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Metaheuristics: A General Framework

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Extended Abstract

In recent years, there have been significant advances in the theory and application of metaheuristics to approximate solutions of complex optimization problems. The meta-heuristics term was used: as a language and a program for stating and solving combinatorial problems in [1]; to describe tabu search in [2] and [3]; to classify recent approaches such as adaptive memory programming, ants systems, evolutionary methods, genetics algorithm, greedy randomized adaptive search procedures, guided local search, neural networks, problem-space search, simulated annealing, scatter search, tabu search, threshold algorithms, and their hybrids in [4, 5, 6 and 7] and as a title for the biennial series of the metaheuristics international conferences (MIC-95, MIC-97, MIC-99, MIC-01).

A metaheuristic was defined in [7, 8] an iterative master process that guides and modifies the operations of subordinate heuristics to efficiently produce high quality solutions. It may combine intelligently different concepts for exploring the search space and uses learning strategies to structure information. It may manipulate a complete (or incomplete) single solution or a collections of solutions at each iteration. The subordinate heuristics may be high (or low) level procedures, or a simple local search, or just a construction method.

Metaheuristics provide decision makers with robust tools that obtain high quality solutions, in a reasonable computational effort, to important applications in business, engineering, economics and the sciences. Finding exact solutions to these applications still poses a real challenge despite the impact of recent advances in computer technology and the great interaction between computer science, management science/operations research and mathematics. For more details on theory and applications, we refer to the comprehensive bibliography on metaheuristics in [5], the books in [6–16].

A metaheuristic may have four components: initial space of solutions; search engines; learning and guideline strategies; management of information structures. In this paper, the most efficient metaheuristics and their associated components are briefly described. The unified-metaheuristic framework presented [4] is extended into a more general one to show how the existing metaheuristics can fit into it. The general framework invites extra research into desiging new innovative and unexplored metaheuristics. Finally, we conclude by highlighting current trends and future research directions in this active area of the science of heuristics.

References

[1] J.L. Lauriere, Language and a program for stating and solving combinatorial problems, Artificial Intelligence 10: (1) (1978) 29–127.

[2] F. Glover, Future paths for integer programming and links to artificial intelligence, Computers and Operations Research, 13 (1986) 533–549.

[3] A. Hertz and D. de Werra, The tabu search metaheuristic: how we used it, Annals of Mathematics and Artificial Intelligence, 1 (1991) 111–121.

[4] I.H. Osman, An introduction to Metaheuristics, in: Operational Research Tutorial Papers, Editors: M. Lawrence and C. Wilsdon (Operational Research Society Press, Birmingham, 1995) 92–122.

[5] I.H. Osman and G. Laporte, Metaheuristics: A bibliography, Annals of Operational Research, Vol. 63 (1996) 513–628.

[6] G. Laporte and I.H. Osaman, Metaheuristics in Combinatorial Optimization, Annals of Operations Research, Vo 63, Baltzer Science Publishers, Basel, 1996.

[7] I.H. Osman and J.P. Kelly, Metaheuristics. Theory and Applications, Kluwer, Boston, 1996.

[8] I.H. Osman and J.P. Kelly, Metaheuristics: An overview, in Metaheuristics: Theory and Applications, Kluwer, Boston, 1996. p.p. 1–21.

[9] S. Voss, S. Martello, I.H. Osman, and C. Roucairol, Metaheuristics: Advances and trends in local search paradigms for optimization, Kluwer, Boston, 1999.

[10] C.C. Ribeiro and P. Hansen, Essays and surveys in Metaheuristics, Kluwer, Boston, 2001.

[11] E.H.L. Aarts and J.K. Lenstra, Local Search in Combinatorial Optimization, Wiley, Chichester, 1997.

[12] D. Corne, M. Dorigo and F. Glover, New ideas in Optimization, MacGraw-Hill, London, 1999.

[13] G. Glover and M. Laguna, Tabu Search, Kluwer, Boston, 1997.

[14] Z. Michalewicz, Genetic Algorithms + Data Structures = Evolutionary Programs, Spinger-Verlag, Berlin, 1992.

[15] V.J. Rayward-Smith, I.H. Osman, C.R. Reeves and G.D. Smith, Modern Heuristic Search Methods, Wiley, Chichester, 1996.

[16] C.R. Reeves, Modern Heuristic Techniques for Combinatorial Problems, Blackwell, Oxford, 1993.

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