Abhishek Mallela, PhD

Contact Information

abhishek.mallela@gmail.com (972) 951-9004 https://www.github.com/dynova

Current Employment

Postdoctoral Fellow with Santiago Schnell at the University of Notre Dame

Education

University of California (UC-DAVIS), Davis, CA

PhD, Applied Mathematics, Mar 2022

- Thesis title – Survival of the Resilient: An Exploration of Tipping Cascades with Positive Change
- Member of Graduate Group in Applied Mathematics (GGAM)
- Member of Hastings' Lab
- GPA: 3.74/4.00

University of Kansas Medical Center (KUMC), Kansas City, KS

MS, Applied Statistics and Analytics, May 2017

- First graduate of inaugural degree program
- GPA: 3.90/4.00

University of Missouri at Kansas City (UMKC), Kansas City, MO

MS, Mathematics and Statistics, May 2015

- Member of Applied Mathematics Group
- Member of Disease Modeling Group
- GPA: 4.00/4.00

BS, Mathematics and Statistics, Dec 2011

- Graduated with departmental honors
- GPA: 3.81/4.00

Professional Summary

I am an applied mathematician with 10+ years of experience in mathematical modeling and computational methods across several subdisciplines of biology. I have 9 first-author publications in peer-reviewed scientific journals and have worked with cross-functional teams to develop useful mathematical models (e.g., to enhance situational awareness of COVID-19, and to minimize the disease burden of HIV-TB co-infection). I am open to opportunities in developing innovative solutions that advance technology and product development in the healthcare space.

Research Experience

Postdoctoral Fellow Feb 2025 to present
Department of Biological Sciences, University of Notre Dame
Advisor: Santiago Schnell, PhD

- **Mathematical Modeling**: Currently working on the design & parameter estimation of enzyme-catalyzed experiments and designing a mathematical model of a minimal mechanism for hormesis.
- **Software**: Python (NumPy, SciPy, Jupyter Notebook, Numba, Keras, Tensorflow)

CNLS Postdoctoral Fellow May 2022 to Jan 2025
Center for Nonlinear Studies, Los Alamos National Laboratory
Advisors: William S. Hlavacek, PhD & Yen Ting Lin, PhD

- **Collaboration**: Contributed significantly to the collective efforts of a large consortium of COVID-19 researchers.
- **Software**: Python (NumPy, SciPy, Jax, Diffrax, Pandas, Jupyter Notebook, Keras, TensorFlow, Numba); Julia
- **Mathematical Modeling**: Estimated the basic reproduction number $\mathcal{R}_0$ for COVID-19 in 50 US states and 280 urban areas, **identifying regions at risk of high disease transmission and aiding future pandemic preparedness**. *Techniques used: Bayesian inference, Adaptive MCMC algorithm, and convergence diagnostics.*
- **AI/ML**: Designed a framework comparing methods of local sensitivity analysis for gradient evaluation in ML, optimization, and statistical inference applications involving ODEs. *Techniques used: AD, methods of adjoint, forward, and finite-differencing, scaling analyses, and cluster computing.*
- **Achievements**: 8 peer-reviewed publications (3 first-author), 2 international conference talks, 3 invited talks, 1 local poster presentation.

PhD Candidate, Graduate Teaching Assistant, and Tutor Sep 2017 to Mar 2022
Department of Mathematics, UC-DAVIS
Advisor: Alan M. Hastings, PhD

- **Mathematical Modeling**: Explored the stochastic aspects of coupled bistable systems arising from the Allee effect in ecology. Found that changing one parameter in multi-dimensional systems can result in tipping point cascades, common in many fields and across spatial scales. *Techniques used: SDEs, IBMs, Fourier transforms, POMDPs*
- **Achievements**: PhD degree with 3 first-author publications, TA and tutor for several math courses.

Graduate Research Associate Oct 2015 to Sep 2017
Center for Computational Biology, University of Kansas
Advisor: Eric J. Deeds, PhD

- **Mathematical Modeling**: Developed mathematical models to analyze a) post-translational modification cycles subject to synthesis and degradation, and b) length control of bacterial structure assembly. Used an agent-based framework based on the stochastic Doob-Gillespie algorithm to efficiently simulate the models numerically on a computer cluster. **Achieved a 100x speedup by switching from MATLAB to Python and then C++**.
- **Achievements**: 1 first-author and 1 second-author publication, 2 local poster presentations.
- **Software**: MATLAB, Python, C++, Kappa, BNGL, R, Mathematica

Graduate Student Researcher and Course Instructor Aug 2013 to May 2015
Department of Mathematics and Statistics, UMKC
Advisor: Naveen K. Vaidya, PhD

- **Mathematical Modeling**: Designed, analyzed, and simulated an ODE model of HIV-TB coinfection. Formulated and solved an optimal control problem to **simultaneously minimize disease burden and implementation cost**.
- **Collaboration**: Led project with research supervisor and external collaborator, a world-class expert in optimal control theory, to design an optimal treatment protocol for HIV-TB coinfected populations.
- **Achievements**: 1 first-author publication, 1 first-place poster prize (500 USD), 2 international conference talks, 3 invited talks, Adjunct Instructor of Record (Trigonometry, College Algebra).

