Comparison of Genetic Algorithm & Ant Colony Optimization

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Given Task :

Please write in 100-200 words how you think that your GA implementation compares to ant colony optimization to solve the Travelling salesman problem.

Response :

Genetic Algorithm and Ant Colony Optimization are two popular optimizations in the field of combinatorial optimization. The two algorithms have their own suite of advantages and disadvantages.

Overview of GA & ACO :

- **Genetic Algorithm** : Between one generation and the next, the best performing individuals are crossed with each other, producing a new population with features of both parents. Diversity is maintained by operations such as mutation.

- **Ant Colony Optimization**: In a somewhat similar manner, between one iteration and the next, ants choose the most ‘visible’ edges to construct new paths, where ‘visibility’ is defined by the amount of Pheromone present in that edge. The pheromone values decay with the evaporation rate ‘ρ’.

Comparison of GA & ACO :

- **Computation** : GA is considered easy to implement and computationally efficient, compared to ACO. ACO is greedy but converges at a better ‘optimal distance’, especially as the size of the search space grows larger.

- **Convergence** : ‘Convergence’ in GA is loosely defined as the concept of all individuals of a population being identical. Convergence in ACO is defined as the concept of all the ants traversing the same path in an iteration. ACO was **proven to converge on the optimal solution** given that $0 < q0 < 1$ [1] where ‘q0’ is the exploitation parameter. The issue being that ACO may take a very long time to actually converge.

Implementation of GA :

My current implementation of GA uses randomized ways of choosing the mutation and crossover ‘points’ (**No real bias towards ‘profitable’ mutations and crossing over**). Due to this, convergence at a local minima is most likely.

Comparatively, an implementation of ACO may use the most profitable combinations of the edges of the routes, unlike the current GA implementation which randomly crosses two ‘well performing’ routes. Naturally, ACO has a better chance of finding a better route.

A simple way to improve the current implementation of GA would be to add **another layer of meta heuristic to add bias towards the best ‘slices’** of the routes to be retained.

Another easy improvement would be to use a more thorough crossover method such as PMX (**Partially Mapped Crossover)** over the simple **OX (Ordered Crossover).**

References :

[1]. Zhu, Q., Wang, L. The analysis of the convergence of ant colony optimization algorithm. *Front. Electr. Electron. Eng. China* **2,** 268–272 (2007).

[2]. T. Chakraborty, S. Chakrabarti and B. Hazra, "Study of β,ρ and Q0 parameters for Shortest Path Estimation using Ant Colony Optimization," *2019 IEEE Region 10 Symposium (TENSYMP).*