

Alexander Chen

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Current Position **General Electric Global Research Center**
Research Scientist, 2015-present

Professional Preparation **Departments of Pharmacology, Mathematics, University of North Carolina at Chapel Hill**
Postdoctoral Researcher, 2011-2015

Statistical and Applied Mathematical Sciences Institute (SAMSI)
Department of Mathematics, University of North Carolina at Chapel Hill
Postdoctoral Researcher, 2011-2013

University of California, Los Angeles
Ph.D. Mathematics, 2011; M.A. Mathematics, 2007
Boundary Tracking in Large Data Sets and Modeling the Evolution of Landscapes
Thesis Advisor: Andrea Bertozzi

Stanford University
B.S. Mathematics with Honors; M.S. Financial Mathematics, 2005

Research Interests Machine Learning, Deep Learning, PDE and Numerical Analysis, Computer Vision, Image Processing, Mucosal Immunity, Landscape Evolution, Financial Mathematics.

Projects at GE Global Research

1. Economic capital model - Built and stress tested an economic capital model for GE Capital Aviation Services's aircraft leasing portfolio. The model quantifies both market and credit risk via multi-factor models correlating variables through copulas. Monte Carlo simulation is used to generate valuations of the portfolio through different market conditions, with importance sampling to resolve the tail more accurately.
2. "Fitness for Work" system - Built a fatigue and distraction detection system for locomotive and aircraft pilots. This is a real-time computer vision (video analytics) model that consists of a Bayesian hidden Markov model taking individual video frames of the pilots' faces as input, and outputting scores for fatigue and distraction.
3. Face expression analysis system - Built and trained a deep learning system (convolutional neural network) for classifying faces into one of 10 emotions, such as anger, fear, and happiness. The system is expected to be utilized in many applications at GE, including vehicle operator analysis, hospital patient analysis, and retail analytics.

4. Automatic x-ray improvement system - Built a system to take images/video of a patient, overlaying a reference lung image on the patient image, and making a go/no-go decision on taking the x-ray. Utilized open source human pose detection systems. The project is expected to significantly decrease the number of faulty x-ray images taken due to improper patient positioning.
5. Machine learning for optimizing additive manufacturing (3D printing) builds - Designed and implemented a model to iteratively build a part and make corrections according to sensor data, converging to ideal build parameters. The model and algorithm utilizes elements of control theory, image processing, and dictionary learning. The system is expected to decrease development cycle time for new parts from six months to five weeks.

**Peer-Reviewed
Journal
Publications and
Preprints**

- Publications: h-index - 9, i10-index - 9
1. Kapustina, M., Tsygankov, D., Yang, X., Zhou, J., Chen, A., Roach, N., Wessler, T., Elston, T.C., Wang, Q., Jacobson, K., Forest, M. G. (2016). Modeling the excess cell surface stored in a complex morphology of bleb-like protrusions. *PLoS Computational Biology*, 12(3): e1004841.
 2. T. Wessler, A. Chen, S.A. McKinley, R. Cone, M.G. Forest, S.K. Lai. Using computational modeling to optimize the design of antibodies that trap viruses in mucus (2015). *ACS Infectious Diseases* 2(1), 82–92.
 3. A. Chen, S.A. McKinley, F. Shi, S. Wang, P. Mucha, D. Harit, M.G. Forest, S.K. Lai (2015). Modeling of virion collisions in cervicovaginal mucus reveals limits on agglutination as the protective mechanism of secretory immunoglobulin A. *PloS one*, 10(7): e0131351.
 4. A. Chen, J. Darbon, C. de Franchis, G. Facciolo, E. Meinhardt, J. Michel, J.-M. Morel (2015). Numerical simulation of landscape evolution and water run-off on digital elevation models obtained from Pleiades. *Revue Française de Photogrammétrie et de Télédétection*, 209, 117–123.
 5. S.A. McKinley, A. Chen, F. Shi, S. Wang, P. Mucha, M.G. Forest, S.K. Lai (2014). Modeling neutralization kinetics of HIV-1 by broadly neutralizing monoclonal antibodies in genital secretions coating the cervicovaginal mucosa. *PLoS one*, 9(6), e100598.
 6. A. Chen, J. Darbon, J.-M. Morel (2014). Landscape evolution models: a review of their fundamental equations. *Geomorphology*, 219, 68–86.
 7. A. Chen, S.A. McKinley, S. Wang, F. Shi, P. Mucha, M.G. Forest, S.K. Lai (2014). Transient antibody-mucin interactions produce a dynamic molecular shield against viral invasion. *Biophysical Journal* 106(9), 2028–2036.
 8. A. Chen, J. Darbon, G. Buttazzo, F. Santambrogio, J.-M. Morel (2014). On the equations of landscape formation. *Interfaces and Free Boundaries* 16, 105-136.
 9. T. Meyer, D. Ziegler, C. Brune, A. Chen, R. Farnham, N. Huynh, J.-M. Chang, A. Bertozzi, P. Ashby (2014). Height drift correction in non-raster atomic force microscopy. *Ultramicroscopy* 137, 48-54.
 10. A. Chen, A. L. Bertozzi, P. D. Ashby, P. Getreuer, and Y. Lou (2013). Enhancement and Recovery in Atomic Force Microscopy Images. *Excursions in Harmonic Analysis, Volume 2*, Andrews, T.D.; Balan, R.; Benedetto, J.J.; Czaja, W.; Okoudjou, K.A. (Eds.), Birkhauser Basel, 311-332.

