

Resume of Hao Sha

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EDUCATION

Xingjian College, Tsinghua University (THU)

Beijing, China

Double Major: (1) Vehicle Engineering (2) Mechanics • GPA: 3.61/4.00

RESEARCH INTEREST

Optimization and Sampling Theory of Machine Learning, Generalization and Safety, Robotics, Autonomous Driving, Reinforcement Learning, AI for Science, and Computer Vision.

PUBLICATIONS AND WORKING PAPERS

- [1] **Hao Sha**, Yao Mu, Yuxuan Jiang, Li Chen, Chenfeng Xu, Ping Luo, Shengbo Eben Li, Masayoshi Tomizuka, Wei Zhan, and Mingyu Ding. “LanguageMPC: Large Language Models as Decision Makers for Autonomous Driving”. **R&R** phase of *IEEE Robotics and Automation Letters (RA-L)*.
- [2] Pengfei Tian*, **Hao Sha***, Jiayun Wu, Yue He, and Peng Cui. “Towards Better Generalization on Test Data with Distributional Uncertainty”. Under review of *IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)*.
- [3] **Hao Sha***, Jingtian Hu*, Pengfei Tian*, Yue He, Chong Chen, Fan Yang, Andre Python, and Peng Cui. “How do Armed Conflict Transfer? Physical Modeling of Spatial Diffusion and Relocation Dynamics in Latent Space”. Under review of *Science Advance*.
- [4] Pengfei Tian*, **Hao Sha***, Yue He, and Peng Cui. “Representative Sampling for Covariate Shift Generalization”. To be submitted to *IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)*.
- [5] **Hao Sha**, Jingtian Hu, Pengfei Tian, Yue He, Chong Chen, Fan Yang, Peng Cui. “Physical Modeling of Spatial Diffusion and Relocation Dynamics of Armed Conflict Prediction”. **Poster** at *The Society for Political Methodology Annual Conference (PolMeth 2024)*.
- [6] **Hao Sha***, Yudong Li*, Adam W Harley, Leonidas Guibas, and Li Yi. “GdNeRF: Generalizable dynamic NeRF”.

RESEARCH EXPERIENCE

Lab of Media and Network, Tsinghua University, Supervised by Prof. Peng Cui

Representative Sampling for Covariate Shift Generalization

Sep. 2024 – Present

- Demonstrated the effectiveness of sample-level covariate decorrelation in addressing Covariate Shift, avoiding the loss of sample size caused by reweighting in the training phase.
- Proposed sampling centrality to ensure the representativeness of data distribution.
- Developed a rejective sampling-based method for arbitrarily distributed unlabeled data, optimizing the balance between decorrelation and sampling centrality.
- Achieved SOTA performance across multiple tabular and biological datasets.
- To be submitted to *TPAMI*.

Towards Better Generalization on Test Data with Distributional Uncertainty

Feb. 2024 – Dec. 2024

- Developed a domain adaptation method addressing Covariate and Concept Shifts using unlabeled test data, applying empirical likelihood to construct distributional uncertainty and adapt perturbed distributions.
- Proved the optimization objective follows a normal distribution centered at the test distribution loss, with variance converging to zero at a rate of $n^{-1/2}$.
- Conducted extensive experiments on real-world tabular benchmarks, vision benchmarks, and biological datasets, demonstrating that our method significantly outperforms baseline approaches in domain adaptation.
- **Under review of *TPAMI*.**

Physical Modeling of Spatial Diffusion and Relocation Dynamics of Armed Conflict

Nov. 2023 – Dec. 2024

- Developed a mathematical model for the transfer of armed conflict, drawing on molecular diffusion theory and political science conflict meta-theory, with a focus on conflict diffusion and aggregation.
- Introduced coupled modeling to account for correlations between conflict factors.
- Embedded the model in deep learning networks to predict armed conflict and incorporated causal modules to eliminate bias from the strong temporal and spatial specificity of conflict data.
- Significantly improved prediction accuracy over baselines, accurately forecasting recent armed conflict hotspots.
- Conducted causal analyses to assess the impact of factors on conflict, offering new insights for conflict management.
- **Under review of *Science Advance*.**

Mechanical Systems Control (MSC) Lab, UC Berkely, Supervised by Prof. Masayoshi Tomizuka**LanguageMPC: Large Language Models as Decision Makers for Autonomous Driving** Jul. 2023 – Sep. 2023

