain, which provides a computation speed up of more than 400 times compared to existing power system tools.

PUBLICATIONS

Journal Papers

[J1]. **W. Cui**, Y. Jiang and B. Zhang, "Reinforcement Learning for Optimal Frequency Control: A Lyapunov Approach", *IEEE Transactions on Power Systems*, vol. 38, no. 2, pp. 1676-1688, 2023.

[J2]. **W. Cui**, W. Yang and B. Zhang, "A Frequency Domain Approach to Predict Power System Transients", *IEEE Transactions on Power Systems,* 2023.

[J3]. J.Feng, **W. Cui**, J.Cortés and Y.Shi, "Bridging Transient and Steady-State Performance in Voltage Control: A Reinforcement Learning Approach with Safe Gradient Flow", *IEEE Control Systems Letters (L-CSS)*, vol. 7, pp. 2845-2850, 2023.

[J4]. **W. Cui** and B. Zhang, "Equilibrium-Independent Stability Analysis for Distribution Systems with Lossy Transmission Lines ", *IEEE Control Systems Letters (L-CSS)*, vol. 6, pp. 3349-3354, 2022.

[J5]. **W. Cui**, J. Li and B. Zhang, "Decentralized Safe Reinforcement Learning for Voltage Control", *Electric Power Systems Research [journal version of Power Systems Computation Conference (PSCC)]*, vol. 211, p. 108609, 2022.

[J6]. **W. Cui** and B. Zhang, "Lyapunov-Regularized Reinforcement Learning for Power System Transient Stability ", *IEEE Control Systems Letters (L-CSS)*, vol. 6, pp. 974-979, 2022.

[J7]. Y. Jiang, **W. Cui**, B. Zhang and J.Cortés, "Stable Reinforcement Learning for Optimal Frequency Control: A Distributed Averaging-Based Integral Approach", *IEEE Open Journal of Control Systems*, vol. 1, pp. 194-209, 2022.

[J8]. C. Doty*, S. Gallagher*, **W. Cui***, W. Chen*, S. Bhushan*, M. Oostrom, S. Akers, S. Spurgeon, "Design of a Graphical User Interface for Few-Shot Machine Learning-Based Classification of Electron Microscopy Data", *Computational Materials Science*, vol. 203, p. 111121, 2022. (* authors contributed equally)

[J9]. N. Shang, Y. Ding, **W. Cui**, "Review of Market Power Assessment and Mitigation In the Reshaping of Power Systems: State-of-Art Status and Potential Research Studies", *Journal of Modern Power System and Clean Energy*, vol. 10, no. 5, pp. 1067-1084, 2022.

[J10]. Y. Ding, **W. Cui**, S. Zhang, H. Hui, Y. Qiu, Y. Song, "Multi-State Operating Reserve Model of Aggregate Thermostatically-Controlled-Loads for Power System Short-Term Reliability Evaluation", *Applied Energy*, vol. 241, pp. 46-58, 2019.

[J11]. **W. Cui**, Y. Ding, H. Hui, Z. Lin, P. Du, Y. Song, C. Shao, "Evaluation and Sequential-Dispatch of Operating Reserve Provided by Air Conditioners Considering Lead-Lag Rebound Effect", *IEEE Transactions on Power Systems*, vol. 33, no. 6, pp. 6935-6950, 2018.

Conference Papers

[C1]. **W. Cui**, Y. Jiang, B. Zhang and Y.Shi, "Structured Neural-PI Control for Networked Systems: Stability and Steady-State Optimality Guarantees", accepted to *Conference on Neural Information Processing Systems (NeurIPS)*, 2023.

[C2]. **W. Cui**, G. Shi, Y.Shi and B. Zhang, "Leveraging Predictions in Power System Frequency Control: an Adaptive Approach", accepted to *IEEE Conference on Decision and Control*, 2023.

[C3]. **W. Cui**, L. Huang, W. Yang and B. Zhang, "Efficient Reinforcement Learning Through Trajectory Generation", *Learning for Dynamics & Control Conference,* 2023.

[C4]. Y. Jiang, **W. Cui**, B. Zhang and J.Cortés, "Equilibria of Fully Decentralized Learning in Networked Systems", *Learning for Dynamics & Control Conference,* 2023.

