

# Prashanth L.A.

## Contact Information

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## Research Interests

**Theory:** Reinforcement Learning, Simulation Optimization, Multi-armed Bandits

**Applications:** Road Traffic Control, Recommendation Systems, Service Systems, Wireless Networks

## Education

**March 2013, Ph.D. in Computer Science and Automation, Indian Institute of Science (IISc)**

Dissertation Topic: “Resource Allocation for Sequential Decision Making under Uncertainty: Studies in Vehicular Traffic Control, Service Systems, Sensor Networks and Mechanism Design”

Advisor: Prof. Shalabh Bhatnagar

**August 2008, M.Sc. (Engg) in Computer Science and Automation, IISc**

Dissertation Topic: “OFDM-MAC algorithms and their impact on TCP performance in next generation mobile networks”

Advisor: Prof. K. Gopinath

**May 2002, B.E. in Computer Engineering, National Institute of Technology, Surathkal**

## Professional Experience

**Mar 2017 - present, Assistant Professor**

At: Department of Computer Science and Engineering, Indian Institute of Technology Madras, Chennai

**April 2015 - Feb 2017, Postdoctoral Researcher**

At: Institute for Systems Research, University of Maryland, College Park MD

**November 2014 - April 2015, Research Associate**

At: Computer Science and Automation, Indian Institute of Science (IISc)

**November 2012 - October 2014, Postdoctoral Researcher**

At: SEQUEL project, INRIA Lille - Nord Europe

**July 2002 - May 2009, Senior Software Systems Engineer**

At: Texas Instruments (India) Pvt. Ltd (On leave of absence from Feb 2008 - May 2009)

**May 2009 - May 2011, Project Associate**

For: Dept. of Information Technology (India) project on wireless sensor networking for industrial automation

**May 2011 - August 2011, Summer Researcher**

At: IBM Research Labs, Bangalore, INDIA

# Awards

**IEEE ITSS Best Ph.D. Dissertation 2014 - Third Prize:** awarded by IEEE Intelligent Transportation Systems Society (ITSS)

**IBM PhD Fellowship, 2012**

# Publications

## Books/Book Chapters

- B1 **Prashanth.L.A.** and Michael Fu, Risk-Sensitive Reinforcement Learning via Policy Gradient Search, *Foundations and Trends in Machine Learning*, Vol. 15: No. 5, pp 537-693, 2022.
- B2 S.Bhatnagar, H.L.Prasad and **Prashanth.L.A.**, Stochastic Recursive Algorithms for Optimization: Simultaneous Perturbation Methods, *Lecture Notes in Control and Information Sciences Series*, Vol. 434, Springer, ISBN 978-1-4471-4284-3, Edition: 2013, 302 pages.
- B3 S. Bhatnagar, V. Borkar and **Prashanth.L.A.**, Adaptive Feature Pursuit: Online Adaptation of Features in Reinforcement Learning, *Reinforcement Learning and Approximate Dynamic Programming for Feedback Control*, by F. Lewis and D. Liu (eds.), IEEE Press Computational Intelligence Series, pp. 517-534, 2012, **Invited article**.

## Journals

- J1 Nirav Bhavsar and **Prashanth L.A.**, Non-asymptotic bounds for stochastic optimization with biased noisy gradient oracles, *IEEE Transactions on Automatic Control*, (To appear), 2022.
- J2 N. Vijayan and **Prashanth L.A.**, Smoothed functional-based gradient algorithms for off-policy reinforcement learning: A non-asymptotic viewpoint. *Systems & Control Letters*, vol. 155, 2021.
- J3 **Prashanth L.A.**, Nathaniel Korda and Remi Munos, Concentration bounds for temporal difference learning with linear function approximation: The case of batch data and uniform sampling, *Machine learning*, vol. 110, issue 3, pp. 559-618, 2021.
- J4 **Prashanth L.A.**, S. Bhatnagar, N. Bhavsar, Michael Fu and Steve Marcus, Random directions stochastic approximation with deterministic perturbations, *IEEE Transactions on Automatic Control*, vol. 65, no. 6, pp. 2450-2465, 2020.
- J5 Ravi Kumar Kolla, **Prashanth L.A.**, Sanjay P. Bhat, Krishna Jagannathan, Concentration bounds for empirical conditional value-at-risk: The unbounded case, *Operations Research Letters*, vol. 47, issue 1, pp. 16-20, 2019.
- J6 Jie Cheng, **Prashanth L.A.**, Michael Fu, Steve Marcus and Csaba Szepesvari, Stochastic optimization in a cumulative prospect theory framework, *IEEE Transactions on Automatic Control*, vol. 63, no. 9, pp. 2867-2882, 2018.
- J7 **Prashanth L.A.**, S.Bhatnagar, Michael Fu and Steve Marcus, Adaptive system optimization using (simultaneous) random directions stochastic approximation, *IEEE Transactions on Automatic Control*, vol. 62, issue 5, pp. 2223-2238, 2017.
- J8 **Prashanth L.A.** and Mohammad Ghavamzadeh, Variance-Constrained Actor-Critic Algorithms for Discounted and Average Reward MDPs, *Machine Learning*, vol. 105, no. 3, pp. 367-417, 2016.
- J9 **Prashanth L.A.**, H.L.Prasad, S.Bhatnagar and P. Chandra, A constrained optimization perspective on actor critic algorithms and application to network routing, *Systems & Control Letters*, vol. 92, pp. 46-51, 2016.

