

Shoukun Sun, Ph.D.

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Research Interests

Computer vision: interactive image segmentation, data-efficient learning with sparse labels, and AI-assisted annotation; Generative models: diffusion-based synthesis and super-resolution of large-content images; Large language models: fine-tuning and agentic systems; AI for scientific imaging: medical, materials, and remote-sensing applications.

Education

Ph.D. in Computer Science (Deep Learning), University of Idaho Jan 2021 – Aug 2025

- Dissertation: *Enhancing Deep Learning for Critical Applications with Sparse Labeling*
- Advisor: Min Xian; Co-advisor: Aleksandar Vakanski

Graduate Studies in Technology Management (transferred to Computer Science), University of Idaho Aug 2019 – Jan 2021

B.S. in Applied Physics, Chengdu University of Technology Sep 2013 – Jun 2018

Appointments

Postdoctoral Researcher, Department of Computer Science, University of Idaho Dec 2025 – Present

- Advisor: Xiaogang Ma.
- Super-resolution of very large scientific images: proposed InfScene-SR, which scales fixed-size diffusion super-resolution models to super-resolve arbitrary size images — variance-corrected joint denoising of overlapping patches eliminates the boundary artifacts of patch-based approaches at constant memory cost; demonstrated on remote-sensing imagery (preprint 2026).
- Reliable co-registration of large optical satellite imagery: proposed SCDF, a training-free estimator whose filters self-calibrate on each image pair; on a new 584-pair ground-truth benchmark, it registers every pair without failure and lowers the best baseline’s median error from 6.83 to 4.17 m (preprint 2026; submitted to IEEE TGRS).
- Developing the official mobile application of mindat.org, the world’s largest open mineralogy database, giving geologists offline field access to mineral occurrence data; now in internal testing.
- Early-stage work on agent systems that strengthen the information-retrieval capabilities of large language models for question answering, with evaluation targeting mineral-science data.
- Collaboration with NCEAS (UC Santa Barbara) on deep-learning species distribution models revealing hurricane-driven seabird displacement (Ecological Informatics 2026), and with NCEAS and The Nature Conservancy on continued invasive-species (iceplant) mapping begun during the Ph.D.

Graduate Research Assistant, Department of Computer Science, University of Idaho Jan 2020 – Dec 2025

- Interactive image segmentation: proposed CFR-ICL, a cascade-forward refinement model with iterative click loss that set the state of the art on standard benchmarks while requiring 33% fewer annotation clicks (AAAI 2024).
- Generative modeling: introduced a training-free diffusion fusion method that enables small text-to-image models to synthesize large-content images, lowering FID from 11.19 to 4.02 (AAAI 2025).

- Medical imaging: proposed MIRST-DM, an adversarial defense for ultrasound-based breast cancer classification that improves robustness to attacks by 45% (MICCAI 2022), and co-authored a benchmark study of breast ultrasound image classification (preprint 2023).
- Nuclear fuel characterization, in collaboration with Idaho National Laboratory (INL): developed a data-efficient instance-segmentation approach for fission gas bubbles in irradiated metallic fuel, reaching 93% recall from only 827 annotated instances (Scientific Reports 2023), and contributed to fission-gas pore segmentation and classification in U10Zr fuel and to TRISO fuel cross-section characterization (Materials Characterization 2024, 2026).
- Natural language processing for nuclear reliability, with INL: built an end-to-end pipeline for automated cause-effect extraction from licensee event reports — spanning PDF parsing, text annotation, and language-model fine-tuning — reaching 99.1% accuracy (preprint 2024), and contributed to failure-event mining of U.S. nuclear power plant reports with fine-tuned LLMs (Risk Analysis 2026).
- Research infrastructure: built and maintained two interactive-segmentation annotation platforms, Auto-IS (general-purpose) and SegMap (remote sensing; QGIS plugin and web), in use at INL, the University of Idaho, NCEAS (UC Santa Barbara), and The Nature Conservancy, underpinning 12+ interdisciplinary projects across materials science, medicine, biology, geography, and geology.
- Administered the group’s GPU computing infrastructure (Linux servers with 15 RTX 8000/6000 GPUs) supporting 20+ researchers.

Research Assistant, Guangzhou Institute of Geography

Dec 2017 – Jul 2019

- Implemented a mechanistic, remote-sensing-driven leaf turnover model reproducing foliar area and photosynthetic seasonality at four Amazon evergreen forest sites, and integrated it into ORCHIDEE — a core component of the IPSL Earth System Model contributing to CMIP and IPCC assessments — in collaboration with the model’s developers at the Institut Pierre-Simon Laplace (IPSL, France).
- Analyzed time-series and spatial datasets to characterize relationships between plant phenology and ecological indices.
- Established a distributed high-performance computing cluster enabling global-scale model simulations, and developed parallel Python toolkits that scaled remote-sensing image analysis from the gigabyte to the terabyte range.

