

# Publications of Samuel Baguley

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## Conference papers

- [1] Baguley, S., Friedrich, T., Neumann, A., Neumann, F., Pappik, M., Zeif, Z., [Fixed Parameter Multi-Objective Evolutionary Algorithms for the W-Separator Problem](#). In: *Genetic and Evolutionary Computation Conference (GECCO)*, 2023.

Parameterized analysis provides powerful mechanisms for obtaining fine-grained insights into different types of algorithms. In this work, we combine this field with evolutionary algorithms and provide parameterized complexity analysis of evolutionary multi-objective algorithms for the W-separator problem, which is a natural generalization of the vertex cover problem. The goal is to remove the minimum number of vertices such that each connected component in the resulting graph has at most  $W$  vertices. We provide different multi-objective formulations involving two or three objectives that provably lead to fixed-parameter evolutionary algorithms with respect to the value of an optimal solution  $OPT$  and  $W$ . Of particular interest are kernelizations and the reducible structures used for them. We show that in expectation the algorithms make incremental progress in finding such structures and beyond. The current best known kernelization of the W-separator uses linear programming methods and requires a non-trivial post-process to extract the reducible structures. We provide additional structural features to show that evolutionary algorithms with appropriate objectives are also capable of extracting them. Our results show that evolutionary algorithms with different objectives guide the search and admit fixed parameterized runtimes to solve or approximate (even arbitrarily close) the W-separator problem.

- [2] Baguley, S., Friedrich, T., Timo, K., Li, X., Pappik, M., Zeif, Z., [Analysis of a Gray-Box Operator for Vertex Cover](#). In: *Genetic and Evolutionary Computation Conference (GECCO)*, pp. 1363–1371, 2022.

Combinatorial optimization problems are a prominent application area of evolutionary algorithms, where the (1+1) EA is one of the most investigated. We extend this algorithm by introducing some problem knowledge with a specialized mutation operator which works under the assumption that the number of 1s of a solution is critical, as frequently happens in combinatorial optimization. This slight modification increases the chance to correct wrongly placed bits while preserving the simplicity and problem independence of the (1+1) EA. As an application of our algorithm we examine the vertex cover problem on certain instances, where we show that it leads to asymptotically better runtimes and even finds with higher probability optimal solutions in comparison with the usual (1+1) EA. Precisely, we compare the performance of both algorithms on paths and on complete bipartite graphs of size  $n$ . Regarding the path we prove that, for a particular initial configuration, the (1+1) EA takes in expectation  $\Theta(n^4)$  iterations while the modification reduces this to  $\Theta(n^3)$ , and present experimental evidence that such a configuration is reached. Concerning the complete bipartite graph our modification finds the optimum in polynomial time with probability  $1 - 1/2^{\Omega(n^\xi)}$  for every positive constant  $\xi < 1$ , which improves the known probability of  $1 - 1/\text{poly}(n)$  for the (1+1) EA.