- J10 **Prashanth L.A.**, H.L.Prasad, N.Desai and S.Bhatnagar, Simultaneous Perturbation Methods for Adaptive Labor Staffing in Service Systems, *Simulation*, vol. 91, issue 5, pp. 432-455, 2015.
- J11 S.Bhatnagar and **Prashanth L.A.**, Simultaneous Perturbation Newton Algorithms for Simulation Optimization, *Journal of Optimization Theory and Applications*, vol. 164, issue. 2, pp. 621-643, 2015.
- J12 **Prashanth L.A.**, A.Chatterjee and S.Bhatnagar, Two Timescale Convergent Q-learning for Sleep–Scheduling in Wireless Sensor Networks, *Wireless Networks*, vol. 20, issue. 8, pp. 2589-2604, 2014.
- J13 H.L.Prasad, **Prashanth L.A.**, S.Bhatnagar and N.Desai, Adaptive Smoothed Functional Algorithms for Optimal Staffing Levels in Service Systems, *Service Science (INFORMS)*, vol. 5, no. 1, pp. 29-55, 2013.
- J14 **Prashanth L.A.** and S.Bhatnagar, Threshold Tuning using Stochastic Optimization for Graded Signal Control, *IEEE Transactions on Vehicular Technology*, vol. 61, no. 9, pp. 3865-3880, 2012.
- J15 **Prashanth L.A.** and S.Bhatnagar, Reinforcement learning with function approximation for traffic signal control, *IEEE Transactions on Intelligent Transportation Systems*, vol. 12, no. 2, pp. 412-421, 2011.

### Proceedings of International Conferences

- C1 Vincent Y. F. Tan, **Prashanth L.A.**, and Krishna Jagannathan, A Survey of Risk-Aware Multi-Armed Bandits, International Joint Conference on Artificial Intelligence (IJCAI) (Survey track), 2022.
- C2 Ajay Pandey, **Prashanth L.A.**, and Sanjay Bhat, Estimation of Spectral Risk Measures, The Thirty-Fifth AAAI Conference on Artificial Intelligence (AAAI), pp. 12166-12173, 2021.
- C3 **Prashanth L.A.**, Krishna Jagannathan and Ravi Kumar Kolla, Concentration bounds for CVaR estimation: The cases of light-tailed and heavy-tailed distributions, *37th International Conference on Machine Learning (ICML)*, PMLR 119:5577-5586, 2020.
- C4 Sanjay P. Bhat and **Prashanth L.A.**, Concentration of risk measures: A Wasserstein distance approach, *33rd Conference on Neural Information Processing Systems*, pp. 11762-11771, 2019.
- C5 V. P. Boda and **Prashanth L.A.**, Correlated bandits: or How to minimize mean-squared error online, *36th International Conference on Machine Learning (ICML)*, PMLR 97:686-694, 2019.
- C6 Aditya Gopalan, **Prashanth L.A.**, Michael Fu and Steve Marcus, Weighted bandits or: How bandits learn distorted values that are not expected, *31st AAAI Conference on Artificial Intelligence (AAAI)*, pp. 1941-1947, 2017.
- C7 D. Sai Koti Reddy, **Prashanth L.A.** and S. Bhatnagar, Improved Hessian estimation for adaptive random directions stochastic approximation, *IEEE Conference on Decision and Control (CDC)*, pp. 3682-3687, 2016.
- C8 **Prashanth L.A.**, Cheng Jie, Michael Fu, Steve Marcus and Csaba Szepesvári, Cumulative Prospect Theory Meets Reinforcement Learning: Prediction and Control, *33rd International Conference on Machine Learning (ICML)*, pp. 1406-1415, 2016.
- C9 Xiaowei Hu, **Prashanth L.A.**, András György and Csaba Szepesvári, (Bandit) Convex Optimization with Biased Noisy Gradient Oracles, *19th International Conference on Artificial Intelligence and Statistics (AISTATS)*, pp. 819-828, 2016.
- C10 Nathaniel Korda and **Prashanth L.A.**, On TD(0) with function approximation: Concentration bounds and a centered variant with exponential convergence, *32nd International Conference on Machine Learning (ICML)*, pp. 626-634, 2015.

