Final-Project

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Comparing heuristics for TSP

1. Comparison based on achieved Loss values In this section, the implemented algorithms are compared based on the minimum, maximum and mean values of the loss-function achieved during $m = 40$ runs. Tables 1-4 summarise the results and also show 95% confidence intervals for the true mean.

Tab. 1: Results for Construction Heuristics

	min	max	mean	95% confidence interval
Best-Insertion	1.4813	1.6081	1.5245	[1.5159, 1.5330]
Shortest-Edge	1.6197	1.7413	1.6725	[1.6638, 1.6813]
Saving	1.7511	2.0129	1.8636	[1.8425, 1.8848]

Tab. 2: Results for Greedy Local Search

Move	min	max	mean	95% confidence interval
Swap	3.5400	4.2071	3.8952	[3.8384, 3.9521]
Translation	1.9867	2.5519	2.2730	[2.2332, 2.3128]
Inversion	1.5052	1.6109	1.5512	[1.5421, 1.5604]
Mixed	1.4664	1.5612	1.5055	[1.4982, 1.5127]

Tab. 3: Results for Metropolis Simulated Annealing

Move	min	max	mean	95% confidence interval
Swap	3.2364	3.8152	3.5222	[3.4763, 3.5680]
Translation	1.9680	2.3782	2.1724	[2.1452, 2.1996]
Inversion	1.4910	1.6040	1.5425	[1.5338, 1.5511]
Mixed	1.4610	1.5689	1.5155	[1.5074, 1.5236]

Tab. 4: Results for Heatbath Simulated Annealing

Move	min	max	mean	95% confidence interval
Swap	3.2542	4.3422	3.6040	[3.5380, 3.6701]
Translation	1.8958	2.4291	2.1767	[2.1390, 2.2144]
Inversion	1.4937	1.5906	1.5417	[1.5340, 1.5493]
Mixed	1.4723	1.5665	1.5192	[1.5116, 1.5267]

2. Solution Paths This section provides figures of the best solution-paths per algorithm achieved after the $m = 40$ runs. Figures 1-5 show the obtained paths. Note that they are not closed, making it possible to observe the starting point.