Fellowships & Awards

National Science Foundation Mathematical Sciences Graduate Fellow
Los Alamos National Laboratory (Remote, Summer 2020)
Advisors: William S. Hlavacek, PhD & Yen Ting Lin, PhD
I was awarded a nationally competitive graduate fellowship by the National Science Foundation. The total amount awarded for 10 weeks was $14,000.

Student Awards

1) Recipient of a competitive, department-wide fellowship for Fall 2020
   The total amount awarded for 10 weeks was $3,000.
2) Recipient of a competitive, department-wide fellowship for Winter 2020
   The total amount awarded for 10 weeks was $3,000.
3) Recipient of the competitive Jastro Shields fellowship from UC-Davis College of Agricultural and Environmental Sciences for Summer 2019
   The total amount awarded for 6 weeks was $2,000.
4) Winner of the top research poster prize in the Health Sciences category at the UMKC Community of Scholars Symposium in May 2014
   The total amount awarded was $500.

Travel Awards

1) Mathematical Sciences Research Institute (MSRI) Workshop on Mathematical Topics in Systems Biology (Jul 2015; Berkeley, CA)
2) AwesomeMath Summer Program (AMSP) (Jun 2015; University of Texas at Dallas; Richardson, TX)
3) Joint Mathematics Meetings (JMM) (Jan 2015; San Antonio, TX)
4) Visiting Fellow at National Institute for Mathematical and Biological Synthesis (NIMBioS) Knoxville, TN (Aug 2014; Knoxville, TN)

Presentations

Invited talks (5)

1) Joint Mathematics Meetings, San Francisco, CA
   - Minisymposium session: Current Advances in Modeling and Simulation to Uncover the Complexity of Disease Dynamics
   - Differential contagiousness of respiratory disease across the United States
   - Jan 2024
2) Postdoctoral seminar talk at the Center for Nonlinear Studies (CNLS) in Los Alamos National Laboratory (LANL)
   - Impacts of vaccination and SARS-CoV-2 variants Alpha and Delta on COVID-19 transmission dynamics in four metropolitan areas of the US
   - Jun 2023
3) Postdoctoral seminar talk at the Center for Nonlinear Studies (CNLS) in Los Alamos National Laboratory (LANL)
   - Differential contagiousness of respiratory disease across the United States
   - Sep 2022
4) Virtual interview talk at the Center for Nonlinear Studies (CNLS) in Los Alamos National Laboratory (LANL)
   - Crosstalk and ultrasensitivity in protein degradation pathways
   - Dec 2021
5) SIAM Central States Sectional Meeting, Rolla, MO
   - Minisymposium session: Current Trends in Ecology and Disease Modeling
   - Ideal treatments for HIV-TB co-infected populations: modeling and optimal control theory perspectives
   - Apr 2015

Contributed talks (5)

1) Society for Industrial and Applied Mathematics (SIAM) Conference on Uncertainty Quantifica-

tion, Trieste, Italy
- Differential contagiousness of respiratory disease across the United States
- Mar 2024

2) Society for Industrial and Applied Mathematics (SIAM) Conference on Applications of Dynamical Systems, Snowbird, UT
   - Session: Topics in Feedback/Control/Optimization II
   - Optimal treatment strategies for HIV-TB co-infected individuals
   - May 2015
3) Master's talk at UMKC Mathematics and Statistics Research Day
   - Ideal treatments for HIV-TB co-infected populations: modeling and optimal control theory perspectives
   - Apr 2015
4) Contributed talk at UMKC Community of Scholars Symposium
   - Optimal treatment strategies for HIV-TB co-infected populations
   - Apr 2015
5) Joint Mathematics Meetings, San Antonio, TX
   - Session: Topics in Analysis II
   - Optimal treatment strategies for HIV-TB co-infected populations
   - Jan 2015

Posters (4)