- C11 H.L.Prasad, **Prashanth L.A.** and S.Bhatnagar, Two Timescale Algorithms for Learning Nash Equilibria in General-Sum Stochastic Games, *14th International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, pp. 1371-1379, 2015.
- C12 Nathaniel Korda, **Prashanth L.A.** and Remi Munos, Fast gradient descent for drifting least squares regression, with application to bandits, *29th AAAI Conference on Artificial Intelligence (AAAI)*, pp. 2708-1714, 2015.
- C13 Raphael Fonteneau and **Prashanth L.A.**, Simultaneous Perturbation Algorithms for Batch Off-Policy Search, *53rd IEEE Conference on Decision and Control (CDC)*, pp. 2622-2627, 2014.
- C14 **Prashanth L.A.**, Policy Gradients for CVaR-Constrained MDPs, *25th International Conference on Algorithmic Learning Theory (ALT)*, pp. 155-169, 2014.
- C15 **Prashanth L.A.**, Nathaniel Korda and Remi Munos, Fast LSTD using stochastic approximation: Finite time analysis and application to traffic control, *7th European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML/PKDD)*, pp. 66-81, 2014.
- C16 **Prashanth L.A.**, A. Chatterjee and S.Bhatnagar, Adaptive sleep-wake control using reinforcement learning in sensor networks, *6th International IEEE Conference on Communication Systems and Networks (COMSNETS)*, pp. 1-8, 2014.
- C17 **Prashanth L.A.** and Mohammad Ghavamzadeh, Actor-Critic Algorithms for Risk-Sensitive MDPs, *27th Annual Conference on Advances in Neural Information Processing Systems (NIPS)*, **Full oral presentation (%1.4 acceptance - 20 out of 1420 submissions)**, pp. 252-260, 2013.
- C18 **Prashanth L.A.**, H.L.Prasad, N.Desai and S.Bhatnagar, Mechanisms for Hostile Agents with Capacity Constraints, *12th International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, pp. 659-666, 2013.
- C19 **Prashanth L.A.**, H.L.Prasad, N.Desai, S.Bhatnagar and G.Dasgupta, Stochastic optimization for adaptive labor staffing in service systems, *9th International Conference on Service Oriented Computing (ICSOC)*, pp. 487-494, 2011.
- C20 **Prashanth L.A.** and S.Bhatnagar, Reinforcement Learning with Average Cost for Adaptive Control of Traffic Lights at Intersections, *14th International IEEE Conference on Intelligent Transportation Systems*, pp. 1640-1645, 2011, **Invited article**.
- C21 **Prashanth.L.A.**, K. Gopinath, OFDM-MAC algorithms and their impact on TCP performance in next generation mobile networks, *3rd International IEEE Conference on COMmunication System softWare and MiddlewaRE (COMSWARE)*, pp. 133-140, 2008.
- C22 **Prashanth L.A.**, Sajal Kumar Das, K Gopinath, MAC design for heterogeneous application support in OFDM based wireless systems, *5th IEEE Consumer Communications and Networking Conference (CCNC)*, (short paper) 2008.

## Workshops

- W1 Xiaowei Hu, **Prashanth L.A.**, András György and Csaba Szepesvári, (Bandit) Convex Optimization with Biased Noisy Gradient Oracles, *8th NIPS Workshop on Optimization for Machine Learning*, 2015.
- W2 **Prashanth L.A.** and Mohammad Ghavamzadeh, SPSA based Actor-Critic Algorithm for Risk Sensitive Control, *11th European Workshop on Reinforcement Learning (EWRL)*, 2013.
- W3 **Prashanth L.A.** and S.Bhatnagar, Control of traffic lights at junctions using reinforcement learning, *Computer Aided Transportation Planning and Traffic Engineering*, 2009.

## Preprints

- P1 **Prashanth L.A.** and Sanjay P. Bhat, A Wasserstein distance approach for concentration of empirical risk estimates, arxiv preprint arXiv:1902.10709, 2022 (Under review in Journal of Machine Learning Research).
- P2 N. Vijayan and **Prashanth L.A.**, Risk-sensitive Reinforcement Learning via Distortion Risk Measures, 2022 (Under review in IEEE Transactions on Automatic Control).
- P3 Arvind S. Menon, **Prashanth L.A.**, Krishna Jagannathan, Online Estimation and Optimization of Utility-Based Shortfall Risk, arxiv preprint arXiv:2111.08805, 2022.
- P4 Xiaowei Hu, **Prashanth L.A.**, András György and Csaba Szepesvári, (Bandit) Convex Optimization with Biased Noisy Gradient Oracles, arxiv preprint arXiv:1609.07087, 2016.
- P5 **Prashanth L.A.**, H.L.Prasad, and S.Bhatnagar, Actor-Critic Algorithms for Learning Nash Equilibria in N-player General-Sum Games, arxiv preprint arXiv:1401.2086, 2015.

