# Abhishek Gupta


CONTACT INFORMATION

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The Ohio State University,
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RESEARCH INTERESTS

**Theory:** Reinforcement learning, multi-agent decision and game theory, optimization, adversarial learning theory

**Applications:** Market design, security of cyberphysical systems

EMPLOYMENT

**Ensemble Control Inc.**, Columbus, OH

**Founder and CEO**, July 2021 – current

**The Ohio State University**, Columbus, OH

**Assistant Professor, Electrical and Computer Engineering**, July 2015 – current

**University of Southern California**, Los Angeles, CA

**Postdoctoral Researcher, Electrical Engineering**, August 2014 – June 2015

- Visiting Researcher: **University of California, Berkeley**, August 2014 – December 2014
- Visiting Researcher: **Stanford University**, January 2015 – May 2015

EDUCATION

**University of Illinois at Urbana-Champaign**, Urbana, USA

**Ph.D., Aerospace Engineering**, May 2011 – August 2014

- Thesis: *Dynamic Sequential Decision Problems with Asymmetric Information: Some Existence Results*

**M.S., Applied Mathematics**, May 2011 – December 2012

**M.S., Aerospace Engineering**, August 2009 – May 2011

- Thesis: *Control in the Presence of an Intelligent Jammer with Limited Actions*

**Indian Institute of Technology Bombay**, Mumbai, India

**B.Tech., Aerospace Engineering**, July 2005 – April 2009

- Thesis: *One-to-one Aerial Combat using Differential Game Theory*

## Awards & Honors

- Lumley Research Award, College of Engineering, OSU 2019
- Kenneth Lee Herrick Memorial Award for outstanding academic and research performance in the Aerospace Engineering department at UIUC 2014
- Mavis Future Faculty Fellowship, College of Engineering, UIUC 2012-13
- Research Internship in Science and Engineering, Indo-US S&T Forum Summer 2012
- Narotam Sekhsaria Excellence in Undergraduate Award for excellence in academic and extra-curricular activities, India 2009
- Award for Excellence, Aerospace Department, IIT Bombay, India 2008, 2009
- IIT Bombay Heritage Fund Scholarship, IIT Bombay, India 2006-08

## Teaching

ECE 5759: Static and Dynamic Optimization (Autumn 2015-21)
ECE 5555: Securing Autonomous Systems (Autumn 2021)
ECE 3050: Signals and Systems (Spring 2017, 2021)
ECE 8851: Reinforcement Learning (Spring 2020)
ECE 3551: Feedback Control Systems (Spring 2016, Autumn 2019)
ECE 6194.04: Game Theory and Mechanism Design (Autumn 2017)

## Online Professional Courses

Introduction to Machine Learning
Linear Algebra and Calculus for Machine Learning
Securing Autonomous Systems

## Funded Projects

CISCO: Anomaly and Attack Detection in Complex Autonomous Systems
($ 116,400, May 2022-Aug 2023)

Ford Motor Company: Optimal charge scheduling for an aggregate of electric vehicles
($ 220,000, May 2020-May 2022)

Army Research Lab: Smart operation and fault diagnosis of next generation wide bandgap power electronics using machine learning (PI: Prof. Julia Zhang, co-PI: Prof. Anant Agarwal and Prof. Jin Wang)
($ 100,000, Aug 2019-June 2021)

Ford Motor Company: Cybersecurity and functional safety of smart cars (co-PIs: Prof. Emre Koksal and Prof. Giorgio Rizzoni)
($ 284,000, May 2019-May 2021)

Ford Motor Company: Uncovering the economic forces in multi-modal transportation
($ 200,000, May 2018-Dec 2020)

ARPA-E NEXTCAR: Fuel Economy Optimization with Dynamic Skip Fire in a Connected and Automated Vehicle (co-PI: Prof. Marcello Canova and Prof. Giorgio Rizzoni; Industry Partners: Delphi Automotive PLC, Tula Technology, and TRC Inc.)

