

## Applications

In computing, turning the obvious into the useful is a living definition of the word “frustration”.

Alan Perlis

### 7.1 Introduction

Although the application of classical multiobjective optimization techniques to solve problems in different areas (e.g., management, engineering and science) started as early as 1951 (see Section 1.6.2 from Chapter 1), Multi-Objective Evolutionary Algorithms (MOEAs) were applied for the first time until the mid-1980s [764, 1440, 518]. However, since the late 1990s, there has been a considerable increase in the number of applications of MOEAs. This has been mainly originated by the success of MOEAs in solving real-world problems.<sup>1</sup> MOEAs have generated either competitive or better results than those produced using other search techniques. This has made the task of classifying MOEA applications difficult and subjective. Trying to deal with this problem, it was decided to use a rather simple and general classification in this chapter, trying to fit each paper reviewed within the closest category according to the focus of the work. For example, a paper that is related to scheduling and naval engineering but is more focused on the second subject, is classified under “environmental, naval and hydraulic engineering”. This avoids overlapping to a certain extent, but can be confusing for some people. Therefore, it was decided to add as many entries as possible to the analytical index provided at the end of this book to facilitate the search. Additionally, *italics* characters are used throughout this chapter to indicate the specific name of an application, in an attempt to facilitate the search of specific information.

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<sup>1</sup> In fact, there are several recent surveys on applications of MOEAs in specific areas (see for example [393, 1445]), and there is even a recent book entirely devoted to real-world applications of MOEAs [277].

Besides indicating the specific application studied, brief discussions about the type of MOEA used (including encoding, genetic operators and type of evolutionary algorithm) are provided (if such information is available). Additionally, if the approach adopted is compared to any other technique, a brief discussion of the results obtained is also provided.<sup>2</sup>

To facilitate location of information, each section contains a table with a summary of the applications reviewed in that section. The table describes briefly the type of specific application reviewed, the references related to it, and the type of MOEA adopted in each case.<sup>3</sup>

For practical purposes, applications of MOEAs have been divided in four main groups: engineering, scientific, industrial and miscellaneous. Each of these has been further divided into subgroups, as we will see later on.

7.2 Engineering Applications

Engineering is, by far, the most popular application domain area within the MOEAs literature. This is mainly because engineering applications normally have “good” mathematical models (equations/inequalities) that can directly be associated with a MOEA search. To understand better the particular areas of interest within this domain, engineering applications have been further divided into eight subgroups: (1) environmental, naval & hydraulic, (2) telecommunications and network optimization, (3) structural & mechanical, (4) aeronautical, (5) electrical and electronics, (6) robotics and control, (7) civil and construction, and (8) transport.

7.2.1 Environmental, Naval and Hydraulic Engineering

Table 7.1: Summary of environmental, naval and hydraulic engineering applications

Specific Applications	Reference(s)	Type of MOEA
Groundwater pollution re-mediation	[1364]	VEGA, GA with Pareto ranking
	[708]	NPGA
	[255]	VEGA, GA with Pareto ranking, GA with Tchebycheff weighting method
	[1325]	Multi-Niche Crowding GA
	[453]	NPGA 2
Water quality control	[542]	GA with a linear aggregating function
	[232]	GA with a nonlinear aggregating function
	[1340, 1341, 1342]	NSGA
	[1507]	Noninferior Surface Tracing Evolutionary Algorithm

<sup>2</sup> When no mention to any comparisons is made, it means that the authors did not report any validation of their approach with respect to other techniques.

<sup>3</sup> See Chapter 2 for information on each specific type of MOEA.