

# Automatic Configuration of NSGA-II with jMetal and irace

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## ABSTRACT

jMetal is a Java-based framework for multi-objective optimization with metaheuristics providing, among other features, a wide set of algorithms that are representative of the state-of-the-art. Although it has become a widely used tool in the area, it lacks support for automatic tuning of algorithm parameter settings, which can prevent obtaining accurate Pareto front approximations, especially for inexperienced users. In this paper, we present a first approach to combine jMetal and irace, a package for automatic algorithm configuration; the NSGA-II is chosen as the target algorithm to be tuned. The goal is to facilitate the combined use of both tools to jMetal users to avoid wasting time in adjusting manually the parameters of the algorithms. Our proposal involves the definition of a new algorithm template for evolutionary algorithms, which allows the flexible composition of multi-objective evolutionary algorithms from a set of configurable components, as well as the generation of configuration files for adjusting the algorithm parameters with irace. To validate our approach, NSGA-II is tuned with a benchmark problems and compared with the same algorithm using standard settings, resulting in a new variant that shows a competitive behavior.

## CCS CONCEPTS

• **Computing methodologies** → *Optimization algorithms*; • **Theory of computation** → *Bio-inspired optimization*;

## KEYWORDS

Multi-objective Optimization, Metaheuristics, Software Tools, Automatic Algorithm Configuration

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## 1 INTRODUCTION

The field of multi-objective optimization with evolutionary algorithms and other metaheuristic techniques is an active research area since the last twenty years. Around year 2000, the most widely used algorithm since then, NSGA-II [5], was proposed, and two seminal books about solving multi-objective problems with evolutionary algorithms were published [3, 4].

A factor that has promoted the development and application of multi-objective metaheuristics has been the availability of software tools. Since the emergence of PISA [2] in 2003, many frameworks have been proposed, being jMetal one of them. jMetal started in 2006 [9] as a research project to develop a Java-based software framework for multi-objective optimization with metaheuristic techniques. The source code is freely available since 2008, and it is hosted in GitHub under MIT license<sup>1</sup>. It has become a popular tool, and the papers describing it [7][9][8][13] sum up more than 1300 cites at the time of writing this paper according to Google Scholar.

jMetal was redesigned from scratch in 2015 [13] to be improved in a number of aspects (architecture, code quality, project organization, algorithm templates, parallelism support), but an aspect that is becoming a hot topic, the automatic configuration of metaheuristics, was not considered then. Most of metaheuristics depend on a number of parameters, and their performance is bound largely by finding proper values for them. This is usually a cumbersome task, particularly in the case of users who are expert in the problem domain but are unfamiliar with the algorithms.

In this paper, we present a proposal to extend jMetal with support for automatic parameter tuning. Our approach is based, on the one hand, on designing a very flexible template for evolutionary algorithms in such a way that a multi-objective evolutionary algorithm can be composed of a number of building blocks that can be configured as parameters which can take a range of values. On the other hand, these parameters are described in a way that they can be tuned by irace [11], an R-based package which has not only been used for algorithm configuration, but also for the automatic design of multi-objective evolutionary algorithms [1]. The goal is to facilitate the combined use of both tools to jMetal users interested in solving a given problem, but not in wasting time in adjusting manually algorithms' parameters.

<sup>1</sup>jMetal site in GitHub: <https://github.com/jMetal/jMetal>