

# Zhiyu Xu

GPA: 3.97/4.00

Weiyang College, Tsinghua University

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## Education

**Tsinghua University**

Mathematics and Physics + Energy and Power Engineering

Sep, 2020 – June, 2024 (expected)

Beijing, China

## Research Experience

**Covariate-assisted Spetrum Estimation for Grade of Membership Model**

May, 2023 – Present

*Advised by Prof. Yuqi Gu, Columbia University*

- Established a non-iterative spectral algorithm for Grade of Membership models
- Derived expectation identifiability for the algorithm and entry-wise estimation guarantee ( $l_\infty$  type bounds), showing the superiority of covariate assistance in both convergence rate and identifiability
- Illustrated the easy achievability of assumptions and the choice of tuning parameter with theoretical support
- Applied to psychometric, educational assessment and scATAC-seq data to show superiority of covariate assistance and computation speed and working on the manuscript

**A Novel Resampling Criterion for Sequential Monte Carlo**

Aug, 2022 – Present

*Advised by Prof. Ke Deng and Dr. Yichao Li, Tsinghua University and Harvard University*

- Established a resampling criterion based on asymptotic variance
- Applied to models including Stochastic Volatility, Gaussian Mixture Models, Particle Markov Chain Monte Carlo and Self-avoiding walks
- Derived the asymptotic variance of any resampling matrix
- Concluded the performance based on theory and simulation results

**Covariate-assisted MLE Estimate of Grade of Membership Models**

Mar, 2023 – May, 2023

*Advised by Prof. Yuqi Gu, Columbia University*

- Added covariate graph regularized terms to incorporate covariate information in likelihood function
- Applied MM algorithm (Majorize-Minimize) to derive the update rule
- Adopted projected gradient descent (PGD) to solve the constrained optimization problem
- Compared the performance of newly derived algorithm with previous likelihood base algorithm

## Related Courses

Real Analysis	A	Logistic Regression (Categorical Data Analysis)	A
Elementary Probability Theory	A	Calculus A(1)	A
Statistical Inference	A, 98	Calculus A(2)	A
Multivariate Statistical Analysis	A+	Linear Algebra	A+
Linear Regression Analysis	A	Mathematical Physics Equations	A
Statistical Computing and Software	A, 99	Introduction to Complex Analysis	A+
Introduction to Bayesian Statistics	A	Introduction to Statistical Learning	A-

Currently taking Convex Optimization, Introduction to Causal Inference, Introduction to Nonparametric Statistics.

## Project Experience

**Popular Words Extraction for US Hit Song Lyrics**

May, 2023 – June, 2023

*Introduction to Statistical Learning*

*Tsinghua University*

- Group project. Proposed the topic of the project and the basic method to accomplish our goal of interpretable learning and cleaned the allocated data
- Performed SVM, word embedding and XGBoost to investigate the potential of decade estimation accuracy of the project, and discussed why SVM and word embedding failed
- Performed LDA, embedded topic models, and BERTopic for unsupervised era division
- Performed regularized Logistic regression for interpretable extraction and wrote my parts in English presented here

**Analysis of how to be a successful Bilibili video blogger**

Oct, 2022 – Jan, 2023

*Logistic Regression (Categorical Data Analysis)*

*Tsinghua University*

- Group project. Proposed basic methods to complete the project and cleaned the allocated data
- Performed  $L_1$  regularized linear regression to identify variables that enjoy stronger expressive power
- Performed log linear and logistic regression on contingency table to identify the effect of category variable
- Performed multiple logistic regression with all variables and compared with multiple linear regression to recognize the effect of discretize response variable

## Analysis of EES consistency in 7 districts of Beijing

Apr, 2022 – June, 2022

### Linear Regression Analysis

Tsinghua University

- Applied entropy weight method to give weight to each variable and performed  $L_1$  regularized multiple linear regression to screen explanatory variables
- Adopted DPSIR analysis to categorize the variables to make concrete conclusion from the perspective of environmental science
- Diagnosed the flaws of multiple linear regression, and made transformations to fulfill normality, and decrease variance inflation factor

## Analysis of gender equality based on economic and religion

Apr, 2022 – June, 2022

### Multivariate Statistical Analysis

Tsinghua University

- Performed EDA including boxplot, scatter plot matrix and direct mapping to identify two major factors in gender equality
- Performed hierarchical clustering and K-means to identify two effects respectively
- Performed MANOVA and CCA to find out the correlation and significance of economic and religion on gender equality

## Awards & Honors

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### Overall Excellence Scholarship

Tsinghua University

### Academic Excellence Scholarship

Tsinghua University

### Philobiblion Scholarship

Tsinghua University

### Excellent Volunteer for Tsinghua University's 110th Anniversary Celebration

Tsinghua University

## Specialized Skills

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**Programming Languages:** R, Python, C++, MATLAB, Pytorch

**Others:**  $\text{\LaTeX}$ , overleaf, git

## Extracurricular Activities

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### Class Monitor

Sep, 2021 – June, 2022

Tsinghua University

- Honored with Outstanding Class Award and Excellent Academic Award
- Collaborated with other classes of different majors in sports activities, ethical discussions and learning activities
- Attained funding from the university that encourage class extracurricular activities

### Member of a Community Service Organization

Oct, 2020 – June, 2022

Tsinghua University

- Arranged volunteer activities that contribute to the bonding between college and high school students
- Organized tutorial classes to prepare students for the volunteer work
- Reorganized the materials needed to submit to make evaluations more truth-oriented

### Class Study Commissioner

Sep, 2020 – June, 2021

Tsinghua University

- Honored with Class Excellent Academic Award
- Organized class learning activities in Calculus, Linear Algebra and Fundamentals of Physics
- Obtained and handed out learning resources to enhance understanding for classmates

## Other Interests

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**Athletics:** Jogging

**Arts:** Reading, films and music, used to play trumpet