

# A survey on handling computationally expensive multiobjective optimization problems with evolutionary algorithms - SUMMARY

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Surrogates, or metamodels by the other name, are used for reducing computation time. This is especially relevant with computationally expensive multiobjective optimization problems. Evolutionary algorithms are often used for solving MOPs, but they don't guarantee convergence to optimal solutions. With computationally expensive problems EAs should be adapted for achieving shorter computation time while maintaining the quality of solutions.

Approximation is one of the algorithms proposed to reduce the computational costs of MOPs that use EAs, which is one of the most popular ones. In multiobjective optimization there are three ways to apply approximation: problem, function and fitness approximation. The latter is used more widely than the others.

In function approximation an explicit or implicit approximation of a computationally expensive function is formed. In stage 1 of function approximation a general evolutionary algorithm works, and in stage an EA with a metamodel will be used. The process includes ten steps that are 1) initialization of population (randomly or with a sampling method), 2) evaluation of individuals, 3) stage 1 ends if a prefixed number of generations is completed, otherwise comes step 4) generation of new population with EA. Completion of stage 1 means a metamodel is created for "each computationally expensive objective and constraint function to work with the EA algorithm for evaluating individuals in stage 2". The metamodel is created using individuals that were stored in an archive in step 2. In step 6) EA operators produce an offspring population, in step 7) individuals are evaluated either with the metamodel or the original functions, in step 8) nondominated individuals from the last population are selected as the final population if a termination criterion is met, in step 9) individuals from step 7 are re-evaluated and then these individuals are added to the archive in step 10) for updating or retraining the metamodel.

Problem and fitness approximation are methods to reduce computation time in MOPs. Problem approximation simplifies the original problem by replasing it with a simplified problem. This reduces the computational complexity. Fitness approximation is algorithms that use metamodels to approximate some element instead of objective functions. There are several issues in using an approximation in an EA, and the numerical settings used to test their efficacy. One of them is a scarce use of constrained problems, another one is the type of test problems used.

The article discusses 45 algorithms that are used for reducing computation time in computationally expensive MOPs. The six recognized challenges are mainly related to metamodels the algorithms create. Handling the metamodel properly is what makes an algorithm efficient to solve computationally expensive problems. The efficiency can be measured by the number of function evaluations used, dimensions of problems solved, and characteristics of the solved problems.