Nanyu Luo

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EDUCATION BACKGROUND

University of Toronto   Toronto, Canada

Ph.D. in Developmental Psychology and Education   Sept. 2024-May 2028

➢ Psychometrics and Responsible AI Lab, supervised by Dr. Feng Ji

➢ Research Area: Psychometrics models; Machine learning, Deep learning and artificial intelligence; Bayesian data analysis

➢ Honour: **Connaught International Scholarship for Doctoral Students** (2025-2029), **Schwartz Reisman Institute for Technology and Society (SRI) 2025 Graduate Fellowship**

University of Oxford   Oxfordshire, United Kingdom

MSc in Statistical Science, Distinction   Oct. 2023-Sept 2024

➢ Thesis Title: Exploring Bayesian Item Response Theory: A Comparative Analysis between MCMC, Variational Inference and Neural Network Approaches

■ Conducted a comparative analysis of two applications of deep learning in IRT model parameter estimation, expanding beyond the traditional focus on a single direction in prior research.

■ Provided new empirical evidence supporting the advantages of Marginal Maximum Likelihood Estimation over Joint Maximum Likelihood Estimation.

■ Implemented algorithms uniformly in Python, whereas most prior research implemented MCMC algorithms in R.

The Chinese University of Hong Kong, Shenzhen (CUHK-Shenzhen)   Shenzhen, China

B.S. in Applied Mathematics with Honours, First Class   Sept. 2019-July 2023

➢ Cumulative GPA: 3.807/4.000 Major GPA: 3.800/4.000   Rank: 5/59

➢ Honours: 2019–20, 2020–21 Academic Performance Scholarship (Class C), 2019-20, 2020-21, 2021-22, 2022-23 Dean's List, 2020-21 Outstanding Student Helper, 2023 Shenzhen Universiade International Scholarship

PUBLICATION

- Luo, N., & Ji, F. (2025). Generative Adversarial Networks for High-Dimensional Item Factor Analysis: A Deep Adversarial Learning Algorithm. *Psychometrika*, 1–24. Advance online publication. https://doi.org/10.1017/psy.2025.10059

- Zhou, B., Yuan, Y., Luo, N., Qi, J., & Ji, F. (2025). FedIRT: An R package and Shiny App for Estimating Federated Item Response Theory Models. *Journal of Open Source Software, 10(113), 7869.*

- Zhou, B., Luo, N., & Ji, F. (2025). Federated Item Response Theory Models. *arXiv preprint arXiv:2506.21744*

- Luo, N., Ji, F., Han, Y., He, J., & Zhang, X. (2024). Fitting item response theory models using deep learning computational frameworks. http://dx.doi.org/10.31219/osf.io/tjxab_v2

- Zhang, Y., Luo, N., Zhang, X., Ji, F., & He, J. (2025). Identifying and Characterizing Eating Disorder Discourse on Chinese Social Media: A Machine Learning Approach. https://doi.org/10.21203/rs.3.rs-7852043/v1

- Ji, F., Zhang, Y., Luo, N., Yan, T., Barnhart, R. W., Cui, S., Zhang, J., Chen, G., Zhou, J., & He, J. (2024). Predicting Probable Eating Disorders Via Machine Learning in Chinese Adolescents: A Comparison Between Traditional Machine Learning and Modern Deep Learning Approaches. [Paper Presentation]. *The 2nd Forum of Young Scholars on Quantitative Research Methods in Social Sciences, Guiyang, Guizhou Province, China.*

- Wang, Y., Luo, N. & Zhou, J. (2022). Mining Assignment Submission Time to Detect At-Risk Students with Peer Information. *EDM2022: The 15th International Conference on Educational Data Mining, Durham, United Kingdom*. https://educationaldatamining.org/edm2022/proceedings/2022.EDM-short-

RESEARCH EXPERIENCE

Large Language Models (LLMs) for Evidence Synthesis: An Exploratory Evaluation for Automated Data Extraction and A Novel Method with Improved Performance Toronto, Canada
PhD student (Supervisor: Prof. Feng Ji, University of Toronto) May 2025-Present

➢ Evaluated multiple LLMs to automate **Evidence-Synthesis (ES)** data extraction for systematic reviews/meta-analyses, benchmarking performance with accuracy, precision, recall, and F1.
➢ Designed and implemented a **Divide–Conquer–Recheck (DCR)** pipeline tailored to ES schemas (PICO elements, study metadata, sample sizes, outcome measures/effect sizes), with a **Recheck** stage to resolve field conflicts, enforce schema constraints, and support human-in-the-loop verification— achieving high accuracy on structured fields.
➢ Built **few-shot prompting** routines to improve extraction of complex ES variables (e.g., correlation coefficients and other effect-size terms), boosting recall/F1 on nuanced items, and documented **Responsible-AI** practices (traceability, error analysis, failure modes) to guide reliable adoption.

