

# Aiying Zhang

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Mental Health Data Science Division

## EDUCATION

Columbia University	EXPECTED JULY 2023
Postdoc Training in Clinical Biostatistics and Psychiatry, COLUMBIA UNIVERSITY IRVING MEDICAL CENTER	
Tulane University	MAY 2021
Ph.D. in Biomedical Engineering, SCHOOL OF SCIENCE AND ENGINEERING	
Dissertation: <i>Study brain functional connectivity using graphical models</i>	
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, Probabilistic graphical models (directed/ undirected)	
University of Science and Technology of China (USTC)	JUN 2014
B.Sc. in Statistics, SCHOOL FOR THE GIFTED YOUNG	
GPA 3.81/4.0	
GPA 3.63/4.0	

## PUBLICATIONS

First Author
Journal Publications
<b>Zhang, A.</b> , 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
<b>Zhang, A.</b> , 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.
<b>Zhang, A.</b> , 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
<b>Zhang, A.</b> , 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.
<b>Zhang, A.</b> , 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.
<b>Zhang, A.</b> , 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.

#### Co-Author

Hu, W., Meng, X., Bai, Y., **Zhang, A.**, Cai, B., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. (2021) Interpretable multimodal fusion networks reveal mechanisms of brain cognition. IEEE Transactions on Medical Imaging, doi: 10.1109/TMI.2021.3057635.

Xiao, L., **Zhang, A.**, Cai, B., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. (2021) Correlation Guided Graph Learning to Estimate Functional Connectivity Networks from fMRI Data. IEEE Transactions on Biomedical Engineering, vol. 68, no. 4, pp. 1154-1165.

Zhou Z., Cai, B., Zhang, G., **Zhang, A.**, Calhoun, V. D. and Wang, Y.-P. (2021) Prediction and classification of sleep quality based on phase synchronization related whole-brain dynamic connectivity using resting state fMRI. NeuroImage, 221, 117-190.

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 multimodal 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

**Zhang, A.**, Zhang, G., Cai, B., Xiao, L., Hu, W., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P.  $\psi$ -Learning Incorporated Linear non-Gaussian Acyclic Model ( $\psi$ -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 Medical Image Analysis.

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. Submitted to Human Brain Mapping.

## PUBLICATIONS (CONTINUED)

### Under Preparation

Sun, L., **Zhang, A.**, Liang, F. Dynamic Bayesian network by Markov neighbor regression and its application in the fMRI data.  
Zhang G., Tu Z., **Zhang, A.**, Cai, B., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. Revealing the abnormal directed connections in SZ patients.

Cai, B., Zhou Z., **Zhang, A.**, Zhang, G., Xiao, L., Hu, W., Stephen, J. M., Wilson, T. W., Calhoun, V. D. and Wang, Y.-P. Functional Connectomes Based on Phase Synchronization during task performance and rest predict individual differences.

**Zhang A.**, Zhang G., Su K.-J., Zhao Q., Wang, Y.-P., Deng H.-W. The mediating effect of metabolomic profiles on bone mineral density in US caucasian women.

## RESEARCH EXPERIENCE

### Research Scientist II, Mental Health Data Science Division

New York State Psychiatric Institute

Statistical Methods for Children's Neurocognitive Development Studies

JULY 2021 –

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

1. Form the basis for developing a new line of statistical methods to identify age-related changes in functional connectivity and examine the role of brain structure and genetics in function development

2. Generate new hypotheses regarding the neural bases of developmentally based psychopathologies, and accurate identification of functional development abnormalities and their mechanisms is crucial to the child and adolescent psychiatry and mental health nursing..

### Research Assistant, Department of Biomedical Engineering

Tulane University

Statistical Methods for Brain Functional Connectivity Studies

JAN 2016 – MAY 2021

- Laboratory: The Multiscale Bioimaging and Bioinformatics Laboratory (MBB)

- Description: Develop solid statistical graphical models for the FC estimation under various situations.

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 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 and epigenomic profiles. 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 to explain the emotional sensitivity and specialty of adolescence.

