

et de Développements en Intelligence Artificielle

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



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## Goals and Motivations

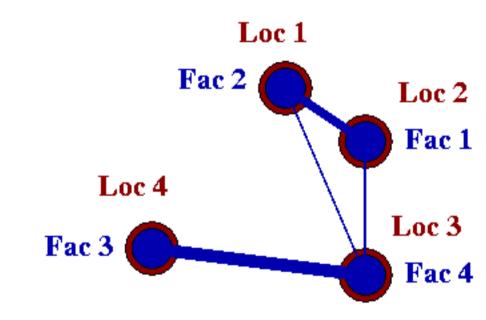
- Incremental local search consists in re-optimizing partial solutions by a local search at regular intervals while constructing a complete solution
- A priori the idea of re-optimizing the partial solution of ants looks promising
- Incremental local search is successful in other constructive methods
- First goal is to study the effect of incremental local search in ACO to solve Quadratic Assignment Problem (QAP)
- Naïve inclusion of incremental local search worsens ACO's performance
- Second goal is to analyze this failure by studying the convergence behavior of ACO

## **Key Findings**

- Incremental local search disturbs ACO's exploitation phase
- Generated solutions are far from the global-best solution

# Quadratic Assignment Problem and $\mathcal{MAX} - \mathcal{MIN}$ Ant System

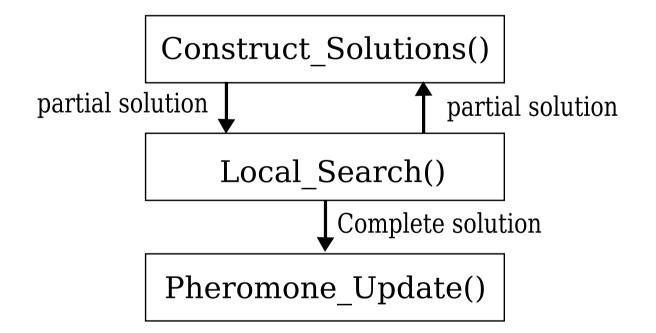
- ullet Quadratic Assignment Problem n facilities have to be assigned to n locations.
- Candidate solution is a permutation of  $\{1, \ldots, n\}$



- We have chosen  $\mathcal{MAX} \mathcal{MIN}$  ant system as a starting point for our analysis
- It uses 2-opt local search to improve each ant's solution

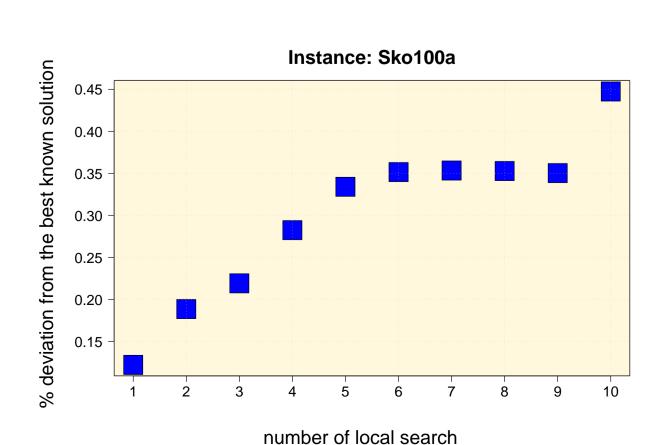
#### Incremental Local Search in ACO for QAP

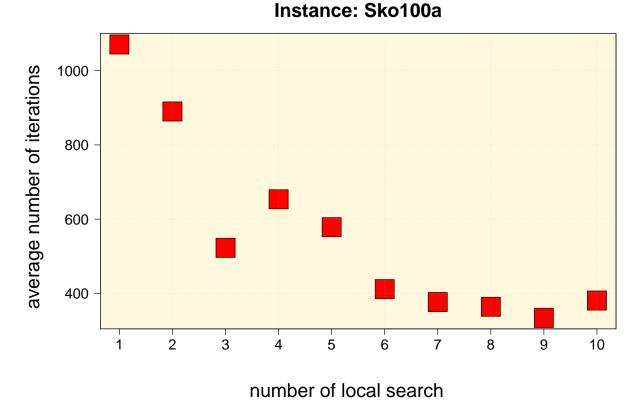
• Local search is applied after equal sized intervals in the solution construction, size of which is a user defined parameter



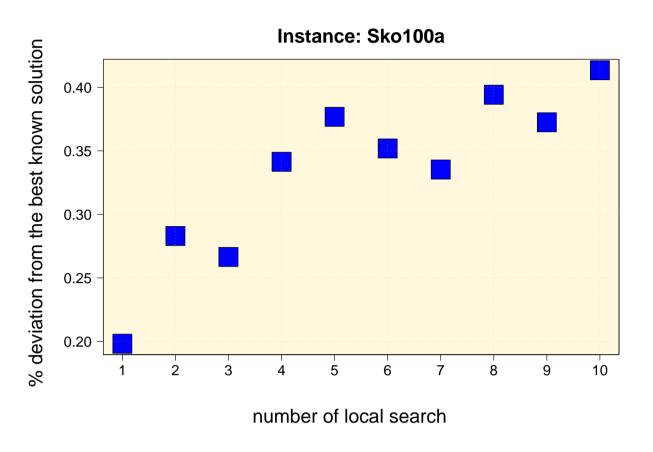
# **Experiments**

- Impact of incremental local search in  $\mathcal{MAX} \mathcal{MIN}$  ant system from QAPLIB ranging in size from 60 to 150.
- Parameters as proposed in  $\mathcal{MAX} \mathcal{MIN}$  ant system QAP literature
- Stopping criterion: On each instance,  $\mathcal{MAX} \mathcal{MIN}$  ant system is allowed to run for 1000 iterations and the average time over 10 trails is then taken as stopping criterion.
- Average solution quality of  $\mathcal{MAX} \mathcal{MIN}$  ant system with incremental local search is rather worse