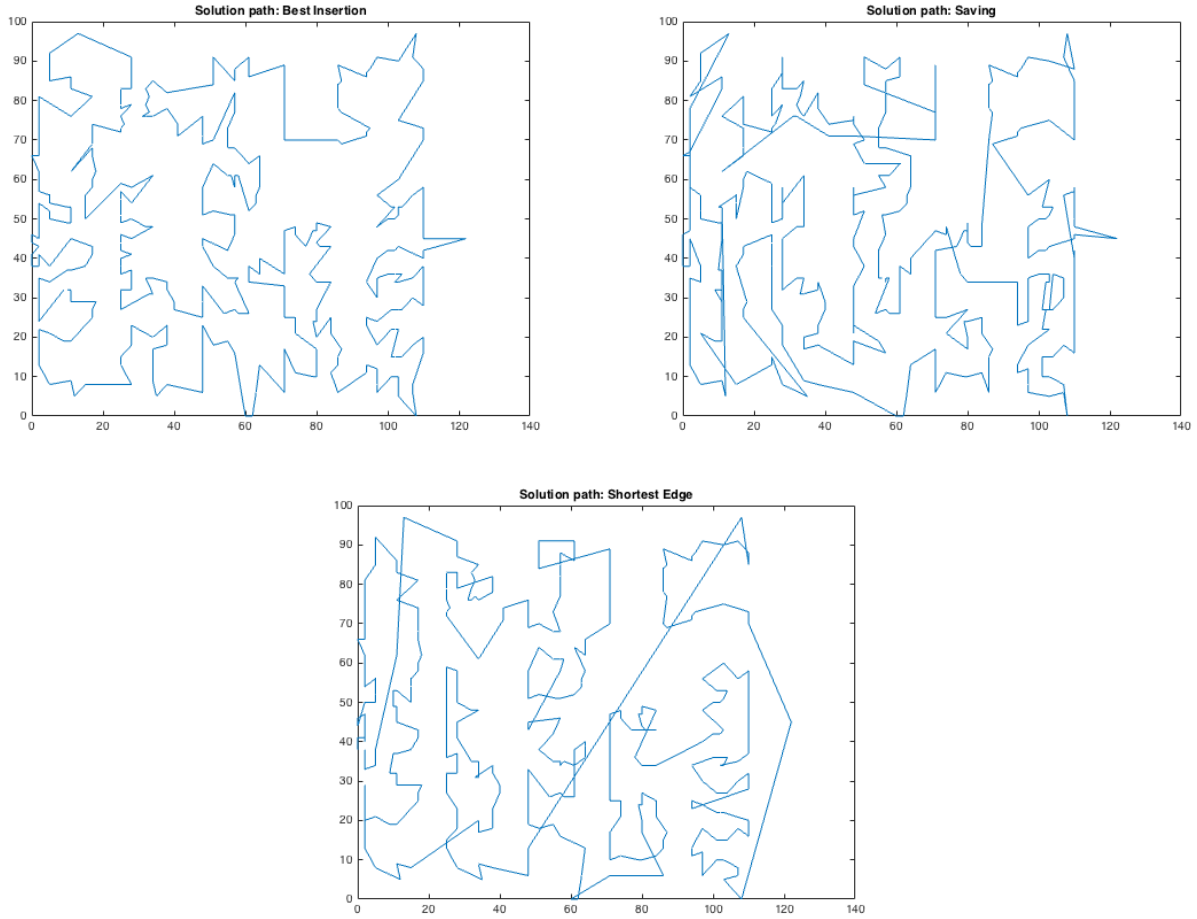

Fig. 1: Construction Heuristics

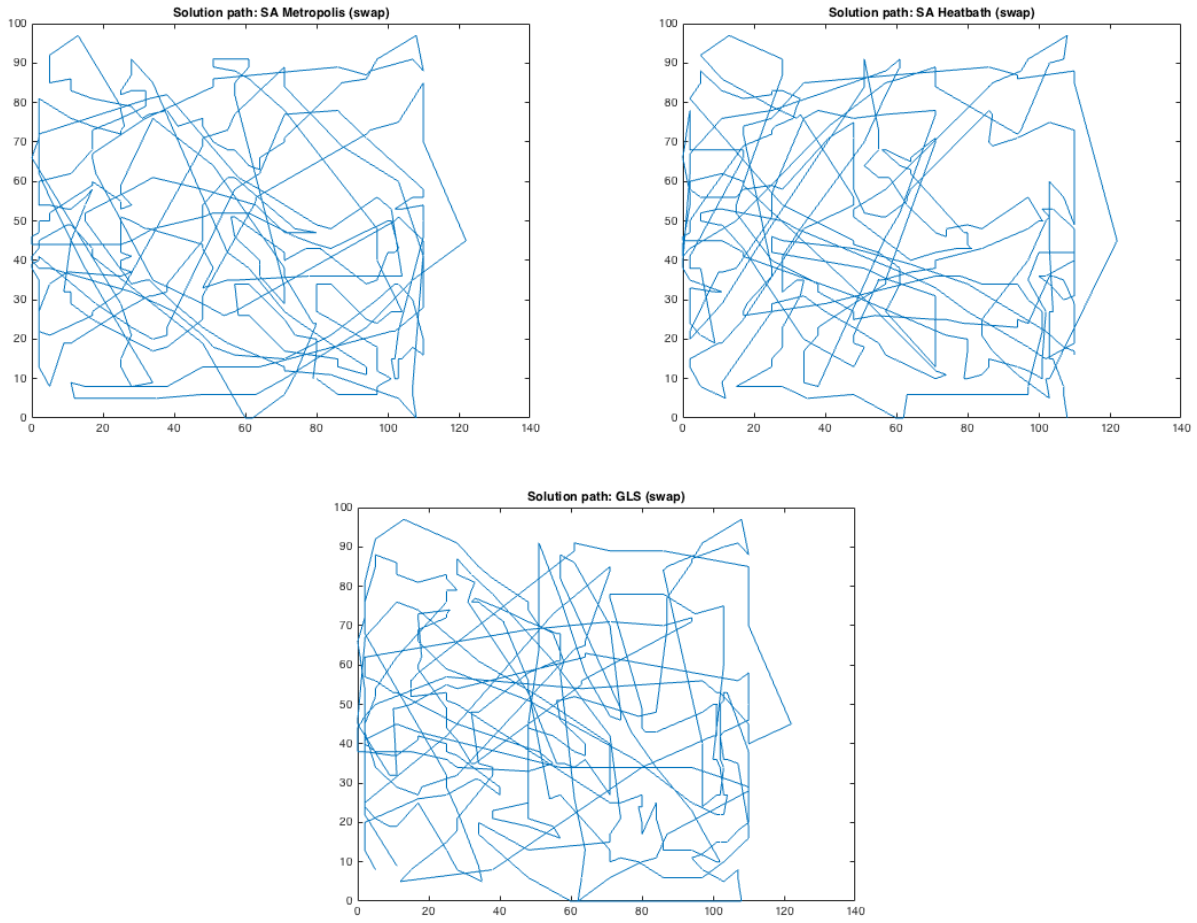

Fig. 2: Improvement Heuristics (Swap)

3. Performance Plots In this section we provide performance plots for the Greedy Local Search (GLS) and Simulated Annealing (SA) algorithms.

Figures 6 and 7 show the performance-plots for both variants of the SA algorithm. They are based on a single run and show the min, max and mean loss value vs. the current temperature.

The performance-plots for GLS are based on $m = 40$ runs and show the min, max and mean loss value against the number of performed moves (Figure 8).

