# **Zixuan** Cang

Curriculum Vitae

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North Carolina State University
Raleigh, NC 27607

Department of Mathematics

## EDUCATION

PhD, Applied Mathematics	2013-2018
Michigan State University, East Lansing, MI.	
BS, Pure and Applied Mathematics	2009-2013
Xiamen University, Xiamen, China	

### **RESEARCH INTERESTS**

Mathematical Biology/Biophysics; Topological Data Analysis; Numerical PDE; Machine Learning/Deep Learning; and Parallel/GPU Computing.

### Employment

North Carolina State University, Raleigh, NC.	
Department of Mathematics	
Assistant Professor	Aug 2021 - Present
University of California, Irvine, Irvine, CA.	
Department of Mathematics	
Visiting Assistant Professor	Jul 2020 - Jul 2021
Postdoctoral Scholar	Aug 2018 - Jun 2020
The NSF-Simons Center for Multiscale Cell Fate	Research
Postdoctoral Fellow	Aug 2018 - Jul 2021
Michigan State University, East Lansing, MI.	
Department of Mathematics	
Graduate Research Assistant	Jul 2014 - Jul 2018

# PUBLICATIONS

(\* co-first author)

24. Zixuan Cang, Yanxiang Zhao, and Qing Nie. Supervised optimal transport. SIAM Journal on Applied Mathematics, 2022

- 23. Honglei Ren, Benjamin L Walker, **Zixuan Cang**, and Qing Nie. Identifying multicellular spatiotemporal organization of cells with spaceflow. *Nature Communications*, 2022
- 22. Benjamin L Walker, **Zixuan Cang**, Honglei Ren, Eric Bourgain-Chang, and Qing Nie. Deciphering tissue structure and function using spatial transcriptomics. *Communications Biology*, 5(1):220, Mar 2022
- David Tatarakis, Zixuan Cang, Xiaojun Wu, Praveer P Sharma, Matthew Karikomi, Adam L MacLean, Qing Nie, and Thomas F Schilling. Singlecell transcriptomic analysis of zebrafish cranial neural crest reveals spatiotemporal regulation of lineage decisions during development. *Cell reports*, 37(12):110140, 2021
- Zixuan Cang, Xinyi Ning, Annika Nie, Min Xu, and Jing Zhang. Scanit: Domain segmentation of spatial transcriptomics images by graph neural network. In *British Machine Vision Conference*, 2021
- 19. Mehrsa Mehrabi, Tessa A Morris, Zixuan Cang, Cecilia HH Nguyen, Yutong Sha, Mira N Asad, Nyree Khachikyan, Taylor L Greene, Danielle M Becker, Qing Nie, Michael V. Zaragoza, and Anna Grosberg. A study of gene expression, structure, and contractility of ipsc-derived cardiac myocytes from a family with heart disease due to lmna mutation. Annals of Biomedical Engineering, pages 1–16, 2021
- 18. Qing Zhu, Yuzhe Du, Yoshiko Nomura, Rong Gao, Zixuan Cang, Guo-Wei Wei, Dalia Gordon, Michael Gurevitz, James Groome, and Ke Dong. Charge substitutions at the voltage-sensing module of domain iii enhance actions of site-3 and site-4 toxins on an insect sodium channel. *Insect Biochemistry and Molecular Biology*, page 103625, 2021
- Axel A. Almet, Zixuan Cang, Suoqin Jin, and Qing Nie. The landscape of cell-cell communication through single-cell transcriptomics. *Current Opinion in Systems Biology*, 26:12–23, 2021
- Floyd Maseda, Zixuan Cang, and Qing Nie. Deepsc: A deep learningbased map connecting single-cell transcriptomics and spatial imaging data. Frontiers in Genetics, 12:348, 2021
- Zixuan Cang\*, Yangyang Wang\*, Qixuan Wang, Ken W. Y. Cho, William Holmes, and Qing Nie. A multiscale model via single-cell transcriptomics reveals robust patterning mechanisms during early mammalian embryo development. *PLOS Computational Biology*, 17(3):1–20,

