Dhananjay Bhaskar

Contact Information	*Email:*	dhananjay.bhaskar@yale.edu	*Mobile:*	(+1) 401-338-9829
	GitHub:	@dbhaskar92	*Website:*	dhananjaybhaskar.com
	Citizenship:	Indian (Permanent Resident, Canada)	*ORCID:*	0000-0001-8068-3101

Interests Topological Data Analysis, Graph Machine Learning, Representation Learning, Dynamical Systems, Agent-Based Models, Mathematical & Computational Biology

Appointments

Yale University, New Haven, CT, USA **Jun 2021 - Present**

Postdoctoral Research Associate, Yale School of Medicine

Advisor: Prof. Smita Krishnaswamy

Brown University, Providence, RI, USA **Jun 2021 - Present**

Visiting Scholar in Engineering

Education

Brown University, Providence, RI, USA **May 2021**

Ph.D. - Biomedical Engineering
Sc.M. - Data Science

Dissertation: Topological Data Analysis of Collective Motion

Advisor: Prof. Ian Y. Wong

University of British Columbia, Vancouver, BC, Canada **May 2017**

M.Sc. - Institute of Applied Mathematics (Specialization in Mathematical Biology)

Dissertation: Morphology-Based Cell Classification: Unsupervised Machine Learning Approach

Advisor: Prof. Leah Edelstein-Keshet

University of British Columbia, Vancouver, BC, Canada **May 2015**

B.Sc. - Combined Major in Computer Science & Mathematics (with distinction)

Honors and Awards

- Yale - Boehringer Ingelheim Biomedical Data Science Fellowship **2021 - 2024**
- Brown Data Science Initiative Seed Grant **2020**
- AMS MRC Collaborative Research Travel Grant **2019**
- E Paul Sorensen Graduate Fellowship **2017**
- Faculty of Science Graduate Award **2016**
- The Tenth q-bio Summer School Scholarship **2016**
- International Tuition Scholarship **2015 - 2016**
- International Undergraduate Summer Research Award **2014**

Journal Publications

8. **Transformer-based protein generation with regularized latent space optimization**, Castro E., Godavarthi A., Rubinfien J., Givechian K., Bhaskar, D.†, & Smita Krishnaswamy. *Nature Machine Intelligence* 4, 840-851, 2022.
7. **Topological data analysis of collective and individual epithelial cells using persistent homology of loops**, Bhaskar, D., Zhang, W., & Wong, I. *Soft Matter* 17, 4653-4664, 2021.
6. **Analyzing collective motion with machine learning and topology**, Bhaskar, D., Manhart, A., Milzman, J., Nardini, J., Storey, K., Topaz, C., & Ziegelmeier, L. *Chaos* 29, 123125, 2019.
5. **Motility-limited aggregation of mammary epithelial cells into fractal-like clusters**, Leggett, S., Neronha, Z., Bhaskar, D., Sim, J., Perdikari, T., & Wong, I. *PNAS* 116 (35), 17298-17306, 2019.

Journal Publications *(Contd.)*

4. **Breast cancer cells transition from mesenchymal to amoeboid migration in tunable 3D silk-collagen hydrogels**, Khoo, A., Valentin, T., Leggett, S., Bhaskar, D., Bye, E., Benmelech, S., Ip, B., & Wong, I. *ACS Biomaterials Science & Engineering* 5 (9), 4341-4354, 2019.
3. **3D printed self-adhesive PEGDA-PAA hydrogels as modular components for soft actuators and microfluidics**, Valentin, T., DuBois, E., Machnicki, C., Bhaskar, D., Cui, F., Wong, I. *Polymer Chemistry* 10 (16), 2015-2028, 2019.
2. **Coupling mechanical tension and GTPase signaling to generate cell and tissue dynamics**, Zmurchock, C., Bhaskar, D., & Edelstein-Keshet, L. *Physical Biology*, 15 (4), 046004, 2018.
1. **Polarization and migration in the zebrafish posterior lateral line system**, Knútsdóttir, H., Zmurchok, C., Bhaskar, D., Palsson, E., Dalle Nogare, D., Chitnis, A. B., & Edelstein-Keshet, L. *PLoS Computational Biology*, 13 (4), e1005451, 2017.

