

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

Prasanna BALAPRAKASH, Mauro BIRATTARI, Thomas STÜTZLE and Marco DORIGO

IRIDIA, CoDE, Université Libre de Bruxelles, Brussels, Belgium

{pbalapra,mbiro,stuetzle,mdorigo}@ulb.ac.be

1 Goals and Motivations

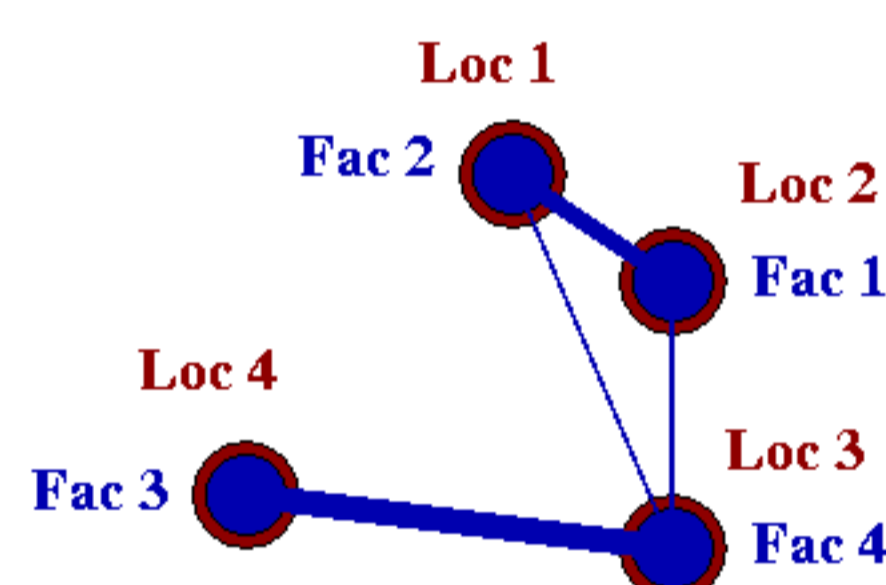
- Incremental local search consists in re-optimizing partial solutions by a local search at regular intervals while constructing a complete solution
- A priori the idea of re-optimizing the partial solution of ants looks promising
- Incremental local search is successful in other constructive methods
- 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

2 Key Findings

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

3 Quadratic Assignment Problem and *MAX* – *MIN* Ant System

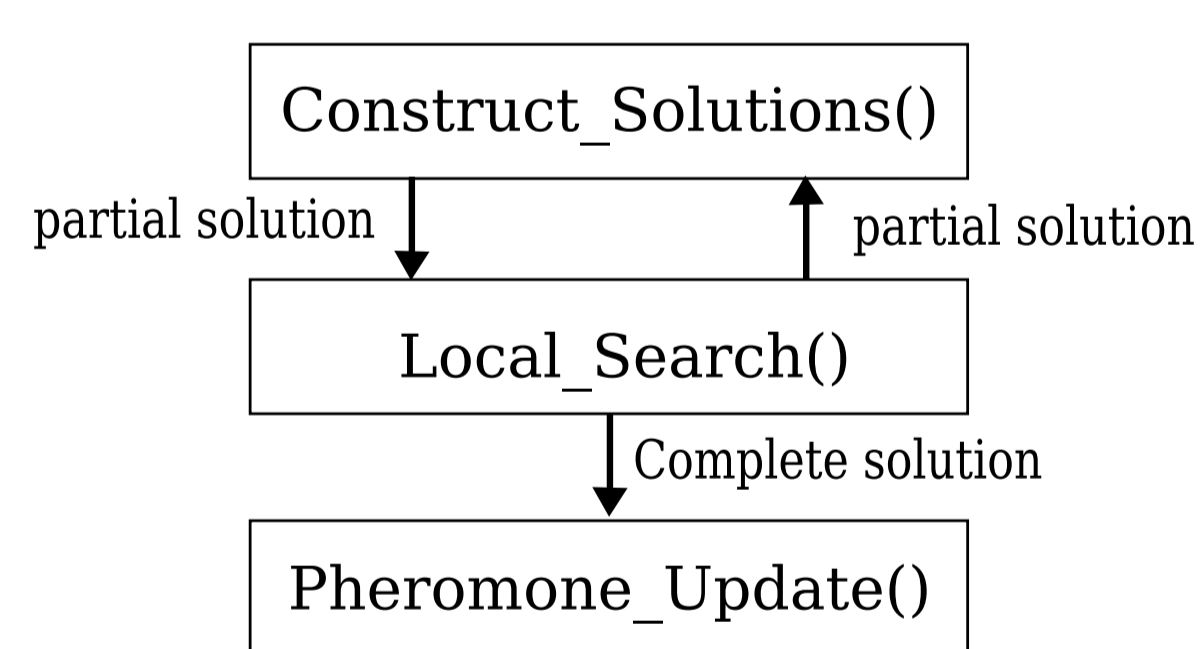
- Quadratic Assignment Problem - n facilities have to be assigned to n locations.
- Candidate solution is a permutation of $\{1, \dots, n\}$



