

# Combined optimization for offshore wind farms

**Cazzaro, Davide; Koza, David Franz; Pisinger, David**

*Publication date:*
2022

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

and lower tolerances of all elements of CBPs. Our results significantly improve computation times for relevant CBPs such as the Linear Bottleneck Assignment Problem (LBAP), which is the problem of assigning jobs to workers and vice versa such that the duration of the longest job is minimized.

# ■ WA-14

*Wednesday, 8:30-10:00 - U261*

## Metaheuristics (contributed)

Stream: Metaheuristics, Matheuristics
*Invited session*
Chair: Adam Górski

**1 - Combined optimization for offshore wind farms**
*Davide Cazzaro, David Franz Koza, David Pisinger*

The two main challenges of optimizing a wind farm are the design of the turbine layout and the design of the cable routing. The first task consists in placing each turbine such that overall power production is maximized, the wake effect (wind shadow) between turbines is minimized, and foundation costs are minimized as well. The second task is to select the minimum cost cable routing to connect the turbines with submarine cables, which transfer the produced electricity to a substation and then onshore.

Although the typical procedure is to solve the two problems sequentially, we investigate the benefit of solving them together. Few studies in the literature attempt to join these two optimization problems, which are often simplified to keep the computational complexity low. In our work, we model the combined problem with all constraints relevant to practical applications of wind farm design. We also present a novel local search that integrates the two problems, thus allowing the cable routing to give direct feedback to the turbine positions in the layout. We benchmark the combined optimization on a set of realistic industry-scale wind farm instances. Our results show that the combined optimization outperforms the sequential approach, especially for lower energy density wind farms, due to the significant savings in the cable routing which widely compensate for a slight reduction in power production.

**2 - Solving the Hamiltonian completion problem by customized evolutionary computing**
*Krunoslav Puljic, Robert Manger*

The Hamiltonian completion problem (HCP) consists of finding the minimal number of extra arcs, which have to be added into a given graph in order to make it Hamiltonian. It is easy to see that the HCP is NP-hard. Also, the HCP can easily be reduced to the better-known traveling salesman problem (TSP). It is expected that both problems can be solved by similar algorithms where the same components are reused. This work is concerned with evolutionary algorithms for the HCP. The aim is to verify suitability of various crossover and mutation operators within the HCP setting. Some of those operators are standard, i.e. they have previously been used for the general TSP, some of them are adjustments of standard TSP operators, and some are custom-designed especially for the HCP. The considered crossovers and mutations are tested on a set of randomly generated problem instances. The obtained results of testing clearly show that the behavior and relative ranking of the considered operators within the HCP environment is different than within the TSP environment. Moreover, the results indicate that our modified or custom-designed operator variants assure much better performance for the HCP than the standard variants.

**3 - Genetic algorithm approach with penalty function for concurrent real-time optimization of detecting unexpected tasks in Internet of Things design process**
*Adam Górski, Maciej Ogorzałek*

Internet of Things (IoT) is internet based network consisted of billions of devices called things. Such devidces can be: embedded systems, sensors, satellites, and many more. Nowadays more and more solutions are based on IoT. IoT is mostly used in smart solutions like: smart houses, smart cities or smart cars. During the work the network can meet some unexpected situations. The situations were not predicted by the designers and even for smart solutions design process or at least a part of it must be repeated. This could generate too much costs and sometimes could be even impossible. Unexpected situaltions can be solved in many ways. It is very important to check which way is better. In this paper we propose genetic algorithm based method to concurrent real-time optimisation of detecting unexpected tasks in IoT design process. Unlike other approaches our algorithm in evolution process investigate not only valid solutions by using penalty function. Therefore the algoritm is able to escape from local minima of optimizing parameters. The algorithm chooses number of unexpected tasks and assign them to available resources. The process is divided on two phases. Each phase impacts another in real time. Therefore any change in one phrase can make change in the second one in the same moment.

# ■ WA-15

*Wednesday, 8:30-10:00 - U262*

## Policy Analytics and Decision Support Systems

Stream: Decision Support Systems
*Invited session*
Chair: Pavlos Delias

**1 - Comparison of metaheuristics for the location of firebreaks in wildfires combat**
*David Palacios, Jaime Carrasco, Sebastián Dávila, Cristobal Pais, Andrés Weintraub*

In the research, different metaheuristics are studied, implemented and compared in order to offer a tool that allows, through operations management, the adoption of firebreak location strategies to reduce the area burned due to forest fires as much as possible. It incorporates the randomness of the nature of wildfires through variations in ignition points and wind direction. In addition, the metaheuristics are tested on different sizes and types of forests (with homogeneous and heterogeneous fuels). In a first implementation, different metaheuristics were tested under basal conditions. In the final implementation, 3 metaheuristics were compared: Genetic Algorithm, GRASP and Taboo Search, which correspond to those that gave better results in previous implementations, highlighting GRASP (Greedy Randomized Adaptive Search Procedure). This result is consistent with one of the conclusions obtained by Mark Finney et al. in the 2008 paper: Simulation of long-term landscape-level fuel treatment effects on large wildfires, where he finds topologies that better favor firewall performance compared to other topologies. Some improvements are proposed, such as not seeking to minimize the burned area in the average of simulated scenarios, but seeking to minimize the burned area of the fire that burns the most area within the simulated scenarios. Finally, it is concluded that GRASP could be a good tool to assist in preventing the impact of forest fires in Chile.

**2 - Paris Agreement targets under uncertain negative emission technologies and climate sensitivity**
*Theresa Schaber, Tommi Ekholm*

The research maps cost-effective emission pathways with uncertain negative emission technologies (NETs) satisfying the Paris temperature targets of 1.5'C under uncertainty in climate sensitivity that decreases over time through exogenous learning. More specifically we investigate the implications from having a fixed assumption of future NETs characteristics today, i.e. betting on negative emissions. We implemented three assumptions (pessimistic, average and optimistic)