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- Zixuan Cang, Elizabeth Munch, and Guo-Wei Wei. Evolutionary homology on coupled dynamical systems with applications to protein flexibility analysis. *Journal of Applied and Computational Topology*, pages 1–27, 2020
- 13. Ruiqiong Guo, **Zixuan Cang**, Jiaqi Yao, Miyeon Kim, Erin Deans, Guowei Wei, Seung gu Kang, and Heedeok Hong. Structural cavities are critical to balancing stability and activity of a membrane-integral enzyme. *Proceedings of the National Academy of Sciences*, 2020
- Zixuan Cang and Qing Nie. Inferring spatial and signaling relationships between cells from single cell transcriptomic data. *Nature Communications*, 11(1):1–13, 2020
- 11. Zixuan Cang and Guo-Wei Wei. Persistent cohomology for data with multicomponent heterogeneous information. SIAM Journal on Mathematics of Data Science, 2(2):396–418, 2020
- Daniel Haensel, Suoqin Jin, Peng Sun, Rachel Cinco, Morgan Dragan, Quy Nguyen, Zixuan Cang, Yanwen Gong, Remy Vu, Adam L. MacLean, Kai Kessenbrock, Enrico Gratton, Qing Nie, and Xing Dai. Defining epidermal basal cell states during skin homeostasis and wound healing using single-cell transcriptomics. *Cell Reports*, 30(11):3932– 3947.e6, Mar 2020
- Duc Duy Nguyen, Zixuan Cang, and Guo-Wei Wei. A review of mathematical representations of biomolecular data. *Physical Chemistry Chemical Physics*, 22(8):4343–4367, 2020
- 8. Menglun Wang, **Zixuan Cang**, and Guo-Wei Wei. A topology-based network tree for the prediction of protein–protein binding affinity changes following mutation. *Nature Machine Intelligence*, 2(2):116–123, 2020
- Duc Duy Nguyen, Zixuan Cang, Kedi Wu, Menglun Wang, Yin Cao, and Guo-Wei Wei. Mathematical deep learning for pose and binding affinity prediction and ranking in d3r grand challenges. *Journal of Computer-Aided Molecular Design*, Aug 2018
- Rundong Zhao, Zixuan Cang, Yiying Tong, and Guo-Wei Wei. Protein pocket detection via convex hull surface evolution and associated Reeb graph. *Bioinformatics*, 34(17):i830–i837, 2018

- 5. **Zixuan Cang**, Lin Mu, and Guo-Wei Wei. Representability of algebraic topology for biomolecules in machine learning based scoring and virtual screening. PLoS Computational Biology, 14(1):e1005929, 2018
- 4. Zixuan Cang and Guo-Wei Wei. Topologynet: Topology based deep convolutional and multi-task neural networks for biomolecular property predictions. PLoS Computational Biology, 13(7):e1005690, 2017
- 3. Zixuan Cang and Guo-Wei Wei. Integration of element specific persistent homology and machine learning for protein-ligand binding affinity prediction. International Journal for Numerical Methods in Biomedical Engineering, page e2914, 2017
- 2. Zixuan Cang and Guo-Wei Wei. Analysis and prediction of protein folding energy changes upon mutation by element specific persistent homology. *Bioinformatics*, 33(22):3549–3557, 2017
- 1. Zixuan Cang, Lin Mu, Kedi Wu, Kristopher Opron, Kelin Xia, and Guo-Wei Wei. A topological approach for protein classification. Molecular Based Mathematical Biology, 3(1):140–162, 2015

#### **GRANTS**

# NSF DMS-2151934 (\$374,381.00) 09/01/2022-08/31/2025

Role: PI

Title: Topological and Geometric Modeling and Computation of Structures and Functions in Single-Cell Omics Data

