Dr. Panpan Cai

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I am a roboticist. I have been conducting active research in decision making under uncertainty, robot learning, and integrating them to solve complex real-world robotics problems. My research vision is to enable robots to operate efficiently in large-scale, dynamic, and uncertain environments like humans, and accomplish challenging tasks. I currently hold a Full-time Faculty appointment at the Shanghai Innovation Institute and an Associate Professorship at the School of Artificial Intelligence, Shanghai Jiao Tong University, where I lead the Robot Planning and Learning (RoPL) Lab.

Education

Nanyang Technological University **Singapore**
Doctor of Philosophy *2011.8–2016.7*
Research on robotic motion planning, collision detection, and GPU computing.

Zhejiang University **Hangzhou, China**
Bachelor's Degree in Mathematics (Information and Computing Science) *2007.8–2011.6*
Top student selected into the Chu Kochen Honors College. Trained in mathematics, scientific computing, and Computer Aided Geometric Design (CAGD).

Professional Experience

Shanghai Innovation Institute (SII) **Shanghai, China**
Full-time Faculty *2024.9–now*
- Foundation models for robot planning;
- Open-world robot planning and embodied AI;
- Mobile manipulation for home-service robots.

School of Artificial Intelligence, Shanghai Jiao Tong University **Shanghai, China**
Associate Professor *2025.1–now*
- Lead the Robot Planning and Learning (RoPL) Lab;
- Research scope: integrating planning and learning, planning under uncertainty, mobile manipulation, autonomous driving;
- Supervising PhD and master students.

Qing Yuan Research Institute, Shanghai Jiao Tong University **Shanghai, China**
Associate Professor *2022.8–2025.1*
- Started my own research group on robot intelligence;
- Research scope: robot learning, robot decision making, reinforcement learning, integrating planning and learning;
- Application domains: autonomous driving and home-service robots.

Department of Computer Science, National University of Singapore **Singapore**
Senior Postdoctoral Research Fellow *2021.12–2022.1*
- Conducted independent research and led research projects on integrating planning with reinforcement learning;
- Published in top robotics venues including T-RO, RA-L, RSS, and ICRA;
- Mentored an undergraduate for an award-winning final-year project, master students, and research interns;
- Main organizer of an international workshop at RSS 2021;
- Taught two lectures in a graduate-level robotics class on POMDP planning, robot systems, and autonomous driving.

Department of Computer Science, National University of Singapore **Singapore**
Postdoctoral Research Fellow *2017.2–2021.12*
- Conducted independent research on decision making under uncertainty, integrating planning and learning, and autonomous driving in crowded environments;
- Published in top robotics venues including IJRR, RA-L, RSS, ICRA, and IROS;
- Mentored PhD, undergraduate, and intern students for independent research;
- Taught a lecture in a graduate-level robotics class on sampling-based motion planning.

School of Mechanical and Aerospace Engineering, Nanyang Technological University **Singapore**
PhD student *2011–2016*
- Independent research on parallel collision detection and motion planning in large-scale industrial environments;
- Published in tier-one journals on industrial applications of robotics and automation;
- Close collaboration with a listed lifting service company;
- Filed a patent on intelligent crane-lifting systems;
- Taught an undergraduate-level lab project.

Awards & Honors

- **Best Paper Award Finalist**, Conference on Robot Learning (CoRL), 2022, for "LEADER: Learning Attention over Driving Behaviors for Planning under Uncertainty" (oral acceptance rate ∼6.5%).
- **Best Paper Award**, 2013 Symposium on GPU Computing and Applications (co-organized by NVIDIA), for "A GPU-enabled parallel genetic algorithm for path planning".

Publications

(*) denotes co-first author. Where I am the corresponding author, this is indicated explicitly.

Peer-reviewed journal papers:

