Pengfei Zhao

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PERSONAL INFORMATION

Birthdate:	Mar 8, 1995 (Beijing, China)
Research Direction:	AI + OR for Energy Management
Position:	Associate Professor, Chinese Academy of Sciences
Google Scholar:	Alexis Pengfei Zhao - Google Scholar
Total Citation (Google Scholar):	1034
Total Publications:	72
First Authored Publications:	26
First Authored IEEE Trans Papers:	19
Researchgate:	Alexis Pengfei Zhao (researchgate.net)
ORCID:	0000-0001-8751-9750
h-index:	**19 (31, i10-index)**

EDUCATION

University of Bath Bath, United Kingdom
Ph.D., Electronic & Electrical Engineering Sep 2017 – Dec 2020
Centre for Sustainable Energy Systems, Institute for Advanced Automotive Propulsion Systems
Advisor: Dr. Reader. Chenghong Gu
Thesis: “Optimization for Integrated Electricity & Gas Systems Considering Uncertainties”

Tsinghua University Beijing, China
Visiting scholar, Department of Electrical Engineering Dec 2019 – Mar 2020
Supervisor: Prof. Yonghua Song (Award Fellow of the Royal Academy of Engineering), Prof. Zechun Hu

North China Electric Power University & University of Bath Bath, United Kingdom
Bachelor of Engineering, Department of Electronic & Electrical Engineering Sep 2013 – Jul 2017

WORK EXPERIENCE

Chinese Academy of Sciences, Institute of Automation (CASIA) Beijing, China

Associate Professor Dec 2020 – Aug 2024

Lab Director: Prof. Feiyue Wang, Prof. Tieniu Tan

State Key Laboratory of Management and Control for Complex Systems
State Key Laboratory of Multimodal Artificial Intelligence Systems

Cornell University New York, US

Assistant Research Professor Sep 2024 – (TBD)

Lab Director: Prof. David Shmoys, Prof. Fengqi You

Center for Data Science for Enterprise & Society

CASIA is the first established national research institute for AI and automation and the earliest national research institutes for conducting brain-inspired intelligence research in China. It is widely recognized as one of the top institutes in the field of AI research in China and worldwide. CASIA has two state key laboratories in AI and control field and has 3 academicians of Chinese Academy of Sciences. CASIA has world renown academic reputation in the field of AI. According to Elsevier (2017), **CAISA's publication impact factor in AI ranks seventh in the world and first in China**.

RESEARCH INTERESTS

AI + OR for Energy Management

My research interests are the complexities of intertwining technological, environmental, and societal factors within energy systems, aiming to forge pathways towards sustainability and resilience. By pioneering sophisticated methodologies and frameworks, I confront the multifaceted challenges inherent in water-energy-carbon nexus management, multi-energy management, cybersecurity, social computing modeling, and distributionally robust optimization.

- ✓ **AI + Operation Research:** When AI and OR are combined, it allows for more intelligent, data-driven, and adaptive approaches to solving complex real-world problems. AI + OR is applied across various domains, including logistics, supply chain management, finance, healthcare, energy, and more, to improve efficiency, effectiveness, and decision quality. For example, the integration of distributionally robust Q-learning exemplifies the synergy between AI and OR in solving complex real-world problems. Unlike conventional Reinforcement Learning, it leverages advanced mathematical techniques to address robustness challenges and adapt to diverse real-world conditions. This algorithm transforms complex learning problems into tractable ones, showcasing the power of mathematical sophistication. With multi-level Monte-Carlo sampling, it attains precise approximations, demonstrating its effectiveness despite mathematical complexity. In domains like logistics, supply chain management, finance, healthcare, and energy, the fusion of AI and OR empowers intelligent, data-driven, and adaptive solutions, enhancing efficiency, effectiveness, and decision quality.