## Tutorials

1. *Risk-Aware Multi-armed Bandits*, IEEE International Conference on Signal Processing and Communications (SPCOM), 2022.
2. *Reinforcement learning*, ACM India Summer School on theoretical and algorithmic aspects on Machine Learning, 2019.
3. *Simultaneous perturbation methods for stochastic non-convex optimization*, ACM MobiHoc, 2017.
4. *Simultaneous perturbation methods for simulation optimization*, Indian Control Conference, 2018.

## Invited Talks

1. *Cumulative prospect theory meets bandits and reinforcement learning*, Department of Computer Science and Automation, Indian Institute of Science, Bangalore, June 2017.
2. *Concentration bounds for TD(0) with function approximation*, Communication, Control and Signal Processing Seminar, University of Maryland - College Park, USA, 2015.
3. *Cumulative Prospect Theory Meets Reinforcement Learning: Estimation and Control*, AI seminar, University of Alberta, Edmonton, Canada, 2015.
4. *On the convergence rate of TD(0) with function approximation: Non-asymptotic bounds in online and batch settings*, Recent Advances in Reinforcement Learning Workshop, Indian Institute Of Technology, Madras, India, 2015.
5. *Stochastic approximation for speeding up LSTD/LSPI (and least squares regression/LinUCB)*, Department seminar, Computer Science and Automation, Indian Institute of Science, India, 2014.
6. *Fast gradient descent for drifting least squares regression with applications to news-recommendation systems*, Large scale Online Learning and Decision Making Workshop, Cumberland Lodge, Windsor, UK, 2014.
7. *Actor-critic algorithms for risk-sensitive MDPs*, French Meeting on Planning, Decision Making and Learning, Liege, Belgium, 2014.



8. *Online gradient descent for LS regression: Non-asymptotic bounds and application to bandits*, Large scale Online Learning and Decision Making Workshop, Cumberland Lodge, Windsor, UK, 2013.

## Projects

**DST-Early Career Research Award** for a project entitled *Simulation-based Optimization in a Cumulative Prospect Theory Framework*, 2018-2021.

## Mentoring

### Ph.D.

- Nithia V (CS17D003): Joined Jul 2017, Status: In progress.

### M.S.

- Nirav Bhavsar (CS17S016): Joined Jul 2017, Status: Graduated. Winner of the 'Biswajit Sain MS Thesis Award 2021'.
- Ajay Pandey (CS17S011): Joined Jul 2017, Status: Graduated.
- Dipayan Sen (CS18S012): Joined Jul 2018, Status: In progress.

## Professional Service

**Senior program committee member:** AAAI 2022, AAAI 2021.

**Conference reviewer:** ICML 2022, ICML 2021, AISTATS 2021, NeurIPS 2020, AAAI 2020, ICML 2020, NIPS 2019, CDC 2019, ICML 2019, NIPS 2018, ECML 2018, ICML 2018, COLT 2018, IJCAI 2018, AAAI 2018, NIPS 2017, ECML 2017, NIPS 2016, COLT 2016, CDC 2016, AAAI 2016, NIPS 2015, ICML 2015, IJCAI 2015, WSC 2015, ICML 2014.

**Reviewer for journals:** IEEE Transactions on Automatic Control, Systems & Control Letters, Mathematics of Operations Research, IEEE Transactions on Information Theory, Statistics and Probability Letters, IEEE Transactions on Vehicular Technology, IEEE Transactions on Intelligent Transportation Systems, Operations Research, IEEE Transactions on Parallel and Distributed Systems.

## Teaching

**Linear algebra and random processes (CS6015):** Jul-Nov 2017, Jul-Nov 2019.

**Multi-armed bandits (CS6046):** Jan-May, 2018, Jan-May 2019.

**Reinforcement learning (CS6700):** Jul-Nov, 2018, Jan-May 2021, Jul-Nov, 2021.

**Pattern recognition and machine learning (CS5691):** Jan-May 2019, Jan-May 2020.

**Stochastic modeling and the theory of queues (EE6150):** Sep-Dec 2020.

**Object oriented algorithms, implementation and analysis lab (CS2810):** Jan-May 2022.