RUI WANG

Email: ruiwang18@fudan.edu.cn

EDUCATION

Ph.D. in Electrical Engineering 9/2018 - 6/2024

Fudan University, Shanghai, China Advisor: Yi Jiang

Research: ***Machine Learning + Communication Systems and Theory***

B.E. in Communication Engineering 9/2014 - 6/2018

Northeastern University, Shenyang, China GPA: 3.7/4.00, top 8% out of 96 students

PEER-REVIEWED PAPERS

AI for Science:

[1] L. Wei*, P. Hu*, R. Feng*, Y. Du, T. Zhang, **R. Wang**, Y. Wang, Z. Ma and T. Wu. "*Generative PDE Control*." ICLR 2024 Workshop on AI4DifferentialEquations In Science. Oral. [paper]

[2] L. Wei*, P. Hu*, R. Feng*, Y. Du, T. Zhang, **R. Wang**, Y. Wang, Z. Ma and T. Wu. "*A Generative Approach to Control Complex Physical Systems.*" Accepted at NeurIPS 2024.

[3] P. Hu*, X. Zheng*, W. Deng, **R. Wang,** et al. "A Probabilistic Generative Method for Safe Physical System Control Problems." Accepted at NeurIPS 2024 Workshop.

Theoretical and AI-Driven Innovations in Wireless Communication:

[1] W. Dai, **R. Wang**, J. Liu, and Y. Jiang. "*Quasi-NN based Design for Downlink Cell-Free Massive MIMO.*" IEEE Transactions on Communications (TCOM), 2024. Accepted.

[2] **R. Wang**, W. Dai and Y. Jiang. "*Distributed Learning for Uplink Cell-Free Massive MIMO Networks*." IEEE Transactions on Communications (TCOM), 2023. [paper]

[3] W. Dai, J. Liu, **R. Wang**, and Y. Jiang. "*Learning by Over-the-Air Training: A Distributed Precoding for Cell-Free Massive MIMO.*" IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC), 2023. [paper]

[4] **R. Wang**, Y. Jiang and W. Zhang. "*Distributed Learning for MIMO Relay Networks*." IEEE Journal of Selected Topics in Signal Processing (JSTSP), 2022. [paper]

[5] **R. Wang** and Y. Jiang. "*Distributed Optimization of Uplink Cell-Free Massive MIMO Networks*." IEEE Vehicular Technology Conference (VTC), 2022. [paper]

[6] Z. Yang, **R. Wang**, Y. Jiang and J. Li, "*Joint Estimation of Velocity, Angle-of-Arrival and Range (JEVAR) Using a Conjugate Pair of Zadoff-Chu Sequences*." IEEE Transactions on Signal Processing (TSP), 2021. [paper]

[7] **R. Wang**, Y. Jiang and W. Zhang, "*A Distributed MIMO Relay Scheme Inspired by Backpropagation Algorithm*." IEEE Global Communications Conference (GLOBECOM), 2021. [paper]

[8] Z. Yang, **R. Wang** and Y. Jiang, "*A Novel Scheme for Joint Estimation of Velocity, Angle-of-arrival and Range in Multipath Environment.*" IEEE Global Communications Conference (GLOBECOM), 2021. [paper]

[9] **R. Wang** and Y. Jiang, "*Distributed Optimization of Multiuser MIMO Relay Network Using Backpropagation Algorithm.*" Asilomar Conference on Signals, Systems, and Computers (ACSSC), 2021. [paper]

[10] **R. Wang** and Y. Jiang, "*A Nonlinear Relay Scheme Resilient to Interference with Unknown CSI.*" Asilomar

Conference on Signals, Systems, and Computers (ACSSC), 2020. [paper]

[11] **R. Wang** and Y. Jiang, "*An Interference-Resilient Relay Beamforming Scheme Inspired by Back-Propagation Algorithm.*" Information: Theory and Applications (ITA) Workshop, 2020. [paper]

[12] Z. Zhang, J. Liu, **R. Wang** and T. Li. "*Study on Medical Image Segmentation Methods of Humerus*." Chinese Control and Decision Conference (CCDC), 2017. [paper]

PAPERS UNDER REVIEW

AI for Science:

[1] P. Hu*, X. Zheng*, W. Deng, **R. Wang,** et al. "*Wavelet Diffusion Neural Operator*."

Wireless Communication:

[2] **R. Wang**, W. Dai, and Y. Jiang. "*Cell-Free Massive MIMO Design via Over-the-Air Signaling*." IEEE Transactions on Wireless Communications (TWC).

