# Computational and Visual Aids for Teaching Multi-objective Linear Optimization

**Carlos Henggeler Antunes [1,3] and Maria João Alves [2,3]**

(1) Department of Electrical Engineering and Computers, University of Coimbra, Portugal; ch@deec.uc.pt

(2) Faculty of Economics, University of Coimbra, Portugal; mjalves@fe.uc.pt

(3) INESC Coimbra, Rua Antero de Quental 199, 3000-033 Coimbra, Portugal

*Abstract: This paper presents a computational tool for teaching multi-objective linear optimization. The aim is to offer students in engineering and economics & management an intuitive environment as the entrance door to multi-objective optimization in which the main theoretical and methodological concepts can be apprehended through experimentation as well as mimicking a realistic decision support setting.*

*Keywords: Multi-objective programming; Interactive methods; Computational tools; Decision support;*

# 1 Introduction

Teaching optimization algorithms to engineering and economics & management student requires, besides the exposition to the essential concepts and methods, a hands-on approach by means of computational tools that enable students to experiment and exert their critical thinking on the results. This is particularly important in teaching multi-objective optimization since a "paradigm change" occurs in the sense that a optimal solution "vanishes" and the non-dominated solution set needs to be discovered, hopefully in a constructive manner that may shed light on the nature of the trade-offs involved.

Presenting a decision maker (DM) with a large set of non-dominated solutions does not generally convey usable information for actual decision support purposes. Therefore, the involvement of the DM by providing indications about his/her preferences is of outmost importance to guide and reduce the scope of the the search process, thus minimizing both the computational effort required for computing new solutions and guaranteeing that these solutions are more in accordance with his/her (evolving) preferences. This is accomplished in the operational framework of interactive methods, which intertwin computation steps

and judgment steps thus allowing for a progressive shaping of the DM's preferences as the selective characterization of the non-dominated solution set unfolds.

In this setting the integration of different interactive methods of multi-objective linear optimization, using different solution computation techniques, search strategies, preference elicitation requirements, visual interaction mechanisms and result displays, is the most adequate tool to be offered to students studying these topics for the first time (after having been exposed to, at least, single objective linear optimization). Our experience shows that this is the best entrance door for enhancing students' understanding of the main issues at stake in multi-objective optimization, before progressing to more technically demanding topics as integer and non-linear optimization or meta-heuristics.

# 2 A Computational Tool for Teaching Multi-objective Linear Optimization

A computational tool has been developed for teaching multi-objective linear optimization. The aim is to offer students in engineering and economics & management an intuitive environment as the entrance door to multi-objective optimization in which the main theoretical and methodological concepts can be apprehended through experimentation, thus learning at their own pace. Furthermore, this tool allows the students playing the role of an actual DM and exploit different search strategies and trade-offs between the competing objective functions leading to distinct non-dominated solutions. This tool is intended for classroom use and also offered to students for carrying out their individual or group assignments.

**Conclusions**

A software package integrating in a consistent operational framework distinct interactive methods has revealed to be an outstanding tool to develop the students' interest in the topic, enhance their technical skills and provide training as decision makers.