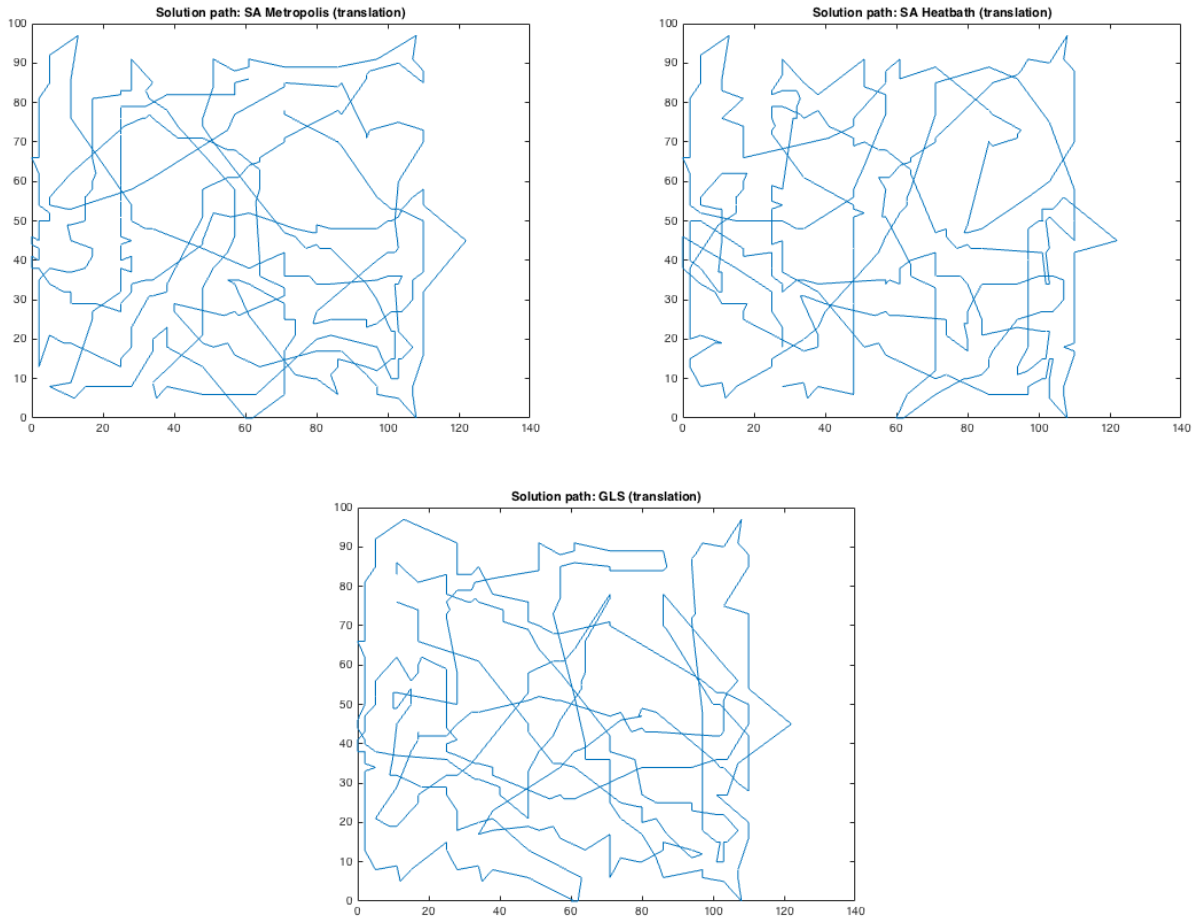

Fig. 3: Improvement Heuristics (Translation)

4. Pairwise Comparisons Finally in this section the results of the pairwise comparisons of some of the algorithms are shown in table 5. The comparison was done using an unmatched pair-test with different variances for the two sequences of $m = 40$ samples per algorithm.

Discussion Looking at the results we see that SA and GLS with