Swarnavo Sarkar

Research Instructor
Georgetown Lombardi Comprehensive Cancer Center, USA

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Experience:

Research Instructor
Georgetown Lombardi Comprehensive Cancer Center Washington DC, February 2023 – present
Computational Modeling and Biostatistics

- Cancer epidemiological modeling of breast cancer survivorship.
- Impact of breast cancer treatment on the occurrence of second cancers and age-related diseases.

Guest Researcher
National Institute of Standards and Technology Gaithersburg MD, November 2013 – December 2022
Computational Biology

- Developed a communication network model of the immune system using pathways and interactome data. This model can determine the information transferred by disease causing factors (*e.g.*, SARS-CoV-2 proteins) and evaluate candidate therapies (preprint).
- Used the mRNA and protein data for *E. coli*, *S. cerevisiae*, *M. musculus*, and *H. sapiens*, to show that the central dogma of molecular biology achieves nearly maximal information gain during translation (article).
- Developed a method for assessing single-cell measurement quality from flow cytometry and microscopy data using information theory (article).
- Developed a method for information propagation and interference in gene regulatory networks (article).
- Developed the construction of information landscapes of biochemical sensors from gene and transcript expression data (article).
- Determined the sensitivity of multiple cell viability assays to cell proliferation, which uses the Area Under the Curve (AUC) analysis of cell proliferation data can extract the viability resolution offered by different cell viability assays (collaboration with the FDA).
- Developed a neural network-based method to evaluate the information transfer through a large library (≈50,000) of synthetic genetic sensors.

Computational Biomaterials

- Developed methods for computational design and characterization of macromolecular networks.
  – Stochastic simulation of polymer network growth due to reaction-diffusion (article).
  – Effective medium methods to compute material properties of disordered networks (article).
  – Crosslink density and relaxation time from simultaneous measurements during polymerization (article).

Education:

Cornell University Ithaca, NY, June 2011 - Jan 2013
Ph.D. in Civil and Environmental Engineering.
Concentration: Applied Mathematics, Structural Mechanics

Cornell University Ithaca, NY, August 2007 - May 2011
M.S. in Civil and Environmental Engineering.
Concentration: Mathematics, Structural Engineering

Indian Institute of Technology Kharagpur, India, August 2003 - May 2007
B.Tech. in Civil Engineering

Skills:

- Programming: Python (numpy, scipy, pandas, networkx, scikit-learn, multiprocessing), C++, Matlab, Tensorflow/Keras, GraphQL, BioPython, Github, Sphinx.
- Biological data analysis: Gene and transcript expression, cell viability assays, cell proliferation, pathways, MSigDB, sequence libraries.

- Visualization: Matplotlib, Neo4j, Gephi, Paraview.
- Computational methods: Information theory, network theory, optimization, uncertainty quantification, stochastic processes, statistical methods, PDEs and ODEs, Monte Carlo simulations, HPC.
- Soft skills: Project planning, scientific writing, technical presentations, collaboration with experimentalists.

Doctoral Research:

- Elucidated the stress-induced change in electrodic reaction rates using *ab initio* electronic structure calculations (article).
- Developed stochastic reduced-order models for uncertainty quantification in reaction rates due to the randomness in anode-cathode sizes (article).
- Developed a finite element method with adaptive remeshing to simulate moving anode-cathode boundaries over long durations of time (article).
- Developed an alternative ionic transport model by constraining independent ionic flow with the electroneutrality condition (article).

Publications: (Google Scholar profile)
Computational biology

- Pierce L, Anderson H, Sarkar S, Bauer S, and Sarkar S (2023) Experimental and computational approach to establish fitfor- purpose cell viability assays. *In review in Regenerative Medicine.*
- Sarkar S (2022) Communication network model of the immune system identifies the impact of interactions with SARS-CoV-2 proteins. *In review in npj Systems Biology and Applications.*
- Sarkar, S. and Rammohan, J. (2023). Nearly maximal information gain due to time integration in central dogma reactions. Iscience, 26(6).
- Rammohan J, Sarkar S, and Ross D (2022) Single-cell measurement quality in bits. PLoS ONE 17(8): e0269272.
- Sarkar S, Hubbard JB, Halter M, and Plant AL (2021) Information thermodynamics and reducibility of large gene networks. Entropy, 23(1), 63 (selected as Editor's Choice article).
- Sarkar S, Tack D, and Ross D (2020) Sparse estimation of mutual information landscapes quantifies information transmission through cellular biochemical reaction networks. Communications Biology, 3(1), pp.1-8.
- Hubbard JB, Halter M, Sarkar S, and Plant AL (2020) The role of fluctuations in determining cellular network thermodynamics. PLOS One 15(3): p.e0230076.