- Developed LanguageMPC, a framework that integrates LLM-based decision-making with the real-time control and robustness of bottom-level controllers.
- Proposed a dual-band system for real-time compliance, enabling MPC to optimize actions under the soft constraints of LLM-generated decisions.
- Outperformed existing methods in key metrics and excelled in complex tasks such as multi-vehicle coordination.
- **R&R phase of RA-L, cited over 120 times on arxiv.**

Institute for Interdisciplinary Information Sciences (IIIS), Tsinghua University, Supervised by Prof. Li Yi & Leonidas Guibas Lab, Stanford University, Supervised by Dr. Adam W Harley**GdNeRF: Generalizable dynamic NeRF** Mar. 2023 – Now

- Proposed a feature-matching approach incorporating motion fields to overcome scene-specific training issues.
- Introduced spatially continuous motion flow to prevent feature mismatches.
- Developed 2.5D scene flow, simplifying model requirements to optical flow and depth differences.
- Developing a dynamic dataset with 10,000+ videos of complex motions, including human body movements.

Learning Neural Implicit Surfaces with Learnable Weight Function Dec. 2022 – Jan. 2023

- Theoretically and experimentally demonstrated the "double peaks of weight" in volume rendering at surface edges.
- Mitigated edge density illusions using the learnable weight function and annealing method.

The Intelligent Vision Group (IVG), Tsinghua University, Supervised by Prof. Jiwen Lu**3D-BERT: Pre-training 3D Point Cloud CNN-Based Models** Aug. 2022 – Dec. 2022

- Developed a coarse-to-fine pretraining method, using teacher model-labeled segments for geometric insights and dynamic mask modeling for detail refinement.
- Improved downstream tasks over SOTA, with 2.4% in classification and 1.2% in segmentation.

G-Diffusion: Diffusion Models for 3D Point Cloud Completion July 2022 - Aug. 2022

- Identified that in point cloud conditional generation, models often ignore conditions due to weak constraints.
- Proposed a new method that aligns Gaussian noise sampling with diffusion results of incomplete point clouds.

Tsinghua Intelligent Connected Vehicle (THICV) Lab, Tsinghua University, Supervised by Prof. Jianqiang Wang**Pedestrian Modeling through Reinforcement Learning** Oct. 2021 – May. 2022

- Developed an RL-based pedestrian control model to evaluate autonomous driving systems under edge cases.
- Developed quantitative metrics to assess pedestrian simulation quality.

SELECTED AWARDS AND HONORS

Fundings: Tsinghua Student Academic Research Advancement Program (5%)	2022, 2023, 2024
Fundings: Top funding of Tsinghua Major Talent Development Program (1/40)	2024
Fundings: Tsinghua Undergraduate Summer Research Program (5%)	2023
Scholarship: Tsinghua Overall Excellence, equivalent to Dean's List (5%)	2022
Scholarship: Tsinghua Overall Excellence (Shenhua Scholarship), equivalent to Dean's List (3%)	2021
Scholarship: Tsinghua Literature and Art Excellence (5%)	2021
Contest: Second Prize in "China Undergraduate Physics Tournament (CUPT)" (5%)	2022
Contest: First Prize in "Tsinghua Theoretical Mechanics Competition" (5%)	2022
Contest: First Prize in "Chinese Mathematics Competitions (CMC)" (1%)	2021
Honorary Title: Member of "Tsinghua Disruptive Innovation Talent Cultivation Program" (0.3%)	2024
Honorary Title: Council Member of "Spark Scientific and Technological Innovation Program" (1/175)	2022
Honorary Title: Council Member of "Heye Innovative Talent Cultivation Program" (3/175)	2021

TECHNICAL SKILLS

Programming	Python, C/C++, Matlab
Simulation Platforms	Blender, SUMO, CARLA
Other Software	Solidworks, AutoCAD, Arduino, Multisim, HighTech

ACTIVITIES AND SERVICES

Director of Event Planning Department of Tsinghua Student Association for Science and Technology
 Monitor of Class Vehivle-0 of Xingjian College, Tsinghua University
 Member of the Sports Team of Xingjian College, Tsinghua University
 Reviewer for KDD 2024, IROS 2024, ICRA 2024