Dr. Tirthajyoti Sarkar

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Summary

Innovator and technologist with 15+ years of experience in R&D and product development. Currently focused on applying data analytics/machine learning to semiconductor/electronics domain.

LinkedIn profile: https://www.linkedin.com/in/tirthajyoti-sarkar-2127aa7/

Data Science, Machine Learning articles: https://medium.com/@tirthajyoti

GitHub Homepage: https://tirthajyoti.github.io

Positions

Position: Senior Principal Engineer
Organization: ON Semiconductor, Sunnyvale, CA
December 2009 - Present

Responsibilities: (a) Leading AI/ machine-learning based projects: (a) design optimization framework development, (b) deep learning for chip optimization, (c) AI-based power IC, (b) Power Semiconductor technology and new product development (NPD) for applications in Automotive, Cloud infrastructure, gaming and AI, mobile, and industrial systems.

Position: Consulting Scientist (Part-time)
Organization: AutonomiQ, Palo Alto, CA
April 2018 - Present

Responsibilities: (a) Advising the software development/data science team about automatic test data synthesis and machine learning based generative model building, (b) Idea generation for the Natural Language Processing (NLP) module.

Position: Author (Packt Publishing)
September 2018 – Present

Responsibilities: Authoring multiple Data Science books

Position: Postdoctoral Research Associate and Research Assistant
Institution: University of Illinois at Chicago
August 2003 – November 2009

Responsibilities: Worked on Federal agency-sponsored R&D projects (NSF, DOE, ONR)

Formal Education (Chronological Order)

Master of Science (MS) in Computational Data Analytics, *Georgia Tech, College of Engineering*. **August 2018 - now**

Doctor of Philosophy (Ph.D) in Electrical Engineering, *University of Illinois at Chicago (UIC)*, Electrical and Computer Engineering. **March 2009**

Bachelor of Technology (B.Tech) in Instrumentation Engineering, *Indian Institute of Technology (IIT)*, Kharagpur, India. **June 2003**

Continuing Professional Education (AI, Machine learning, Data science)

"*Artificial Intelligence: An Introduction To Neural Networks And Deep Learning*", Stanford Univ. **July – August 2018**

MIT Professional Program, "*Data Science: Data to Insights*", Massachusetts Institute of Technology, Continuing Education. **May 2017 – July 2017**

Core Competencies

✓ **Proven innovator**: Inventor/co-inventor on 5 issued U.S. patents, multiple U.S. patents are in application

✓ **Proven communicator of scientific study**: Author of 30+ international journal and conference papers in Tier-I category (IEEE or equivalent); Author of 2 book chapters/monographs

✓ 15+ years' experience with numerical computing and finite-element simulations – modeling of semiconductors, switching electronics circuits, and electromagnetic components – Medici/T-Suprem/Ansys/Silvaco/PSPICE

- **Software technology stack experience**:
  - *GitHub public profile:* https://github.com/tirthajyoti
  - *Statistical modeling*: Statsmodels, R-stats, JMP (SAS)
  - *Scientific computation*: MATLAB/Simulink, Octave
  - *Statistical Visualization*: Seaborn, ggplot2, Tableau, Plotly, Bokeh
  - *Classical Machine Learning*: NumPy, SciPy, Scikit-Learn, Caret, kernlab
  - *Data wrangling, NLP, others*: Pandas, BeautifulSoup, SymPy, PySpark, SpaCy, NLTK,dplyr
  - *Deep Learning*: TensorFlow, Keras, PyTorch
  - *Web technologies (basic experience)*: HTML5, CSS, JavaScript
  - *Cloud technologies (basic experience)*: AWS, Google Colaboratory for machine learning

✓ **Analytics in manufacturing, quality, and product development**: 10+ years of experience in analysis of semiconductor data - multivariate statistics, advanced graphing, control charts, hypothesis testing.

Books, Open-source packages, and data science/machine learning projects

BOOK: *Hands on Mathematics for Data Scientists*: Working on a book covering essential mathematics topics for machine learning and data science – set algebra, functions, calculus, statistics, optimization techniques, and linear algebra. Expected to be published in 2020.

BOOK: *Data Wrangling with Python*: Principal author of a book/courseware for Packt publishing on data wrangling techniques using Python, covering the fundamentals of data scraping, cleaning, imputation, statistical plotting, and formatting for a machine learning pipeline. Published in Jan 2019.

Python Package: `MLR`: This is a lightweight Python package for doing statistical analysis on a regression problem - residual analysis and plotting, multicollinearity check, outlier detection, F-test, etc. These are not generally present in Python ML libraries such as Scikit-learn and this package aims to fulfill that gap. Here is the documentation.

