Zhi Zhang Resume

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2022, Fall, domestic

OBJECTIVE

Have intensive and extensive practice in research, self-motivated with high commitment and research aptitude – curious, collaborative, persistent, assertive, and candid, easy-going and love to teach and share. Love math, statistics, optimization, theory, algorithms, and numerical methods.

EDUCATION

Northwestern — PhD of Computer Science
(GPA: On-going) — Evanston, IL 09/21-current

UC-Davis — Master of Statistics (Completed)
GPA 3.77 (Major GPA 3.95) — Davis, CA 10/19 - 08/21

Georgia Tech — Master of Computer Science(Completed)
Specialization: Machine Learning(GPA:3.87) — Atlanta, GA, 09/16- 05/19

China Agricultural University — Bachelor of Food Science and Engineering
The 3 years program with Honor(GPA: 3.65) — Beijing, China 09/06 - 09/2009

SKILLS

Programming: Python/R(8), Matlab(5), C/C++(4), C#Java(5).
Optimization: Mosek, CVX, CPLEX, Gurobi, NEOS Server
Database: SQL(Stored Procedures), Hadoop (HDFS, MapReduce, Hive, Storm, Hbase), Spark (Core, Streaming, MLlib, SQL, GraphX)
Tools: TensorFlow, Pytorch, Keras, Open Gym, Ray RLlib, Flow, OpenCV, Scipy, Entity Framework Core, ASP.NET, AWS (EC2, RDS, DynamoDB)
Simulation Environments: Sumo, continuous large traffic multi-modal traffic simulation environment
RL Environments: Mujoco, Atari Game, RoboCup, StarCraft, Pommerman

PUBLICATIONS

webpage: https://zzh237.github.io/

Zhang, Z. et al. Reinforcement learning under a Multi-agent Predictive State Representation Model: Method and Theory (Got an Averaged Review Score of 8, **ICLR 2022**) link

Zhang, Z., Yang, J., & Zha, H. (2019). Integrating independent and centralized multi-agent reinforcement learning for traffic signal network optimization. *arXiv preprint arXiv:1909.10651*. (Accepted to **AAMAS** 2020) link

Zhang, Z. Few-shot Lifelong Reinforcement Learning with Generalization Guarantees (In submission to **ICML 2022**) link

YANG, L., LI, S., ZHANG, Z., & YANG, X. (2020). Classification of phonocardiogram signals based on envelope optimization model and support vector machine. *Journal of Mechanics in Medicine and Biology*, 1950062. link

Writing Samples

Zhang, Z. Review of Statistical Guarantees for the EM. link

Zhang, Z. Review of Large-dimensional Central Limit Theorem with Fourth-moment Error Bounds on Convex Sets and Balls. link

Zhang, Z., Xiucai D. Mathematical Model of GAN. link

Zhang, Z., Hyojin, K., Allen J., Jones D. Explainable 3D-CNN For Protein-Ligand Binding. (Presentation done at Lawrence Livermore National Lab) link

Other Co-authored Publications see google scholar: https://scholar.google.com/citations?user=0__axAoAAAAJ&hl=en

SCHOOL ACTIVITY

Northwestern 09/21 - Current
Evanston, IL

- Worked on robustness in POMDP under $\epsilon-$ contamination of POMDP
- Independent study project on Algorithm for Large Sparse Covariance Matrix Estimation.
- Conferred Courses: IEMS450 Math-Optimization I, Textbook: Dimitris Bertsimas, Introduction to Linear Optimization (Simplex Method, Geometry of Linear Optimization, Duality Theory, Network Flow, Large Scale Optimization, Integer Optimization, Instructor: Simge Kucukyavuz)
- COMP496 High Dimensional Robust Statistics, (design and analysis of robustness of algorithms for solving the statistical or machine learning problems, such as mean covariance estimation, clustering, matrix completion, classification, under different corruption models like contamination, perturbations, semi-random models, and adversarial perturbations, Instructor: Aravindan Vijayaraghavan)
- On-going courses, (Math-Optimization II, Sta Theory&Methodology, Real Analysis)

