

Proposal - Invited Open TRACK at 20th IFAC World Congress Advances in Real-Time Optimization of Uncertain Process Systems

Organizers:

- Timm Faulwasser, Institute for Applied Informatics, Karlsruhe Institute of Technology & Laboratoire d'Automatique, École Polytechnique Fédérale de Lausanne, tim.faulwasser@epfl.ch
- Alejandro Marchetti, CONICET & Laboratoire d'Automatique, École Polytechnique Fédérale de Lausanne, alejandro.marchetti@epfl.ch
- Gregory Francois, Institute for Materials and Processes, School of Engineering, The University of Edinburgh, gregory.francois@ed.ac.uk
- Dominique Bonvin, Laboratoire d'Automatique, École Polytechnique Fédérale de Lausanne, dominique.bonvin@epfl.ch

Abstract

The steadily increasing need for optimal operation of plants and processes with respect to economic and ecological requirements has led to a manifold of research efforts in the field of real-time optimization (RTO) of uncertain process systems. Recent advances on RTO include conditions guaranteeing plant optimality upon convergence based on first-order modification of the optimization problem; conditions guaranteeing feasibility of the whole sequence of RTO iterates, and methods which allow combining data-driven approaches with existing first-principle models. While these developments aim at optimizing steady-state performance based on steady-state measurements, a complementary direction of research proposes the use of transient measurements to tackle the same problem for instance via extremum-seeking concepts. The proposed Invited Open Track aims at gathering recent advances on static and dynamic RTO. The track welcomes contributions on theory and application aspects of RTO. These include static RTO using steady-state measurements, static RTO using transient measurements, dynamic RTO approaches, and their applications. The track specifically aims to bring together researchers working on different RTO methods. This way, it shall provide a platform for presenting theoretical and application-oriented contributions, and it shall foster discussions on new ideas regarding the development of tailored RTO schemes for uncertain process systems.

IFAC Technical Committee for Evaluation

TC 6.1 Chemical Process Control

Detailed Description

The problem of economic operation of continuous and batch processes is of paramount importance in the chemical industry. Following the early works on integrated systems optimization and parameter estimation (ISOPE) by P. D. Roberts and co-authors, many groups have proposed RTO methods to overcome the drawbacks of repeated model-based optimization and parameter estimation, which is also known as the two-step approach. Examples of such RTO schemes include modifier adaptation, extremum-seeking control, and self-optimizing control for continuous processes, and tracking the necessary conditions of optimality (NCO), also known as NCO tracking, for batch processes. In general, the core challenges in designing RTO schemes are threefold:

- Enforcing plant optimality and feasibility upon convergence of the RTO scheme.
- Guaranteeing feasibility of all plant iterations.
- Limiting the number of RTO iterations needed to an acceptable level.

Tackling these challenges directly leads to numerous research issues such as efficient data-driven gradient estimation methods, combination of data-driven and model-based techniques, or bridging the gap between steady-state optimization and the use of transient measurements.

The proposed invited open track aims at collecting recent advances and results on these questions. The track welcomes contributions on theoretical, methodological, and applied aspects of RTO. This includes static RTO using steady-state measurements, static RTO using transient measurements, dynamic RTO approaches, and the application of all of these. The already foreseen contributions come from leading groups in the field of RTO based in different countries such as Argentina, Brazil, Canada, Chile, China, Germany, Switzerland and the United Kingdom. These contributions will present advances on different RTO methods such as extremum seeking, self-optimizing control, (centralized and distributed) modifier adaptation, and NCO tracking based on multi-parametric programming. Different case studies, such as a penicillin fed-batch process and a fluidized catalytic cracking (FCC) unit operated in partial combustion mode, will be covered. The invited track will also include contributions presenting RTO implementation results for a laboratory-scale flotation column for copper concentration and a solid-oxide fuel cell system. As the economic and ecological operation of uncertain processes is of major relevance to many fields of application, we expect further contributions besides the ones listed below, also addressing theory as well as application-oriented recent advances in the field of RTO. This way, the track shall foster discussions on new ideas regarding the development of tailored RTO schemes for uncertain process systems.

Intended Contributions

1. **Title:** t.b.a.
Authors: Martin Guay (Department of Chemical Engineering, Queens University, Kingston, Canada)
2. **Title:** A novel approach for Real-Time Optimization: calibration of the method.
Authors: Galo Carrillo Le Roux (Department of Chemical Engineering, University of Sao Paolo, Brazil)
3. **Title:** Global Self-Optimizing Control for Uncertain Constrained Process Systems
Authors: Lingjian Ye (Ningbo Institute of Technology, Zhejiang University, China) and Yi Cao (School of Water, Energy and Environment, Cranfield University, UK)
4. **Title:** A Set-Based Parameter Adaptation Scheme for the Batch-to-Batch Optimization Under Model-Plant Mismatch
Authors: Hector Budman (Department of Chemical Engineering, University of Waterloo, Canada)
5. **Title:** Modifier-adaptation based on transient measurements applied to a laboratory-scale flotation column
Authors: A. Puen, D. Navia (Dpt de Ingeniería Química y Ambiental, Universidad Técnica Federico Santa María, Spain), D. Sarabia (Dpt of Electromechanical Engineering, University of

Burgos), T. Rodríguez-Blanco , C. de Prada (Dpt of Systems Engineering and Automatic Control, University of Valladolid, Spain)

6. **Title:** Including stochastic information for real time optimization applied to a laboratory-scale flotation column
Authors: R. Unzueta , D. Stipo, I. Cornejo, L. Bergh, C. de Prada, D. Navia, Spain
7. **Title:** On RTO of large-scale systems via distributed modifier adaptation
Authors: Predrag Milosavljevic, Rene Schneider, Alejandro Marchetti, Timm Faulwasser and Dominique Bonvin (Laboratoire d'Automatique, Ecole Polytechnique Fédérale de Lausanne, Switzerland)
8. **Title:** Robust multi-parametric NCO tracking controllers for linear dynamic systems
Authors: Muxin Sun, Mario E. Villanueva, Efstratios N. Pistikopoulos (Texas A&M Univ., USA), Benoit Chachuat (Dpt of Chemical Engineering, Imperial College London, UK)
9. **Title:** Fusion of data and models via modifier adaptation with quadratic approximation (MAwQA) to enable a reliable real-time optimization
Authors: Weihua Gao, Sebastian Engel (TU Dortmund, Germany)