

# Huilin Tai

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## Education

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### McGill University, Montreal, QC, Canada

Bachelor of Science - Major statistics and computer science, GPA 3.85 (Sep. 2020 - present)

Mathematics: strength in Analysis, Algebra, Probability, Bayesian Inference

Computer science: Algorithm and Data Structures, Machine Learning, Deep learning, Python, Java, R language, Matlab, JavaScript, C, HTML/CSS, Bash/Shell, MIPS, OCaml

## Publications

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- [1] Dehai Wu, Congyi Zhang, Guanqun Liao, Kaiming Leng, Bowen Dong, Yang Yu, **Huilin Tai**, Lining Huang, Feng Luo, Bin Zhang, Tiexiang Zhan, Qiuhui Hu, Sheng Tai. *Targeting uridine-cytidine kinase 2 induced cell cycle arrest through dual mechanism and could improve the immune response of hepatocellular carcinoma*. Cellular & Molecular Biology Letters, 105 (2022).
- [2] Adam M.R. Groh, Nina Caporicci-Dinucci, Brianna Lu, Maxime Bigotte, Elia Afanasiev, Joshua Gertsvolf, Dale J. Hatrock, Victoria Mamane, Sienna Drake, **Huilin Tai**, Jun Ding, Alyson Fournier, Catherine Larochelle, Jo Anne Stratton. *Ependymal cells undergo an astrocyte-like gliosis in response to chronic and acute neuroinflammation*. Journal of Neurochemistry (under review)
- [3] Xiaorong Guo, **Huilin Tai**, Xiaoqing Li, Peng Liu, Jin Liu, Shan Yu *SPARC is a novelty prognostic biomarker for ovarian cancer and associated with immune signatures and drug response*. Clinical and Experimental Obstetrics & Gynecology (accepted)

## Computer Science Research Experience

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McGill University Department of Computer Science (Sep. 2023 - April 2024)

Research Assistant (Supervised by Professor Hamed Hatami)

### Communication Complexity for Hamming Distance Estimation

- Developed a protocol based on a group testing algorithm to estimate the Hamming distance between two n-bit strings and reduced the upper bound of communication complexity from  $O(\log n)$  to  $O(\log \log n)$ .
- Adopted adaptive solutions to improve algorithm efficiency, focusing on randomized algorithms for Hamming distance estimation.

### Excess-Error Dependent Replicability

- Proposed an algorithm for covering hypothesis classes with finite VC dimensions, focusing on accurately approximating real error rates using empirical data.
- Explored the concept of excess-error dependent replicability in agnostic learning, establishing a framework for generating hypothesis lists with guaranteed risk limits.

University at Buffalo (June 2023 - Feb. 2024)

Voluntary Research Assistant

- Advanced the TartanVO model by integrating a Vision Transformer, leveraging deep learning techniques to optimize visual odometry (VO) performance in real-world scenarios to increase the model's adaptability and computational efficiency.
- Employed machine learning algorithms and deep learning architectures to directly incorporate up-to-scale loss functions and camera intrinsic parameters into the TartanVO model. The revised model outperformed existing geometric-based VO methods and demonstrated robust generalization capabilities on real-world datasets.

McGill University Department of Computer Science (Jan. 2023 - Jan. 2024)

Research Assistant (Lab of Professor Jun Ding)

### Unsupervised Learning for Cell Profiling

- Robustly performed data mining and removed batch effects with Harmony, thereby ensuring the data quality and comparability across different experiments or conditions.
- Designed and fine-tuned unsupervised models for clustering based on PCA and UMAP to determine the composition of the PBMCs, to identify potentially pathogenic cell subsets and their associated transcriptional signatures.

### Computational Analysis and Website Enhancement of Cellar (Cooperating with Stratton Lab)

- Improved the data presentation layer of Cellar, a web-based platform for single-cell analysis by adding new features enabling more effective visualization and interpretation of epidermal cell data particularly in the context of neuroimmunological diseases.
- Conducted robust data preprocessing and cleansing operations and employed visualization techniques to present data in an insightful manner, aiding in the exploration and understanding of complex biological interactions.

