PEDRO HESPANHOL

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PROFESSIONAL SUMMARY

My research is focused on the interplay between control, learning, and optimization, with emphasis on autonomous systems applications and multi-agent systems. I have work experience in both prototyping (Python, Matlab) and developing production-level code (C, C++) of embedded algorithms for real-time applications, including nonlinear, hybrid, and stochastic systems, as well as a patent on an efficient algorithm for Model Predictive Control based on second-order methods. During Spring 2020, I have designed and taught a course on approximate dynamic programming and deep reinforcement learning theory and algorithms. My current research interests include: real-time optimal control, reinforcement learning, and algorithmic mechanism design.

CURRRENT POSITION

PhD Student, Industrial Engineering and Operations Research, UC Berkeley

EDUCATION

PhD, Industrial Engineering and Operations Research, UC Berkeley, 2020
Minors: Statistics and Economics
Advisor: Anil Aswani

MS, Industrial Engineering and Operation Research, UC Berkeley, 2016

BS, Industrial Engineering, Pontifical Catholic University Of Rio De Janeiro, 2014
Minor: Risk Analysis

RESEARCH AREAS AND COURSEWORK

Optimization Theory and Optimal Control
Math Programming I & II, Computational Optimization, Graph Algorithms and Network Flows, Predictive Control, Learning and Optimization, Applied Dynamic Programming

Statistical Learning and Deep Learning
Statistical Learning Theory, Deep Time-Series Learning, Deep Reinforcement Learning

Game Theory and Mechanism Design
Microeconomics and Game Theory, Mechanism Design and Agency Theory

Financial Engineering and Stochastic Processes
Financial Engineering I & II, Stochastic Processes I & II

JOURNAL PUBLICATIONS

Sensor Switching Control Under Attacks Detectable by Finite Sample Dynamic Watermarking Tests
Pedro Hespanhol, Matthew Porter, Ram Vasudevan, and Anil Aswani
Submitted to *IEEE Transactions on Automatic Control*, under 2nd round of review (2020)
preprint: https://arxiv.org/abs/1909.00014

Statistical Consistency of Set-Membership Estimator for Linear Systems
Pedro Hespanhol and Anil Aswani
IEEE Control Systems Letters (2020)
https://doi.org/10.1109/LCSYS.2020.2990998

Detecting Generalized Replay Attacks via Time-Varying Dynamic Watermarking
Matthew Porter, Pedro Hespanhol, Anil Aswani, Matthew Johnson-Roberson, and Ram Vasudevan
Submitted to *IEEE Transactions on Automatic Control*, under 2nd round of review (2020)
preprint: https://arxiv.org/abs/1909.08111

Adjoint-Based SQP Method with Block-Qise Quasi-Newton Jacobian Updates for Nonlinear Optimal Control
Pedro Hespanhol and Rien Quirynen
Optimization Methods and Software (2019)
https://doi.org/10.1080/10556788.2019.1653869

CONFERENCE PAPERS

Hypothesis Testing Approach to Detecting Collusion in Competitive Environments
Pedro Hespanhol and Anil Aswani
In Proceedings of *International Conference on Performance Evaluation Methodologies and Tools (Valuetools)*, to appear (2020)
preprint: https://arxiv.org/abs/2003.09967

Detecting Deception Attacks on Autonomous Vehicles via Linear Time-Varying Dynamic Watermarking
Matthew Porter, Sidhartha Dey, Arnav Joshi, Pedro Hespanhol, Anil Aswani, Matthew Johnson-Roberson, and Ram Vasudevan
In Proceedings of *Conference on Control Technology and Applications (CCTA)*, to appear (2020)
preprint: https://arxiv.org/abs/2001.09859

Surrogate Optimal Control for Strategic Multi-Agent Systems
Pedro Hespanhol and Anil Aswani
In Proceedings of *Conference on Decision and Control (CDC)* (2019)
https://doi.org/10.1109/CDC40024.2019.9029475

A Structure Exploiting Branch-and-Bound Algorithm for Mixed-Integer Model Predictive Control
Pedro Hespanhol, Rien Quirynen, and Stefano Di Cairano
In Proceedings of *European Control Conference (ECC)* (2019)
https://doi.org/10.23919/ECC.2019.8796242