- X. Jin, C. Zeng, S. Zhu, C. Liu, P. Cai (corresponding author). Hi-Drive: Hierarchical POMDP Planning for Safe Autonomous Driving in Diverse Urban Environments. *IEEE Robotics and Automation Letters (RA-L)*, 2025.
- P. Cai and D. Hsu. Closing the Planning-Learning Loop with Application to Autonomous Driving in a Crowd. *IEEE Transactions on Robotics (T-RO)*, 2023, DOI:10.1109/TRO.2022.3210767.
- Y. Luo*, P. Cai* (co-first and corresponding author), Y. Lee, D. Hsu. GAMMA: A General Agent Motion Model for Autonomous Driving. *IEEE Robotics and Automation Letters (RA-L)*, 2022, DOI:10.1109/LRA.2022.3144501.
- P. Cai, Y. Luo, D. Hsu, W.S. Lee. HyP-DESPOT: A Hybrid Parallel Algorithm for Online Planning under Uncertainty. *International Journal of Robotics Research (IJRR)*, 2021, DOI:10.1177/0278364920937074.
- Y. Luo, P. Cai, A. Bera, D. Hsu, W.S. Lee, D. Manocha. PORCA: Modeling and Planning for Autonomous Driving among Many Pedestrians. *IEEE Robotics and Automation Letters (RA-L)*, 2018, DOI:10.1109/LRA.2018.2852793.
- P. Cai, Y. Cai, I. Chandrasekaran, J. Zheng. Automatic Path Planning for Dual-Crane Lifting in Complex Environments Using a Prioritized Multi-objective PGA. *IEEE Transactions on Industrial Informatics (TII)*, 2017, DOI:10.1109/TII.2017.2715835.
- P. Cai, Y. Cai, I. Chandrasekaran, J. Zheng. Parallel GA Based Automatic Crane Lifting Path Planning in Complex Environments. *Automation in Construction (AIC)*, 2016, DOI:10.1016/j.autcon.2015.09.007.

Peer-reviewed conference papers:

- R. Huang, C. Zeng, W. Tang, J. Cai, C. Lu, P. Cai (corresponding author). Mimic Intent, Not Just Trajectories. *Robotics: Science and Systems (RSS)*, 2026.
- X. Jin, Y. Dong, B. Sun, H. Xu, Z. Hao, X. Lang, P. Cai (corresponding author). Vec-QMDP: Vectorized POMDP Planning on CPUs for Real-Time Autonomous Driving. *Robotics: Science and Systems (RSS)*, 2026.
- W. Tang, X. He, Y. Huang, Y. Xiao, C. Lu, P. Cai (corresponding author). Tru-POMDP: Task Planning Under Uncertainty via Tree of Hypotheses and Open-Ended POMDPs. *Advances in Neural Information Processing Systems (NeurIPS)*, 2025.
- H. Ye, Y. Xiao, C. Lu, P. Cai (corresponding author). UniDomain: Pretraining a Unified PDDL Domain from Real-World Demonstrations for Generalizable Robot Task Planning. *Advances in Neural Information Processing Systems (NeurIPS)*, 2025.
- J. Yu*, H. Liu*, Q. Yu*, J. Ren, C. Hao, H. Ding, G. Huang, G. Huang, Y. Song, P. Cai, W. Zhang, C. Lu. ForceVLA: Enhancing VLA Models with a Force-aware MoE for Contact-rich Manipulation. *Advances in Neural Information Processing Systems (NeurIPS)*, 2025.
- S. Wang, Z. Fei, Q. Cheng, S. Zhang, P. Cai, J. Fu, X. Qiu. World Modeling Makes a Better Planner: Dual Preference Optimization for Embodied Task Planning. *Annual Meeting of the Association for Computational Linguistics (ACL)*, 2025.
- P. Tran*, H. Wu*, C. Yu*, P. Cai, S. Zheng, D. Hsu. What Truly Matters in Trajectory Prediction for Autonomous Driving? *Advances in Neural Information Processing Systems (NeurIPS)*, 2023.
- M.H. Danesh*, P. Cai* (corresponding author), D. Hsu. LEADER: Learning Attention over Driving Behaviors for Planning under Uncertainty. *Conference on Robot Learning (CoRL)* (Best Paper Finalist), 2022, PMLR 205:199–211.
- Y. Lee, P. Cai, D. Hsu. MAGIC: Learning Macro-Actions for Online POMDP Planning using Generator-Critic. *Robotics: Science & Systems (RSS)*, 2021, DOI:10.15607/RSS.2021.XVII.041.
- P. Cai* (co-first author), Y. Lee*, Y. Luo, D. Hsu. SUMMIT: A Simulator for Urban Driving in Massive Mixed Traffic. *International Conference on Robotics and Automation (ICRA)*, 2020, DOI:10.1109/ICRA40945.2020.9197228.
- M. Meghjani, Y. Luo, Q.H. Ho, P. Cai, S. Verma, D. Rus, D. Hsu. Context and Intention Aware Planning for Urban Driving. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2019, DOI:10.1109/IROS40897.2019.8967873.
- P. Cai, Y. Luo, A. Saxena, D. Hsu, W.S. Lee. LeTS-Drive: Driving in a Crowd by Learning from Tree Search. *Robotics: Science & Systems (RSS)*, 2019, DOI:10.15607/RSS.2019.XV.018.
- P. Cai, Y. Luo, D. Hsu, W.S. Lee. HyP-DESPOT: A Hybrid Parallel Algorithm for Online Planning under Uncertainty. *Robotics: Science & Systems (RSS)*, 2018, DOI:10.15607/RSS.2018.XIV.004.
- L. Huang, Y. Zhang, J. Zheng, P. Cai, S. Dutta, Y. Yue, N. Thalmann, Y. Cai. Point cloud based path planning for tower crane lifting. *Computer Graphics International Conference (CGI)*, 2018, DOI:10.1145/3208159.3208186.

