

Zhongyuan Zhao

Curriculum Vitae

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Keywords

Wireless Communications & Systems
Autonomous Networks
Cloud/Edge/Fog Computing
Signal Processing

AI/Machine Learning
Graph Neural Networks
Combinatorial Optimization
Distributed Algorithms

Education

- 2019 **Ph.D. in Computer Engineering**, University of Nebraska-Lincoln.
Minor in Finance (15 credits)
Advisor: Mehmet C. Vuran
- 2009 **M.S. in Signal and Information Processing**, University of Electronic Science and Technology of China, Department of Electronic Engineering.
Advisor: Zishu He
- 2006 **B.S. in Information Countermeasures Technology**, University of Electronic Science and Technology of China, Department of Electronic Engineering.

Research Experience

- 2024–Cont. **Research Assistant Professor**, RICE UNIVERSITY, Houston, TX.
- 2019–2024 **Postdoctoral Research Associate**, RICE UNIVERSITY, Houston, TX.
Conduct research on graph neural networks and graph-based reinforcement learning to address the resource allocation challenges in infrastructureless wireless networks, in particular, seeking distributed solutions for near-optimal link scheduling, routing, and computational offloading. Write research papers, reports, and proposals. Supervise PhD and undergraduate students.
- 2019 **Software Developer**, UNIVERSITY OF NEBRASKA-LINCOLN, Lincoln, NE.
Developed software with Python+R to facilitate drug repurposing for gene-related diseases.
- 2013–2019 **Research Assistant**, UNIVERSITY OF NEBRASKA-LINCOLN, Lincoln, NE.
Conducted research on smart wireless networks for enhanced network capacity and spectrum efficiency. Developed interactive spectrum sharing, large-scale wireless testbed, and artificial neural network-based wireless receiver. Wrote research papers, reports, and proposals.
- 2011–2013 **Radio-Frequency Integration and Verification Engineer**, ERICSSON, Chengdu, China.
Conducted R&D tests for radio frontends in TD-LTE base-stations. Led radio test automation.
- 2009–2011 **DSP Software Engineer**, ARRAYCOMM, Chengdu, China.
Developed digital signal processing (DSP) software for 4th generation (4G) cellular base-stations.
- 2006–2009 **Research Assistant**, UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA, Department of Electronic Engineering, Chengdu, China.
Designed mixed-signal printed circuit boards (PCB) and developed DSP and FPGA software for a software-defined radio receiver and a PID control system for high-power electrical motor.

Publication Summary

- Journal 8 peer-reviewed journal articles since 2013 (4 as first author) in wireless systems (TWC, JSAC, TVT, CC, Ad-Hoc), operations research (M&SOM), bioinformatics
- Conference 12 peer-reviewed conference papers (10 as first author) in machine learning (ICLR), signal processing (ICASSP, CAMSAP), wireless systems (GlobeCom, DySPAN, BalkanCom)
- Patent 2 patents (1 as first author) in digital signal processing and analog circuit design
- Impact 352 citations, 9 h-index, 7 i10-index (Google Scholar, 07/20/24)
- [Full list of publications can be found at the end of this CV](#)

Research Proposals

- 2023 Participated in writing proposal "Distributed Machine Learning for Tactical Networks" to Army Research Office, award amount: \$1.1M
- 2015–2018 Participated in writing proposal "CoSeC-RAN: Cognitive Secure Cloud RAN for Efficient Spectrum Sharing", award: NSF CNS #1731833, amount \$435,399; and an US-Ignite grant.

Teaching Experience

- 2020–2023 **Research Mentor**, *Dept. of Electrical and Computer Engineering*, Rice University.
Guided undergraduates in 3-month research internships (Summer 2020, 2022 [C3]).
- 2017–2019 **Teaching Assistant**, *Dept. of Computer Science & Engineering*, Univ. of Nebraska-Lincoln.
Data Structure and Algorithms (Fall 2017, Spring 2019).
Multi-Agent System (Fall 2017).
- 2017 **ITA Teaching Certificate**, *Institute for International Teaching Assistants*, University of Nebraska-Lincoln.
Advanced training for teaching on the college and university level, August 2017.
- 2016–2018 **Senior Design Mentor**, *Jeffrey S. Raikes School of Computer Science and Management*, University of Nebraska-Lincoln.
Guided undergraduate teams in their senior design projects (2016-2017 [C10], 2017-2018).
- 2005–2007 **Teaching Assistant**, *Undergraduate Innovation Centre*, University of Electronic Science and Technology of China.
Advised undergraduates in a 2-year training program for national electronic design contest.