† co-senior author

Peer-Reviewed Conference Papers

2. **Diffusion curvature for estimating local curvature in high dimensional data**, Bhaskar, D., MacDonald, K., Fasina, O., Thomas, D., Rieck, B., Adelstein, I., & Krishnaswamy S. *Thirty-sixth Conference on Neural Information Processing Systems (NeurIPS)*, New Orleans, USA, 2022.
1. **Molecular graph generation via geometric scattering**, Bhaskar, D., Grady, J., Castro, E., Perlmutter, M., & Krishnaswamy, S. *IEEE 32nd International Workshop on Machine Learning for Signal Processing (MLSP)*, Xi'an, China, pp. 1-6, 2022.

Reviews & Opinion

2. **Current trends in artificial intelligence in reproductive endocrinology**, Bhaskar, D., Chang, T., & Wang S. *Current Opinion in Obstetrics and Gynecology*, 34 (4), 159-163, 2022.
1. **The need for speed: Migratory cells in tight spaces boost their molecular clock**, Bhaskar, D., Hruska, A., & Wong, I. *Cell Systems*, 13 (7), 509-511, 2022.

Preprints

4. **Topological data analysis of spatial patterning in heterogeneous cell populations: Clustering and sorting with varying cell-cell adhesion**, Bhaskar, D., Zhang, W., Volkening, A., Sandstede, B., & Wong I. *arXiv:2212.14113*
3. **G2 stem cells orchestrate time-directed, long-range coordination of calcium signaling during skin epidermal regeneration**, Moore, J., Gao, F., Matte-Martone, C., Du, S., Lathrop, E., Ganesan, S., Shao, L., Bhaskar, D., Cox, A., Hendry, C., Rieck, B., Krishnaswamy, S., & Greco, V. *bioRxiv*, DOI:10.1101/2021.10.12.464066
2. **Learnable filters for geometric scattering modules**, Tong, A., Wenkel, F., Bhaskar, D., Macdonald, K., Grady, J., Perlmutter, M., Krishnaswamy, S., & Wolf G. *arXiv:2208.07458*
1. **A methodology for morphological feature extraction and unsupervised cell classification**, Bhaskar, D., Lee, D., Knútsdóttir, H., Tan, C., Zhang, M., Dean, P., Roskelley, C., & Edelstein-Keshet L. *bioRxiv*, DOI:10.1101/623793

Invited Talks

Minisymposium on Data-driven, Modeling and Topological Techniques in Cell and Developmental Biology, SMB Annual Meeting, Ohio State University	**Jul 2023**
Applied Mathematics and Computation Seminar, UMass Amherst	**Feb 2023**
AMS Special Session on Modeling Collective Behavior in Biology, Joint Mathematics Meetings (JMM), Boston, MA	**Jan 2023**
Pint of Postdoc, Yale Postdoc Association, New Haven, CT	**Apr 2022**
Applied Topology Seminar, AATRN *[Virtual]*	**Mar 2022**
Joint UBC and U. Utah MathBio Seminar *[Virtual]*	**Sep 2021**
Topological Data Analysis Seminar, Michigan State University *[Virtual]*	**Aug 2021**

Invited Talks *(Contd.)*

Society for Mathematical Biology Annual Meeting	**Jun 2021**
Applied Topology Seminar, Mathematical Institute, University of Oxford	**May 2021**
Thinking Out Loud, Samuel M. Nabrit Black Graduate Student Association, Brown University	**Nov 2019**
BIRS Workshop on Bridging Cellular and Tissue Dynamics from Normal Development to Cancer: Mathematical, Computational, and Experimental Approaches, Banff, AB	**Jun 2019**

