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An improved multi-objective simulated annealing algorithm: a water distribution network case study

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The resolution of optimization problems dealing with engineering infrastructures such as electric, gas, roads, communication and water networks is very complex and require the use of powerful optimization tools. Decision-making on this type of infrastructures should consider aspects as financial viability, network robustness, environmental concerns, etc... Therefore, these are intrinsically multiobjective optimization problems with conflicting objectives and their resolution by optimization methods is nowadays one of the most active areas in operations research. The optimal design of WDNs has been studied by numerous researchers as well confirmed in the extensive literature review of Mala-Jetmarova et al. (2018) with 124 papers where it is also noticed that the optimization of WDNs is essentially a multiobjective problem. There is a large body of literature dedicated to the use of Multiobjective Evolutionary Algorithms (MOEAs), but in most of studies the performance was not truly compared with other algorithms by means of a vast number of case studies. This kind of analysis was executed by Wang et al. (2015) that compare the performance of 5 algorithms (NSGA-II, -MOEA, -NSGA-II, AMALGAM and Borg), on the resolution of an optimisation model including two objectives (cost minimisation and resilience index maximisation), using the same computational effort in all the 5 algorithms in twelve benchmark case studies of different nature and with different complexities.

In contrast with MOEAs algorithms, there are few Multiobjective Simulated Annealing (MOSA) based techniques applied to the optimal design of WDNs. This work proposes an improved MOSA that is an enhanced version of the algorithm presented in Marques et al. (2018). An archive guided approach is implemented and the concept of domination status, as defined by Bandyopadhyay et al. (2008), is used. Comparisons of diverse ways to build candidate solutions for functions evaluation are analysed for different case studies. The results include also the comparison of the application of different MOEAs and this new MOSA to some benchmark case studies (as in Wang et al. 2015). It can be noticed the significant improvement on the number of non-dominated solutions obtained and the more balanced coverage of the Pareto front.

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