Ching-An Cheng

Senior Researcher
Microsoft Research

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Research Interests

Theory, algorithms, and applications of learning and control in sequential decision making and robotics.

Reinforcement Learning · Imitation Learning · Online Learning · Meta Learning · Gaussian Processes · Variational Inference · Kernel Methods · Stochastic Optimal Control · System Identification · Force/Impedance Control · Humanoid · Exoskeleton · Manipulation · Grasping

Work Experiences

2020–	**Senior Researcher, Microsoft Research, Redmond, USA**

Education

2015–2019	Ph.D. in Robotics, Georgia Institute of Technology, USA
	Thesis: *Efficient and Principled Robot Learning: Theory and Algorithms*
	Advisor: Byron Boots
	Committee: Seth Hutchinson, Geoff Gordon, Evangelos A. Theodorou, Karen Liu
2011–2013	M.S. in Mechanical Engineering, National Taiwan University, Taiwan
	Thesis: *Robot Dynamics Learning and Human-Robot Interaction*
	Advisor: Han-Pang Huang
2007–2011	B.S. in Mechanical Engineering, National Taiwan University, Taiwan
	B.S. in Electrical Engineering, National Taiwan University, Taiwan

Awards and Honors

2022	**Outstanding Paper Award (Runner-Up), ICML 2022**
2019	**Best Paper Award, OptRL Workshop @ NeurIPS 2019**
2019	**Best Student Paper Award, RSS 2019**
2019	**Best Systems Paper Award (Finalist), RSS 2019**
2019	**Google PhD Fellowship, Machine Learning** (declined)
2019	**Nvidia PhD Fellowship**
2018	**Best Systems Paper Award (Finalist), RSS 2018**
2018	**Best Paper Award, AISTATS 2018**
2015	Government Scholarship to Study Abroad, Ministry of Education, Taiwan
2014	Excellent Project Award, Industrial Technology Research Institute, Taiwan
2010	Cheng-Tai Scholarship, Taiwan

Publications

Journal

2021	C.-A. Cheng, M. Mukadam, J. Issac, S. Birchfield, D. Fox, B. Boots, and N. Ratliff. RMPflow: A geometric framework for generation of multitask motion policies. *IEEE Transactions on Automation Science and Engineering*, 18(3):968–987, 2021
2019	Y. Pan, C.-A. Cheng, K. Saigol, K. Lee, X. Yan, E. A. Theodorou, and B. Boots. Imitation learning for agile autonomous driving. *The International Journal of Robotics Research*, 39(2-3):286–302, 2020
2019	Z.-H. Kang, C.-A. Cheng, and H.-P. Huang. A singularity handling algorithm based on operational space control for six-degree-of-freedom anthropomorphic manipulators. *International Journal of Advanced Robotic Systems*, 16(3), 2019
2016	C.-A. Cheng and H.-P. Huang. Learn the Lagrangian: A vector-valued RKHS approach to identifying Lagrangian systems. *IEEE Transactions on Cybernetics*, 46(12):3247–3258, 2016
2016	S.-Y. Lo, C.-A. Cheng, and H.-P. Huang. Virtual impedance control for safe human-robot interaction. *Journal of Intelligent & Robotic Systems*, 82(1):3, 2016
2016	C.-A. Cheng, H.-P. Huang, H.-K. Hsu, W.-Z. Lai, and C.-C. Cheng. Learning the inverse dynamics of robotic manipulators in structured reproducing kernel Hilbert space. *IEEE Transactions on Cybernetics*, 46(7):1691–1703, 2016
2015	H.-P. Huang, Y.-H. Liu, W.-Z. Lin, Z.-H. Kang, C.-A. Cheng, and T.-H. Huang. Development of a p300 bci and design of an elastic mechanism for a rehabilitation robot. *International Journal of Automation and Smart Technology*, 5(2):91–100, 2015

