Aiying Zhang

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Department of Global Biostatistics and Data Science
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Education

Tulane University — Expected May 2021

Ph.D. candidate, Department of Biomedical Engineering — **GPA 3.81/4.0**

Dissertation: *Study brain functional connectivity using graphical models*

Committee members: Yu-Ping Wang (Chair), Donald P. Gaver, Department of Biomedical Engineering
Jihun Hamm, Department of Computer Science
Hongwen Deng, Department of Biostatistics and Data Science

Research Field: Brain imaging, Imaging (epi)genetics

Concentration: Network analysis, Graphical models (Directed/ Undirected)

University of Science and Technology of China (USTC) — Jun 2014

B.Sc. in Statistics, School for the Gifted Young — **GPA 3.63/4.0**

Publications

First Author

Journal Publications

Zhang, A., Fang, J., Hu, W., Calhoun, V. D., and Wang, Y.-P. (preprint). A Latent Gaussian Copula Model for Mixed Data Analysis in Brain Imaging Genetics. IEEE/ACM transactions on computational biology and bioinformatics. DOI: 10.1109/TCBB.2019.2950904

Zhang, A., Cai, B., Hu, W., Jia, B., Liang, F., Wilson, T. W., Stephen, J. M., Calhoun, V. D. and Wang, Y.-P. (2020). Joint Bayesian-incorporating estimation of multiple Gaussian graphical models to study brain connectivity development in adolescence. IEEE transactions on medical imaging. vol. 39, no. 2, pp. 357-365.

Zhang, A., Fang, J., Liang, F., Calhoun, V. D. and Wang, Y.-P.(2019). Aberrant Brain Connectivity in Schizophrenia Detected via a Fast Gaussian Graphical Model. IEEE journal of biomedical and health informatics. vol. 23, no. 4, pp. 1479-1489.

Conference Publications

Zhang, A., Zhang, G., Calhoun, V. D. and Wang, Y.-P. (2020, March). Causal brain network in schizophrenia by a two-step Bayesian network analysis. In Medical Imaging 2020: Imaging Informatics for Healthcare, Research, and Applications (Vol. 11318, p. 1131817). International Society for Optics and Photonics.

Zhang, A., Calhoun, V. D. and Wang, Y.-P. (2019, March). Joint Gaussian copula model for mixed data with application to imaging epigenetics study of schizophrenia. In Medical Imaging 2019: Imaging Informatics for Healthcare, Research, and Applications (Vol. 10954, p. 109540R). International Society for Optics and Photonics.

Zhang, A., Fang, J., Calhoun, V. D. and Wang, Y.-P. (2018, April). High dimensional latent Gaussian copula model for mixed data in imaging genetics. In 2018 IEEE 15th International Symposium on Biomedical Imaging (ISBI 2018) (pp. 105-109).

Zhang, A., Jia, B. and Wang, Y.-P. (2018, March). Tracking the development of brain connectivity in adolescence through a fast Bayesian integrative method. In Medical Imaging 2018: Imaging Informatics for Healthcare, Research, and Applications (Vol. 10579, p. 105790O). International Society for Optics and Photonics.

Publications (continued)

Co-Author

Zhou Z., Cai, B., Zhang, G., **Zhang, A.**, Calhoun, V. D. and Wang, Y.-P. Prediction and classification of sleep quality based on phase synchronization related whole-brain dynamic connectivity using resting state fMRI. Accepted by NeuroImage.

Cai, B., Zhang, G., **Zhang, A.**, Hu, W., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. (2020). A GICA-TVGL framework to study sex differences in resting state fMRI dynamic connectivity. Journal of Neuroscience Methods, 332, p.108531.

Cai, B., Zhang, G., Hu, W., **Zhang, A.**, Zille, P., Zhang, Y., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. (2019). Refined measure of functional connectomes for improved identifiability and prediction. Human brain mapping, 40(16), pp.4843-4858.

Zhang, G., Cai, B., **Zhang, A.**, Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. (2020). Estimating Dynamic Functional Brain Connectivity with a Sparse Hidden Markov Model. IEEE transactions on medical imaging, vol. 39, no. 2, pp. 488-498.

Hu, W., **Zhang, A.**, Cai, B., Calhoun, V. D. and Wang, Y.-P. (2019). Distance canonical correlation analysis with application to an imaging-genetic study. Journal of Medical Imaging, 6(2), 026501.

Hu, W., Cai, B., **Zhang, A.**, Calhoun, V. D. and Wang, Y.-P. (2019). Deep collaborative learning with application to multi-modal brain development study. IEEE Transactions on Biomedical Engineering, 66(12), 3346-3359.