mixed moves perform the best (achieving the lowest mean-loss), closely followed by the Best-Insertion construction heuristic.

We can also observe that SA does not considerably perform better or worse than

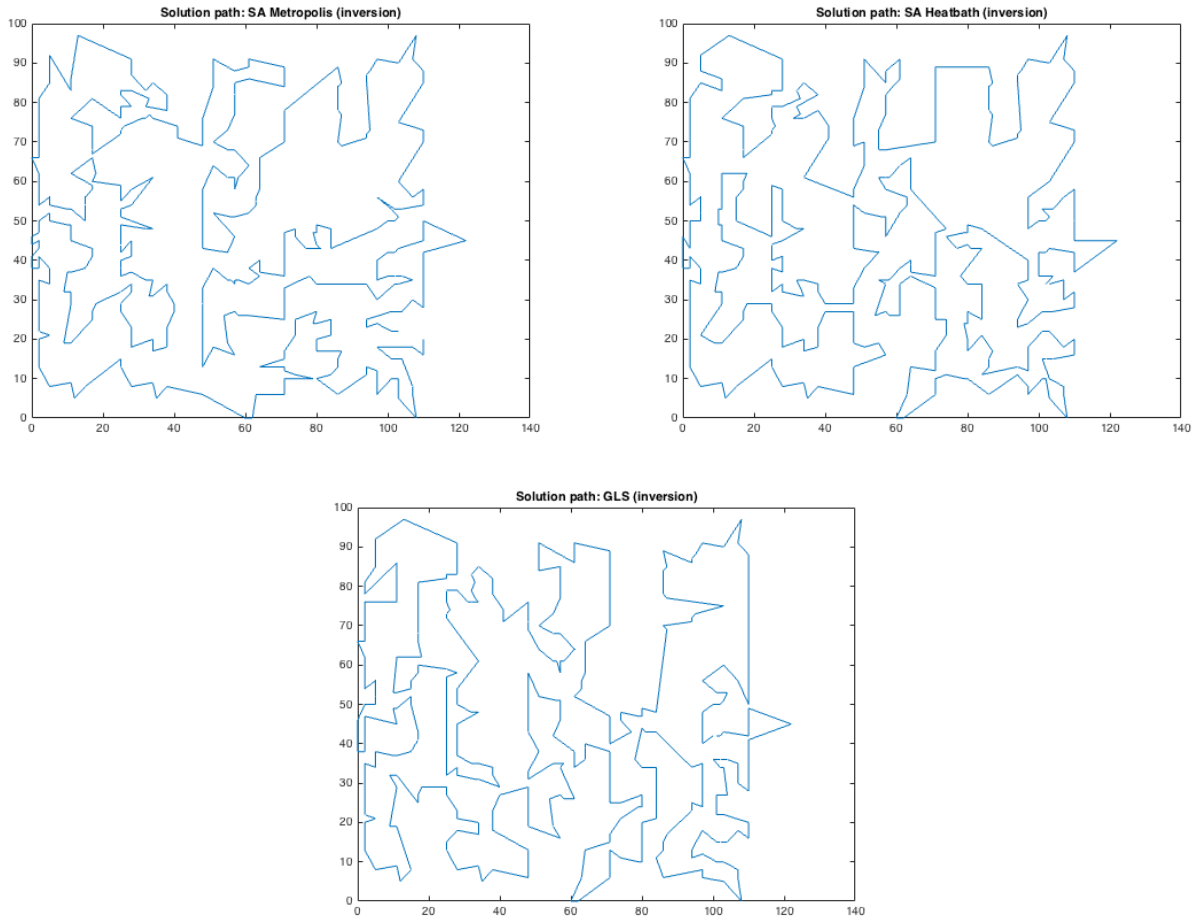

Fig. 4: Improvement Heuristics (Inversion)

the simple greedy GLS in the given example. Also, the cooling-schedule does not seem to affect the performance of SA in this setting.

