Zhuo Ouyang

+86 177-7146-8148 | 2200011199@stu.pku.edu.cn | HomePage
3501 Saint Paul St., Baltimore, MD 21218, USA

Education

- **Peking University** *Sep. 2022 - Jun. 2026*
  B.E. in Robotics Engineering Beijing, China
  - GPA: 3.86/4.00 (Grades in Major Courses: 93.5/100)
  - **Rank: 1/26 in Robotics Engineering and Top 5%/156 in College of Engineering**
- **Johns Hopkins University** *Oct. 2025 - Feb. 2026*
  Visiting Research Student Advised by Prof. Enrique Mallada Baltimore, MD, U.S.

Research Interests

- Self-Supervised Learning (Contrastive Learning)
- Safe Reinforcement Learning
- Transfer Learning
- Data-Drive Learning and Control in Nonlinear Systems

Honors and Awards

- **Award for Academic Innovation, College of Engineering, Peking University (top 1%)** *2025*
- **China National Scholarship (Top Undergraduate Student Award)** *2025*
- **Beijing Natural Science Foundation Start-up Fellowship (Chinese Yuan 50,000)** *2025*
- **Merit Student Pacesetter, Peking University** *2025*
- **Peking University Students of the Year Finalist (20 Candidates, Most Prestigious Award for All University Students)** *2024*
- **Merit Student Pacesetter, Peking University** *2024*
- **China National Scholarship (Top Undergraduate Student Award)** *2024*
- **The First Prize in the Final Round of Chinese National College Mathematics Competition (Top 20 among all Participants)** *2024*
- **The First Prize in Preliminary Round of Chinese National College Mathematics Competition (Non-Mathematics Major, Top 0.05% in Beijing)** *2023*
- **First Prize in Chinese National College Physics Competition (Top 1%)** *2023*
- **Merit Student, Peking University** *2023*
- **Third Prize Scholarship for Freshman of Peking University** *2022*

Publications and Preprints

- **Z. Ouyang**, K. Hu, Q. Zhang, Y. Wang, and Y. Wang. **Projection Head is Secretly an Information Bottleneck.** (ICLR 2025)
- Learning to Act in Hamiltonian Systems via Recurrent Expert Demonstrations: Ongoing work

Research Experiences

- **Projection Head is Secretly an Information Bottleneck** *Apr. 2024 - Jan. 2025*
  ***Advisor**: Prof. Yisen Wang, School of Artificial Intelligence, Peking University*
  - We develop a new theoretical understanding for the role of the projection head in contrastive learning from the **information-theoretic perspective**. Mathematically, we rigorously derive both **lower and upper bounds for the downstream performance** of the features preceding the projection head.
  - Our findings indicate theoretical principles for designing an effective projection head: it should act as an **information bottleneck**, filtering out the irrelevant information and preserving the essential information for the contrastive objective.

◦ Based on theoretical principles, we propose two categories of methods to improve projection head design, namely **training regularization** and **structural regularization**, that outperform previous approaches across a range of datasets and contrastive methods.

- **Safe RL based Transfer Learning to Enhance Sample Efficiency**

  Advisor: *Prof. Pengcheng You, Department of Industrial Engineering and Management, Peking University* March 2025 - Present

  ◦ We apply the **upper confidence bound value iteration** (UCBVI) method to safe reinforcement learning settings. In this way, we extend prior work on safe RL from a generative-learning setting to an online-learning paradigm, making the approach better suited to real-world deployment.

  ◦ We generalize **transfer learning paradigm** to safe RL settings, utilizing offline dataset from source environment to **enhance sample efficiency** in target environment with shifted dynamics.

  ◦ Furthermore, we conduct numerical experiments on transfer safe RL settings to demonstrate reduction of sample complexity.

- **Data-Driven Learning and Control in Hamiltonian Systems** *July 2025 - Present*

  Advisor: *Prof. Enrique Mallada, Electrical and Computer Engineering, Johns Hopkins University*

  ◦ We propose a method for **data-driven reachability and stabilizability of Hamiltonian systems**, namely **Nonparametric Chain Policies** (NPC).

  ◦ We demonstrate that the NPC control can **break the exponential dependence on dimensionality**, which is more effective than canonical imitation learning and scalable to large state spaces.

  ◦ By leveraging recurrence property in Hamiltonian systems, we aim to show that trajectories that temporarily leave well-covered regions return to data-supported subsets sufficiently often, enabling reliable control and improved **generalization beyond the data-covered area**.

Selected Technical Projects

- **F1TENTH Autonomous Racing Competition in CDC 2024** *Oct 2024 - Dec 2024*

  Advisor: *Prof. Pengcheng You, Department of Industrial Engineering and Management, Peking University*

  ◦ We develop and validate a full autonomy stack for the 1:10-scale race car in the **F1TENTH ROS2 system**, integrating sensing with perception, planning, and control to avoid crashing and minimize lap time.

  ◦ We implement the safe reinforcement learning algorithm (via a **primal-dual saddle-point** method) and integrate it with nonlinear MPC, which could learn optimal policies without crashing into obstacles and control the vehicle in real time.

Extra Personal Background and Convictions

- **Volunteer:** As a hearing-impaired individual who relies on hearing aids daily, I often volunteer with organizations supporting people with disabilities.
- **Convictions: Modern AI technologies can improve the hearing aids** – for example, enabling hearing aids to better enhance the voice a user intends to focus on while decreasing irrelevant background noise. This would address a major limitation of current hearing aids, especially in noisy and multi-speaker environments (at least from my own perspective). Although my previous research has not focused directly on this area, conversations with engineers working on assistive devices have motivated me to think and explore how AI-driven methods could meaningfully benefit people with disabilities.

Leadership and Teaching Experiences

- **Leadership:** President of the External Relations Department, Peking University College of Engineering Student Union
- **Teaching Assistant:** Mathematical Analysis, Linear Algebra and Geometry, Probability and Mathematical Statistics
- **Speech:** Delivering Speech on the 2025 Opening Ceremony of College of Engineering, Peking University (as the Senior Undergraduate Representative).

Professional Skills

- **Programming Languages:** Python (Pytorch), MATLAB, C, C++, R
- **Engineering Software Skills:** SolidWorks, Simulink, ROS 2
- **Sports:** Athletics (Sprints, Middle-Distance Running), Table Tennis, and Badminton
- **TOEFL:** Total 105, Reading 29, Listening 27, Speaking 23, Writing 26