

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
Advisor: Manfred Morari
GPA: 3.98/4
- 2012–2015 **Swiss Federal Institute of Technology (ETH) Zurich**, Switzerland.
Master of Science in Robotics, Systems and Control
Advisors: Manfred Morari, Christopher Onder
GPA: 5.80/6
- 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
 - Developed new algorithms for black-box modeling of physical systems that enable predictive control
 - Currently deploying and testing these algorithms to a real building to evaluate energy cost savings
 - Applied principles of Gaussian processes, deep learning, Bayesian optimization, optimal experiment design, and stochastic model predictive control. See [talk](#) and publications [C9](#), [C11](#)
 - Adapted decision trees and random forests for control. See [talk](#) and publications [J3](#), [J4](#), [C5](#), [C6](#)**Research: Machine Learning for Autonomous Racing**
 - Working on algorithms for optimizing racing line and minimum-time robust predictive control
 - With focus on reducing effort required for system identification, especially at high-speeds
- 2019 **Amazon Web Services (AWS)**, Seattle, U.S.A.
Applied Scientist Intern at Amazon AI Platforms
 - Worked on an application of 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 [\[video\]](#)
 - Managing pilot deployments on real buildings to estimate savings under different scenarios
- 2014 **Daimler A.G.**, Stuttgart, Germany.
Researcher at Advanced Engineering Powertrain Research Group
 - Developed a control-oriented model of a hybrid electric vehicle with an electric-boost (Formula 1 config)
 - 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
 - Investigated the use of regression models as meta-models for optimization of computationally expensive and noisy functions; applied to design optimization of finite element models
 - Applied principles of support vector machines, black-box optimization, and model predictive control
- 2013 **Automatic Control Lab**, ETH Zurich, Switzerland.
Semester Thesis
 - Designed model predictive controller for wind turbines, with a focus on controller's tuning tradeoffs
 - Proposed a tuning approach based on sensitivity analysis and tested its performance
 - Used principles of modeling of dynamical systems and model predictive control. 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
 - 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 **Reinforcement Learning**, STAT991 UPenn.
Student talk on "Model-free learning and control using monte carlo and temporal difference methods"
- Spring 2019 **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 Selected for Amazon's 5th annual Graduate Research Symposium
- 2017 Energy Systems **Best Paper Award** at the 2017 IEEE American Control Conference (ACC)
- 2016 3rd prize in CIS 520 Machine Learning Competition on Tweet Classification, UPenn
- 2016 **Best Presentation Award** at the 3rd ACM International Conference on Systems for Energy-Efficient Built Environments (BuildSys), Stanford University
- 2016 Diversity Scholarship, PyData Chicago
- 2016 Selected for GE Student Research Summit
- 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
- 2012 Samsung Innovation Award, finalist
- 2011-12 Undergraduate Scholarship, IIT Delhi
- 2008-09 Semester Merit Awards (2) for ranking in top 7% in the batch, IIT Delhi

Publications [\[Google Scholar Citations: 201, h-index: 9, i-index: 8 as on January 1, 2020\]](#)

Journals

- 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 & 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

- C12 **A. Jain**, P. Chaudhari, M. Morari. BayesRace: Minimum time robust predictive control using prior experience for autonomous racing. [in preparation]
- 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. [submitted] [\[pdf\]](#)
- 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 Work Placement 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

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|--------------------------|---|
| 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

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| 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 |

Other Activities

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| 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 Buildings Journal, 2019 |
| | Amazon Machine Learning Conference (AMLC), 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

- 2016-18 The only Ph.D. student to be featured 3 times in ESE department's accomplishments at UPenn [\[link\]](#)
- 2018 Penn Engineers Win Award for Paper on AI for Smart Buildings [\[link\]](#)
- 2017 Achin Jain, Madhur Behl and Rahul Mangharam won ACC Best Paper award for their work on Energy Systems [\[link\]](#)
- 2014 Featured on ABB Switzerland's webpage [\[link\]](#)
- 2012 Finalist for the Samsung Innovation Award [\[link1\]](#) [\[link2\]](#)