

Achin Jain

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Research Interests

Machine Learning, Robotics, Optimization, Control Theory, Statistics

Education

- 2015–present **University of Pennsylvania (UPenn)**, Philadelphia, U.S.A.
Ph.D. in Electrical and Systems Engineering GPA: 3.98/4
Advisor: Manfred Morari
- 2012–2015 **Swiss Federal Institute of Technology (ETH) Zurich**, Switzerland.
Master of Science in Robotics, Systems and Control GPA: 5.80/6
Advisors: Manfred Morari, Christopher Onder
- 2008–2012 **Indian Institute of Technology (IIT) Delhi**, India.
Bachelor of Technology in Mechanical Engineering GPA: 8.77/10

Experience

- 2015–present **University of Pennsylvania**, Philadelphia, U.S.A.
Research: Machine Learning for Smart Buildings
 - Novel algorithms for data-driven model predictive control (MPC)
 - Neural network based MPC for energy savings and climate control of a real building. See publication [C11](#)
 - Gaussian processes for optimal experiment design and stochastic MPC. See [talk](#) and publication [C9](#)
 - Decision trees and random forests for building control. See [talk](#) and publications [J4](#), [J3](#), [C6](#), [C5](#)**Research: Machine Learning for Autonomous Racing**
 - Algorithms for racing line optimization and minimum-time robust predictive control. See publication [C12](#)
 - Reducing manual effort required for system identification and parameter tuning. See publication [C10](#)
- 2019 **Amazon Web Services (AWS)**, Seattle, U.S.A.
Applied Scientist Intern at Amazon AI Platforms
 - Deep reinforcement learning in robotics, jointly with Amazon Robotics AI and AWS RoboMaker
- 2018 **Flexergy AI**, Philadelphia, U.S.A.
Co-founder and Technology Lead
 - Flexergy uses data-driven control technology to make real-time recommendations on how to reduce energy costs in commercial buildings while maintaining occupant comfort [\[video\]](#)
- 2014 **Daimler A.G.**, Stuttgart, Germany.
Researcher at Advanced Engineering Powertrain Research Group
 - Control-oriented modeling of a hybrid electric vehicle with an electric-boost (Formula 1 configuration)
 - Designed a framework for optimal energy management using dynamic programming for (1) minimizing fuel consumption and (2) maximizing acceleration performance. See overview [slides](#) and publication [J2](#)
- 2013–2014 **ABB Corporate Research**, Dättwil, Switzerland.
Intern at Control and Optimization Group
 - Black-box optimization using surrogate functions of noisy and computationally expensive models
 - Optimal power management of a wind farm using model predictive control
- 2013 **Automatic Control Lab**, ETH Zurich, Switzerland.
Semester Thesis
 - Model predictive control for wind turbines, with a focus on MPC tuning trade-offs. Check publication [J1](#)
- 2011–2012 **Mechatronics Lab**, IIT Delhi, India.
Bachelor Thesis
 - Prototyped a Brain Machine Interface, to assisting spinal cord injury victims regain motor abilities [\[video\]](#)
 - Used neural signals from primate's brain during 1-D motion to control a (self-designed) delta robot

Teaching

- Fall 2019 **Topics in Deep Learning**, STAT991 UPenn.
Student talk on "Hindsight experience replay" [\[slides\]](#)
- Spring 2019 **Optimization Methods in Machine Learning**, STAT991 UPenn.
Student talk on "Fast nonconvex optimization" [\[slides\]](#)
Reinforcement Learning, STAT991 UPenn.
Student talk on "Model-free learning and control using monte carlo and temporal difference methods"
Model Predictive Control, ESE619 UPenn.
Instructor for "Constrained finite time optimal control" with Manfred Morari
- Spring 2018 **Learning and Control**, ESE680 UPenn.
Guest Lecturer for "Learning and control using Gaussian processes"
- Fall 2017 **Machine Learning**, CIS520 UPenn.
Teaching Assistant with Shivani Agarwal and Lyle Ungar
- Summer 2017 **Introduction to Probability and Statistics**, ENM503 UPenn.
Teaching Assistant with Santosh Venkatesh
- Spring 2017 **Model Predictive Control**, ESE619 UPenn.
Teaching Assistant with Manfred Morari
- Fall 2016-17 **Real-Time Embedded Systems**, ESE519 UPenn.
Instructor for "Real-time control systems" with Rahul Mangharam

Honors and Awards

- 2018 **Best Paper Award** at IEEE/ACM International Conference on Cyber-Physical Systems (ICCPs)
- 2017 Energy Systems **Best Paper Award** at the 2017 IEEE American Control Conference (ACC)
- 2016 **Best Presentation Award** at the 3rd ACM International Conference on Systems for Energy-Efficient Built Environments (BuildSys), Stanford University
- 2016 Selected for French-American Doctoral Exchange (FADEX) on Cyber-Physical Systems, Grant from Office of Science and Technology, Embassy of France in the US
- 2015 Master's Degree with Distinction for scoring overall grade 5.75+, ETH Zurich
- 2012 **Swiss Government Excellence Scholarship** (ESKAS), ETH Zurich
- 2012 Scholarship by ParisTech Foundation
- 2012 BOSS Award for the **Best Experimental Bachelor Thesis**, IIT Delhi
- 2011-12 Undergraduate Scholarship, IIT Delhi
- 2008-09 Semester Merit Awards (2) for ranking in top 7% in the batch, IIT Delhi