($ 5,000,000 total, co-PI budget: $ 94,000, Aug 2017-Dec 2020)

NSF EPCN: Smarter Markets for a Smarter Grid: Pricing Randomness, Flexibility and Risk (PI: Prof. Rahul Jain, USC)
($ 225,000, Aug 2016-Aug 2020)

NSF CRII: Securing Smart Cyberphysical Systems against Man-in-the-Middle Attacks
($ 175,000, Aug 2016-Aug 2019)

## JOURNAL PUBLICATIONS

[J1] S. Shao, H. Sartipizadeh, and **A. Gupta**, *"Large-scale Market EV Charging Scheduling for the Demands with Different Reliability"*, *accepted in IEEE Transactions on Intelligent Transportation Systems*, 2022.

[J2] S. Shao, F. Harirchi, D. Dave, and **A. Gupta**, *"Preemptive Scheduling of EV Charging for Providing Demand Response Services"*, *Sustainable Energy, Grids and Networks*, pp. 100986, 2022.

[J3] J. Tang, S. Shao, J. Song, and **A. Gupta**, *"Nash Equilibrium Control Policy against Bus-off Attacks in CAN Networks"*, *IEEE Transactions on Forensics & Security*, pp. 980-990, 2022.

[J4] S. Gupta, S. D'Alessandro, **A. Gupta**, S. Stockar, and M. Canova, *"A Computationally Efficient Algorithm for Perturbed Dynamic Programs (A-PDP)"*, *IEEE Control Systems Letters*, pp. 847-852, 2022.

[J5] Y. Deng, **A. Gupta**, and N. Shroff, *"Fleet Sizing and Charger Allocation in Electric Vehicle Sharing Systems"*, in *IFAC Journal of Systems and Control*, pp. 100210, 2022.

[J6] J. Regatti and **A. Gupta**, *"Finite Sample Analysis of Minmax Variant of Offline Reinforcement Learning for General MDPs"*, in *IEEE Open Journal on Control Systems*, vol. 1, pp. 152-163, 2022.

[J7] R. Singh, **A. Gupta**, and N. Shroff, *"Learning in Constrained Markov Decision Processes"*, in *IEEE Transactions on Control of Network Systems*, to appear, 2022.

[J8] Y. Deng, S. Shao, A. Mittal, R. Twumasi-Boakye, J. Fishelson, **A. Gupta**, and N. Shroff, *"Incentive Design and Profit Sharing in Multi-modal Transportation Network"*, in *Transportation Research Part B: Methodological*, vol. 163, pp. 1-21, 2022.

[J9] J. L. Heyman and **A. Gupta**, *"Rank Reduction in Bimatrix Games"*, in *International Game Theory Review*, pp. 2250017, 2022.

[J10] **A. Gupta**, S. D. Rajakumar, and M. Canova, *"An Algorithm to Warm Start Perturbed (WASP) Constrained Dynamic Programs"*, in *IEEE Open Journal on Control Systems*, vol. 1, pp. 1-14, 2022.

[J11] Z. Zhu, N. Pivaro, S. Gupta, **A. Gupta**, and M. Canova, *"Safe Model-based Off-policy Reinforcement Learning for Eco-Driving in Connected and Automated Hybrid Electric Vehicles"*, in *IEEE Transactions on Intelligent Vehicles*, vol. 7 (2), pp. 387-398, 2022.

[J12] Y. Deng, H. Chen, S. Shao, J. Tang, J. Pi, and **A. Gupta**, *"Multi-Objective Vehicle Rebalancing for Ridehailing System using a Reinforcement Learning Approach", in Journal of Management Science and Engineering*, vol. 7(2), pp. 346-364, 2022.

[J13] S. D. Rajakumar, S. Gupta, **A. Gupta**, and M. Canova, *"Real-time Eco-Driving Control in Electrified Connected and Autonomous Vehicles using Approximate Dynamic Programming", in ASME Journal of Dynamic Systems, Measurement and Controls*, vol. 144 (1), pp. 011111, 2022.

[J14] **A. Gupta** and W. B. Haskell, *"Convergence of recursive stochastic algorithms using Wasserstein divergence", in SIAM Journal on Mathematics of Data Science*, vol. 3 (4), pp. 1141–1167, 2021.

[J15] J. Tang and **A. Gupta**, *"A Sketching Approach for Prioritizing Communication Links in Static Teams", in IEEE Control Systems Letters*, vol. 6, pp. 1016–1021, 2021.

