

Shaowei Lin

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Engineering Systems and Design Pillar
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Education

- 2006–2011 **Ph.D. Mathematics, University of California, Berkeley.**
Advisor: Bernd Sturmfels
Topic: Algebraic Statistics
Thesis: *Algebraic methods for evaluating integrals in Bayesian statistics*
- 2002–2005 **B.S. Mathematics, Stanford University.**
Honors with Distinction, Minor in Computer Science
Advisor: Yakov Eliashberg
Topic: Symplectic Topology
Thesis: *Invariants on Legendrian knots*

Career History

- 2016–Present **Singapore University of Technology and Design.**
Engineering Systems and Design Pillar, Assistant Professor
- 2012–2016 **Institute for Infocomm Research.**
Sense and Sense-abilities
2015–2016 Deputy Head (Research)
2013–2015 Sense-making Group Leader
2012–2013 Scientist
- 2011–2012 **University of California, Berkeley.**
Mathematical Challenges in Deep Learning, Postdoctoral Scholar
- 2005–2006 **Institute for Infocomm Research.**
Digital Wireless, Research Officer

Research Interests

smart cities, internet-of-things architecture, wireless sensor networks
machine reasoning, homotopy type theory, linked data
machine learning, neural networks, deep learning, compressive sensing
statistical learning, algebraic statistics, singular learning
algebraic geometry, computer algebra, singularity theory, tropical geometry

Grants and Projects

- 2018-2021 **Enabling Spiking Neuromorphic Computation with On-Board Learning Through Algorithm and Hardware Co-design**
Principal Investigator
Funded by AI Singapore
- 2018-2021 **AI-enabled Cyber Resilience for Power Systems**
Co-Investigator
Funded by EMA
- 2017-2020 **Theoretical and Algorithmic Foundations for Internet-of-Things (IoT) and Internet-of-Data (IoD)**
Principal Investigator
Funded by SUTD-ZJU Collaboration
- 2017-2018 **Phase 3 Development of IDC's High-Performance Computing Resources for Education and Design Research**
Co-Investigator
SUTD International Design Centre Infrastructure Grant
- 2017 TtT **MIT-SUTD Teach-the-Teacher Programme**
Visiting Scholar
Collaboration between MIT, SUTD
- 2016-2021 **Trusted and Resilient Monitoring Infrastructure**
Co-Investigator
STEE-SUTD Cybersecurity Corporate Lab
- 2016-2017 **Hardware Infrastructure for GPU Accelerated Computing**
Co-Investigator
SUTD International Design Centre Infrastructure Grant
- 2016-2019 **Deep Probability Flow and Functional Web for Artificial Intelligence**
Principal Investigator
SUTD Start-Up Research Grant
- 2014-2017 **Urban Microclimate Multiphysics Integrated Simulation Tool**
UM-MIST I²R Proposal Lead
Funded by L2NIC (MND, NRF)
Collaboration between I²R (S&S), IHPC, HDB
- 2013-2016 **Heterogeneous Sense-making and Learning Networks**
HELEN Principal Investigator
*Funded by A*STAR SERC*
Collaboration between I²R (S&S), SUTD (Tony Quek)
- 2014 **Data-Driven Research & Future Computing Paradigms**
Futurescape 2025 Panel Chairperson
*Steered by A*STAR SERC*
- 2014 **Semantic Web of Things**
Futurescape 2025 Panel Member
*Steered by A*STAR SERC*

- 2012–2014 **Wireless sensor networks for real-time, continuous ambient noise mapping**
 WSNnoise Analytics Lead
Funded by NEA
- 2012–2014 **Dense, rural, large scale deployment of S&S technologies for vertical farming**
 SkySense Analytics Lead
*Funded by A*STAR SERC*
Collaboration between I²R (S&S), Sky Greens
- 2011–2012 **Mathematical Challenges in Deep Learning**
 Postdoctoral Scholar
Funded by DARPA, USA
Collaboration between Berkeley (Bernd Sturmfels), Stanford (Andrew Ng)

