Title
Real-time optimization with application to autonomous systems

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Brief description of the theme
Solving optimization problems in real-time for autonomous mobile systems is a challenging task, especially because of new constrains arising from a complex evolving environment or other autonomous systems operating in the same scenario, changing of exogenous variables and availability of onboard stored energy during realistic operative conditions which could make unfeasible the implementation of the nominal (often pre-computed) optimal trajectories. The PhD will focus on techniques able to generate in real-time safe trajectories with possibly non-decreasing performance for highly interactive heterogeneous autonomous systems, by exploiting data coming from the real-time environment detection and the onboard battery management. Such techniques will exploit fast iterative heuristics, parallel processing and machine learning approaches (or a combination of the three). The PhD is expected to master both methodological and implementation aspects and dedicate part of the activities to laboratory experiments for the validation of iterative optimization techniques in applications such as the coordinated flight of nano-quadcopters or the interactive recharging of electric vehicles. The techniques implemented in these applications must take into account issues such as scalability (decentralized algorithm and receding horizon to make the algorithms scalable) and privacy-preserving (non-decreasing performance also with limited information shared by the agents).

Indicative references
D. Natella, S. Onori, F. Vasca, “A co-estimation framework for state of charge and parameters of Lithium-ion battery with robustness to aging and usage conditions,” IEEE Transactions on Industrial Electronics, 70 (6), 2023, p. 5760-5770.
C. Bernardo, F. Vasca, C. Altafini, “Finite-time convergence of opinion dynamics in homogeneous asymmetric bounded confidence models,” European Journal of Control, 68 (11), p. 100674, 2022.
F. Vasca, C. Bernardo, R. Iervolino, “Practical consensus in bounded confidence opinion dynamics,” Automatica, vol. 127, n. 7, 2021, p. 109683.
R. Vignali, A. Falsone, F. Ruiz, G. Gruosso, “Towards a comprehensive framework for V2G optimal operation in presence of uncertainty,” Sustainable Energy, Grids and Networks, 31, p. 100740, 2022.

Type of scholarship
DM 118/2023 – Project on PNRR (Italy's Recovery and Resilience Plan)