Simulation and Real-World Evaluation of Attack Detection Schemes
Matthew Porter, Arnav Joshi, Pedro Hespanhol, Anil Aswani, Matthew Johnson-Roberson, and Ram Vasudevan
In Proceedings of *American Control Conference (ACC)* (2019)
https://doi.org/10.23919/ACC.2019.8815318

Statistical Watermarking for Networked Control Systems
Pedro Hespanhol, Matthew Porter, Ram Vasudevan, and Anil Aswani
In Proceedings of *American Control Conference (ACC)* (2018)
https://doi.org/10.23919/ACC.2018.8431569

Quasi-Newton Jacobian and Hessian Updates for Pseudospectral based NMPC
Pedro Hespanhol and Rien Quirynen
In Proceedings of *International Federation of Automatic Control (IFAC)* (2018)
https://doi.org/10.1016/j.ifacol.2018.10.169

A Real-Time Iteration Scheme with Quasi-Newton Jacobian Updates for Nonlinear Model Predictive Control

Pedro Hespanhol and Rien Quirynen

In Proceedings of *European Control Conference (ECC)* (2018)

<https://doi.org/10.23919/ECC.2018.8550541>

Family-Personalized Dietary Planning with Temporal Dynamics

Pedro Hespanhol and Anil Aswani

In Proceedings of *American Control Conference (ACC)* (2018)

<https://doi.org/10.23919/ACC.2018.8430885>

Impact of Occupancy Modeling and Horizon Length on HVAC Controller Efficiency

Christian Garaza, Pedro Hespanhol, Yonatan Mintz, Jhoanna Rhodette Pedrasa, and Anil Aswani

In Proceedings of *European Control Conference (ECC)* (2018)

<https://doi.org/10.23919/ECC.2018.8550389>

Dynamic Watermarking for General LTI Systems

Pedro Hespanhol, Matthew Porter, Ram Vasudevan, and Anil Aswani

In Proceedings of *Conference on Decision and Control (CDC)* (2017)

<https://doi.org/10.1109/CDC.2017.8263914>

PATENTS

System and Method for Mixed-Integer Model Predictive Control

Rien Quirynen, Pedro Hespanhol, and Stefano Di Cairano

2019 - application pending, filed on 03/11/2019

Method with quasi-Newton Jacobian updates for nonlinear predictive control

Rien Quirynen and Pedro Hespanhol

Sep 2019 - patent number: US10409233B2

<https://patents.google.com/patent/US10409233B2/en>

WORK HISTORY

UBER ATG, Pittsburgh, PA   May 2020

Autonomy Engineer II

- **Full time position rescinded due to Covid-19 - Referral letter available upon request*
- Incoming full-time employee on their Motion Planning team specializing in developing real-time optimal control algorithms for vehicle planning, decision-making, and motion control.

University Of California Berkeley, Berkeley, CA   January 2020 - May 2020

Course Instructor

- Lead Course Instructor of IEOR 265 - Learning and Optimization (Spring 2020).
- Designed a graduate-level course which covers approximate dynamic programming, deep reinforcement learning, and learning-based model predictive control (LBMPC).
- Course materials available on website: <http://pedrohespanhol.com>

UBER ATG, Pittsburgh, PA   May 2019 - August 2019

Software Engineering Intern

- Worked on the Motion Planning team developing new optimal control algorithms and software. Prototyped (Python) and developed production level code (C++) for real-time operation of autonomous vehicles.
- Validated methods with rigorous test cases to showcase improvement in vehicle/system performance.

Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA   May 2018 - August 2018
Research Intern

· Research on mixed-integer optimization algorithms. Developed efficient mixed integer software for fast online optimal control problems, focusing on implementation in embedded platforms.
· Developed algorithm in C and evaluated its performance on realistic optimal control problems, beating state-of-art solvers/methods across several different problems.

Mitsubishi Electric Research Laboratories (MERL) Cambridge, MA   June 2017 - September 2017
Research Intern

· Worked on research of efficient optimization algorithms tailored to solve non-linear optimal control problems, with emphasis on computational performance and solution tractability.
· Worked on implementation in C/C++ of such algorithms in embedded platforms, focusing on rigorously analyzing computation times and memory usage of the developed methods.

