Yibo Ma

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EDUCATION

Tsinghua University - Department of Electronic Engineering   09/2022 - Present

Master of Science in Electronic and Information Engineering

- GPA: 3.40/4.0

Tongji University - School of Mechanical and Energy Engineering   09/2018 - 06/2022

Bachelor of Engineering in Mechanical Design Manufacture and its Automation

- GPA: 3.27/4.0

<u>*Research Interests*</u>**: Machine Learning, Network Digital Twins, Reinforcement Learning, Large-Scale Data Mining**

PUBLICATIONS

- **Yibo Ma**, Tong Li, Li Yu, Haifeng Wang, Hongqiao Gao, Yong Li, *RENEW: Enhancing Real-World Mobile Network Energy Efficiency Using Digital Twin Systems*, WWW 2025, Under Review

- **Yibo Ma**, Tong Li, Yuwei Du, Schahram Dustdar, Zhaocheng Wang, Yong Li, *Exploring Traffic Usage and Energy Consumption in 5G Networks: Overcoming Misalignment for Sustainability*, IEEE Transaction on Mobile Computing (TMC), Under Review

- **Yibo Ma**, Tong Li, Yuwei Du, Schahram Dustdar, Zhaocheng Wang, Yong Li, *Sustainable connections: exploring energy efficiency in 5G networks*, Proceedings of the 20th International Conference on emerging Networking EXperiments and Technologies (CoNEXT 2024), California, USA, December 2024. ([DOI](#))

- **Yibo Ma**, Tong Li, Yan Zhou, Li Yu, Depeng Jin, *Mitigating Energy Consumption in Heterogeneous Mobile Networks Through Data-Driven Optimization*, IEEE Transactions on Network and Service Management (TNSM), P:1-1 (2024) ([DOI](#))

- Tong Li, Li Yu, **Yibo Ma**, Tong Duan, Wenzhen Huang, Yan Zhou, Depeng Jin, Yong Li, Tao Jiang, *Carbon emissions of 5G mobile networks in China*, Nature Sustainability, 6, 1620–1631 (2023) ([DOI](#))

RESEARCH EXPERIENCE

Deployment of Energy-Saving Strategies for Real-World Mobile Networks   03/2024 – 11/2024

Core Researcher, Advised by Prof. Yong Li and Prof. Tong Li

- ✧ Investigated energy-saving strategies in real-world mobile networks, addressing the complexities of heterogeneous networks, such as cell collaboration and traffic offloading constraints. Proposed a deployable framework leveraging network digital twins to model dynamic network operations, control cell status, and optimize real-world networks.

- ✧ Developed RENEW, an energy-saving method based on network digital twin systems, which models cells' collaboration and integrates real-world constraints. Designed a base station energy consumption model to support energy efficiency profiling and optimization of cell status in RENEW. Proposed a soft logic function (SoftControl) to map cell status to protocol parameters.

- ✧ Validated the method RENEW by using a mobile network dataset from Hangzhou, demonstrating accurate simulation of cell coverage, traffic offloading, and energy consumption. Achieved significant energy savings in both 4G and 5G networks with minimal MSE in cell status control, while improving energy efficiency by 80% in the optimized areas.

- ✧ Conducted What-If analysis and real-world testing, confirming that the method RENEW improves energy efficiency and quality-of-service indicators, reducing energy consumption by 6.63% in 4G and 2.38% in 5G networks, with no congestion risks.

The Impact of Deep 5G Mobile Network Adoption on Residential Power Systems   09/2023 -Present

Core researcher, Advised by Prof. Yong Li and Prof. Tong Li

- ✧ Employed machine learning methods such as SVM, KNN, and K-Means to investigate the relationship between 5G base station deployment and spatial attributes such as map data, 4G base station distribution, and population distribution. Modeled the spatial

distribution of densely deployed 5G networks with various base station types on a grid basis.

- ✧ Utilized a VAE-based model to generate daily user trajectories, which can capture the correlation between adjacent points in a trajectory, capturing city-scale user activity patterns and simulating network traffic demand.
- ✧ Incorporated network usage preferences (4G or 5G) into traffic demand modeling, modeling the joint distribution of multi-dimensional traffic demand attributes and generating synthetic traces. Analyzed the impact of network energy consumption on residential power systems under varying deployment densities and user preferences.

Large-Scale Measurements: Understanding 5G Network Usage and Energy Efficiency   03/2023 - 12/2023
Core researcher, Advised by Prof. Yong Li and Prof. Tong Li

- ✧ Collected datasets of a real-world mobile network from a mobile operator, applying statistical analysis and regression models to clean and impute cell-level performance data, and used cluster analysis to identify 5G network traffic usage patterns.
- ✧ Predicted 5G network deployment trends using a power law distribution, proposing regional recommendations to optimize base station deployment strategies for effective resource utilization.
- ✧ Developed a comprehensive energy consumption model based on the characteristics of base station subsystems and their relationship with traffic load.Created a large-scale data-driven framework to quantitatively assess energy consumption since the launch of 5G networks and analyzed the decline in energy efficiency due to 5G deployment.
- ✧ Analyzed city Point of Interest data to delineate functional regions, proposing three metrics to assess misalignment between network deployment and usage within these regions and providing customized optimization recommendations.
- ✧ Conducted quantitative analysis of the impact of three energy-saving methods—Radio frequency carrier shutdown, channel shutdown, and deep sleep—on base station energy consumption and provided tailored recommendations for applying these methods based on different network usage patterns across functional regions.

Carbon Emissions of 5G Mobile Networks in China   04/2022 - 03/2023
Core Researcher, Advised by Prof. Yong Li and Prof. Tong Li

- ✧ Proposed a misalignment measurement metric between energy consumption and traffic usage, estimating the additional carbon emissions caused by 5G deployment in each province and identifying carbon efficiency traps.
- ✧ Developed a policy network for cell control using graph neural networks to integrate intra-cell and base station relationships, addressing the complexity of large-scale agents. Applied Mean-Field Multi-Agent Reinforcement Learning (MF-MARL) to efficiently estimate action values, optimizing system energy consumption while managing interactions between agents.
- ✧ Simulated the photovoltaic power generation using the PVWatts Calculator developed by the NREL, designing Python crawler scripts to automate the simulation of distributed photovoltaic systems in large-scale networks.
- ✧ Proposed REDEEM, a data-driven energy-saving framework integrating active control and energy efficiency profiling, to address the limitations of traditional energy-saving methods in large-scale urban scenarios involving heterogeneous 5G and 4G networks.
- ✧ Conducted comprehensive experimental validation of REDEEM's effectiveness in mobile networks, achieving state-of-the-art performance in reducing network energy consumption and improving energy efficiency, also demonstrating REDEEM's robustness across various temporal, spatial, and traffic load scenarios.

HONOURS

- ✧ First-Class Chaozhou Talent Scholarship of Tsinghua University (Top 6%), 2024-2025
- ✧ Second Prize at 9th Shanghai University Student Mechanical Engineering Innovation Competition (Top 10%), 2020-2021
- ✧ Outstanding Project at 2020 Tongji University Excellent Research Program, (Top 15%), 2021-2022

ADDITIONAL INFORMATION

- ✧ Programming Languages: Python (PyTorch, Tensorflow), C++, Matlab, LaTeX
- ✧ Software: SolidWorks, AutoCAD, Adobe Illustrator, Microsoft Office
- ✧ Tools: Jupyter Notebook, Git, MySQL
- ✧ Interests: Programming, Swimming, Playing Guitar, Reading