

Research Objective

Machine learning and quantitative modeling on time series, computer vision, and semiconductor manufacturing; design automation and hardware/software integration for bioelectronics.

Education

Massachusetts Institute of Technology (MIT) – Cambridge, MA, USA *Jan 2022 – Present*

Ph.D. in Electrical Engineering and Computer Science (GPA: 5.00/5.00)

Selected Courses: Advances in Computer Vision, Inference and Information

National Taiwan University (NTU) – Taipei, Taiwan

M.S. in Bio-industrial Mechatronics Engineering (GPA: 3.94/4.00 - 35 credits)

Aug 2017 – Jul 2019

B.S. in Bio-industrial Mechatronics Engineering (GPA: 3.68/4.00 - 188 credits)

Aug 2013 – Jul 2017

Experiences

Research Intern, Applied Sciences Group, Microsoft Corporation *Jun 2023 – Aug 2023*

Neural Text Image Compression [Ongoing]

- Introduced text logit loss that significantly reduces the character/word error rate in text image compression, supported by experimentation with state-of-the-art algorithms.

PhD Researcher, Statistical Metrology Group (Prof. Duane Boning) *Jan 2022 – Present*

Physics-Informed Machine Learning for Semiconductor Manufacturing [Ongoing]

Machine Learning on Time Series [NeurIPS-23]

- Proposed an algorithm for time series anomaly detection based on point/sequence. Derived an induced anomaly score which is proven superior under some conditions and outperforms state-of-the-art models.

Machine Learning in Computer Vision

- Realized speech-driven facial animation approach from noisy data using pre-trained GANs and seq2seq models.

Standard Cell Layout Designer, Taiwan Semiconductor Manufacturing Co. (TSMC) *Dec 2019 – Jan 2022*

Automated Placer, DLCAR, and PPA Estimator (AutoPDE)

- Developed an end-to-end automated system that can generate optimized standard cells by integrating a transistor placer, router, and machine learning based PPA estimator.
- Invented DLCAR, a functional block-based standard cell routing system that can generate functional and commercially manufacturable standard cell libraries within a few minutes for the N3 process node.

Design of Manufacturability in Advanced Technology Node

- Pioneered in standard cell structure definition for the initial development stage of world-class technology nodes, being first inventor of 8 US patents for 3D IC and advanced structures.

Research Assistant, Academia Sinica *Aug 2019 – Nov 2019*

- Served as research leader and secured research project grant (over 800,000NTD, 1yr project) from Ministry of Science and Technology for developing miniaturized bio-electronic platforms.

Graduate Researcher, Intelligent Bio-sensing Lab *Aug 2016 – Jul 2019*

Novel Circuit Element for Interdigitated Electrode Modeling

- Derived an integral equation for modeling the diffusion impedance of interdigitated electrodes (IDEs) by conformal mapping and the usage of Jacobi elliptic functions, elliptic integrals and Bessel functions. The element is used for modeling impedimetric tumor marker DNA biosensing data obtained from IDE chips and unprecedentedly succeeded to extract underlying physical properties.

Undergraduate Researcher, Lab of Computational Biology *Sep 2015 - Jul 2016*

Big Data Analytics for Semiconductor Manufacturing

- Implemented an ML stack method based on random forest and SVR models for prediction of key stages and tools and won 1st prize in the Big Data Analytics for Semiconductor Manufacturing contest held by TSMC.

