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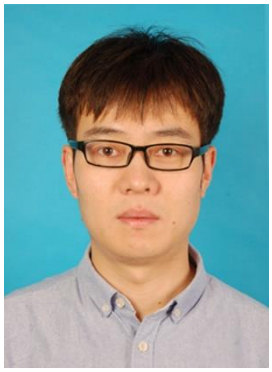

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László T. Kóczy,

Discrete Bacterial Memetic Evolutionary Algorithms for solving high complexity problems

Evolutionary algorithms attempt to copy the solutions nature offers for solving (in the quasi-optimal sense) intractable problems, whose exact mathematical solution is impossible. The prototype of such algorithms is the Genetic Algorithm, which is, however rather slow and often does not find a sufficient solution. Nawa and Furuhashi proposed a more efficient modified one, under the name of Bacterial Evolutionary Algorithm (BEA). Moscato proposed the combination of evolutionary global search with nested local search based on traditional optimization techniques, and called the new approach memetic algorithm (MA).

We attempted to combine BEA first with Levenberg-Marquardt local search and we obtained very good results on a series of benchmarks. The next step was to apply the new type of MA for NP-hard discrete optimization, starting with the classic and well known Traveling Salesman Problem (TSP), applying discrete local search, and thus proposing the novel Discrete Bacterial Memetic Evolutionary Algorithm (DBMEA). Then, we continued with a series of related, but

mathematically different graph search problems, applying the same approach. Although we could not improve the tailor made Helsgaun-Lin-Kernighan (HLK) heuristics for the basic TSP, we got comparably good results, and in some other problem cases, we obtained new, so far the best accuracy and running time combinations. The Traveling Repairman Problem is an eminent example, where DBMEA delivers the best solutions.

The advantages of the new approach are as follows:

- Rater general applicability. With minimal adaptation to the concrete problem type the same method could be successfully applied, there was no need to construct new tailor made algorithms for every new problem
- Predictability. Knowing the problem size, it was easy to give a good estimation of the running time, assuming a certain accuracy. This is not true for any of the other approaches, including the HLK, and especially not true for other methods, finding approximate solutions (often with large error)

In the talk, two examples will be presented with standard benchmarks going up to large numbers of graph nodes, and the DBMEA results will be compared with the best practices from the literature. The predictability feature will also be illustrated by a size-running time graph.

László T. Kóczy 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),Poland AGH University, Austria (J. Kepler U.), and Italy (U. of Trento), etc. His research interests are fuzzy systems, evolutionary and memetic algorithms and neural networks as well as applications. He has published over 890 articles, most of those being refereed papers, and several text books and numerous edited volumes on the subject. His Hirsch-index is 41 by Google Scholar (based on ~71350 citations there).

His main results are: he did introduce the concept of , and , , and also and fuzzy situational maps, further fuzzy signature state machines among others. He also proposed a (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 was Lead Guest Editor at Complexity and is now at Algorithms and Symmetry. 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), and for in member of the Polish Academy of Science (2017). He is the 2020 recipient of the IEEE Fuzzy Pioneer Award.