Weizheng Zhang

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EDUCATION

School of Mathematics, Sun Yat-sen University *Guangzhou, China*
Bachelor of Science in Mathematics and Applied Mathematics (Second Degree) *Feb. 2016 – present*
Major GPA: 95/100 (130 credits from 34 courses). Ranking is not applicable for the second degree.
Courses: Real Analysis (99), Probability (100), Mathematical Analysis III (97), Geometry and Algebra II (100), Abstract Algebra (99), Functional Analysis (96), Advanced Probability (96), Matrix Analysis (96), Differential Geometry (100), Multivariate Statistics (100), Complex Data Analysis (98), C^{++} (97), Dissertation (A^{+}), etc.

School of Business and Finance, Sun Yat-sen University *Guangzhou, China*
Bachelor of Economics in Finance (First Degree) *Aug. 2013 – June 2017*
Major GPA: 92/100 (106 credits from 39 courses). Rank top 4% in the last three academic years.

PUBLICATIONS AND MANUSCRIPTS

Weizheng Zhang, Liubin Hua and Yongjin Li (2019). On the Hyers-Ulam stability of operator equations in quasi-Banach algebras. *Appl. Math. E-Notes.* 19 141-152. **[link]**
Weizheng Zhang, Zhuoran Yang, Tim Lau and Han Liu. Bregman divergence and generalized entropy regularized two-player zero-sum Markov stochastic games and approximate modified policy iteration. **Manuscript.*
Weizheng Zhang, Zhuoran Yang and Han Liu. Iterative value-aware model learning for approximate modified policy iteration in zero-sum Markov stochastic games with generalized entropy regularization **Manuscript.*
Weizheng Zhang. Missing indexes recovery and the optimality of naive ranking. **Manuscript.*

ACADEMIC EXPERIENCE

Research assistant at Northwestern University *Evanston, IL, U.S.*
Advisor: Professor Han Liu *Fall 2018 – present*

- Research in **regularized Markov stochastic games** (MGs): We proposed to penalize greedy steps generating near-optimal policies with Bregman divergences (BDs) between two consecutive policies, using regularization to encourage exploration and improve robustness, and using approximation to make computation more efficient. We put forward the minimax mirror-descent modified policy iteration for BD-regularized MGs, studied approximate dynamic programming and provided error propagation analysis, by leveraging tools from convex optimization like Legendre-Fenchel transform. I attempted to prove the convergence of regularized value functions to the unregularized optimal value. I derived and proved two lemmas, one is about inequalities relating (un)regularized Bellman operators, the other is about some upper bounds of differences among values of interest. After replacing BDs with generalized entropies, I proposed to introduce time-varying regularization factors. I derived a sufficient condition about the decaying rate of regularization factors that can ensure the boundedness of regret, and therefore can ensure the convergence of regularized value functions to the unregularized optimal value.
- Research in **model-based reinforcement learning**: Inspired by iterative value-aware model learning, we propose a data-driven algorithm for MDPs that incorporates learning transition probability kernels when employing approximate modified policy iteration, where transition kernels are estimated by minimizing empirical risk functions that use the information about value functions. By deriving finite-sample upper bounds for error propagation for both policy evaluation and the control case, I have analyzed how the errors incurred at each iteration propagate throughout the iterations and affect the quality of outcome policies, showing the effect of the number of samples and the complexity of the model on the error bounds. Furthermore, I have extended these results to the scheme of generalized entropy regularized zero-sum Markov games, which is more complex but of greater significance.
- Research in **price-stable cryptocurrency** (PSC): We conducted theoretical analysis of PSCs. Inspired by the DUO model by Steven Kou et al that aims to design a PSC using tools in stochastic differential equations such as the Feynman-Kac representation for diffusion processes, I made various attempts to design a system permitting long-term evolution of type-II or type-III ideal PSCs. I expressed the stochastic representation of the

price into a non-recursive form and derived that it is governed by a periodic PDE with nonlocal terminal and boundary conditions, which has no analytical solutions. I employed an iterative algorithm to find the numerical solutions. This attempt failed, but I developed a general framework for type-II PSCs and theoretically derived the nonexistence of ideal PSCs, showing that there don't exist better designs of PSCs than the DUO model.