SELECTED RESEARCH EXPERIENCE

Efficient Reinforcement Learning Through Trajectory Generation June. 2022 - Dec. 2022

- Proposed a simple end-to-end approach to generate trajectories for linear systems, which significantly reduces the burden of sample collection in RL methods
- The generated trajectories are adaptive to updated control policies, which overcome the challenges of distributional shift and lack of exploration
- Via an adaptive online linearization approach, the algorithm extends to nonlinear systems satisfying smoothness conditions

Structured Learning with Steady-State Optimality Guarantees Oct. 2021 - June. 2022

- Proposed structured neural network-based controllers that have provable guarantees on stability and zero steady-state output tracking error for large range of networked systems
- If the communication between neighbours is available, the controller can distributedly achieve optimal resource allocation at the steady state
- Constructed a stacked-ReLU neural network that universally approximate any monotonically increasing functions through the origin, which implicitly guarantees stability by design

A Lyapunov Approach for Safe Reinforcement Learning Apr. 2020 - Mar. 2022

- Derived structure property of stablizing neural network controllers according to Lyapunov condition in power system frequency and voltage control problem
- Proposed a modular approach for transient stability analysis that can scale to large distribution systems
- For lossy power networks without a well-defined Lyapunov function, we proposed to learn a neural Lyapunov function as regularization for safe RL

Power System Dynamic Prediction using Fourier Neural Operator **Jun. 2021 - Oct. 2021**

- Developed a Fourier Neural Operator for solving the set of algebraic or ordinary differential equations for power system transient dynamics
- The system topology and fault information are encoded through a 3D Fourier transform
- The proposed framework is orders of magnitude faster than current simulators while also remain high accuracy for the prediction under different fault types

INVITED TALKS AND PRESENTATIONS

[1]. "Structured Neural-PI Control with End-to-End Stability and steady-state efficiency guarantees", Department of Electrical and Computer Engineering, University of California San Diego, 2023/06. Hosted by Prof. Yuanyuan Shi.

[2]. "Efficient Reinforcement Learning Through Trajectory Generation", Learning for Dynamics & Control Conference, University of Pennsylvania, 2023/06.

[3]. "Equilibrium-Independent Stability Analysis for Distribution Systems with Lossy Transmission Lines ", the 61th IEEE conference on Decision and Control, Cancun, Mexico, 2022/12.

[4]. "Structured Neural-PI Control for Networked Systems: Stability and Steady-State Optimality Guarantees", AI Power Lunch, Microsoft Research, Redmond, WA, 2022/08. Hosted by Dr. Andrea Britto.

[5]. "Decentralized Safe Reinforcement Learning for Voltage Control", Power Systems Computation Conference, Porto, Portugal, 2022/06.

[6]. "Predicting Power System Dynamics and Transients: A Frequency Domain Approach", SIAM Conference on Uncertainty Quantification, Atlanta, Georgia, 2022/04.

[7]. "Lyapunov-regularized Reinforcement Learning for Power System Transient Stability ", INFORMS Annual Meeting, Anaheim, CA, 2021/10.

[8]. "Predicting Power System Dynamics and Transients: A Frequency Domain Approach", Azure Global Commercial Industry, Microsoft, Redmond, WA, 2021/09. Hosted by Dr. Peeyush Kumar.

[9]. "Safe Reinforcement Learning for Optimal Frequency Control", Department of Electrical and Computer Engineering, University of Texas at Austin, 2021/08. Hosted by Prof. Hao Zhu.

[10]. "Reinforcement Learning for Optimal Frequency Control: A Lyapunov Approach", *Tackling Climate Change with Machine Learning workshop at ICML 2021*, spotlight talk, 2021/07.

TEACHING EXPERIENCE

Teaching assistant for EE 351 Energy Systems, University of Washington *Mar.2023 -Jun.2023*

- Held weekly office hours, designed and graded assignments/exams.
- Taught lab sessions including 1) power electronics converters; 2) Photovoltaic generation; 3) power plant that consists of a prime mover, synchronous generator and three-phase transformer.

Guest lecturer for EE 583 Nonlinear Systems and Control *Sept.2023 -Dec.2023*

- Give a lecture on learning-based control with applications in networked systems.

HONORS & AWARDS

2023	Rising Stars in Cyber-Physical Systems, The University of Virginia
2023	Best Poster Award, Grid Science Winter School & Conference, Los Alamos National Lab
2022	Rising Stars in EECS, The University of Texas at Austin
2021	Sarala Vadari Award, University of Washington
2020	Clean Energy Institute (CEI) Fellowship, University of Washington
2019	Rushmer Innovator Fellowship, University of Washington
2019	Excellent Postgraduate Students' Award, Department of Education of Zhejiang Province
2018 & 2014	National Scholarship, Chinese Ministry of Education (top 3%)
2015	Chancellor Scholarship, Southeast University (top 1%)

SERVICES & ACTIVITIES

Nov. 2018 - Present	Reviewer for IEEE Transactions on Power Systems; IEEE Transactions on Smart Grid; IEEE Transactions on Automatic Control; IEEE Transactions on Control of Networked Systems; IEEE Transactions on Control Systems Technology; IEEE Control Systems Letters; Systems & Control Letters; IEEE Power Engineering Letters; Applied Energy; American Control Conference; IEEE Conference on Decision and Control; AAAI
Oct. 2020 - Jun. 2021	Clean Energy Institute (CEI) Ambassador for K-12 Students
Oct. 2016 - Oct. 2017	Deputy Director of Academic Department in Graduate Union, Zhejiang University
Sept. 2013 - Sept. 2014	Deputy Director of Academic Department in Student Union, Southeast University