The biggest change performance can be observed when comparing the different moves performed. Clearly, Inversion is the most powerful move of the three and combining all of them only provides a minor performance boost (increasing the explorable neighbourhood even more).

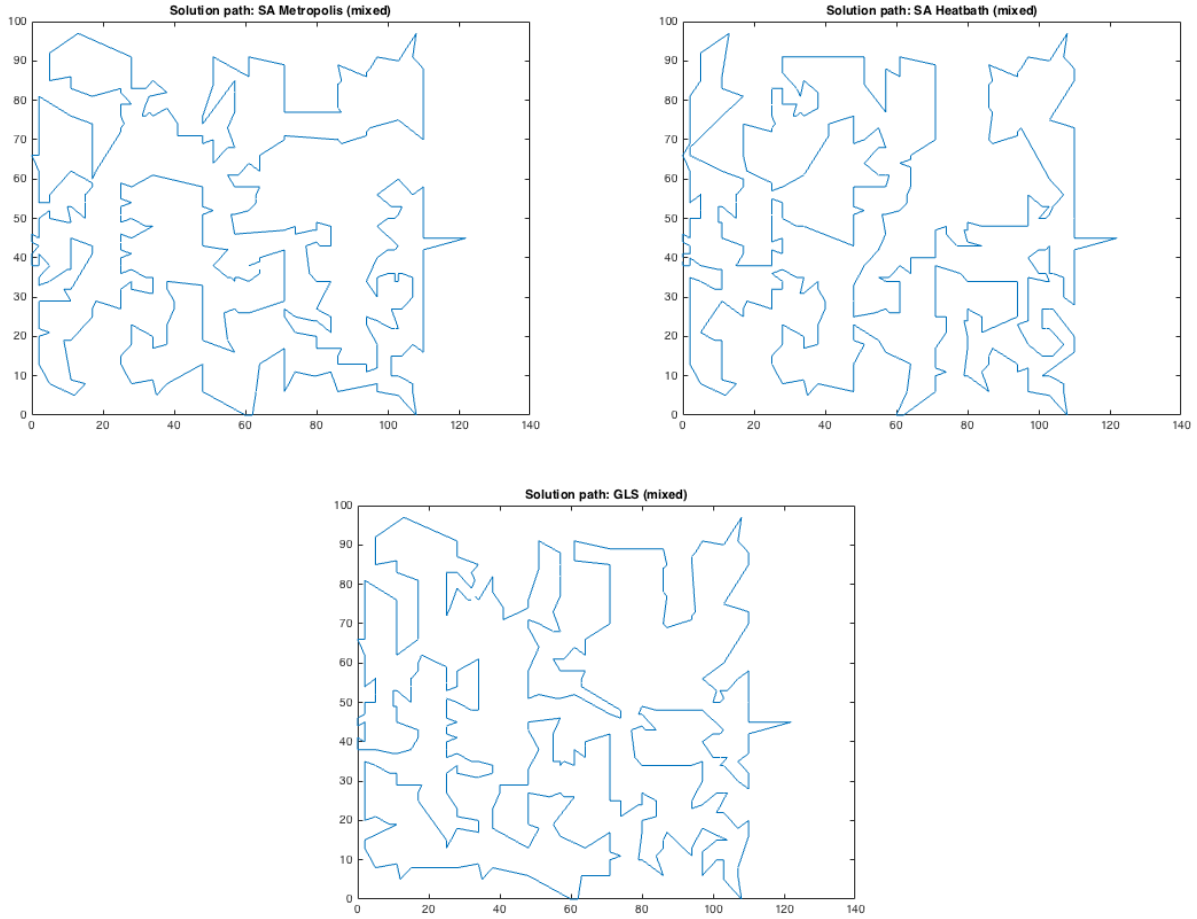

Fig. 5: Improvement Heuristics (Mixed)

