Built utilizing DESDEO: the modular and open source framework for interactive multiobjective optimization [3]
desdeo.it.jyu.fi

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# Explainable interactive multiobjective optimization

## ABSTRACT

**In interactive multiobjective optimization methods we iteratively incorporate the preferences of a decision maker into the optimization process to find the most preferred solution with satisfying trade-offs. Various such methods exist, but do not offer much support to the decision maker in formulting preferences that help them achieve preferred solutions. We argue that most interactive methods seem like black-boxes to decision makers, and explore how interactive multiobjective optimization methods can be made explainable.**

**Utilizing explanations, we can offer the decision maker further support in supplying their preferences. We present an approach based on ideas from game theory and machine learning to explain reference point based interactive multiobjective optimization methods. Based on the explanations, we formulate suggestions, which can support the decision maker in improving a certain objective function value. We achieve this by providing the decision maker with information on which objective is in the greatest conflict with the objective they wish to improve. Lastly, we confirm the validity of the proposed method by conducting numerical experiments.**

**In multiobjective optimization** [1], we are concerned with problems with multiple conflicting objectives. Multiobjective optimization problems are interesting and important to consider because:

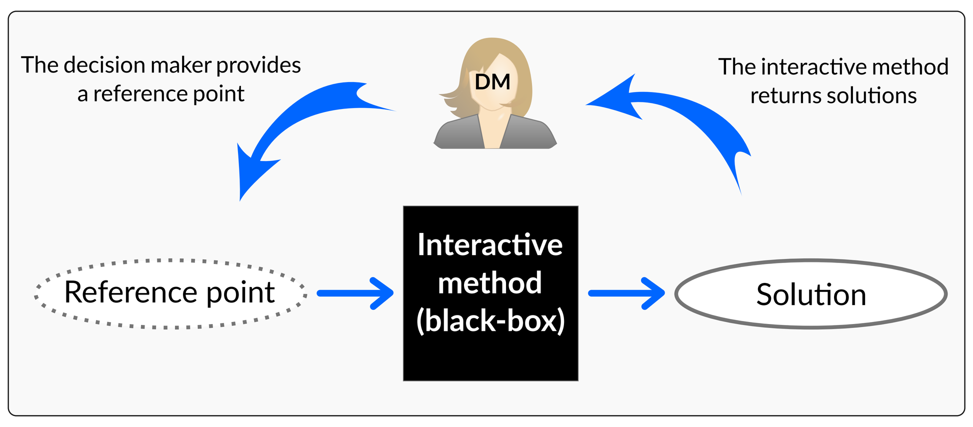
- In decision making, we are seldom concerned with just a single objective.
- The role of the decision maker, a human domain expert, is emphasized since no mathematically defined best solution exists to multiobjective optimization problems.
- Many real-life problems have conflicting perspectives, which characterize the goodness of the solution.

## INTERACTIVE MULTIOBJECTIVE OPTIMIZATION

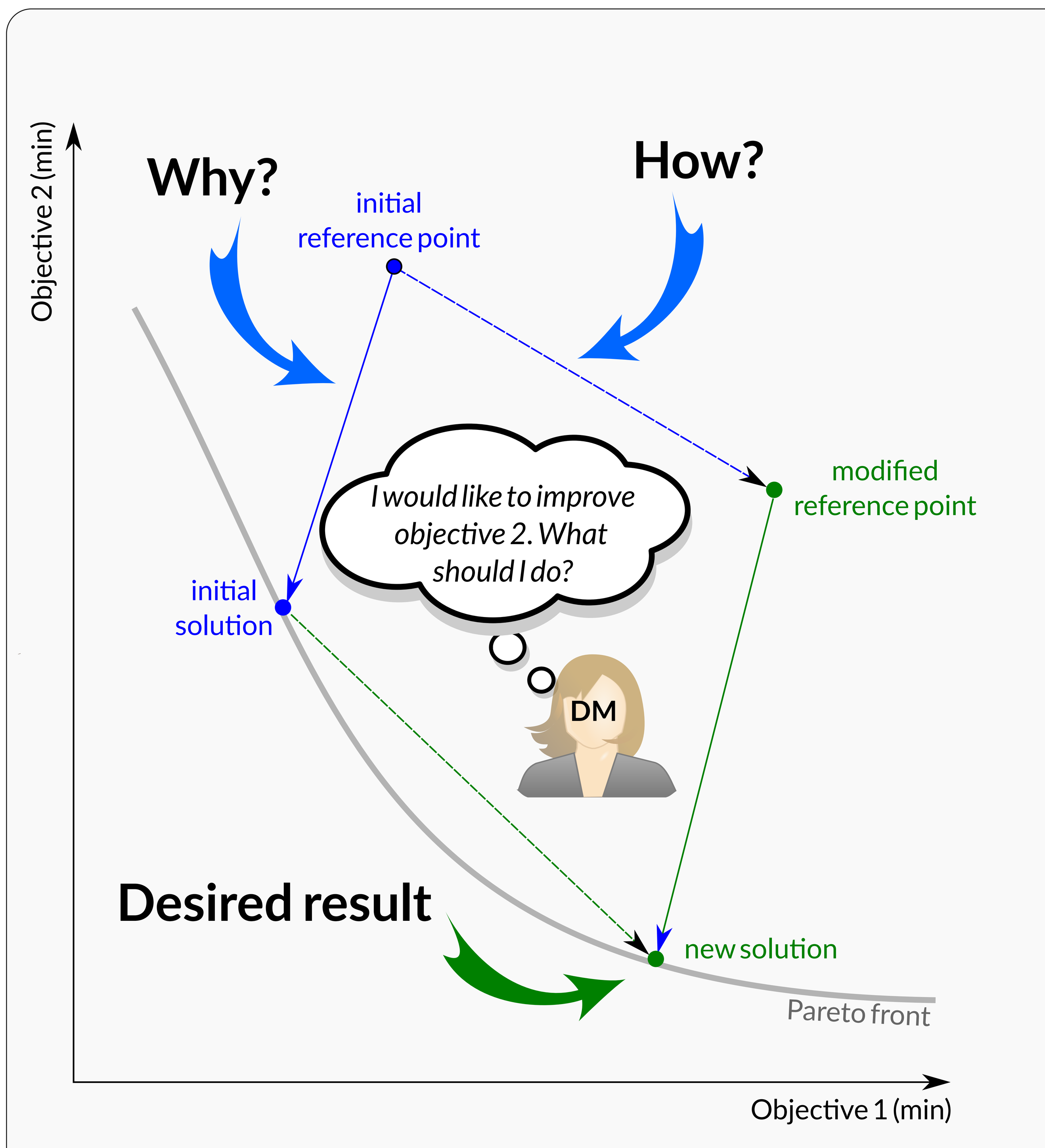
In interactive multiobjective optimization methods, the preferences of a decision maker are incorporated in the optimization process. This offers many advantages compared to *a priori* and *a posteriori* methods where the preferences are incorporated before and after the optimization process, respectively. These advantages include:

