DTU Library

State of the art of wind farm optimization

Tesauro, Angelo; Réthoré, Pierre-Elouan; Larsen, Gunner Chr.

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

PO. 131

State of the Art of Wind Farm Optimization

Angelo Tesauro, Pierre-Elouan Réthoré, Gunner C. Larsen
DTU Wind Energy, Risø campus, Roskilde-4000, Denmark.

Abstract

The present work attempts to outline the state of the art in the field of wind farm layout optimization. To do so the literature of the last two decades has been analyzed and the common structure of the problem has been defined. The most effective techniques and models are described. The usual pitfalls are as well listed, whose aim is the creation of a blueprint for future development of wind farm optimization tools/softwares. The last point touched by this work highlights the areas where a better understanding is needed and more research should be addressed to determine realistic layouts.

Objectives

Creating a tidy knowledge base and defining a common structure for future development of wind farm optimization tools/softwares.

Methods

Clear definition of the layout optimization problem which is made of two components:

► **definition of the objective function**, or the criterion that the wind farm has to meet to be considered optimal. The most commonly used functions in literature are **ENERGY YIELD, COST OF ENERGY AND PROFIT** or **FINANCIAL BALANCE,**

► **definition of a wake model,** to asses the energy yield,

► **definition and assessment of ALL the costs that depend on the wind farm topology: ELECTIRCAL GRID, INFRASTRUCTURE, INVESTMENT, DEGRADATION,**

► **definition of the optimization strategy:**

► ONE STEP OPTMIZATION: **genetic algorithm, particle swarm, Montecarlo.**

► TWO STEPS OPTMIZATIONS, needed for heavy objective functions. Usually a combination of meta-heuristic and a local search algorithm (**gradient based, linear programming, greedy heuristic** e.g.**).**