Cai, B., Zhang, G., **Zhang, A.**, Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. (2018). Capturing dynamic connectivity from resting state fMRI using time-varying graphical LASSO. IEEE Transactions on Biomedical Engineering, 66(7), 1852-1862.

Zhang, G., **Zhang, A.**, Calhoun, V. D. and Wang, Y.-P. (2020, February). A causal brain network estimation method leveraging Bayesian analysis and the PC algorithm. In Medical Imaging 2020: Biomedical Applications in Molecular, Structural, and Functional Imaging (Vol. 11317, p. 113170X). International Society for Optics and Photonics.

Under Review

Xiao, L., **Zhang, A.**, Cai, B., Stephen, J. M., Wilsom, T. W., Calhoun, V. D. and Wang, Y.-P. Correlation Guided Graph Learning to Estimate Functional Connectivity Networks from fMRI Data. Submitted to IEEE transactions on biomedical engineering.

Hu, W., Meng, X., Bai, Y., **Zhang, A.**, Cai, B., Stephen, J. M., Wilson, T. W., Calhoun, Calhoun, V. D. and Wang, Y.-P. Interpretable multimodal fusion networks reveal mechanisms of brain cognition. Submitted to IEEE transactions on medical imaging.

Zhang, A., Zhang, G., Cai, B., Xiao, L., Hu, W., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. ψ-Learning Incorporated Linear non-Gaussian Acyclic Model (ψ-LiNGAM) for causal inference of brain connectivity from fMRI. Submitted to IEEE transactions on biomedical engineering.

Zhang, A., Zhang, G., Cai,B., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. A Bayesian incorporated linear non-Gaussian acyclic model for multiple directed graph estimation to study brain emotion circuit development in adolescence. Submitted to IEEE transactions on medical imaging.

Under Preparation

Cai, B., Zhang, G., **Zhang, A.**, Xiao, L., Hu, W., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. Functional connectome fingerprinting: Identifying individuals and predicting cognitive functions using refined brain connectivity.

Research Experience

Research Assistant, Department of Biomedical Engineering — Tulane University

Statistical Methods for Brain Functional Connectivity Studies — Jan 2016 – Present

- Laboratory: The Multiscale Bioimaging and Bioinformatics Laboratory (MBB)
- Description: Develop solid statistical graphical models for the FC estimation under various situations. Two types of graph: undirected graph, and directed graph are concerned, each corresponds to the association and causal relationships, respectivly.

1. Develop a systematic framework of undirected graph estimation under various circumstances. Specifically, we consider cases of high dimensionality, mixed data types, joint estimation for multiple graph, and time-series data.
2. Address current difficulties in directed graph estimation. Specifically, we work on the imporvement of causal inference especially for small sample size problems.

Developmental Chronnecto-Genomics (Dev-CoG)

- Collaborator: the Mind Research Network (MRN), the University of Nebraska Medical Center (UNMC), and the Center for Translational Research in Neuroimaging and Data Science (TReNDS)
- Description: Leverage advanced brain imaging and omics data, for biomarkers that can help address relevant areas of brain health and disease.

1. Deepen the understanding of the neural /neurogenetic mechanism of schizophrenia (SZ) using fMRI, genomic (SNP) and epigenomic profiles (DNA methylation). Identify new and reliable biomarkers of SZ for precise diagnosis and provide an enormous impetus for drug discovery.
2. Study the brain emotion circuit development in adolescence to explain the emotional sensitivity and specialty of adolescence.
3. Analyze the dynamic functional connectivity and individual variability.

Multi-omics data integration for biomarkers indentification in osteoporosis

- Collaborator: Tulane Center for Bioinformatics and Genomics
- Description: Integrate multi-omics data include SNP, DNA methylation, DNA expression, RNA transcription, metabolomics (and lipidomics) for biomarkers indentification and their biological interactions and causal mechanisms of osteoporosis.

Research Assistant, Department of Biostatistics — University of Florida

Research of Early Detection of Infectious Disease Outbreaks — Aug 2014 – Dec 2015

- Description: Built an effective and flexible spatial-temporal monitoring system for disease surveillance and early detection.

1. Statistical model: developed nonparametric spatial-temporal statistical models for estimating the incidence rate and proposed a method coping with irregular spatial-temporal data with measurement error in sensor network.
2. Compared with the well-received Hierarchical Bayesian Model, Conditional Autoregressive Model and Log-Gaussian Cox Process Model.