- ✓ **Water-Energy-Carbon Nexus:** I tackle the intricate optimization of interconnected water, energy, and carbon resources. This involves advanced modeling to capture the nuanced dynamics among these critical resources, considering regional disparities, policy frameworks, and climate change implications. My goal is to devise adaptive strategies that are robust against future uncertainties, employing cutting-edge optimization and simulation techniques. The challenge is multifaceted, encompassing technical innovation as well as the strategic navigation of regulatory and stakeholder landscapes to realize sustainable resource management.
- ✓ **Multi-Energy Management:** My work in multi-energy management focuses on the cohesive integration and optimization of diverse energy carriers. This demands a deep understanding of the physical and operational intricacies of various energy sources, necessitating the development of innovative mathematical models and algorithms. These models are adept at managing the stochastic nature of energy supply and demand, the interdependencies between systems, and the integration of decentralized energy resources. Incorporating real-time data and predictive analytics, I aim to dynamically manage these complex systems, highlighting the sophisticated integration of distributed resources and demand response mechanisms.
- ✓ **Cybersecurity in Energy Systems:** In the realm of energy systems' cybersecurity, I spearhead the development of advanced defense mechanisms that utilize artificial intelligence, machine learning, and blockchain technologies. My research is not just about defending against cyber threats but ensuring the resilience of critical infrastructures against evolving cyber challenges. This area requires a blend of technical prowess and strategic foresight, aiming to pre-empt and neutralize potential cyber threats through innovative security strategies that can adapt to future adversarial tactics.
- ✓ **Social Computing Modelling in Energy Systems:** My incorporation of social computing modeling into energy systems research represents a novel approach to understanding and influencing energy consumption behaviors. This interdisciplinary venture combines behavioral science, big data analytics, and user-centric design to leverage social networks, gamification, and participatory sensing. The primary challenge here is the accurate modeling of unpredictable human behaviors and crafting interventions that effectively promote energy efficiency and sustainability across diverse communities.
- ✓ **Distributionally Robust Optimization:** My work with Distributionally Robust Optimization seeks to create optimization models resilient to worst-case scenarios of uncertain parameters, a critical aspect of decision-making under uncertainty. This effort involves forging new theoretical frameworks and computational algorithms capable of dealing with ambiguous and incomplete data. Drawing on statistics, machine learning, and operations research, I aim to equip energy planners and operators with tools for optimal performance and resilience, even under significant future uncertainties like renewable energy availability, market volatility, and climate change impacts.

FIRST AUTHORED PUBLICATIONS

1. P. Zhao, C. Gu, D. Huo, Y. Shen and I. Hernando-Gil, "Two-Stage Distributionally Robust Optimization for Energy Hub Systems," in ***IEEE Transactions on Industrial Informatics***, vol. 16, no. 5, pp. 3460-3469, May 2020. (IF=12.3)
2. P. Zhao, Z. Cao, D. D. Zeng, C. Gu, Z. Wang, Y. Xiang, M. Qadrdan, X. Chen, X. Yan, and S. Li, "Cyber-Resilient Multi-Energy Management for Complex Systems," ***IEEE Transactions on Industrial Informatics***, vol. 18, no. 3, pp. 2144-2159, 2022, doi: 10.1109/TII.2021.3097760. (IF=12.3)