· Other topics: variants of iterative shrinkage thresholding algorithm (ISTA) for sparse signal recovery, combinatorial inference for graphical models with applications in brain images, secure multi-party computation (SMPC) with applications in privacy-preserving machine learning, Markov logic networks, simulational inference, etc.

Hyers-Ulam stability of operator equations in quasi-Banach algebras *Guangzhou, China*
Research as part of dissertation in Mathematics, Advisor: Prof. Yongjin Li *Spring 2018*

· I analyzed the Hyers-Ulam stability of typical operator equations in quasi-Banach algebras. I constructed contraction mappings and used fixed-point methods with other tools to prove the results. It's also shown that the stability of operator equations depends heavily on the specified spaces. Link: *Appl. Math. E-Notes* (2019) 141-152.

Time-varying and nonlinear features of volume-price dependence *Guangzhou, China*
Research as part of dissertation in Finance, Advisor: Prof. Fengping Tian *Spring 2017*

· Studied the underlying nonlinear correlation and dynamic patterns in price-volume dependence structures; developed mixed Copula and TVP-VAR models to analyze the nonlinear correlation at tails and dynamic patterns with time-varying coefficients, employed EM algorithm to estimate parameters, etc. The one-way price-to-volume effect dominates the two-way interaction, with dependence structures characterized by an asymmetric pattern with high correlation at upper tails, including both positive and negative dependence.

· This dissertation was honored as distinguished undergraduate dissertation (top 1%) by Sun Yat-sen University.

Selected projects in statistics *Guangzhou, China*
Instructors: Prof. Xueqin Wang and Prof. Hui Huang *2017*

· Evaluation of MLEs for GLMMs: designed and implemented revised Monte Carlo EM and Monte Carlo Newton-Raphson algorithms to evaluate MLEs for GLMMs with latent variables in a clustering problem with missing data, analyzed their convergence properties and employed BFGS algorithm to accelerate the process.

· Forest cover type prediction: used extremely randomized trees and integrated stratified classifiers in supervised multi-class classification problems with categorical predictors and unbalanced data; ranked top 2% on Kaggle.

Teaching assistant at Sun Yat-sen University *Guangzhou, China*
For undergraduate courses: Linear Algebra, Real Analysis, and Financial Engineering *2015 – 2017*

· Sorted out handouts, held office hours, answered questions, and rated homework paper;

· Helped professors proofread and refine their lecture notes, found and fixed more than one hundred errors.

INDUSTRIAL EXPERIENCE

Quantitative Research Intern, *Summer 2016* **Bank of China**, *Guangzhou, China*
Summer Research Intern, *Summer 2015* **JD.com (Jingdong) Inc.**, *Guangzhou, China*

HONORS AND AWARDS

National Scholarship (top 1%), Ministry of Education, P. R. China (No. 201614568) *Dec. 2016*
Distinguished Undergraduate Dissertation Award (top 1%), Sun Yat-sen University, P. R. China *May 2017*
First Prize of Merit Scholarship (top 1%), Sun Yat-sen University, P. R. China *Nov. 2016*
Meritorious Winner of Mathematical Contest in Modeling, COMAP, U.S. *Feb. 2016*
First Prize in National Mathematics Competition, Guangdong, Chinese Mathematical Society *Dec. 2015*
Second Prize of Merit Scholarship (top 5%), Sun Yat-sen University, P. R. China *Nov. 2015*

MISCELLANEOUS

Research Interests High-dimensional statistics, statistical learning, stochastic optimization and control, etc.
Computer Skills R, C^{++}, Python, MATLAB, LaTeX, Microsoft Office, etc.
English Proficiency TOEFL Best Scores: Reading 28, Listening 24, Speaking 22 and Writing 29.