- P. Cai, Y. Cai, I. Chandrasekaran, J. Zheng. A GPU-enabled parallel genetic algorithm for path planning. 2013 Symposium on GPU Computing and Applications (Best Paper Award), 2013, DOI:10.1007/978-981-287-134-3_1.

Preprints (under review):

- Y. Huang, Z. Wang, W. Tang, C. Lu, P. Cai (corresponding author). I-Perceive: A Foundation Model for Vision-Language Active Perception. *arXiv preprint*, 2026.
- Z. Liu, Y. Li, R. Huang, C. Lu, P. Cai (corresponding author). Any House Any Task: Scalable Long-Horizon Planning for Abstract Human Tasks. *arXiv preprint*, 2026.
- H. Ye, Y. Xiao, C. Lu, P. Cai (corresponding author). UniPlan: Vision-Language Task Planning for Mobile Manipulation with Unified PDDL Formulation. *arXiv preprint*, 2026.
- Y. Lu, Y. Ma, D. Hsu, P. Cai (corresponding author). Neural Randomized Planning for Whole Body Robot Motion. *arXiv preprint*, 2024.
- R. Zhang, J. Hou, F. Walter, S. Gu, J. Guan, F. Röhrbein, Y. Du, P. Cai, G. Chen, A. Knoll. Multi-Agent Reinforcement Learning for Autonomous Driving: A Survey. *arXiv preprint*, 2024.
- H. Cao, Z. Zhang, P. Cai, Y. Liu, J. Zou, E. Abbasnejad, B. Huang, M. Gong, A. van den Hengel, J.Q. Shi. Rethinking State Disentanglement in Causal Reinforcement Learning. *arXiv preprint*, 2024.
- Y. Lee, K. Lee, P. Cai, D. Hsu, L.E. Kavraki. The Planner Optimization Problem: Formulations and Frameworks. *arXiv preprint*, 2023.

Book chapters:

- P. Cai, I. Chandrasekaran, Y. Cai, Y. Chen, X. Wu. Simulation-Enabled Vocational Training for Heavy Crane Operations. In *Simulation and Serious Games for Education* (pp. 47–59), 2017, DOI:10.1007/978-981-10-0861-0_4.
- P. Cai, C. Indhumathi, Y. Cai, J. Zheng, Y. Gong, T. Lim, P. Wong. Collision Detection Using Axis-Aligned Bounding Boxes. In *Simulations, Serious Games and Their Applications* (pp. 1–14), 2014, DOI:10.1007/978-981-4560-32-0_1.

Patent

- Y. Cai, P. Cai, C. Indhumathi, J. Zheng, N.M. Thalmann, P. Wong, T.S. Lim, Y. Gong (PEC Ltd. and Nanyang Technological University). Method and System for Intelligent Crane Lifting. WIPO (PCT), 2015, WO2015053711A1.

Professional Services

Editorial & Organization Roles:

- **Associate Editor**, *IEEE Transactions on Robotics (T-RO)*, 2024–present.
- **Area Chair**, Robotics: Science and Systems (RSS), 2026.
- Associate Editor, IEEE International Conference on Robotics and Automation (ICRA), 2023.
- Program committee member, International Conference on Automated Planning and Scheduling (ICAPS), 2022.
- Main organizer, RSS 2021 Workshop on Integrating Planning and Learning.
- Organization committee member, RSS Pioneers Workshop, 2021.
- Program committee member, Robotics: Science & Systems (RSS), 2020.
- Program committee member, Conference on Robot Learning (CoRL), 2019.
- Organization committee member, CS Research Week 2019, School of Computing, NUS.