11. A. Chen, T. Wittman, A. Tartakovsky, and A. Bertozzi (2011). Efficient Boundary Tracking Through Sampling. *Applied Mathematics Research eXpress*, 2, 182–214.

Peer-Reviewed Conferences

1. A. Chen, X. Ping, S. Roychowdhury. On a high definition scanning strategy for optimization of energy deposition across a complex geometry in power bed fusion additive manufacturing. In preparation.
2. A. Chen. Active Contours with Edges: Combining Hyperspectral and Grayscale Segmentation (2012). *Proceedings of SPIE Remote Sensing*.
3. A. Chen. The Inpainting of Hyperspectral Images: A Survey and Adaptation to Hyperspectral Data (2012). *Proceedings of SPIE Remote Sensing*.
4. A. Chen. Improved Boundary Tracking by Off-Boundary Detection (2012). *Proceedings of SPIE Remote Sensing*.
5. A. Chen, T. Wittman, A. Tartakovsky, and A. Bertozzi. Image segmentation through efficient boundary sampling (2009). *Proceedings of the Workshop on Sampling Theory and Applications*.

Selected Talks and Posters

- “Hyperspectral imaging,” Poster Presentation at SIAM Conference on Computational Science and Engineering, Costa Mesa, CA, 2007.
- “Image segmentation through efficient boundary sampling,” Workshop on Sampling Theory and Applications, Marseille, France, 2009.
- “Mathematical morphology of landscapes,” Talk at California State University, Long Beach, 2010.
- “Modeling the diffusion of viruses through mucus.” Talk at SIAM Analysis of PDE Conference, San Diego, CA, November, 2011.
- “The effect of antibody attacks on a diffusing population of virus.” Talk at Midwest Numerical Analysis Day, University of Notre Dame, May, 2012.
- “Stochastic and deterministic models of virus and antibody co-diffusion,” Poster Presentation at the Uncertainty Quantification Transition Workshop, SAMSI, Research Triangle Park, NC, 2012.
- “Classification of hyperspectral images by variational methods,” Talk at the SIAM Annual Meeting, Minneapolis, MN, July, 2012.
- “Utilizing change-point detection to improve boundary tracking in noisy images,” Talk at the Joint Statistical Meetings, San Diego, CA, July 2012.
- “The effect of antibody attachment on the infectivity of virus invasion,” Poster Presentation at the SIAM Conference on the Life Sciences, San Diego, CA, July, 2012.
- “Improved boundary tracking by off-boundary detection,” SPIE Remote Sensing Conference, Edinburgh, Scotland, September, 2012.
- “The inpainting of hyperspectral images: a survey and adaptation to hyperspectral data,” SPIE Remote Sensing Conference, Edinburgh, Scotland, September, 2012.
- “Active contours with edges: combining hyperspectral and grayscale segmentation,” SPIE Remote Sensing Conference, Edinburgh, Scotland, September, 2012.
- “Deterministic and stochastic modeling of antibody sequestration of viral populations in mucosal layers,” Invited Talk at AMS Fall Southeastern Sectional Meeting, New Orleans, LA, October, 2012.

