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Chih-Yu (Andrew) Lai

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Research Objective

Machine learning and quantitative modeling on time series, computer vision, semiconductor manufacturing, design automation, and bioelectronics.

Education

Massachusetts Institute of Technology (MIT)   Cambridge, MA, USA

Ph.D. in Electrical Engineering and Computer Science (GPA: 4.9/5.0)   *Jan 2022 – Present*
  Minor: Business & Finance
  Selected Courses: Advances in Computer Vision, Inference and Information, Sensorimotor Learning
  Research Interest: Machine learning for time series; Physics-informed ML for semiconductor manufacturing

National Taiwan University (NTU)   Taipei, Taiwan

M.S. in Bio-industrial Mechatronics Engineering (GPA: 3.9/4.0)   *Aug 2017 – Jul 2019*
  Selected Courses: Design of Automated Systems, Artificial Neural Networks, Integrated Circuit Design
  Research Interest: Quantitative modeling for miniaturized bioelectronic devices

B.S. in Bio-industrial Mechatronics Engineering (GPA: 3.7/4.0 – 188 credits)   *Aug 2013 – Jul 2017*
  Presidential Award (Fall 2014)
  Selected Courses: Linear Algebra, Complex Variables, Engineering Mathematics, Mechatronics and System Design

Research Experiences

NVIDIA   Austin, TX, USA
Research Intern, Design Automation Research Group (Dr. Haoxing (Mark) Ren)   *Jun 2024 – Aug 2024*

Microsoft Corporation   Redmond, WA, USA
Research Intern, Applied Science Group (Dr. Kazuhito Koishida)   *Jun 2023 – Aug 2023*
Neural Text Image Compression [**ICIP 2024**]
- Introduced text logit loss that significantly reduces the character/word error rate in text image compression, supported by experiments using state-of-the-art algorithms.

Massachusetts Institute of Technology   Cambridge, MA, USA
PhD Researcher Assistant, Statistical Metrology Group (Prof. Duane S. Boning)   *Jan 2022 – Present*
Physics-Informed Machine Learning for Semiconductor Manufacturing [**Ongoing**]
- Explore methods for plasma etch optimization using physics-informed neural networks incorporated with a level-set equation-based loss function on time-dependent surface evolution datasets.

Machine Learning on Time Series [**NeurIPS-23**][Submitted to ICML-25]
- 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.
- Proposed a novel framework for probabilistic forecasting using residual-based conditional diffusion modeling to optimize predictions and outperform state-of-the-art models in terms of CRPS performance.

Machine Learning in Computer Vision
- Realized speech-driven facial animation approach from noisy data using pre-trained GANs and seq2seq models.

Taiwan Semiconductor Manufacturing Company (TSMC)   *Hsinchu, Taiwan*
Layout Designer, Design Technology Platform (DTP) (Dr. Chih-Liang Chen)   *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 power-performance-area (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 inventor of 14 US patents for 3D IC and advanced structures.

Academia Sinica *Taipei, Taiwan*
Research Assistant, Institute of Physics (Prof. Chia-Fu Chou) *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 bioelectronic platforms.

National Taiwan University *Taipei, Taiwan*
Graduate Research Assistant, Intelligent Bio-sensing Lab (Prof. Lin-Chi Chen) *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, (Prof. Chien-Yu Chen) *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.

Publications

Conference Papers

[1] C.-Y. Lai, D. Tran, and K. Koishida, Learned Image Compression with Text Quality Enhancement, *International Conference on Image Processing (ICIP),* 2024. [[arXiv](#)]

[2] C.-Y. Lai, F.-K. Sun, Z. Gao, J. H. Lang, and D. S. Boning, Nominality Score Conditioned Time Series Anomaly Detection by Point/Sequential Reconstruction, *Neural Information Processing Systems (NeurIPS),* 2023. [[arXiv](#)] [[NeurIPS](#)] [[GitHub](#)]

[3] C.-Y. Lai, F.-K. Sun, J. H. Lang, and D. S. Boning, Unsupervised Multivariate Time Series Anomaly Detection for High-Frequency Data, *Microsystems Annual Research Conference (MARC),* (2023). [[Proceedings](#)]

[4] C.-Y. Lai, T.-H. He, W.-C. Huang, and L.-C. Chen, MUC1 impedimetric aptasensing based on interdigitated array electrode chip using a novel diffusion element, *31st Anniversary World Congress on Biosensors*, (2021). [[Poster](#)] [[Presentation](#)]

[5] C.-Y. Lai, J.-H. Weng, W.-L. Shih, L.-C. Chen, C.-F. Chou, and P.-K. Wei, Diffusion impedance modeling for interdigitated array electrodes by conformal mapping and cylindrical finite length approximation, *11th International Symposia on Electrochemical Impedance Spectroscopy*, (2019). [[Slides](#)] [[Presentation](#)]