PATENTS

[1] Y. Jiang, Z. Yang and **R. Wang**. "Joint Estimation of Velocity, Angle-of-Arrival and Range (JEVAR) Using a Conjugate Pair of Zadoff-Chu Sequence." Apr. 12 2022. CN Patent 113,156,365.

[2] Y. Jiang, J. Yang, Q. Du, **R. Wang**, W. Zhang and F. Li. "Sensitivity of Bluetooth Receiver by Introducing Interleaver." Sept. 27 2022. US Patent 11,456,818. **&** Mar. 18 2022. CN Patent 112,653,537.

EXPERIENCES

Institute for Interdisciplinary Information Sciences (IIIS) 8/2024 - Present

Visiting Scholar (advisor: Longbo Huang) Tsinghua University, Beijing, China

- Efficient learning.

AI for Scientific Simulation and Discovery Lab 12/2023 - 7/2024

Research Intern (advisor: Tailin Wu) Westlake University, Zhejiang, China

- Developed a diffusion-based method to generate safety control strategies with provable probabilities.
- Developed the Wavelet Diffusion Neural Operator, a novel framework for super-resolution control and prediction.
- Developed advanced control methods for complex physical systems using generative models.

School of Information Science and Technologies 9/2018 - 6/2024

Ph.D. Candidate (advisor: Yi Jiang) Fudan University, Shanghai, China

- Developed distributed optimization algorithms for IP Radio Access Network and Cell-Free networks.
- Created the "Quasi-Neural Network" with strong global interpretability, applied in distributed relay beamforming to suppress interference.
- Developed a high-precision, low-complexity algorithm for the joint estimation of velocity, angle-of-arrival, and range, approaching the theoretical limits set by the Cramér-Rao Bound.
- Achieved perfect scores in many coursework, including Optimization Theory and Algorithms, Convex Optimization (Optimization of Communication Systems), Basics of Linear Algebra (Modern Communication System), Digital Signal Processing (New Methods of Communication Signal Processing), and Fundamentals of Wireless Communication.

CORE EXPERTISE

Machine Learning & Artificial Intelligence:

- Advanced techniques, including **diffusion** models, **conformal prediction**, Fourier Neural **Operators**, and **reinforcement learning**.
- **Neural Networks**, specifically the creation of the Quasi-Neural Network, applied in collaborative optimization for Cell-Free and relay networks, channel estimation, and spectral analysis.

Mathematics:

- **Differential calculus** for nonconvex functions with complex-valued matrix variables.
- **Optimization** methods, including Riemannian optimization, Newton's iteration, backtracking line search, and sequential convex programming.
- **Statistical** techniques, including Maximum Likelihood Estimation, Cramér-Rao Bound (CRB), and 2D Fast Fourier Transforms.
- **Matrix theory**, specifically the enhancement of the Eigen Zero-Forcing algorithm using the non-uniqueness of the Singular Value Decomposition.
- **Signal processing**, focusing on designing sequence structures and filtering techniques to optimize estimation accuracy and reduce computational complexity; development of signal-amplitude-compression models as complex activation functions.

Systems Design & Algorithm Analysis:

- Design of frame structures compatible with 5G 3GPP NR standards for tracking time-varying scenarios.
- Comprehensive evaluations of computational complexity, training overhead and performance bounds.

Programming Languages:

- **MATLAB, PyTorch**, and **Python**.

OTHER INFORMATION

- **Honors:**

  Scholarship of Academic Excellence **(**2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023**)**
  Scholarship of Academic Excellence (2014-2015, 2015-2016)
  Outstanding Student Leader (2015-2016)

- **Reviewers for Journals:**

  IEEE Internet of Things Journal (IoT)
  IEEE Transactions on Communications (TCOM)
  IEEE Transactions on Machine Learning in Communications and Networking (TMLCN)

- **Teaching Experience:**

  Teaching Assistant, Fudan University.
  Responsible for enhancing students' course comprehension and managing grading of homework and exams.
  - Mathematical Basis of Artificial Intelligence: Tutored 120 master's students. 9/2023 - 2/2024
  - Mathematical Basis of Artificial Intelligence: Tutored 110 master's students. 9/2021 - 2/2022
  - Linear Algebra: Tutored 200 undergraduate students. 9/2019 - 1/2020

- **Hobbies:**

  Enthusiastically engaged in running, dancing, badminton, and photography.