

CURRICULUM VITAE

Lingchao Mao

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RESEARCH INTERESTS

- Methodological developments in statistical machine learning and deep learning:
 - Machine learning with limited supervision (knowledge-informed machine learning, weakly-supervised learning, self-supervised pre-training)
 - Multi-modal learning with incomplete data
- Application domains:
 - Personalized predictive modeling for precision medicine of brain cancer
 - Data-driven biomarker discovery of post-traumatic headache
 - Early prediction for Alzheimer's Disease
 - Automated classification and segmentation of dental images

EDUCATION

Ph.D. Machine Learning Georgia Institute of Technology, Advisor: Dr. Jing Li	2025
M.S. Computer Science Georgia Institute of Technology, GPA: 3.85/4.0	2023
B.S. Statistics, B.S. Industrial and Systems Engineering North Carolina State University, GPA: 4.0/4.0, Advisors: Dr. Sara Shashaani and Dr. Julie Swann	2020

AWARDS

- **George F. Fellowship**, H. Milton Stewart School of Industrial & Systems Engineering, 2022-2024
- **Best Student Paper Award**, Data Analytics and Information Systems Division, IISE Annual Conference, 2022.
- **Finalist for Best Student Paper Award**, INFORMS Conference of Service Science, 2021
- **Runners up for Best Poster Competition**, Quality and Productivity Research Conference, 2021
- **Williams S. Green Fellowship**, H. Milton Stewart School of Industrial & Systems Engineering, 2020-2022
- **NSF Travel Scholarship**, Quality and Productivity Research Conference, 2021
- **Stewart Fellowship**, H. Milton Stewart School of Industrial & Systems Engineering, 2020
- **Caldwell Fellowship**, North Carolina State University , 2016-2020
- **Edward P. Fitts Sholar**, North Carolina State University, 2019

PUBLICATIONS

Journals

- (P1) **Mao L**, Wang L, Hu L, Eschbacher J, Leon GD, Singleton K, Curtin W, Urcuyo A, Sereduk J, Tran L, Hawkins A, Swanson K, Li J. Weakly supervised transfer learning with application in precision medicine. *IEEE Transactions on Automation Science and Engineering*. doi:10.1109/TASE.2023.3323773
- (P2) **Mao L**, Li J, Schwedt TJ, Berisha V, Nikjou D, Wu T, Dumkrieger G, Ross K, Chong CD. Questionnaire and structural imaging data accurately predict headache improvement in patients with acute post-traumatic headache attributed to mild traumatic brain injury. *Cephalalgia*. 2023;43(5). doi:10.1177/03331024231172736
- (P3) **Mao L**, Dumkrieger G, Ku D, Ross K, Berisha V, Wu T, Schwedt TJ, Li J, Chong CD. Developing multivariable models for predicting headache improvement in patients with acute post-traumatic headache attributed to mild traumatic brain injury: A preliminary study. *Headache: The Journal of Head and Face Pain* 63(1). doi:10.1111/head.14450
- (P4) **Mao L**, Chu E, Gu J, Hu T, Weyner B, Su Y. A 4D theoretical framework for measuring topic-specific influence on Twitter: development and usability study on dietary sodium tweets *Journal of Medical Internet Research*. 2023. doi:10.2196/45897 <http://dx.doi.org/10.2196/45897>

Conference Papers

- (C1) Ku D, Zheng Z, **Mao L**, Chen RQ, Su Y, Chen K, Weidman D, Wu T, Lure F, Lo S and Li J. A high-dimensional incomplete-modality transfer learning method for early prediction of Alzheimer's disease. *Alzheimer's Dementia*, 19, p.e078606.. 2023, July. doi: 10.1002/alz.078606
- (C2) **Mao L**, Vahdat K, Shashaani S, Swann J. Personalized predictions for unplanned urinary tract infection hospitalizations with hierarchical clustering. *AI and Analytics for Public Health: Proceedings of the 2020 INFORMS International Conference on Service Science (pp. 453-465)* (pp. 453-465). https://doi.org/10.1007/978-3-030-75166-1_34

Working Papers

- (W1) Lewis E, **Mao L**, Wang L, Swanson L, Li J, Tran N, Leland Hu, Plaisier C. Revealing the biology behind MRI signatures in high grade glioma. medRxiv, 2023-12. doi: 10.1101/2023.12.08.23299733 (*under review*).
- (W2) Montoya A*, **Mao L***, Drewnowski A, Chen J, Shi E, Liang A, Weiner B, Su Y. Tracking influencers in policy field on social media: a global longitudinal study of dietary sodium reduction tweets, 2006-2022. (*under review*).
- (W3) Kwak M, **Mao L**, Su Y, Chen K, Weidman D, Wu T, Lure F, Li J. A mutual knowledge distillation-empowered AI framework for early detection of Alzheimer's Disease using incomplete multi-modal images (*under review*).
- (W4) **Mao L***, Wang H*, Li J. Knowledge-informed machine learning for cancer prognosis and predictions: a review. (*under review*).
- (W5) **Mao L**, Wang Q, Su Y, Lure F, Li J. Supervised multi-modal fusion learning. (*in preparation*).