UC Davis 09/19 - 08/21
Davis, CA

- Passed two statistics written qualifying exams: Probability Theory and Mathematical Statistics (STA 200, 201), Statistical Methods for Research I, II (STA 206, 207)
- Independent study project on Random Matrix Theory for deep learning representation of data.
- Conferred Courses: STA250 Special Topics - Stein's Method (covered the fundamentals of Stein's method, bounds for distributional approximations and concentration inequalities, some recent analytic and probabilistic advancements in Stein's method, and applications of Stein's method to statistics, machine learning, optimization and sampling. Instructor: Krishna Balasubramanian, Grade:A-)
- STA231C Math Statistics III, High-dimensional statistics, Textbook: Martin Wainwright, High-Dimensional Statistics: A Non-Asymptotic Viewpoint (concentration bounds, uniform law of large numbers, metric entropy, random matrices, and covariance estimation, sparse linear models. Instructor: Miles Lopes, Grade:A)
- MAT258A Numerical Optimization, Textbook: Jorge Nocedal and Stephen J. Wright, Numerical Optimization (gradient method, quasi-Newton method, proximal gradient method,Nesterov's accelerated gradient method, augmented Lagrangian method, alternating direction methodof multipliers, block coordinate descent method, stochastic gradient descent method, Instructor: Shiqian Ma, Grade:B+)
- MAT236A Stochastic Dynamics, Textbook: Bernt Oksendal, Stochastic Differential Equations:An Introduction with Applications. (Ito integrals and formula, chaos expansion, solution methods for SDE, Diffusions and Markov property, Generator, Dynkin formula, Kolmogorov's backward equations, Feynman-Kac formula, Random time change, Girsanov theorem, Dirchlet problem, Poisson problem, Linear filtering , Optimal stopping, Instructor: Alexander Soshnikov, Grade:A)
- MAT150A Modern Algebra I, Textbook: Michael Artin, 2nd edition of Algebra. (Permutations, Subgroups, Homomorphisms, Cosets, Orthogonal matrices, Orbits and stabilizers,Finite groups of motion, Group actions, Conjugation, Sylow subgroups, Free groups, Generators and relations, Grade:S)
- MAT235A Probability theory I, Textbook: R. Durrett, Probability: Theory and Examples 5th edition. (Phd level course, Measure-theoretic foundations, abstract integration, independence, laws of large numbers, characteristic functions, central limit theorems, Instructor: Janko Gravner, Grade:A)