Reviewing:

- Journals: International Journal of Robotics Research (IJRR), IEEE Transactions on Robotics (T-RO), IEEE Robotics and Automation Letters (RA-L), Autonomous Robots (AURO).
- Conferences: Robotics: Science & Systems (RSS), IEEE International Conference on Robotics and Automation (ICRA), IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Conference on Robot Learning (CoRL), Neural Information Processing Systems (NeurIPS), American Control Conference (ACC), International Joint Conference on Artificial Intelligence (IJCAI).

Teaching & Mentoring

Lecturing:

- AI1804 "Algorithm Design and Analysis," Autumn 2025, SJTU School of Artificial Intelligence. Lecturing; sophomore undergraduate course.
- CS7355 "Frontiers in Autonomous Driving," Spring 2024 and Spring 2025, SJTU School of Electronic Information and Electrical Engineering (SEIEE). *Self-designed graduate course*; recognized as an **SJTU University-Level Outstanding Course**.
- CS3317 "Artificial Intelligence," Autumn 2022/2023 and 2023/2024, SJTU SEIEE. Co-lecturing; sophomore undergraduate course, 50+ students.
- CS4278/CS5478 "Intelligent Robots: Algorithms and Systems," Semesters 1&2, 2021/2022, NUS. Co-lecturing;

graduate course, 100+ students; delivered Lectures 11 (POMDP planning) and 12 (Robot systems).
- CS6244 "Robot Motion Planning & Control," Semester 1, 2017/2018, NUS. Co-lecturing; graduate course, 20–30 students; delivered Lecture 3 (Sampling-based motion planning).
- Project P3.6 "Vibration Testing of Multiple DOF Systems," AY 2015/16, S1 & S2, NTU. Teaching assistant; undergraduate-level lab.

Mentoring:
- Supervising PhD and master students at the Robot Planning and Learning (RoPL) Lab, Shanghai Jiao Tong University.
- Co-supervised Mr. Yunfan Lu for his master research; now Senior Robotics Software Engineer at Dyson.
- Supervised Mr. Mohamad Danesh for his research internship; now research engineer at Ivy.
- Co-supervised Mr. Yiyuan Lee for his Final Year Project; now PhD candidate at Rice University.
- Supervised Ms. Shuyuan Jin for her Final Year Project; now Software Engineer at Facebook.
- Co-supervised Dr. Yuanfu Luo for his PhD research; now algorithm engineer at DJI.
- Supervised Mr. Arthur Wandzel for his research internship; now co-founder of JAMM, an AI startup.
- Supervised Mr. Aseem Saxena for his research internship; now master student at Oregon State University.

Selected Research Talks

- *Upcoming:* Invited talks at two CoRL 2026 workshops, Nov 2026.
- *Upcoming:* Invited talk at the RSS 2026 Workshop on Human-Centered Mobile Manipulation, Jul 2026.
- Invited talk at SJTU V2X Innovation Center. "Robot Planning with Commonsense", May 2026.
- Invited talk at CCF Young Elite Forum (YEF) 2025. "Robot Planning with Commonsense", Jun 2025.
- Invited talk at XYZ Robotics. "Robot Planning under Uncertainty", Feb 2025.
- Invited talk at Kuwa Robot. "How does a robot drive better than us?", May 2023.
- Invited talk at SenseTime. "How does a robot drive better than us?", Aug 2022.
- Invited talk at the Department of Computer Science, Brown University. "How does a robot drive better than us?", Aug 2020.
- AI lunch talk at the School of Computing, National University of Singapore. "Hybrid intelligence of robots: modeling, decision making, and learning", Oct 2019.
- Invited talk at ISEE AI, an MIT startup on autonomous driving. "How can a robot drive better than us?", Nov 2019.
- Invited talk at the School of Mathematical Sciences, Zhejiang University. "Planning under uncertainty in robotics: theory to practice, and serial to parallel", May 2018.

References

- Dr. David Hsu (IEEE Fellow).
  Provost's Chair Professor, Department of Computer Science, National University of Singapore.
  Relationship: Postdoc supervisor.
  Email: dyhsu@comp.nus.edu.sg
  Phone: +65 6825 4200
- Dr. Wee Sun Lee.
  Professor (Head of Department), Department of Computer Science, National University of Singapore.
  Relationship: Close collaborator.
  Email: leews@comp.nus.edu.sg
  Phone: +65 6516 4526
- Dr. Yiyu Cai.
  Associate Professor, School of Mechanical and Aerospace Engineering, Nanyang Technological University.
  Relationship: PhD supervisor.
  Email: MYYCai@ntu.edu.sg
  Phone: +65 6790 5941