

WENQI CUI

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EDUCATION

University of Washington, Seattle, WA

Sept.2019 -

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 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

Preprints

- [1]. **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.
- [2]. **W. Cui**, W. Yang and B. Zhang, “Predicting Power System Dynamics and Transients: A Frequency Domain Approach”, *arXiv preprint*: 2111.01103.

Journal and Conference Papers

- [3]. **W. Cui**, Y. Jiang and B. Zhang, “Reinforcement Learning for Optimal Frequency Control: A Lyapunov Approach”, *IEEE Transactions on Power Systems*, 2022.
- [4]. **W. Cui** and B. Zhang, “Equilibrium-Independent Stability Analysis for Distribution Systems with Lossy Transmission Lines ”, *IEEE Control Systems Letters (L-CSS)*, 2022.
- [5]. **W. Cui**, J. Li and B. Zhang, “Decentralized Safe Reinforcement Learning for Voltage Control”, *Electric Power Systems Research*, 2022.

- [6]. 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.
- [7]. 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)
- [8]. **W. Cui** and B. Zhang, “Lyapunov-Regularized Reinforcement Learning for Power System Transient Stability”, *IEEE Control Systems Letters (L-CSS)*, 2021.
- [9]. 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.
- [10]. 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)
- [11]. **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.
- [12]. **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 for Networked Systems: Stability and Steady-State Optimality Guarantees”, AI Power Lunch, Microsoft Research, Redmond, WA, 2022/08. Hosted by Dr. Andrea Britto.
- [2]. “Predicting Power System Dynamics and Transients: A Frequency Domain Approach”, SIAM Conference on Uncertainty Quantification, Atlanta, Georgia, 2022/04.
- [3]. “Lyapunov-regularized Reinforcement Learning for Power System Transient Stability”, *the 60th IEEE conference on Decision and Control*, Austin, Texas, 2021/10.
- [4]. “Power System Dynamic Prediction using Fourier Neural Operator”, Azure Global Commercial Industry, Microsoft, Redmond, WA, 2021/09. Hosted by Dr. Peeyush Kumar.
- [5]. “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.
- [6]. “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

Structured Neural-PI Control for Networked Systems Jan. 2022 - June. 2022

- Proposed structured neural-PI controllers that have provable guarantees on stability and zero steady-state output tracking error
- If 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

Equilibrium-Independent Stability Analysis for Lossy Distribution Systems Dec.2021-Mar.2022

- Proposed a modular approach for transient stability analysis that can scale to large distribution systems
- Designed a tunable model for the subsystem of lossy transmission lines, which serves to explicitly trade off between the control effort and the stability region
- Certified equilibrium-independent transient stability of the distribution systems through passivity of subsystems, providing a simple yet effective approach to optimize control efforts with stability guarantees

A Lyapunov Approach for Safe Reinforcement Learning Apr. 2020 - Dec. 2021

- Derived structure property of stabilizing neural network controllers according to Lyapunov condition in power system frequency control and voltage control problem
- For centralized training, we integrated state transition dynamics in recurrent neural network (RNN) to implicitly satisfy the inequality and equality constraints. The proposed RNN based framework reduces computational time by over 70% compared with the general RL structures
- For decentralized training in a networked system, we constructed a multi-agent safe RL framework to optimize neural network controller in each node with locally observed trajectories

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

- Developed a Fourier Neural Operator for solving the set of 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

PATENTS AND SOFTWARE COPYRIGHTS

- [1]. Chinese Patent No.CN201810584434.9 “ Sequential-Dispatch of Operating Reserve Provided by Air Conditioners Considering Lead-Lag Rebound Effect”, July 6, 2021.
- [2]. Chinese Software Copyrights No. 2018SR449433 “Software for Coupon Computing and Settlement in Friendly Interactive Smart Grid,” , May 26, 2018.

HONORS & AWARDS

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; 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