[J16] S. Shao and **A. Gupta**, *"Fair Pricing of Ridehailing Services with Asymmetric Demand and Travel Time", in IEEE Transactions on Control of Networked Systems*, vol. 9(2), pp. 670-681, 2021.

[J17] H. Li, S. Shao, and **A. Gupta**, *"Fitted Value Iteration in Continuous Markov Decision Processes with State Dependent Action Sets", in IEEE Control Systems Letters*, vol. 6, pp. 1310–1315, 2021.

[J18] **A. Gupta**, *"Existence of Team-Optimal Strategies in Teams with Countable Observation Spaces", in IEEE Transactions on Automatic Control*, pp. 4792 – 4798, 2021.

[J19] **A. Gupta**, H. Chen, J. Pi, and G. Tendolkar, *"Some limit properties of Markov chains induced by recursive stochastic algorithms", SIAM Journal on Math of Data Science*, vol. 2, no. 4, pp. 967–1003, 2020.

[J20] **A. Gupta**, *"Optimal solutions in static teams with common information: A topology of information approach." SIAM Journal on Control and Optimization*, vol. 58, no. 2, pp. 998–1021, 2020.

[J21] B. Dakhil and **A. Gupta**, *"Auctioning electricity under deep renewable integration using a penalty for shortfall"*, in *Sustainable Energy, Grids and Networks*, vol. 20, 2019.

[J22] **A. Gupta**, C. Langbort, and T. Başar, *"Dynamic games with asymmetric information and resource constrained players with applications to security*

*of cyberphysical systems"*, in *IEEE Transactions on Control of Network Systems*, vol. 4, no. 1, pp. 71–81, 2017.

[J23] **A. Gupta**, S. Yüksel, T. Başar, and C. Langbort, *"On the existence of optimal policies for a class of static and sequential dynamic teams"*, in *SIAM Journal on Control and Optimization*, Volume 53, No. 3, pp. 1681–1712, June 2015.

[J24] **A. Gupta**, A. Nayyar, C. Langbort, and T. Başar, *"Common information based Markov perfect equilibria for linear-Gaussian games with asymmetric information"*, in *SIAM Journal on Control and Optimization*, Volume 52, Issue 5, pp. 3228–3260, November 2014.

[J25] M. Barbie and **A. Gupta**, *"The topology of information on the space of probability measures over Polish spaces"*, in *Journal of Mathematical Economics*, Volume 52, pp. 98–111, May 2014.

[J26] A. Nayyar, **A. Gupta**, C. Langbort, and T. Başar, *"Common Information based Markov perfect equilibria for stochastic games with asymmetric information: Finite games"*, in *IEEE Transactions of Automatic Control*, Volume 59, pp. 555–570, March 2014.

[J27] S. Bhattacharya, **A. Gupta**, and T. Başar, *"Jamming in mobile networks: A game-theoretic approach"*, in *Journal of Numerical Algebra, Control and Optimization*, Volume 3, Number 1, pp. 1-30, 2013.

[J28] A. Sarkar, **Abhishek**, and U. A. Yajnik, *"PeV scale Left-Right symmetry and Baryon asymmetry of the universe"*, in *Nuclear Physics B*, Volume 800, Issue 1-2, pp. 253-269, 2008.

## Conference Proceedings

[C1] H. Chen, J. Tang, and **A. Gupta**, *"Change Detection of Markov Kernels using Maximum Mean Discrepancy". In IEEE Conference on Decision and Control*, to appear, 2022.

[C2] J. Regatti, H. Chen, and **A. Gupta**, *"Byzantine Resilience With Reputation Scores ". In Proc. Annual Allerton Conference on Communication, Control, and Computing (Allerton)*, pp. 1-8, 2022.

[C3] Y. Deng, X. Zhou, A. Ghosh, **A. Gupta**, and N. Shroff, *"Interference Constrained Beam Alignment for Time-Varying Channels via Kernelized Bandits"*, in *Proc. of 20th International Symposium on Modeling and Optimization in Mobile, Ad hoc, and Wireless Networks (WiOpt)*, pp. 25-32, 2022.

[C4] Y. Deng, X. Zhou, B. Kim, A. Tewari, **A. Gupta**, and N. Shroff, *"Weighted Gaussian Process Bandits for Non-stationary Environments"*, in *Proc. of 25th International Conference on Artificial Intelligence and Statistics*, pp. 6909-6932, 2022.

