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Daniel Arnold

Appointments

Lawrence Berkeley National Laboratory, Berkeley, Ca. — *Research Scientist*

July 2017 - PRESENT

- Deputy Cybersecurity R&D Lead, responsible for fundraising, project planning, project execution, interacting with program sponsors and other stakeholders
- Conduct research at the intersection of machine learning, control theory, convex optimization, and electric power systems
- Develop artificial intelligence and machine learning algorithms to increase the cyber-resiliency of the electric power distribution grid

Civil and Environmental Engineering Dept., UC Berkeley, Berkeley, Ca. — *Adjunct Professor*

July 2023 - PRESENT

Civil and Environmental Engineering Dept., UC Berkeley, Berkeley, Ca. — *Lecturer*

Jan. 2018 - July 2023

Lawrence Berkeley National Laboratory, Berkeley, Ca. — *ITRI-Rosenfeld Postdoctoral Fellow*

Jan. 2016 - July 2017

- Develop data analysis pipeline in python for clustering and regression analysis of electric power distribution grid synchrophasor data
- Develop model-free optimization algorithms for real-time control of distributed energy resources

Teaching

CE 295 - Data Science for Energy (https://ecal.berkeley.edu/ce295.html)

- Introduces data science fundamentals and programming techniques to graduate and upper division students, with energy focus
- Course content includes: dynamic systems modeling, state estimation, convex optimization, machine learning, and optimal control

CE 191 - Engineering Systems Analysis (https://ecal.berkeley.edu/ce295.html)

- Introduces optimization fundamentals and programming techniques to graduate and upper division undergraduate students

- Course content includes: linear programming, quadratic programming, mixed integer programming, nonlinear programming, search algorithms, and dynamic programming

EDUCATION

U.C. Berkeley, Berkeley, Ca. — *Ph.D Mechanical Engineering*

Sept. 2009 - Dec. 2015
Advisors: Duncan Callaway and David Auslander
Dissertation: Extremum Seeking Control of Distributed Energy Resources

U.C. San Diego, San Diego, Ca. — *M.S. Mechanical Engineering*

Sept. 2005 - Dec. 2006
Advisor: Miroslav Krstic

U.C. San Diego, San Diego, Ca. — *B.S. Mechanical Engineering (cum laude)*

Sept. 2001 - Sept. 2005

RELEVANT PROJECTS

Mitigation via Analytics for Grid-Inverter Cybersecurity (MAGIC), PI — *$5,000,000 award*

Jan. 2024 - Dec. 2027

- Sponsor: Risk Management and Tools (RMT) program, U.S. Department of Energy, CESER office
- Objective: Creation of artificial intelligence-based cyber attack detection and mitigation algorithms for distributed energy resources in the electric power grid.

Supervisory Parameter Adjustment for Distribution Energy Storage (SPADES), PI — *$3,000,000 award*

Jan. 2019 - July 2023

- Sponsor: Risk Management and Tools (RMT) program, U.S. Department of Energy, CESER office
- Objective: Creation of reinforcement learning-based controllers to manage battery storage systems to counteract cyber attacks on the electric grid.

Cybersecurity via Inverter-Grid Automatic Reconfiguration (CIGAR), co-PI — *$2,500,000 award*

April 2018 - Mar. 2021

- Sponsor: Cyber Security for Energy Delivery Systems (CEDS) program, U.S. Department of Energy
- Objective: Creation of reinforcement learning-based controllers to manage rooftop solar panels to counteract cyber attacks on the electric grid

SELECT PUBLICATIONS

Conference

Wu, T., Scaglione, A., Arnold, D., and Chen, T., “Transferable Learning of GCN Sampling Graph Data Clusters from Different Power Systems.” Allerton Conference, 2024, *accepted.*

Wu, T., Scaglione, A., and Arnold, D. “Constrained Reinforcement Learning for Dynamic Optimal Power Flow Control”, IEEE Power and Energy Society General Meeting (PESGM), 2023.

Roberts, C., Callaway, D. S., and Arnold, D., “Adaptive Control of Converter-Interfaced Generation for Cyber-Physical Security,” 56th Hawaii International Conference on System Sciences (HICSS), Maui, HI, Jan. 2023.

Wu, T., Scaglione, A., and Arnold, D. “Graph Convolutional Neural Network for the Control of Smart Inverters in Power Grids”, 58th Annual Allerton Conference on Communication, Control, and Computing (Allerton) , Sept. 2022.

D. Arnold, S. Ngo, C. Roberts, Y. Chen, A. Scaglione, S. Peisert, “Adam-based Augmented Random Search for Control Policies for Distributed Energy Resource Cyber Attack Mitigation”, American Control Conference (ACC), Atlanta, GA., June 2022, pp. 4559-4566.

