Chapter 19

TUNING TABU SEARCH STRATEGIES VIA VISUAL DIAGNOSIS

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Abstract: While designing working metaheuristics can be straightforward, tuning them to solve the underlying combinatorial optimization problem well can be tricky. Several tuning methods have been proposed but they do not address the new aspect of our proposed classification of the metaheuristic tuning problem: tuning search strategies. We propose a tuning methodology based on Visual Diagnosis and a generic tool called Visualizer for Metaheuristics Development Framework (V-MDF) to address specifically the problem of tuning search (particularly Tabu Search) strategies. Under V-MDF, we propose the use of a Distance Radar visualizer where the human and computer can collaborate to diagnose the occurrence of negative incidents along the search trajectory on a set of training instances, and to perform remedial actions on the fly. Through capturing and observing the outcomes of actions in a Rule-Base, the user can then decide how to tune the search strategy effectively for subsequent use.

Key words: Metaheuristics, Software Framework, Tuning Problem, Visualization

1. INTRODUCTION

Metaheuristics have been used extensively to solve hard combinatorial optimization problems, often with significant success. Given that metaheuristics do not guarantee optimality in general, the challenge is not so much to design a working algorithm but to tune it so as to obtain the best possible result. One way to measure the goodness of a metaheuristic algorithm is by checking its result against a set of benchmark problem instances.

Since different problems or even instances of the same problem may require the metaheuristic algorithm to be configured with different search parameters, components and/or strategies in order to work optimally, some
resort to trial-and-error tuning through extensive experiments. Others use their past knowledge or experiences to tune the algorithm. From the industry standpoint, this process is unproductive especially against a backdrop of tight development schedules.

Alternatively, human\(^1\) intelligence and machines can collaborate to shorten development time through the use of a well-designed visualization and interaction tool. The human-plus-computer collaboration has obtained considerable success in solving complex tasks, e.g. CAD/CAM. With the help of a well-designed visual diagnostic tool, an algorithm designer is able to examine search trajectories more systematically, steer the search, and readily see the impact of his action. We argue that this significantly reduces the time to design good search strategies which in turn speed up the overall development time.

Using visualization to assist optimization has been proposed in the seminal work of (Jones, 1996). In this paper, we propose a visualization scheme that determines quickly a set of rules that are helpful to the underlying metaheuristic algorithm. Unlike works due to (Klau et al., 2002) and others which focused on problem-specific visualization, we emphasize the design of a generic problem-independent tool called Visualizer for Metaheuristics Development Framework (V-MDF). This work is an extension of MDF proposed in (Lau et al., 2004b, 2006).

Instead of relying on specific problem domain information, V-MDF seeks to capture a pictorial view of the search trajectories and reports any anomalies to the human user. By visual inspection of these anomalies, the user can determine with higher accuracy the problems encountered during search, and apply remedial actions (such as tuning the parameters, adjusting the components of metaheuristics, or deriving better adaptive search strategies). With V-MDF, the algorithm designer begins with a metaheuristic on some defined search strategies, observes the search run-time dynamics, and dynamically improves the search strategies.

V-MDF differs from existing approaches for tuning metaheuristic which focused on the design of an efficient method for automatically choosing the best parameter values and/or metaheuristic components in black-box fashion (Adenso-Diaz and Laguna, 2006; Birattari, 2004). Instead, we extend the idea of visualizing the search process by (Kadluczka et al., 2004) and that of analyzing the search landscape by (Fonlupt et al., 1999; Merz, 2000; Hoos and Stuetzle, 2005), to help the users in designing better metaheuristics. This feature makes V-MDF especially useful for designing metaheuristics for new combinatorial optimization problems where search strategies have not been well-defined.

\(^1\) The terms human, user, or algorithm designer are used interchangeably to refer to those who specialize in the development of metaheuristic algorithms.