

# SHENGTAI YAO

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## EDUCATION

<b>Johns Hopkins University</b>	Baltimore, MD, United States	8/24-12/25
<i>Master of Science in Engineering in Applied Mathematics and Statistics</i>	GPA: 4.0/4.0	(Expected)
<i>Selected Courses:</i> Introduction to Convexity (A+), Computing for Applied Mathematics (A), Bayesian Statistics (A), (PhD Level): Nonlinear Optimization 2 (A+), Introduction to Control theory and Optimal Control (A), Probability Theory 1		
<i>Master's thesis:</i> Any Dimensional Universality: Invariant and Equivariant Models on Sets, Graphs and Point clouds		
<b>Tsinghua University</b>	Beijing, China	9/19-6/24
<i>Bachelor of Engineering in Mechanical Engineering (Elite Program)</i>	GPA: 3.56/4.0	
<i>Selected Courses:</i> Calculus A1, Calculus A2, Linear Algebra, Advanced Topics in Linear Algebra, Probability and Statistics, Discrete Mathematics 1, Introduction to Complex Analysis, Advanced Python Programming, Deep Learning, Strength of Material, Theoretical Mechanics, Fluid Mechanics		
<i>Honors:</i>	Outstanding Graduation Thesis (Top 5%)	6/24
	Scholarship for Technological Innovation (3%)	11/23
	Scholarship for Academic Performance (10%)	12/20
<i>Undergraduate's thesis:</i> Physics-Informed Neural Networks (PINN) for Multi-Physics Coupling and Deformation Inversion Analysis in Mechanical Seal End Faces		

## PUBLICATIONS & CONFERENCES

- **S. Yao**, Y. Wu, R.H. Taylor, E.M. Bector, *Boost Calibration for Dual-Arm Co-Robotic Ultrasound System*. **2025 IEEE International Ultrasonics Symposium (IUS)**, Accepted
- **S. Yao**, W. Huang, Y. Hu, Q. He, *Boundary Region Reinforcement Physics-Informed Neural Networks for PDEs solving*. **Engineering Applications of Artificial Intelligence (EAAI)**, Under reviewed
- **S. Yao**, H. Li, X. Hu, K. Hermann, K. Zhang, Y. Li, M. Li, *Identifying Traffic Risk Hotspots Using Spatial-temporal Network Kernel Density Estimation: A Novel Optimal Parameter Selection Method with Dual Dataset Validation*. TRB 103th Annual Meeting. **Transportation Research Board (TRB)**, Poster Presented

## PATENTS

- Y. Liu, J. Yang, Z. Guo, **S. Yao**, J. Xiang, B. Luo, S. Ruan, *Science popularization exhibits used to showcase vibration phenomena and vibration influencing factors*, CN Patent 2023235678170, Jul 23, 2024.
- J. Yang, Q. Wu, Z. Xu, Z. Ning, F. Meng, **S. Yao**, Y. Liu, S. Pan, *Science Popularization Display Device for The Principle of Space Station Robotic Arm*, CN Patent 202222928298.5. Mar 24, 2023.

## RESEARCH AT JOHNS HOPKINS UNIVERSITY

<b>Any Dimensional Universality: Invariant and Equivariant Models on Sets, Graphs and Point clouds</b>	4/25-current
<i>Advisor:</i> Assistant Professor Mateo Díaz, Department of Applied Mathematics and Statistics	(Master's thesis)
<ul style="list-style-type: none"><li>• Conducted literature review on equivariant machine learning and neural network universality</li><li>• Strengthened theoretical foundations in abstract algebra (Artin) and functional analysis (Rudin)</li><li>• Proved the universal approximation capability of DeepSet architecture (invariant) for any-dimensional sets (limit space)</li><li>• Ongoing work: establishing the invariant universality for graphs and point clouds; developing theoretical tools to address the equivariant case</li></ul>	
<b>Finite-Sample Guarantees for Causal Distributionally Robust Optimization</b>	4/25-current
<i>Advisor:</i> Assistant Professor Luhao Zhang, Department of Applied Mathematics and Statistics	
<ul style="list-style-type: none"><li>• Reviewed statistical learning theory tools including Rademacher complexity and covering numbers</li><li>• Reviewed finite-sample guarantees in Wasserstein Distributionally Robust Optimization (DRO)</li><li>• Ongoing work: extending the finite-sample guarantee to Causal Distributionally Robust Optimization</li></ul>	
<b>Boost Calibration for Dual-Arm Co-Robotic Ultrasound System</b>	10/24-2/25
<i>Advisor:</i> Postdoc Yixuan Wu, Department of Computer Science	
<ul style="list-style-type: none"><li>• Proposed a new method, Boost Calibration, for accurately calibrating dual-arm robotic systems by solving the nonlinear equation <math>AXt_1 = YCZt_2</math> in SE(3)</li><li>• Developed a robust and efficient error estimation method for dual-arm robot simulation</li><li>• Performed simulations to demonstrate its applicability to ultrasound tomography</li></ul>	

## Bayesian Statistics Coursework Project: Bayesian Hierarchical Spatial Modeling for Photoacoustic Spectral Unmixing 4/25

- Developed a Bayesian hierarchical spatial model based on the Conditional Autoregressive (CAR) to incorporate spatial smoothness into photoacoustic spectral unmixing
- Derived full conditional distributions and implemented Gibbs sampling with KDE for posterior inference
- Achieved smoother and more biologically consistent concentration maps while preserving model interpretability

## RESEARCH AT TSINGHUA UNIVERSITY

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**Physics-Informed Neural Networks (PINN) for Multi-Physics Coupling and Deformation Inversion** 10/23-7/24  
**Analysis in Mechanical Seal End Faces** <https://github.com/Yaoshengtai/BRR-PINNs.git> (Undergraduate's thesis)

*Advisor: Assistant Researcher Qiang He, Department of Mechanical Engineering*

- Developed new method BRR-PINNs to more accurately satisfy boundary conditions and to deliver higher precision in solutions and built ground truth dataset using COMSOL
- Validated BRR-PINNs in thermo-elastic coupling problem, obtaining relative  $L_2$  error of  $\mathcal{O}(10^{-5})$  for heat transfer and  $\mathcal{O}(10^{-4})$  for deformation
- Performed inverse calculation predicting physical state of seal faceplate with accuracy of  $\mathcal{O}(10^{-2})$
- Developed PINNs open-source computing software based on Pytorch

**Data-Driven Urban Traffic Risk Analysis** <https://github.com/HuXiao-THU/Traffic-risk-detection.git> 9/22-12/23

*Advisor: Professor Meng Li, Department of Civil Engineering, Dean of Tsinghua-Benz Institute*

- Utilized Spatial-temporal Network Kernel Density Estimation (ST-NKDE) method to estimate risk distribution on road networks, visualizing results
- Proposed novel method based on Kullback-Leibler (KL) divergence for calculating optimal bandwidth in kernel density estimation, enhancing result reliability
- Collaborated with Mercedes to develop visualization website to showcase results

## EXTRACURRICULAR ACTIVITIES

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**Algorithm Training Program, Tsinghua University**

*Trainee* 7/22

**Study Group of Technology Association, Department of Mechanical Engineering, Tsinghua University**

*Group Head* 2/20-6/21

**Chinese Calligraphers Association of Shenyang, Liaoning, China**

*Member* 7/19

## SKILLS

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Computer Languages: C++(Proficient), Python(Proficient), and R(Proficient)

Software: Solidworks (Proficient), AutoCAD (Proficient), and COMSOL (Proficient)