University Of California Berkeley, Berkeley, CA   January 2017 - December 2019
Graduate Student Instructor

· Graduate Student Instructor for IEOR 262A - Math Programming I. Graduate-level course which covers linear and nonlinear optimization theory and algorithms.
· Graduate Student Instructor for IEOR 165 - Engineering Statistics, Quality Control, and Forecasting. Senior undergraduate-level course which covers classical statistical and modern machine learning techniques applied to several industrial applications.
· Graduate Student Instructor for IEOR 151 - Service Design and Operation Analysis. Senior undergraduate-level course which covers analysis and modeling of service-based systems.

PSR - Energy Consulting and Analytics, Rio de Janeiro, Brazil   August 2014 - August 2015
Analyst

· Worked in development team (SDDP software): Extensive use of C/C++ and high-level mathematical modeling languages and statistical tools to improve software performance, decrease run-time, and solution output.
· Programmed optimization algorithm for HERA software: HERA is a geographical and financial analysis software to evaluate construction of hydro power-plants. HERA team won ENGIE Brazil Innovation Prize in 2015.
· Developed mathematical models and algorithms to support decision making in: energy trading, portfolio optimization, operation planning and capacity expansion in power systems.

NexO, Rio de Janeiro, Brazil   January 2012 to July 2013
Analyst Intern

· Worked in development team: Implemented mathematical algorithms to optimally operate oil refineries. Work done together with CENPES. (Petrobras' Research Center)
· Developed of graphical interfaces to show refineries products flows.

PRESENTATIONS AND INVITED TALKS

Surrogate Optimal Control for Strategic Multi Agent Systems
Professor S. Shankar Sastry semiautonomous group at UC Berkeley

A Structure Exploiting Branch-and-bound Algorithm For Mixed-integer Model Predictive Control
INFORMS Annual Meeting, Seattle, WA, 2019.

Statistically-Consistent Identification of Switched Linear Systems
INFORMS Annual Meeting, Seattle, WA, 2019.

Surrogate Optimal Control for Strategic Multi-Agent Systems
58th IEEE Conference on Decision and Control, Nice, France, December 11-13, 2019.

Statistical Watermarking for Networked Control Systems
Annual American Control Conference, Milwaukee, USA, June 27-29, 2018.

Newton Jacobian Updates for Nonlinear Model Predictive Control
Annual European Control Conference, Lymassol, Cyprus, June 12-15 2018.

Family-Personalized Dietary Planning with Temporal Dynamics
Annual American Control Conference, Milwaukee, USA, June 27-29, 2018.

Dynamic Watermarking for General LTI Systems
56th IEEE Conference on Decision and Control, Melbourne, Australia, December 12-15, 2017.

Deterministic Approximation Algorithm For Population-Scale Personal Dietary Management
INFORMS Computing Society Conference, Austin, TX, 2017.

Deterministic Approximation Algorithms For Population-scale Personal Dietary Management
INFORMS Annual Meeting, Nashville, TN, 2016.

HONORS AND AWARDS

Marshall-Oliver-Rosenberger Fellowship Award - granted by the Industrial Engineering and Operations Research Department at University of California Berkeley

Outstanding GSI Awards - granted by the Industrial Engineering and Operations Research Department at University of California Berkeley

Outstanding Graduate Student Instructor 2019 - granted by the Graduate Division of University of California Berkeley

ENGIE Brazil Innovation Prize - granted by ENGIE Group for the development of the HERA software.

PUC's Academic Performance Premium - granted by Pontifical Catholic University of Rio de Janeiro to students with the highest GPA.

Medal Graça Couto - granted by the Military School of Rio de Janeiro to the student with the highest academic performance of the school.

Medal Thomaz Coelho - granted by the Military School of Rio de Janeiro to the student with the highest GPU during all years during highschool.

TECHNICAL SKILLS

Programming Languages	C/C++ , Python, Matlab, R
Mathematical Programming	Xpress, Gurobi,CPLEX, GAMS, AMPL
Machine Learning and Big Data	TensorFlow, Pandas, Keras
Software and Algorithm Development	
Statistical and Risk Analysis	
Soft skills	Communicative. Proactive leader. Problem-solver
Languages	English, Portuguese, Spanish
Others	VBA, @Risk, Eviews, MS Office

VOLUNTEER WORK

Associação Paulo Cesar - Worked with a group of students to recover and repair computers for children in the community of Morro do Adeus in Rio de Janeiro, Brazil.