Conference

2023	A. Li, D. Misra, A. Kolobov, and C.-A. Cheng. Survival instinct in offline reinforcement learning. *Conference on Neural Information Processing Systems*, 2023 **(Spotlight (<1%))**
2023	M. Bhardwaj, T. Xie, B. Boots, N. Jiang, and C.-A. Cheng. Adversarial model for offline reinforcement learning. *Conference on Neural Information Processing Systems*, 2023
2023	G. Thomas, C.-A. Cheng, R. Loynd, V. Vineet, M. Jalobeanu, and A. Kolobov. Plex: Making the most of the available data for robotic manipulation pretraining. *Conference on Robot Learning*, 2023
2023	V. Myers, A. He, K. Fang, H. Walke, P. Hansen-Estruch, C.-A. Cheng, M. Jalobeanu, A. Kolobov, A. Dragan, and S. Levine. Goal representations for instruction following: A semi-supervised language interface to control. *Conference on Robot Learning*, 2023
2023	A. Li, B. Boots, and C.-A. Cheng. Mahalo: Unifying offline reinforcement learning and imitation learning from observations. *International Conference on Machine Learning*, 2023
2023	H.-A. Nguyen and C.-A. Cheng. Provable reset-free reinforcement learning by no-regret reduction. *International Conference on Machine Learning*, 2023
2023	S. R. Sinclair, F. Frujeri, C.-A. Cheng, L. Marshall, H. Barbalho, J. Li, J. Neville, I. Menache, and A. Swaminathan. Hindsight learning for mdps with exogenous inputs. *International Conference on Machine Learning*, 2023
2023	S. Amani, L. F. Yang, and C.-A. Cheng. Provably efficient lifelong reinforcement learning with linear function representation. *International Conference on Learning Representations*, 2023
2022	N. Wagener, A. Kolobov, F. V. Frujeri, R. Loynd, C.-A. Cheng, and M. Hausknecht. Mocapact: A multi-task dataset for simulated humanoid control. *Neural Information Processing Systems Datasets and Benchmarks Track*, 2022

2022   C.-A. Cheng*, T. Xie*, N. Jiang, and A. Agarwal. Adversarially trained actor critic for offline reinforcement learning. *International Conference on Machine Learning*, 2022 **(Outstanding Paper Award, Runner-Up)** (*equal contribution)

2021   T. Xie, C.-A. Cheng, N. Jiang, P. Mineiro, and A. Agarwal. Bellman-consistent pessimism for offline reinforcement learning. *Advances in Neural Information Processing Systems*, 34:6683–6694, 2021 **(Oral Presentation (<1%))** (*equal contribution)

2021   C.-A. Cheng, A. Kolobov, and A. Swaminathan. Heuristic-guided reinforcement learning. *Advances in Neural Information Processing Systems*, 34:13550–13563, 2021

2021   N. C. Wagener, B. Boots, and C.-A. Cheng. Safe reinforcement learning using advantage-based intervention. In *International Conference on Machine Learning*, pages 10630–10640. PMLR, 2021

2021   A. Zanette, C.-A. Cheng, and A. Agarwal. Cautiously optimistic policy optimization and exploration with linear function approximation. In *Conference on Learning Theory*, pages 4473–4525. PMLR, 2021

2021   A. Li*, C.-A. Cheng*, M. A. Rana, M. Xie, K. Van Wyk, N. Ratliff, and B. Boots. RMP^2: A structured composable policy class for robot learning. *Robotics: Science and Systems*, 2021 (*equal contribution)

2021   X. Yan, B. Boots, and C.-A. Cheng. Explaining fast improvement in online imitation learning. In *Uncertainty in Artificial Intelligence*, pages 1874–1884. PMLR, 2021

2020   C.-A. Cheng, A. Kolobov, and A. Agarwal. Policy improvement via imitation of multiple oracles. *Advances in Neural Information Processing Systems*, 33:5587–5598, 2020 **(Spotlight Talk (<3%))**

2020   A. Rahimi*, A. Shaban*, C.-A. Cheng*, B. Boots, and R. Hartley. Intra order-preserving functions for calibration of multi-class neural networks. *Advances in Neural Information Processing Systems*, 33:13456–13467, 2020 (*equal contribution)

2020   C.-A. Cheng, R. T. Combes, B. Boots, and G. Gordon. A reduction from reinforcement learning to no-regret online learning. In *International Conference on Artificial Intelligence and Statistics*, pages 3514–3524. PMLR, 2020

2020   C.-A. Cheng*, J. Lee*, K. Goldberg, and B. Boots. Online learning with continuous variations: Dynamic regret and reductions. In *International Conference on Artificial Intelligence and Statistics*, pages 2218–2228. PMLR, 2020 (*equal contribution)

