

ALESSANDRO ALLA

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RESEARCH INTERESTS

Scientific Computing, Numerical Analysis, Machine Learning, Data-Driven modeling, Numerical Optimization, Optimization with PDE constraints, Open-Loop Control, Closed-Loop Control, Model Predictive Control, Hamilton-Jacobi-Bellman equations, Reduced Order Modeling, Proper Orthogonal Decomposition, Dynamic Mode Decomposition.

EMPLOYMENT

Pontifical Catholic University (PUC-Rio), Brazil. *August 2017–present*

Assistant Professor (Tenure-Track) in the Department of Mathematics

Research Area: Data-Driven Methods, Model Order Reduction for Nonlinear Dynamical Systems and Optimal Control Problems.

Florida State University, USA. *February 2016–July 2017*

PostDoctoral Researcher in the group of Prof. Max Gunzburger.

Research Area: Model Order Reduction for Nonlinear Dynamical Systems

University of Hamburg, Germany. *February 2014–January 2016*

PostDoctoral Researcher in the group of Prof. Michael Hinze.

Research Area: Model Order Reduction and Optimal Control within the project *SIMUROM*.

EDUCATION

Sapienza, University of Rome, Italy. *November 2010–January 2014*

Ph.D. in Applied Mathematics.

Advisor: Prof. Maurizio Falcone.

Thesis: *Model Reduction for a Dynamic Programming Approach to Optimal Control Problems with PDE Constraints*.

Committee: Prof. Elisabetta Carlini, Prof. Michael Hinze, Prof. Gianluigi Rozza.

Sapienza, University of Rome, Italy. *September 2007–December 2009*

M.Sc. in Applied Mathematics

Advisor: Prof. Maurizio Falcone.

Final Evaluation: 110/110 (on 5 year average).

Sapienza, University of Rome, Italy. *September 2004–September 2007*

B.Sc. in Mathematics.

PUBLICATIONS, CONFERENCE PROCEEDINGS, PREPRINTS, THESES

Peer Reviewed Publications

1. A. Alla, M. Falcone, L. Saluzzi, *A tree structure algorithm for optimal control with state constraints* accepted for Rendiconti di Matematica e delle sue Applicazioni, 2020.
<https://arxiv.org/abs/2009.12384>

2. A. Alla, C. Balzotti, M. Briani, E. Cristiani, *Understanding Mass Transfer Directions via Data-Driven Models with Application to Mobile Phone Data*, SIAM J. Appl. Dyn. Syst., **19**, 2020, 1372–1391.
3. A. Alla, B. Haasdonk, A. Schmidt, *Feedback control of parametrized PDEs via model order reduction and dynamic programming principle*, Advances in Computational Mathematics, **46**, 2020.
4. A. Alla, L. Saluzzi, *A HJB-POD approach for the control of nonlinear PDEs on a tree structure*, Applied Numerical Mathematics, **155**, 2020, 192-207.
5. A. Alla, M. Falcone, L. Saluzzi, *An efficient DP algorithm on a tree-structure for finite horizon optimal control problems*, SIAM J. Sci. Comput., **41**, 2019, A2384-A2406.
6. M. Hess, A. Alla, A. Quaini, G. Rozza, M. Gunzburger. *A localized reduced-order modeling approach for PDEs with bifurcating solutions*, Computer Methods in Applied Mechanics and Engineering, **311**, 2019, 379-403.
7. S. Rudy, A. Alla, S. Brunton, J.N. Kutz, *Data-driven identification of parametric partial differential equations*, SIAM J. Appl. Dyn. Syst., **18**, 2019, 643–660.
8. A. Alla, J.N. Kutz. *Randomized Model Order Reduction*, to appear in Advances in Computational Mathematics, **45**, 2019, 1251-1271.
9. A. Alla, M. Hinze, P. Kolvenbach, O. Lass, S. Ulbrich, *A Certified Model Reduction Approach for Robust Parameter Optimization with PDE Constraints*, in Advances in Computational Mathematics, **45**, 2019, 1221-1250.
10. A. Alla, C. Graessle, M. Hinze. *A-posteriori snapshots location for POD in optimal control of linear parabolic equations*, ESAIM:M2AN, **52**, 2018, 1847-1873.
11. A. Alla, M. Falcone, S. Volkwein. *Error analysis for POD approximations of infinite horizon problems via the dynamic programming approach*, SIAM J. Control Optim., **55**, 2017, 3091-3115.
12. A. Alla, J.N. Kutz. *Nonlinear model order reduction via Dynamic Mode Decomposition*, SIAM J. Sci. Comput., **39**, 2017, 778-796.
13. A. Alla, M. Falcone, D. Kalise. *A HJB-POD feedback synthesis approach for wave equation*, Bulletin of the Brazilian Mathematical Society, New Series, **47**, 2016, 51-64.
14. A. Alla, S. Volkwein. *Asymptotic Stability and Suboptimality of Model Predictive Control for semilinear PDEs*, in Advances in Computational Mathematics, Springer US, **41**, 2015, 1073-1102.
15. A. Alla, M. Falcone, D. Kalise. *An efficient Policy Iteration algorithm for dynamic programming equations*, SIAM J. Sci. Comput., **37**, 2015, 181-200.

