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Solving Multi Objective Problems with Single Objective Solver

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Abstract: The main difference between multi-objective optimization and single-objective optimization is that the first one has more than one target function. The single-objective solver provides a single result value when multi-objective problems have a full set of optimal values, called the Pareto set. One very common approach for solving multi-objective problems is by transforming the multi objectives into a single objective. The simplest transformation is through an additive model, where a weighting factor is given on each objective. This research proposes a calculation procedure by which the LibreOffice Calc NLP Solver is used to generate solutions in the Pareto subset for multi-objective problems.

Keywords:multi-objective optimization, single-objective optimization, LibreOffice Calc NLP Solver

# 1. Introduction

Multi-objective optimization is part of general optimization. It has great practical importance since a lot of real-world problems suites for modeling by multiple conflicting objectives [1]. The most popular approach to solving such problems is primarily focused on transforming multiple objectives into a single objective.

Many practical optimization problems are admittedly defined as nonlinear problems having multiple conflicting objectives [2]. Because of the absence of proper solution techniques, these problems are mathematically transformed into a single-objective problem and then solved. The complexity comes from the fact that multi-objective problems lead to a set of trade-off optimal solutions (Pareto-optimal set [3]). In contrast, single-objective problems, in general cases, lead to a single optimum solution. The goal in multi-objective optimization is to find as many Pareto-optimal solutions as possible. Having many Pareto-optimal solutions is important because each taken two by two constitutes a trade-off in the objectives. The decision-maker would have more options to select which objectives to compromise [4].

In multi-objective optimization, there are two or more functions for which the optimal value is sought, for the same input vector. If the input vector is denoted by *x*, then its components can be denoted by {*x1*, ... , *xn*}. The presence of multiple functions for simultaneous optimization {*f1*, …, *fm*} [5] leads to the appearance of two optimization spaces - the search space of variables and the search space of objectives [6]. For the variables, lower and upper bounds may be imposed as possible values. In addition to the finite constraints, it is possible to specify linear and nonlinear equations/inequalities to be met. If only one objective or only one constraint has a nonlinear nature, then the problem becomes nonlinear.

The most used scalarization [7] formula is the additive model. In this model, each objective has a weight associated with it. The weighted objectives are sum after that (Eq. 1).

*f = w1f1(x) + … + wmfm(x)* (1)

Exactly this model is applied in the present scientific research. In the general case, a minimum of the function *f* is sought. A minimum value is also sought for each of the objectives. If a maximum is sought for any of the objectives, its weight participates as a negative number.

This study proposes a single-objective NLP Solver of LibreOffice Calc to be used for multi-objective problems. The rest of this paper is organized as follows: Section 1 introduces the problem with searching for Pareto optimal solutions; Section 2 describes the way in which a single-objective solver can be used for multi-objective problems; Section 3 reveals some practical experiments and related results; and Section 4 concludes with some suggestions for further work.

# 2. LibreOffice Calc NLP Solver

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# 3. Searching Pareto Points for Binh and Korn Function

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# **4**. Conclusion

This research examines the capabilities of a single-objective solver to be applied to multi-objective problems. By giving random weights for the objectives, various solutions are provided close to the Pareto front. The stochastic nature of the solver does not allow the proposed solutions to be on the front itself, and they are positioned close to it. From a mathematical point of view, this is not acceptable, but in real practice, even decent solutions are preferable in the absence of any solutions.

The application of random coefficients does not always give a good distribution of the points around the Pareto front. It would be interesting to apply some strategy for a wider study of the possible values for the coefficients. Although it is possible to change the coefficients manually, some form of automation would significantly speed up the process of finding an acceptable solution.

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