### Machine Learning Application for Sex Prediction

- Developed machine-learning classifiers for sex prediction based on gene expressions to isolate significant sex markers through advanced feature selection strategies., utilizing xgboost, randomforest, svm, logistic models.

- Achieved a 93.5% accuracy rate in sex prediction with 12 elected features by fine-tuning a multi-layer perceptron neural network through grid search and tailored architecture.

### Deep Learning Model for Spatial Gene Expression Prediction

- Designed a Variational Autoencoder integrated with Stochastic Variational Inference for scalable learning and developed a comprehensive data visualization process to graphically depict the results of a clustering algorithm on scaled tissue images to enhance the understanding of the interaction of genomic features in the physical tissue space.
- Implemented custom Evidence Lower Bound and shift sigmoid transformation functions to optimize model performance.

## Applied Math Research Experience

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**Mcgill University Department of Mathematics and Statistics** (Nov. 2022 - Dec. 2023)

*Research Assistant (Lab of Professor Anmar Khadra)*

### NP Binding Process Quantification:

- Applying probability models to quantify nanoparticle binding dynamics, correlating IFN $\gamma$  dose-response and valence of pMHC, with the resulting models exhibiting strong agreement with experimental data.
- Optimized serial engagement model with Markov chain Monte Carlo Simulation to study the effect of geometry factors on T-cell activation, underscoring the biophysical properties of the agents involved.

### Quantification for Multivalent Nanoparticle T-cell Therapies

- Utilizing mathematical models that employ Poisson and Rayleigh distributions to investigate the selective binding phenomena towards the clustered surface and uniformly distributed tcr surface.
- Designing model calculating binding capacity with randomization algorithm, and perform visualization of binding probability of different surface with respect to tcr distribution.
- Utilizing Monte Carlo simulations to analyze nanoparticle and TCR binding dynamics, incorporating kinetic parameters and spatial considerations.

## Biostatistics Research Experience

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**Mcgill University Faculty of Science** (Jan. 2023 - June 2023)

*Research Mentee (Mcgill DRP program)*

- Applied Bayesian and Generalized Linear models for survival analysis, skillfully managing missing data and improving the detection of individual risk factors.

**Harbin Medical University** (May 2022 - Sep. 2023)

*Research Assistant*

- Developed survival analysis to estimate if targeting uridine-cytidine kinase 2 could improve the immune response of hepatocellular carcinoma. Implemented an interactive monogram with R language for 1-year, 3-year, and 5-year survival analysis.
- Launched a GSEA analysis, processed data with different tumor risk levels to elucidate the enrichment patterns within KEGG and Hallmark pathways, and identified pathways in the order of Normal-TumorLR-Tumor-HR according to the enrichment output.
- Led a pivotal study on the SPARC gene's impact on ovarian cancer prognosis, applied Kaplan-Meier survival analyses, and validated data integrity through log-rank tests.
- Extracted and analyzed data from UCSC XENA and GTEX databases, and correlated SPARC expression with key clinical parameters.

## Honors and Awards

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- Mackey-Glass Summer Research Bursary, Issued by McGill Faculty of Medicine, Apr. 2023
- Hugh Brock Scholarship, Issued by McGill University, Sep. 2020

## Leadership and Extracurricular

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**McGill University** (Sep. 2022 - present)

*Course Assistant*

- Graded assignments for Math235 Algebra, Math240 Discrete Math, and Math356 Honor Probability .

**Simplify McGill** (2020 - 2021)

*Finance Department Member*

- Managed the club budget across multiple departments and led enterprise-sponsored activities.

**4-D English** (2017 - 2019)

*English Volunteer Teacher*

- Coached middle school students to improve English speaking skills, providing personalized learning strategies.