1) Quantitative and Systems Biology Conference, Fort Collins, CO
   - Bayesian inference with PyBioNetFit of state-level $\mathcal{R}_0$ values for COVID-19 across the US
   - Jun 2022
2) Conference on Modeling Protein Interactions, Lawrence, KS
   - Protein turnover impacts dynamics of post-translational modifications
   - Oct 2016
3) Quantitative and Systems Biology Conference, Nashville, TN
   - Protein turnover impacts dynamics of post-translational modifications
   - Jul 2016
4) UMKC Community of Scholars Symposium, Kansas City, MO
   - Optimal treatment strategies for HIV-TB co-infected populations
   - May 2014

Teaching Experience

Graduate Teaching Assistant, UC-DAVIS Sep 2017 to Mar 2022

Employed as a 50% FTE student employee.

Courses: Pre-calculus, Short calculus, Linear Algebra (Theory), Linear Algebra (Computation), Applied Linear Algebra, Differential Equations, History of Mathematics, Number Theory, and Numerical Analysis

Responsibilities: Assisted the instructor of record with grading homework assignments, quizzes, exams, and proctoring. Worked with students in a tutoring capacity in the Calculus Room.

Graduate Teaching Assistant, UMKC Aug 2014 to May 2015

MATH 110 - College Algebra

Responsibilities: Taught 2 course sections per semester with nearly 40 students in each section; assisted with grading assignments, exams, and proctoring exams.

Adjunct Instructor, UMKC Summer 2014

MATH 110 - College Algebra

Responsibilities: Taught 1 course section with over 20 students; designed, administered, and graded assignments and exams.

Instructor of Record, UMKC Spring 2014
MATH 125 - Trigonometry
Responsibilities: Taught 1 course section with over 15 students; designed, administered, and graded assignments and exams.

Service

Judge, T-Division Lightning Talk Student Symposium, Los Alamos National Laboratory (LANL) Jul 2022
Provided directed feedback on presentations by summer student interns in the Theoretical Division of LANL

Teaching Assistant, AwesomeMath LLC, UT Dallas Jun 2015
Provided Olympiad-level training to budding mathematicians

RooWriter Essay Evaluator, UMKC Sep 2014 to May 2015
Evaluated and critiqued student essays submitted online through the RooWriter, an online writing assessment for undergraduates at UMKC

Math Success Lab Tutor, UMKC Sep 2013 to May 2014
Tutored undergraduate students in math courses; reviewed homework assignments, provided guidance to solve problems, and prepared students for examinations

Skills Summary

- Programming: Python (Keras, TensorFlow, Jax), R, MATLAB, LaTeX, Mathematica, SAS, Julia, Kappa, BNGL, SBML, & basic C++
- AI/ML: Automatic Differentiation (AD); completed the Deep Learning, NLP, and Foundations of Algorithms & Data Structures specializations on Coursera
- Data: Pre- and post-processing of COVID-19 surveillance data across all US counties.
- Communication: 14 publications in peer-reviewed journals, 5 invited talks, cross-disciplinary expertise, proficiency in technical writing and presentations

Software Certifications

- Feb 2024: Completed the Deep Learning specialization (5 courses) on Coursera
- Feb 2024: Completed the Career Essentials in Software Development specialization (3 courses) on LinkedIn
- Jun 2024: Completed the Natural Language Processing specialization (4 courses) on Coursera
- Dec 2024: Completed the Foundations of Algorithms and Data Structures specialization (3 courses) on Coursera

Publications

First author on 9 of 15 articles

1) Mathis, S.M., Webber, A.E., Basu, A., **et al.** (2024) "Evaluation of FluSight influenza forecasting in the 2021–22 and 2022–23 seasons with a new target laboratory–confirmed influenza hospitalizations", *Nature Communications*, 15:6289
2) **Mallela, A.**, Chen, Y., Lin, Y.T., Miller, E.F., Neumann, J., He, Z., Nelson, K.E., Posner, R.G., and Hlavacek, W.S. (2024) "Impacts of vaccination and Severe Acute Respiratory Syndrome Coronavirus 2 variants Alpha and Delta on Coronavirus Disease 2019 transmission dynamics in four metropolitan areas of the United States", *Bulletin of Mathematical Biology*, 86(3):31
3) **Mallela, A.**, Lin, Y.T., and Hlavacek, W.S. (2023) "Differential contagiousness of respiratory disease across the United States", *Epidemics*, 45:100718
4) Miller, E.F., Neumann, J. Chen, Y., **Mallela, A.**, Lin, Y.T., Hlavacek, W.S., and Posner, R.G. (2023) "Quantification of early nonpharmaceutical interventions aimed at slowing transmission of Coronavirus Disease 2019 in the Navajo Nation and surrounding states (Arizona, Colorado,