[C5] H. You, H. Wang, J. R. Regatti, J. Hall, A. Schnabel, B. Hu, J. Zhang, **A. Gupta**, and J. Wang, *"Intelligent Health Monitoring System Hardware Design for Paralleled Devices with Fast Dv/dt Output". In 2021 IEEE International Electric Machines & Drives Conference (IEMDC)*, 2021.

[C6] J. R. Regatti, H. You, H. Wang, J. Hall, A. Schnabel, B. Hu, J. Zhang, J. Wang, and **A. Gupta**, *"A Discussion of Artificial Intelligence Applications in SiC MOSFET Device Operation". In 2021 IEEE International Electric Machines & Drives Conference (IEMDC)*, 2021.

[C7] J. Regatti, G. Tendolkar, Y. Zhou, **A. Gupta**, and Y. Liang, *"Distributed SGD Generalizes Well Under Asynchrony". In Proc. 57th Annual Allerton Conference on Communication, Control, and Computing (Allerton)*, pp. 863-870, 2019.

[C8] J. Regatti and **A. Gupta**, *"Traffic-Aware Adaptive Routing for Minimizing Fuel Consumption"*, in *Proc. of 2019 American Control Conference*, pp. 4818-4825, 2019.

[C9] J. L. Heyman and **A. Gupta**, *"A Polynomial Time Algorithm to Solve* $2 \times n$ *Bimatrix Games"*, in *Proc. of 18th European Control Conference (ECC)*, pp. 1049-1054, 2019.

[C10] H. Sharma, R. Jain, and **A. Gupta**, *"An empirical relative value learning algorithm for non-parametric MDPs with continuous state space", in Proc. of 18th European Control Conference (ECC)*, pp. 1368-1373, 2019.

[C11] B. Dakhil and **A. Gupta**, *"Selling renewable generation with a penalty for shortfall"*, in *57th IEEE Conference on Decision and Control (CDC)*, pp. 6495–6500, December 2018.

[C12] J. Tang and **A. Gupta**, *"Communication link elimination in static LQG teams"*, in *56th Annual Allerton Conference on Communication, Control, and Computing*, pp. 290–296, IEEE, 2018.

[C13] **A. Gupta**, B. Dakhil, and R. Jain, *"Dynamic economic dispatch and price evolution under ramping constraints and uncertain demand"*, in *56th Annual Allerton Conference on Communication, Control, and Computing*, pp. 48–55, IEEE, 2018.

[C14] J. L. Heyman and **A. Gupta**, *"Colonel Blotto game with coalition formation for sharing resources"*, in *International Conference on Decision and Game Theory for Security*, pp. 166–185, Springer, 2018.

[C15] A. Nayyar and **A. Gupta**, *"Information structures and values in zero-sum stochastic games"*, in *2017 American Control Conference (ACC)*, pp. 3658–3663, IEEE, 2017.

[C16] **A. Gupta**, *"Privacy-aware stochastic control with a "snoopy" adversary: A game-theoretic approach"*, in *Proc. of 2016 Annual Conference on Information Science and Systems*, pp. 193–197, March 2016.

[C17] **A. Gupta**, R. Jain, K. Poolla, and P. Varaiya, *"Equilibria in two-stage electricity markets"*, in *Proc. of 54th IEEE Conference in Decision and Control (CDC)*, pp. 5833–5838, December 2015.

[C18] **A. Gupta**, R. Jain, and P. Glynn, *"An empirical algorithm for relative value iteration for average-cost MDPs "*, in *Proc. of 54th IEEE Conference in Decision and Control (CDC)*, pp. 5079–5084, December 2015.

[C19] **A. Gupta**, R. Jain, and R. Rajagopal, *"Scheduling, pricing, and efficiency of non-preemptive flexible loads under direct load control"*, in *Proc. of 53rd Annual Allerton Conference on Communication, Control, and Computing*, pp. 1008–1015, October 2015.

[C20] **A. Gupta**, S. Yüksel, and T. Başar, *"On the existence of optimal strategies in dynamic stochastic teams"*, in *Proc. of 53rd IEEE Conference in Decision and Control (CDC)*, pp. 1681–1686, December 2014.

