

## Research Objective

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

## Education

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

Ph.D. in Electrical Engineering and Computer Science

Courses: Sensorimotor Learning, Advances in Computer Vision (GPA: 5.00/5.00)

**National Taiwan University (NTU)** – Taipei, Taiwan *Aug 2017 – Jul 2019*

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

**National Taiwan University (NTU)** – Taipei, Taiwan *Aug 2013 – Jul 2017*

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

## Experiences

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

*Machine Learning on Time Series*

- Implemented a method for unsupervised time series anomaly detection on high-frequency data, out-performing most state-of-the-art algorithms.

*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* - [1] [2] [3]

- Pioneering in standard cell structure definition for the initial development stage of world-class technology nodes, with 13 US patent applications for 3D IC and advanced structures (3 published as of Feb 2023).

**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* - [5] [8] [9]

- 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.

*Microfluidic Bio-sensing Platform* - [4] [10] [11]

- Developed a symmetric Randles circuit model for quantitatively characterizing symmetric electrode systems and applied it to impedimetric aptasensing. Constructed website-controlled embedded systems for microfluidic control and real-time impedance detection of the IDE bio-chip using raspberry Pi.

**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

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- 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

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### Patents

- [1] C.-Y. Lai et al., Semiconductor device and method of making, *US Patent App.* 17/466,417, (2023).
- [2] C.-Y. Lai et al., Semiconductor device having self-aligned interconnect structure and method of making, *US Patent App.* 17/231,527, (2022).
- [3] C.-Y. Lai et al., Amphi-fet structure, method of making and method of designing, *US Patent App.* 17/214,194, (2022).

### Journal Papers

- [4] C.-Y. Lai et al., Impedimetric aptasensing using a symmetric Randles circuit model, *Electrochimica Acta* (IF = 6.216), **337** (2020) 35750.
- [5] 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.
- [6] 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.
- [7] 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.

### International Conference Papers

- [8] C.-Y. Lai et al., Unsupervised Multivariate Time Series Anomaly Detection for High-Frequency Data, *Microsystems Annual Research Conference (MARC)*, (2023).
- [9] C.-Y. Lai et al., MUC1 impedimetric aptasensing based on interdigitated array electrode chip using a novel diffusion element, *31<sup>st</sup> Anniversary World Congress on Biosensors*, (2021).
- [10] C.-Y. Lai et al., Diffusion impedance modeling for interdigitated array electrodes by conformal mapping and cylindrical finite length approximation, *11<sup>th</sup> International Symposia on EIS*, (2019).
- [11] C.-Y. Lai et al., Real-time impedimetric MUC1 aptasensor using microfluidic symmetric Au electrodes, *The 22<sup>nd</sup> International Conference on Miniaturized Systems for Chemistry and Life Sciences ( $\mu$ TAS)*, (2018).
- [12] C.-Y. Lai and L.-C. Chen, EIS detection of MUC1 with two symmetric aptamer/Au electrodes, *22<sup>nd</sup> Topical Meeting of the International Society of Electrochemistry*, (2018).

## Honors and Awards

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

## Selected Projects

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- 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.

## Extracurricular Events

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- Co-Founder**, Sensio (Start-up of Olfactory Alarm Clock) – NTU Garage *Sep 2015 – Oct 2016*
- Development of an olfactory alarm clock that can awake people using fragrance.
  - Served as engineering role for hardware/software integration, and secured 40,000NTD in a fundraising event.