Multiobjective Optimization Software

Silvia Poles¹, Mariana Vassileva², and Daisuke Sasaki³

¹ ESTECO - Research Labs, Via Giambellino, 7 35129 Padova, ITALY
silvia.poles@esteco.com

² Institute of Information Technologies, Bulgarian Academy of Sciences,
BULGARIA mvassileva@iinf.bas.bg

³ CFD Laboratory, Department of Engineering, University of Cambridge,
Trumpington Street, Cambridge CB2 1PZ, UK ds432@eng.cam.ac.uk

Abstract. This chapter provides a description of multiobjective optimization software with a general overview of selected few available tools developed in the last decade. This chapter can be considered a revision of previous valid papers and chapters on nonlinear multiobjective optimization software such as the ones written by Weistroffer et al. (2005) and Miettinen (1999) that lists existing software packages up to the year 1999. More precisely, this chapter is focused on the tools and features that advisable multiobjective optimization software should contain.

12.1 Introduction

The main topic to be discussed in this chapter is available multiobjective optimization software. The main concern is devoted to software developed for nonlinear problems. Several questions may be raised when discussing multiobjective optimization software, but among the most recurring questions we may list the following:

• What do experts think about multiobjective optimization tools and what are the most important features good software should always possess?
• What is the current state-of-the-art of multiobjective optimization software?
• What are the advantages and gaps of all these optimization tools?

The description of an ideal software is very close to a complex integrated environment such as a “Process Integration and Design Optimization” (PIDO) or a “Problem Solving Environment” (PSE) (Gallopoulos et al., 1991, Houstis et al., 1997). PIDO and PSE are integrated computing environments which...
provide the users all the necessary tools for solving multiobjective optimization problems and for supporting decision making.

An ideal tool should have: an easy-to-use graphical user interface, a good set of optimization methods, a good tool for visualizing the results and choosing the final solutions. Moreover meta-modeling and validation of models are fundamental when dealing with time-consuming function evaluations. Last but not least, robustness and reliability of solutions are of primary importance for selecting the best design.

There are many attributes and characteristics that can be used to measure software quality as seen by end-users. Leaving out all the problems related to reliability, absence of bugs, extensibility and maintainability of each tool, we here refer to requirements that a decision maker may have for a multiobjective optimization software.

In the following sections a list of advisable program specifications is explained. Next, a list of software is described and their conformance to requirements and specifications is analyzed.

### 12.2 Software Features and Quality

#### 12.2.1 Graphical User Interface

One of the most evident characteristics of a software is always a flexible, complete and easy-to-use graphical user interface (GUI). Even with multiobjective optimization tools, the GUI plays an important role. In this case, the GUI should give to the users of the software being it analysts or decision makers (e.g. engineers and managers) the ability to define and modify a problem, to define input, output, objectives and constraints. Moreover, the GUI should give to the decision makers the ability to choose optimization strategies, manage software and hardware resources, describe how the processes are synchronized and visualize and analyze results. Moreover, the GUI should be suitable for introducing decision maker’s preferences in order to solve multiobjective decision making problems with an intelligent guidance.

For example, a multiobjective optimization problem can be described using graph-based formalisms as shown in Fig. 12.1. The figure describes a standard mechanical design problem, the design of a welded beam structure with the aim to minimize cost and displacement subject to constraints on shear.

#### 12.2.2 Optimization Methods

Problems related to one or more than one conflicting objective functions, originate in several disciplines; their solution has been a challenge for a long time. Typically, using a single optimization technology is not sufficient to deal with real-life problems.