

# WENQI CUI

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## EDUCATION

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### University of Washington, Seattle, WA

*Sept.2019 - Present*

Ph.D. Student in Electrical and Computer Engineering

Advisors: Prof. Baosen Zhang, Prof. Daniel Kirschen

### 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

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### 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 power system dynamic predictions by learning in the frequency domain, which provides a computation speed up of more than 400 times compared to existing power system tools.

## PUBLICATIONS

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### Preprints

- [1]. **W. Cui**, W. Yang and B. Zhang, "Predicting Power System Dynamics and Transients: A Frequency Domain Approach", submitted to *Nature Energy*; *arXiv preprint*: 2111.01103.
- [2]. **W. Cui**, J. Li and B. Zhang, "Decentralized Safe Reinforcement Learning for Voltage Control", submitted to *Power System Computation Conference (PSCC)*; *arXiv preprint*: 2110.01126.
- [3]. **W. Cui** and B. Zhang, "Reinforcement Learning for Optimal Frequency Control: A Lyapunov Approach", submitted to *IEEE Transactions on Control of Networked Systems*; *arXiv preprint*: 2009.05654.
- [4]. 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", submitted to *Nature Scientific Data*; *arXiv preprint*: 2107.10387. (\* authors contributed equally)

### Journal and Conference Papers

- [5]. **W. Cui** and B. Zhang, "Lyapunov-Regularized Reinforcement Learning for Power System Transient Stability ", *IEEE Control Systems Letters (L-CSS)* 2021;6:974-979.
- [6]. 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;99:1-18.
- [7]. 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;241:46-58. (\*corresponding author)

- [8]. **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; 33(6):6935-6950.
- [9]. 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; 121(5):52059. (\*corresponding author)
- [10]. **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;142:2050–2056.
- [11]. Y. Ding, H. Hui, Z. Lin, M. Zheng, X. Qu, **W. Cui**, "Design of Business Model and Market Framework Oriented to Active Demand Response of Power Demand Side", *Automation of Electric Power Systems* 2017; 41(14):2-9.
- [12]. J. Liu, **W. Cui**, C. Wang, M. Liu, Q. Xu, "Feasibility Analysis on Using Photovoltaic System with Battery as Black-Start Unit Under Uncertain Environment", *Southern Power System Technology* 2016; 10(8): 82–88.

## TALKS AND PRESENTATIONS

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- [1]. "Lyapunov-regularized Reinforcement Learning for Power System Transient Stability ", INFORMS Annual Meeting, Anaheim, CA, 2021/10.
- [2]. "Power System Dynamic Prediction using Fourier Neural Operator", Azure Global Commercial Industry, Microsoft, Redmond, WA, 2021/09. Hosted by Dr. Peeyush Kumar.
- [3]. "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.
- [4]. "Reinforcement Learning for Optimal Frequency Control: A Lyapunov Approach", *Tackling Climate Change with Machine Learning workshop at ICML 2021*, spotlight talk, 2021/07.
- [5]. "Two-Stage Payback Model for the Assessment of Curtailment Services Provided by Air Conditioners", *the 9th International Conference on Applied Energy*, Cardiff, UK, 2017/08.

## SELECTED RESEARCH EXPERIENCE

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### **A Lyapunov Approach for Safe Reinforcement Learning    Apr. 2020 - Nov. 2021**

- 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
- For lossy power networks without a well-defined Lyapunov function, we proposed to learn a neural Lyapunov function as regularization for safe RL

### **Decentralized and Centralized Training Framework for Safe RL    Oct. 2019 - Nov. 2021**

- 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 nodes 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

### **Optimization and Control for Power System Operation    Sept. 2016 - Dec. 2019**

- Proposed an optimal sequential dispatch strategy of demand side resources to mitigate the harmful payback effect to the power system
- Improved the reliability of demand side resources for the provision of ancillary services, e.g., frequency regulation, spinning reserve, non-spinning reserve
- Implemented a coupon-based pilot demand response policy in residential areas with approximately 110,000 residential customers in Changzhou and Suzhou

## **PATENTS AND SOFTWARE COPYRIGHTS**

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- [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**

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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%)
Aug. 2014	Third Prize in 2014 National University Student Social Practice and Science Contest on Energy Saving & Emission Reduction, Chinese Ministry of Education

## **SERVICES & ACTIVITIES**

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Nov. 2018 - Present	Reviewer for IEEE Transactions on Power Systems; IEEE Transactions on Smart Grid; Applied Energy; American Control Conference
Oct. 2020 - Present	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