[6] C.-Y. Lai, J.-H. Weng, and L.-C. Chen, Real-time impedimetric MUC1 aptasensor using microfluidic symmetric Au electrodes, *The 22nd International Conference on Miniaturized Systems for Chemistry and Life Sciences (µTAS)*, (2018). [[Poster](#)]

[7] 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). [[Slides](#)] [[Presentation](#)]

[8] C.-Y. Lai and L.-C. Chen, The study of an impedimetric microfluidic chip design for mucin1 aptasensing, 64th TwIChE Annual Meeting, (2017). **Outstanding Poster Award** [[Poster](#)]

[9] C.-Y. Lai and L.-C. Chen, Detection of mucin1 with a microfluidic impedimetric aptasensor, International Symposium on Smart-Sensing Medical Devices and 22nd Symposium of Association for Chemical Sensors in Taiwan, (2017). [[Slides](#)] [[Presentation](#)]

Journal Papers

[10] C.-Y. Lai, W.-C. Huang, J.-H. Weng, L.-C. Chen, C.-F. Chou, and P.-K. Wei, Impedimetric aptasensing using a symmetric Randles circuit model, *Electrochimica Acta* (IF = 6.6), **337** (2020) 35750. [[Paper](#)]

[11] C.-Y. Lai, J.-H. Weng, W.-L. Shih, L.-C. Chen, C.-F. Chou, and P.-K. Wei, Diffusion impedance modeling for interdigitated array electrodes by conformal mapping and cylindrical finite length approximation, *Electrochimica Acta*, **320** (2019) 134629. [[Paper](#)]

[12] J.-H. Weng, C.-Y. Lai, and L.-C. Chen, Microfluidic amperometry with two symmetric Au microelectrodes under one-way and shuttle flow conditions, *Electrochimica Acta*, **297** (2019) 118-128. [[Paper](#)]

[13] M.-Y. Pan, D.-K. Yang, C.-Y. Lai, J.-H. Weng, K.-L. Lee, L.-C. Chen, C.-F. Chou, and 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. [[Paper](#)]

Patents

[14] C.-Y. Lu, Y.-H. Chiu, C.-L. Chen, C.-Y. Lai, and S.-H. Chiu, Source/drain isolation structure, layout, and method (U.S. Pub. No. US20230386998A1), U.S. Patent and Trademark Office, (2023). [Patent]

[15] C.-Y. Lu, C.-L. Chen, C.-T. Wu, C.-Y. Lai, and S.-H. Chiu, First metal structure, layout, and method (U.S. Pub. No. US20230387011A1), U.S. Patent and Trademark Office, (2023). [Patent]

[16] C.-Y. Lu, C.-Y. Lai, M.-H. Wang, C.-L. Chen, and S. H. Chiu, Semiconductor devices with reduced effect of capacitive coupling (U.S. Pub. No. US20230386997A1), U.S. Patent and Trademark Office, (2023). [Patent]

[17] C.-Y. Lai, H.-Z. Zhuang, C.-L. Chen, and L.-C. Tien, Method of manufacturing integrated circuit (U.S. Pub. No. US20230387014A1), U.S. Patent and Trademark Office, (2023). [Patent]

[18] C.-Y. Lai, C.-L. Chen, C.-Y. Lu, and C.-H. Wang, Semiconductor device including through via and method of making (U.S. Pub. No. US20230343703A1), U.S. Patent and Trademark Office, (2023). [Patent]

[19] P. Wang, C.-Y. Lai, C.-Y. Lu, S.-S. Chiu, H.-Z. Zhuang, and C.-L. Chen, Semiconductor cell and active area arrangement (U.S. Pub. No. US20230268339A1), U.S. Patent and Trademark Office, (2023). [Patent]

[20] C.-Y. Lai, C.-L. Chen, C.-Y. Lu, and S.-S. Chiu, Arrangement of source or drain conductors of transistor (U.S. Pub. No. US20230154990A1), U.S. Patent and Trademark Office, (2023). [Patent]

[21] C.-Y. Lai, C.-L. Chen, C.-W. Tsai, S.-W. Chang, and L.-C. Tien, Semiconductor device segmented interconnect (U.S. Pub. No. US20230067952A1), U.S. Patent and Trademark Office, (2023). [Patent]

[22] C.-Y. Lai, C.-L. Chen, and L.-C. Tien, Integrated circuits having stacked transistors and backside power nodes (U.S. Pub. No. US20230067311A1), U.S. Patent and Trademark Office, (2023). [Patent]