--- Honours and Awards

- 2015 Borderless Silver Award (UM-MIST, for interagency research), MTI
- 2014 Finalist at World Smart Cities Award (SkySense, for smart agriculture), Spain
- 2014 Borderless Award (Urban Systems Initiative, for interdisciplinary research), A*STAR
- 2014 TALENT Award (S&S, for nurturing young scientists), A*STAR
- 2006 National Science Scholarship (Ph.D.), A*STAR
- 2005 Roll of Honour, A*STAR
- 2003–2005 Chairman's Honours List, A*STAR
- 2005 Mathematics Undergraduate Research Award, Stanford, USA
- 2004 William Lowell Putnam Mathematical Competition – Top 15 Ind, USA
- 2002 William Lowell Putnam Mathematical Competition – Top 40 Ind, USA
- 2002 National Science Scholarship (B.S.), A*STAR
- 1997–1999 International Mathematical Olympiad, Singapore Team – 3 Bronze Medals

Professional Activities

Conference Organization

2015 **IEEE ISSNIP, RIoT**. Local Arrangements Coordinator.

2014 **IEEE ISSNIP**. Symposium and Tutorial Coordinator.

Technical Committee

2017 **J. R. Soc. Interface**. *Journal of the Royal Society Interface*.

2017 **IEEE TBDATA**. *Transactions on Big Data*.

2016 **ISSAC**. *International Symposium on Symbolic and Algebraic Computation*.

2014 **PHYSCOMNET**. *Physics-Inspired Paradigms in Wireless Comms. and Networks*.

2014 **IEEE ISSNIP**. *Intelligent Sensors, Sensor Networks and Information Processing*.

2014 **IEEE VTS APWCS**. *Asia Pacific Wireless Communications Symposium*

2014 **DAMLCity**. *Data Analytics and Machine Learning for Smart Cities*

Program Committee

2017 **AI Singapore**. *Grand Challenge Program Committee in Urban Solutions*.

2017 **NVIDIA**. *Technology Center for Asia-Pacific and Japan. Associate Member*.

2016 **A*STAR I2R**. *Thematic PhD Programme in Big Data Analytics. Board Member*.

Miscellaneous

2017 **MIT TtT Seminar**. "Building Research Centers of Excellence", Organizer.

2016 **SGInnovate**. Consultant for Artificial Intelligence.

2016 **SUTD Deep Learning Day**. Co-organizer with NVIDIA.

2016 **Research Workshop on the Future of AI**. Co-organizer with NVIDIA.

Recent Events

2018 "Preparing Students for AI Future", GE Annual Conference, MOE

2018 "Boltzmann Machines" (participant), AIM Workshop, San Jose

2018 "Poly Equiv of the Kullback Info for Mixture Models", IMS-Vilnius, Lithuania

2018 "Machine Reasoning and Deep Spiking Nets", NVAITC Symposium, Singapore

2018 "Machine Reasoning and Deep Spiking Nets", AISG Visions of AI Futures, Singapore

2017 "The Brain and Computation" (participant), Simons Institute, Berkeley

2017 "Biologically Plausible DL for Recurrent Spiking NNs", Redwood Center, Berkeley

2017 "What is Deep Learning?" (tutorial), DataSpark, Singapore

2017 "Towards Artificial General Intelligence", Math-CS-Stats, Yale-NUS

2017 "Biologically Plausible DL for Recurrent Spiking NNs", NUS Stat

2017 "Artificial General Intelligence for IoT" (keynote), AMD Asia Tech, Singapore

2017 "Artificial General Intelligence for IoT", DAO, NUS

2017 "Biologically Plausible DL for Recurrent Spiking NNs", ML Day, SUTD

2017 "Biologically Plausible DL for Recurrent Spiking NNs", Brain Lab, SUTD

2017 "Biologically Plausible DL for Recurrent Spiking NNs", CBMM, MIT

2017 “Artificial General Intelligence for IoT”, NVIDIA GTC, San Jose

2017 “Generalization in Deep Learning”, Workshop on Alg. Stat., Oberwolfach

2017 “Kullback Information of Gaussian Mixtures”, Workshop on Alg. Stat., Oberwolfach

2017 “Reinforcement Learning and Generative Adversarial Nets” (tutorial), IDSS, MIT

2017 “Deep Learning and Variational Inference” (tutorial), IDSS, MIT

2017 “Towards Model-Parallelism and Hebbian Learning”, CBMM, MIT

2016 “Intentional intelligence”, SGInnovate AI Evening, Singapore

2016 “Smarter cities through distributed AI”, SUTD-ZJU IDEA, Hangzhou

2016 “Game changers in HPC for AI” (panellist), Cloud Asia ICCCRI, Singapore

2016 “Understanding the curse of singularities in machine learning”, 6th SCSS, NUS

