Alireza Olama

Curriculum Vitae

Automation and Systems Engineering Department
Federal University of Santa Catarina (UFSC)
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Areas of Expertise/ Research Interests

Mathematical Optimization: My research focuses on developing distributed algorithms and tools to solve large-scale optimization problems, with emphasis on addressing challenges posed by nonlinear expressions and a mix of continuous and discrete decision variables.

Distributed and Federated Machine Learning: My primary research focuses on developing algorithms and tools to address challenging problems in distributed and federated machine learning. I aim to apply these solutions to various domains, including engineering and autonomous systems.

Distributed and Parallel Computing: I have a profound interest in the field of parallel and high-performance computing, particularly in its application for tackling computationally intensive problems.

Control Systems Engineering: I possess a broad knowledge and genuine interest in the field of control engineering, with a specific focus on Model Predictive Control (MPC) design and implementation. I have gained hands-on experience in this area, further fueling my passion for exploring and advancing control engineering techniques.

Software Engineering: My research centers around the design and development of high-performance distributed optimization solvers for tackling challenges in machine learning and model predictive control.

Research Experience

Federal University of Santa Catarina (UFSC)

Feb 2019 – present — ***Sparse Convex Optimization in Distributed Machine Learning***.

- Designed DiHOA, a distributed LP/NLP-based branch and bound algorithm specifically developed for solving convex mixed-integer optimization problems.
- Designed DiPOA, a distributed multiple-tree outer approximation algorithm aimed at solving convex mixed-integer optimization problems.
- Developed RH-ADMM, a distributed optimization algorithm tailored to solving constrained-coupled convex optimization problems in machine learning and distributed model predictive control.
- Developed SCOT, an open-source distributed optimization solver dedicated to solving a specific class of mixed-integer nonlinear optimization problems that commonly arise in sparse optimization. (Please refer to the "Software Projects" section for further details.).

Sep 2017 – Sep 2019 — ***Strategies for static and dynamic optimization of complex marine oil and gas systems***.

- Provided integral support in the development, design, maintenance, and deployment of BRSiOP v2, an enterprise-grade web-based software system specifically designed for dynamic optimization of complex marine oil and gas production.
- Assisted in the development of a mixed-integer linear mathematical model aimed at dynamic optimization of marine oil and gas production processes.

University of Bologna (Unibo), Bologna, Italy

Sep 2022 – March 2023 — ***Distributed Optimization for Cooperative Machine Learning in Complex Networks***.

- Contributed as a visiting researcher to a collaborative project between Brazil and Italy focused on consensus optimization in distributed machine learning.
- Designed and developed Distributed Sparse Gradient Tracking (DiSGT), an innovative fully distributed algorithm that effectively solves the best subset selection problem in distributed sparse machine learning.

Shiraz University of Technology (SUTECH), Shiraz, Iran

Sep 2022 – March 2023 ***Hybrid Model Predictive control of Mixed Logical Dynamical Systems***.

- Developed an ellipsoidal hybrid model predictive control method to effectively address the robust stability problem in uncertain hybrid dynamical systems, leveraging the mixed logical dynamical framework.
- Designed and implemented a stable hybrid model predictive control method specifically tailored for energy optimization in a smart microgrid incorporating non-dispatchable renewable sources.

Education

2019–2023: **Ph.D., Automation & Systems Engineering**, *Federal University of Santa Catarina (UFSC)*, Florianópolis, Brazil.
Thesis Topic: A Distributed Framework for Sparse Convex Optimization: Algorithms and Software Tools.
Keywords: Distributed Optimization, Networked Systems, Mixed-Integer Nonlinear Programming (MINLP) Distributed and Parallel Computing.

2015–2017: **Master of Science, Electrical Engineering - Control**, *Shiraz University of Technology (SUTECH)*, Shiraz, Iran.
Thesis Topic: Ellipsoidal Lyapunov-based hybrid model predictive control for mixed logical dynamical systems with a recursive feasibility guarantee.
Keywords: MIQP, Hybrid Dynamical Systems, Model Predictive Control

2009–2014: **Bachelor of Science, Electrical and Computer Engineering**, *Pasargad University of Shiraz*, Shiraz, Iran.