Contributed Talks

42nd Department of Genetics Annual Retreat, Yale School of Medicine, Westbrook, CT	**Aug 2022**
The 39th Annual (Online) Workshop in Geometric Topology *[Virtual]*	**Jun 2022**
5th Annual Postdoc Symposium, Yale University	**May 2022**
AMS Contributed Paper Session on Algebraic Topology and Knot Theory, Joint Mathematics Meetings (JMM), Seattle, WA *[Virtual]*	**Jan 2022**
2nd Workshop on Topological Methods in Data Analysis, Heidelberg University *[Virtual]*	**Oct 2021**
83rd New England Complex Fluids Meeting, UMass Amherst	**Jun 2020**
Continua Research Society Colloquium, Brown University	**Apr 2019**
10th Annual q-bio Conference, Vanderbilt University	**Jul 2016**
Canadian Undergraduate Mathematics Conference, Carleton University	**Jul 2014**
Canadian Undergraduate Mathematics Conference, Université de Montréal	**Jul 2013**

Poster Presentations

6th Montreal AI and Neuroscience (MAIN) Conference, Montreal, QC	**Dec 2022**
17th Machine Learning in Computational Biology (MLCB) Conference *[Virtual]*	**Nov 2022**
Conference on the Mathematical Theory of Deep Neural Networks (DeepMath), UC San Diego	**Nov 2022**
Biomedical Engineering Society (BMES) Annual Meeting, San Antonio, TX	**Oct 2022**
21st European Conference on Computational Biology (ECCB), Sitges, Spain	**Sep 2022**
Bridging Applied and Quantitative Topology Workshop, AATRN *[Virtual]*	**May 2022**
Workshop on Geometrical and Topological Representation Learning, ICLR *[Virtual]*	**Apr 2022**
Learning Meaningful Representations of Life (LMRL) Workshop, NeurIPS *[Virtual]*	**Dec 2021**
ELLIS Machine Learning for Molecule Discovery Workshop, NeurIPS *[Virtual]*	**Dec 2021**
Applied Algebraic Topology Research Network (AATRN) Poster Session *[Virtual]*	**Oct 2021**
American Society for Reproductive Medicine Scientific Congress & Expo *[Virtual]*	**Oct 2020**
Society for Mathematical Biology Annual Meeting† *[Virtual]*	**Aug 2020**
New England Computer Vision Conference, Brown University	**Dec 2019**
Biomedical Engineering Society (BMES) Annual Meeting, Philadelphia, PA	**Oct 2019**
Frontiers in Biophysics Conference, UBC	**Jun 2017**
Frontiers in Biophysics Conference, SFU	**Jun 2016**
Multidisciplinary Undergraduate Research Conference, UBC	**Mar 2015**
Frontiers in Biophysics Conference, UBC	**Mar 2015**
Mathematics at the Frontier of Developmental Biology Workshop, PIMS/UBC	**Jul 2014**

† Winner of the best poster award in the Mathematical Oncology subgroup

Teaching Experience

Guest Lectures:

MATH 322a - Geometric and Topological Methods in Machine Learning — Yale, Fall '22
CEMA 0919 - An Introduction to Applied Mathematics — Summer@Brown '19

Graduate/Undergraduate Teaching Assistant:

DATA 1010 - Probability, Statistics & Machine Learning — Brown University, Fall '19
ENGN 2912B - Scientific Programming in C++ — Brown University, Fall '18
CPSC 313 - Computer Hardware & Operating Systems — UBC, Summer '16 & '17
MATH 257/316 - Partial Differential Equations — UBC, Fall '16
MATH 256 - Differential Equations — UBC, Spring '16
MATH 253 - Multivariable Calculus — UBC, Fall '15
MATH 307 - Applied Linear Algebra — UBC, Fall '15
CPSC 259 - Data Structures & Algorithms for Electrical Engineers — UBC, Spring '13 & '14
CPSC 260 - Data Structures & Algorithms for Computer Engineers — UBC, Fall '12
CPSC 260 - Object-Oriented Program Design (old syllabus) — UBC, Summer '11
CPSC 101 - Connecting with Computer Science — UBC, Spring '11, Summer '11
CPSC 211 - Introduction to Software Development (old syllabus) — UBC, Fall '10

- Developed autograder software, lectured on OpenMP, MPI and OpenACC, and mentored HPC-related course projects for ENGN 2912B
- Created a guide for compiling C++ programs that use the MATLAB Engine API on GNU/Linux for CPSC 259
- Taught tutorial sections for all Computer Science (CPSC) courses and MATH 256 at UBC

Pedagogical Training:

