

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

Advisor: Prof. Baosen Zhang

Zhejiang University, Hangzhou, P.R. China

Sept. 2016 - Jun. 2019

Master of Science in Electrical Engineering Ranking:1/58 Advisor: Prof. Yi Ding

Southeast University, Nanjing, P.R. China

Sept. 2012 - Jun. 2016

Bachelor of Engineering in Electrical Engineering and Automation Ranking:1/163

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 controlling largescale physical systems, including power systems and traffic networks. The algorithms overcome the challenges of partial observability, sample complexity, and distribution shift of trajectories from updated control policies.

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

Preprints

- [1]. **W. Cui**, G. Shi, Y.Shi and B. Zhang, “Leveraging Predictions in Power System Frequency Control: an Adaptive Approach”, *arXiv preprint*: 2305.12044.
- [2]. J.Feng, **W. Cui**, J.Cortes and Y.Shi, “Bridging Transient and Steady-State Performance in Voltage Control: A Reinforcement Learning Approach with Safe Gradient Flow”, *arXiv preprint*: 2303.11417.
- [3]. **W. Cui**, Y. Jiang, B. Zhang and Y.Shi, “Structured Neural-PI Control for Networked Systems: Stability and Steady-State Optimality Guarantees”, *arXiv preprint*: 2206.00261.

Journal and Conference Papers

- [4]. **W. Cui**, L. Huang, W. Yang and B. Zhang, “Efficient Reinforcement Learning Through Trajectory Generation”, accepted to *Learning for Dynamics & Control Conference*; *arXiv preprint*: 2211.17249.
- [5]. Y. Jiang, **W. Cui**, B. Zhang and J.Cortes, “Equilibria of Fully Decentralized Learning in Networked Systems”, accepted to *Learning for Dynamics & Control Conference*; *arXiv preprint*: 2305.09002.
- [6]. **W. Cui**, W. Yang and B. Zhang, “Predicting Power System Dynamics and Transients: A Frequency Domain Approach”, accepted to *IEEE Transactions on Power Systems*; *arXiv preprint*: 2111.01103.

- [7]. **W. Cui**, Y. Jiang and B. Zhang, “Reinforcement Learning for Optimal Frequency Control: A Lyapunov Approach”, *IEEE Transactions on Power Systems*, 2022.
- [8]. **W. Cui** and B. Zhang, “Equilibrium-Independent Stability Analysis for Distribution Systems with Lossy Transmission Lines ”, *IEEE Control Systems Letters (L-CSS)*, 2022.
- [9]. **W. Cui**, J. Li and B. Zhang, “Decentralized Safe Reinforcement Learning for Voltage Control”, *Electric Power Systems Research*; 2022.
- [10]. Y. Jiang, **W. Cui**, B. Zhang and J.Cortes, “Stable Reinforcement Learning for Optimal Frequency Control: A Distributed Averaging-Based Integral Approach”, *IEEE Open Journal of Control Systems*, 2022.
- [11]. 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*, 2022. (* authors contributed equally)
- [12]. **W. Cui** and B. Zhang, “Lyapunov-Regularized Reinforcement Learning for Power System Transient Stability ”, *IEEE Control Systems Letters (L-CSS)*, 2021.
- [13]. 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*, 2021.
- [14]. 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*, 2019. (*corresponding author)
- [15]. **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*, 2018.
- [16]. Z. Liu, **W. Cui***, R. Shen, Y. Hu, H. Wu, C. Ye, “Design of Capacity Incentive and Energy Compensation for Demand Response Programs”, *IOP Conf. Ser. Earth Environ. Sci.* 2018.(*corresponding author)
- [17]. **W. Cui**, Y. Ding, H. Hui, M. Li, “Two-Stage Payback Model for the Assessment of Curtailment Services Provided by Air Conditioners”, *Energy Procedia* 2017.

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”, SIAM Conference on Applications of Dynamical Systems, Portland, Oregon, 2023/05.
- [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 ”, *the 60th IEEE conference on Decision and Control*, Austin, Texas, 2021/12.
- [8]. ”Power System Dynamic Prediction using Fourier Neural Operator”, 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.

SELECTED RESEARCH EXPERIENCE

Efficient Reinforcement Learning Through Trajectory Generation June. 2022 - June. 2023

- 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 Neural-PI Control with Stability and Efficiency Guarantees Oct. 2021 - June. 2023

- Proposed structured neural Proportional-Integral (PI) controllers that have provable guarantees on stability and zero steady-state output tracking error for a large range of networked systems
- If the communication between neighbours is available, the controller can distributedly achieve optimal resource allocation at the steady state
- The key structure is the strict monotonicity on PI terms, which is parameterized as gradients of strictly convex neural networks (SCNN). We construct SCNN with tunable softplus- β activations, which yields universal approximation capability and is also useful in incorporating communication constraints.

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

- Derived structure property of stabilizing neural network controllers according to Lyapunov condition in power system frequency and voltage control problem
- Proposed a stacked-ReLU neural network controller to construct a monotonic increasing function through the origin, which implicitly guarantee exponential stability for all system parameters and topologies
- 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

HONORS & AWARDS

May. 2023 Rising Stars in Cyber-Physical Systems, The University of Virginia

Jan. 2023	Best Poster Award, Los Alamos National Lab
Sept. 2022	Rising Stars in EECS, The University of Texas at Austin
Nov. 2021	Sarala Vadari Award, University of Washington
Sept. 2020	Clean Energy Institute (CEI) Fellowship, University of Washington
Sept. 2019	Rushmer Innovator Fellowship, University of Washington
Mar. 2019	Excellent Postgraduate Students' Award, Department of Education of Zhejiang Province
Oct. 2018	National Scholarship, Chinese Ministry of Education (top 3%)
Oct. 2018	Graduate of Merit, Zhejiang University (top 10%)
Jun. 2016	Outstanding Graduate Award, Southeast University (top 5%)
Oct. 2015	Chancellor Scholarship, Southeast University (top 1%)
Nov. 2014	Pacemaker to Merit Student, Southeast University (top 1%)
Oct. 2014	National Scholarship, Chinese Ministry of Education (top 3%)

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; IET Renewable Power Generation; IET Generation, Transmission
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