* co-first author

CONFERENCE TALKS

- (T1) Multi-modal Fusion Learning. *IISE Annual Conference*, May 19, 2024, Montreal, Canada
- (T2) Baseline Questionnaires and Longitudinal Headache Diary Data Predict Headache Improvement in Patients with Acute Post-Traumatic Headache Attributed to Mild Traumatic Brain Injury: Balancing Prediction Accuracy and Patient Burden. *Fifth Annual NIH HEAL Initiative Investigator Meeting*, February 8, 2024, Bethesda, Maryland (**selected oral presentation**)

- (T3) Predicting Headache Improvement in Patients with Acute Post-traumatic Headache Attributed to Mild Traumatic Brain Injury Using Imaging, Clinical, and Speech Data: a Multi-Modality Machine-Learning Study. *American Headache Society Annual Scientific Meeting*, June 15, 2023, Austin, TX (**selected oral presentation**).
- (T4) A Machine Learning Model Including Questionnaire and Structural Imaging Data Predicts Headache Improvement in Patients with Acute Post-traumatic Headache Attributed to Mild Traumatic Brain Injury. *American Academy of Neurology 2023 Annual Meeting*, April 25, 2023, Boston, MA (poster).
- (T5) Biomarker Signature to Predict the Persistence of Post-traumatic Headache. *Fourth Annual NIH HEAL Initiative Investigator Meeting*, February 21, 2023, Bethesda, Maryland (**selected oral presentation**).
- (T6) Predicting Headache Persistence in Patients with Acute Post-traumatic Headache Attributed to Mild Traumatic Brain Injury: a Preliminary Study. *American Headache Society Annual Scientific Meeting*, June 9, 2022, Denver, CO (poster)
- (T7) Weakly Supervised Transfer Learning with Application in Precision Medicine. *IISE Annual Conference*, May 21, 2022, Seattle, WA. (**Best student paper in Data Analytics & Information Systems**)
- (T8) Multivariate models for predicting headache improvement in patients with acute post-traumatic headache attributed to mild traumatic brain injury using baseline clinical data: a preliminary study. *Third Annual NIH HEAL Initiative Investigator Meeting*, April 11, 2022 (poster).
- (T9) Weakly Supervised Transfer Learning with Application in Precision Medicine. *INFORMS Workshop on Data Mining and Decision Analytics*, October 23, 2021 (poster).
- (T10) A Hybrid Regression-Ranking Model with Application in Personalized Radiomics. *Quality and Productivity research Conference*, 2021 July 27, virtual. (**Best student poster runner-up**)
- (T11) Personalized Predictions for Unplanned Urinary Tract Infection Hospitalizations with Hierarchical Clustering. *INFORMS Conference of Service Science*, 2020 December 20, virtual. (**Best student paper finalist**)

RESEARCH EXPERIENCE

Research Assistant, Georgia Institute of Technology, Atlanta, GA

2020 - present

- **Precision medicine of brain cancer.** This research aims to develop personalized machine learning models to predict regional tumor cell density from MRI. My contributions included: 1) developing a novel weakly-supervised transfer learning (WS-TL) model that leverages domain knowledge about the tumor, which addresses the small sample problem and outperforms existing models, 2) an active sampling algorithm to select informative pairs of weakly labeled samples, 3) a GUI for non-technical users to run pre-operative and post-operative model to assist cancer treatment.

This research is in collaboration with Drs. Kristin Swanson and Leland Hu at Mayo Clinic.

- **Prognosis of persistent post-traumatic headache.** This research develops predictive machine learning algorithms for the prognosis of post-traumatic headache based on neuroimaging (MRI, fMRI, DTI), clinical questionnaires, and mobile-collected speech data. My contributions include: 1) implemented a dimension reduction and classification pipeline to predict patient's headache improvement from multi-modality data, and 2) applied functional regression and tensor decomposition to analyze the temporal trend of headache evolution.

This research is in collaboration with Drs. Catherine D. Chong and Todd Schwedt at Mayo Clinic.

- **Early prediction of Alzheimer's Disease.** This research aims to do early prediction of AD conversion from incomplete multi-modality neuroimaging and genetics data (MRI, PET, SNP). My contribution include: 1) implemented a state-of-the-art model for comparison on ADNI benchmark dataset, 2)

developing a new Supervised Multi-modal Fission Learning (MMFL) model that can decompose multi-modality data into globally joint, locally joint, and individual components while handling incomplete-modality data, and 3) developing a new mutual student-teacher multi-modal learning model with theoretical analysis of the knowledge distillation effectiveness.