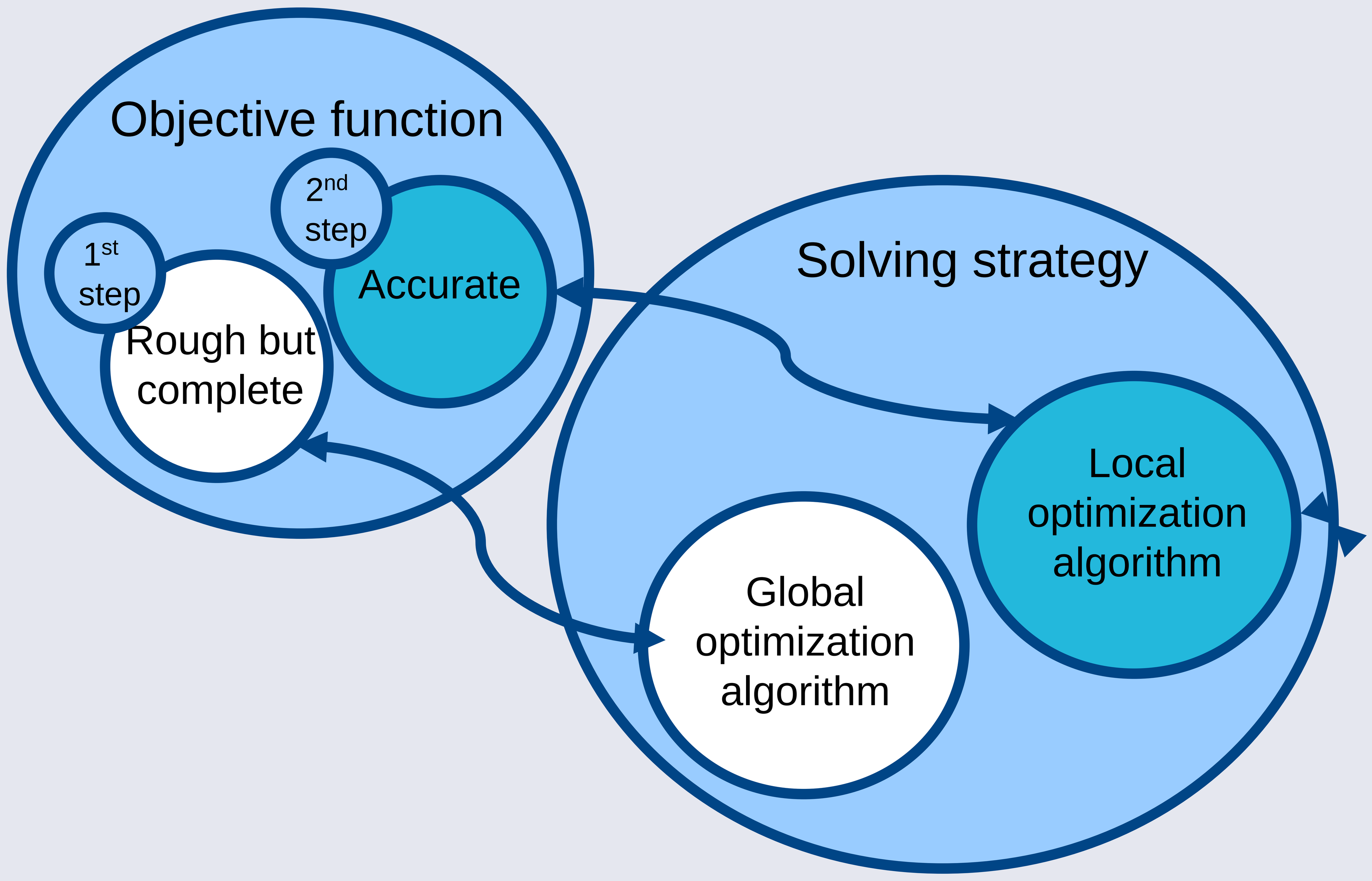
Results

The main findings concern:

► The **high dependency of the resulting layout on the objective function**, which, for practical purposes should be the most accurate possible. and not only the energy yield.

► As a consequence the **cost functions need always to be modeled** and assessed, which in turn raises the complexity of the objective and the computational time, yielding to nested optimizations.

► **The rise in complexity creates the need for a optimization strategy**, a **combination of two algorithms** is currently used in the state-of-the-art research tools, instead of one, as used at the wind farm optimization infancy.



Conclusions

The next steps should be:

► **set-up of a benchmark case** to test new objective functions and/or compare performances of different methods,

► **refinement of cost models**, degradation cost, e.g., because of the dependency of the solution on them,

► **development of new specific searching algorithm,** based on the properties of the problem, instead of the natural-inspired algorithms.

References

[1] Christopher N. Elkinton, James F. Manwell and Jon G. McGowan, Algorithms for Offshore Wind Farm Layout Optimization.
[2] Christopher N. Elkinton, James F. Manwell and Jon G. McGowan, Offshore Wind Farm Layout Optimization (OWFLO) Project.
[3] S.A.Grady, M.Y Husaini, M.M. Abdullah, Placement of Wind Turbines using Genetic Algorithm.
[4] Carlos M. Ituarte-Villareal and Jose f. Espiritu, Optimzation of wind turbine placement using a viral based optimization algorithm.
[5] Jensen N.O., A note on Wind Generator Interaction.
[6] Matthew A. Lackner, and Christopher N. Elkinton, An Analytical Framework for Offshore Wind Farm Layout Optimization.
[7] G. Mosetti, C. Poloni and B. Diviacco, Optimization of wind turbine positioning in large windfarms by means of a genetic algorithm.
[8] Pierre-Elouan Réthoré, Peter Fuslgang, Gunner C. Larsen, Thomas Buhl, Torben J. Larsen and Helge A. Madsen, TopFarm: Multi-fidelity Optimization of Offshore Wind Farm.
[9] Chunqiu Wan, Jun Wang, Geng Yang, and Xing Zhang, Optimal Micro-siting of Wind Farms based on Improved Wind and Turbine Models.
[10] Chunqiu Wan, Jun Wang, Geng Yang, and Xing Zhang, Optimal Micro-siting of Wind Farms by Particle Swarm Optimization.
[11] Jun Wang, Xiaolan Li, and Xing Zhang, Genetic Optimal Micrositing of Wind Farms by Equilateral Triangle Mesh.
[12] J Serrano Gonzalez, A.G. Gonzalez Rodriguez, J. Castro Mora, J. Riquelme Santos and M. Burgos Payan, A New Tool for Wind Farm Optimal Design.
[13] C. Szafron, Offshore Windfarm Layout Optimization.
[14] WindFarmer, GL Garrard Hassan.
[15] OpenWind, AWS Truepower.
[16] WindPro, EMD International A/S