Parallelization of population-based evolutionary algorithms for combinatorial optimization problems

Parallelization of population-based evolutionary algorithms for combinatorial optimization problems

Calégari, Patrice Roger

1999

Abstract

The objective of the present work is to make efficient parallelization of evolutionary algorithms (EA) easier in order to solve large instances of difficult combinatorial optimization problems within an acceptable amount of time, on parallel computer architectures. No known technique allows one to exactly solve within an acceptable amount of time, such difficult combinatorial optimization problems (NP-complete). Moreover, traditional heuristics that are used to find sub-optimal solutions are not always satisfactory since they are easily attracted by local optima. Evolutionary algorithms (EA), that are heuristics inspired by natural evolution mechanisms, explore different regions of the search space concurrently. They are thus rarely trapped in a local optimum and are well suited to treat difficult combinatorial optimization problems. Their behavior can be improved by hybridizing (i.e., combining) them with other heuristics (EA or not). Unfortunately, they are greedy in computation power and memory space. It is thus interesting to parallelize them. Indeed, the use of parallel computers (with dozens of processors) can speed up the execution of EAs and provides the large memory space they require. It is possible to take benefit of the intrinsic parallelism of EAs (e.g., for the concurrent exploration of the search space) in order to design efficient parallel implementations. However each EA has its own characteristics and therefore a general rule cannot be defined. This thesis starts with a description of the state of the art in which the different existing approaches and terminologies are outlined. The fundamental ingredients of EAs are then detailed and these ingredients are grouped by a classification tool called TEA (Table of Evolutionary Algorithms). This table is taken as a basis for the analysis of the criteria that influence the parallelization of EAs in order to define parallelization rules. The analysis considers especially the implementation of hybrid EAs on MIMD-DM1 architectures. A notation of the granularity of parallel EAs is proposed. Further to this analysis, an object-oriented library named APPEAL (Advanced Parallel Population-based Evolutionary Algorithm Library) that applies the parallelization rules is designed and then used in order to experimentally validate these rules. During the experiments, different hybrid EAs are executed on a network of workstations in order to treat two problems: first the optimization of the best set of transceiver sites in a mobile radio network and second the classical graph coloring problem. Finally, a comparison of results and a discussion about future work conclude this thesis. ----------1MIMD-DM stands for

Multiple Instruction stream, Multiple Data stream, Distributed Memory.

Details

Title
Parallelization of population-based evolutionary algorithms for combinatorial optimization problems

Author(s)
Calégari, Patrice Roger

Advisor(s)
Coray, Giovanni

Date
1999

Publisher
Lausanne, EPFL

Keywords
parallel computing; evolutionary algorithms; combinatorial optimization; taxonomy; object-oriented library; transceiver siting; graph coloring; parallélisme; algorithmes d'évolution; optimisation combinatoire; taxonomie; conception logicielle orientée objet; planification de réseaux radio; coloration de graphes

DOI
10.5075/epfl-thesis-2046

Record Appears in
Scientific production and competences > EPFL Theses
Work produced at EPFL
Published
Theses

Preview

Select file:

EPFL_TH2046 - Texte intégral / Full text - Texte intégral / Full text

In computational intelligence (CI), an evolutionary algorithm (EA) is a subset of evolutionary computation, a generic population-based metaheuristic optimization algorithm. An EA uses mechanisms inspired by biological evolution, such as reproduction, mutation, recombination, and selection. Candidate solutions to the optimization problem play the role of individuals in a population, and the fitness function determines the quality of the solutions (see also loss function). Evolution of the population Abstract—Combinatorial optimization problems are those problems that have a finite set of possible solutions. The best way to solve a combinatorial optimization problem is to check all the feasible solutions in the search space. However, checking all the feasible solutions is not always possible, especially when the search space is large. Thus, many meta-heuristic algorithms have been devised and modified to solve these problems. The meta-heuristic approaches are not guaranteed to find the optimal solution since they evaluate only a subset of the feasible solutions, but they try to explore dif In this paper, an opposition-based evolutionary algorithm with the adaptive clustering mechanism is proposed for solving the complex optimization problem. In particular, opposition-based learning is integrated in the proposed algorithm to initialize the solution, and the nondominated sorting scheme with a new adaptive clustering mechanism is adopted in the environmental selection phase to ensure both convergence and diversity. Wan Liang Wang, Weikun Li, Yu Le Wang, "An Opposition-Based Evolutionary Algorithm for Many-Objective Optimization with Adaptive Clustering Mechanism", Computational Intelligence and Neuroscience, vol. 2019, Article ID 5126239, 27 pages, 2019. https://doi.org/10.1155/2019/5126239. Show citation. A university quantum algorithms/computation course supplement based on Qiskit. We consider 2 examples to illustrate combinatorial optimization problems. We will only implement the first example as in Qiskit, but provide a sequence of exercises that give the instructions to implement the second example as well. 2.1 (weighted) *MAXCUT*

.