- MAT235B Probability theory II, Textbook: R. Durrett, Probability: Theory and Examples 5th edition. (Phd level course, studied weak convergence in metric spaces, markov chain, martingale, conditional expectation, Brownian motion, Instructor: Janko Gravner, Grade:A)
- STA200B Mathematical statistics, Textbook: M.H. DeGroot and M.J. Shervish: Probability and Statistics. (estimation, bayes, maximum likelihood, sufficient, efficient, unbiased statistics, Instructor: Hans Müller, Grade:A-)
- STA135 Multivariate Data analysis, Textbook: Applied Multivariate Statistical Analysis by Johnson and Wichern. (Matrix Algebra, Sample Mean and Covariance, Population Mean and Covariance, Multivariate Normality, Random Samples, Two Sample Test, Multivariate Linear Regression, Principal Components, Discrimination and Classification. Instructor:Xiaodong Li, Grade:A)
- STA208 Statistical machine learning Textbook: The Elements of Statistical Learning: Data Mining, Inference, and Prediction, by T. Hastie, R. Tibshirani and J. Friedman. (OLS, Matrix Decompositions, Subset selection, Convex optimization, Generative methods, Online learning, stochastic gradient descent, kernel trick, Instructor: James Sharpnack, Grade:A)
- STA243 Computational Statistics: Textbook: Convex Optimization Algorithms by Dimitri P. Bertsekas, 2015. Monte Carlo Strategies in Scientific Computing by Jun Liu, 2004. Computer Age Statistical Inference:Algorithms, Evidence and Data Science by Bradley Efron and Trevor Hastie. (including randomized linear algebra, convex, non-convex optimization, sampling, Instructor: Krishna Balasubramanian, Grade:A)
- ECS271 Machine learning and knowledge discovery,Textbook: Understanding Machine Learning: From Theory to Algorithms, by Shai Shalev-Shwartz and Shai Ben-David. (deep neural networks with unsupervised spectral clustering for generalization and computing, fairness and transparency in machine learning, embedding and transfer learning with SVM, VC-dimension, MCTS with RL, manifold learning, Instructor: Ian Davidson, Grade:A+)
- STA206 Statistical Methods For Research I Textbook: Applied Linear Statistical Models by Kutner, Nachtsheim, Neter and Li. (Least squares principle; Estimation of error variance; Properties of LS estimators; Normal error model; Mean responses estimation; Prediction intervals; Geometric interpretation; Multiple regression models in matrix form; Standardization, correlation transformation; Multicollinearity; Partial correlations; Polynomial regression; Interactions models involving qualitative predictors; model building; Bias-variance trade-off; Criteria for model selection; Model validation; experimental design; Estimation of factor level means, Instructor:Jie Peng, Grade:A-)
- STA207 Statistical Methods For Research II Textbook: Applied Regression Analysis and other Multivariable Methods, by Kleinbaum, D,. Kupper, L. Nizam, A. and Muller, K. Thompson, Brooks-Cole. (linear mixed models, repeated measures, generalized linear models, model selection, analysis of missing data, and multiple testing procedures. Instructor:Shizhe Chen, Grade:A-)
- MATH022 Differential Equations, Textbook: Elementary Differential Equations and Boundary Value Problems, by Boyce/DiPrima 11th Edition. (Ordinary differential equations; Vector differential equations; The existence and uniqueness problem; Introduction to partial differential equations; Laplace transform. Instructor: Becca Thomases, Grade:Audit (AU))
- MAT201B Analysis II, Textbook: Real Analysis by Stein and Shakarchi. (Basic measure and integration theory, Fourier Series, Bounded linear operators on Hilbert spaces and spectral theory Calculus on Banach spaces, Grade:AU)
- MAT201C Analysis III, Textbook: lecture notes. (Four Modes of Convergence, Convergence Relationships, Convergence for Finite Measure Spaces, Dominated Convergence, L^p spaces, Weak L^p Spaces, Approximations of L^p functions, Dual Characterization of L^p, Bounded Linear Functionals on L^p, Weak Convergence, Fundamental Theorem of Calculus for L1 Functions, Calderon-Zygmund Decomposition, Convolution, Sobolev Spaces, Extension and Trace, Sobolev Inequalities, Poincare's Inequality, Morrey's Inequality, Fourier Transform, Schwartz Functions, Tempered Distributions, Grade:AU)
- MAT202 Function Analysis, Textbook: lecture notes. (Banach Spaces Hahn-Banach Theorem, Banach-Steinhaus Theorem, Open Mapping Theorem Geometry of Banach Space Compact Operators Weak Topologies Spectral Theory, Grade:AU)
- MAT206 Measure Theory, Textbook: D. L. Cohn, Measure Theory, 2nd Edition. (measure spaces,The construction of measure spaces from premeasures on algebras, Lebesgue-Stieltjes measures, measurable functions, Lebesgue integral and associated convergence theorems, Convergence in measure; Egoroff's theorem; and Lusin's theorem, Product measures and the Fubini-Tonelli theorem, Signed and complex measures, Radon-Nikodym theorem, Lebesgue differentiation theo-