C. Roberts, S. Ngo, A. Milesi, A. Scaglione, S. Peisert, and D. Arnold, “Deep Reinforcement Learning for Mitigating Cyber-Physical DER Voltage Unbalance Attacks", American Control Conference (ACC), New Orleans LA, 2021, pp. 2861-2867.

C. Roberts, S. Ngo, A. Milesi, S. Peisert, S. Saha, A Scaglione., N. Johnson, A. Kocheturov, D. Fradkin, and D. Arnold “Deep Reinforcement Learning for DER Cyberattack Mitigation", IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm), Tempe, AZ, USA, 2020, pp. 1-7.

Journal

Wu, T., Scaglione, A., and Arnold, D. “Complex-Value Spatio-temporal Graph Convolutional Neural Networks and its Applications to Electric Power Systems AI,” IEEE Transactions on Smart Grid, 2023.

Wu, T., Scaglione, A., and Arnold, D., “Constrained Reinforcement Learning for Predictive Control in Real-Time Stochastic Dynamic Optimal Power Flow,” in IEEE Transactions on Power Systems, 2023.

Roberts, C., Arnold, D., and Callaway, D., “An Online Adaptive Damping Controller for Converter-Interfaced Generation.”, IEEE Transactions on Power Systems, 2023.

Losada Carreno, I., Saha, S. S., Scaglione, A., Arnold, D., Ngo, S., and Roberts, C., “Log(v) 3LPF: A Linear Power Flow Formulation for Unbalanced Three-Phase Distribution Systems,” IEEE Transactions on Power Systems, Vol. 38(1), Mar. 2022, pp. 100 - 113.

D. Arnold, S.Saha, S. Ngo, C. Roberts, A. Scaglione, N. Johnson, S. Peisert, and D. Pinney, “Adaptive Control of Distributed Energy Resources for Distribution Grid Voltage Stability”, IEEE Transactions on Power Systems, *Vol. 38(1), Mar. 2022, pp. 129 - 141.*

S. Saha. D. Arnold, A. Scaglione, E. Schweitzer, C. Roberts, S. Peisert, and N. Johnson, “Lyapunov Stability of Smart Inverters Using Linearized DistFlow

Approximation”, IET Renewable Power Generation, vol. 15, no. 1, pp. 114-126, 2021.

R. Dobbe, W. Van Westering, S. X. Liu, D. Arnold, D. S. Callaway and C. Tomlin, "Linear Single- and Three-Phase Voltage Forecasting and Bayesian State Estimation with Limited Sensing," IEEE Transactions on Power Systems, vol. 35, no. 3, pp. 1674-1683, May 2020.

E. Schweitzer, S. S. Saha, A. Scaglione, N. G. Johnson and D. Arnold, "Lossy DistFlow Formulation for Single and Multiphase Radial Feeders," IEEE Transactions on Power Systems, vol. 35, no. 3, pp. 1758-1768, May 2020.

R. Dobbe, O. Sondermeijer, D. Fridovich-Keil, D. Arnold, D. Callaway, C. Tomlin, “Towards Distributed Energy Services: Decentralizing Optimal Power Flow with Machine Learning”, IEEE Transactions on Smart Grid, vol. 11, no. 2, pp. 1296-1306, March 2020.

M.D. Sankur, R. Dobbe, A. von Meier, E. Stewart, and D. Arnold, “Model-Free Optimal Voltage Phasor Regulation in Unbalanced Distribution Systems”, vol. 11, no. 1, pp. 884-894, Jan. 2020.

C. Roberts, A. Scaglione, M. Jamei, R. Gentz, S. Peisert, E. Stewart, C. McParland, A. McEachern, and D. Arnold, “Learning Behavior of Distribution System Discrete Control Devices for Cyber-Physical Security”, IEEE Transactions on Smart Grid, vol. 11, no. 1, pp. 749-761, Jan. 2020.

D. Arnold, M. Negrete-Pincetic, M. Sankur, and D. Callaway, “Model-Free Optimal Coordination of Distributed Energy Resources for Provisioning Transmission-Level Services” IEEE Transactions on Power Syst., vol. 33, issue 1, pp. 817-828, 2018.

D. Arnold, M. Negrete-Pincetic, M. Sankur, D. Auslander, and D. Callaway, “Model-Free Optimal Control of VAR Resources in Distribution Systems: An Extremum Seeking Approach,” IEEE Transactions on Power Systems, vol. 31, issue 5, pp. 3583-3593, 2016.

C. Zhang, D. Arnold, N. Ghods, A. Siranosian, and M. Krstic, “Source Seeking with Nonholonomic Unicycle Without Position Measurement and with Tuning of Forward Velocity,” Systems and Control Letters, vol. 56, pp. 245-252, 2007.