

# Bartolomeo Stellato

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## EDUCATION

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<b>University of Oxford</b> , Oxford, United Kingdom PhD in Engineering Science Thesis: “Mixed-Integer Optimal Control of Fast Dynamical Systems” Supervision: Prof. P. Goulart	2017
<b>ETH Zürich</b> , Zürich, Switzerland MSc in Robotics, Systems and Control Thesis: “Data-Driven Chance constrained Optimization” Supervision: Prof. B. Van Parys, Prof. J. Lygeros Final Grade: 5.51/6	2014
<b>Politecnico di Milano</b> , Milano, Italy BSc in Automation Engineering Final Grade: 110/110	2012

## RESEARCH INTERESTS

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Data-driven computational tools for mathematical optimization, machine learning and optimal control.

## RESEARCH EXPERIENCE

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<b>Princeton University</b> , Princeton NJ, USA Assistant Professor <b>Research:</b> Real-time and embedded optimization. Dynamical systems and optimization-based control. Differentiable optimization. First-order methods for large scale optimization. Machine learning for optimization and data-driven algorithms. <b>Applications:</b> control of fast dynamical systems, finance, robotics and autonomous systems.	Jul 2020 – Present
<b>MIT Sloan School of Management</b> , Cambridge MA, USA Postdoctoral Research Associate Project: “Machine Learning for Optimization” Supervision: Prof. D. Bertsimas Introduced the machine learning framework “The Voice of Optimization” for solving continuous and integer optimization. <ul style="list-style-type: none"><li>• Reformulated optimization algorithms as machine learning tasks (classification or regression) mapping data to the optimal solutions.</li><li>• Gained insights on the optimal solution behavior using interpretable machine learning models.</li><li>• Obtained multiple orders of magnitude speed improvements over state-of-the-art algorithms.</li></ul>	Jan 2018 – Jun 2020

**Stanford University**, Stanford CA, USA  
Visiting Student Researcher and Collaborator

2016 – 2018

Project: “OSQP: An Operator Splitting Solver for Quadratic Programs”  
Supervision: Prof. S. Boyd

Lead the development of the open-source numerical optimization software OSQP ([osqp.org](http://osqp.org)): the first industry-grade first-order algorithm for quadratic optimization (2 mln downloads).

- Corporate users include: Google, Lyft, Adobe, LinkedIn, Baidu, Amazon, Siemens.
- Academic users include: MIT, Stanford, Berkeley, UCLA, Oxford, ETH Zürich.
- Applications in Finance, Robotics, Machine Learning, Self-Driving Cars, Control.
- Outreach: created project website, users forum ([osqp.discourse.group](http://osqp.discourse.group)) and integrated it with CVXPY community.

**University of Oxford**, Oxford, United Kingdom  
European Union Marie Curie Fellow

Sep 2014 – Dec 2017

Project: “TEMPO: Training in Embedded Predictive Control and Optimization”  
Supervision: Prof. P. Goulart

Developed new algorithms for mixed-integer programming for optimal control problems of fast dynamical systems with discrete controls.

- Proposed approximate dynamic programming methods to solve mixed-integer optimization problems in  $< 25 \mu s$  ([First Paper Prize for IEEE Transactions on Power Electronics](#))
- Developed efficient smooth optimization algorithms to solve mixed-integer optimal control problems for switched dynamical systems (software package [SwitchTimeOpt.jl](#)).
- Outreach and dissemination: organized internal seminar activities, group website and github organization for software development and distribution at the Oxford Control Group.

**IMT Lucca**, Lucca, Italy  
Guest Scholar

Jan 2017

Project: “Mixed-Integer Quadratic Programming using the OSQP Solver”  
Supervision: Prof. A. Bemporad

Developed extensions of the OSQP solver for mixed-integer quadratic optimization with applications to embedded optimization (software package [miOSQP](#)).

**ETH Zürich**, Automatic Control Laboratory, Zurich, Switzerland  
Master Thesis Student

Feb 2014 – Aug 2014

Project: “Data-Driven Chance Constrained Optimization”  
Supervision: Prof. B. Van Parys, Dr. X. Zhang, Prof. P. Goulart and Prof. J. Lygeros

Derived data-driven tractable algorithms with guarantees for uncertain optimization programs based on distributionally robust optimization.

**Siemens**, Building Technologies Division, Zug, Switzerland  
Research Intern

Jul 2013 – Dec 2013

Project: “Adaptive Superheat Control on HVAC systems”  
Supervision: B. Baumann

Developed adaptive control schemes for safe automatic tuning of HVAC system controllers for large commercial buildings.