Selected Projects

- 2023–Cont. **Distributed Machine Learning for Tactical Networks**, *Rice University*, PI: Santiago Segarra, Co-PI: Ashutosh Sabharwal, references: [C1].
Investigate distributed multi-hop computational offloading in infrastructureless wireless networks to support the army's multi-domain operations through edge AI. Develop graph neural networks, distributed learning, and fail-safe mechanism to enhance the contextual awareness, adaptability, scalability, and robustness of edge AI solutions in self-organizing autonomous networks.
- 2019–Cont. **Autonomous Networking for Multi-domain Operations**, *Rice University*, PI: Ashutosh Sabharwal, Edward W. Knightly, Santiago Segarra, references: [C2, C3, C4, C5, C6, C7, J3].
Conduct research on graph neural networks and graph-based reinforcement learning to address resource allocation challenges in infrastructureless wireless networks, in support of the army's multi-domain operations. Develop efficient and distributed heuristics for link scheduling, routing, and computational offloading, which can improve the efficiency, performance, and edge intelligence of networks while retaining their self-organizing capabilities, scalability, and robustness.

- 2019 **Computational Biology for Drug Repurposing**, *University of Nebraska-Lincoln*, PI: Tomáš Helikar, references: [J2].
Developed software with Python+R to facilitate identification of potential drug candidates for gene-related diseases, by analyzing human genome data and molecular interaction networks.
- 2018–2021 **Neural OFDM Receiver**, *University of Nebraska-Lincoln*, PI: Mehmet C. Vuran, co-PI: Stephen D. Scott, references: [J4, T1].
Developed a wireless receiver using deep neural networks (DNNs) to directly process time-domain orthogonal frequency-division multiplexing (OFDM) signals, gaining extra performance from redundancy in the cyclic prefix (CP) discarded by FFT/iFFT-based receivers. It established a data-driven model-inspired approach for addressing signal artifacts and model mismatches in wireless systems.
- 2017 **Experimental Vehicle-to-Barrier Communications**, *University of Nebraska-Lincoln*, PI: Mehmet C. Vuran, references: [J8].
Investigated transient behaviors of wireless channels in vehicle-to-barrier communications under different antenna configurations, in order to provide design guidelines for smart barriers for reducing single-vehicle crashes. Participated in measurements and led the data analysis of 5.8GHz radio propagation between vehicles and road-side barriers during experimental crash tests.
- 2017–2019 **Nebraska Experimental Testbed of Things (NEXTT)**, *University of Nebraska-Lincoln*, PI: Mehmet C. Vuran, references: [C8, J5, T1].
Collaborated with university, government, and industrial partners to develop NEXTT, a large-scale cloud-radio access network (Cloud-RAN) testbed. NEXTT connects computing clusters to software-defined radio (SDR) transceivers deployed across two university campuses and a public street. It facilitates wireless research and education by providing researchers and students with easy access to live experiments and datasets in areas such as cellular, vehicle-to-infrastructure, and underground-to-aboveground communications. The testbed has benefited hundreds of researchers and students, and supported multiple courses at Univ. of Nebraska-Lincoln (CSCE 465, 422, 990, ECE6102).
- 2013–2017 **Cog-TV: Business and Technical Analysis of Cognitive Radio TV Sets for Enhanced Spectrum Access**, *University of Nebraska-Lincoln*, PI: Mehmet C. Vuran, co-PI: Demet Batur, references: [C9, C10, C11, J7, J6, T1].
Studied the feasibility of providing wireless broadband services on the television (TV) spectrum with the help of cooperative TV sets. Developed a technical solution and analyzed how much TV-band spectrum could be opportunistically accessed in 274 U.S. cities, based on databases of TV ratings, census, and TV stations [C10, C11, J6]. Developed a dynamic pricing scheme for the network operators to profit and manage congestion under frequent interruptions from TV viewers [J7], and a model of aggregated interference in shared spectrum for interference management [C9].
- 2011–2013 **R&D Testing of 4G TD-LTE Remote Radio Head**, *Ericsson*, references: [P1].
Conducted extensive testing on the radio frontend of Time-Division Long-Term Evolution (TD-LTE) cellular base stations to ensure compliance with internal and regulatory standards in R&D iterations. Diagnosed radio performance issues under various temperature, moisture, and vibration challenges. Designed a patented clock circuit to withstand vibration challenge [P1]. Led a team of 5 engineers to develop in-house test automation software, coaching the entire department in transitioning from manual to Python programming-based testing, resulting in a 10-fold increase in productivity.
- 2009–2011 **Real-time DSP software for 4G WiMAX and LTE Physical Layer**, *ArrayComm*.
Developed real-time digital signal processing (DSP) software for WiMAX and LTE cellular base-stations, including proprietary algorithms for multi-antenna signal processing (beamforming, MIMO, MU-MIMO, channel estimation), and physical layer protocols (MIMO detection, source & channel coding). Optimized software performance with mixed C and Assembly programming. Designed real-time software system on multi/many-core digital signal processors.