- We have chosen *MAX* – *MIN* ant system as a starting point for our analysis
- It uses 2-opt local search to improve each ant's solution

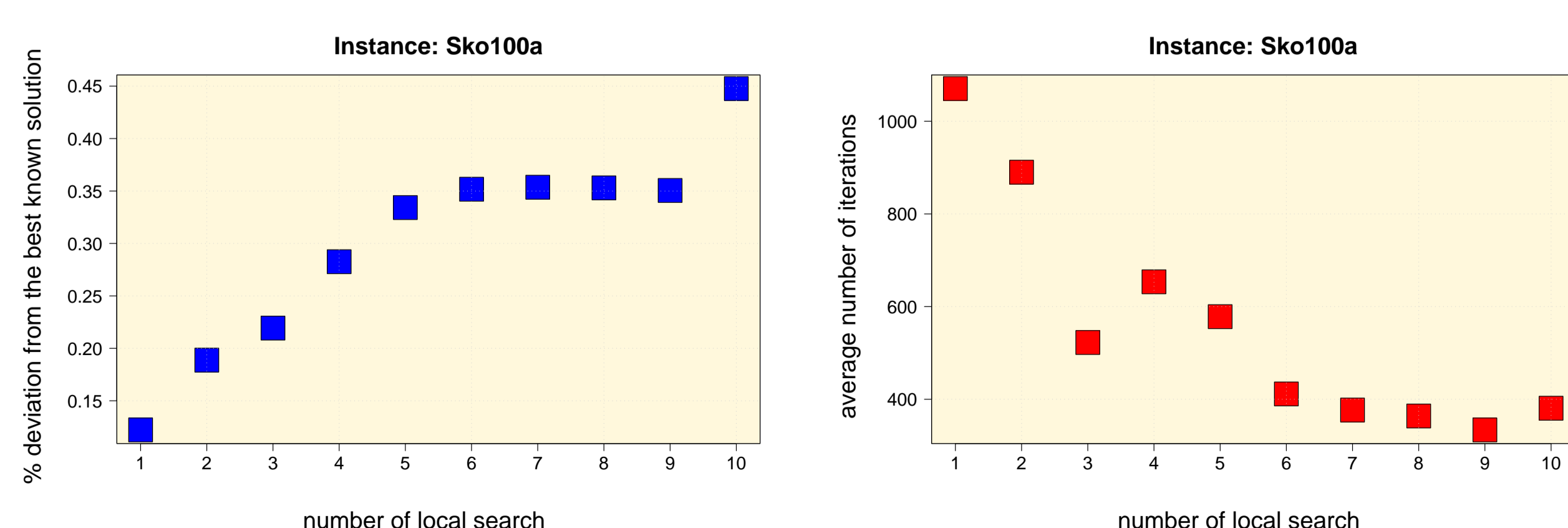
4 Incremental Local Search in ACO for QAP