Python Package: `Pydbgen`: This is a lightweight Python library for generating random database tables. Useful for beginners in data science when they want to create SQL database tables with synthetic data for practicing machine learning and data extraction algorithms.. Here is the detailed documentation

Python Package: UCI-ML API: This is an intuitive API written in Python to interface with the famous UC Irvine Machine Learning repository. It can help a user easily search and download relevant datasets or selectively choose a dataset based on its size or machine learning task categories. Here is the detailed documentation.

Python Package: `DOEPY`: Design of Experiment (DOE) is a critical activity for any scientist, engineer, or statistician planning to conduct scientific research. This is a wrapper library around the core packages (pyDOE and DiversiPy) to help generate various types of DOE matrices (random, Latin hypercube, face centered design, factorial matrix) from an arbitrary range of input variables. Read the detailed documentation here.

Random regression/classification problem set generation using symbolic input: For beginners in data science and machine learning, a common problem is to get hands on good, clean data set for practicing various algorithms. In this project, I built a controllable function/API to generate randomized regression/classification problems based on a well-defined function (involving linear, nonlinear, rational, or even transcendental terms) using symbolic expression from user. Read my article on Medium about this project

Current Machine Learning based projects (Proprietary)

Semiconductor device design automation pipeline with machine learning

Goal: This project aims to automate/aid the complex technology development and device design tasks in the field of high-power semiconductors, using machine learning, statistical modeling, and advanced optimization.

Tools/Techniques used: Scikit-learn, SciPy, JMP, R-part, nonlinear regressions, regularization, and various cross-validation strategies, decision trees, random forest, derivative-free optimization.

Deep learning-based semiconductor design feature extraction:

Goal: To use deep learning framework to mimic 'high-level' design experience of human experts by classification of designs into categories such as 'sub-optimal' or 'aggressive'.

Tools/Techniques used: TensorFlow, Keras, PIL, OpenCV, Scikit-image

Low power neural network for Power IC controller

Goal: Implement and embed deep learning function inside a controller IC for optimizing power conversion efficiency with a limited compute power and memory budget.

Tools/Techniques used: Keras/TensorFlow, SciPy.

Neural network-in-loop-SPICE modeling

Goal: Build and deploy machine learning models and advanced optimization modules for finding best semiconductor die design for a given electrical target using physically-scalable SPICE modeling data.

Tools/Techniques used: Scikit-learn, Keras/TensorFlow, SciPy.

Python-based data analytics framework for semiconductor manufacturing:

Goal: Build Python-based notebooks for analyzing silicon wafer data involving failure analysis, statistical plotting, normality analysis, and causality discovery by multivariate regression, outlier detection with Gaussian mixture models.

Tools/Techniques used: Scikit-learn, Statsmodels, Pandas, Seaborn.

Selected professional experience/services

- Data Science track chair, State of AI/ML, IEEE/ACM, December 2019, January 2020 (upcoming)
- Speaker and contributor, ValleyML – a non-profit working with ACM, IEEE Silicon Valley AI/CS/SSCS Chapters and other AI related organizations to cover the state-of-the art advances in AI technology
- Editorial Associate, Towards Data Science, Online publication
- Senior Member, IEEE; Electron Device Society (EDS) and Power Electronics Society (PELS)
- Chair, Semiconductor Committee, Power Supply Manufacturers' Association (PSMA)
- Industry Expert member, Wide and Narrow bandgap technologies for Sustainable Energy Systems, IEEE
- Topic Chair, Sustainable Energy, IEEE ECCE Conference, 2016, 2017, 2018
- Technical Track Chair - International Transportation Electrification Conference, 2017.
- Visiting Lecturer, Indian Institute of Technology (IIT) Bombay, India, 2011-2012.

Selected Data Science/Machine learning articles

- "*Human-compatible AI*", Towards Data Science, Medium
- "*How to use a clustering technique for synthetic data generation*", Towards Data Science
- "*Activation maps for deep learning models in a few lines of code*", KDNuggets
- "*A single function to streamline image classification with Keras*", Towards Data Science
- "*Statistical Modeling with Python: How-to & Top Libraries*", Kite (AI-powered Python IDE) blog
- "*Object-oriented programming for data scientists: Build your ML estimator*", KDNuggets (Gold Badge)
- "*Machine learning with Python: Essential hacks and tricks*", Opensource.com
- "*When Bayes, Ockham, and Shannon come together to define machine learning*", KDNuggets
- "*How do you check the quality of your regression model in Python*?", Towards Data Science, Medium.
- "*Synthetic data generation — a must-have skill for new data scientists*", Towards Data Science, Medium
- "*Essential Math for Data Science*", Curated and Featured by Medium Editors
- "*Eight ways to perform linear regression analysis in Python and how they scale with data set size*", Experfy