- **Automated Detection and Diagnosis of Dental Lesion.** This project aims to develop an automated pipeline to detect, segment, and classify lesion from 3D CBCT dental volumes. I am developing a deep learning model that can combine local view and global views for accurate lesion classification.

This research is in collaboration with Dr. Frank Setzer from UPenn School of Dental Medicine

Undergraduate Research Assistant, North Carolina State University, Raleigh, NC 2019 - 2020

- **Prediction of Unplanned Hospitalization of Medicare Patients.** This project developed machine learning models to predict unplanned hospitalization of eight types of common diseases and four type of adverse events by analyzing over 15M Medicare claims and various public datasets. My methodological contributions included co-developing a multi-layered feature selection and dynamic personalized scoring algorithm to predict monthly hospitalization risk for individual patients.

Team selected top 25 out of 300+ teams into Stage I of the \$1M CMS AI Health Outcomes Challenge.

SIDE PROJECTS

- **Mendel AI, a LLM Assistant for Bioinformatics Data Analysis and Visualization.** I created a chat model that generates an analysis plan, python code, and output figures from single cell RNA-seq data given users' biological question. The model was implemented using Langchain with vector database and document database integrations and Chanlit for interactive UI.

This project is lead by Dr. Assaf Magen, former Assistant Professor at Precision Immunology Institute.

- **Segmentation of Retinal Layers from OCT Images.** This research develops deep learning models to segment retinal nerve fiber layer from OCT images for eye disease diagnosis. My contribution involved implementating a customized U-Net that outputs predictive uncertainty along the segmentation maps. Our model achieved 0.86 DICE on a pre-clinical dataset, comparable to the state-of-the-art.

This research used data from Feola Lab from Wallace H. Coulter Dept. of Biomedical Engineering.

- **Self-supervised Reconstruction of MRI.** This research develops deep learning models that can reconstruct fully-sampled brain MRI from under-sampled, accelerated MRI. My contribution involve implementing a self-supervised learning pre-training strategy that relies on none or few paired fully-sampled images. The framework is model-agnostic and efficient. Our model achieved similar performance as its supervised counterpart using only 20% of labeled samples on the IXI dataset.

- **MMTrip, a Personalized Multi-modal Routing Planner.** We are building a multi-modal trip planning application with the following capabilities: 1) Door-to-door routes considering all multi-modal combinations of flights, public transit, driving, biking, and walking, 2) Personalization via user-defined trip details/preferences/constraints, 3) Accurate prediction of taxi fare via based on Uber's surge pricing model, and 4) Interactive map visualization of routes. My contribution involves overseeing product design and implementing the backend routing algorithm.

- **Analyzing Influence of Public Health Organizations on on Twitter.** This project aims to develop methodologies to quantify user influence on social media. We designed a four-dimensional framework to analyze topic-specific influence on Twitter. We applied this framework to 1M+ tweets from health organizations and analyzed their influence about sodium intake, one of the risk factors of cardiovascular diseases. We also compiled a database of national, state-level, and local sodium-reduction policies across the U.S. from 1965-2010 to correlate the policy data with social media patterns.

I mentored a masters, an undergraduate, and three high school students in this project.

GRANT WRITING EXPERIENCE

Helped Ph.D. advisor in preparation of the following grant applications. My involvement included literature review and participating in component section writing.

- NIH-NCI, "The Coordinating and Data Management Center for PDAC Stromal Reprogramming Research," unfunded, 7/1/2022 – 6/30/2027, \$1,856,218 (GT share)

TEACHING

- H. Milton Stewart Ph.D. Student Teaching Fellow
- Teaching Assistant, ISE110 Computer-Based Modeling for Engineers, North Carolina State University
- University Tutorial Center, PY205 & PY208 Physics for Engineers I & II, North Carolina State University ((College Reading & Learning Association (CRLA) Level II certified tutor))

SERVICE AND LEADERSHIP

- Reviewer
 - IEEE Transactions on Automation Science and Engineering (IEEE-TASE)
 - INFORMS Journal on Computing
 - President's Undergraduate Research Awards (PURA), Georgia Institute of Technology
- Professional Memberships
 - Member, Institute of Industrial and Systems Engineers (IISE)
 - Member, Institute for Operations Research and the Management Sciences (INFORMS)
- Community Service and Volunteering
 - **Advisory Committee**, Caldwell Fellows at North Carolina State University, 2023 - present
 - **Treasurer**, Institute for Operations Research and the Management Sciences (INFORMS) Chapter at Georgia Tech, 2023 - present
 - **Project Manager**, Society of Asian Scientists and Engineers (SASE) Chapter at North Carolina State University, 2019 - 2020
 - **HR Lead**, Project Management Lite Internship program at North Carolina State University, 2019 - 2020
 - **Geographic Information System Analyst**, Habitat for Humanity, 2018
 - **Guatemala Water Systems Team**, Engineers Without Borders, 2018
 - **Treasurer**, IT Club at NC State University, 2018-2020