

# Rui Zhou

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## EDUCATION

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<b>University of Illinois Urbana Champaign</b> <i>Master of Science in Computer Science</i>	Champaign, IL May 2026
<b>University of Illinois Urbana Champaign</b> <i>Bachelor of Science in Computer Science</i>	Champaign, IL May 2024

**Relevant Courses:** *Machine Learning · Deep Learning · Data Mining · Computer Vision · Algorithms · LLM Agents · Natural Language Processing · Database Systems · Statistics*

## PUBLICATIONS

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- Sijia Fenga, Aoyang Li, **Rui Zhou**, Klaus Butterbach-Bahl, Kaiyu Guan, Zhenong Jin, Majken C. Looms, Sherrie Wang, Christian Igel, Claire Treat, Jørgen Eivind Olesen, Sheng Wang. (2025). Improved global SMAP daily 9 km surface soil moisture dataset with microwave radiative transfer process-guided machine learning (2015 - 2024). *Nature Scientific Data*.
  - Tianhang Cheng, Albert J. Zhai, Evan Z. Chen, **Rui Zhou**, Yawen Deng, Zitong Li, Kejie Zhao, Janice Shiu, Qianyu Zhao, Yide Xu, Xinlei Wang, Yuan Shen, Sheng Wang, Lisa Ainsworth, Kaiyu Guan, Shenlong Wang. (2025). Demeter: A Parametric Model of Crop Plant Morphology from the Real World. *ICCV 2025 Conference*.
  - Wang, S., Guan, K., E. Olesen, J., **Zhou, R.**, Lu, Z., Lin, Z., Feng, S., Gislum, R., Treat, C., and Butterbach-Bahl, K.: Cross-scale Sensing of Field-level Essential Agroecosystem Variables for the EU Climate-smart Agriculture, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-8055, <https://doi.org/10.5194/egusphere-egu25-8055>, 2025.
  - Wang, S., **Zhou, R.**, Prikaziuk, E., Guan, K., Gislum, R., van der Tol, C., Fensholt, R., Butterbach-Bahl, K., Ibrom, A., and Olesen, J. E.: Quantifying Evapotranspiration and Gross Primary Productivity Across Europe Using Radiative Transfer Process-Guided Machine Learning, EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024, EGU24-14280, <https://doi.org/10.5194/egusphere-egu24-14280>, 2024.
  - Wang, S., Yuan, B., Guan, K., Olesen, J. E., **Zhou, R.**, and Gislum, R.: Detecting Field-level Crop Residue Cover across the EU Using Multi-source Satellite Data and Explainable Machine Learning, EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024, EGU24-14253, <https://doi.org/10.5194/egusphere-egu24-14253>, 2024.

## RESEARCH EXPERIENCE

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<b>UIUC - Institute for Sustainability, Energy, and Environment (iSEE)</b> <i>Graduate Research Assistant</i> Advisor: Prof. Kaiyu Guan & Prof. Sheng Wang	Urbana, IL May 2024 - Present
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### **Project 1: Physics-Guided Deep Learning for Continental-Scale Spatiotemporal Modeling**

- Designed **Physics-Guided Machine Learning (PGML)** that integrate **domain-governed physical processes** into **deep neural networks** for large-scale spatiotemporal prediction across multimodal environmental and simulation data, including Fluxnet2015 and European Fluxnet.
- Demonstrated that **embedding physics processes** within deep neural networks significantly improves generalization across complex systems, **improving  $R^2$  to up to 0.99** on multi-variable spatial-temporal prediction tasks.
- Generated **continental-scale, 300 m-resolution daily** inference products of GPP & ET from **2016 to 2023** through distributed GPU pipelines optimized for I/O.
- Defined **extreme-condition regimes** at eddy-covariance sites by statistically deriving **5th/95th-percentile** thresholds on vapor-pressure deficit, soil-moisture, wind-speed, and temperature distributions.

### **Project 2: Foundation Model Integration and Explainable AI for Global Energy Flux Prediction**

- Integrated **MOMENT Foundation Model** with **PGML frameworks** to enhance generalization, **improving  $R^2$  from 0.76 to 0.94 (GPP) and 0.81 to 0.89 (ET)**.
- Conducted **SHAP-based feature attribution** and **partial-dependence analysis** to interpret cross-variable interactions, identifying **non-linear controls** of vapor-pressure deficit and soil-moisture regimes on photosynthetic activity.