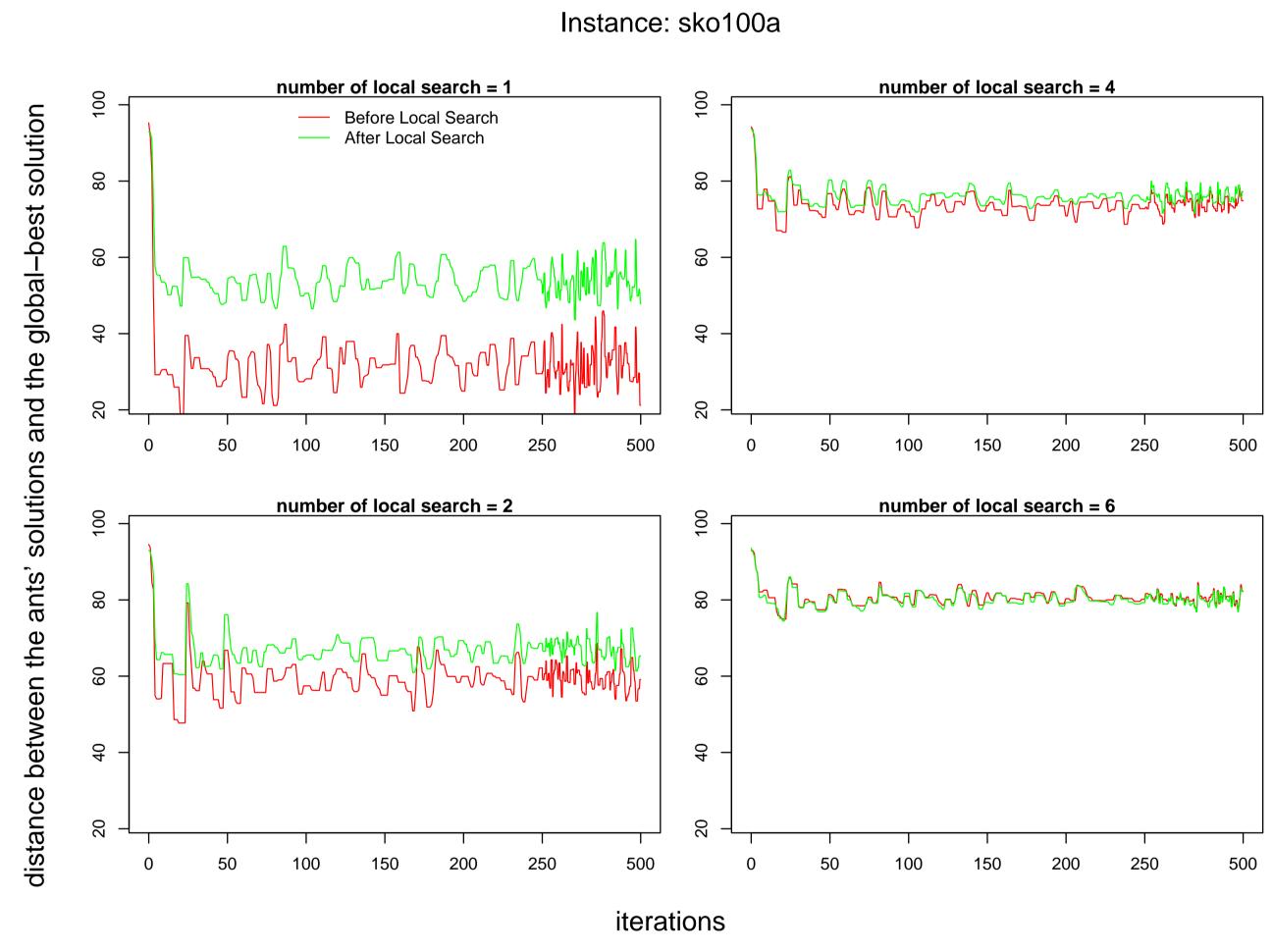
• Even if all algorithms are allowed to generate the same number of complete solutions (500 iterations is allowed to each algorithm) the scenario does not change.



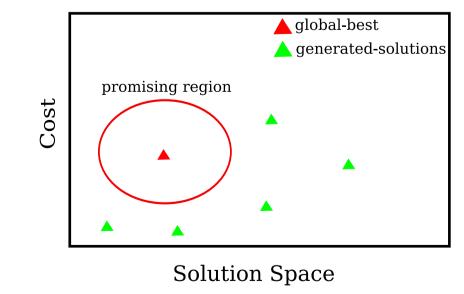
• For QAP, incremental local search is not only computationally expensive but also interferes negatively with the solution construction process.

## Analysis

- Permutation distance between the generated solutions and the *global-best* is computed before and after the final local search
- Even one incremental local search applied after n/2 assignments leads to a strong perturbation in the exploitation phase
- The intensity of perturbation increases with the increase in the number of local search applied



• Solutions are rather distant from the *global-best* 



• However, incremental local search in random-restart local search eventually leads to good performance

#### **Conclusion and Future work**

- Incremental local search somehow destroys the exploitation phase of ACO
- It could be useful for increasing the exploration in convergence situations
- Careful addition in specific situation could possibly result in improvements for other problems.

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