3. Analyze the dynamic functional connectivity and individual variability.

#### Multi-omics data integration for biomarkers identification in osteoporosis

- Collaborator: Tulane Center for Bioinformatics and Genomics

- Description: Integrate multi-omics data include SNP, DNA methylation, DNA expression, RNA transcription, metabolomics for biomarkers identification 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
<ul style="list-style-type: none"> <li>• Description: Built an effective and flexible spatial-temporal monitoring system for disease surveillance and early detection.</li> </ul>	
<ol style="list-style-type: none"> <li>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.</li> <li>2. Compared with the well-received Hierarchical Bayesian Model, Conditional Autoregressive Model and Log-Gaussian Cox Process Model.</li> </ol>	

## 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
<ul style="list-style-type: none"> <li>• Prepared lectures for lab sessions using SAS and conducted discussions with students</li> <li>• Graded, provided correct homework solutions, provided office hours</li> </ul>	
Advanced Biostatistical Methods	SEP 2015 - DEC 2015
<ul style="list-style-type: none"> <li>• Conducted homework discussions with students weekly</li> <li>• Graded, provided correct homework solutions, provided office hours</li> </ul>	

## PRESENTATIONS

Invited Talk
<b>Department of Psychiatry at University of Pittsburgh</b> , Virtual Presentation, Mar 17, 2021. <i>Study Brain Functional Connectivity Using Graphical Models</i>
<b>Department of Electrical and Computer Engineering at Rice University</b> , Virtual Presentation, Jan 12, 2021. <i>Study Brain Functional Connectivity Using Graphical Models</i>
<b>Mental Health Data Science at Coulumbia University</b> , Virtual Presentation, Jan 8, 2021. <i>Study Brain Functional Connectivity Development in Adolescence Using Graphical Models</i>
<b>Department of Biostatistics at Coulumbia University</b> , Virtual Presentation, Dec 3, 2020. <i>A Latent Gaussian Copula Model for Data Integration and Its Application in Imaging Genetics</i>
<b>The Cole Neurocognition Lab at Rutgers University</b> , Virtual Presentation, Nov 23, 2020. <i>Study Brain Functional Connectivity Using Graphical Models</i>
Conference Presentations
<b>Joint Statistical Meetings (JSM)</b> , Virtual Presentation, August 4th, 2020. <i>A Bayesian Incorporated Linear Non-Gaussian Acyclic Model (BiLiNGAM) for Multiple Directed Acyclic Graph Estimation with application to causal brain connectivity using fMRI (#313970)</i>
<b>OHBM Annual Meeting</b> , Virtual Presentation, June 23 - July 3, 2020. <i>Causal functional brain network: An advanced approach to study brain cognitive variance (#1068)</i>
<b>SPiE Medical Imaging</b> , Feb 17, 2020, Houston, TX, USA. <i>Estimation of a causal brain network in schizophrenia via a two-step Bayesian network analysis (#11318-40)</i>

**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)

## PRESENTATIONS (CONTINUED)

### 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
Reviewer for IEEE transactions on medical imaging	2020
Abstract Triage for the Neuromatch Conference	2020

## RELATED TRAINING

<b>Woman in Neuroscience</b>	JULY 8-10, 2019
Organization: Brown University, Dartmouth College, Montana State University and University of Nevada at Reno	
Content: Elevator Pitch Talk Training	
<b>Deep Learning by deeplearning.ai</b>	MARCH 22, 2019
Platform: Coursera	
Certification: Completion of five interconnected courses, which are <i>Neural Networks and Deep Learning</i> , <i>Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization</i> , <i>Structuring Machine Learning Projects</i> , <i>Convolutional Neural Networks</i> , and <i>Sequence Models</i> .	
<b>Biostatistics Summer Institutes in Statistical Genetics (SISG) and Statistics in Big Data (SISBID)</b>	JULY 11-29, 2016
Organization: University of Washington, Seattle	
Certification: Completion of <i>Quantitative Genetics</i> and <i>Supervised Methods for Statistical Machine Learning</i>	
<b>CCNS: Computational Neuroscience Summer School</b>	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

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Member of American Statistician Association (ASA).	2015 – PRESENT
Member of SPIE, the international society for optics and photonics	2018 – PRESENT

## HONORS AND REWARDS

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<b>2021 Biomedical Engineering Graduate Student Outstanding Achievement Award</b> , Tulane University	2021
<b>GSSA Travel Award</b> , Tulane University	2017 – 2020
<b>Certificate of Outstanding Academic Achievement</b> , University of Florida	2014 – 2015
<b>Outstanding Student Scholarship</b> , USTC	2011 – 2013
<b>Outstanding Freshman Scholarship</b> , USTC	2010

## SKILLS

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<b>Languages</b> C/C++, Fortran, Matlab, Python, R, SAS, SPSS, SQL, STATA	<b>Tools</b> Linux/Unix, $\LaTeX$
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