2020   B. Wingo, C.-A. Cheng, M. Murtaza, M. Zafar, and S. Hutchinson. Extending Riemmanian motion policies to a class of underactuated wheeled-inverted-pendulum robots. In *2020 IEEE International Conference on Robotics and Automation (ICRA)*, pages 3967–3973. IEEE, 2020

2019   C.-A. Cheng, X. Yan, and B. Boots. Trajectory-wise control variates for variance reduction in policy gradient methods. In *Conference on Robot Learning*, pages 1379–1394. PMLR, 2020 (*equal contribution)

2019   M. Mukadam, C.-A. Cheng, D. Fox, B. Boots, and N. Ratliff. Riemannian motion policy fusion through learnable lyapunov function reshaping. In *Conference on robot learning*, pages 204–219. PMLR, 2020

2019   A. Li, C.-A. Cheng, B. Boots, and M. Egerstedt. Stable, concurrent controller composition for multi-objective robotic tasks. In *2019 IEEE 58th Conference on Decision and Control (CDC)*, pages 1144–1151. IEEE, 2019

2019   N. Wagener*, C.-A. Cheng*, J. Sacks, and B. Boots. An online learning approach to model predictive control. *Robotics: Science and Systems*, 2019 (*equal contribution) **Best Student Paper Award; Best Systems Paper Award, Finalist**

2019   C.-A. Cheng, X. Yan, N. Ratliff, and B. Boots. Predictor-corrector policy optimization. In *International Conference on Machine Learning*, pages 1151–1161. PMLR, 2019 **(Long Talk (<5%))**

2019   C.-A. Cheng, X. Yan, E. Theodorou, and B. Boots. Accelerating imitation learning with predictive models. In *The 22nd International Conference on Artificial Intelligence and Statistics*, pages 3187–3196. PMLR, 2019

2019   A. Shaban*, C.-A. Cheng*, N. Hatch, and B. Boots. Truncated back-propagation for bilevel optimization. In *The 22nd International Conference on Artificial Intelligence and Statistics*, pages 1723–1732. PMLR, 2019 (*equal contribution)

2018   C.-A. Cheng, M. Mukadam, J. Issac, S. Birchfield, D. Fox, B. Boots, and N. Ratliff. RMPflow: A computational graph for automatic motion policy generation. In *International Workshop on the Algorithmic Foundations of Robotics*, pages 441–457. Springer, 2018

2018   H. Salimbeni*, C.-A. Cheng*, B. Boots, and M. Deisenroth. Orthogonally decoupled variational Gaussian processes. *Conference on Neural Information Processing Systems*, 2018 (*equal contribution)

2018   C.-A. Cheng, X. Yan, N. Wagener, and B. Boots. Fast policy learning using imitation and reinforcement. *Conference on Uncertainty in Artificial Intelligence*, 2018 **(Plenary Presentation ($<9\%$))**

2018   Y. Pan, C.-A. Cheng, K. Saigol, K. Lee, X. Yan, E. Theodorou, and B. Boots. Agile off-road autonomous driving using end-to-end deep imitation learning. *Robotics: Science and Systems*, 2018 **Best Systems Paper Award, Finalist**

2018   C.-A. Cheng and B. Boots. Convergence of value aggregation for imitation learning. In *International Conference on Artificial Intelligence and Statistics*, volume 84, pages 1801–1809, 2018 **Best Paper Award**

2018   J. L. Molnar, C.-A. Cheng, L. O. Tiziani, B. Boots, and F. L. Hammond. Optical sensing and control methods for soft pneumatically actuated robotic manipulators. In *2018 IEEE International Conference on Robotics and Automation (ICRA)*, pages 3355–3362. IEEE, 2018

2017   C.-A. Cheng and B. Boots. Variational inference for Gaussian process models with linear complexity. In *Advances in Neural Information Processing Systems*, 2017

2017   M. Mukadam, C.-A. Cheng, X. Yan, and B. Boots. Approximately optimal continuous-time motion planning and control via probabilistic inference. In *IEEE International Conference on Robotics and Automation*, pages 664–671, 2017