Honors & Awards

- Outstanding Ph.D. Student, University of Idaho (2024–2025)
- MIDA Star Award, Machine Intelligence and Data Analytics Lab, University of Idaho (2024)
- Outstanding Graduate Student in Idaho Falls, University of Idaho (2022–2023)
- Meritorious Winner, Interdisciplinary Contest in Modeling (ICM), COMAP (2016)

Publications

Peer-Reviewed Publications

- [1] Z. Wang, **S. Sun**, X. Que, X. Ma, C. G. García, “Deep-Learning-Based Interactive Segmentation in Remote Sensing,” *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (JSTARS)*, vol. 19, pp. 6202–6213, 2026.
- [2] S. Zhang, S. R. Sohag, M. Xian, **S. Sun**, Z. Ma, “Failure Event Mining With Fine-Tuned Large Language Model: Case Study of Analyzing United States Nuclear Power Plant Failure Event Reports,” *Risk Analysis*, vol. 46(3), e70191, 2026.
- [3] L. Cai, F. Xu, M. Xian, Y. Tang, **S. Sun**, J. Stempien, “RU-net for Automatic Characterization of TRISO Fuel Cross Sections,” *Materials Characterization*, vol. 232, 116019, 2026.
- [4] L. Li, M. Zuzuarregui, J. Bai, **S. Sun**, Y. Chen, Z. Wang, “Hurricanes Drive Bird Displacement

- Revealed by Deep Learning Species Distribution Models,” *Ecological Informatics*, vol. 95, 103785, 2026.
- [5] L. Li, J. Bai, **S. Sun**, M. A. Zuzuárregui, Z. Wang, “The risk of birds’ functional diversity loss with climate change uncovered using deep learning hurdle models,” *Ecological Indicators*, vol. 190, 115321, 2026.
- [6] Z. Wang, C. Fan, **S. Sun**, H. F. Liao, M. Xian, X. Ma, X. Que, “Cross-Scale U-Net: A Deep Transfer Learning Framework for Automated High-Resolution Urban Land Cover Mapping,” *Buildings*, vol. 16(12), 2441, 2026.
- [7] **S. Sun**, M. Xian, T. Yao, F. Xu, L. Capriotti, “Guided and Variance-Corrected Fusion with One-Shot Style Alignment for Large-Content Image Generation,” *Proceedings of the AAAI Conference on Artificial Intelligence (AAAI)*, vol. 39(7), pp. 7114–7121, 2025. Code: github.com/TitorX/GVCFDiffusion.
- [8] **S. Sun**, M. Xian, F. Xu, L. Capriotti, T. Yao, “CFR-ICL: Cascade-Forward Refinement with Iterative Click Loss for Interactive Image Segmentation,” *Proceedings of the AAAI Conference on Artificial Intelligence (AAAI)*, vol. 38(5), pp. 5017–5024, 2024. Code: github.com/TitorX/CFR-ICL-Interactive-Segmentation.
- [9] Y. Tang, F. Xu, **S. Sun**, D. Salvato, F. G. Di Lemma, M. Xian, D. J. Murray, C. Judge, L. Capriotti, T. Yao, “Segmentation and Classification of Fission Gas Pores in Reactor Irradiated Annular U10Zr Metallic Fuel Using Machine Learning Models,” *Materials Characterization*, vol. 215, 114061, 2024.
- [10] **S. Sun**, F. Xu, L. Cai, D. Salvato, L. Capriotti, M. Xian, T. Yao, “An Efficient Instance Segmentation Approach for Studying Fission Gas Bubbles in Irradiated Metallic Nuclear Fuel,” *Scientific Reports*, vol. 13(1), 22275, 2023.
- [11] **S. Sun**, M. Xian, A. Vakanski, H. Ghanem, “MIRST-DM: Multi-Instance RST with Drop-Max Layer for Robust Classification of Breast Cancer,” *International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI)*, pp. 401–410, 2022.
- [12] Z. Wang, D. Xue, **S. Sun**, “Phase-Unwrapping Algorithm Study Based on Goldstein Path Following Method,” *Geology and Resources*, vol. 26(2), pp. 184–189, 2017.