[C21] **A. Gupta** and T. Başar, *"Dynamic incentive design in multi-stage linear-Gaussian games with asymmetric information: A common information based approach"*, in *Proc. of 53rd IEEE Conference in Decision and Control (CDC)*, pp. 414–419, December 2014.

[C22] **A. Gupta**, T. Başar, and G. Schwartz, *"A three-stage Colonel Blotto game: When to provide more information to an adversary"*, in *Decision and Game Theory for Security (GameSec)*, Lecture Notes in Computer Science edited by R. Poovendran and W. Saad, Volume 8840, pp. 216 – 233, November 2014.

[C23] **A. Gupta**, G. Schwartz, C. Langbort, S. Sastry, and T. Başar, *"A Three-Stage Colonel Blotto game with applications to cyberphysical security"*, in *Proc. of 2014 American Control Conference (ACC)*, pp. 3832–3837, June 2014.

[C24] **A. Gupta**, S. Yüksel, and T. Başar, *"On the existence of optimal strategies in multi-agent stochastic teams"*, in *Proc. of 2014 American Control Conference (ACC)*, pp. 1945–1950, June 2014.

[C25] **A. Gupta**, A. Nayyar, C. Langbort, and T. Başar, *"A dynamic transmitter-jammer game with asymmetric information"*, in *Proc. of 51st IEEE Conference on Decision and Control (CDC)*, pp. 6477–6482, December 2012.

[C26] **A. Gupta**, P. Grover, C. Langbort, and T. Başar, *"On myopic strategies in dynamic adversarial team decision problems"*, in *Proc. of 46th Annual Conference on Information Sciences and Systems (CISS)*, pp. 1–6, March 2012.

[C27] **A. Gupta**, C. Langbort, and T. Başar, *"One-stage control over an adversarial channel with finite codelength"*, in *Proc. of 50th IEEE Conference on Decision and Control (CDC)*, pp. 4072–4077, December 2011.

[C28] S. Bhattacharya, **A. Gupta**, and T. Başar, *"Decentralized opportunistic navigation strat- egies for multi-agent systems in the presence of an adversary"*, in *Proc. of IFAC World Congress*, vol. 18, pp. 11809–11814, August 2011.

[C29] **A. Gupta**, S. Bhattacharya, and T. Başar, *"Decentralized control of multi-agent system with adversarial switching topology"*, in *Infotech@Aerospace Conference, AIAA*, March 2011.

[C30] **A. Gupta**, C. Langbort, and T. Başar, *"Optimal control in the presence of an intelligent jammer with limited actions"*, in *Proc. of 49th IEEE Conference on Decision and Control (CDC)*, pp. 1096–1101, December 2010.

## Manuscripts Submitted

[S1] S. Shao, W. Haskell, and **A. Gupta**, *"Robustness to Modeling Errors in Risk-Sensitive Markov Decision Problems with Markov Risk Measures"*, *submitted to SIAM Journal on Control and Optimization, available on arXiv:2209.12937*, 2022.

[S2] J. Tang, J. Song, and **A. Gupta**, *"A Dynamic Watermarking Algorithm for Finite Markov Decision Problems"*, *submitted to IEEE Open Journal on Systems and Control*, 2022.

[S3] **A. Gupta**, R. Jain, and P. Glynn, *"Probabilistic contraction analysis of iterated random operators"*, *Submitted to IEEE Transactions on Automatic Control*, arXiv preprint arXiv:1804.01195, 2019.

[S4] Z. Zhu, S. Gupta, **A. Gupta**, and M. Canova, *"A Deep Reinforcement Learning Framework for Eco-driving in Connected and Automated Hybrid Electric Vehicles"*, *submitted to IEEE Transactions on Intelligent Transportation Systems*, 2021.

## In Preparation

[P1] J. Regatti, A. A. Deshmukh, F. Cheng, Y. H. Jung, **A. Gupta**, and U. Dogan, *"Offline RL With Resource Constrained Online Deployment"*, *in preparation*, 2021.

[P2] S. Shao, J. Pi, and **A. Gupta**, *"Weak Continuity of Dissimilarity Metrics between Measures over Polish Spaces"*, 2021.

## Invited Talks & Posters

[IT1] "Recursive Stochastic Algorithms: A Markov Chain Approach", Information Theory and its Applications, San Diego, USA, Feb 2020.