Skills

- Languages: English (Fluent), Chinese Mandarin (Fluent), French (Elementary), Japanese (Elementary)
- Programming: C/C++, Python, MATLAB, SKILL, JavaScript, Visual Basic
- Tools: PyTorch, Tensorflow, Virtuoso, OpenCV, Solidworks, LabVIEW, COMSOL, Raspberry Pi

Publications

Conference Papers

- [1] C.-Y. Lai et al., Nominality Score Conditioned Time Series Anomaly Detection by Point/Sequential Reconstruction, *Neural Information Processing Systems (NeurIPS)*, 2023.
- [2] C.-Y. Lai et al., Unsupervised Multivariate Time Series Anomaly Detection for High-Frequency Data, *Microsystems Annual Research Conference (MARC)*, (2023).
- [3] C.-Y. Lai et al., MUC1 impedimetric aptasensing based on interdigitated array electrode chip using a novel diffusion element, *accepted to 31st Anniversary World Congress on Biosensors*, (2021).
- [4] C.-Y. Lai et al., Diffusion impedance modeling for interdigitated array electrodes by conformal mapping and cylindrical finite length approximation, *11th International Symposia on EIS*, (2019).
- [5] C.-Y. Lai et al., Real-time impedimetric MUC1 aptasensor using microfluidic symmetric Au electrodes, *The 22nd International Conference on Miniaturized Systems for Chemistry and Life Sciences (μ TAS)*, (2018).
- [6] C.-Y. Lai and L.-C. Chen, EIS detection of MUC1 with two symmetric aptamer/Au electrodes, *22nd Topical Meeting of the International Society of Electrochemistry*, (2018).

Journal Papers

- [7] C.-Y. Lai et al., Impedimetric aptasensing using a symmetric Randles circuit model, *Electrochimica Acta* (IF = 6.216), **337** (2020) 35750.
- [8] C.-Y. Lai et al., Diffusion impedance modeling for interdigitated array electrodes by conformal mapping and cylindrical finite length approximation, *Electrochimica Acta*, **320** (2019) 134629.
- [9] J.-H. Weng, C.-Y. Lai, L.-C. Chen, Microfluidic amperometry with two symmetric Au microelectrodes under one-way and shuttle flow conditions, *Electrochimica Acta*, **297** (2019) 118-128.
- [10] M.-Y. Pan, D.-K. Yang, C.-Y. Lai, J.-H. Weng, K.-L. Lee, L.-C. Chen, C.-F. Chou, P.-K. Wei, Spectral contrast imaging method for mapping transmission surface plasmon images in metallic nanostructures, *Biosensors and Bioelectronics* (IF = 12.54), **142** (2019) 111545.

Selected Patents

- [11] C.-Y. Lai et al., Integrated circuits having stacked transistors and backside power nodes, *US Patent App.* 17/459,818, (2023).
- [12] C.-Y. Lai et al., Semiconductor device having self-aligned interconnect structure and method of making, *US Patent App.* 17/231,527, (2022).
- [13] C.-Y. Lai et al., Amphifet structure, method of making and method of designing, *US Patent App.* 17/214,194, (2022).

Honors and Awards

Golden Trade Secret Award , <i>Trade Secret Competition – TSMC</i>	2022
Golden Star Award , <i>RD Idea Forum Competition – TSMC</i>	2021
Best Presentation Award , <i>DTP Conference – TSMC</i>	2021
Golden Trade Secret Award , <i>Trade Secret Competition – TSMC</i>	2021
Best Presentation Award , <i>DTP Conference – TSMC</i>	2020
Honorable Mention , <i>RD Idea Forum Competition – TSMC</i>	2020
1st Prize , <i>Big Data Analytics for Semiconductor Manufacturing – TSMC</i>	2016
Presidential Award , <i>National Taiwan University (Fall 2014)</i>	2015
Entered Final Stage , <i>Contestant Training Camp – Taiwan Olympiad in Informatics</i>	2013

Selected Projects

- Multi-Agent Reinforcement Learning (MARL) for “The Resistance”** *May 2022*
- Trained proximal policy optimization (PPO) agents to play the hidden role game The Resistance, showing that emergent communication is helpful for cooperative and adversarial MARL for partially observable states.
- Deep Q-Learning applied to Automated Forex Trading** *Jun 2018*
- Developed a trading model for profitable forex trading using a deep Q-network that can automatically adapt to dynamic environments to maximize its profits. Constructed a system for implementation of trading models, automatic transaction, real-time price acquisition and forex history data storage using the LAMP software stack.