Tab. 5: Pairwise-Comparison

Algorithm A	Algorithm B	μ_A	μ_B	T	β	Conclusion
Best Insertion	Shortest Edge	1.5245	1.6725	-24.4798	1.2922	$\mu_A < \mu_B$
Saving	Shortest Edge	1.8636	1.6725	16.9157	1.2978	$\mu_A > \mu_B$
SA Metropolis	SA Heatbath	1.5155	1.5192	-0.6661	1.2923	$\mu_A \approx \mu_B$
GLS (swap)	GLS (translation)	3.8952	2.2730	47.2782	1.2935	$\mu_A > \mu_B$
GLS (swap)	GLS (inversion)	3.8952	1.5512	82.3048	1.3025	$\mu_A > \mu_B$
GLS (swap)	GLS (mixed)	3.8952	1.5055	84.3213	1.3029	$\mu_A > \mu_B$
GLS (translation)	GLS (inversion)	2.2730	1.5512	35.7527	1.3014	$\mu_A > \mu_B$
GLS (translation)	GLS (mixed)	2.2730	1.5055	38.3922	1.3022	$\mu_A > \mu_B$
GLS (inversion)	GLS (mixed)	1.5512	1.5055	7.9280	1.2928	$\mu_A > \mu_B$

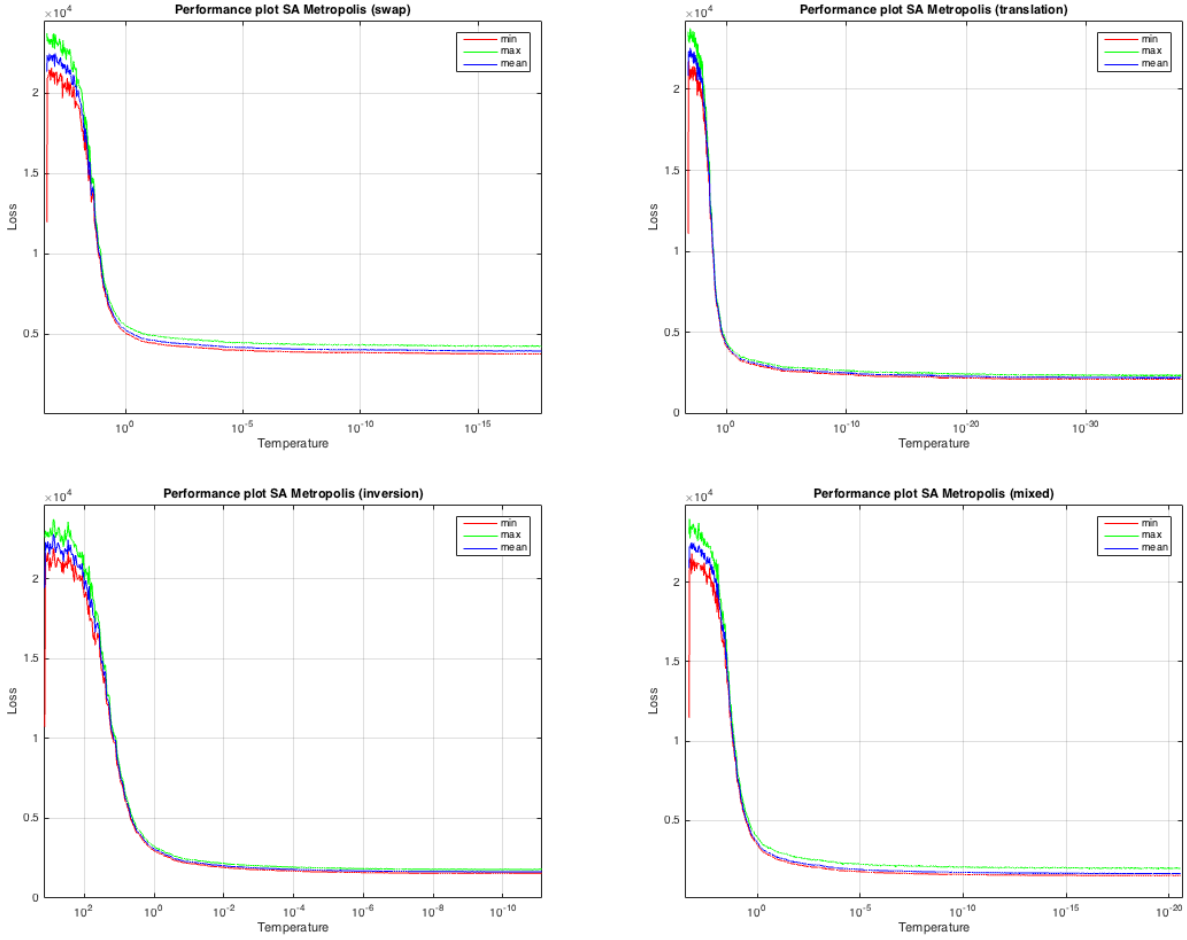

Fig. 6: Performance plots: Simulated Annealing Metropolis

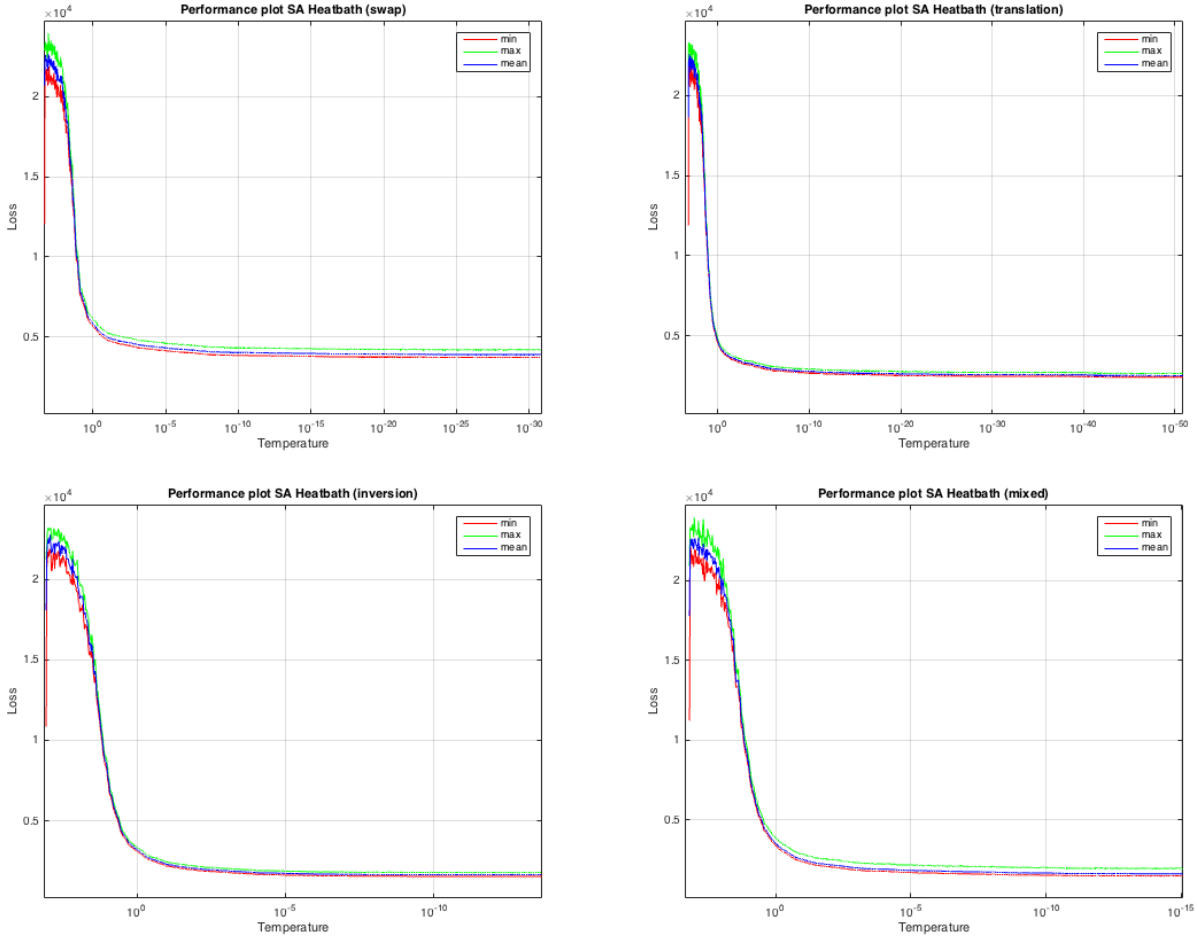

Fig. 7: Performance plots: Simulated Annealing Heatbath

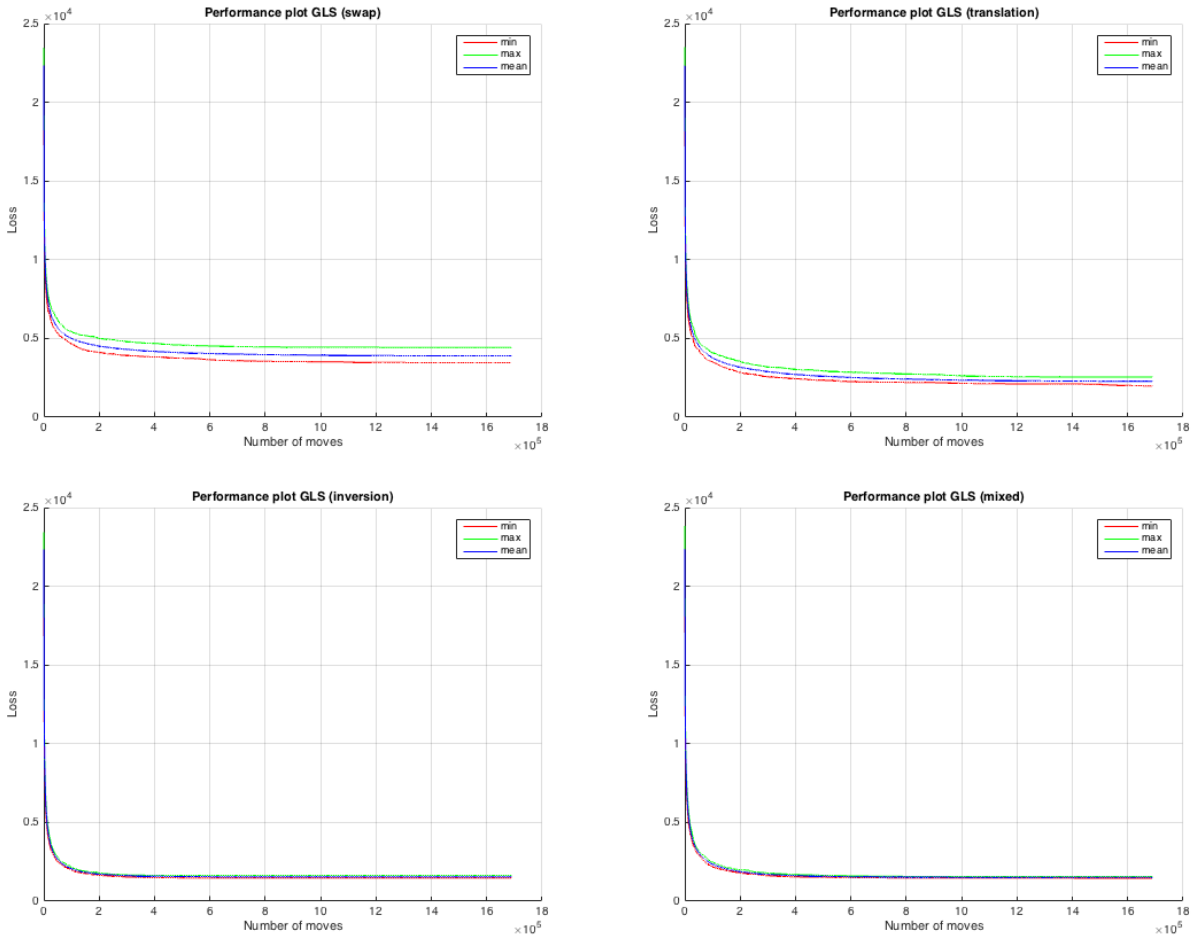

Fig. 8: Performance plots: Greedy Local Search