New Mexico, and Utah)", *PLOS Global Public Health*, 3(6):e0001490

5) Cramer, E.Y., Huang, Y., Wang, Y., **et al.** (2022) "The United States COVID-19 Forecast Hub dataset", *Scientific Data*, 9(462):1–15
6) **Mallela, A.** and Hastings, A. (2022) "Optimal management of stochastic invasion in a metapopulation with Allee effects", *Journal of Theoretical Biology*, 549:111221
7) **Mallela, A.**, Neumann, J., Miller, E.F., Chen, Y., Posner, R.G., Lin, Y.T., and Hlavacek, W.S. (2022) "Bayesian inference of state-level COVID-19 basic reproduction numbers across the United States", *Viruses*, 14(1):157
8) Neumann, J., Lin, Y.T., **Mallela, A.**, Miller, E.F., Colvin, J., Duprat, A.T., Chen, Y., Hlavacek, W.S., and Posner, R.G. (2021) "Implementation of a practical Markov chain Monte Carlo sampling algorithm in PyBioNetFit", *Bioinformatics*, 38(6):1770–1772
9) **Mallela, A.** and Hastings, A. (2021) "Tipping cascades in a multi-patch system with noise and spatial coupling", *Bulletin of Mathematical Biology*, 83(11):1–27
10) Nariya, M.K., **Mallela, A.**, Shi, J.J., and Deeds, E.J. (2021) "Robustness and the evolution of length control strategies in the T3SS and flagellar hook", *Biophysical Journal*, 120(17):3820–3830
11) **Mallela, A.** and Hastings, A. (2021) "The role of stochasticity in noise-induced tipping cascades: A master equation approach", *Bulletin of Mathematical Biology*, 83(5):1–20
12) Lin, Y.T., Neumann, J., Miller, E.F., Posner, R.G., **Mallela, A.**, Safta, C., Ray, J., Thakur, G., Chinthavali, S., and Hlavacek, W.S. (2021) "Daily forecasting of regional epidemics of coronavirus disease with bayesian uncertainty quantification", *Emerging Infectious Diseases*, 27(3):767
13) **Mallela, A.**, Nariya, M.K., and Deeds, E.J. (2020) "Crosstalk and ultrasensitivity in protein degradation pathways", *PLOS Computational Biology*, 16(12):e1008492
14) **Mallela, A.** (2020) "Optimal control applied to a SEIR model of 2019-nCoV with social distancing", *medRχiv preprint*: `https://doi.org/10.1101/2020.04.10.20061069`
15) **Mallela, A.**, Lenhart, S., and Vaidya, N.K. (2016) "HIV-TB co-infection treatment: modeling and optimal control theory perspectives", Journal of Computational and Applied Mathematics, 307: 143–161

Professional Memberships

- American Mathematical Society (AMS); Aug 2014 to May 2015 and Sep 2017 to Mar 2022
- Society of Industrial & Applied Mathematics (SIAM); May to Dec 2015

Extracurricular Activities

- Awarded the title of National Chess Master by the United States Chess Federation after reaching a requisite over-the-board classical rating of 2200 (Jul 2009). Less than 1% of rated players hold this title.
- Tied for 2nd place out of 161 players in the Under 2300 section of the North American Open chess tournament in Las Vegas, NV (Dec 2023)
- New Mexico State Chess Champion in classical, rapid, and blitz chess formats (Dec 2023)
- New Mexico State Chess Champion in rapid and blitz chess formats (Nov 2022)
- Interview – "Chess in Missouri", Central Standard, KCUR, NPR (Nov 2016)
- Missouri State Chess Champion in both classical and blitz chess formats (Sep 2015)
- Kansas State Chess Champion in blitz chess format (Jul 2014)
- Texas State High School Chess Champion (Mar 2009)
- Hiking: Summited Wheeler Peak (2x), Tesuque Peak, and Deception Peak in New Mexico; several hills in California.

References

- Santiago Schnell, postdoctoral advisor, santiago.schnell@nd.edu, (574) 631-5399
- William Hlavacek, postdoctoral advisor, hlavacek@lanl.gov, (505) 500-7327
- Alan Hastings, PhD advisor, amhastings@ucdavis.edu, (530) 752-8116
- Eric Deeds, research advisor, deeds@ucla.edu, (310) 825-1034
- Naveen Vaidya, MS advisor, nvaidya@sdsu.edu, (619) 594-6697
- Suzanne Lenhart, collaborator, slenhart@utk.edu, (865) 974-4270