## Abhishek Gupta

CONTACT Assistant Professor Cell: +1-217-819-6382

INFORMATION ECE Department, Email: gupta.706@osu.edu

The Ohio State University, http://gupta706.github.io/2015 Neil Avenue, Room 464,

Columbus, OH – 43210

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

INTERESTS 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

Introduction to Machine Learning

PROFESSIONAL Linear Algebra and Calculus for Machine Learning

Courses

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, 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.
- [J2] 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.
- [J3] 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.
- [J4] 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.
- [J5] 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.
- [J6] R. Singh, A. Gupta, and N. Shroff, "Learning in Constrained Markov Decision Processes", in IEEE Transactions on Control of Network Systems, to appear, 2022.
- [J7] 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.
- [J8] J. L. Heyman and **A. Gupta**, "Rank Reduction in Bimatrix Games", in International Game Theory Review, pp. 2250017, 2022.
- [J9] **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.
- [J10] 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.

- [J11] 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.
- [J12] 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.
- [J13] **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.
- [J14] 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.
- [J15] 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.
- [J16] 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.
- [J17] **A. Gupta**, "Existence of Team-Optimal Strategies in Teams with Countable Observation Spaces", in IEEE Transactions on Automatic Control, pp. 4792 4798, 2021.
- [J18] **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.
- [J19] **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.
- [J20] 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.
- [J21] **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.
- [J22] **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.

- [J23] **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.
- [J24] 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.
- [J25] 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.
- [J26] 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.
- [J27] 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 multiagent 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] S. Shao, H. Sartipizadeh, and A. Gupta, "Large-scale Market EV Charging Scheduling for the Demands with Different Reliability", submitted to IEEE Transactions on Intelligent Transportation Systems, 2022.
- [S3] 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.
- [S4] **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.
- [S5] 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