

In (Haemers' Ph.D. thesis, 1980) an upper bound (based on the least and largest adjacency eigenvalues) on the independence number of arbitrary graphs was introduced. Later, in (Lu et al, 2007), upper bounds (using the largest Laplacian eigenvalue) were deduced. For regular graphs, in (Bussemaker et al, 1976) a spectral upper bound on the order of induced subgraphs with average degree d was obtained. This upper bound is herein extended to arbitrary graphs, introducing three new upper bounds, based on adjacency, Laplacian and signless Laplacian eigenvalues, respectively.

3 - Graph spectra and combinatorial optimization

Nair Abreu, Production Engineering, Federal University of Rio de Janeiro, Rua Joao Lira 106/401, Leblon, 22430 210, Rio de Janeiro, Rio, Brazil, nairan@veloxmail.com.br, *Claudia Justel*, *Domingos Cardoso*

Wilf(1967), followed by Hoffman(1970), presented the first results on graph spectra in combinatorial optimization by introducing graph eigenvalue bounds to the chromatic number. Later several articles appeared relating eigenvalues to classical invariants of graphs: stability and clique numbers, matching, connectivity and isoperimetric number. Furthermore, some hard combinatorial optimization problems have been approximated by using spectral techniques. We present a survey of significant results about graphs spectra applied to combinatorial optimization.

■ TB-06

Tuesday, 10:30-12h00

RB-Gamma

Performance evaluation and new metaheuristics

Stream: Metaheuristics

Invited session

Chair: *Cristina C. Vieira*, Department of Electronics and Informatics Engineering, University of Algarve, Faculty of Science and Technologies, Campus de Gambelas, Faro, Localidade, Portugal, cvieira@ualg.pt

1 - Using a multicriteria function to evaluate metaheuristics performance

Paulo Oswaldo Boaventura-Netto, Production Engineering, Federal University of Rio de Janeiro/COPPE, Rua Pinheiro Machado 99, ap. 1508, Laranjeiras, 22231-090, Rio de Janeiro, RJ, Brazil, pausa@globo.com, *Valdir Melo*

We propose a multicriteria evaluation scheme based on Condorcet ranking technique. It uses weights associated to the algorithms from a set being object of comparison. We used five criteria and a function on the set of natural numbers to create a ranking. The comparison involves three well-known problems of combinatorial optimization, taking instances from public libraries. Each algorithm was used with essentially the same structure, the same local search was used and the initial solutions were similarly built. The metaheuristics GRASP, Tabu Search, ILS and VNS, participate from the comparison.

2 - Performance Assessment of Electromagnetism-like Algorithm

Alkin Yurtkuran, Industrial Engineering Department, Uludag University, Uludag University, Industrial Engineering Department, 16059, Bursa, Turkey, alkin@uludag.edu.tr, *Erdal Emel*

Meta-heuristic algorithms are robust and efficient techniques for solving complex real-world problems. Electromagnetism-like Algorithm (EMA) is one of the recently introduced population based meta-heuristic which simulate the behavior of charged particles on an electrical field. This work provides a comparison between EMA and popular foraging and evolutionary algorithms using well-known CEC05 benchmark functions based on the solution value and solution time. The results show that the performance of EMA is comparable to novel meta-heuristic algorithms in terms of solution quality and time.

3 - From constructive search to local search

Cristina C. Vieira, Department of Electronics and Informatics Engineering, University of Algarve, Faculty of Science and Technologies, Campus de Gambelas, Faro, Localidade, Portugal, cvieira@ualg.pt, *Carlos M. Fonseca*

Constructive search may be reinterpreted as local search by considering an appropriate solution space, defining a neighbourhood structure based on the original construction rules and specifying how to evaluate incomplete solutions. The resulting problem formulation is compatible with both local and constructive optimisation methods, and allows very different metaheuristics to be studied on exactly the same (local) formulation of a given (global) optimisation problem. The proposed approach is illustrated in the context of ACO and evolutionary algorithms on the TSP.

4 - Algorithm of inspired by virus and bacterium attack: A meta-heuristic approach as an optimization tool

Mahdi Bashiri, Shahed University, Iran, Islamic Republic Of, Bashiri@shahed.ac.ir, *Masoud Bagheri*, *Zeinab Rasoolinezhad*

In this paper, a new meta-heuristic algorithm has been proposed based on virus and bacterium attack (VBA). Actually presented solution approach is inspired by attack of virus and bacterium to human body. In the proposed algorithm, virus and bacteria attack to reach the body cells death. Some numerical examples have been selected from the literature to consider the proposed VBA's efficiency. Also the algorithm has been compared by the genetic algorithm (GA). The computational results verify its efficiency from computational time and solution quality aspects as well.

■ TB-07

Tuesday, 10:30-12h00

RB-Eta

Vehicle Routing and Logistics Optimization

Stream: Vehicle Routing and Logistics Optimization

Invited session

Chair: *Erdener Özçetin*, Industrial Engineering, Anadolu University, Iki Eylül Kamp., MMF END 107, 26000, Eskişehir, Turkey, eoçetin@gmail.com

1 - A Parallel Procedure for Dynamic Multi-objective TSP

Weiqi Li, School of Management, University of Michigan-Flint, 303 East Kearsley Street, 48502, Flint, Michigan, United States, weli@umflint.edu

We propose a new parallel search procedure for dynamic multi-objective traveling salesman problem. We design a multi-objective TSP in a stochastic dynamic environment. The proposed procedure first uses parallel processors to identify the extreme solutions of the search space for each of k objectives individually at the same time. These solutions are merged into a matrix E . The solutions in E are then searched by parallel processors and evaluated for dominance relationship. The proposed procedure was implemented in two different ways: a master-worker architecture and a pipeline architecture.

2 - Solving the vehicle routing problem with time windows by an interior point branch-price-and-cut framework

Pedro Munari, ICMC, University of Sao Paulo, Sao Carlos, Sao Paulo, Brazil, pedro.munari@gmail.com, *Jacek Gondzio*

In this talk, we present a branch-price-and-cut framework for the vehicle routing problem with time windows which is based on a primal-dual interior point method for efficiently solving the linear relaxations at each branch node. The interior point method is used to obtain well-centred, non-optimal solutions that are used to improve the generation of columns and valid inequalities. Computational results using the Solomon's instances show that the proposed approach has a better overall performance than the best branch-price-and-cut framework available in the literature.