[23] C.-Y. Lai, H.-Z. Zhuang, C.-L. Chen, and L.-C. Tien, Integrated circuit conductive line arrangement for circuit structures, and method (U.S. Pub. No. US20230062140A1), U.S. Patent and Trademark Office, (2023). [Patent]

[24] C.-Y. Lai and C.-L. Chen, Integrated circuit and method of forming same (U.S. Pub. No. US20230050555A1), U.S. Patent and Trademark Office, (2023). [Patent]

[25] C.-Y. Lai, C.-L. Chen, C.-Y. Lu, and S.-S. Chiu, Semiconductor device and method of making (U.S. Pub. No. US20230008866A1), U.S. Patent and Trademark Office, (2023). [Patent]

[26] C.-Y. Lai, C.-L. Chen, C.-Y. Lu, S.-S. Ciou, H.-Z. Zhuang, C.-W. and Tsai, S.-W. Chang, Semiconductor device having self-aligned interconnect structure and method of making (U.S. Pub. No. US20220336325A1), U.S. Patent and Trademark Office, (2022). [Patent]

[27] C.-Y. Lai, C.-L. Chen, C.-Y. Lu, S.-S. Ciou, H.-Z. Zhuang, C.-W. Tsai, and S.-W. Chang, Amphi-fet structure, method of making and method of designing (U.S. Pub. No. US20220310591A1), U.S. Patent and Trademark Office, (2022). [Patent]

Preprint

[28] Z. Gao, X. Chen, Z. Zhang, C.-Y. Lai, U Chakraborty, W. Bogaerts, and D. S. Boning, Provable Routing Analysis of Programmable Photonics, arXiv preprint arXiv:2306.12607. [arXiv]

Teaching Experiences

National Taiwan University   Taipei, Taiwan

Teaching Assistant, Unit Operations in Bio-industry (F '18)   *Sep 2018 – Jan 2019*
- Grading, composing lecture notes, lab lectures

Teaching Assistant, Physical Chemistry (F '17)   *Sep 2017 – Jan 2018*
- Grading

Teaching Assistant, Bio-industrial Engineering Practice (S' 17)   *Feb 2017 – Jun 2017*
- Grading, composing lab notes, lab lectures

Other Experiences

Peer-review service

IEEE Transactions on Knowledge and Data Engineering (4 papers)
                                                                                                                                    Aug 2024

Invited Talks

Seminar, Lam Research – Time Series Anomaly Detection   *Jul 2024*

Honors and Awards

Huang-Philips Fellowship	Massachusetts Institute of Technology	**2022**
Golden Trade Secret Award	*Trade Secret Competition,* TSMC	**2022**
Golden Star Award	*RD Idea Forum Competition,* TSMC	**2021**
Best Presentation Award	*DTP Conference,* TSMC	**2021**
Golden Trade Secret Award	*Trade Secret Competition,* TSMC	**2021**
Best Presentation Award	*DTP Conference,* TSMC	**2020**
Honorable Mention	*RD Idea Forum Competition,* TSMC	**2020**
Research Project Grant	Ministry of Science and Technology	**2020**
Educational Scholarship	ECLAT Foundation	**2019**
Outstanding Poster Award	Annual Meeting of TwIChE	**2017**
1ˢᵗ Prize	*Big Data Analytics for Semiconductor Manufacturing,* TSMC	**2016**
Presidential Award	*National Taiwan University (Fall 2014)*	**2015**
Entered Final Stage	National Collegiate Programming Contest	**2015**
Educational Scholarship	TIWC Educational Foundation	**2013**
Entered Final Stage	*Contestant Training Camp,* Taiwan Olympiad in Informatics	**2013**
Harvard Prize Book	Harvard Alumni Association	**2012**

Selected Self-motivated Projects and Coursework

Speech-driven Facial Animation with StyleGAN3 and Wav2Vec2   *Jun 2022*
- This project introduces a novel training approach with pre-trained models (StyleGAN3, Wav2Vec2, MTCNN) and achieving the implementation using StyleGAN3 for facial animation from speech audio and image inputs, minimizing dataset and training needs.

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.

Automated Microfluidic Controlling Platform   *Jun 2019*
- A microfluidic controlling platform that can automatically manipulate liquid-based solutions of little volume, and assist in real-time detection experiments.

Real-time Impedance Detection Systems   *Apr 2019*
- Developing portable bio-sensing systems, we present real-time impedance detection systems, with Generation β enhancing features, including expanded frequency range and remote accessibility through a website.

Survival Rate Prediction Model for Startup Companies   *Jan 2019*
- Startup success prediction framework using a deep MLPs and decision trees

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.

Remote Commandable Self-Driving Toy Car   *Jun 2018*
- A remotely controlled car with ball-tracking capabilities that integrates computer vision, mechatronics, Bluetooth communication, and mobile app design.

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