2006–2009 **Channelized Software-Defined Radio (SDR) Receiver**, *University of Electronic Science and Technology of China*, PI: Zishu He, references: [P2, T2].

Developed a channelized multi-antenna SDR receiver for electronic reconnaissance, in which the input analog intermediate-frequency signal is sampled and down-converted into digital base-band signal, and then transformed into 256 ~ 32768 sub-channels of narrow-band signals via a patented high-speed filter bank [P2]. Contributions include design of mixed-signal printed circuit board (PCB) and DSP system on field-programmable gate array (FPGA).

Academic Service

Conference Activities

- 2023 Chair of session “Machine Learning Applications to Communications” at ICASSP
- 2022 Co-chair of session “Machine Learning for Communications” at ICASSP
- 2020 Member of technical program committee at IEEE VTC’20-Fall

Reviewer Duties

Journals Reviewer for 16 academic journals

IEEE Comm. Surveys & Tutorials

IEEE Trans. Wireless Comm. (TWC)

IEEE Trans. Signal Processing (TSP)

IEEE Trans. Mobile Computing

IEEE Trans. Vehicular Technology (TVT)

IEEE Trans. Signal Info. Process. Netw.

Elsevier Physical Communication

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IEEE J. Selected Areas in Comm. (JSAC)

IEEE Comm. Letters

IEEE Signal Processing Letters

IEEE Trans. Multimedia

IEEE Trans. Cognitive Comm. & Netw.

EURASIP J. on Wireless Comm. & Netw.

The Intl. J. Computer & Telecomm. Netw.

Wireless Comm. & Mobile Computing

Conferences Reviewer for 10 IEEE conferences

Asilomar, ICASSP, ICC, INFOCOM, GLOBECOM, DySPAN, LCN, SECON, VTC, ICDCS

Membership

- 2019–Cont. IEEE Signal Processing Society Member
- 2013–Cont. IEEE Communications Society Member
- 2013–Cont. IEEE Member

Community Service

2017–2018 **Secretary**, *Graduate Student Association*, in Dept. of Computer Science and Engineering, University of Nebraska-Lincoln.

Awards

- 2023 Future Faculty Fellow, George R. Brown School of Engineering, Rice University
- 2022 IEEE Signal Processing Society Travel Grant for ICASSP 2022
- 2006–2009 National Scholarship, University of Electronic Science and Technology of China
- 2006 Outstanding Graduate, University of Electronic Science and Technology of China
- 2005 First-class prize in National Undergraduate Electronic Design Contests in China
- 2003–2005 People’s Scholarship, University of Electronic Science and Technology of China

Skills

Languages Chinese (native speaker), English (fluent)
Programming Python, Matlab, C/C++, SQL, Bash, Javascript, Assembly, Verilog HDL, R, SAS
Circuits Mixed-signal and radio-frequency instruments and PCB design

Chartered Financial Analyst (CFA)

CFA[®] Program participant, CFA Institute. Completed CFA level III in 2024. (Max Level III)