Submitted Papers

16. A. Alla, C. Graessle, M. Hinze, *Time adaptivity in Model Predictive Control*, submitted to SIAM Journal on Control and Optimization.
<https://arxiv.org/pdf/2009.01332.pdf>

17. L. Saluzzi, A. Alla, M. Falcone, *Error estimates for a tree structure algorithm solving finite horizon control problems*, submitted to SIAM Journal on Numerical Analysis.
<https://arxiv.org/pdf/1812.11194.pdf>

Peer Reviewed Conference Proceedings

18. A. Alla, M. Falcone, L. Saluzzi, *High-order Approximation of the Finite Horizon Control Problem via a Tree Structure Algorithm*, in IFAC-PapersOnLine, **52**, 2019, 19-24.
19. A. Alla, V. Simoncini, *Order reduction approaches for the algebraic Riccati equation and the LQR problem*, In: Falcone M., Ferretti R., Grüne L., McEneaney W. (eds) Numerical Methods for Optimal Control Problems. Springer INdAM Series, **29**. Springer, Cham, 2019, 89-109.
20. J.N. Kutz, S. Rudy, A. Alla, S. Brunton *Data-driven discovery of governing physical laws and their parametric dependencies in engineering, physics and biology*, to appear in Conference Proceedings CAMSAP 2017.
21. A. Alla, G. Fabrini, M. Falcone. *A HJB-POD approach to the control of the level set equation*, In Benner P., Ohlberger M., Patera A., Rozza G., Urban K. (eds) Model Reduction of Parametrized Systems. MS&A (Modeling, Simulation and Applications), **17**. Springer, Cham, 2017, 317-331.
22. A. Alla, A. Schmidt, B. Haasdonk. *Model order reduction approaches for infinite horizon optimal control problems via the HJB equation*, In: Benner P., Ohlberger M., Patera A., Rozza G., Urban K. (eds) Model Reduction of Parametrized Systems. MS&A (Modeling, Simulation and Applications), **17**. Springer, Cham, 2017, 333-347.
23. A. Alla, U. Matthes. *Model order reduction for a linearized robust PDE constrained optimization*, in Conference Proceedings of the 2nd IFAC Conference on Control of Partial Differential Equations, **49**, 2016, 321-326.
24. A. Alla, C. Graessle, M. Hinze. *A residual based snapshot location strategy for POD in distributed optimal control of linear parabolic equations*, in Conference Proceedings of the 2nd Conference on Control of Partial Differential Equations, **49**, 2016, 13-18.
25. A. Alla, G. Fabrini, M. Falcone. *Coupling MPC and DP methods for an efficient solution of optimal control problems*, in System Modeling and Optimization, 27th IFIP TC 7 Conference, CSMO 2015, 68-77.
26. A. Alla, M. Hinze. *HJB-POD feedback control of advection-diffusion equation with a model predictive control snapshot sampling*, in Conference Proceedings of the 5th IFAC Conference on Nonlinear Model Predictive Control, **48**, 2015, 527-532.
27. A. Alla, M. Hinze, O. Lass, S. Ulbrich. *Model order reduction approaches for the optimal design of permanent magnets in electro-magnetic machines*, in Conference Proceedings MATHMOD **48**, 2015, 242-247.
28. A. Alla, M. Hinze. *HJB-POD feedback control for Navier-Stokes equations*, in Russo G., Capasso V., Nicosia G., Romano V. (eds) Progress in Industrial Mathematics at ECMI 2014. ECMI 2014. Mathematics in Industry, **22**. Springer, Cham, 2017, 861-868.
29. A. Alla, M. Falcone, D. Kalise. *An accelerated value/policy iteration scheme for the solution of DP equations*, Numerical Mathematics and Advanced Applications - ENUMATH 2013,

