

Abhishek Mallela, PhD

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EDUCATION

Applied Mathematics, PhD, Mar '22

Applied Statistics and Analytics, MS, May '17

Mathematics and Statistics, MS, May '15; BS, Dec '11

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

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

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

SUMMARY

Applied mathematician with over 10 years of experience in modeling and computation across various biological subfields. Expert in TensorFlow, JAX, and Python, with a strong background in deep learning and mathematical modeling. Authored 8 publications as first-author in peer-reviewed journals and collaborated with cross-functional teams. Eager to contribute to innovative projects in modeling and machine learning.

SKILLS

- Programming: Python, MATLAB, R, Julia, LaTeX, Mathematica, basic C++, and shell scripting
- AI/ML: Automatic differentiation; Completed Deep Learning, Natural Language Processing, and Foundations of Algorithms and Data Structures specializations (Coursera)
- Data: Pre- and post-processing of COVID-19 surveillance data across all US counties and county equivalents
- Communication: 14 publications in peer-reviewed journals, 5 invited talks, 9 contributed talks and posters, cross-disciplinary expertise, and proficiency in technical writing

EXPERIENCE

- *Postdoctoral Fellow (Lab of Santiago Schnell at University of Notre Dame and Dartmouth College; Feb '25 to present)*
 - **Modeling:** Designing and estimating the parameters of enzyme-catalyzed experiments and designing a mathematical model of a minimal mechanism for hormesis in protein aggregation.
- *Postdoctoral Fellow (Center for Nonlinear Studies at Los Alamos National Laboratory; May '22 to Jan '25)*
 - **Modeling:** Estimated the basic reproduction number 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.*
 - **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
 - **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: Automatic differentiation, methods of adjoint, forward, and finite-differencing, scaling analyses, and cluster computing.*
 - **Achievements:** 8 peer-reviewed publications (3 as first-author), 2 international conference talks, 3 invited talks, 1 local poster presentation.
- *PhD Candidate, Graduate Teaching Assistant, and Tutor (UC-DAVIS; Sep '17 to Mar '22)*
 - **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: Stochastic Differential Equations, Individual-Based Models, Fourier transforms, Partially Observable Markov Decision Processes*
 - **Achievements:** PhD degree with 3 first-author publications, TA and tutor for several math courses.
- *Graduate Research Associate (University of Kansas; Oct '15 to Sep '17)*
 - **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++.
 - **Software:** MATLAB, Python, C++, Kappa, BNGL, R, Mathematica
 - **Achievements:** 2 peer-reviewed publications (1 as first-author), 2 local poster presentations.
- *Graduate Student Researcher and Course Instructor (UMKC; Aug '13 to May '15)*
 - **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 and College Algebra).

PUBLICATIONS AND PRESENTATIONS

• Publications (15)

