Shaowei Lin

Director of Research
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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

2023–present **Topos Institute**.
Director of Research

2021–2023 **Awecom, Inc.**.
Head of Artificial Intelligence

2016–2020 **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 UM-MIST **Urban Microclimate Multiphysics Integrated Simulation Tool**
I^2R Proposal Lead
Funded by L2NIC (MND, NRF)
Collaboration between I^2R (S&S), IHPC, HDB

2013–2016 HELEN **Heterogeneous Sense-making and Learning Networks**
Principal Investigator
Funded by A*STAR SERC
Collaboration between I^2R (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**
WSNoise 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 I^2R (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-Fouth 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 $4\times$ 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** *Systems World (Undergraduate)*
Course Instructor.

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

2019–2023 **Tenzin Chan.** Ph.D. student.
Project: Characterizing Criticality in Natural Systems using Information Theory

2019–2020 **Matthew Yap.** EDB-IPP MSc. student (with AMD).
Project: Fault Detection for Microprocessors

2018–2022 **Lim Jin Xing.** Ph.D. student.
Project: Incentivized Mechanism Design for Collaborative Proofs and Programs through Blockchain and Theorem Provers

2017–2020 **Ng Aik Beng.** EDB-IPP Ph.D. student (with NVIDIA).
Project: Human-AI Collaboration: Type theoretic composition, conglomeration and communication of intents for an AI-augmented knowledge workforce

2016–2020 **Lai Zhangsheng.** EDB-IPP Ph.D. student (with NVIDIA).
Project: Dependent Types, Canonical Structures and Reflection Strategies for Assisted Reasoning and Computation on Knowledge Graphs

2016–2020 **Gary Phua.** Ph.D. student.
Project: Hyperdimensional States and Transition Rate Operators for Natural Language Representation

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 (I^2R), 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