[IT2] "Recursive Stochastic Algorithms: A Markov Chain Approach", Tata Institute of Fundamental Research, Mumbai, India, Dec 2019.

[IT3] “Recursive Stochastic Algorithms: A Markov Chain Approach”, University of Texas at Austin, Nov 2019.

[IT4] “Rank Reduction in Bimatrix Games”, University of Michigan, Ann Arbor, June 2019.

[IT5] “Recursive Stochastic Algorithms: A Markov Chain Approach”, University of Michigan, Ann Arbor, June 2019.

[IT6] “Recursive Stochastic Algorithms: A Markov Chain Approach”, Google Deepmind (London), May 2019.

[IT7] “Auctioning Renewable Energy with a Penalty for Shortfall”, Isaac Newton Institute, Cambridge University, April 2019.

[IT8] “Recursive Stochastic Algorithms: A Markov Chain Approach”, MIT LIDS, April 2019.

[IT9] “Reinforcement Learning for Connected Autonomous Cars”, GE Global Research, Niskayuna, February 2019.

[IT10] “Auctioning Renewable Energy with a Penalty for Shortfall”, INFORMS Pricing and Revenue Management Conference, Canada, June 2018.

[IT11] “Dynamic Games with Asymmetric Information”, Indian Institute of Science, Bangalore, India, June 2017.

[IT12] “Witsenhausen’s Counterexample and Learning in Teams of Agents”, INFORMS Optimization Society Conference, Princeton, USA, March 2016.

[IT13] “Malicious Attacks on Networked Control Systems”, Networking Technology and Systems Early-Career Investigators (NeTS-ECI) Workshop, Arlington, USA, July 2015.

[IT14] “Cyber-physical System Security Problems as Dynamic Games: A Novel Solution Approach”, University of California at Los Angeles, USA, November 2014.

[IT15] “Axiomatic Foundations of Decision Theory”, University of California at Berkeley, USA, October 2014.

[IT16] “Cyber-physical System Security Problems as Dynamic Games: A Novel Solution Approach”, Carnegie Mellon University, Pittsburgh, USA, October 2014.

[IT17] “Dynamic Teams with Non-classical Information”, Carnegie Mellon University, Pittsburgh, USA, October 2014.

[IT18] “The Topology of Information on the Space of Measures over Polish Spaces”, University of California at Berkeley, USA, September 2014.

[IT19] "Dynamic Teams with Non-classical Information", University of California at Berkeley, USA, June 2014.

[IT20] "Multi-stage LQG Games and Incentive Design Problems with Asymmetric Information", Poster Session, 15th ACM Conference on Economics and Computation, Palo Alto, USA, June 2014.

[IT21] "Dynamic Sequential Decision Problems with Asymmetric Information: Some Existence Results", University of Southern California, Los Angeles, USA, May 2014.

[IT22] "Dynamic Games and Teams with Asymmetric Information: Some Existence Results", California Institute of Technology, Pasadena, USA, May 2014.

[IT23] "Common Information based Markov Perfect Equilibrium in Dynamic LQG Games with Asymmetric Information", 3rd Midwest Workshop on Control and Game Theory, Columbus, USA, April 2014.

[IT24] "Teams with Non-classical Information Structures: Some Technical Challenges", University of California Berkeley, USA, May 2013.

[IT25] "Optimal Control in the Presence of an Intelligent Jammer with Limited Actions", 2011 National Control Engineering Students Workshop, University of Maryland at College Park, USA, April 2011.

## PROFESSIONAL SERVICES

- General Chair for 2019 IMACCS Workshop at OSU
- Associate Editor for 2019 Indian Control Conference and 2019 American Control Conference
- Served as a reviewer for
  - IEEE Transactions on Automatic Control
  - SIAM Journal on Control and Optimization
  - Mathematics of Operations Research
  - IEEE Transactions on Control of Networked Systems
  - Automatica
  - Discrete Event Dynamic Systems
  - International Game Theory Review
  - Mathematics of Control, Signals, and Systems
  - IEEE Conference on Decision and Control (IEEE-CDC)
  - American Control Conference (ACC)
  - INFORMS Annual Meeting
  - IEEE International Conference on Computer Communications (INFOCOM)
- General Chair of 8th CSL Student Conference, 2013