LNCSSE **103**, 2015, 489-497.

30. A. Alla, M. Falcone, D. Kalise. *An efficient Policy Iteration algorithm for dynamic programming equations*, PAMM, **37**, 2013, 467-468.
31. A. Alla, M. Falcone. *A time adaptive POD method for optimal control problems*, in Conference Proceedings of the 1st IFAC Conference on Control of Systems Governed by Partial Differential Equations, **1**, 2013, 245-250.
32. A. Alla, M. Falcone. *An adaptive POD approximation method for the control of advection-diffusion equations*, in Control and Optimization with PDE Constraints, K. Kunisch, K. Bredies, C. Clason, G. von Winckel (eds), International Series of Numerical Mathematics, **164**, Birkhäuser, Basel, 2013, 1-17.

Phd Thesis

33. A. Alla. *Model Reduction for a Dynamic Programming Approach to optimal control problems with PDE constraints*, PhD Thesis, 2014.

HONORS AND AWARDS

Bolsas de Produtividade em Pesquisa. Research grant from CNPq, 2019-2022.

Bolsa PUC de Produtividade em Pesquisa. Research grant from PUC-Rio, 2018-2022.

Brazilian-French Network in Mathematics. Financial Support for a research visit of Dr. Adriano Festa at PUC-Rio, 2018.

IMPA, Rio de Janeiro, Brazil. Financial support to attend the conference HYP2014, 2014.

European Science Foundation (ESF). Stipend for a three-month long research visit at the University of Konstanz, Germany. Grant n. 4160, 2013.

University of Seville. Stipend for a four-month research visit at the University of Seville, Spain, 2010.

Sapienza, University of Rome, Italy. Fellowship *Master's thesis abroad*. Stipend for a two-month research visit at Karl Franzens University of Graz, Austria, 2009.

European Region Action Scheme for the Mobility of University Students. Erasmus stipend exchange student for a six-month visit at Karl Franzens University of Graz, Austria, 2008.

ACADEMIC ADVISOR

PhD Student

- Hugo Souza Oliveira. Numerical approximation methods for the control of PDEs via dynamic programming equations (on going)

Master Student

- Iago Arcas da Fonseca. *Applications of heat equation in oil industry*.

Iniciação Científica

- Breno Pereira. *FEniCs for nonlinear PDEs*.

- Jerônimo Augusto Soares. *Numerical optimization* (on going)

SHORT RESEARCH VISITS (>1 MONTH)

- The University of Hong Kong, China.** *January 2019–February 2019*
Visiting Professor Zheng Qu.
- University of Konstanz, Germany.** *January 2013–May 2013*
Visiting Professor Stefan Volkwein.
- University of Seville, Spain.** *March 2010–June 2010*
Post graduate intensive course: *Constructive Approximation, Optimization and Mathematical Modelling.*
- Karl Franzens University of Graz, Austria.** *April 2009–May 2009*
Visiting Professor Karl Kunisch.
- Karl Franzens University of Graz, Austria.** *February 2009–July 2008*
Erasmus Exchange Project.

