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An Improved Big Bang – Big Crunch Algorithm For Size Optimization of Trusses

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Abstract

The Big Bang–Big Crunch (BB–BC) optimization algorithm is a new optimization method that relies on the Big Bang and Big Crunch theory, one of the theories of the evolution of the universe. This method is among the heuristic population-based search procedures that incorporate random variation and selection, such as genetic algorithm (GA) and simulated annealing (SA). Alongside the main advantages of these methods, the problems resulting from the improper distribution of candidate solutions cannot be ignored, especially for high-dimensional functions. In this paper a method, namely Audze-Eglais' approach, has been applied to produce population that increases accuracy via homogeneous candidate solutions. Numerical results demonstrate the efficiency of the improved BB-BC method compared to other heuristic algorithm.

Keywords: Big Bang-Big Crunch, Size optimization, Truss structures, Heuristic algorithms

1. INTRODUCTION

In general, the optimization techniques used in structural design can be categorized into classical and heuristic search methods. Classical optimization methods such as linear programming, nonlinear programming and optimality criteria often require substantial gradient information. In these methods the final results depend on the initially selected points and the number of computational operations increases with the size of the structure. The solution in these methods does not necessarily correspond to the global optimum. Many engineering design problems are too complex to be handled with mathematical programming methods; while heuristic search methods do not require the data as in the conventional mathematical programming and have better global search abilities than the classical optimization algorithms [1].

A new optimization heuristic method relied on one of the theories of the evolution of the universe namely, the Big Bang and Big Crunch theory is introduced by Erol and Eksin [2] which has a low computational time and high convergence speed. According to this theory, in the Big Bang phase energy dissipation produces disorder and randomness is the main feature of this phase; whereas, in the Big Crunch phase, randomly distributed particles are drawn into an order. The Big Bang–Big Crunch (BB–BC) Optimization method similarly generates random points in the Big Bang phase and shrinks these points to a single representative point via a center of mass in the Big Crunch phase. After a number of sequential Big Bangs and Big Crunches where the distribution of randomness within the search space during the Big Bang becomes smaller and smaller about the average point computed during the Big Crunch, the algorithm converges to a solution.

In this study, an Improved Big Bang–Big Crunch optimization (IBB–BC) is implemented to solve the truss optimization problems. The IBB–BC method consists of two phases: a Big Bang phase where candidate solutions are randomly distributed over the search space, and a Big Crunch phase working as a convergence operator where the center of mass is generated. Then new solutions are created by using the center of mass to be used as the next Big Bang. These successive phases are carried repeatedly until a stopping criterion has been met.