Teaching Consultant Program, Brown Sheridan Center — 2020
Course Design Seminar, Brown Sheridan Center — 2020
Reflective Teaching Seminar, Brown Sheridan Center — 2019
Instructional Skills Workshop, UBC Center for Teaching, Learning and Technology — 2016

Mentorship

Yale College First-Year Summer Research Fellowship in the Sciences & Engineering

Topic: Adversarial Knowledge Graph Embedding for Indication Expansion — **Summer 2022**
Student: Garrek Chan (Saybrook College, Class of 2025)

Summer Undergraduate Math Research at Yale (SUMRY)

Topic: Directed-graph based Inference in Machine Learning — **Summer 2022**
Students: Tesfa Asmara, Kincaid MacDonald, Nhi Nguyen, Guy Thampakkul & Joia Zhang

Topic: Diffusion Geometry and Topology — **Summer 2021**
Students: Kincaid MacDonald, Jennifer Paige, Dawson Thomas & Sarah Zhao

Independent Study Projects

Topic: Identifying Transitions in Collective Cell Behavior using TDA — **Spring 2020**
Student: William Zhang (Brown University, Sc.B.'22)

Topic: Diffusion Geometry and Topology — **Fall 2020**
Student: William Zhang (Brown University, Sc.B.'22)

BrownConnect Collaborative SPRINT Award

Topic: Data-driven Modeling of Collective Motion on Curved Surfaces in 3D **Summer 2020**
Student: Tej Stead (Brown University, Sc.B.'23)

Brown University Undergraduate Teaching and Research Award

Topic: Computational Models of Swarming and Collective Cell Motility **Spring 2019**
Student: Subhanik Purkayasta (Brown University, Sc.B.'21)

Honors Thesis

Topic: Profiling EMT in 3D Microenvironments Using TDA **Sep 2018 - May 2019**
Student: Zachary J. Neronha (Brown University, Sc.B.'19)

NSERC Undergraduate Summer Research Award

Topic: Cell Cluster Analysis and Neighbour Detection **Summer 2017**
Student: Cindy Tan (UBC, B.Sc.'19)

Topic: Simulating Cell-Cell Interactions and Migration in Multicellular Tissues **Summer 2017**
Student: MoHan Zhang (UBC, B.Sc.'18)

Topic: Morphology-Based Cell Classification **Summer 2016**
Student: Darrick Lee (UBC, B.A.Sc.'16)

Topic: Extending the CHASTE Open Source C++ Simulation Library **Summer 2015**
Student: Eviatar Bach (UBC, B.Sc.'17)

Service and Leadership

Co-Organizer:

6th Annual Yale Postdoctoctoral Symposium, Yale University, New Haven, CT, May 25, 2023

Minisymposium on "The Convergence of Data, Geometry, and Biology: Insights from the 'shape' of Biological Data", Sigma Xi International Forum for Research Excellence (IFoRE), Alexandria, VA, Nov 3-6, 2022

Reviewer:

Nature Communications Materials, Cell Systems, PLOS Computational Biology, LMRL Workshop 2022 (NeurIPS), RSGDREAM 2022 (RECOMB/ISCB)

Workshops and Training

Virtual Hands-on Workshop on Computational Biophysics, National Center for Multiscale Modeling of Biological Systems (MMBioS) *[Virtual Event]* **Jul 5 - 8, 2022**

OxML.2020 Machine Learning Summer School†, Oxford University *[Virtual Event]* **Aug 17 - 25, 2020**

Petascale Computing Institute *[Virtual Event]* **Aug 19 - 23, 2019**

AMS Mathematic Research Communities Program on Modeling in Biological and Social Systems, West Greenwich, RI **Jun 17 - 23, 2018**

Research Computing Summer School, UBC **Jun 19 - 22, 2017**

Tenth q-bio Summer School on Membrane Dynamics, University of New Mexico **Jul 11 - 22, 2016**

EMBO Course on Multi-level Modelling of Morphogenesis, John Innes Centre, Norwich, UK **Jul 12 - 24, 2015**

Joint CAMBAM-MBI-NIMBioS Summer School on Nonlinear Dynamics in Biological Systems, McGill University **Jun 1 - 12, 2015**

† Among top 12% applicants accepted into the program