Talks on data science/machine learning

- "Data wrangling methods", ValleyML.ai State of AI/ML, January 2020 (upcoming)
- "Statistical methods for data science", ValleyML.ai ML/DL boot camp, August 2019.
- "How AI/ML will drive emerging semiconductor markets", Panel discussion, International SoC conference, UC Irvine, October 2019.
- "How AI and ML techniques can help ON Semiconductor business", Panel discussion, Engineering Technology Forum, October 2019.
- "AI and Machine Learning for Power Electronics and Sustainable Energy Systems", IEEE Technical Committee Traveling Lecture, TBD, 2020 (upcoming).

Keynote/Plenary/Invited talks on semiconductor technology

T1. T. Sarkar, "Discrete FET opportunities catering to higher power demand for future mobile/battery protection applications", Invited talk, *IEEE Safe Advanced Mobile Power Workshop*, Milpitas, CA, September 2015.

T2. S. Deb Roy, R. Sodhi, T. Sarkar, G. Dolny, and J. Kavalam, "Lateral Thin-film SOI MOSFET for High Frequency DC-DC Buck Converter Applications", Invited talk, *International Workshop on the Physics of Semiconductor Devices* (IWPSD), 2013.

T3. T. Sarkar, et al., "Study on Two-stage Architecture for Synchronous Buck Converter In High-power-density Computing Power Supplies", Invited talk, *IBM Power Symposium*, Nov. 2012.

T4. S.K. Mazumder, T. Sarkar, and S.R. Bose, "Photonic modulation of SiC based power semiconductor device switching dynamics using optically triggered power transistor", Keynote lecture, International Workshop on Physics of Semiconductor Devices (IWPSD), 2009.

T5. S.K. Mazumder and T. Sarkar, "Optically-triggered Power Transistor (OTPT) for fly-by-light (FBL)/EMI Susceptible Power Electronics", Plenary talk, IEEE Power Electronics Specialists Conference, 2006.

Peer-reviewed publications on semiconductor technology and power electronics

Monograph/ Book Chapter

B1. T. Sarkar, *Optical intensity modulated gate control of power-electronic system performance parameters*, ProQuest, UMI, September 11, 2011, ISBN-10**:** 1244041181.

B2. S.K. Mazumder, T. Sarkar, M. Dutta and M. S. Mazzola, *Photoconductive Devices in Power Electronics*, Electrical Engineering Handbook, Taylor & Francis, 3rd Ed., pp. 9 - 42, 2005.

International Journals and Transactions

J1. T. Sarkar, and S.K. Mazumder, "Analysis of Input Current Ripple and Optimum Filter Capacitor for Fuel-Cell Based Single-Phase Inverter", *ASME Journal of Fuel Cell Science and Technology*, doi:10.1115/1.4032040.

J2. S.K. Mazumder, T. Sarkar, and K. Acharya, "A DirectFET based high-frequency fuel-cell inverter", *IEEE Journal of Emerging and Selected Topics in Power Electronics*, 2015.

J3. S.K. Mazumder and T. Sarkar, "Optically-activated gate control for power electronics", *IEEE Transactions on Power Electronics*, Vol. 26, Issue: 10, pp. 2863-2886, 2011.

J4. T. Sarkar and S.K. Mazumder, "Photonic compensation of temperature-induced drift of SiC-DMOSFET switching dynamics", *IEEE Transactions on Power Electronics*, Vol. 25, Issue: 11, pp. 2704-2709, 2010.

J5. S.K. Mazumder and T. Sarkar, "SiC based optically-gated high-power solid-state switch for pulsed-power application", *Materials Science Forum*, Vols. 600-603, pp. 1195-1198, 2008.

J6. T. Sarkar, S. K. Mazumder, "Epitaxial Design and Sensitivity Studies for Optically-triggered GaAs-AlGaAs Superjunction Heterostructure Power Device", *IEEE Trans. on Electron Dev.*, Vol.54, No.4, pp. 589-600, 2007.

J7. T. Sarkar, S. K. Mazumder, "Dynamic power density, wavelength, and switching time modulation of optically-triggered power transistor (OTPT) performance parameters", *Microelectronics Journal*, pp. 285-298, 2007.

