

# Wenhan (Winston) Cao

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## RESEARCH INTERESTS

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My research interests are optimal control and estimation using Bayesian machine learning, with applications to autonomous vehicles and robots.

## EDUCATION

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**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 PREPRINTS

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**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](#)]

## SELECTED PUBLISHED PAPERS

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**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](#)]

## HONORS & AWARDS

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*Student Best Paper Finalist of 2021 Modeling, Estimation and Control Conference*, Texas, USA, 2021

*National Scholarship*, Beijing, China, 2016

*The First Prize Scholarship*, Beijing, China, 2016 – 2018

## SOFTWARE

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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

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*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

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**Conference Reviewer:** CDC, ACC, L4DC, ICLR, AAMAS & IFAC NMPC

**Journal Reviewer:** TASE, TITS, TNNLS & RA-L