Publications [\[Google Scholar Citations: 228, h-index: 9, i-index: 9 as on March 1, 2020\]](#)

Journals

- J5 F. Smarra, G. D. Di Girolamo, V. De Iuliis, **A. Jain**, R. Mangharam, A. D'Innocenzo. Data-driven switched affine modeling for MPC using regression trees and random forests. Nonlinear Analysis: Hybrid Systems (NAHS), 2020. [\[pdf\]](#)
- J4 F. Smarra*, **A. Jain***, T. Rubeis*, D. Ambrosini, A. D'Innocenzo, R. Mangharam. Data-driven model predictive control using random forests for building energy optimization and climate control. Applied Energy, 2018. [\[pdf\]](#)
- J3 **A. Jain**, F. Smarra, M. Behl, R. Mangharam. Data-driven model predictive control with regression trees – An application to building energy management. ACM Transactions on Cyber-Physical Systems, 2018. [\[pdf\]](#)
- J2 **A. Jain**, T. Nüesch, C. Nägele, P. M. Lassus, C. H. Onder. Modeling and control of a hybrid electric vehicle with an electrically assisted turbocharger. IEEE Transactions on Vehicular Technology, 2016. [\[pdf\]](#)
- J1 **A. Jain**, G. Schildbach, L. Fagiano, M. Morari. On the design and tuning of linear model predictive control for wind turbines. Renewable Energy, 2015. [\[pdf\]](#)

Conferences

- C13 **A. Jain**, P. Chaudhari, M. Morari. BayesRace: Minimum time robust predictive control using prior experience for autonomous racing. [in preparation]
- C12 **A. Jain**, M. Morari. Computing the racing line using Bayesian optimization. arXiv preprint arXiv:2002.04794, 2020. [\[pdf\]](#)
- C11 **A. Jain**, F. Smarra, E. Reticcioli, A. D'Innocenzo, M. Morari. NeurOpt: Neural network based optimization for building energy management and climate control. The 2nd Annual Conference on Learning for Dynamics and Control (L4DC), 2020. [\[pdf\]](#)
- C10 M. O'Kelly*, H. Zheng*, **A. Jain***, J. Auckley, K. Luong, R. Mangharam. Tunercar: A superoptimization toolchain for autonomous racing. The International Conference on Robotics and Automation (ICRA), 2020.
- C9 **A. Jain***, T. X. Nghiem*, M. Morari, R. Mangharam. Learning and control using Gaussian processes. The ACM/IEEE 9th International Conference on Cyber-Physical Systems (ICCPs), 2018. [\[pdf\]](#) – **Best Paper Award**
- C8 **A. Jain**, D. Nong, T. X. Nghiem, R. Mangharam. Digital twins for efficient modeling and control of buildings – An integrated solution with SCADA systems. Building Performance Analysis Conference and SimBuild, 2018. [\[pdf\]](#)
- C7 F. Smarra, **A. Jain**, R. Mangharam, A. D'Innocenzo. Data-driven switched affine modeling for model predictive control. The 6th IFAC Conference on Analysis and Design of Hybrid Systems, 2018. [\[pdf\]](#)
- C6 **A. Jain**, F. Smarra, R. Mangharam. Data predictive control using regression trees and ensemble learning. The 56th IEEE Conference on Decision and Control (CDC), 2017. [\[pdf\]](#)
- C5 **A. Jain**, M. Behl, R. Mangharam. Data predictive control for building energy management. The 2017 American Control Conference, 2017. [\[pdf\]](#) – **Energy Systems Best Paper Award**
- C4 **A. Jain**, M. Behl, R. Mangharam. Data predictive control for peak power reduction. The 3rd ACM International Conference on Systems for Energy-Efficient Built Environments (BuildSys), 2016. [\[pdf\]](#) – **Best Presentation Award**
- C3 M. Behl, **A. Jain**, R. Mangharam. Data-driven modeling, control and tools for cyber-physical energy systems. The IEEE 7th International Conference on Cyber-Physical Systems, 2016. [\[pdf\]](#)
- C2 **A. Jain**, J. Qin, G. Abba. Optimal workplacement for robotic friction stir welding task. The 3rd IFToMM International Symposium on Robotics and Mechatronics (ISRM), 2013. [\[pdf\]](#)
- C1 P. Ajay, P. Singhal, **A. Jain**, S. Mukherjee. Teleoperation through brain machine interface. The National Conference on Emerging Trends in Mechanical Engineering, 2012. [\[pdf\]](#)

