

Pingchuan Ma

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Biography

Research Interests: machine learning, robotics, physical simulation.

Research Goals: (1) reconstructing efficient realistic physics-based world models, (2) generating intelligent agents upon the world models, and (3) realizing the agents in the physical world.

Publications

- [1] **Pingchuan Ma**, Tsun-Hsuan Wang, Minghao Guo, Zhiqing Sun, Joshua B Tenenbaum, Daniela Rus, Chuang Gan, and Wojciech Matusik. “LLM and Simulation as Bilevel Optimizers: A New Paradigm to Advance Physical Scientific Discovery.” In: *International Conference on Machine Learning (ICML)*. PMLR. 2024.
- [2] Tsun-Hsuan Wang, Juntian Zheng, **Pingchuan Ma**, Yilun Du, Byungchul Kim, Andrew Spielberg, Joshua B Tenenbaum, Chuang Gan, and Daniela Rus. “DiffuseBot: Breeding Soft Robots with Physics-Augmented Generative Diffusion Models.” In: *Advances in Neural Information Processing Systems (NeurIPS)* (2023). [Oral]
- [3] **Pingchuan Ma**, Peter Yichen Chen, Bolei Deng, Joshua B Tenenbaum, Tao Du, Chuang Gan, and Wojciech Matusik. “Learning Neural Constitutive Laws from Motion Observations for Generalizable PDE Dynamics.” In: *International Conference on Machine Learning (ICML)*. PMLR. 2023, pp. 23279–23300.
- [4] Tsun-Hsuan Wang, **Pingchuan Ma**, Andrew Spielberg, Zhou Xian, Hao Zhang, Joshua B Tenenbaum, Daniela Rus, and Chuang Gan. “SoftZoo: A Soft Robot Co-design Benchmark For Locomotion In Diverse Environments.” In: *International Conference on Learning Representations (ICLR)*. 2023.
- [5] John Z Zhang, Yu Zhang, **Pingchuan Ma**, Elvis Nava, Tao Du, Philip Arm, Wojciech Matusik, and Robert K Katzschmann. “Sim2Real for Soft Robotic Fish via Differentiable Simulation.” In: *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE. 2022, pp. 12598–12605.
- [6] Allan Zhao, Tao Du, Jie Xu, Josie Hughes, Juan Salazar, **Pingchuan Ma**, Wei Wang, Daniela Rus, and Wojciech Matusik. “Automatic Co-Design of Aerial Robots Using a Graph Grammar.” In: *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE. 2022, pp. 11260–11267.
- [7] Elvis Nava, John Z Zhang, Mike Yan Michelis, Tao Du, **Pingchuan Ma**, Benjamin F Grewe, Wojciech Matusik, and Robert Kevin Katzschmann. “Fast Aquatic Swimmer Optimization with Differentiable Projective Dynamics and Neural Network Hydrodynamic Models.” In: *International Conference on Machine Learning (ICML)*. PMLR. 2022, pp. 16413–16427.
- [8] Allan Zhao, Jie Xu, Juan Salazar, Wei Wang, **Pingchuan Ma**, Daniela Rus, and Wojciech Matusik. “Graph Grammar-Based Automatic Design for Heterogeneous Fleets of Underwater Robots.” In: *2022 International Conference on Robotics and Automation (ICRA)*. IEEE. 2022, pp. 3143–3149.
- [9] **Pingchuan Ma**^{*}, Tao Du^{*}, Joshua B Tenenbaum, Wojciech Matusik, and Chuang Gan. “RISP: Rendering-Invariant State Predictor with Differentiable Simulation and Rendering for Cross-Domain Parameter Estimation.” In: *International Conference on Learning Representations (ICLR)*. 2021. [Oral] (* indicates equal contribution)
- [10] Tao Du, Kui Wu, **Pingchuan Ma**, Sebastien Wah, Andrew Spielberg, Daniela Rus, and Wojciech Matusik. “DiffPD: Differentiable Projective Dynamics.” In: *ACM Transactions on Graphics (Proc. SIGGRAPH)* 41.2 (2021), pp. 1–21.
- [11] **Pingchuan Ma**, Tao Du, John Z Zhang, Kui Wu, Andrew Spielberg, Robert K Katzschmann, and Wojciech Matusik. “DiffAqua: A Differentiable Computational Design Pipeline for Soft Underwater Swimmers with Shape Interpolation.” In: *ACM Transactions on Graphics (Proc. SIGGRAPH)* 40.4 (2021), pp. 1–14.
- [12] **Pingchuan Ma**^{*}, Tao Du^{*}, and Wojciech Matusik. “Efficient Continuous Pareto Exploration in Multi-Task Learning.” In: *International Conference on Machine Learning (ICML)*. PMLR. 2020, pp. 6522–6531. (* indicates equal contribution)