Teaching Experience

Advisor of Undergraduate Research, Department of Biomedical Engineering — Tulane University

Student: Jason Dent — Jan 2018 – Dec 2018

Thesis: Using a Multilayer Perceptron to Categorize fMRI Data

Teaching Assistant, Department of Biostatistics — University of Florida

Biostatistical Computing with SAS — Sep 2015 - Dec 2015

- Prepared lectures for lab sessions using SAS and conducted discussions with students
- Graded, provided correct homework solutions, provided office hours

Advanced Biostatistical Methods — Sep 2015 - Dec 2015

- Conducted homework discussions with students weekly
- Graded, provided correct homework solutions, provided office hours

Presentations

Conference Presentations

OHBM Annual Meeting, Virtual Presentation, June 23 - July 3, 2020.

Causal functional brain network: An advanced approach to study brain cognitive variance (#1068)

SPIE Medical Imaging, Feb 17, 2020, Houston, TX, USA.

Estimation of a causal brain network in schizophrenia via a two-step Bayesian network analysis (#11318-40)

SPIE Medical Imaging, Feb 18, 2019, San Diego, CA, USA

Joint Gaussian copula model for mixed data with application to imaging epigenetics study of schizophrenia (#10954-26)

IEEE ISBI 2018, Apr 5, 2018, Washington, D.C., USA

High dimensional latent Gaussian copula model for mixed data in imaging genetics (#551)

SPIE Medical Imaging, Feb 14, 2018, Houston, TX, USA

Tracking the development of brain connectivity in adolescence through a fast Bayesian integrative method (#10579-20)

OHBM Annual Meeting, June 28, 2017, Vancouver, BC, CA.

Discovery of aberrant brain connectivity networks associated with Schizophrenia using a high-dimensional Gaussian Graphical Model (#4028)

Upcoming:

Joint Statistical Meetings (JSM), Virtual Presentation, August 4th, 2020.

A Bayesian Incorporated Linear Non-Gaussian Acyclic Model (BiLiNGAM) for Multiple Directed Acyclic Graph Estimation with application to causal brain connectivity using fMRI (#313970)

Campus Presentations

School of Science and Engineering (SSE) Research Day, April 11, 2019

High Dimensional Latent Gaussian Copula Model for Mixed Data in Imaging Genetics

Tulane Health Sciences Research Days (HSRD), Feb 20-21, 2017

Discovery of Aberrant Brain Connectivity in Schizophrenia using Gaussian Graphical Models

SSE Research Day, April 6, 2017

Discovery of Aberrant Brain Connectivity in Schizophrenia using Gaussian Graphical Models

Service To Profession

Editorial Coordinator of Technometrics, American Statistician Association (ASA). 2014 – 2015

Volunteer of K-12 STEM Education Outreach 2017 – present

Related Training

Woman in Neuroscience July 8-10, 2019

Organization: Brown University, Dartmouth College, Montana State University and University of Nevada at Reno

Content: Elevator Pitch Talk Training

Deep Learning by deeplearning.ai March 22, 2019

Platform: Coursera

Certification: Completion of five interconnected courses, which are *Neural Networks and Deep Learning*, *Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization*, *Structuring Machine Learning Projects*, *Convolutional Neural Networks*, and *Sequence Models*.

Biostatistics Summer Institutes in Statistical Genetics (SISG) and Statistics in Big Data (SISBID) July 11-29, 2016

Organization: University of Washington, Seattle

Certification: Completion of *Quantitative Genetics* and *Supervised Methods for Statistical Machine Learning*

CCNS: Computational Neuroscience Summer School July 27-31, 2015

Organization: The Statistical and Applied Mathematical Sciences Institute (SAMSI)

Content: Courses on five major research topics in computational neuroscience, including neural spike train analysis, compressed sensing for signal processing, functional data analysis for medical imaging data, big-biomedical data integration and analysis, shape analysis and diffeomorphisms for medical imaging data.

Membership

Member of American Statistician Association (ASA). 2015 – present

Member of SPIE, the international society for optics and photonics 2018 – present

Honors and Rewards

GSSA Travel Award, Tulane University 2017 – 2020

Certificate of Outstanding Academic Achievement, University of Florida 2014 – 2015

Outstanding Student Scholarship , USTC 2011 – 2013

Outstanding Freshman Scholarship, USTC 2010

Skills

Languages C/C++, Fortran, Matlab, Python, R, SAS, SPSS, SQL, STATA **Tools** Linux/Unix, LaTeX