rem, Functions of bounded variation and the fundamental theorem, the Holder inequality; and L^p duality,Weak L^p spaces and inequalities, Interpolation of L^p spaces, Grade:AU)
- Teaching Assistant for MAT 021 - Calculus at Math Department
- Teaching Assistant for ECS 032A: Introduction to Programming at Computer Science Department
- Visiting to UMD machine learning center (09/20 - 05/21)
- CMSC828W Foundation of Deep Learning (ERM, SGD convergence and its implicit bias, over-parameterization and double descent, Neural tangent kernels, Adversarial attacks and defenses, VAEs, GANs., Min-Max (Convex-Concave), Flow-based models, Domain adaptation and generalization, self-supervised DL, meta-learning, transformers, Explainable DL, Deep RL. I studied this course when I was visiting UMD. Instructor: Soheil Feizi, Grade: A)
- CMSC828U Algorithmic Machine Learning, Guarantees and Analysis (PAC learning basics, and PAC learning in Neural Networks, Boosting and unsupervised boosting, Graphical model basics, Spectral methods, Reinforcement learning. I studied this course when I was visiting UMD. Instructor: Furong Huang, Grade: A+)
- CMSC764 Advanced Numerical Optimization, Textbook: lecture notes. (Banach Spaces Hahn-Banach Theorem, Banach-Steinhaus Theorem, Open Mapping Theorem Geometry of Banach Space Compact Operators Weak Topologies Spectral Theory, Grade: AU)
- MATH674 Partial Differential Equation II, Textbook: lecture notes. sobolev spaces, elliptic equations, parabolic equations, dispersive (hyperbolic) equations , Instructor: Manoussos Grillakis, Grade: AU)
- MATH848C Geometric Structures, Textbook: Moduli spaces of real prrojective structures on surfaces by Alex Casella, Dominic Tate and Stephan Tillmann. (Classical geometries, such as Euclidean geometry, from the viewpoint of transformation groups, the theory of locally homogeneoous geometric structures on manifolds, following Ehresmann, Thurston, hyperbolic geometry, affine geometry, projective geometry and conformal geometry, emphasizing the inter-relationships between these various geometries. Instructor: William Goldman, Grade:AU)
- MATH868C Complex Geometry, Textbook: lecture notes. (maximum principles, Cauchy's formula, Taylor series expansions, the Weierstrass preparation theorems, the coherence theorem of Oka, Remmert's proper mapping theorem and Chow's theorem, the Hartogs phenomenon in C^n, stein manifolds. Instructor: Tamas Darvas, Grade: AU)

Georgia Institute of Technology 09/16 - 05/19
Atlanta, GA

- Worked on Master Thesis of Multi-agent Reinforcement Learning
- Teaching Assistant for CSE6740/ISYE6740/CS7641 Computational Data Analysis/Machine Learning.
- MATH4305 Topics in Linear Algebra, Textbook: Lay-Lay-McDonald, Linear Algebra and its Applications, (Linear algebra in R^n, standard Euclidean inner product in R^n, general linear spaces, general inner product spaces, least squares, determinants, eigenvalues and eigenvectors, symmetric matrices, Grade:AU)
- MATH4640 Numerical Analysis, Textbook: Scientific Computing: An Introductory Survey, Second Edition, Michael T. Heath, (Systems of Linear Equations, Linear Least Squares, Solution of Nonlinear Equations, Interpolation, Numerical Differentiation and Integration, Numerical Solutions of Ordinary Differential Equations, Optimization, Instructor: Prof. Haesun Park, Grade:AU)
- CS7545 Machine learning Theory, (concentration inequalities, uniform deviation bounds, Vapnik-Chervonenkis Theory, Rademacher Complexity, margin bounds, boosting, some theoretical aspects of deep learning, online learning theory, regret minimization, multi-armed bandit algorithms, and connections to convex optimization, Instructor: Prof. Jacob Abernethy, Grade:AU)
- CSE6140 Design and Analysis of Algorithms, I studied: Dynamic Programming, Divide and Conquer, Greedy, Branch and Bound, Integer Programming, Local Search Algorithms, Max Flow. Class project, implemented and improved different algorithms for solving the NP-Complete problem TSP, included the exact algorithms, Branch and Bound and tried different relaxation bound criteria, heuristic approximation algorithms and found the tight lower bound, local search algorithms simulated annealing and tabu search. , Grade:B
- CS7641/ISYE6740 Machine Learning, I learned from concepts and practice of many common machine learning topics, such as Linear regression, Logistic regression, Variable selection, and sparse regression, Classification and regression trees and boosting, Neural networks and deep learning, unsupervised learning, Clustering, GMMs, and EM algorithm, PCA and ICA, latent linear models,

Monte Carlo Method and MCMC, Kernel method, Sequential models: HMM and SSM, Graphical models: Bayesian Networks, MRF, Variational Inference, Grade:A

