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Comparative analysis of ROPAR, a method to find robust optimum solutions to problems with multiple objectives

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In engineering, optimization problems are typically solved assuming deterministic conditions. This deterministic approach has the advantage of easing the process to find a solution and at the same allowing to have the first insights of the solution to the problem. However there is a high chance that these solutions might underperform or even fail when these conditions deviate from what was assumed. If one assumes uncertainty in conditions or problem parameters, the problem is often called Robust Optimization problem. Robust optimization aims at finding solutions which remain near an optimum performance despite the uncertainties above mentioned.

One common method to find a robust solution, is by replacing the deterministic objective function by its 'smoothed'version, e.g. by averaging values of the objective functions in the proximity of a given point (Kapelan et al. 2005; Deb and Gupta 2006; Kuzmin 2009). This approach has proven to be useful because has allowed the design of solutions that endure conditions different from the ideal conditions.

However we find that this approach has two limitations. First, the number of solutions offered to the decision maker is limited. Second, the information about how the performance of the solution is impacted by the uncertainty is not readily available.

Here we present a methodology named ROPAR (Marquez-Calvo and Solomatine (2018) that allows to find robust solutions to problems with multiple objectives, and has the following features. First, it shows how the uncertainty is propagated to the solutions, so that the information presented to the decision maker is enriched. Second, it finds several solutions with different trade-offs between the objective functions. Third, it generates solutions with different trade-offs of robustness. Fourth, it can be straightforwardly parallelized. We compared ROPAR to other methods on two cases studies.

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