Federated Item Response Models: A Gradient-driven Privacy-preserving Framework for Distributed Psychometric Estimation Toronto, Canada
PhD student (Supervisor: Prof. Feng Ji, University of Toronto) Jan. 2025-Present

➢ Manuscript under revision for *Psychometrika*.
➢ Developed a novel Federated Item Response Theory (FedIRT) framework that integrates federated learning with traditional IRT models, enabling privacy-preserving, distributed estimation of respondents' latent abilities and item difficulties.
➢ Developed FedIRT-DP, a user-level differentially private extension that uses clipped gradients and noisy aggregation to provide formal privacy guarantees and robustness.
➢ Validated the FedIRT approach through numerical experiments showing comparable accuracy to centralized IRT methods with minimal communication costs.

Generative Adversarial Networks for High-Dimensional Item Factor Analysis: A Deep Adversarial Learning Algorithm Toronto, Canada
PhD student (Supervisor: Prof. Feng Ji, University of Toronto) Sept. 2024-Present

➢ Developed an innovative deep learning algorithm inspired by Adversarial Variational Bayes (AVB) from computer vision to address challenges in high-dimensional item factor analysis (IFA).
➢ Positioned the algorithm as a generalization of the Variational Autoencoder (VAE) utilizing Generative Adversarial Network (GAN) framework, achieving comparable performance in standard scenarios.
➢ Demonstrated superior performance for AVB over VAE in handling multimodal distributions of latent variables, offering improved adaptability to real-world data in psychometrics.

Fitting Item Response Theory Models Using Deep Learning Computational Frameworks Remote
Research Assistant (Advisor: Prof. Feng Ji, University of Toronto) Sept. 2023-Aug. 2024

➢ Conditionally accepted at the *Journal of Educational and Behavioral Statistics* (JEBS)
➢ Utilizing TensorFlow and PyTorch, to effectively implement multidimensional Item Response Models. These models encompassed the Grade Response Model, Partial Credit Model, and Nominal Response Model.
➢ Conducted simulations studies and demonstrated high computational efficiency, characterized by notably short execution times, while maintaining low levels of bias and variance. This approach integrated deep learning with well-established psychometric models, underscoring its potential to deliver exceptional results in the intersection of these fields.

Course Recommendation System for Undergraduate Students at CUHK-Shenzhen Shenzhen, China
Final project for the course Advanced Machine Learning; won the **Best Course Project Award**
Jan. 2023-May 2023

➢ Designed a Course Recommendation System aiming to empower students in optimizing their course selections, particularly given the diverse optional course schedules and the academic pressure at CUHK-

Shenzhen.

- ➢ Implemented a powerful combination of fundamental collaborative filtering, a classical recommendation algorithm, and the low-rank matrix completion method. This approach successfully handled the sparse grade matrix, predicting final scores for potential courses and recommending those with higher predicted scores.
- ➢ Demonstrated satisfactory performance in the training dataset, achieving a low Root Mean Square Error (RMSE) of 1.50 within a score range of 1 to 11 (matching F to A). Moreover, for cold start problems like new courses, employed the ChatGPT to get similar courses by analyzing course syllabi so that the students' final scores in the new courses are predicted by the weighted sum of predictions from similar courses.

Reinforcement Learning Application: Tic-Tac-Toe Game Shenzhen, China

Final project for the course Optimization in Data Science and Machine Learning (Final grade **A**).
MS&E311 equivalent taught by Prof. Yinyu Ye at Stanford University.

Jan. 2023-May 2023

- ➢ Used Reinforcement Learning to solve the Tic-Tac-Toe game problem, implementing the Q-learning Method, which can be applied to more scenarios compared to the value iteration method.
- ➢ Conducted extensive experiments by letting an adversarial model (train X to play optimally against another intelligent O) play against a trained model (train X to play optimally against random O). The adversarial model consistently secured victories when playing the offensive move and achieved draws in all defensive moves due to the superiority of the first player, which showcased that the adversarial model is smarter.

Exploring Eating Disorder Topics on Weibo Shenzhen, China

Research Assistant (Advisor: Prof. Jinbo He, the Chinese University of Hong Kong, Shenzhen)

Mar. 2023-Aug. 2024

- ➢ After collecting 6500 Weibo posts relevant to eating disorders (ED) and manually labelling them into three categories (*ED-irrelevant, ED-promotional and education, ED-laypeople*), used CNN, LSTM, random forest and XGBoost algorithms to train automatic text classifiers. The best test result attained 0.89 in accuracy, 0.88 in recall, and 0.89 in F1-score.
- ➢ Applied topic modeling method based on the Correlation Explanation and LDA model to validate whether the corpus built by our developed classifiers could produce similar ED-relevant topics compared with the manually identified gold standard corpus.
- ➢ Derived a specialized dictionary of highly relevant words for eating disorders based on the training outcome of machine learning algorithms, such as parameter coefficients or feature importance, which helps clarify the complex relationships between eating behaviours and social media in the Chinese context.

