Abhishek Mallela, PhD

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EDUCATION

Applied Mathematics, PhD, Mar '22 Applied Statistics & Analytics, MS, May '17 Mathematics & 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

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, or 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.

SKILLS SUMMARY

- Programming: Python, MATLAB, R, basic C++, LaTeX, Mathematica, Julia, BNGL, and shell scripting
- 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

EXPERIENCE

- Postdoctoral Research Scientist (Lab of Santiago Schnell at University of Notre Dame; Feb '25 to present)
 - **Mathematical modeling**: Currently working on the design & parameter estimation of enzyme-catalyzed experiments and designing a mathematical model of a minimal mechanism for hormesis.
- Postdoctoral Research Scientist (Center for Nonlinear Studies at Los Alamos National Laboratory; May '22 to Jan '25)
 - **Collaboration**: Contributed significantly to the collective efforts of a large consortium of COVID-19 researchers.
 - o Software: Python (NumPy, SciPy, Jax, Diffrax, Pandas, Jupyter Notebook, Keras, TensorFlow, Numba); Julia
 - **Mathematical Modeling**: Estimated the basic reproduction number R₀ 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 (UC-DAVIS; Sep '17 to Mar '22)
 - 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*
 - o 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)

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- **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.
- o Software: MATLAB, Python; C++, Kappa, BNGL, R, Mathematica
- Graduate Student Researcher and Course Instructor (UMKC; Aug '13 to May '15)
 - **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).

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
- o 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
- o Optimal control applied to a SEIR model of 2019-nCoV with social distancing. Mallela, A. ('20), medRχiv
- 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)

- o 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 & optimal control theory perspectives

• Contributed talks & 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 R₀ 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)
- o Joint Mathematics Meetings, San Antonio, TX (Jan '15)
 - Talk: Optimal treatment strategies for HIV-TB co-infected populations