2016   C.-A. Cheng and B. Boots. Incremental variational sparse Gaussian process regression. In *Advances in Neural Information Processing Systems*, pages 4410–4418, 2016

2015   C.-H. Chang, H.-P. Huang, H.-K. Hsu, and C.-A. Cheng. Humanoid robot push-recovery strategy based on cmp criterion and angular momentum regulation. In *IEEE International Conference on Advanced Intelligent Mechatronics*, pages 761–766. IEEE, 2015

2015   M.-B. Huang, H.-P. Huang, C.-C. Cheng, and C.-A. Cheng. Efficient grasp synthesis and control strategy for robot hand-arm system. In *IEEE International Conference on Automation Science and Engineering*, pages 1256–1257. IEEE, 2015

2013   C.-A. Cheng, H.-P. Huang, H.-K. Hsu, W.-Z. Lai, C.-C. Cheng, and Y.-C. Li. Identification of the inverse dynamics of robot manipulators with the structured kernel. In *International Automatic Control Conference*, pages 266–271. IEEE, 2013

2013   T.-H. Huang, C.-A. Cheng, and H.-P. Huang. Self-learning assistive exoskeleton with sliding mode admittance control. In *IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 698–703. IEEE, 2013

2013   C.-A. Cheng, T.-H. Huang, and H.-P. Huang. Bayesian human intention estimator for exoskeleton system. In *IEEE/ASME International Conference on Advanced Intelligent Mechatronics*, pages 465–470. IEEE, 2013

2012   T.-H. Huang, H.-P. Huang, C.-A. Cheng, J.-Y. Kuan, P.-T. Lee, and S.-Y. Huang. Design of a new hybrid control and knee orthosis for human walking and rehabilitation. In *IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 3653–3658. IEEE, 2012

2012   H.-P. Huang, Y.-H. Liu, T.-H. Huang, Z.-H. Kang, W.-Z. Lin, W. Ching-Ping, and C.-A. Cheng. Development of a brain-machine interface for motor imagination task. In *International Conference on Automation Technology*, 2012

2011	Y.-H. Liu, C.-A. Cheng, and H.-P. Huang. Novel feature of the EEG based motor imagery BCI system: Degree of imagery. In *International Conference on System Science and Engineering*, pages 515–520. IEEE, 2011
2010	C.-A. Cheng, Y.-H. Liu, and H.-P. Huang. Motor imagery recognition for brain-computer interfaces using Hilbert-Huang transform and effective event-related-desynchronization features. In *CSME National Conference*, 2010

Workshop

2023	A. Li, D. Misra, A. Kolobov, and C.-A. Cheng. Survival instinct in offline reinforcement learning and implicit human bias in data. *Interactive Learning with Implicit Human Feedback Workshop at ICML 2023*, 2023 **Oral Presentation**
2023	H.-A. Nguyen and C.-A. Cheng. Provable reset-free reinforcement learning by no-regret reduction. *AAAI 2023 Reinforcement Learning Ready for Production Workshop*, 2023
2022	T. Xie, M. Bhardwaj, N. Jiang, and C.-A. Cheng. Armor: A model-based framework for improving arbitrary baseline policies with offline data. *NeurIPS 2022 Offline RL Workshop*, 2022
2022	G. Thomas, A. Kolobov, C.-A. Cheng, V. Vineet, and M. Jalobeanu. Heetr: Pre-training for robotic manipulation on heteromodal data. In *CoRL 2022 Workshop on Pre-training Robot Learning*, 2022
2020	A. Li*, C.-A. Cheng*, M. A. Rana, N. Ratliff, and B. Boots. RMP^2: A differentiable policy class for robotic systems with control-theoretic guarantees. *NeurIPS 2020 3rd Robot Learning Workshop*, 2020
2019	J. Lee*, C.-A. Cheng*, K. Goldberg, and B. Boots. Continuous online learning and new insights to online imitation learning. *NeurIPS 2019 Optimization Foundations of Reinforcement Learning Workshop*, 2019 (*equal contribution) **Best Paper Award**
2019	C.-A. Cheng*, X. Yan*, and B. Boots. Trajectory-wise control variates for variance reduction in policy gradient method. *NeurIPS 2019 Optimization Foundations of Reinforcement Learning Workshop*, 2019
2018	C.-A. Cheng, X. Yan, N. Ratliff, and B. Boots. Predictor-corrector policy optimization. *Deep Reinforcement Learning Workshop NeurIPS*, 2018
2017	Y. Pan, C.-A. Cheng, K. Saigol, K. Lee, X. Yan, E. Theodorou, and B. Boots. Learning deep neural network control policies for agile off-road autonomous driving. *The NIPS Deep Reinforcement Learning Symposium*, 2017
2017	C.-A. Cheng and B. Boots. Convergence of value aggregation for imitation learning. In *The NIPS Deep Reinforcement Learning Symposium*, 2017
2016	C.-A. Cheng and B. Boots. Incremental variational sparse Gaussian process regression. In *NIPS Workshop on Adaptive and Scalable Nonparametric Methods in Machine Learning*, 2016