International Conference Papers

C1. Y. Xiao, J. Victory, S. Pearson, T. Sarkar, A. Challa, M. Dagan, P. Collanton, C. Andreev, "Corner and statistical SPICE model generation for shielded-gate trench power MOSFETs based on backward propagation of variance", *Proceedings of IEEE Applied Power Electronics Conference* (APEC), 2019.

C2. T. Sarkar, K. Huang, A. Challa, D. Probst, P. Venkatraman, "Application-driven device/circuit co-simulation framework for power MOSFET design and technology development", *Proceedings of International Symposium on Power Semiconductor Devices and ICs* (ISPSD), 2018.

C3. J. Victory, S. Pearson, S. Benczkowski, T. Sarkar, HW Jang, K. Mao "A Physically Based Scalable SPICE Model for Shielded-Gate Trench Power MOSFETs", *Proceedings of International Symposium on Power Semiconductor Devices and ICs* (ISPSD), 2016, pp – 217.

C4. T. Sarkar, R. Gurevich, S. Pearson, J. Yedinak, R. Stokes, H.L. Lin, A. Wang, "Circuit-simulation Methodology for Application-specific Device Design for Mid-voltage MOSFETs", *Proceedings of the PCIM Europe*, 2013.

C5. T. Sarkar, A. Challa, and S. Sapp, "Enhanced Shielded-Gate Trench MOSFETs for High-Frequency, High-Efficiency Computing Power Supply Applications", *Proceedings of IEEE Applied Power Electronics Conference*, 2013, pp. 507 -511.

C6. T. Sarkar, Bhargava C.V., M. Joshi, R. Sodhi, and S. Sapp, "Study on Next-Generation two-Stage Architecture for Synchronous Buck Converter in High-Power-Density Computing Power Supplies", *Proceedings of the PCIM Europe*, 2012.

C7. A. Challa, T. Sarkar, and S. Sapp, "Optimized shielded-gate trench MOSFET technology for high-frequency, high-efficiency power supplies", *SPIE Proceedings of the International Workshop on the Physics of Semiconductor Devices* (IWPSD), 2011.

C8. T. Sarkar and S. K. Mazumder, "Optimum input-filter-capacitor sizing for fuel-cell based single-phase inverter for current-ripple mitigation", *European Conference on Power Electronics and Applications*, 2011.

C9. T. Sarkar, A. Upadhaya, R. Sodhi, S. Pearson, S. Sapp, "Effect of inductive parasitics on the device loss and system efficiency in a DC-DC synchronous buck converter for computing applications", *PCIM Europe*, 2011.

C10. S. Pearson, S. Benczkowski, T. Sarkar, S. Sapp, and R. Sodhi, "DC-DC Converter Evaluation with Automated Efficiency Plot Generation", *Proceedings of the PCIM Europe*, 2011.

C11. S.K. Mazumder and T. Sarkar, "Optically-activated gate control of power semiconductor device switching dynamics", *IEEE International Symposium on Power Semiconductor Devices and ICs*, 2009, pp. 152-155.

C12. S.K. Mazumder and T. Sarkar, “Optically-activated gate control (OAGC) for the next-generation SiC-based power electronics devices and applications”, IEEE ECCE, 2009, pp. 2285-2292.

C13. S.K. Mazumder and T. Sarkar, “Optically-modulated Active Gate Control for Switching Electrical Power Conversion Systems”, Proceedings of IEEE Electric Ship Technologies Symposium, 2009, pp. 326-333.

C14. K. Acharya, T. Sarkar, and S.K. Mazumder, “A DirectFET™ based high-frequency fuel-cell inverter”, Proceedings of IEEE Applied Power Electronics Conference, 2009, pp. 1805-1812.

C15. S.K. Mazumder and T. Sarkar, “Optical modulation for high power systems: potential for electromagnetic-emission, loss, and stress control by switching dynamics variation of power semiconductor devices”, Proceedings of IEEE Energy 2030 Conference, 2008, pp. 1-8.

C16. S.K. Mazumder and T. Sarkar, “Device Technologies for Photonically-Switched Power-Electronic Systems”, Proceedings of IEEE International Pulsed Power Conference, 2005, pp. 919-922.

C17. T. Sarkar and S.K. Mazumder, “Steady-state and Switching Characteristics of an Optically-Triggered Power Transistor (OTPT)”, Proceedings of Power Systems World 2004, 2004 (CD publication).

C18. T. Sarkar and S.K. Mazumder, “Amplitude, Pulse-Width, and Wavelength Modulation of A Novel Optically-Triggered Power DMOS”, Proceedings of 35th IEEE Power Electronics Specialists Conference, 2004, pp. 3004 – 3008.