

# Achin Jain

## Research Interests

Machine Learning, Robotics, Optimization, Control Theory, Statistics

## Education

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

## Experience

2015–present	<b>University of Pennsylvania</b> , Philadelphia, U.S.A. <b>Research: Machine Learning for Smart Buildings</b> <ul style="list-style-type: none"><li>Developed new algorithms for black-box modeling of physical systems that enable predictive control</li><li>Currently deploying and testing these algorithms to a real building to evaluate energy cost savings</li><li>Applied principles of Gaussian processes, deep learning, Bayesian optimization, optimal experiment design, and stochastic model predictive control. See <a href="#">talk</a> and publications <a href="#">C9</a>, <a href="#">C11</a></li><li>Adapted decision trees and random forests for control. See <a href="#">talk</a> and publications <a href="#">J3</a>, <a href="#">J4</a>, <a href="#">C5</a>, <a href="#">C6</a></li></ul> <b>Research: Machine Learning for Autonomous Racing</b> <ul style="list-style-type: none"><li>Working on algorithms for optimizing racing line and minimum-time robust predictive control</li><li>With focus on reducing effort required for system identification, especially at high-speeds</li></ul>	
2019	<b>Amazon Web Services (AWS)</b> , Seattle, U.S.A. <b>Applied Scientist Intern at Amazon AI Platforms</b> <ul style="list-style-type: none"><li>Worked on an application of deep reinforcement learning in robotics, jointly with Amazon Robotics AI and AWS RoboMaker</li></ul>	
2018	<b>Flexergy AI</b> , Philadelphia, U.S.A. <b>Co-founder and Technology Lead</b> <ul style="list-style-type: none"><li>Flexergy uses data-driven control technology to make real-time recommendations on how to reduce energy costs in commercial buildings while maintaining occupant comfort <a href="#">[video]</a></li><li>Managing pilot deployments on real buildings to estimate savings under different scenarios</li></ul>	
2014	<b>Daimler A.G.</b> , Stuttgart, Germany. <b>Researcher at Advanced Engineering Powertrain Research Group</b> <ul style="list-style-type: none"><li>Developed a control-oriented model of a hybrid electric vehicle with an electric-boost (Formula 1 config)</li><li>Designed a framework for optimal energy management using dynamic programming for (1) minimizing fuel consumption and (2) maximizing acceleration performance. See overview <a href="#">slides</a> and publication <a href="#">J2</a></li></ul>	
2013–2014	<b>ABB Corporate Research</b> , Dättwil, Switzerland. <b>Intern at Control and Optimization Group</b> <ul style="list-style-type: none"><li>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</li><li>Applied principles of support vector machines, black-box optimization, and model predictive control</li></ul>	
2013	<b>Automatic Control Lab, ETH Zurich</b> , Switzerland. <b>Semester Thesis</b> <ul style="list-style-type: none"><li>Designed model predictive controller for wind turbines, with a focus on controller's tuning tradeoffs</li><li>Proposed a tuning approach based on sensitivity analysis and tested its performance</li><li>Used principles of modeling dynamical systems and model predictive control. Check publication <a href="#">J1</a></li></ul>	

- 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. Ackley, 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

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

## Other Activities

- |           |   |
|-----------|---|
| 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>Amazon Machine Learning Conference (AMLC), 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 |

- 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 [\[link1\]](#) [\[link2\]](#)