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

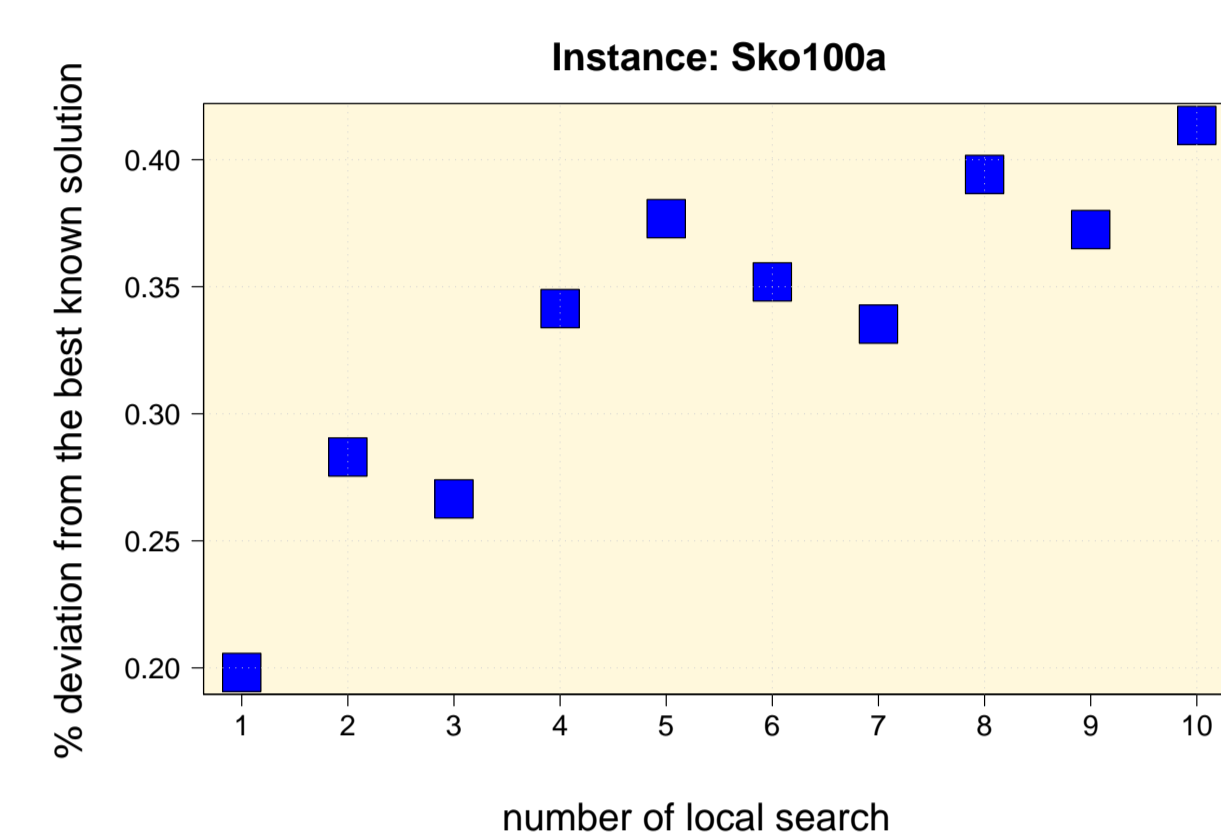


5 Experiments

- Impact of incremental local search in *MAX* – *MIN* ant system from QAPLIB ranging in size from 60 to 150.
- Parameters as proposed in *MAX* – *MIN* ant system QAP literature
- Stopping criterion: On each instance, *MAX* – *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 *MAX* – *MIN* ant system with incremental local search is rather worse