- “Enhancement and recovery in atomic force microscopy images,” Talk at the OMICS Materials Science Conference, Chicago, IL, October, 2012.
- “The equations of landscape formation: review and a new model,” Talk at the GSA Annual Meeting, Charlotte, NC, November 2012.
- “Numerical simulations of landscape evolution with a comparison to natural formations,” Poster Presentation at the GSA Annual Meeting, Charlotte, NC, November, 2012.
- “The equations of landscape formation: review and a new model,” Talk at University of Cambridge, UK, June, 2013.
- “Modeling neutralization kinetics of HIV by antibodies in the cervicovaginal mucosa,” Talk at Society for Mathematical Biology Annual Meeting, Tempe, AZ, June, 2013.
- “Transient antibody-mucin interactions produce a dynamic molecular shield against viral invasion,” Talk at University of North Carolina, Greensboro, November, 2013.
- “Improving protection against HIV invasion,” Talk at Duke University for mathematical biology REU students, June, 2014.
- “Competing time scales in HIV invasion,” Talk at Metron Scientific Solutions, February, 2015.
- “Competing time scales in HIV invasion,” Talk at West Chester University, February, 2015.
- “Competing time scales in HIV invasion,” Talk at Colorado School of Mines, February, 2015.
- “Competing time scales in HIV invasion,” Talk at General Electric Global Research Center, February, 2015.
- “Competing time scales in HIV invasion,” Talk at Syracuse University, March, 2015.
- “Methods of image processing for hyperspectral data,” Talk at Air Force Research Laboratory, March, 2015.
- “Competing time scales in HIV invasion,” Talk at SUNY Oswego, April, 2016.

Teaching and Mentoring Experience

- Mentor for a summer project (2014) for a student from the North Carolina School of Science and Math on “A computational model of viral behavior for improving gene therapy in the treatment of cystic fibrosis.”
- Lecturer for Math 528, “Mathematical Methods for the Physical Sciences I,” UNC Chapel Hill, Fall, 2013.
- Co-mentor for a summer project (2013) for two students from North Carolina School of Science and Math on the application of virus/antibody kinetics model to treatment of cystic fibrosis (won High School Cell Biology/Biochemistry/Immunology category of the Sigma Xi Scientific Research Society Annual Meeting).
- Lecturer for Math 528, “Mathematical Methods for the Physical Sciences I,” UNC Chapel Hill, Fall, 2012.
- Lab and lecture entitled “Monte Carlo methods,” assisted in the workshop project on harmonic oscillators, Interdisciplinary Workshop for Undergraduate Students, SAMSI, May, 2012.

- Lab and lecture, entitled “This means war! Modeling combat with applications to real time strategy games,” mathematical modeling of war-related topics through PDE and SDE. Applications of Uncertainty Quantification - Undergraduate Workshop, SAMSI, February, 2012.
- Mentor for Research Experience for Undergraduates (REU), “Fast atomic force microscopy imaging using self-intersecting scans and inpainting,” UCLA, 2011.
- Mentor for REU, “Boundary tracking in atomic force microscopy” and “Correlation effects in stock market volatility,” UCLA, 2010.
- Mentor for REU, “Classification of hyperspectral images,” UCLA, 2006.
- Teaching Assistant, UCLA 2005-2010.
- Tutor for Math 50 series (Linear Algebra, Multivariable Calculus, Differential Equations), Stanford University 2001.
- Tutor for Education Program for Gifted Youth, Stanford University 2001-2002.

Awards and Honors

- Travel award for Society for Math. Bio. Annual Meeting, Tempe, AZ, June, 2013.
- International Scholarship for study at ENS Cachan, France, 2009 (advised by Jean-Michel Morel).
- VIGRE Graduate Fellowship, UCLA, 2005.
- Top 200, William Lowell Putnam Mathematics Competition, 2001, 2003, 2004.

Professional Activity

- Volunteer proctor for MathCounts competition, Niskayuna, NY, 2016.
- Reviewer for
 - Mathematical and Computational Applications
 - Geomorphology
 - PLoS One
 - Remote Sensing
 - Journal of Imaging
 - Asian Journal of Control
 - International Journal of Robust and Nonlinear Control
- Organizer of mini-symposium on “Hyperspectral and High-Dimensional Image Processing,” SIAM Annual Meeting 2012.

Patent

- Patent Pending - Optimized Crosslinkers for Trapping a Target on a Substrate - with Sam Lai, Greg Forest, Christine Henry, Tim Wessler, Jennifer Schiller.