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On the convergence of Scatter Search and Star Paths with Directional Rounding for 0-1 Mixed Integer Programs

Abstact: The 0-1. Scatter Search is an evolutionary metaheuristic introduced by Fred Glover (1977) as a heuristic for integer programming and was joined with a directional rounding strategy for 0-1 Mixed Integer Programming (MIP) problems based on Star Paths in Glover (1995). In this paper, we address directional rounding both independently and together with these other algorithmic components, studying its properties as a mapping from continuous to discrete (binary) space. Moreover, we observe that directional rounding of a line, as embodied in a Star Path, contains a finite number of distinct 0-1 points. This property, together with those of the solution space of 0-1 MIP, enables us to organize the search for an optimal solution of 0-1 MIP problems using Scatter Search in association with both cutting plane and extreme point solution approaches. Building on this we provide a Convergent Scatter Search algorithm for 0-1 MIP with proof of its finite convergence, accompanied by two variants of its implementation and examples that illustrate the running of the approach. In addition we introduce several heuristic approaches for finding good solutions based on scatter search with directional rounding. The versions of the methods tested are first stage implementations to establish the power of the methods. Additionally, we conduct an empirical study in order to identify the best way for choosing ingredients of a heuristic that combines Scatter search and directional rounding. Finally, we disclose the merit of our approaches by computational testing on a test bed of 0-1 MIP problems.

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