MULTIOBJECTIVE EVOLUTIONARY ALGORITHMS IN PUMP SCHEDULING OPTIMISATION

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Typically, a pumping station of a water supply system is composed of a set of different pumps. These pumps are used to supply reservoirs, located through out the community. In time, these reservoirs supply consumers. Pumps work in combination with each other in order to satisfy water demand from the community. This system must satisfy several hydraulic and technical restrictions. Thus, at a particular point in time, some pumps may be working while others may not. Hence, a pump schedule is the set of all pump combinations chosen for every time interval in a scheduling scope. Therefore, an optimal pump schedule is the one that optimises established objectives (i.e., cost of energy and maintenance) while fulfilling all restrictions of the system.

Some approaches to this problem have been presented showing that important savings can be made; especially when evolutionary algorithms are used [1,2,3]. The purpose of this work is to utilise several recognised optimisation algorithms to solve an optimal pump-scheduling problem and to compare their performance. Without lost of generality, a simplified hydraulic model was chosen. It consists of a water source, a pumping station with five pumps, a water reservoir and a main pipe to drive water from the station to the reservoir. Restrictions considered in this work include: maximum and minimum levels in the reservoir, water demand, technical characteristics of pump combinations and others [4].

An important contribution of this work is the analysis of four simultaneous minimisation objectives. The first one is the cost of electrical energy consumed by the pumps. The second one is the pump’s maintenance cost. The third one is the level variation in the reservoir between the beginning and the end of the optimisation period, and finally, the maximum power peak, considering the cost of reserved power.

This work solves the optimal pump-scheduling problem using *Multiobjective Evolutionary Algorithms* (MOEAs). For the first time, six recognised MOEAs are applied on this problem: the Strength Pareto Evolutionary Algorithm (SPEA) [5], the Non Dominated Sorting Genetic Algorithm (NSGA) [6], its second version (NSGA-II) [7], the Controlled Elitist Non Dominated Sorting Genetic Algorithm (CNSGA) [8], the Niched Pareto Genetic Algorithm (NPGA) [9] and the Multiple Objective Genetic Algorithm (MOGA) [10]. In order to satisfy hydraulic and technical restrictions, a heuristic algorithm was developed and combined with the above algorithms.

Multiobjective optimisation metrics [11] were used to compare the performance of MOEAs. Experimental results show that SPEA is the best method for this problem, although other algorithms may also be useful. Furthermore, SPEA's set of solutions provides pumping station engineers with many optimal pump schedules to choose from. Engineer's criteria can then be used to make a final selection, knowing other compromise alternatives.

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