

Abhishek Mallela, PhD

CONTACT INFORMATION

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CURRENT EMPLOYMENT

Postdoctoral Fellow with Santiago Schnell at Dartmouth College

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.

RESEARCH EXPERIENCE

Postdoctoral Fellow

Feb 2025 to present

Department of Biological Sciences, University of Notre Dame;
Department of Mathematics, Dartmouth College
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 hormonesis.
- **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 co-infection. 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 co-infected 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 Quantification, 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, Jul 2022**Los Alamos National Laboratory (LANL)***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”, *medRxiv 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 2% 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 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