**ETH Zürich**, Institute for Dynamic Systems and Control, Zurich, Switzerland      Feb 2013 – Jun 2013  
Semester Student

Project: “A new quaternion-based LQR Controller for Quadcopters”

Supervision: Dr. R. Ritz, Prof. R. D’Andrea

Implemented and tested an efficient low level optimal controller for quadcopters based on quaternions able perform acrobatic maneuvers.

## AWARDS

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IEEE Trans. on Power Electronics First Place Prize Paper Award, PELS (1000\$)      Sep 2018  
Vice-Chancellors’ Fund, University of Oxford (3000£)      May 2017  
Masterclass Award, St Edmund Hall, University of Oxford (1000£)      Apr 2015  
Marie Curie PhD Fellowship, European Commission (250,000€)      Sep 2014

## TEACHING EXPERIENCE

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**Princeton University**      Fall 2020

Principal Lecturer. *ORF 522: Linear and Nonlinear Optimization*

Graduate level course on linear and nonlinear optimization with around thirty Ph.D. students. Planned the course and designed exercise sessions.

Topics include linear optimization modeling, duality, sensitivity analysis and interior point methods. First order and Newton’s methods for nonlinear optimization, real-time optimization and data-driven algorithms. Applications range from engineering and autonomous systems to finance and statistics.

**MIT Teaching & Learning Laboratory**      Aug 2019

Kaufman Teaching Certificate Program

Completed teaching program based on eight workshops aimed at developing teaching skills, organizing new courses and interacting with the students.

**University of Oxford**      Sep 2015 – Jun 2016

Tutor

Responsible for holding weekly *tutorials*: small interactive teaching sessions with groups of four students with in-depth discussions.

Undergraduate courses taught:

- System Identification (Trinity 2016)
- Optimal Control (Hilary 2016)
- Linear Dynamical Systems (Michaelmas 2015)

**University of Oxford**      Jun 2015 – Jun 2017

Laboratory Assistant

Co-organized hands-on undergraduate laboratory courses.

Laboratories covered:

- LEGO Football Laboratory (Trinity 2017)
- Instrumentation and Control Laboratory (Hilary 2017)
- Helicopter Laboratory (Trinity 2015)

## SUPERVISION

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### Princeton University

#### Senior Thesis

Holly Cunningham      2020 – Present

Ava Jiang      2020 – Present

Max Jun Kim      2020 – Present

## MIT

### Graduate Students

Shuvomoy Das Gupta (co-supervised with Prof. B. Van Parys) Sep 2019 – Present  
First-order methods for nonconvex and combinatorial optimization

Liangyuan Na (co-supervised with Prof. D. Bertsimas) Apr 2019 – Present  
Coupled adaptive and robust optimization

### MBA Students

Luca Mingardi (co-supervised with Prof. D. Bertsimas) Sep 2019 – Present  
Hearth disease predictions from ECG data

## SERVICE

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### Review

IEEE Transactions on Automatic Control, The American Statistician, IEEE Transactions on Power Electronics, Autonomous Robots, INFORMS Journal of Optimization, Optimal Control Applications and Methods, Computers and Operations Research, IEEE Access, IEEE Transactions on Control Systems Technology, IEEE Transactions on Neural Networks and Learning Systems.

### Conferences and seminars organization

Invited session “Mixed-Integer Programming in Control” Sep 2016  
European Conference on Computational Optimization (EUCCO), KU Leuven

Control and Optimization Seminars 2016 – 2017  
University of Oxford

## PUBLICATIONS

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### Journal Articles

Bertsimas, D. and B. Stellato. “The Voice of Optimization”. In: *Machine Learning* (June 2020). URL: <https://doi.org/10.1007/s10994-020-05893-5>.

Stellato, B., G. Banjac, P. Goulart, A. Bemporad, and S. Boyd. “OSQP: An Operator Splitting Solver for Quadratic Programs”. In: *Mathematical Programming Computation* (Feb. 2020). URL: <https://doi.org/10.1007/s12532-020-00179-2>.

Banjac, G., P. Goulart, B. Stellato, and S. Boyd. “Infeasibility detection in the alternating direction method of multipliers for convex optimization”. In: *Journal of Optimization Theory and Applications* 183.2 (2019), pp. 490–519. URL: <https://link.springer.com/article/10.1007%2Fs10957-019-01575-y>.