Publications

Under Review

- [R1] Negar Erfanian, Zhongyuan Zhao, Kevin Chan, Gunjan Verma, Ananthram Swami, and Santiago Segarra. Ant backpressure routing for wireless multi-hop networks with mixed traffic pattern. In *IEEE Military Communications Conference (MILCOM)*, June 2024. submitted to.
- [R2] Zhongyuan Zhao, Bojan Radojičić, Gunjan Verma, Ananthram Swami, and Santiago Segarra. Biased Backpressure routing using link features and graph neural networks. *IEEE Transactions on Machine Learning in Communications and Networking*, Apr. 2024. submitted to, preprint: <https://arxiv.org/abs/2407.09753>.
- [R3] Zhongyuan Zhao, Gunjan Verma, Ananthram Swami, and Santiago Segarra. Distributed link sparsification for scalable scheduling using graph neural networks. *IEEE Transactions on Wireless Communications*, Feb 2024. submitted to.

Journal Articles

- [J1] Eli Chien, Mufei Li, Anthony Aportela, Kerr Ding, Shuyi Jia, Supriyo Maji, Zhongyuan Zhao, Victor Fung, Callie Hao, Yunan Luo, Olgica Milenkovic, David Pan, Santiago Segarra, Javier Duarte, and Pan Li. Exploring the opportunities and challenges of graph neural networks in electrical engineering. *Nature Reviews Electrical Engineering*, 2024. Accepted for publication.
- [J2] Brandt Bessell, Josh Loecker, Zhongyuan Zhao, Sara Sadat Aghamiri, Sabyasachi Mohanty, Rada Amin, Tomáš Helikar, and Bhanwar Lal Puniya. COMO: A pipeline for multi-omics data integration in metabolic modeling and drug discovery. *Briefings in Bioinformatics*, 24(6), Nov. 2023.
- [J3] Zhongyuan Zhao, Gunjan Verma, Chirag Rao, Ananthram Swami, and Santiago Segarra. Link scheduling using graph neural networks. *IEEE Transactions on Wireless Communications*, 22(6):3997–4012, June 2023.
- [J4] Zhongyuan Zhao, Mehmet Can Vuran, Fujuan Guo, and Stephen D. Scott. Deep-waveform: A learned ofdm receiver based on deep complex-valued convolutional networks. *IEEE Journal on Selected Areas in Communications*, 39(8):2407–2420, Aug. 2021.
- [J5] Zhongyuan Zhao, Mehmet C. Vuran, Baofeng Zhou, Mohammad M.R. Lunar, Zahra Aref, David P. Young, Warren Humphrey, Steve Goddard, Garhan Attebury, and Blake France. A city-wide experimental testbed for the next generation wireless networks. *Ad Hoc Networks*, 111:102305, Feb. 2021.

- [J6] Zhongyuan Zhao, Mehmet C. Vuran, Demet Batur, and Eylem Ekici. Shades of white: Impacts of population dynamics and tv viewership on available tv spectrum. *IEEE Transactions on Vehicular Technology*, 68(3):2427–2442, March 2019.
- [J7] Demet Batur, Jennifer K. Ryan, Zhongyuan Zhao, and Mehmet C. Vuran. Dynamic pricing of wireless internet based on usage and stochastically changing capacity. *Manufacturing and Service Operations Management*, 21(4):1–21, Feb. 2019.
- [J8] Samil Temel, Mehmet C. Vuran, Mohammad M.R. Lunar, Zhongyuan Zhao, Abdul Salam, Ronald K. Faller, and Cody Stolle. Vehicle-to-barrier communication during real-world vehicle crash tests. *Computer Communications*, 127:172–186, Sep. 2018.
- [J9] Haihong Tang and Zhongyuan Zhao. DSP and CPLD-based digital AC soft starter. *Automation Information*, 2007(5):53–55, May 2007.

