

# 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

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## 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

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## 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

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

### 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. [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 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]

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## 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

|                  |  |
|------------------|--|
| 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 <a href="#">[link]</a>   |
| Reviewer  | IEEE Transactions on Automation Science and Engineering (TASE), 2020<br>Energy and Buildings Journal, 2019<br>Conference on Decision and Control (CDC), 2019<br>Journal of Artificial Intelligence Research (JAIR), 2018<br>ACM/IEEE International Conference on Cyber-Physical Systems (ICCPs), 2018<br>American Control Conference (ACC), 2017<br>IEEE Transactions on Vehicular Technology (TVT Journal), 2015<br>IEEE IET Control Theory and Applications Journal, 2015<br>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 [\[link1\]](#) [\[link2\]](#)