- *Evaluation of FluSight influenza forecasting in the 2021-22 and 2022-23 seasons with a new target laboratory-confirmed influenza hospitalizations.* Mathis, S.M., Webber, A.E., Basu, A., **et al.** ('24), *Nature Communications*, 15:6289
- *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.* **Mallela, A.**, Chen, Y., Lin, Y.T., Miller, E.F., Neumann, J., He, Z., Nelson, K.E., Posner, R.G., and Hlavacek, W.S. ('24), *Bulletin of Mathematical Biology*, 86(3):31
- *Differential contagiousness of respiratory disease across the United States.* **Mallela, A.**, Lin, Y.T., and Hlavacek, W.S. ('23), *Epidemics*, 45:100718
- *Quantification of early nonpharmaceutical interventions aimed at slowing transmission of Coronavirus Disease 2019 in the Navajo Nation and surrounding states.* Miller, E.F., Neumann, J., Chen, Y., **Mallela, A.**, Lin, Y.T., Hlavacek, W.S., and Posner, R.G. ('23), *PLOS Global Public Health*, 3(6):e0001490
- *The United States COVID-19 Forecast Hub dataset.* Cramer, E.Y., Huang, Y., Wang, Y., **et al.** ('22), *Scientific Data*, 9(462):1-15
- *Optimal management of stochastic invasion in a metapopulation with Allee effects.* **Mallela, A.** and Hastings, A. ('22), *Journal of Theoretical Biology*, 549:111221
- *Bayesian inference of state-level COVID-19 basic reproduction numbers across the United States.* **Mallela, A.**, Neumann, J., Miller, E.F., Chen, Y., Posner, R.G., Lin, Y.T., and Hlavacek, W.S. ('22), *Viruses*, 14(1):157
- *Implementation of a practical Markov chain Monte Carlo sampling algorithm in PyBioNetFit.* Neumann, J., Lin, Y.T., **Mallela, A.**, Miller, E.F., Colvin, J., Duprat, A.T., Chen, Y., Hlavacek, W.S., and Posner, R.G. ('22), *Bioinformatics*, 38(6):1770-1772
- *Tipping cascades in a multi-patch system with noise and spatial coupling.* **Mallela, A.** and Hastings, A. ('21), *Bulletin of Mathematical Biology*, 83(11):1-27
- *Robustness and the evolution of length control strategies in the T3SS and flagellar hook.* Nariya, M.K., **Mallela, A.**, Shi, J.J., and Deeds, E.J. ('21), *Biophysical Journal*, 120(17):3820-3830
- *The role of stochasticity in noise-induced tipping cascades: A master equation approach.* **Mallela, A.** and Hastings, A. ('21), *Bulletin of Mathematical Biology*, 83(5):1-20
- *Daily forecasting of regional epidemics of Coronavirus disease with Bayesian uncertainty quantification.* 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. ('21), *Emerging Infectious Diseases*, 27(3):767
- *Crosstalk and ultrasensitivity in protein degradation pathways.* **Mallela, A.**, Nariya, M.K., and Deeds, E.J. ('20), *PLOS Computational Biology*, 16(12):e1008492
- *Optimal control applied to a SEIR model of 2019-nCoV with social distancing.* **Mallela, A.** ('20), medRxiv
- *HIV-TB co-infection treatment: modeling and optimal control theory perspectives.* **Mallela, A.**, Lenhart, S., and Vaidya, N.K. ('16), *Journal of Computational and Applied Mathematics*, 307:143-161

• Invited talks (5)

- Joint Mathematics Meetings, San Francisco, CA (Jan '24)
 - Title: *Differential contagiousness of respiratory disease across the United States*
- CNLS at LANL, Los Alamos, NM
 - Title: *Impacts of vaccination and SARS-CoV-2 variants Alpha and Delta on COVID-19 transmission dynamics in four metropolitan areas of the US* (Jun '23)
 - Title: *Differential contagiousness of respiratory disease across the United States* (Sep '22)
 - Title: *Crosstalk and ultrasensitivity in protein degradation pathways* (Dec '21)
- SIAM Central States Sectional Meeting, Rolla, MO (Apr '15)
 - Title: *Ideal treatments for HIV-TB co-infected populations: modeling and optimal control theory perspectives*

• Contributed talks and posters (9)

- SIAM Conference on Uncertainty Quantification, Trieste, Italy (Mar '24)
 - Talk: *Differential contagiousness of respiratory disease across the United States*
- Quantitative and Systems Biology (q-bio) conference
 - Poster: *Bayesian inference with PyBioNetFit of state-level R_0 values for COVID-19 across the US*; Fort Collins, CO (Jun '22)
 - Poster: *Protein turnover impacts dynamics of post-translational modifications*; Nashville, TN (Jul '16)
- Conference on Modeling Protein Interactions, Lawrence, KS (Oct '16)
 - Poster: *Protein turnover impacts dynamics of post-translational modifications*
- SIAM Conference on Applications of Dynamical Systems, Snowbird, UT (May '15)
 - Talk: *Optimal treatment strategies for HIV-TB co-infected individuals*
- UMKC Mathematics and Statistics Research Day, Kansas City, MO (Apr '15)
 - Talk: *Ideal treatments for HIV-TB co-infected populations: modeling and optimal control theory perspectives*
- UMKC Community of Scholars Symposium, Kansas City, MO
 - Talk: *Optimal treatment strategies for HIV-TB co-infected populations* (Apr '15)
 - Poster: *Optimal treatment strategies for HIV-TB co-infected populations* (May '14)
- Joint Mathematics Meetings, San Antonio, TX (Jan '15)
 - Talk: *Optimal treatment strategies for HIV-TB co-infected populations*