#### PATENTS

System and methods for machine learning for drug design and discovery U.S. Patent Application No. 16/372,239 Authors: Wei, Guowei, Duc Nguyen, and Zixuan Cang

#### HONORS and AWARDS

(2019) ICCM Best Paper Award, International Consortium of Chinese Mathematics (2018) Douglas A. Spragg Endowed Fellowship in Mathematics, Michigan State University (2018) Dr. Paul and Wilma Dressel Endowed Scholarship, Michigan State University

(2017) Dissertation Completion Fellowship, Michigan State University

# **CONFERENCES and PRESENTATIONS**

## Conferences organized

- 3. Mini-symposium "Molecular Biosciences: Modeling for Sequence and Structure-Based Molecular Analysis" at the 2022 SIAM Conference on the Life Sciences, Pittsburgh, Pennsylvania, 2022.7.11-2022.7.14 (organized with Jiahui Chen)
- 2. Workshop "Optimal Transport: Theory, Computation, and Biology", University of California, Irvine, 2022.6.3-2022.6.4 (organized with Anna Ma and Wuchen Li)
- 1. Mini-symposium "Topological data learnin" at the 2020 SIAM Conference on Mathematics of Data Science, Online virtual meeting, 2020.6.25 (organized with Kelin Xia)

# Conferences attended

- 33. (invited speaker) 2022 SIAM Conference on the Life Sciences (LS22), Minisymposium: Molecular Biosciences: Modeling for Sequence and Structure-Based Molecular Analysis, Pittsburgh, Pennsylvania, 2022.7.11-2022.7.14
- 32. (invited speaker) Interdisciplinary Center for Quantitative Modeling in Biology Seminar, University of California Riverside, 2022.5.10
- 31. (invited speaker) Applied Mathematics Seminar, Department of Mathematics, University of Georgia, 2022.4.12
- 30. (invited speaker) MINDS (Mathematicsal Institute for Data Science) Seminar Series, Pohang University of Science and Technology, 2022.3.22
- 29. (invited speaker) The Fourth TSIMF Conference on Computational and Mathematical Bioinformatics and Biophysics, Tsinghua Sanya International Mathematics Forum, Online virtual meeting, 2021.12.12-2021.12.15
- 28. (seminar speaker) Applied Mathematics Seminar, Department of Mathematics, The George Washington University 2021.10.29
- 27. (symposium speaker) Geometric and Topological Information in Data Analysis, Joint Statistical Meeting (JSM) 2021.8.8

- 26. (seminar speaker) Department of Mathematics, University of Alabama, 2021.1.21
- 25. (seminar speaker) Interdisciplinary Center for Quantitative Modeling in Biology, University of California Riverside, 2021.1.19
- 24. (seminar speaker) Department of Mathematics, North Carolina State University, 2021.1.13
- 23. (seminar speaker) Department of Mathematics, University of California Irvine, 2021.1.12
- 22. (invited speaker) The Third Conference on Computational and Mathematical Bioinformatics and Biophysics, Tsinghua Sanya International Mathematics Forum, Online virtual meeting, 2020.12.19-2020.12.23
- 21. (seminar speaker) Department of Mathematics, Auburn University, 2020.12.14
- 20. (minisymposium organizer/speaker) SIAM Conference on Mathematics of Data Science (MDS20), Online virtual meeting, 2020.6.26
- (invited speaker) Special Session on Mathematical Modeling in Developmental Biology, AMS Fall Western Sectional Meeting, University of California, Riverside, California, 2019.11.9-2019.11.10
- (invited speaker) Applied Math Seminar, Colorado State University, Fort Collins, Colorado, 2019.10.30
- (poster) 2nd Annual Symposium on Multiscale Cell Fate, University of California, Irvine, California, 2019.10.28-2019.10.29
- 16. (invited speaker) Structure in the Micro-world, Ohio State University, Columbus, Ohio, 2019.5.28-2019.5.31
- (invited speaker) NSF-CBMS Conference: Mathematical Molecular Bioscience and Biophysics, The University of Alabama, Tuscaloosa, Alabama, 2019.5.13-2019.5.17
- 14. (poster) 1st Annual Symposium on Multiscale Cell Fate, University of California, Irvine, California, 2018.10.1-2018.10.2
- 13. (participant) Workshop on the Mathematics of Drug Design/Discovery, The Fields Institute, Toronto, Canada, 2018.6.4-2018.6.8
- 12. (invited speaker) CCMA PDEs and Numerical Methods Seminar Series, Pennsylvania State University, University Park, Pennsylvania, 2018.3.21
- (participant) D3R 2018 Workshop, University of California San Diego, San Diego, CA, 2018.2.22-2018.2.23
- (invited speaker) The 3rd Annual Meeting of SIAM Central States Section, Colorado State University, Fort Collins, CO, 2017.9.29-2017.10.1
- 9. (invited participant) Topology of the Biomolecular World, American