Stellato, B., T. Geyer, and P. Goulart. “High-Speed Finite Control Set Model Predictive Control for Power Electronics”. In: *IEEE Transactions on Power Electronics* 32.5 (May 2017), pp. 4007–4020. ISSN: 0885-8993. URL: <http://dx.doi.org/10.1109/TPEL.2016.2584678>.

Stellato, B., S. Ober-Blöbaum, and P. Goulart. “Second-Order Switching Time Optimization for Switched Dynamical Systems”. In: *IEEE Transactions on Automatic Control* 62.10 (Oct. 2017), pp. 5407–5414. ISSN: 0018-9286. DOI: [10.1109/TAC.2017.2697681](https://doi.org/10.1109/TAC.2017.2697681).

Stellato, B., B. P.G. Van Parys, and P. Goulart. “Multivariate Chebyshev Inequality with Estimated Mean and Variance”. In: *The American Statistician* 71.2 (2017), pp. 123–127. URL: <http://dx.doi.org/10.1080/00031305.2016.1186559>.

## Conference Proceedings

- Agrawal, A., S. Barratt, S. Boyd, and B. Stellato. “Learning Convex Optimization Control Policies”. In: *Proceedings of the 2nd Conference on Learning for Dynamics and Control*. Vol. 120. Proceedings of Machine Learning Research. PMLR, Oct. 2020, pp. 361–373. URL: <http://proceedings.mlr.press/v120/agrawal20a.html>.
- Stellato, B., V. V. Naik, A. Bemporad, P. Goulart, and S. Boyd. “Embedded Mixed-Integer Quadratic Optimization Using the OSQP Solver”. In: *European Control Conference (ECC)*. July 2018.
- Banjac, G., B. Stellato, N. Moehle, P. Goulart, A. Bemporad, and S. Boyd. “Embedded Code Generation Using the OSQP Solver”. In: *IEEE Conference on Decision and Control (CDC)*. Dec. 2017. URL: <https://ieeexplore.ieee.org/document/8263928>.
- Stellato, B. and P. Goulart. “High-Speed Direct Model Predictive Control for Power Electronics”. In: *European Control Conference (ECC)*. July 2016, pp. 129–134. URL: <http://ieeexplore.ieee.org/document/7810275/>.
- Stellato, B. and P. Goulart. “Real-time FPGA Implementation of Direct MPC for Power Electronics”. In: *IEEE Conference on Decision and Control (CDC)*. Dec. 2016, pp. 1471–1476. URL: <https://doi.org/10.1109/CDC.2016.7798474>.
- Stellato, B., S. Ober-Blöbaum, and P. Goulart. “Optimal Control of Switching Times in Switched Linear Systems”. In: *IEEE Conference on Decision and Control (CDC)*. Dec. 2016, pp. 7228–7233. URL: <https://doi.org/10.1109/CDC.2016.7799384>.

## Preprints

- Bertsimas, D., L. Boussioux, R. Cory Wright, A. Delarue, V. Digalakis, A. Jacquillat, D. Lahlou Kitane, G. Lukin, M. L. Li, L. Mingardi, O. Nohadani, A. Orfanoudaki, T. Papalexopoulos, I. Paskov, J. Pauphilet, O. Skali Lami, B. Stellato, H. Tazi Bouardi, K. Villalobos Carballo, H. Wiberg, and C. Zeng. “From predictions to prescriptions: A data-driven response to COVID-19”. In: *medRxiv* (2020). DOI: [10.1101/2020.06.26.20141127](https://doi.org/10.1101/2020.06.26.20141127). eprint: [2020.06.26.20141127](https://arxiv.org/abs/2020.06.26.20141127).
- Bertsimas, D., G. Lukin, L. Mingardi, O. Nohadani, A. Orfanoudaki, B. Stellato, H. Wiberg, S. Gonzalez-Garcia, C. L. Parra-Calderon, K. Robinson, M. Schneider, B. Stein, A. Estirado, L. a Beccara, R. Canino, M. Dal Bello, F. Pezzetti, and A. Pan. “COVID-19 Mortality Risk Assessment: An International Multi-Center Study”. In: *medRxiv* (2020). DOI: [10.1101/2020.07.07.20148304](https://doi.org/10.1101/2020.07.07.20148304). eprint: [2020.07.07.20148304](https://arxiv.org/abs/2020.07.07.20148304).
- Cauligi, A., P. Culbertson, B. Stellato, D. Bertsimas, M. Schwager, and M. Pavone. “Learning Mixed-Integer Convex Optimization Strategies for Robot Planning and Control”. In: *arXiv e-prints* (Mar. 2020). arXiv: [2004.03736](https://arxiv.org/abs/2004.03736) [cs.RG]. URL: <https://arxiv.org/abs/2004.03736>.
- Bertsimas, D. and B. Stellato. “Online Mixed-Integer Optimization in Milliseconds”. In: *arXiv e-prints* (July 2019). arXiv: [1907.02206](https://arxiv.org/abs/1907.02206) [math.OA]. URL: <https://arxiv.org/abs/1907.02206>.