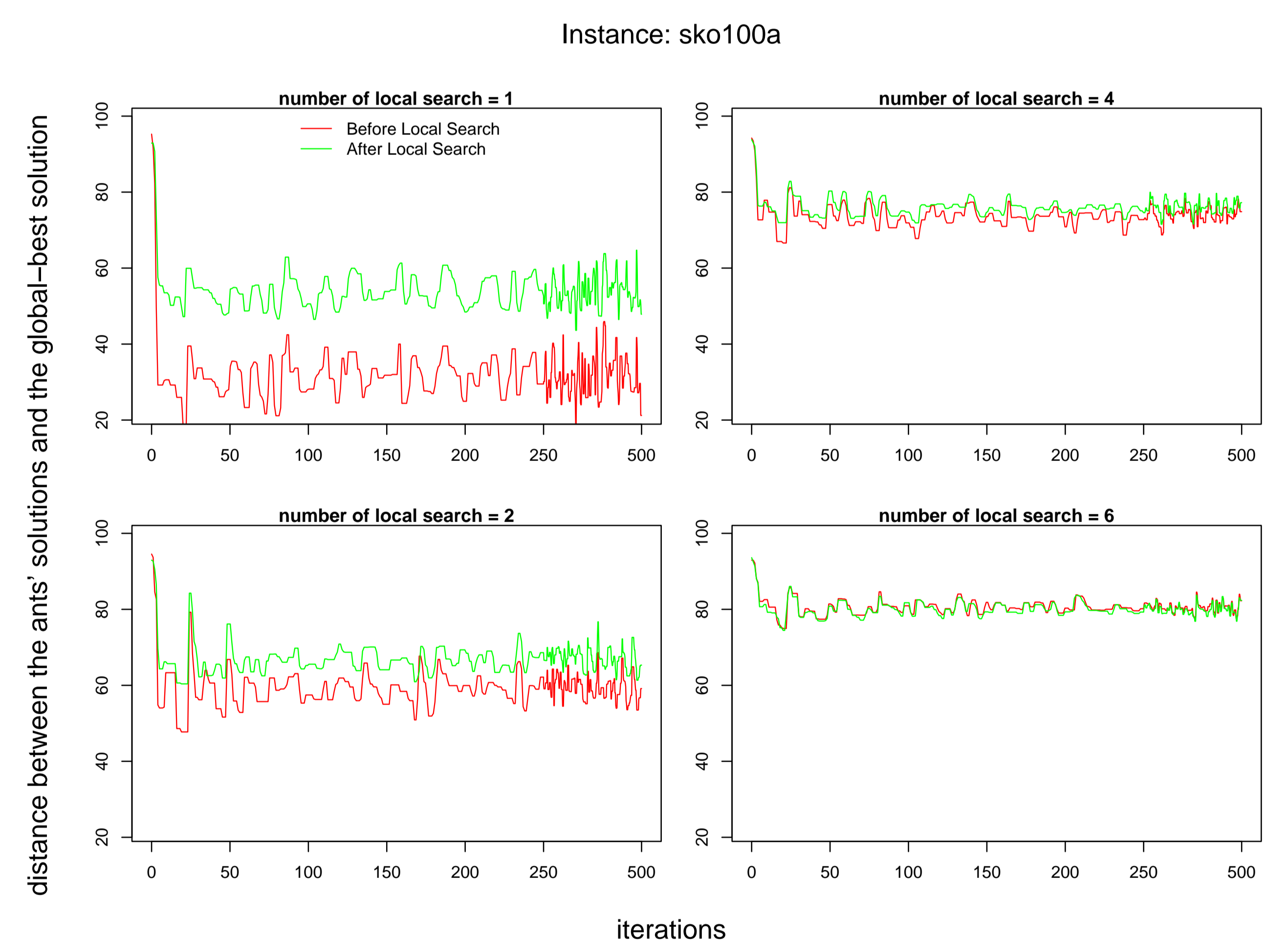
- Even if all algorithms are allowed to generate the same number of complete solutions (500 iterations is allowed to each algorithm) the scenario does not change.



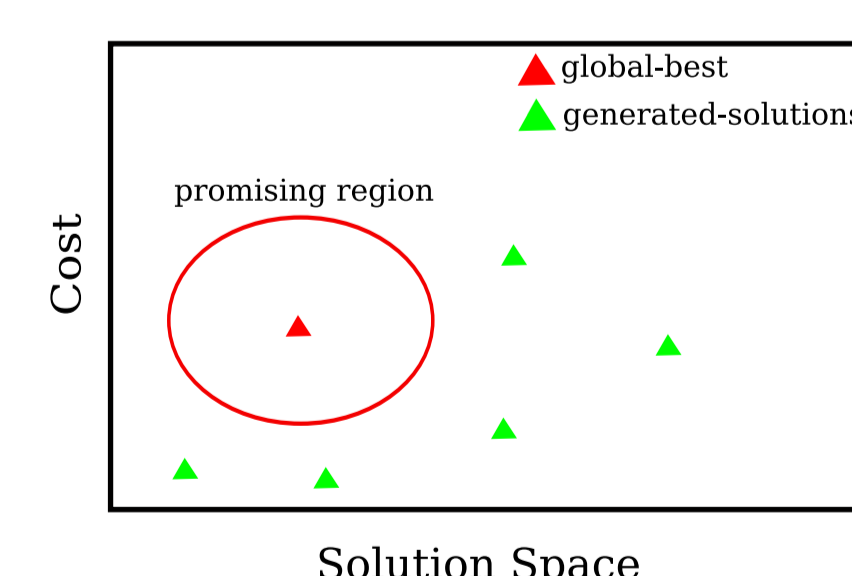
- For QAP, incremental local search is not only computationally expensive but also interferes negatively with the solution construction process.

6 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

7 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.