Technical Reports and Thesis

- T3 **A. Jain**, K. Jang. Classification of tweets using supervised and semisupervised learning. CIS520 Machine Learning Competition, University of Pennsylvania, 2016. [\[pdf\]](#)
- T2 **A. Jain**. Optimal control of a hybrid electric vehicle with an electrically assisted turbocharger. Master's Thesis, ETH Zurich, 2014. [\[pdf\]](#)
- T1 J. Poland, **A. Jain**, K. So. Ordinal regression for meta-modeling in optimization. Technical Report, ABB Corporate Research Switzerland, 2014. [available upon request]

Invited Talks

Autonomous Robotic Manipulation using Deep Reinforcement Learning

- 10/2019 Amazon India, Bangalore, India
- 09/2019 AWS RoboMaker, Seattle, USA
- 09/2019 Amazon Robotics AI, Seattle, USA

Learning and Control using Gaussian Processes

- 07/2019 Amazon Machine Learning Conference (AMLC) 2019, Seattle, USA
- 08/2018 Honeywell – worldwide online talk
- 04/2018 University of L'Aquila, Italy

Bridging Machine Learning and Controls for Intelligent Buildings

10/2018 International Conference on Industrial Internet (ICII), Seattle, USA
 09/2018 TEDergy, Building Performance Analysis Conference and SimBuild, Chicago, USA
 07/2018 Intelligent Buildings Workshop, Purdue University, USA

From Energy Efficiency to Energy Flexibility for Smart Cities

02/2018 Smart Cities Forum, Perry World House, Philadelphia, USA

Bridging Machine Learning and Controls for Volatile Energy Markets

12/2017 Australian National University, Canberra, Australia

08/2017 Amazon, Bangalore, India

08/2017 Flipkart Data Science, Bangalore, India

08/2017 TCS Innovation Labs, Bangalore, India

05/2017 Microsoft Research Redmond, USA [\[video\]](#)

05/2017 University of Washington, Seattle, USA

03/2017 Ph.D. Colloquium, University of Pennsylvania, USA

Data Predictive Control for Energy Cyber-Physical Systems

07/2016 University of L'Aquila, Italy

07/2016 French-American Doctoral Exchange, Grenoble, France

Optimal Control of a Hybrid Electric Vehicle with an Electrically Assisted Turbocharger

02/2016 Ph.D. Colloquium, University of Pennsylvania, USA

12/2014 Daimler AG, Stuttgart, Germany

Coursework

Machine Learning	Deep Learning, Reinforcement Learning, Online Methods in Machine Learning, Optimization Methods in Machine Learning
Probability & Statistics	Theory of Probability, Mathematical Statistics, Applied Regression and Analysis of Variance, Applied Econometrics
Optimization & Controls	Convex Optimization, Model Predictive Control, Dynamic Programming and Optimal Control, Recursive Estimation, Systems Identification, Control Systems-I & II, Nonlinear Controls, Linear Systems Theory
Miscellaneous	Robotics, Advanced Robotics, Vehicle Propulsion Systems

Technical Skills

Programming	Python, MATLAB, R, C++
Machine Learning	TensorFlow, PyTorch, Keras, SageMaker, GPflow, GPML, scikit-learn, RL Coach, RL Baselines, Deep RL Spinning Up
Optimization	CPLEX, CVX, CVXPY, YALMIP, MPT, CasADi, CVXOPT, IPOPT
Modeling	Simulink, EnergyPlus, Modelica, SolidWorks, Ansys APDL/Workbench
Robotics	MuJoCo, OpenAI Gym, ROS

Professional Services

Web Chair	Workshop on Autonomy in Cyber-Physical Systems at CPS-IoT Week, 2020 [link]
Reviewer	IEEE Transactions on Automation Science and Engineering (TASE), 2020 Energy and AI (EAI) Journal, 2020 Energy and Buildings Journal, 2019 Conference on Decision and Control (CDC), 2019 Journal of Artificial Intelligence Research (JAIR), 2018 ACM/IEEE International Conference on Cyber-Physical Systems (ICCPs), 2018 American Control Conference (ACC), 2017 IEEE Transactions on Vehicular Technology (TVT Journal), 2015 IEEE IET Control Theory and Applications Journal, 2015

Foundations and Trends in Electronic Design Automation Journal, 2015
Energies MDPI Journal, 2015
Secretary Society of Automotive Engineers (SAE) IIT Delhi, 2011-12
Coordinator Suspension Department, Formula Racing Team IIT Delhi, 2010-11
Speaker CAD Workshops, IIT Delhi, 2011

In the News

- 2020 Researchers at Empa Switzerland write about “self-learning control system” where they deploy my research on Data Predictive Control [\[link\]](#). Related publications [J4](#), [C6](#), [C5](#)
- 2018 Penn Engineers Win Award for Paper on AI for Smart Buildings [\[link\]](#). Related publication [C9](#)
- 2017 Achin Jain, Madhur Behl and Rahul Mangharam won ACC Best Paper award for their work on Energy Systems [\[link\]](#). Related publication [C5](#)
- 2014 Featured on ABB Switzerland’s webpage [\[link\]](#)
- 2012 Finalist for the Samsung Innovation Award [\[link1\]](#) [\[link2\]](#)