CONFERENCES, SEMINARS, GIVEN TALKS

Invited Conference Talks

- Workshop on Optimal Control and Mean Field Games, Rio de Janeiro, Brazil *October 2019*
A HJB-POD approach for the control of nonlinear PDEs on a tree structure
- 3rd AFOSR WS Computational Issues in Nonlinear Control, Monterey, USA *October 2019*
A Dynamic Programming approach on a tree structure for finite horizon optimal control problems
- 3rd IFAC Workshop on Control of Systems Modeled by PDEs, Oaxaca, Mexico *May 2019*
High-order Approximation of the Finite Horizon Control Problem via a Tree Structure Algorithm
- VI Latin American Workshop on Optimization and Control, Quito, Ecuador *September 2018*
Numerical approximation of feedback control for PDEs via Dynamic Programming
- 14th Conference on Optimal Control and Dynamic Games, Vienna, Austria *July 2018*
Basis generation for feedback control problems
- Data-Driven methods for Multi-Scale Physics and Complex Systems, Rome, Italy *August 2017*
DMD-Galerkin Approximation for nonlinear dynamical system
- SIAM Conference on Computational Science, Atlanta, USA *March 2017*
Nonlinear Model Order Reduction via Dynamic Mode Decomposition
- Data-Driven Methods for ROM and Stochastic PDEs, Banff, Canada. *January 2017*
Randomized Model Order Reduction.
- Optimal Control of Partial and Ordinary Differential Equations, Paris, France. *November 2015*
Optimal snapshot location for POD model reduction in optimal control.
- SIAM Conference on Control and its Applications, Paris, France. *July 2015*
A POD-MOR approach for robust optimal control with PDE constraints.
- From Open Loop to Closed Loop control, Graz, Austria. *June 2015*
On the stabilization of feedback controls in a dynamic programming framework.

SIAM Conference on Computational Science, Salt Lake City, USA. *March 2015*
HJB-POD feedback control for advection-diffusion equations.

Mathmod, Vienna, Austria. *February 2015*
Model order reduction approaches for the optimal design of permanent magnets in electro-magnetic machines.

18th European Conference on Mathematics for Industry (ECMI), Taormina, Italy. *June 2014*
HJB-POD feedback control for Navier-Stokes equations.

1st IFAC Workshop on Control of Systems Modeled by PDEs, Paris, France. *September 2013*
A Time-Adaptive POD Method for the Optimal Control Problems.

Modeling and Control of Large Interacting Dynamical Systems, Paris, France. *September 2013*
Asymptotic Stability and Suboptimality of Model Predictive Control for Semilinear PDEs.

Model Reduction and Approximation for Complex Systems, Luminy, France. *June 2013*
Asymptotic Stability and Suboptimality of Model Predictive Control for Semilinear PDEs.

Contributed Conference Talks

Numerical methods for OCPs: algorithms, analysis and applications, Rome, Italy. *June 2017*
Model order reduction for the control of parametrized PDEs via dynamic programming.

4th Workshop on Sparse Grids and Applications, Miami, USA. *October 2016*
Nonlinear Model Reduction via Dynamic Mode Decomposition.

2nd IFAC Workshop on Control of Systems Governed by PDEs, Bertinoro, Italy. *June 2016*
Model order reduction for a linearized robust PDE constrained optimization.

36th NoKo, Bremen, Germany. *April 2015*
On the coupling between MPC and DP methods for optimal control problems.

XV International Conference on Hyperbolic Problems, Rio De Janeiro, Brazil. *July 2014*
HJB-POD feedback control for Navier-Stokes equations.

Recent trends in Computational Science and Engineering, Plön, Germany. *March 2014*
HJB-POD feedback control for Navier-Stokes equations.

84th GAMM Annual Meeting, Novi Sad, Serbia. *March 2013*
An adaptive POD approximation method for the control of evolutive equations.

Adaptivity and MOR in PDE Constrained Optimization, Hamburg, Germany. *July 2012*
An adaptive POD approximation method for the control of advection-diffusions equation.

Summer School on Optimal Control of Partial Differential Equations, Cortona, Italy. *July 2010*
Optimal control problems for PDEs via POD and HJB.

Seminars

GFDI Colloquium, FSU, USA *April 2019*
Discovery mathematical models from experimental data
Invited by Prof. Kevin Spear.

