Synergistic Approach of Multi-Energy Models for an European Optimal Energy System Management Tool

Deliverable D5.3
New version of the
`NDOSolver/FiOracle` software

Deliverable No. Dx.y	Work Package No. WPx	Task/s No. Task x.y	
Work Package Title	Methods and Algorithms		
Linked Task/s Title	TASK 5.3. DECOMPOSITION ALGORITHMS		
Status	Draft	(Draft/Draft Final/Final)	
Dissemination level	PU	(PU-Public, CO-Confidential)	
Due date deliverable	2019-03-31	Submission date	2019-02-26
Deliverable version	D5.3 – version 1.0		

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773897

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History of Changes

Release	Date	Reason for Change	Status
0.1	23/01/2019	Initial release	Draft
0.5	28/01/2019	Release to reviewers	In Review
0.9	19/02/2019	Updates due to reviewers' comments	In Review
1.0	26/02/2019	Final check from reviewers'	Released

List of acronyms used in this document

NDO NonDifferentiable Optimization (problem)

MP Matematical Program

Glossary of terms used in this document

`NDOSolver` base (abstract) class for solvers of NonDifferentiable Optimization problems

`FiOracle` base (abstract) class representing functions to be optimized

`MPSolver` base (abstract) class for solvers of master problems within Bundle methods

DISCLAIMER / ACKNOWLEDGMENT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773897

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Executive Summary

The goal of plan4res is to develop a modeling framework that allows to obtain a holistic assessment of the energy system. This requires solving a combined problem that, as quite common in energy production and distribution problems (see e.g. http://www.energy-opt.eu), is very challenging. In particular, the plan4res approach is characterized by eschewing the simplifications that traditional modeling tools do when representing decisions on multi-decade timescales, i.e., to dramatically simplify the description of the behavior of the system on shorter time spans; on the contrary, the model takes into account detailed decisions up to the hourly, and possibly sub-hourly, time discretization. Also, the plan4res system aims at covering the energy system of a whole continent without the customary aggregations at the geographical level, but rather keeping a disaggregate information down to quite small districts. Furthermore, uncertainty about the state of the system (which is pervasive, and if anything worsening due to a number of factors) is not disregarded, which makes the corresponding MP even more challenging. Solving the corresponding MP with traditional "monolithic" approaches is clearly not possible; even when considering the relatively small subset corresponding to operational management of electrical generators over a short time frame, decomposition methods have long been, and still are save for "very simple" cases, the approaches of choice [22]. This justifies the interest for the plan4res project of algorithms capable of efficiently solving the Lagrangian Dual [9] or the Benders' Decomposition [18] of complex, large-scale MP. The difficulty in doing so can be traced to several concurring facts: the corresponding problem is that of optimizing a function of possibly a rather large number of variables, whose derivatives are not continuous and for which just the evaluation of the function value and first-order information requires the solution of a possibly hard and large-scale problem. This justifies the large amount of research in the last four decades about NDO [21]. Furthermore, doing so is often only a step in a complex, multi-level solution process: the solution information produced by the NDO should ideally be updated with as little as possible computational effort when the data of the corresponding (sub-)model changes in predictable ways. However, this is a capability that is very seldom present in NDO solvers.

The NDOSolver/FiOracle C++ suite of NDO solvers have been developed at the Department of Computer Science of the University of Pisa over the last 25 years; this deliverable provides to plan4res partners the version of the framework incorporating state-of-the-art NDO solvers with advanced and unique capabilities. These solvers will provide the foundations for building the even more advanced versions that will be required in order to solve the extremely demanding MPs envisioned by the project.

Key Words: Mathematical Programming Solver, NonDifferentiable Optimization, Bundle Method, Subgradient Method, Decomposition, C++

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