2016 “Big data and data analytics” (tutorial), CSD&M Asia, Singapore

Publications

- [1] C. Améndola, M. Drton, and S. Lin. “Analiticity and Equivalence of the Kullback-Leibler Divergence for Exponential and Polynomial Families”. *in preparation* (2019).
- [2] Z. Liu, T. Chotibut, S. Lin, and C. Hillar. “Biologically Plausible Sequence Learning with Spiking Neural Networks”. *Thirty-Fourth AAAI Conference on Artificial Intelligence*. 2020.
- [3] C. Feng, Z. Liu, S. Lin, and T. Q. Quek. “Attention-based Graph Convolutional Network for Recommendation System”. *ICASSP 2019-2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE. 2019, pp. 7560–7564.
- [4] Z. Liu, W. Zhang, S. Lin, and T. Q. Quek. “Heterogeneous sensor data fusion by deep learning”. *Data Fusion in Wireless Sensor Networks: A Statistical Signal Processing Perspective* (2019), p. 57.
- [5] C. Hillar, Z. Lai, and S. Lin. “Toric McCulloch-Pitts processes for spiking neural networks”. *Poster presented at: Max Planck Institute Workshop on Linking Topology to Algebraic Geometry and Statistics* (2018).
- [6] Z. Liu, T. Q. Quek, and S. Lin. “Variational Probability Flow for Biologically Plausible Training of Deep Neural Networks”. *Thirty-Second AAAI Conference on Artificial Intelligence*. 2018.
- [7] Z. Liu, T. Q. Quek, and S. Lin. “Variational probability flow for biologically plausible training of deep neural networks”. *Poster presented at: NIPS 2017 Workshop on Cognitive Informed Artificial Intelligence* (2017).
- [8] M. A. Alsheikh, D. Niyato, S. Lin, H.-P. Tan, and D. I. Kim. “Fast adaptation of activity sensing policies in mobile devices”. *IEEE Transactions on Vehicular Technology* 66.7 (2017), pp. 5995–6008.
- [9] Z. Liu, W. Zhang, S. Lin, and T. Q. Quek. “Heterogeneous Sensor Data Fusion By Deep Multimodal Encoding”. *IEEE Journal of Selected Topics in Signal Processing* 11.3 (2017), pp. 479–491.

- [10] Z. Liu, W. Zhang, T. Q. Quek, and S. Lin. "Deep fusion of heterogeneous sensor data". *Acoustics, Speech and Signal Processing (ICASSP), 2017 IEEE International Conference on*. IEEE. 2017, pp. 5965–5969.
- [11] S. Lin. "Ideal-Theoretic Strategies for Asymptotic Approximation of Marginal Likelihood Integrals". *Journal of Algebraic Statistics* 8.1 (2017).
- [12] M. Drton, S. Lin, L. Weihs, and P. Zwiernik. "Marginal likelihood and model selection for Gaussian latent tree and forest models". *Bernoulli* 23.2 (2017), pp. 1202–1232.
- [13] M. A. Alsheikh, D. Niyato, S. Lin, H.-P. Tan, and Z. Han. "Mobile big data analytics using deep learning and Apache Spark". *Network, IEEE* 30.3 (2016), pp. 22–29.
- [14] M. A. Alsheikh, A. Selim, D. Niyato, L. Doyle, S. Lin, and H.-P. Tan. "Deep activity recognition models with triaxial accelerometers". *Workshops at the Thirtieth AAAI Conference on Artificial Intelligence*. 2016.
- [15] M. A. Alsheikh, S. Lin, D. Niyato, and H.-P. Tan. "Rate-Distortion Balanced Data Compression for Wireless Sensor Networks". *Sensors Journal, IEEE* 16.12 (2016), pp. 5072–5083.
- [16] M. A. Alsheikh, S. Lin, H.-P. Tan, and D. Niyato. "Toward a robust sparse data representation for wireless sensor networks". *Proceedings of IEEE Conference on Local Computer Networks*. 2015.
- [17] P. Zhang, X. Ma, W. Zhang, S. Lin, H. Chen, A. L. Yirun, and G. Xiao. "Multimodal fusion for sensor data using stacked autoencoders". *Poster presented at: Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2015 IEEE Tenth International Conference on*. IEEE. 2015, pp. 1–2.
- [18] M. A. Alsheikh, D. T. Hoang, D. Niyato, H.-P. Tan, and S. Lin. "Markov Decision Processes with Applications in Wireless Sensor Networks: A Survey". *Communications Surveys Tutorials, IEEE* 17.3 (2015), pp. 1239–1267.
- [19] S. Lin, C. Uhler, B. Sturmfels, and P. Bühlmann. "Hypersurfaces and their singularities in partial correlation testing". *Foundations of Computational Mathematics* 14.5 (2014), pp. 1079–1116.
- [20] M. Abu Alsheikh, P. K. Poh, S. Lin, H.-P. Tan, and D. Niyato. "Efficient data compression with error bound guarantee in wireless sensor networks". *Proceedings of the 17th ACM international conference on Modeling, analysis and simulation of wireless and mobile systems*. 2014, pp. 307–311.
- [21] L. Z. Wong, H. Chen, S. Lin, and D. C. Chen. "Imputing missing values in sensor networks using sparse data representations". *Proceedings of the 17th ACM international conference on Modeling, analysis and simulation of wireless and mobile systems*. 2014, pp. 227–230.
- [22] M. A. Alsheikh, D. Niyato, S. Lin, and H.-P. Tan. "Area coverage under low sensor density". *Poster presented at: Proceedings of the 11th IEEE Communications Society Conference on Sensor and Ad Hoc Communications and Networks*. 2014.