Institute of Mathematics, San Jose, California, 2017.7.24-2017.7.28

- 8. (poster) Topological, geometrical, and statistics techniques in biological data analysis, Mathematical Biosciences Institute, 2016.9.12-2016.9.16
- (invited speaker) 2016 SIAM Conference on the Life Sciences (LS16), Westin Boston Waterfront, Boston, 2016.7.11-2016.7.14
- (invited speaker) Workshop on Modeling and Analysis in Molecular Biology and Electrophysiology, Soochow University, China, 2016.6.16-2016.6.18
- 5. (poster) Modeling and Computation of Transmembrane Transport, Mathematical Biosciences Institute, 2015.11.16-2015.11.20
- 4. (invited participant) Geometric and Topological Modeling of Biomolecules, Mathematical Biosciences Institute,2015.9.28-2015.10.02
- (poster) IMA hot topic workshop on "Mathematics of Biological Charge Transport: Molecular and Beyond", IMA, Twin Cities, 2015.07.20-2015.07.24
- 2. (travel award) Winter school: Geometric PDEs and their approximations , Texas A&M, 2015.1.10-2015-1.16
- (invited participant) Workshop on persistent homology for biosciences, East Lansing, 2014.10.18-2014.10.20

#### TEACHING EXPERIENCE

MTH124, Survey of Ca	lculus I	Michigan State University	
Instructor	2014 Summe	er/2014 Fall/2015 Spring/2015 Fall	
MTH234, Multivariable	e Calculus	Michigan State University	
Recitation TA		2013 Fall/2014 Spring/2016 Spring	
MATH2D, Multivariabl	le Calculus I	University of California Irvine	
Instructor		2020 Fall	
MATH3A, Intro Linear	Algebra	University of California Irvine	
Instructor		2021 Winter/2021 Spring	
MA131H, Calculus for Life and Management Sciences A			
		North Carolina State University	
Instructor		2021 Fall	
MA305, Introductory Linear Algebra and Matrices			
		North Carolina State University	
Instructor		2022 Spring	
Undergraduate research	n mentoring		

North Carolina State University

July 2022 - Present

Michigan State University (With Prof. Guo-Wei Wei)

Tianwei Yue Kollin David Poindexter Yuecheng Li Fatme Hourani

2017 Spring 2017 Spring/2017 Summer 2017 Spring 2017 Summer

#### PROFESSIONAL SERVICES Journal Referee

ournal Referee

Tram Huynh

- Cell Systems
- Nucleic Acids Research
- Briefings in Bioinformatics
- Journal of Chemical Information and Modeling
- Journal of Machine Learning Research
- BMC Bioinformatics
- IEEE/ACM Transactions on Computational Biology and Bioinformatics
- ACS Omega
- Mathematical Biosciences and Engineering
- International Journal for Numerical Methods in Biomedical Engineering
- Communications in Information & Systems
- Computational and Mathematical Biophysics