Discrete Bacterial Memetic Algorithm – an efficient approach for solving NP-hard graph search problems

László T. Kóczy

Abstract. It is well known that the optimal solution of any NP-hard problem cannot be found in a general case, because the computational complexity causes the unbounded and very steep raise of the costs (time and space). Thus, quasi-optimal solutions, and efficient heuristics are very much in demand for such problems. There are several heuristic solutions known in the literature, and the best results are usually very efficient indeed, and deliver very good approximations of the optimum for reasonably large instances. However, such approaches are always tailor made, their applicability is restricted to the given type of problem. One of the most well-known (NP-hard) graph search problems is the Traveling Salesman Problem (TSP). Various heuristic quasi-optimal solutions have been published in the literature during the past decades. The classical approaches are the Lin-Kernighan [1], the Concorde algorithms and more recently, Helsgaun's. The latter is a further development of the LK-algorithm, and at present, the best solution. It should be noted, however, that these methods are all specific for the TSP problem, and not applicable for any other search. There are several extensions of TSP, among which the following two deserve special attention: TSP with Time Window (TSP TW) and Time Dependent TSP (TD TSP). For both problems there are similarly efficient heuristics. For TSP TW the best results were produced by Ohlmann and da Silva , while the most up-to-date approaches to TD TSP were proposed in by Golden et al and Schneider . All four methods are completely different and unusable for any other similar problem. A fourth related, but still different problem is the Travelling Repairman Problem (also called Minimum Latency), where cumulated path lengths are calculated, thus, it is different in the sense of the total cost to be optimized. Here, Salehipour and the GILS-RVND heuristics developed by M.M. Silva, A. Subramanian, T. Vidal and L.S. Ochi has delivered the best speed and approximation accuracy results.

Laszlo T. Koczy received the M.Sc., M.Phil. and Ph.D. degrees from the Technical University of Budapest (BME) in 1975, 1976 and 1977, respectively; and the D.Sc. degree from the Hungarian Academy of Science in 1998. He spent his career at BME until 2001, and from 2002 at Szechenyi Istvan University (Gyor, SZE). He has been from 2002 to 2011 Dean of Engineering, and from 2013 to current President of the University Research Council and of the University Ph.D. Council. From 2012 he has been a member of the Hungarian Accreditation Committee (for higher education), appointed by the Prime Minister, and elected Chair of the Engineering and Computer Science sub-committee, member of the Professors and Ph.D. sub-committee, and has been a member of the National Doctoral Council since 2012. He has been a visiting professor in Australia (ANU, UNSW, Murdoch and Deakin), in Japan (TIT, being LIFE Endowed Fuzzy Theory Chair Professor), in Korea (POSTECH), Austria (J. Kepler U.), and Italy (U. of Trento), etc. His research interests are fuzzy systems, evolutionary algorithms and neural networks as well as applications. He has published over 570 articles, most of those being refereed papers, and several text books on the subject. He has close to 2600 independent citations (mtmt.hu) and his Hirsch-index is 36 by Google Scholar (based on ~5470 citations there). His main results are: he did introduce the concept of **rule interpolation in sparse fuzzy models**, and **hierarchical interpolative fuzzy systems, fuzzy Hough transform**, and also fuzzy signatures and fuzzy situational maps, **further fuzzy signature** state machines among others. He also proposed a **family of memetic algorithms** (Bacterial Memetic Algorithm, Discrete Bacterial Memetic Algorithm) which, among others, provides the best solutions to the Minimum Latency Traveling Salesman Problem. His research interests include applications of CI for telecommunication, transportation and logistics, vehicles and mobile robots, control, information retrieval, etc. He is Lead Guest Editor at Complexity. He was an Associate Editor of IEEE TFS for several periods, and is now AE of Fuzzy Sets and Systems, Int. Journal of Fuzzy Systems, Journal of Advanced Computational Intelligence, Int. J. of Fuzzy Systems, Soft Computing, etc. He is a Fellow of IFSA, of ISME and of the Hungarian Academy of Engineering. He was the founding President and is now the Life Honorary President of the Hungarian Fuzzy Association, was President, etc. of IFSA, AdCom member of IEEE CIS, and of IEEE Systems Council, etc. He is a member of the St. Stephan Academy of Science (2016).