

Achin Jain

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Research Interests

Machine Learning, Optimization, Control Theory, Statistics, Cyber-Physical Systems

Education

- 2015–present **University of Pennsylvania (UPenn)**, Philadelphia, U.S.A.
Ph.D. in Electrical and Systems Engineering GPA: 3.97/4
Advisors: Rahul Mangharam, 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
 - Developed new algorithms for black-box modeling of physical systems that enable predictive control
 - Applied principles of Gaussian processes, Bayesian optimization, optimal experiment design, and stochastic model predictive control to save energy costs in buildings. See [talk](#) and publication [C7](#)
 - Adapted decision trees and random forests for control. See [talk](#) and publications [J3](#), [J4](#), [C5](#), [C6](#)**Research: Machine Learning for Autonomous Racing**
 - Recently started working on model correction in [F1/10](#) car using machine learning for high-speed maneuvers
- 2018–present **Flexergy AI**, Philadelphia, U.S.A.
Co-founder and Chief Technology Officer
 - Flexergy uses data-driven control technology to make real-time recommendations on how to reduce energy costs in commercial buildings while maintaining occupant comfort [\[video\]](#)
 - Currently managing pilot deployments on real buildings to estimate savings under different scenarios
 - Funded by NSF – received \$225K SBIR Phase I grant; now awaiting results for \$750K SBIR Phase II
- 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

- Spring 2019 **Reinforcement Learning**, STAT991 UPenn.
Lecture on "Model-free Learning and Control using Monte Carlo and Temporal Difference Methods"
- Spring 2019 **Model Predictive Control**, ESE619 UPenn.
Lecture on "Constrained Finite Time Optimal Control"
- Fall 2017 **Machine Learning**, CIS 520 UPenn.
Teaching Assistant
- Summer 2017 **Introduction to Probability and Statistics**, ENM503 UPenn.
Teaching Assistant
- Spring 2017 **Model Predictive Control**, ESE619 UPenn.
Teaching Assistant
- Fall 2016-17 **Real-Time Embedded Systems**, ESE519 UPenn.
Lectures (2) on "Real-time Control Systems"

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: 114, h-index: 7, i-index: 4 as on Jan 31, 2019]

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

- C9 **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. [\[pdf\]](#)

- C8 F. Smarra, **A. Jain**, R. Mangharam, A. D'Innocenzo. Data-driven Switched Affine Modeling for Model Predictive Control. 6th IFAC Conference on Analysis and Design of Hybrid Systems, 2018. [\[pdf\]](#)
- C7 **A. Jain***, T. X. Nghiem*, M. Morari, R. Mangharam. Learning and Control using Gaussian Processes. 9th ACM/IEEE International Conference on Cyber-Physical Systems (ICCPs), 2018. [\[pdf\]](#) – **Best Paper Award**
- C6 **A. Jain**, F. Smarra, R. Mangharam. Data Predictive Control using Regression Trees and Ensemble Learning. 56th IEEE Conference on Decision and Control (CDC), 2017. [\[pdf\]](#)
- C5 **A. Jain**, M. Behl, R. Mangharam. Data Predictive Control for Building Energy Management. American Control Conference, 2017. [\[pdf\]](#) – **Energy Systems Best Paper Award**
- C4 **A. Jain**, M. Behl, R. Mangharam. Data Predictive Control for Peak Power Reduction. 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. 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. 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. 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

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

Learning and Control using Gaussian Processes

- 04/2018 University of LAquila, Italy
- 02/2018 Guest Lecture in ESE 680: Learning and Control, University of Pennsylvania, 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 LAquila, 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 (on-going)
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, GPflow, GPML, scikit-learn
Optimization	CPLEX, CVX, YALMIP, MPT, CasADi, CVXOPT, IPOPT
Modeling	Simulink, EnergyPlus, Modelica, SolidWorks, Ansys APDL/Workbench

Other Activities

Reviewer	Journal of Artificial Intelligence Research (JAIR), 2018 ACM/IEEE International Conference on Cyber-Physical Systems (ICCPs), 2018 American Control Conference, 2017 IEEE Transactions on Vehicular Technology, 2015 IEEE IET Control Theory and Applications, 2015 Foundations and Trends in Electronic Design Automation, 2015 Energies MDPI, 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]