Conference Publications

- [C1] Zhongyuan Zhao, Jake Perazzone, Gunjan Verma, and Santiago Segarra. Congestion-aware distributed task offloading in wireless multi-hop networks using graph neural networks. In *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 1–5, Seoul, Korea, April 2024. Accepted for publication.
- [C2] Zhongyuan Zhao, Gunjan Verma, Ananthram Swami, and Santiago Segarra. Enhanced backpressure routing using wireless link features. In *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*, pages 1–5, Los Sueños, Costa Rica, Dec. 2023.
- [C3] Zhongyuan Zhao, Bojan Radojičić, Gunjan Verma, Ananthram Swami, and Santiago Segarra. Delay-aware Backpressure routing using graph neural networks. In *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 1–5, Rhodes Island, Greece, June 2023.
- [C4] Zhongyuan Zhao, Ananthram Swami, and Santiago Segarra. Graph-based deterministic policy gradient for repetitive combinatorial optimization problems. In *The 11th International Conference on Learning Representations (ICLR)*, pages 1–21, Kigali, Rwanda, May 2023.
- [C5] Zhongyuan Zhao, Ananthram Swami, and Santiago Segarra. Distributed link sparsification for scalable scheduling using graph neural networks. In *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 5308–5312, Singapore, Singapore, May 2022.
- [C6] Zhongyuan Zhao, Gunjan Verma, Ananthram Swami, and Santiago Segarra. Delay-oriented distributed scheduling using graph neural networks. In *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 8902–8906, Singapore, Singapore, May 2022.
- [C7] Zhongyuan Zhao, Gunjan Verma, Chirag Rao, Ananthram Swami, and Santiago Segarra. Distributed scheduling using graph neural networks. In *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 4720–4724, Toronto, ON, Canada (virtual), June 2021.
- [C8] Zhongyuan Zhao, Mehmet C. Vuran, Zahra Aref, David P. Young, Warren Humphrey, Steve Goddard, Garhan Attebury, Blake France, Baofeng Zhou, and Mohammad M. R. Lunar. A city-wide experimental testbed for next generation wireless networks. In *Proc.*

Int. Balkan Conference on Communications and Networking (BalkanCom'19), Skopje, North Macedonia, June 2019.

- [C9] Zhongyuan Zhao and Mehmet C. Vuran. Modeling aggregate interference with heterogeneous secondary users and passive primary users for dynamic admission and power control in tv spectrum. In *Proc. Int. Balkan Conference on Communications and Networking (BalkanCom'18)*, Podgorica, Montenegro, June 2018.
- [C10] Davis Rempe, Mitchell Snyder, Andrew Pracht, Andrew Schwarz, Tri Nguyen, Mitchel Vostrez, Zhongyuan Zhao, and Mehmet C. Vuran. A cognitive radio TV prototype for effective TV spectrum sharing. In *IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN)*, pages 1–2, Baltimore, MD, May 2017.
- [C11] Zhongyuan Zhao, Mehmet C. Vuran, Démet Batur, and Eylem Ekici. Ratings for spectrum: Impacts of tv viewership on tv whitespace. In *IEEE Global Communications Conference (GLOBECOM)*, pages 941–947, Austin, TX, Dec. 2014.
- [C12] Hongping Hu and Zhongyuan Zhao. A real-time high resolution image compression system based on ADV212. In *2nd International Congress on Image and Signal Processing (CISP)*, pages 1–4, Tianjin, China, Oct. 2009.

Patents

- [P1] Zhongyuan Zhao, Weixu Wang, and Luping Pan. PLL and adaptive compensation method in PLL, issued: May 11, 2016. US Patent 9,496,881.
- [P2] Zishu He, Zhongyuan Zhao, Jianzhong Zhang, Ting Chen, and Kexin Jia. Method and apparatus for an implementation of polyphase filter structure, issued: Nov. 14, 2012. China Patent CN101958697B.

Theses

- [T1] Zhongyuan Zhao. *Improving Spectrum Efficiency by Exploiting User and Channel Behaviors for Next Generation Wireless Networks*. PhD dissertation, University of Nebraska-Lincoln, 2019.
- [T2] Zhongyuan Zhao. *Design and Implementation of Channelized Digital Receiver based on PCI-Express*. Master's thesis, University of Electronic Science and Technology of China, 2009.
- [T3] Zhongyuan Zhao. *Design of Motor Soft Starter based on DSP and CPLD*. Bachelor's thesis, University of Electronic Science and Technology of China, 2006.

Tutorials

- [S1] Santiago Segarra, Ananthram Swami, and Zhongyuan Zhao. Graph-based machine learning in wireless communications. *IEEE International Conference on Machine Learning for Communication and Networking (IEEE ICMLCN)*, May 2024.