- [23] G. Peters, I. Nevat, S. Lin, and T. Matsui. "Modelling threshold exceedence levels for spatial stochastic processes observed by sensor networks". *Intelligent Sensors, Sensor Networks and Information Processing, IEEE Ninth International Conference on*. 2014, pp. 1–7.
- [24] P. Zhang, J. Y. Koh, S. Lin, and I. Nevat. "Distributed event detection under Byzantine attack in wireless sensor networks". *Intelligent Sensors, Sensor Networks and Information Processing, IEEE 9th International Conference on*. 2014, pp. 1–6.
- [25] M. Abu Alsheikh, S. Lin, D. Niyato, and H.-P. Tan. "Machine Learning in Wireless Sensor Networks: Algorithms, Strategies, and Applications". *Communications Surveys Tutorials, IEEE* 16.4 (2014), pp. 1996–2018.
- [26] V. I. Morgenshtern, E. Riegler, W. Yang, G. Durisi, S. Lin, B. Sturmfels, and H. Bolcskei. "Capacity Pre-Log of Noncoherent SIMO Channels Via Hironaka's Theorem". *Information Theory, IEEE Transactions on* 59.7 (2013), pp. 4213–4229.
- [27] M. A. Cueto and S. Lin. "Tropical secant graphs of monomial curves". *Beiträge zur Algebra und Geometrie* 54.1 (2013), pp. 383–418.
- [28] C. J. Hillar, S. Lin, and A. Wibisono. "Inverses of symmetric, diagonally dominant positive matrices and applications". *submitted to SIAM Journal on Matrix Analysis and Applications, arXiv:1203.6812* (2017).
- [29] E. Riegler, V. I. Morgenshtern, G. Durisi, S. Lin, B. Sturmfels, and H. Bolcskei. "Noncoherent SIMO pre-log via resolution of singularities". *Information Theory Proceedings, IEEE International Symposium on*. 2011, pp. 2020–2024.
- [30] S. Lin. "Algebraic methods for evaluating integrals in Bayesian statistics". PhD thesis. University of California, Berkeley, 2011.
- [31] M. A. Cueto and S. Lin. "Tropical secant graphs of monomial curves". *FPSAC 2010, DMTCS Proceedings AN*. 2010, pp. 669–680.
- [32] S. Lin and B. Sturmfels. "Polynomial relations among principal minors of a 4×4 -matrix". *Journal of Algebra* 322.11 (2009), pp. 4121–4131.
- [33] S. Lin, B. Sturmfels, and Z. Xu. "Marginal likelihood integrals for mixtures of independence models". *JMLR* 10 (2009), pp. 1611–1631.
- [34] S. Lin, W. W. Ho, and Y.-C. Liang. "Block diagonal geometric mean decomposition (BD-GMD) for MIMO broadcast channels". *Wireless Communications, IEEE Transactions on* 7.7 (2008), pp. 2778–2789.
- [35] S. Lin, W. W. Ho, and Y.-C. Liang. "Block-diagonal geometric mean decomposition (BD-GMD) for multiuser MIMO broadcast channels". *Personal, Indoor and Mobile Radio Communications, IEEE 17th International Symposium on*. 2006, pp. 1–5.
- [36] S. Lin, W. W. Ho, and Y.-C. Liang. "MIMO broadcast communications using block-diagonal uniform channel decomposition (BD-UCD)". *Personal, Indoor and Mobile Radio Communications, IEEE 17th International Symposium on*. 2006, pp. 1–5.