3. P. Zhao, C. Gu, Z. Cao, Y. Shen, F. Teng, X. Chen, C. Wu, D. Huo, X. Xu and S. Li, , "Data-Driven Multi-Energy Investment and Management under Earthquakes," in ***IEEE Transactions on Industrial Informatics***, doi: 10.1109/TII.2020.3043086. (IF=12.3)
4. P. Zhao, S. Li, P. J. H. Hu, C. Gu, S. Lu, S. Ding, Z. Cao, D. Xie, and Y. Xiang, "Blockchain-Based Water-Energy Transactive Management With Spatial-Temporal Uncertainties," ***IEEE Transactions on Smart Grid***, vol. 14, no. 4, pp. 2903-2920, 2023, doi: 10.1109/TSG.2022.3230693. (IF=9.6)
5. P. Zhao, S. Li, P. J. H. Hu, C. Gu, Z. Cao, and Y. Xiang, "Managing Water-Energy-Carbon Nexus for Urban Areas With Ambiguous Moment Information," ***IEEE Transactions on Power Systems***, vol. 38, no. 5, pp. 4432-4446, 2023, doi: 10.1109/TPWRS.2022.3214189. (IF=6.6)
6. P. Zhao, C. Gu, Z. Cao, D. Xie, F. Teng, J. Li, X. Chen, C. Wu, D. Yu, X. Xu and S. Li "A Cyber-Secured Operation for Water-Energy Nexus," in ***IEEE Transactions on Power Systems***, doi: 10.1109/TPWRS.2020.3043757. (IF=6.6)
7. P. Zhao, C. Gu, Z. Hu, X. Zhang, X. Chen, I. Hernando-Gil and Y. Ding, "Economic-Effective Multi-Energy Management with Voltage Regulation Networked with Energy Hubs," in ***IEEE Transactions on Power Systems***, doi: 10.1109/TPWRS.2020.3025861. (IF=6.6)
8. P. Zhao, X. Lu, C. Gu, Q. Ai, H. Liu, Z. Cao, Y. Bian and S. Li. " Volt-VAR-Pressure Optimization of Integrated Energy Systems with Hydrogen Injection," in ***IEEE Transactions on Power Systems***, doi: 10.1109/TPWRS.2020.3028530. (IF=6.6)
9. P. Zhao, C. Gu, Q. Ai, Y. Xiang, T. Ding and S. Li. " Water-Energy Nexus: A Mean-Risk Distributionally Robust Co-Optimization of District Integrated Energy Systems," in ***IEEE Transactions on Power Systems***, doi: 10.1109/TPWRS.2020.3038076. (IF=6.6)
10. P. Zhao, C. Gu, Z. Hu, D. XIE, I. Hernando-Gil and Y. Shen, "Distributionally Robust Hydrogen Optimization with Ensured Security and Multi-Energy Couplings," in ***IEEE Transactions on Power Systems***, doi: 10.1109/TPWRS.2020.3005991. (IF=6.6)
11. P. Zhao, C. Gu and D. Huo, "Two-Stage Coordinated Risk Mitigation Strategy for Integrated Electricity and Gas Systems under Malicious False Data Injections," in ***IEEE Transactions on Power Systems***, doi: 10.1109/TPWRS.2020.2986455. (IF=6.6)
12. P. Zhao, S. Li, Z. Cao, P. J.-H. Hu, D. D. Zeng, D. Xie, Y. Shen, J. Li, and T. Luo, "A Social Computing Method for Energy Safety," ***Journal of Safety Science and Resilience***, 2024/01/12/ 2024, doi: https://doi.org/10.1016/j.jnlssr.2023.12.001. (IF=5.4)
13. P. Zhao, S. Li, Z. Cao, P. J. H. Hu, C. Gu, X. Yan, D. Huo, T. Luo, and Z. Wang, "Socially Governed Energy Hub Trading Enabled by Blockchain-Based Transactions," ***IEEE Transactions on Computational Social Systems***, pp. 1-16, 2023, doi: 10.1109/TCSS.2023.3308608. (IF=5)
14. P. Zhao, Y. Ding, C. Gu, H. Liu, Y. Bian and S. Li, "Cyber-Resilience Enhancement and Protection for Uneconomic Power Dispatch under Cyber-Attacks," in ***IEEE Transactions on Power Delivery***, doi: 10.1109/TPWRD.2020.3038065. (IF=4.4)
15. P. Zhao, S. Li, PJ. Hu, Z. Cao, C. Gu, D. Xie, D. Zeng, "Coordinated Cyber Security Enhancement for Grid-Transportation Systems With Social Engagement," in ***IEEE Transactions on Emerging Topics in Computational Intelligence***, 2022, doi: 10.1109/TETCI.2022.3209306 (IF=5.3)
16. P. Zhao, S. Li, PJ. Hu, Z. Cao, C. Gu, X. Yan, D. Huo, I. Hernando-Gil, "Two-Stage Co-Optimization for Utility-Social Systems With Social-Aware P2P Trading," in ***IEEE Transactions on Computational Social Systems***, 2022, doi: 10.1109/TCSS.2022.3200032 (IF=5)
17. Zhao, P., Gu, C., Cao, Z., Xiang, Y., Yan, X. and Huo, D., 2020, September. A two-stage data-driven multi-energy management considering demand response. In Adjunct Proceedings of the 2020

ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2020 ACM International Symposium on Wearable Computers (pp. 588-595).

18. S. Li, P. Zhao, C. Gu, S. Bu, J. Li, and S. Cheng, "Integrating Incentive Factors in the Optimization for Bidirectional Charging of Electric Vehicles," ***IEEE Transactions on Power Systems***, pp. 1-12, 2023, doi: 10.1109/TPWRS.2023.3308233. (IF=6.6) (Co-first author)
19. S. Li, P. Zhao, C. Gu, S. Bu, J. Li, and S. Cheng, "Modeling and Mitigating the Cycle Aging Cost of Vehicle Batteries in Energy Transportation Nexus," ***IEEE Transactions on Smart Grid***, pp. 1-1, 2023, doi: 10.1109/TSG.2023.3296328. (IF=9.6) (Co-first author)
20. S. Li, P. Zhao, C. Gu, S. Bu, X. Pei, X. Zeng, J. Li, and S. Cheng, "Hybrid Power System Topology and Energy Management Scheme Design for Hydrogen-Powered Aircraft," ***IEEE Transactions on Smart Grid***, pp. 1-1, 2023, doi: 10.1109/TSG.2023.3292088. (IF=9.6) (Co-first author)
21. P. Zhao, C. Gu, Y. Xiang, X. Zhang, Y. Shen and S. Li, "Reactive Power Optimization in Integrated Electricity and Gas Systems," in ***IEEE Systems Journal***, doi: 10.1109/JSYST.2020.2992583. (IF=4.4)
22. P. Zhao, H. Wu, C. Gu, and I. H. Gil, "Optimal Home Energy Management under Hybrid PV-Storage Uncertainty: A Distributionally Robust Chance-Constrained Approach," ***IET Renewable Power Generation***, vol. 13, no. 11, pp. 1911-1919, 19 8 2019. (IF=3.0)
23. P. Zhao, I. Hernando-Gil, and H. Wu, "Optimal Energy Operation and Scalability Assessment of Microgrids for Residential Services," in 2018 IEEE International Conference on Environment and Electrical Engineering and 2018 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), 12-15 June 2018 2018, pp. 1-6, doi: 10.1109/EEEIC.2018.8493765.

