Title: Incremental Local Search in Ant Colony Optimization: Why it Fails for the Quadratic Assignment Problem

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Ant colony optimization (ACO) is a recent metaheuristic technique that is inspired by the pheromone trail laying and following behavior of some ant species. In ACO algorithms, artificial ants are stochastic solution construction procedures that generate solutions using artificial pheromones and heuristic information; the ants' solutions are then used to modify the artificial pheromone trails. This mechanism shifts the stochastic solution construction procedure towards the construction of solutions similar to the better ones seen previously in the algorithm. The definition of the ACO metaheuristic includes also the possibility of using local search: Once ants complete their solution construction phase, local search algorithms can be used to refine their solutions before using them for the pheromone update. Various experimental researches have shown that the combination of solution construction by ants and local search procedures is a promising approach.

The primary goal of this research is to investigate the opportunity of adopting incremental local search in ACO, that is, to improve via a local search algorithm the ants' partial solutions at regular intervals during the solution construction process.

The main motivation behind our research is that *a priori* the idea of re-optimizing the partial solutions of the ants during the solution construction looks promising, since the use of local search in ACO algorithms has already proven to often lead to a strong improvement of performance, and incremental local search has been successfully applied in other settings where constructive methods were used. However, the results of our computational experiments are negative and, at least for the quadratic assignment problem, the inclusion of incremental local search actually worsens the performance. In this research, we analyse the possible reasons for this effect by studying the convergence behavior of the ACO algorithm. In fact, our analysis also gives hints on conditions under which incremental local search may become useful in ACO algorithms. For instance, since the empirical analysis shows that the incremental local search introduces a strong exploration in the search process of the ACO algorithm studied here, one might try to use it to generate new solutions when the search stagnates.