Exercise 1: GA/Ants

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Introduction

We chose to apply Ant Colony Optimization (ACO) and Genetic Algorithms (GA) to the Knapsack problem (with multiple knapsacks, and item dimensions), to TSP and to minimizing the Rastrigin function.

Findings

Runtime

For run times relative to instance size, we tested 5 iterations/generations each for ACO and GA on three different instance sizes.

For Rastrigin, we chose $n = 2, 3, 5$ and saw ACO increase from around 1 second to nearly 10 seconds. GA stayed roughly the same, only increasing from around .021 seconds to .021 seconds.

For Knapsack, we chose $ks = 1, 5, 10$, $i = 10, 50, 100$ and $n = 1, 2, 3$ (these being the number of knapsacks, the items to choose from and the dimensions of the items respectively). We saw ACO increase from around 0.95 seconds to nearly 33 seconds. GA increased less, from around .1 seconds to 3.3 seconds.

For TSP, we chose 10, 20 and 50 cities, and saw ACO increase from around 0.09 seconds to around 14.3 seconds. GA once again was well below that, only increasing from around .3 seconds to .75 seconds.

Convergence

Below is a plot showing a comparison of GA and ACO on our three problems. Both were set to run for 200 iterations/generations, with an early stop for ants in case there was no improvement for 50 generations.

Rastrigin for n=5

Knapsack for 10 knapsacks and 100 items of dim=3

TSP for 50 citites
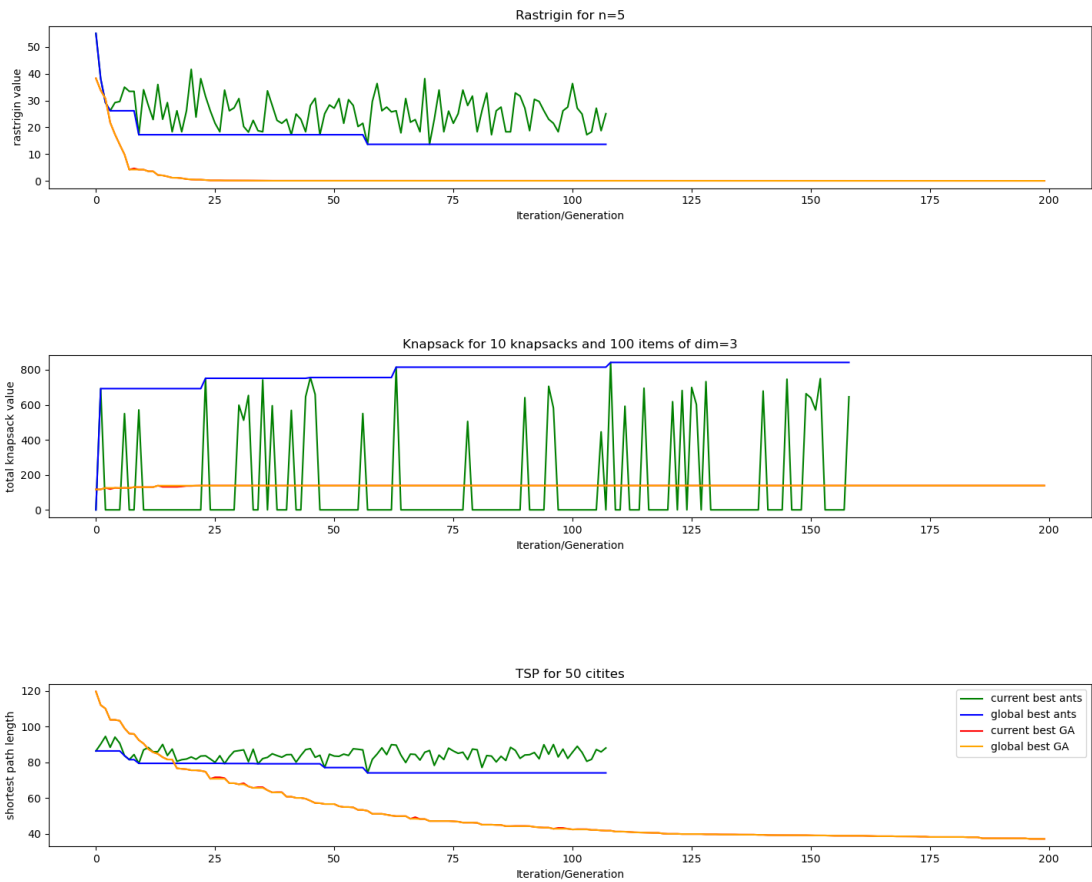
We can see that GA works decently for all three problems. ACO is generally worse, aside from quickly finding a good solution for the knapsack problem that is better than the one found by GA. For Rastrigin, GA outperforms ACO across the board. For TSP, ACO initially finds a decent solution, but gets outperformed by GA eventually.

We can further see that for GA, the global best is only rarely and then narrowly better than the current best, while the same isn't true for ACO.

Conclusion

- Rastrigin: GA is the obviously better choice.

- Knapsack: ACO finds a better solution, but also scales badly with input size, so on larger instances GA might be preferable

- TSP: GA will likely be the better choice, since it scales better to larger instances and also outperforms ACO in the long run.