Anran Xu

EDUCATION

The University of British Columbia Vancouver, Canada
Doctor of Philosophy in Geophysics 2025.02-present
- Four Year Doctoral Fellowship (UBC)
- President's Academic Excellence Award

The University of British Columbia Vancouver, Canada
Master of Science in Geophysics 2022.09-2024.10
- Outstanding Student Presentation Award (AGU 2023)

University of Toronto Toronto, Canada
Honours Bachelor of Science 2018.09-2022.06
Mathematics & Its Applications Specialist (Physical Science); Physics Major
- GPA: **3.91/4.0**
- Dean's List Scholar (Fall/Winter 2019-2020 & 2020-2021)
- The Don Salt Memorial Scholarship (Canadian Exploration Geophysical Society (KEGS))
- New College Council In-Course Scholarship
- Summer Undergraduate Research Program (SURP) in astronomy & astrophysics

SELECTED RESEARCH EXPERIENCE

Neural Fields for Imaging Inverse Problems in Fluorescence Microscopy (CNRS internship) Sophia-Antibus, France 2024.05-2024.10
Advisor: Luca Calatroni and Laure Blanc-Féraud, CNRS
- Developed an NF-based approach to represent continuous positions of fluorescent molecules, enhancing fluorescence microscopy by addressing challenges such as blur, noise, and undersampling
- Design a novel pipeline for the super-resolution using the PyTorch and DeepInverse
- Analyze the mechanism of the implicit regularization effect observed in the proposed pipeline

Development of ML Methods for Power Spectrum Emulators (SURP internship) Toronto, Canada
Advisor: Dr. Keir Rogers, University of Toronto 2022.05-2022.08
Poster: http://www.astro.utoronto.ca/wp-content/uploads/2022/12/AnranXu_SURP2022.pdf
- Reviewed the literature about Cosmopower and axion dark matter cosmology
- Studied the background material on cosmology including cosmic microwave background, LSS matter density, etc.
- Used the axionCAMB package to generate a dataset with different LCDM parameters' space
- Grasped the Cosmopower packages to train a DNN that maps the input cosmological parameters to CMB and matter power spectra in an axion dark matter cosmology model, achieving error less than 0.06σ for 99% of the CMB spectra

Visual Sentiment Analysis using Deep Learning Models Toronto, Canada
AI4Good Lab (Amii) 2022.05-2022.07
- Reviewed the existing research literature on image sentiment analysis
- Collaborated with team members to write a project proposal
- Pre-processed the collected data to create a labeled dataset
- Built and optimized a convolutional neural network (CNN) model using transfer learning from ResNet50v2, achieving accuracy of 72% for the training set and 75% for the validation set

Development of AI Methods for Finding Hidden Dimensions Toronto, Canada
Advisor： Dr. Hazem Daoud, University of Toronto 2021.05-2021.08
- Reviewed the literature about diffraction pattern analysis using machine learning methods, and explored how A.I. can aid in matching changes in diffraction pattern to structural changes of bismuth
- Gained essential knowledge and skills by taking two courses: *Deep Learning Specialization* and *TensorFlow Developer Professional Certificate* on Coursera

- Exported the synthetic profiles of the electron diffraction patterns and converted them into the ring-like electron diffraction images using Python
- Built and optimized a convolutional neural network (CNN) model, achieving accuracy of 93.2% for the training set and 91.15% for the validation set
- Used the CNN model to predict the Uiso values of real diffraction patterns, and the prediction has the right trend

Moment Tensor Inversion for the Mw=6.5 Earthquake in Nevada Toronto, Canada

Advisor: Prof. Qinya Liu, University of Toronto 2021.05-2021.07

- Studied background material on seismic wave equation, seismic wave propagation, and earthquake source representations (focal ball, moment tensor)
- Grasped software packages (gCAP & FK package) on seismic data processing and source mechanism inversions
- Used FK package to calculate the required Green's functions in multi-layered media
- Performed moment-tensor inversion about the Mw=6.5 earthquake in Nevada in 2020 using gCAP package, the result shows that most of segments have correlation coefficients greater than 90 (100 is the maximum)

Publications

1. (In progress) **Xu, A.** and Heagy, L. J. Understanding Neural Network Reparameterization in Geophysical Inversion from an Optimization Perspective.

2. **Xu, A.** and Heagy, L. J. (2025) Toward Understanding the Benefits of Neural Network Parameterizations in Geophysical Inversions: A Study With Neural Fields. IEEE Transactions on Geoscience and Remote Sensing, vol. 63, pp. 1-14.

3. **Xu, A.** and Heagy, L. J. (2024) A Test-Time Learning Approach to Reparametrize the Geophysical Inverse Problem With a Conventional Neural Network. IEEE Transactions on Geoscience and Remote Sensing, vol. 62, pp. 1-12.

Selected Conferences († indicates award)

1. **Xu, A.** and Heagy, L. J. (2026) Exploring the Inductive Bias from the Positional Encoding of Nueral Network Reparameterization Methods for Geophysical Inversion. NeurIPS Sim2Science workshop, Paris, France. (International, poster)
2. **Xu, A.** and Heagy, L. J. (2026) How Does Implicit Bias from the Optimization Affect Test-Time Machine Learning Methods in Geophysical Inverse problems? SIAM (Society for Industrial and Applied Mathematics) Conference on Mathematics of Data Science. (International, poster).
3. ***[Session chair]*** **Xu, A.** and Heagy, L. J. (2026) Leveraging Implicit Regularization with Test-Time Machine Learning Methods for PDE-Constrained Optimization. SIAM (Society for Industrial and Applied Mathematics) Conference on Optimization, Edinburgh, UK. (International, oral presentation).
4. **Xu, A.** and Heagy, L. J. (2025) Exploring Why the Implicit Regularization Effects Provided by Neural Networks Can Be Effective for Geophysical Inversions. KEGS (Canadian Exploration Geophysical Society) Symposium, Toronto, Canada (National, oral presentation).
5. **Xu, A.** and Heagy, L. J. (2024) A Test-Time Learning Approach to Reparametrize the Geophysical Inverse Problem With a Conventional Neural Network. IEEE Transactions on Geoscience and Remote Sensing, vol. 62, pp. 1-12.
6. **Xu, A.** and Heagy, L. J. (2024) Leveraging Neural Fields for Geophysical Inverse Problems. SIAM (Society for Industrial and Applied Mathematics) Conference on Mathematics of Data Science, Atlanta, Georgia, U.S. (International, poster presentation).
7. † **Xu, A.**, Heagy, L. J., and Weis, J. (2023) Leveraging Convolutional Neural Networks for Implicit Regularization in DC Resistivity Inversions. AGU Fall Meeting, vol. 2023, no. 7, Art. No. NS33C-07, San Francisco, CA, U.S. (International, e-poster presentation).
8. **Xu, A.** and Heagy, L. J. (2023) Reparametrizing the Geophysical Inverse Problem using a Convolutional Neural Network. 7th International Symposium on Three-Dimensional Electromagnetics, Vancouver, BC, Canada (International, poster presentation).

SKILLS

Language: Chinese Mandarin (Native), English (Fluent)

Computer Skills: Python (PyTorch and TensorFlow), Julia, LaTeX, BASH shell, Linux