Wenhan (Winston) Cao

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RESEARCH INTERESTS

My research focuses on bridging the theory of learning and control, with the goal of building trustworthy autonomous systems. In simple terms, I explore how AI can enhance control systems to provide greater efficiency, while using control theory to ensure that AI systems are guaranteed to perform reliably.

EDUCATION

Tsinghua University September 2019-Present
Ph.D student in Intelligent Vehicle Engineering *Beijing, China*
Supervisor: Dr. Shengbo Eben Li, Professor of Intelligent Driving Laboratory
Co-supervisor: Dr. Chang Liu, Assistant Professor of Autonomous Robots Lab

University of Manchester *January 2023-June 2024*
Visiting Ph.D. Student in Computer Science *Manchester, UK*
Supervisor: Dr. Wei Pan, Senior Lecturer of Robotics and Embodied AI Lab

Technical University of Munich *September 2023-December 2023*
Visiting Ph.D. Student in Control and Optimization *Munich, Germany*
Supervisor: Dr. Sandra Hirche, Professor of Chair of Information-Oriented Control

Beijing Jiaotong University *September 2015-June 2019*
Bachelor of Electrical Engineering *Beijing, China*
GPA ranking: 1/305

SELECTED PUBLISHED PAPERS

Wenhan Cao, Chang Liu, Zhiqian Lan, Shengbo Eben Li, Wei Pan & Angelo Alessandri. *Robust Bayesian Inference for Moving Horizon Estimation.* To Appear in Automatica. [Paper] [Code]

Wenhan Cao & Wei Pan (2024). *Impact of Computation in Integral Reinforcement Learning for Continuous-Time Control*. In 2024 International Conference on Learning Representations (ICLR). **(Spotlight)** [Paper] [Poster] [Code]

Wenhan Cao, Alexandre Capone, Rishabh Yadav, Sandra Hirche & Wei Pan. *Computation-Aware Learning for Stable Control with Gaussian Process.* In 2024 Robotics: Science and Systems (RSS). [Paper] [Poster] [Recording]

Jingliang Duan, **Wenhan Cao**, Yang Zheng & Lin Zhao. *On the Optimization Landscape of Dynamic Output Feedback Linear Quadratic Control*. IEEE Transactions on Automatic Control (TAC), 69(2):920–935, 2024. **(Regular Paper)** [Paper] [Code]

Shiqi Liu, **Wenhan Cao**, Chang Liu, Tianyi Zhang & Shengbo Eben Li. *Convolutional Unscented Kalman Filter for Multi-Object Tracking with Outliers*. IEEE Transactions on Intelligent Vehicles (TIV), pp. 1–12, 2024. [Paper]

Wenhan Cao, Chang Liu, Zhiqian Lan, Yingxi Piao & Shengbo Eben Li. *Generalized Moving Horizon Estimation for Nonlinear Systems with Robustness to Measurement Outliers*. In 2023 American Control Conference (ACC). [Paper] [Code] [Slides]

Wenhan Cao, Jingliang Duan, Shengbo Eben Li, Chen Chen, Chang Liu, & Yu Wang. *Primal-Dual Estimator Learning Method with Feasibility and Near-Optimality Guarantees*. In 2022 IEEE Conference on Decision and Control (CDC). [Paper] [Slides]

Wenhan Cao, Jianyu Chen, Jingliang Duan, Shengbo Eben Li & Yao Lyu. *Reinforced Optimal Estimator*. In 2021 Modeling, Estimation and Control Conference (MECC). **(Student Best Paper Finalist)** [Paper] [Slides]

SELECTED PREPRINTS **(* denotes equal contribution)**

Wenhan Cao, Shiqi Liu, Chang Liu, Zeyu He, Stephen S.-T. Yau & Shengbo Eben Li. *Convolutional Bayesian Filtering*. Submitted to IEEE Transactions on Automatic Control. [Paper] [Slides]

Wenhan Cao, Tianyi Zhang, Zeju Sun, Chang Liu, Stephen S.-T. Yau & Shengbo Eben Li. *Nonlinear Bayesian Filtering with Natural Gradient Gaussian Approximation*. Submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence. [Paper] [Code] [Slides]

Shiqi Liu*, **Wenhan Cao***, Zeyu He, Chang Liu, Tianyi Zhang & Shengbo Eben Li. *One Filters All: A Generalist Filter For State Estimation*. Submitted to ICML 2025.

Tianyi Zhang, **Wenhan Cao**, Chang Liu, Tao Zhang, Jiangtao Li & Shengbo Eben Li. *Robust State Estimation for Legged Robots with Dual Beta Kalman Filter*. Submitted to IEEE Robotics and Automation Letters. [Paper]

HONORS & AWARDS

Study Abroad Fund from Tsinghua University	2022
Student Best Paper Finalist of Modeling, Estimation and Control Conference	2021
China National Scholarship	2016
The First Prize Scholarship from Beijing Jiaotong University	2016, 2017 & 2018

SOFTWARE

I contributed to the General Optimal Control Problem Solver (GOPS), an easy-to-use reinforcement learning (RL) solver package designed to build real-time, high-performance controllers for industrial applications. I was primarily responsible for the core design and implementation of the trainer, sampler, and buffer modules. [Docs] [Paper]

INVITED TALKS & CONFERENCES PRESENTATIONS

NANO filter: Bayesian Filtering with Natural Gradient Gaussian Approximation at the Department of Astronomy, Tsinghua University, Beijing, China, hosted by Prof. Zheng Cai, August 2024.

Convolutional Bayesian Filtering at the Department of Mathematical Sciences, Tsinghua University, Beijing, China, hosted by Prof. Stephen Shing-Toung Yau, February 2024.

Generalized Moving Horizon Estimation for Nonlinear Systems with Robustness to Measurement Outliers in 2023 American Control Conference, San Diego, CA, USA (Oral Presentation), May 2023.

Learning-based state estimation methods at the Technical University of Munich, Munich, Germany (Online Presentation), hosted by Prof. Sandra Hirche, February 2023.

Primal-Dual Estimator Learning Method with Feasibility and Near-Optimality Guarantees in 2022 IEEE 61st Conference on Decision and Control, Cancún, Mexico (Oral Presentation), December 2022.

Reinforced Optimal Estimator in 2021 IFAC Modeling, Estimation and Control Conference, Texas, USA (Oral Presentation), October 2021.

Accelerated Inverse Reinforcement Learning with Randomly Pre-sampled Policies for Autonomous Driving Reward Design in 2019 IEEE Intelligent Transportation Systems Conference, Auckland, New Zealand (Oral Presentation), October 2019.

PROFESSIONAL SERVICES

Conference Reviewer: CDC, ACC, L4DC, ICLR, AAMAS & IFAC NMPC
Journal Reviewer: TASE, TITS, TNNLS & RA-L