Invited Talks

2022	"A Game Theoretic Approach to Offline Reinforcement Learning," Workshop on Structure of Constraints in Sequential Decision-Making, Simons Institute, USA
2020	"Efficient Policy Optimization by Online Imitation Learning," MSR AI Seminar, Microsoft Research, USA
2020	"Trajectory-wise Control Variates for Policy Gradient Methods," GTC, Nvidia, USA
2019	"RMPflow: A Geometric Framework for Policy Fusion," Fanuc, USA (host: Hsien-Chung Lin)
2019	"Learning from Past Mistakes and Future Predictions for Sequential Decision Making," RIKEN, Osaka, Japan (host: Yoshinobu Kawahara)
2019	"Learning to Optimize," NTU, Taipei, Taiwan (host: Han-Pang Huang)
2018	"Policy Optimization as Predictable Online Learning Problems," Microsoft Research, Montreal, Canada (host: Geoffrey Gordon)
2018	"Policy Optimization as Predictable Online Learning Problems: Imitation Learning and Beyond," Microsoft Research, Redmond, USA (host: Andrey Kolobov)

Service

- Reviewer:
  JMLR · NATURE · JAIR · IEEE RA-L · IEEE TPAMI · IEEE SPL · JINT · MACH · IEEE Trans SMC Systems · NeurIPS · ICML · COLT · ICLR · AAAI · RSS · ICRA · AIM · IROS · WAFR

- Organizer:
  Microsoft Research Summit (RL track) 2021
  MSR Reinforcement Learning Day 2021
  ICML 2019 Workshop: Real-World Sequential Decision Making: Reinforcement Learning and Beyond

Mentorship

- Interns: Huihan Liu (PhD Student, University of Texas at Austin) Ruijie Zheng (PhD Student, University of Maryland) Allen Nie (PhD Student, Stanford) Sumedh A Sontakke (PhD Student, University of Southern California) Ying Fan (PhD Student, UW-Madison) Sinong Geng (PhD Student, Princeton) Hoai-An Nguyen (Undergraduate Student, Rutgers) Garrett Thomas (PhD Student, Stanford) Sean Sinclair (PhD Student, Cornell) Nolan Wagener (PhD Student, Georgia Tech) Tengyang Xie (PhD Student, UIUC) Andrea Zanette (PhD Student, Stanford)

- Collaborators: Anqi Li (PhD Student, UW) Sanae Amani (PhD Student, UCLA) Mohak Bhardwaj (PhD Student, UW) Jonathan Lee (Undergraduate Student, UC Berkeley) Bruce Wingo (PhD Student, Georgia Tech)

Teaching Experience

2018	Teaching Assistant in Statistical Techniques in Robotics (CS8803, Byron Boots), Georgia Institute of Technology, USA (lectured "Gaussian Process Regression")
2017	Teaching Assistant in Statistical Techniques in Robotics (CS8803, Byron Boots), Georgia Institute of Technology, USA (lectured "Inference of Graphical Model")
2013	Lectured "Introduction to Machine Learning" in Intelligent Control (ME7144, Han-Pang Huang), National Taiwan University, Taiwan
2012 & 2013	Lectured induction training of Robotics Laboratory in linear algebra, matrix theory, convex optimization, machine learning, Matlab, and C++, National Taiwan University, Taiwan

Skills

Python, Pytorch, Tensorflow, LaTeX., C++

Languages

Chinese (native), English (fluent), Japanese (basic)