Tianjun Ke

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Education

Renmin University of China   *Sept 2020 - June 2024**

BS in Statistics   *(Expected)*

- **Overall GPA**: 3.95/4.0
- **Ranking**: 1/61

Publications

Revisiting Logistic-softmax Likelihood in Bayesian Meta-Learning for Few-Shot Classification
   Tianjun Ke*, Haoqun Cao*, Zenan Ling, Feng Zhou
   NeurIPS 2023 poster

CLIP as Multi-Task Multi-Kernel Learning
   Yucong Lin*, Tianjun Ke*, Xingpeng Xia, Jiaheng Yin, Jiaxing Xu, Tianxi Cai, Junwei Lu
   Submitted to ICML 2024

Accelerating Convergence in Bayesian Few-Shot Classification
   Tianjun Ke, Haoqun Cao, Feng Zhou
   Submitted to ICML 2024

MIN: Multi-channel Interaction Network for Drug-Target Interaction with Protein Distillation
   Shuqi Li, Shufang Xie, Hongda Sun, Yuhan Chen, Tao Qin, Tianjun Ke, Rui Yan
   Submitted to IEEE/ACM Transactions on Computational Biology and Bioinformatics

* denotes equal contribution

Research Interest

My research interest lies in the intersection of statistics and computer science, focusing on giving statistical analyses of modern learning methods, with application to complex biomedical data. My research topics include machine learning theory, Bayesian statistics, reinforcement learning, and AI4Science.

Research Experience

Accelerating Convergence in Bayesian Few-Shot Classification   *Nov 2023 - Feb 2024*

Core group member, supervised by Prof. Feng Zhou, Renmin University of China

- Objective: Accelerate variational inference for Bayesian Gaussian process classification in bi-level optimization and address the non-conjugacy challenge.
- Introduced variational inference based on mirror descent to GP-based few-shot classification to achieve conjugacy.
- Enhanced the convergence rate with the steepest descent direction along the non-Euclidean manifold via mirror descent.
- Maintained invariance to the parameterization of the variational distribution.
- Conducted extensive experiments on benchmark datasets, and established sota results for classification accuracy and uncertainty calibration.
- Verified accelerated convergence with comparison to vanilla gradient descent method.

Research on In-context Learning (ICL) with Hawkes Process   *July 2023 - Current*

Core group member, supervised by Prof. Junwei Lu, Harvard University

- Objective: Investigate the dynamics of ICL in transformers with a single linear self-attention layer trained by gradient flow in a Hawkes process setting.
- Generalize the continuous-time multivariate Hawkes process to discrete-time to improve the modeling of natural language.
- Prove preliminary results about the gradient flow of the self-attention layer.
- Explore how to control the higher moments of the Hawkes process.

Research on Statistical Inference after Adaptive Sampling in Linear Markov Decision Process (MDP)   *May 2023 - Current*

Core group member, supervised by Prof. Junwei Lu, Harvard University

- Objective: Provide a theoretical foundation for statistical inference in linear MDP and design novel algorithms that exploit the derived normality.
- Prove a series of Law of Large Numbers and Central Limit Theorem for generalized weighted martingale triangular array applicable to linear MDP.
- Derive theoretical analysis for linear MDP in a hypothetical "forward" algorithm.
- Explore how to apply the sub-sampling technique to tackle the dependency of states brought by "backward" Upper Confidence Bound algorithms that use Policy/Value Iteration.

Revisiting Logistic-Softmax Likelihood in Bayesian Meta-Learning for Few-Shot Classification

Feb 2023 - May 2023

Core group member, supervised by Prof. Feng Zhou, Renmin University of China

- Objective: Uncover the theoretical properties of logistic-softmax besides conditional conjugacy in Gaussian process models.
- Introduced logistic-softmax with temperature and proved its unique limiting behavior.
- Theoretically and empirically showed that softmax can be viewed as a particular case of logistic-softmax and logistic-softmax induces a larger family of data distributions than softmax.
- Derived an analytical mean-field approximation for posterior inference through data augmentation.
- Implemented the model in PyTorch, conducted extensive few-shot classification experiments on several benchmark datasets, and established sota results for classification accuracy and uncertainty calibration.

CLIP as Multi-Task Multi-Kernel Learning with Application to Medical Imaging Data and Phecodes

July 2022 - May 2023

Core group member, supervised by Prof. Junwei Lu, Harvard University

- Objective: Provide a theoretical interpretation of CLIP utilizing the Reproducing Kernel Hilbert Space (RKHS) framework.
- Reformulated the notion of CLIP by a solid RKHS framework, reducing the problem of estimating the optimal CLIP mapping ϕ to selecting an optimal RKHS by multiple kernel learning.
- Proved optimal convergence rate of the proposed multi-task multi-kernel estimator.
- Implemented the model in PyTorch and accelerated optimization by block coordinate gradient descent with closed-form updates.
- Conducted extensive simulation experiments for empirical investigation and verification of theoretical properties.
- Aligned the medical imaging data with the clinical codes in electronic health records with the proposed method.

Research on Drug-Target Interaction and Cell Classification

Sep 2022 - Feb 2023

Group member, supervised by Prof. Rui Yan, Renmin University of China

- Objective: Utilize conservation score for automatic residue selection and noise reduction in drug-target interaction.
- Empirically verified that residues in the binding pocket are more conservative than that in the non-pocket area through experiments on the PDBbind v2020 dataset and coauthored a paper submitted to Artificial Intelligence.
- Investigated prospective deep learning methods for cell classification in scRNA-sequencing data, consisting of contrastive learning, hyperbolic learning, and graph neural networks.

Work Experience

China Resources Trust

Jun 2022 - Jul 2022

Intern at Department of Intelligence and Digitalization

Shenzhen, China

- Independently handled the setup of testing environments and the development of application scenarios.
- Developed statistical analysis functionalities and implemented approval workflows on the workflow engine platform.
- Grasped the process management of enterprise-level software development.

Skills

Computer Skills	C/C++, R, Python (DL Framework: Pytorch, Keras; Parallel Computing Framework: Pyspark)
Math Skills	Probability, Statistics, Mathematics Analysis, Linear Algebra, Measure Theory, Real analysis, Point Process, Functional Analysis, Financial Mathematics
Language Skills	Chinese (**Native**), Cantonese (**Native**), English (**GRE** 331+4, **TOEFL** 111), Japanese (**N2**)

Awards

2023	**Bronze Prize in Programming Contest of RUC**, Renmin University of China
2022	**National Scholarship (Awarded to 3 out of 179 candidates)**, China
2022	**National Third Prize in the 12th Market Research and Analysis Competition**, Commerce Statistical Society of China
2021	**Academic Excellence Award (Top 3% GPA)**, Renmin University of China

Service

Lab Mentor

Sep 2022 - Current

MedAI Lab (directed by Prof. Yucong Lin, Beijing Institute of Technology)

Renmin University of China

- Instruct new lab members with basic coding skills in PyTorch and elementary AI and statistical knowledge.
- Design and deliver a series of statistical lectures on machine learning, covering topics such as simulation experiments and learning theory.

Interests

Gender issues	Enthusiast for gender and LGBTQ+ issues; member of RUC Sex & Gender Study Community.
Cinema	Big cinephile; favorite film of all time is *The Lighthouse*; member of RUC Flim Association.