- CS7642 Reinforcement Learning, I learned TD-learning, a convergence of RL, Algorithmic analysis of VI, DP, and PI, Exploitation, and Exploration, Bandits, Functional Approximation for Generalization in RL, POMDP, EM in RL, Bayesian in RL, PSR, Options in RL, Game Theory. In Projects, I implemented multiple DRL algorithms: Double Q-Learning, Prioritized Experience Replay, Dueling Network Architectures for DQN, Asynchronous Methods, Proximal Policy Optimization Algorithms, DDPG, for guiding a space vehicle to land autonomously in the environment without crashing, by setting up an environment using the OpenAI's Lunar Lander problem, which has an 8-dimensional state space and 4-dimensional action space. Also implemented Correlated-Q Foe-Q Friend-Q and Multiagent Q-learning to study the equilibrium policies on a general-sum Markov game, which is a two-player soccer game environment. Grade:A
- CS8803 Artificial Intelligence for Robotics, studied topics: localization, motion, tracking, image and vision, search, computational geometry, PID Control, recognition, SLAM. Project did: simulated Intelligent Robot Tracking Agent: in course project, I developed a naive, intelligent agent to predict the future trajectory of a Nano robot's dynamic moving position; evaluated multiple training algorithms in Bayesian probabilistic model, linear-Gaussian model (Kalman Filters), sequential Monte Carlo simulation (particle filters), deep learning; reduced video data dimensionality by PCA; tuned hyperparameters and applied bootstrap aggregation with multiple ResNets to do prediction. Grade:A
- CS6476 Computer Vision, topics learned: Image Formation and Filtering, Feature Detection and Matching, Multiple Views and Motion, Recognition and Deep Learning, class project did: activity classification using MHI, I classified different human movements behavior by training video data containing multiple human movements, using the motion history image stack to represent the video data, performed background subtraction, motion history images moments calculation, and applied CNN to train the image moments, then predicted the human behavior from real-world video. Grade:A
- CS7637 Knowledge-Based Artificial Intelligence, through the course, topics I learned: structured Knowledge Representations, Semantic Networks, Production Rules, Frames, Scripts, Constraints, Logic; Planning, Learning, Classification, Diagnosis, Configuration; Reasoning: case-Based, Non-Monotonic, Analogical, Visual Meta. Class projects: I tested approaches to find a human-level, human-like intelligent agent that can answer human intelligence tests such as visual analogy problems based on both verbal and visual representations. Grade:A

PROFESSIONAL EXPERIENCE

Computer Science Research Intern 06/20 - 09/2020
Lawrence Livermore National Laboratory, Livermore, CA

- Investigated 3D-CNN, GCNN, Fusion Model, GAM++ models to model the 3D binding affinity of proteins for drug discovery (Mentor: Kim Hyojin).
- Investigated and implemented deep learning algorithms for high-dimensional protein crystal and docking data

Algorithm Scientist Intern 05/17 - 08/17, 05/18-08/18
Selux Diagnostics Inc., Charlestown, MA

- Worked with two Yale alumni founders, to develop a new generation of patients' antibiotics susceptibility test automation medical device, brought statistical modeling and machine learning algorithms to predict bacteria behavior antibiotics test results, helped with successful 5 million fundraise.
- Participated in building a multi-functional software that embedded the algorithms into the device's system to do seamlessly machine running and prediction using SQL, C# and Matlab/Tensorflow and transmit JSON data through pipe message between the platform of the device.

Data Scientist 01/14 - 07/16
Harvard Medical School, Boston, MA

- Worked with doctor scientists to do statistical research, statistical machine Learning and data mining for healthcare, (Supervisor: Prof. Daniel H. Solomon).
- Participated in research projects: statistical modeling for patient risk prediction, selecting dynamic predictors for drug adherence, score testing, clustering patients-profile, genome-wide association

study from genomic sequencing data, meta-analysis, multi-disease automated phenotyping, modeling of multi-source data and theoretical analysis of statistical learning algorithms, worked on claims, EHR, Nex-gen sequencing, clinical procedures ICD codes data.

Consultant-Data Analysis and Engineering 08/12 - 12/13
Teletech Insights , Burlington, MA

- Developed marketing analytical tools using SQL, and C#.Net framework.
- Applied statistical methods for clustering of customers, revenue forecasting through ARIMAX, classification of buying/not-buying customers by logistic regression.

HONORS

National Scholarship, in recognition of the best student in the major (60) Ministry of Education of China
First Class Scholarship for Academic Excellence, in recognition of the rank first China Agricultural University

Honor class, three years for a four-year program China Agricultural University