Preprints

- [P1] **S. Sun**, Z. Wang, S. Salati, J. Zhang, H. Wang, X. Ma, “Self-Calibrating Dense Displacement Fields for Reliable Co-Registration of Large Optical Satellite Imagery,” *arXiv preprint arXiv:2608.22300*, 2026.
- [P2] **S. Sun**, Z. Wang, X. Que, J. Zhang, X. Ma, “InfScene-SR: Seamless Super-Resolution of Arbitrarily Large Remote-Sensing Scenes via Variance-Preserving Joint Denoising,” *arXiv preprint arXiv:2602.19736*, 2026. Code: github.com/TitorX/infscene-sr.
- [P3] K. Lucke, Z. Krajewska-Travar, **S. Sun**, L. Cai, J. D. Stempien, M. Xian, “UA-Net: Uncertainty-Aware Network for TRISO Image Semantic Segmentation,” *arXiv preprint arXiv:2604.15542*, 2026.
- [P4] S. R. Sohag, S. Zhang, M. Xian, **S. Sun**, F. Xu, Z. Ma, “Causality Extraction from Nuclear Licensee Event Reports Using a Hybrid Framework,” *arXiv preprint arXiv:2404.05656*, 2024.
- [P5] B. M. Shareef, M. Xian, **S. Sun**, A. Vakanski, J. Ding, C. Ning, H. Cheng, “A Benchmark for Breast Ultrasound Image Classification,” *SSRN preprint 4339660*, 2023.

Full list: Google Scholar profile.

Selected Research Software

- **Auto-IS:** General-purpose interactive image-annotation platform combining interactive segmentation, AI-assisted labeling, incremental model training, and group collaboration. Deployed and in routine research use at Idaho National Laboratory and the University of Idaho, reducing data preparation time by up to 90%.

- **SegMap:** Interactive-segmentation tool for annotating remote-sensing imagery, available as both a QGIS plugin (3,900+ downloads) and a web application. In use at NCEAS (UC Santa Barbara) and The Nature Conservancy for ecological and conservation research, including invasive-species (iceplant) mapping. Code: github.com/TitorX/SegMap-QGIS.

Talks & Presentations

Invited Talks and Guest Lectures

- “InfScene-SR: Spatially Continuous Inference for Arbitrary-Scene Image Super-Resolution,” Invited lecture, CS 5621 Data Science, University of Idaho, Moscow, ID, Feb 2026.
- “CFR-ICL: Cascade-Forward Refinement with Iterative Click Loss for Interactive Image Segmentation,” CS 501 Graduate Seminar, University of Idaho, Idaho Falls, ID, Mar 2024.
- “MIRST-DM: Multi-Instance RST with Drop-Max Layer for Robust Classification of Breast Cancer,” CS 501 Graduate Seminar, University of Idaho, Idaho Falls, ID, Feb 2023.
- “MIRST-DM: Multi-Instance RST with Drop-Max Layer for Robust Classification of Breast Cancer,” Guest lecture, CS 504 Adversarial Machine Learning, University of Idaho, Idaho Falls, ID, Feb 2023.
- “Adversarial Attack and Defense,” Guest lecture, CS 504 Adversarial Machine Learning, University of Idaho, Idaho Falls, ID, Nov 2022.

Conference Presentations

- “Guided and Variance-Corrected Fusion with One-Shot Style Alignment for Large-Content Image Generation,” AAAI Conference on Artificial Intelligence (AAAI-25), Philadelphia, PA, Feb–Mar 2025 (poster).
- “CFR-ICL: Cascade-Forward Refinement with Iterative Click Loss for Interactive Image Segmentation,” AAAI Conference on Artificial Intelligence (AAAI-24), Vancouver, BC, Canada, Feb 2024 (poster).
- “MIRST-DM: Multi-Instance RST with Drop-Max Layer for Robust Classification of Breast Cancer,” International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI 2022), Virtual, Sep 2022 (poster).

Teaching

- **Teaching Assistant**, CS 577 — Python for Machine Learning, University of Idaho. Mentored graduate students on applied machine-learning course projects and provided detailed assignment feedback.
- **Teaching Assistant**, CS 574 — Deep Learning, University of Idaho. Guided graduate students through deep-learning course projects and provided detailed feedback.

Service

- Proposal Review Panelist, National Science Foundation (NSF) (2026)
- Reviewer, AAAI Conference on Artificial Intelligence (AAAI) (2026)
- Reviewer, Applied Computing and Geosciences (2025, 2026)
- Reviewer, European Conference on Computer Vision (ECCV) (2026)
- Reviewer, Formal Ontology in Information Systems (FOIS) (2026)
- Reviewer, International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI) (2026)
- Reviewer, IEEE International Symposium on Biomedical Imaging (ISBI) (2024)
- Reviewer, The Web Conference (WWW) (2024)

Technical Skills

- **Programming:** Python, C/C++, R, MATLAB, SQL, JavaScript
- **Frameworks & Tools:** PyTorch, TensorFlow, Scikit-Learn, LangChain/LangGraph, OpenCV, GDAL, SLURM/HPC, Docker, Git