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Achin Jain

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
- 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 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 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

J5 F. Smarra, G. Di Girolamoa, 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.

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

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 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

Other Activities

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]