Scientific Computing Colloquium, Department of Scientific Computing, FSU, USA *April 2019*
A DP approach on a tree structure for finite horizon optimal control problems
Invited by Prof. Bryan Quaife.

- Computational Science Seminar, The University of Hong Kong, China. *January 2019*
Discovery mathematical models from experimental data.
Invited by Prof. Zheng Qu.
- Computational Science Seminar, The University of Hong Kong, China. *January 2019*
A DP approach on a tree structure for finite horizon optimal control problems.
Invited by Prof. Zheng Qu.
- Seminari di Modellistica Numerica, Sapienza University of Rome, Italy. *December 2018*
Discovery mathematical models from experimental data.
Invited by Prof. Maurizio Falcone.
- IMPA, Rio De Janeiro, Brazil *April 2017*
Model order reduction for large-scale problem with applications to PDE constrained optimization.
Invited by Prof. A. Nachbin.
- PUC-Rio Seminario q.t.p., Rio de Janeiro, Brazil *March 2017*
Feedback control for PDEs.
Invited by Prof. L. Diaz.
- University of Washington Colloquium, Seattle, USA *April 2017*
Model order reduction for the control of PDEs via dynamic programming
Invited by Prof. J. Nathan Kutz.
- Scientific Computing Colloquium, FSU, USA. *September 2016*
The HJB-POD approach for infinite dimensional control problems.
Invited by Prof. Max Gunzburger.
- Seminari di Modellistica Numerica, Sapienza University of Rome, Italy. *February 2016*
Nonlinear Model Reduction via Dynamic Mode Decomposition.
Invited by Prof. Maurizio Falcone.
- Lothar-Collatz Seminar, Hamburg, Germany. *January 2016*
Nonlinear Model Reduction via Dynamic Mode Decomposition.
Invited by Lothar-Collatz Center.
- SimTech MOR-Seminar, Stuttgart, Germany. *December 2015*
Model order reduction for infinite horizon optimal control problems via the dynamic programming principle.
Invited by Prof. Bernard Haasdonk.
- Seminari di Modellistica Numerica, Sapienza University of Rome, Italy. *March 2015*
Optimization and Model Reduction for a permanent magnet.
Invited by Prof. Maurizio Falcone.
- Group Seminar, RICAM, Linz, Austria. *February 2015*
On the coupling between MPC and DP methods for optimal control problems.
Invited by Dr. Dante Kalise and Prof. Karl Kunisch.
- Lothar-Collatz Seminar, Hamburg, Germany. *April 2014*
Model Reduction for a Dynamic Programming Approach to optimal control problems with PDE constraints.
Invited by Lothar-Collatz Center.

Seminari di Modellistica Numerica, Sapienza University of Rome, Italy. *November 2013*
Model Reduction for a Dynamic Programming Approach to optimal control problems with PDE constraints.

Invited by Prof. Maurizio Falcone.

Kolloquium, Constance, Germany. *September 2012*
An adaptive POD approximation method for the control of advection-diffusions equation.

Invited by Prof. Stefan Volkwein.

Seminari di Modellistica Numerica, Sapienza University of Rome, Italy. *February 2010*
POD Method and reduced order model.

Invited by Prof. Maurizio Falcone.

Poster Session

MoRePas 2018, Model Reduction of Parametrized Systems IV, Nantes, France. *April 2017*
Basis generations for feedback control problems.

Optimal Control of Partial and Ordinary Differential Equations, Paris, France. *November 2015*
A POD-MOR approach for robust optimal control with PDE constraints.

MoRePas 2015, Model Reduction of Parametrized Systems III, Trieste, Italy. *October 2015*
A POD-MOR approach for robust optimal control with PDE constraints.

5th IFAC Conference on Nonlinear Model Predictive Control, Seville, Spain. *September 2015*
HJB-POD feedback control of advection-diffusion equation with a Model Predictive Control snapshot sampling.

New trends on optimal control, Torus, France. *June 2014*
MPC initialization for Bellman equations.

Scientific Divulagation

Meeting with the students of *Liceo Scientifico G.B. Grassi*, Latina, Italia. *December 2018.*
La matematica e le sue applicazioni: un mestiere moderno.