- [13] Jie Xu, Yunsheng Tian, **Pingchuan Ma**, Daniela Rus, Shinjiro Sueda, and Wojciech Matusik. “Prediction-Guided Multi-Objective Reinforcement Learning for Continuous Robot Control.” In: *International Conference on Machine Learning (ICML)*. PMLR. 2020, pp. 10607–10616.
- [14] **Pingchuan Ma**^{*}, Yunsheng Tian^{*}, Zherong Pan, Bo Ren, and Dinesh Manocha. “Fluid Directed Rigid Body Control using Deep Reinforcement Learning.” In: *ACM Transactions on Graphics (Proc. SIGGRAPH)* 37.4 (2018), pp. 1–11. (^{*} indicates equal contribution)

Preprints

- [15] Ziming Liu, **Pingchuan Ma**, Yixuan Wang, Wojciech Matusik, and Max Tegmark. “KAN 2.0: Kolmogorov-Arnold Networks Meet Science.” In: *arXiv preprint arXiv:2408.10205* (2024).
- [16] Minghao Guo, Bohan Wang, **Pingchuan Ma**, Tianyuan Zhang, Crystal Elaine Owens, Chuang Gan, Joshua B. Tenenbaum, Kaiming He, and Wojciech Matusik. “Physically Compatible 3D Object Modeling from a Single Image.” In: *arXiv preprint arXiv:2405.20510* (2024).
- [17] Yifei Li, Yuchen Sun, **Pingchuan Ma**, Eftychios Sifakis, Tao Du, Bo Zhu, and Wojciech Matusik. “Neural Fluidic System Design and Control with Differentiable Simulation.” In: *arXiv preprint arXiv:2405.14903* (2024).
- [18] Liane Makatura, Michael Foshey, Bohan Wang, Felix Hähnlein, **Pingchuan Ma**, Bolei Deng, Megan Tjandrasuwita, Andrew Spielberg, Crystal Elaine Owens, Peter Yichen Chen, et al. “How Can Large Language Models Help Humans in Design and Manufacturing?” In: *arXiv preprint arXiv:2307.14377* (2023).
- [19] **Pingchuan Ma**^{*}, Yao Zhou^{*}, Yu Lu, and Wei Zhang. “Learning Efficient Video Representation with Video Shuffle Networks.” In: *arXiv preprint arXiv:1911.11319* (2019). (^{*} indicates equal contribution)

Education

Massachusetts Institute of Technology , Cambridge, MA <i>Ph.D. in Computer Science, EECS</i> · Thesis: Building World Models with Neural Physics · Cumulative Graduate GPA: 5.0/5.0	Sep. 2019 - Present
Massachusetts Institute of Technology , Cambridge, MA <i>S.M. in Computer Science, EECS</i> · Thesis: Efficient Continuous Pareto Exploration In Multi-Task Learning	Sep. 2019 - Feb. 2023
Nankai University , Tianjin, China <i>B.Eng. in Software Engineering, Software College</i> · Outstanding Undergraduate Thesis Award (Top 1%) · Major GPA: 93.9/100 Overall GPA: 92.1/100 Ranking: #1/91	Sep. 2015 - Jun. 2019

Research Experience

Research Assistant at MIT CSAIL , Cambridge, MA <i>Computational Design and Fabrication Group</i> · With Prof. Wojciech Matusik.	Sep. 2019 - Present
Research Summer Intern at NVIDIA Research , Seattle, WA <i>Seattle Robotics Lab</i> · With Prof. Dieter Fox.	May 2024 - Present
Research Summer Intern at MIT-IBM Watson AI Lab , Cambridge, MA · Differentiable simulation and rendering for sim-to-real. · With Prof. Chuang Gan.	Jun. 2021 - Aug. 2021
Research Intern at SenseTime Research , Shenzhen, China	May 2018 - Feb. 2019

- Large-scale efficient video understanding.
- With Dr. Wei Zhang and Prof. Ping Luo.

Research Assistant at Nankai University, Tianjin, China
· Deep reinforcement learning for high-dimensional control.
· Efficient CUDA-accelerated fluid simulation.
· With Prof. Bo Ren and Prof. Ming-Ming Cheng.

Apr. 2016 - Jun. 2019

Professional Experience

Conference Reviewer
· Advances in Neural Information Processing Systems (**NeurIPS**)
· International Conference on Learning Representations (**ICLR**)
· International Conference on Machine Learning (**ICML**)
· Conference on Computer Vision and Pattern Recognition (**CVPR**)
· Eurographics Conference (**EG**)
· Pacific Graphics (**PG**)

Journal Reviewer
· ACM Transactions on Graphics (Proc. **SIGGRAPH**)
· ACM Transactions on Graphics (Proc. **SIGGRAPH Asia**)
· IEEE Robotics and Automation Letters (**RA-L**)
· Computer Graphics Forum (**CGF**)

Teaching Experience
· MIT 6.807/6.839 Advanced Computer Graphics

Fall 2022

Challenges and Competitions

2nd place for MIT in Citadel Terminal Live: Harvard v. MIT	2020
2nd place in Meitu Short Video Real-Time Classification Competition	2018
1st place in Microsoft Hackaton - Nankai University	2015

Awards and Honors

Outstanding Undergraduate Thesis Award (Top 1%)	2019
Zhou Enlai Scholarship Candidate (20 out of all undergrads)	2018
The First Prize Scholarship (Top 5%)	2017, 2018
Excellent Volunteer, Nankai University	2017
National Scholarship (Top 1%)	2016