- Extended the **PGML** framework to global scale, **producing daily ET and GPP predictions at 1 km resolution from 1999 to 2020** via distributed training and inference on the **Delta Supercomputer**.

UIUC - National Center for Supercomputing Applications (NCSA)

Urbana, IL

Research Intern

June 2023 - May 2024

Advisor: Prof. Sheng Wang

- Developed **hierarchical neural networks** and **multi-layer perceptrons** for learning non-linear mappings between multimodal satellite data and latent process variables.
- Constructed **synthetic pretraining datasets** via the **SCOPE radiative-transfer simulator** to benchmark domain generalization and data efficiency in hybrid learning.
- Engineered **HPC-optimized training workflows** (asynchronous data loading, multi-GPU data parallelism) for large-scale spatiotemporal models.
- Conducted model explainability diagnostics using **SHAP and feature-interaction** visualization to ensure spatial consistency and robustness across inference grids.

Carnegie Mellon University

Remote

Research Assistant

October 2022 - December 2022

Advisor: Prof. David Woodruff

- Designed and implemented **supervised and semi-supervised learning (SSL)** architectures for recommender systems using **Matrix Factorization**, focusing on the integration of unlabeled item-side data to improve representation learning.
- Performed systematic benchmarking on the **MovieLens-100K dataset**, evaluating SSL variants under controlled supervision ratios and demonstrating **that item-only SSL regularization** yields better generalization compared to symmetric (query- and item-side) regularization.
- Empirically analyzed the role of **negative sampling strategies** in contrastive and pairwise ranking losses, finding that increased negative pair counts saturate performance gains—highlighting **diminishing returns in sample-based contrastive optimization**.

## PUBLICATIONS (UNDER REVIEW)

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- [Under review] Sheng Wang, Zhiju Lu, Boqin Yuan, Kaiyu Guan, **Rui Zhou**, Zhixian Lin, Klaus Butterbach-Bahl, Kiril Manevski, Jørgen E. Olesen, Chenhui Zhang, René Gislum. (2024). Leveraging Citizen Science and Large Vision-language Models for Monitoring Wheat Harvest and Residue Management Across the EU from Sentinel-1 and 2. *Remote Sensing of Environment*.
- [In Preparation] **Rui Zhou**, Sheng Wang, Kaiyu Guan. (2025). Overlooked Global Photosynthesis Suppression by Excess Soil Moisture Revealed via Hybrid Learning. *Nature Water*.
- [In Preparation] **Rui Zhou**, Sheng Wang, Kaiyu Guan. (2025). Enhanced Remote Sensing of Land-Atmosphere Flux Exchanges Under Climate Extremes via Process-guided Machine Learning. *Nature Water*.

## RELEVANT PROJECTS

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### Model Construction for Natural Language Processing

August 2023 - September 2023

- Developed a **Naive Bayes model** to classify sentiments of the Stanford Movie Review Dataset, achieved **89.1% accuracy** on the development set.
- Enhanced preprocessing with **Porter Stemming** and **stop-word removal** in a **bag-of-words model**; addressed zero probabilities using **Laplace smoothing** in Python and ensured numerical stability with log-transforms.
- Explored the **bigram method** with Python for preprocessing and benchmarked its performance against traditional word tokenization, which **improved the accuracy to 90.46%**.

## ACHIEVEMENTS

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Fiddler Innovation Graduate Student Fellowship Award (2025)

Urbana, IL

Celebration of Excellence, University of Illinois at Urbana Champaign (2025)

Urbana, IL

Fiddler Innovation Fellowship Award, National Center for Supercomputing Applications (2024)

Urbana, IL

## TECHNICAL PROFICIENCIES

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**Programming Languages:** Python, Java, Linux, C, C++, Verilog, SQL, OCaml

**Technical Skills:** Machine Learning, Deep Learning, Google Earth Engine, Google Cloud Platform, Linux System, High Performance Computing Application