Meeting with the students of *Liceo Scientifico G.B. Grassi*, Latina, Italia. *June 2017.*
La matematica (non) sarà il mio mestiere.

Meeting with the students of *Liceo Scientifico G.B. Grassi*, Latina, Italia. *March 2015.*
Controllo ottimo di equazioni differenziali.

TEACHING EXPERIENCE

Lecturer at Sapienza University of Rome, Italy. (PhD course)
 Model order reduction for PDEs, Department SBAI. *Fall 2020*

Lecturer at The University of Hong Kong, China. (PhD course)
 Model order reduction for dynamical systems, Department of Mathematics. *Fall 2019*

Lecturer at PUC-Rio, Brazil.
 Calculus 4, Department of Mathematics. *Fall 2020*

Numerical Methods for ODEs, Department of Mathematics. *Fall 2020*

Calculus 4, Department of Mathematics. *Spring 2020*

Numerical Methods for PDEs, Department of Mathematics. *Spring 2020*

Calculus 4, Department of Mathematics.	<i>Fall 2019</i>
Numerical Methods for ODEs, Department of Mathematics.	<i>Fall 2019</i>
Numerical Linear Algebra, Department of Mathematics.	<i>Spring 2019</i>
Introduction to Matlab, Department of Mathematics.	<i>Spring 2019</i>
Nonlinear Numerical Analysis, Department of Mathematics.	<i>Fall 2018</i>
Numerical Methods for ODEs, Department of Mathematics.	<i>Fall 2018</i>
Numerical Linear Algebra, Department of Mathematics.	<i>Spring 2018</i>
Introduction to Matlab, Department of Mathematics.	<i>Spring 2018</i>
Topics of Applied Mathematics, Department of Mathematics.	<i>Fall 2017</i>
Teaching Assistant at Florida State University, USA.	
Finite Element, Department of Scientific Computing.	<i>Fall 2016</i>
Lecturer at University of Hamburg, Germany.	
Model Reduction, Department of Mathematics.	<i>Fall 2015</i>
Teaching Assistant at University of Hamburg, Germany.	
Model Reduction, Department of Mathematics.	<i>Fall 2015</i>
Model Reduction, Department of Mathematics.	<i>Fall 2014</i>
Teaching Assistant at Sapienza, University of Rome, Italy.	
Programming and Computing Laboratory, Department of Mathematics.	<i>Fall 2013</i>
Calculus I, Department of Engineering.	<i>Fall 2013</i>
Programming and Computing Laboratory, Department of Mathematics.	<i>Fall 2012</i>
Numerical Analysis, Department of Mathematics.	<i>Spring 2011</i>
Programming and Computing Laboratory, Department of Mathematics.	<i>Fall 2011</i>
Calculus I, Department of Aerospace Engineering.	<i>Fall 2010</i>
Calculus II, Department of Aerospace Engineering.	<i>Fall 2010</i>
Calculus I, Department of Chemistry.	<i>Fall 2010</i>

ACADEMIC SERVICE

Referee for Acta Applicandae Mathematicae (ACAP), American Control Conference, Advances in Computational Mathematics, Annual Reviews in Control, DFG grant proposal, ESAIM Control, Optimization and Calculus of Variations, IFAC Journals, Journal of Guidance Control and Dynamics, Numerische Mathematik, SIAM Journal in Optimization and Control, SIAM Journal on Scientific Computing.

Minisymposium organizer for the 2015 SIAM Conference on Control and its Applications, the 2017 SIAM Conference on Computational Science and Engineering, and the 2017 SIAM Conference on Control and its Applications.

Organizer of OktoberMath 2019 and 2020.

Local organizer of Workshop on Optimal Control and mean field games at FGV, Rio de Janeiro, Brazil 2019.

COMPUTER SKILLS

C++, FEniCS, L^AT_EX, Linux, Mac OS X, Matlab, Microsoft Windows, OpenOffice.

LANGUAGES

Italian: Native Speaker

English: Fluent

Portuguese: Intermediate

Spanish: Elementary