Grands & Awards

2019 – present **Ph.D. Research Grant:** Received a Ph.D. Research Grant from CAPES, the Ministry of Education's funding agency in Brazil. The grant supports my Ph.D. studies at the Federal University of Santa Catarina (UFSC).

2021 – present **Research Grant from Petrobras:** Secured a competitive Research Grant from Petrobras, a prominent Brazilian oil company, to conduct research on static and dynamic optimization of complex marine oil and gas systems.

2022 **FAPESC Research Grant:** Recognized as a recipient of the FAPESC Research Grant in Brazil. The grant supports a joint project between Italy and Brazil titled "Distributed Optimization for Cooperative Machine Learning in Complex Networks.

2020 **FAPESC Research Grant (2020):** Awarded the FAPESC Research Grant in Brazil to attend the Advanced School of Data Learning Science, a renowned program organized by the Institute of Mathematics, Statistics, and Scientific Computing at the University of São Paulo (USP).

Research Visits / Collaborations

Sep 2022 – Present **Visiting researcher at University of Bologna:** A collaboration on distributed optimization with Professor Giuseppe Notarstefano and two Ph.D. candidates Guido Carnevale and Andrea Testa. An ongoing collaboration has so far resulted in one accepted conference paper and one journal paper under preparation.

2021 – Present **KTH Royal Institute of Technology:** A remote collaboration on distributed sparse convex optimization with Professor Jan Kronqvist. An ongoing collaboration has so far resulted in one accepted journal paper.

2018 **University of Seville:** A remote collaboration on hybrid model predictive control with Professor Eduardo Camacho. The collaboration resulted in one published journal paper.

Publications

Journal Articles

2023 **Alireza Olama**, Eduardo Camponogara, and Jan Kronqvist. Sparse convex optimization toolkit: a mixed-integer framework (accepted for publication). *Optimization Method and Software*, 2023.

2022 **Alireza Olama**, Eduardo Camponogara, and Paulo RC Mendes. Distributed primal outer approximation algorithm for sparse convex programming with separable structures. *Journal of Global Optimization*, pages 1–34. Springer, 2022.

2019 **Alireza Olama**, Mokhtar Shasadeghi, Amin Ramezani, Mostafa Khorramizadeh, and Paulo RC Mendes. Ellipsoidal lyapunov-based hybrid model predictive control for mixed logical dynamical systems with a recursive feasibility guarantee. *Transactions of the Institute of Measurement and Control*, volume 41, pages 2475–2487. SAGE Publications Sage UK: London, England, 2019.

2019 **Alireza Olama**, Mokhtar Shasadeghi, and Abdolrahman Ramezani. Stable mpc design for hybrid mixed logical dynamical systems: ℓ_1-based lyapunov approach. TABRIZ JOURNAL OF ELECTRICAL ENGINEERING, 2019.

2019 **Alireza Olama**, Nicola Bastianello, Paulo RC Mendes, and Eduardo Camponogara. Relaxed hybrid consensus admm for distributed convex optimisation with coupling constraints. *IET Control Theory & Applications*, volume 13, pages 2828–2837. Wiley Online Library, 2019.

2018 **Alireza Olama**, Paulo RC Mendes, and Eduardo F Camacho. Lyapunov-based hybrid model predictive control for energy management of microgrids. *IET Generation, Transmission & Distribution*, volume 12, pages 5770–5780. Wiley Online Library, 2018.

In Conference Proceedings

2023 **Alireza Olama**, Guido Carnevale, Notarstefano Giuseppe, and Eduardo Camponogara. A tracking augmented lagrangian method for ℓ_0 sparse consensus optimization. In *International Conference on Control, Decision and Information Technologies (Accepted)*. IEEE, 2023.

Research Projects

March 2021 – Present **Strategies for static and dynamic optimization of complex marine oil and gas systems** The increasing complexity of offshore oil production fields, particularly in pre-salt reservoirs, makes it necessary to develop and employ computer systems to optimize the production of assets. For example, the Santos Basin is mentioned, where several production platforms are found that share a subsea gas flow network, which requires the coordination of decisions of the local production units with the onshore fluid processing terminals to ensure the viability of operations. In this sense, the present project seeks to propose and implement models and methods for optimizing offshore platforms' local and integrated production. To deal with unforeseen failure situations or scheduled maintenance of critical equipment on platforms, a methodology will be developed for the optimal sequencing of operations that may involve reducing production, closing, and sharing wells, among others. Finally, the project also synthesizes approximate models for flow lines and meshes to allow rapid simulation based on historical data and field measurements.