Computational materials

- Sarkar S and Lin-Gibson S (2018) Computational Design of Photocured Polymers Using Stochastic Reaction–Diffusion Simulation. Advanced Theory and Simulations, 1(7), p.1800028 (selected as cover article).
- Sarkar S, Baker PJ, Chan EP, Lin-Gibson S and Chiang MYM (2017) Quantifying the sensitivity of the network structure and properties from simultaneous measurements during photopolymerization. Soft matter, 13(21), pp.3975-3983.
- Sarkar S, Warner JE, Aquino W, and Grigoriu, MD (2014) Stochastic reduced order models for uncertainty quantification of intergranular corrosion rates. Corrosion Science, 80, pp.257-268.
- Sarkar S and Aquino W (2013) Changes in electrodic reaction rates due to elastic stress and stress-induced surface patterns. Electrochimica Acta, 111, pp.814-822.
- Sarkar S, Warner JE, and Aquino, W (2012) A numerical framework for the modeling of corrosive dissolution. Corrosion science, 65, pp.502-511.
- Sarkar S and Aquino W (2011) Electroneutrality and ionic interactions in the modeling of mass transport in dilute electrochemical systems. Electrochimica acta, 56(24), pp.8969-8978.

Conference Presentations:

- S Sarkar. Communication network model of the immune system identifies the impact of SARS-CoV-2 protein-protein interactions. Gordon Research Conference on Immunoengineering, Ventura, CA, July 2022.

- S Sarkar. Identifying therapies for SARS-CoV-2 PPIs using a communication network model of the immune system. Gordon Research Conference on Drug Safety, Easton, MA, June 2022.
- S Sarkar and D Ross. Information Landscapes of Genetic Sensors and Fitness of Regulated Cell Populations. Gordon Research Conference on Stochastic Physics in Biology, Ventura, CA, January 2019.
- S Sarkar, D Ross, and S Lin-Gibson. Evaluating Channel Capacity of Genetic Sensors from Sparse Samples. Gordon Research Conference on Systems Chemistry, Newry, ME, July 2018.
- S Sarkar, S Lin-Gibson, and MYM Chiang. Using Simultaneous Measurements during Photopolymerization to Measure Relaxation Time Growth and Connection to Network Clustering. Society for Biomaterials Annual Meeting, Atlanta, GA, April 2018.
- S Sarkar and S Lin-Gibson, Computational Design of Topological Disorder and Emergent Properties of Polymers using Stochastic Reaction-Diffusion Simulation. MGI PI Meeting, Washington DC, March 2018.
- S Sarkar, S Lin-Gibson, and MYM Chiang. Simulating the Evolution of Molecular Diffusivity during Photopolymerization. 254^{th} ACS Meeting, Washington DC, August 2017.
- S Sarkar, S Lin-Gibson, and MYM Chiang. Sensitivity of Material Properties of Photocured Networks to Composition and Curing Protocols. Gordon Research Conference on Polymers, Mt. Holyoke, MA, June 2017.
- S Sarkar, S Lin-Gibson, and MYM Chiang. Computer-Aided Design of Photocured Polymer Networks. APS March Meeting, Baltimore, MD, March 2016.
- S Sarkar, S Lin-Gibson, and MYM Chiang. Virtual Design of Photocured Polymer Networks. Gordon Research Conference on Multifunctional Materials and Structures. Ventura, CA, January 2017.
- S Sarkar, S Lin-Gibson, and MYM Chiang. Sensitivity of Material Properties of Photocured Networks to Composition and Curing Protocols. Gordon Research Conference on Polymers, Mt. Holyoke, MA, June 2017.
- S Sarkar and W Aquino. Determination of shift in electrodic reaction rates due to the presence of stress. APS March Meeting, Baltimore, MD, March 2013.
- S Sarkar and W Aquino. A simulation framework to model damage due to corrosion in Aluminum alloys. 7th IWSHM, Stanford University, CA, September 2009.
- S Sarkar and W Aquino. A simulation framework for corrosion-induced damages. 9th USNCCM, Columbus, OH, July 2009.

Awards:

- NSF Fellowship to attend the Biology through Information Theory, Communication, and Coding Theory workshop, January 2020.
- 2010 John E. Perry Teaching Assistantship Prize at Cornell University.
- 2007 Institute Silver Medal for highest GPA in the Civil Engineering Department, IIT Kharagpur, India.
- 2007 Institute Proficiency Prize for Best Undergraduate Thesis Project in Civil Engineering, IIT Kharagpur, India.