- The optimization process can focus on particular regions of interest, saving computational resources.
- The method allows the decision maker to explore and learn about the underlying interdependencies, trade-offs and the feasibility of preferences.
- Since preferences are used interactively and iteratively, interesting solutions can be found in real-time.
- There is no burden on the decision maker to provide preferences before the optimization process like in a priori methods.
- Analysts (e.g., data scientists) do not have to guess what the decision maker could deem preferable, like in a posteriori methods where preferences are available only after the optimization process.

However, there are also challenges. For instance, the decision maker has little to no support when providing preferences.




*The iterative process typically found in reference point based interactive multiobjective optimization methods.*




## Why

By providing **explanations**, we are able to tell the DM why a given reference point has produced a solution. We can utilize **SHAP values** to determine how each objective value in the reference point given by the DM has affected the objective values in the solution.

## How

We can provide the DM with **suggestions** on how to change the reference point to achieve a better value in the solution for a specified objective. We achieve this by **suggesting** trading-off regarding another objective, which according to computed **SHAP values**, is in the biggest conflict with the objective the DM wishes to improve.

## Desired result

Our method **supports the DM** in formulating a new reference point, which will result in a new solution with an improved value for a desired objective. This way, **the DM gets additional support** in expressing their preferences, and information on how the solution was produced. Ultimately, this will allow the DM to have **more confidence** in the solution reached and **more control** during the interactive optimization process.

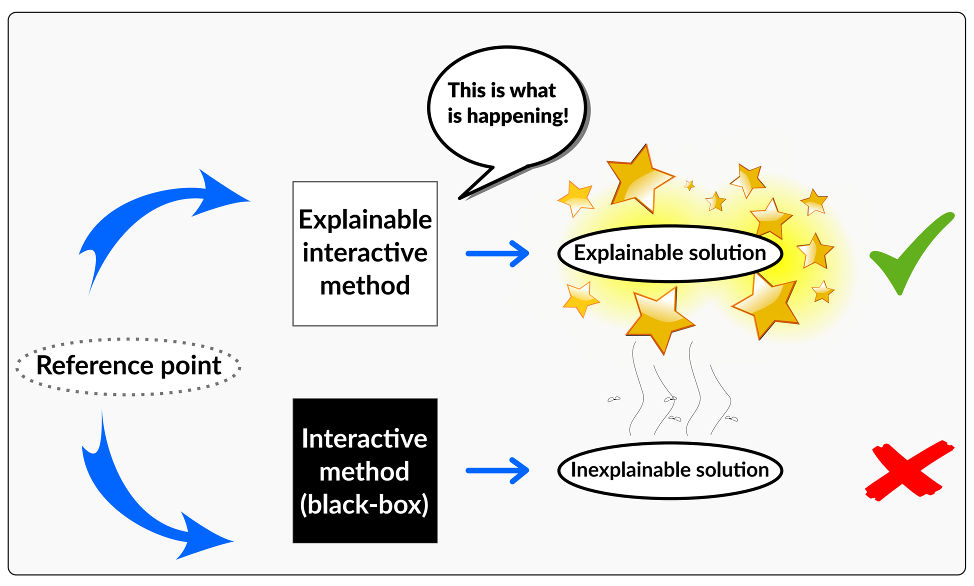
*The proposed method to explain reference point based interactive multiobjective optimization methods.*

***Our claim is that interactive multiobjective optimization methods can benefit a lot from explainability.***

## OUR PROPOSED APPROACH TO EXPLAIN INTERACTIVE METHODS

We utilize SHAP values [2] to explain reference point based interactive multiobjective optimization methods.

- For a given reference point and solution computed by an interactive method, we compute SHAP values.
- Utilizing the SHAP values, we can formulate a simple explanation to inform the decision maker how the given reference point has affected the solution.
- Utilizing the SHAP values, we can also formulate a suggestion to the decision maker how they may improve a certain objective value in the solution by altering the previously provided reference point.




*Explainability makes solutions better in interactive methods by shedding light on the optimization process.*

## CONCLUSIONS

- **Our method explains reference point based interactive multiobjective optimization methods with the help of SHAP values.**
- **Our method can also suggest the decision maker on how to modify a given reference point to improve some objective function value.**
- **Our method is an answer to the lack of support decision makers typically face when using interactive multiobjective optimization methods.**
- **Our method allows decision makers to make transparent decisions with increased confidence.**

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