Teaching

- 2020 **SUTD** *Statistical and Machine Learning (Undergraduate)*
Course Instructor.
- 2019 **SUTD** *Statistics (Graduate)*
Course Instructor.
- 2018 **SUTD** *Statistics (Graduate)*
Course Instructor.
- 2017 **SUTD** *Machine Learning (Undergraduate)*
Course Co-Instructor.
- 2016 **SUTD** *Machine Learning (Undergraduate)*
Course Co-Instructor.
- 2016 **SUTD** *Statistics (Graduate)*
Course Instructor.
- 2013 **CMND** *Thematic Program on Motivic Invariants and Singularities.*
Undergraduate Summer School (21-25 May) Mini-course on Singular Learning.
- 2009 **UC Berkeley** *Math 1B Calculus*
Graduate Student Instructor.
- 2002, 2006 **National University of Singapore** *International Mathematical Olympiad*
Trainer for Singapore National Team.
- 2002 **Dunman High School** *Upper and Lower Secondary Mathematics*
Relief Teacher for the Gifted Education Programme.

Mentorship

- 2019–Present **Tenzin Chan.** Ph.D. student.
Project: Neuromorphic Computing
- 2019–Present **Matthew Yap.** EDB-IPP MSc. student (with AMD).
Project: Fault Detection for Microprocessors
- 2018–Present **Lim Jin Xing.** Ph.D. student.
Project: Symbolic Artificial Intelligence
- 2017–Present **Ng Aik Beng.** EDB-IPP Ph.D. student (with NVIDIA).
Project: Artificial Intelligence for Personal Assistants
- 2016–Present **Lai Zhangsheng.** EDB-IPP Ph.D. student (with NVIDIA).
Project: Machine Reasoning
- 2016–Present **Gary Phua.** Ph.D. student.
Project: Statistical Physics and Neural Networks
- 2018–2019 **Colin Tan Weiyu.** Postdoctoral scholar.
Project: Dependent Type Theory for Internet-of-Things
- 2016–2019 **Thiparat Chotibut.** Postdoctoral scholar.
Project: Theoretical Physics and Deep Learning

- 2015–2019 **Liu Zuozhu.** Ph.D. student, with Tony Quek (SUTD).
Project: Biologically Inspired Algorithms for Variational Learning in Neural Networks
- 2014–2019 **Zack Xuereb Conti.** Ph.D. student, with Sawako Kaijima, Sam Conrad Joyce
Project: A Probabilistic Design Space Representation for Intelligent Decision-making
- 2014–2015 **Steven Dinh Thinh Quang.** Ph.D. student, with Tony Quek (SUTD).
Project: Multimodal Data Fusion for Sensor Networks
- 2013–2014 **Poh Puay Kai.** UROP student, with Seth Gilbert (NUS).
Project: Sensor Data Compression using Neural Networks
- 2013–2014 **Zhang Wenyu.** Research Attachment.
Project: Deep Learning for Multimodal Sensor Fusion
- 2013–2014 **Wong Liang Ze.** Research Attachment.
Project: Missing Data Imputation for Sensor Networks
- 2013–2017 **Mohammad Abu Alsheikh.** Ph.D. student, with H.P. Tan (I²R), D. Niyato (NTU).
Project: Machine Learning Principles for Designing Sensor Networks
- 2011–2012 **Luca Weihs.** UROP student, for Bernd Sturmfels (UCB).
Project: Tensor Tree Cumulants and the Salmon Conjecture
- 2011–2012 **Andrew Critch.** Ph.D. student, for Bernd Sturmfels (UCB).
Project: Algebraic Statistics