March 2021 – Present

Distributed Optimization for Cooperative Machine Learning in Complex Networks: A broad class of important engineering applications, including intelligent transportation systems, smart grids and smart factories can significantly benefit from novel methodological approaches that: (i) involve cooperation among agents with local computation and communication capabilities (*distributed computing*) and (ii) exploit novel Machine Learning approaches to enhance the autonomy of the complex system. This novel paradigm, combining distributed computing and Artificial Intelligence (AI), calls for novel numerical methods that lie at the intersection of optimization theory, network systems, and Machine Learning. While most of the available optimization-based methods in Machine Learning are inherently centralized, in the above-mentioned scenarios a new distributed optimization paradigm is needed due to the presence of big-data problems in which data are spatially distributed and private. The first main objective of the project is to model *distributed machine learning* problems in cyber-physical networks as distributed optimization problems whose solution can lead to high-level learning performance. These problems are typically non-convex and possibly mixed-integer, so that a limited number of algorithms is available. The second objective is to develop distributed numerical optimization algorithms for these challenging classes of problems. These algorithms have to be numerically accurate, fast, and stable since in many learning contexts they have to be implemented online. Finally, a numerical software package, implementing the proposed distributed learning algorithms, will be developed to give users a novel tool to address the solution of learning problems in concrete application contexts.

Software Engineering Skills

Programming Languages	Python (Fluent), C/C++ (Advanced), Java (Advanced), JavaScript (Intermediate), Julia (Intermediate)
Machine Learning	TensorFlow, Pytorch, Skit-learn, Pandas, Scipy, Seaborn.
Mathematical Modeling	GAMS, AMPL, Pyomo, JumP, Yalmip.
Optimization Solvers	GUROBI, CPLEX.
Numerical Computing	BLAS, LAPACK, EIGEN, Message Passing Interface (MPI), OpenMP.
Software Engineering	Software architecture and software design, operating systems, networking, distributed systems.
Software Frameworks	Spring and Spring boot, Django, FastAPI, VueJS

Software Projects

SCOT Research-oriented, open-source mathematical software for solving sparse convex optimization problems in distributed machine learning. Based on the outer approximation algorithm, SCOT implements two distributed Mixed Integer Nonlinear Programming (MINLP) algorithms; DiPOA and DiHOA. TechStack:

- Features: Task-base algorithm implementation, distributed computation over computer clusters
- Programming Languages: C++17 for solver implementation and Python for accessing the solver API.
- Distributed Programming framework: Message Passing Interface (MPI) with OpenMPI.
- MIP Solver: Gurobi
- Linear Algebra library: Eigen

DOSE Research-oriented, open-source mathematical software for solving distributed convex optimization problems. Tech: C/C++, OpenMPI.

BRSiOP An Enterprise web-based micro-services system for dynamic optimization of complex marine oil and gas production.

Teaching & TA Experience

Spring, 2022 : **Lecturer of Fundamentals of Computer Programming Course**, *Fasa University*.
Fall, 2021 : **Lecturer of Data Mining in Python Course**, *Fasa University*.
Fall, 2021 : **TA of Numerical Computing Course**, *Federal University of Santa Catarina*.
Fall, 2020 : **TA of Numerical Computing Course**, *Federal University of Santa Catarina*.
Fall, 2017 : **Lecturer of Convex Optimization and Machine Learning**, Shiraz University of Technology.
Spring, 2017 : **Lecturer of Convex Optimization**, *Faradars Online Learning Institution*.

Professional Services

Reviewer **IEEE Transactions on Automatic Control** .
Reviewer **ISA Transactions**.
Reviewer **Transactions of the Institute of Measurement and Control**.

Languages

English **Fluent**.
Portuguese **Intermediate**.
Farsi **Native**.

References

Dr. Eduardo Camponogara
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