Using Different Models to Reveal Different Stages of COVID-19: Past, Now, and Future

Shenzhen, China
Final project for the course Mathematical Modeling Sept. 2022-Dec. 2022

- ➢ Developed and validated a comprehensive 'Susceptible-Exposed-Infectious-Recovered-Deceased' (SEIRD) model to investigate the early stages of transmission dynamics and the impact of the COVID-19 virus, with a specific focus on the Delta variant. Additionally, a 'Susceptible-Exposed-Infectious-Recovered-Exposed' (SEIRE) model was employed to analyze the characteristics of the relatively moderate Omicron variant.
- ➢ Utilized Python and Scipy to implement and rigorously validate both SEIRD and SEIRE models using real-world data from Italy and Singapore. Investigated the influence of various epidemic prevention measures and hospital capacity on the case fatality rate and the total number of deaths. The findings strongly support the likelihood of the continuous existence of a relatively moderate virus variant in the near future.

Using Social Media to Explore the Association between Eating Disorders and Suicidality

Shenzhen, China

Research Assistant (Advisor: Prof. Jinbo He, the Chinese University of Hong Kong, Shenzhen)

May 2022-Dec. 2022

➢ Created a systematic crawler program to download the profiles and posts of 542 Weibo users. Experimental and control groups consisted of users who have expressed eating disorders in their posts and who haven't.

➢ Implemented feature extraction methodologies to capture dynamic aspects, incorporating Linguistic Inquiry and Word Count features, as well as behavioural features. These features comprehensively mapped the psychological and linguistic dimensions embedded in the written expressions within user posts.

➢ Employed a meticulously trained prediction model to estimate users' Suicide Probability Scales, exploring the intricate association between eating disorders and suicidality. This endeavour showed a nuanced understanding of the interplay between psychological expressions and behavioural patterns in the context of mental health on social media.

Data Mining Assignment Submission Time to Detect At-Risk Students with Peer Information

Shenzhen, China

Research Assistant (Advisor: Dr. Jianjun Zhou, c)

June 2021-Aug. 2022

➢ Designed a program to detect assignments' deadlines with assignment submission time (AST) data, based on whether the majority of students in a specific class execute the operation of assignment submission on a Learning Management System.

➢ Collaborated with other research assistants to introduce a novel metric, Relative AST (RAST), strategically designed to mitigate the impact of variations in assignment time limits and difficulty levels. Employed logistic regression models leveraging RAST to effectively identify students at risk of poor grades by the term's end. This proactive identification enabled the implementation of targeted warm reminders to support these students. The outcome is presented at the 15th International Conference on Educational Data Mining.

SOCIAL PRACTICE EXPERIENCE

School of Science and Engineering at CUHK-Shenzhen   Shenzhen, China

Undergraduate Student Teaching Fellow for *Elementary Real Analysis II* and *Real Analysis*   Jan.-Dec. 2022

➢ Conducted a 1-hour tutorial in English and offered 2-3 hours of office hours every week, helping students with problems onsite or online.

➢ Wrote comprehensible and detailed slides and notes, assisting peers in grasping a thorough understanding of complex mathematical definitions, theorems, and their practical applications.

➢ Delivered public speeches to younger students offering valuable insights on major selection, effective mathematics learning strategies, and guidance on postgraduate applications. Volunteered to provide one-to-one consultations, particularly focusing on assisting individuals pursuing postgraduate studies, dedicating to mentorship and support in academic and career advancement.

The Career Planning and Development Office at CUHK-Shenzhen   Shenzhen, China

Leader of Visual Design Department   Aug. 2021-May 2022

➢ Operated software Photoshop, Illustrator, and InDesign to design publicity material such as posters.

➢ Through meaningful conversations in the consultation, I provided suggestions for students' career planning according to their talents and interests.

Cunxin Non-profit Hospital   Shantou, China

Volunteer   Jun. 2019-Aug 2019

➢ Helped elderly patients living in poverty and isolation with mental and physical stimulation by chatting, reading, and doing some chair-based exercises together.

➢ Supported staff in non-clinical areas and prepared medical supplies and instruments.

SKILLS AND OTHERS

- Language: Chinese (native), English (fluent) [IELTS 8.0 (7.0)], Teochew (dialect), Cantonese (dialect)
- Computer: Python (including NumPy, pandas, sklearn, TensorFlow, PyTorch), R, Stata, Matlab, C++