## Theses

- Stellato, B. “Mixed-Integer Optimal Control of Fast Dynamical Systems”. PhD thesis. University of Oxford, 2017. URL: <https://ora.ox.ac.uk/objects/uuid:b8a7323c-e36e-45ec-ae8d-6c9eb4350629>.
- Stellato, B. “Data-driven chance constrained optimization”. MA thesis. ETH Zürich, 2014. URL: <http://dx.doi.org/10.3929/ethz-a-010266857>.

## SELECTED INVITED TALKS

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A Machine Learning Approach to Optimization	Jun 2020
<i>Mathematics of Data and Decisions at Davis (MADDD) Seminars</i> , UC Davis, CA	
The Voice of Optimization	Nov 2019

<i>Fields Institute Focus Program on Data Science and Optimization</i> , Toronto, CA	
The Voice of Optimization <i>IEOR Seminars</i> , UC Berkeley, USA	Oct 2019
The Voice of Optimization <i>SISL Seminars</i> , Stanford, USA	Oct 2019
The Voice of Optimization <i>Invited Session at the INFORMS Annual Meeting 2019</i> , Seattle, USA	Oct 2019
The Voice of Optimization <i>Operations Research Center IAP Seminar</i> , MIT, USA	May 2019
The Voice of Optimization <i>IDSS Seminar on Algebra Statistics and Optimization</i> , MIT, USA	Jan 2019
OSQP: An Operator Splitting Solver for Quadratic Programs <i>Intl. Symposium of Mathematical Programming (ISMP)</i> , Bordeaux, France	Jul 2018
OSQP: An Operator Splitting Solver for Quadratic Programs <i>Mathematical Institute</i> , University of Oxford, UK	Nov 2017
OSQP: An Operator Splitting Solver for Quadratic Programs <i>Control Systems Group</i> , Cambridge University, UK	Jun 2017
OSQP: An Operator Splitting Solver for Quadratic Programs <i>Operations Research Center</i> , MIT, USA	Jun 2017
High-Speed Integer Optimal Control Using Approximate Dynamic Programming <i>DYSCO Research Group</i> , IMT Lucca, Italy	Jan 2017
High-Speed Integer Optimal Control Using Approximate Dynamic Programming <i>MPC Laboratory</i> , UC Berkeley, USA	Oct 2016
Switching Time Optimization <i>European Conf. on Computational Optimization (EUCCO)</i> , KU Leuven, Belgium	Sep 2016
High-Speed Integer Optimal Control Using Approximate Dynamic Programming <i>European Conf. on Computational Optimization (EUCCO)</i> , KU Leuven, Belgium	Sep 2016

## TECHNICAL SKILLS

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Programming	Python, Julia, C, C++, SLURM, MATLAB, Git, Bash, L <sup>A</sup> T <sub>E</sub> X
Web Design	HTML, CSS, Javascript
Embedded Design	Xilinx FPGA Programming

## LANGUAGES

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Italian (Mother tongue)	English (Fluent C2)	French (Intermediate B1)	German (Basic A2)
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## INTERESTS AND ACTIVITIES

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Music	<p>Collection and playing</p> <ul style="list-style-type: none"> <li>• Piano diploma (5<sup>th</sup> year), <i>Istituto Superiore di Studi Musicali “F. Vitadini”</i>, Pavia, Italy, Grade 8.50/10</li> <li>• Music theory and solfeggio diploma, <i>Istituto Superiore di Studi Musicali “C. Monteverdi”</i>, Cremona, Italy, Grade 9.60/10</li> </ul>
MITaly	<p>Member of the MIT Italian Association Board.</p> <ul style="list-style-type: none"> <li>• Organized large events in collaboration with Italian communities and the Consulate General of Italy in Boston.</li> <li>• Organized seminar series with Italian professors at MIT and Harvard.</li> <li>• Developed the association main website (<a href="http://mitaly.mit.edu">mitaly.mit.edu</a>).</li> </ul>