PROJECT EXPERIENCE

1. **Project #1:** Cross-Modal Social Risk Perception and Understanding
   Funder: Ministry of Science and Technology, China
   Time: Jan 2020 – June 2025
   Key task:

- ✓ Cross-Modal Analysis: Cross-modal analysis of social risk perception, encompassing various communication channels such as traditional media, social media, interpersonal interactions, and emerging technologies.
- ✓ Stakeholder Engagement: Surveys, interviews, and focus groups with a diverse range of stakeholders, including government agencies, civil society organizations, community leaders, and the general public.
- ✓ Qualitative Assessment of Risk Factors: Key factors and parameters that contribute to social risk perception and understanding.
- ✓ Development of Analytical Tools: Evaluation of the impact of various communication strategies, risk management initiatives, and policy interventions on societal responses to emerging risks.
- ✓ Interdisciplinary Approach: A holistic understanding of cross-modal social risk perception and its implications for decision-making and policy formulation.

2. **Project #2:** Policy Derivation for Complex Social Systems
   Funder: NSFC, China
   Role: Research fellow.
   Time: Dec 2022 – Dec 2027
   Key task:

- ✓ Complex Systems Analysis: A comprehensive analysis of complex societal systems, exploring the interdependencies among various factors such as technological advancements, environmental pressures, economic dynamics, and social trends.
- ✓ Stakeholder Engagement: A diverse array of stakeholders, including government entities, civil society organizations, industry representatives, and the general public.
- ✓ Qualitative Policy Assessment: A qualitative assessment of existing policies and regulations within complex social systems.
- ✓ Policy Modeling and Simulation: Scenarios to assess the potential impact of proposed policies on complex social systems to predict outcomes, evaluating trade-offs, and refining policy recommendations.
- ✓ Policy Derivation Framework: A comprehensive policy derivation framework that combines insights from stakeholder engagement, complex systems analysis, and policy modeling.

3. **Project #3:** Big Data-Driven Cybersecurity Informatics
   Funder: NSFC, China
   Time: Jan 2017 – Dec 2022
   Key task:

- ✓ Big Data Analysis: The analysis of vast and complex datasets related to cybersecurity incidents, network traffic, and threat intelligence.
- ✓ Stakeholder Collaboration: A wide spectrum of stakeholders, including government agencies, cybersecurity firms, academic institutions, and private sector organizations.
- ✓ Qualitative Assessment of Cybersecurity Policies: A qualitative assessment of existing cybersecurity policies and regulations.
- ✓ Predictive Modeling and Threat Detection: Algorithms for early threat detection and anomaly recognition.
- ✓ Informatics Framework: An informatics framework that integrates insights from big data analysis, stakeholder collaboration, policy assessment, and predictive modeling.

TEACHING EXPERIENCE

- **Course: Social Computing Fundamentals**

  Main content: Uncovering trends through social media analysis; Visual storytelling with data; Network dynamics and behavioral insights; Sentiment analysis in digital conversations; Interactive dashboards for real-time data engagement; Statistical computing for social pattern recognition.

  Duty: Conducting academic research related to social computing, involving literature reviews, data collection, and analysis; Assisting the instructor in managing course logistics, preparing materials, and possibly handling some grading or student inquiries; Facilitating discussions, study groups, or mentoring students on course-related projects; Assisting in creating or updating course content, such as lecture slides, reading lists, or case studies.

BOOK

Zhao P, Gu C, Cao Z, and Li S. **Integrated Energy System: A Low-Carbon Future Enabler**. The 4Ds of Energy Transition: Decarbonization, Decentralization, Decreasing Use and Digitalization, 2022: 207-238.