Title: Improvement of combinatorial optimization heuristics

Director: Dr. Sergio Gómez Jiménez

Co-director: Dr. Àlex Arenas Moreno

Research group: Algorithms Embedded in Physical Systems

Masters: MIA; MEIS - Sistemes Intel·ligents

Description:

The objective of this research Master Project is the improvement of the efficiency of combinatorial optimization heuristics using new ideas (confidential) physically and biologically inspired.

The search of optimization heuristics for NP-complete and NP-hard problems is a research field of high interest, since this kind of problems appear very frequently and in all kind of situations, and do not exist algorithms capable of finding the optimal solutions. These problems consist in finding the configuration which minimizes a certain error function (or maximizes fitness), such that the number of possible configurations grows at least exponentially on the size of the problem. Some well-known examples are the Travelling Salesman Problem (TSP), where the objective is to find the shortest path through a set of points whose distances are known beforehand, or the Graph Bisection Problem (GBP), where a graph is divided in two subsets such that the number of links between these subsets is minimized.

There exist many general-purpose heuristics which allow to find good approximations in a reasonable amount of time, e.g. those based in Tabu Search, Genetic Algorithms, Neural Networks, Simulated Annealing, Particle Swarm Optimization, Ant Colony Systems, etc. Usually these techniques have to be adapted to each particular problem to improve their performance, and often they have to be merged in order to take advantage of the different ways of exploration of the configuration space.

Our objective is the incorporation, in some of these algorithms, of new ways to explore the search space, based in recent knowledge in the fields of biology and physics.

The working plan is the following:

1. Introduction to the problem: study of the basic bibliography on combinatorial optimization and heuristics.

2. Selection of the heuristics and problems.

3. Design and implementation, if needed, of the initial heuristics, and test of their performance.

4. Design, implementation and test of the new algorithms which incorporate our new ideas in optimization.

5. Comparison between the original and modified algorithms, both in terms of computation time and quality of the solutions.

References:

M. R. Garey, D. S. Johnson: *Computers and Intractability: A Guide to the Theory of NP-Completeness*, Freeman (1979)

D. Corne, M. Dorigo, F. Glover: *New ideas in optimization*, McGraw-Hill (1999)

Optimization: http://www.optimization-online.org/