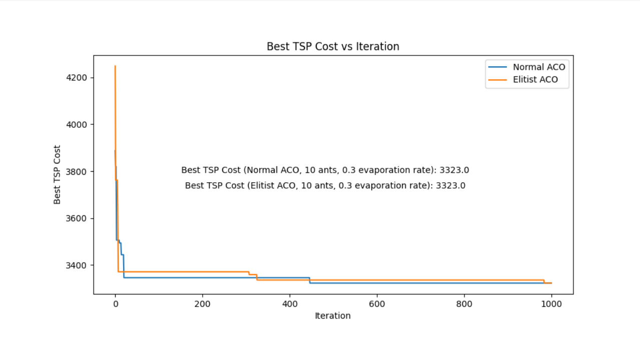
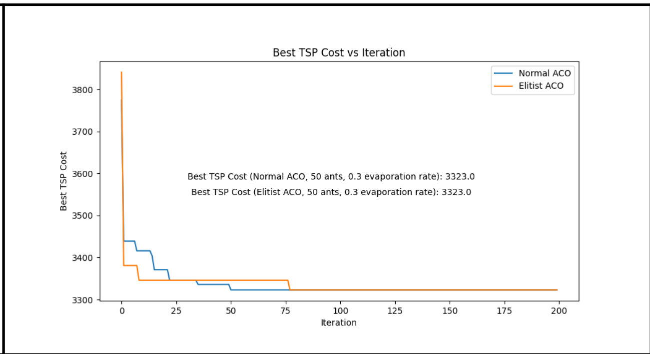
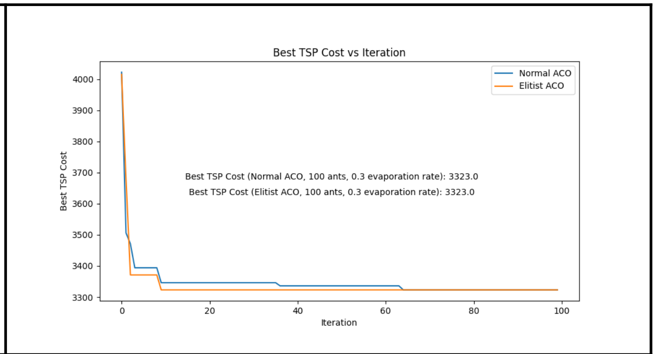
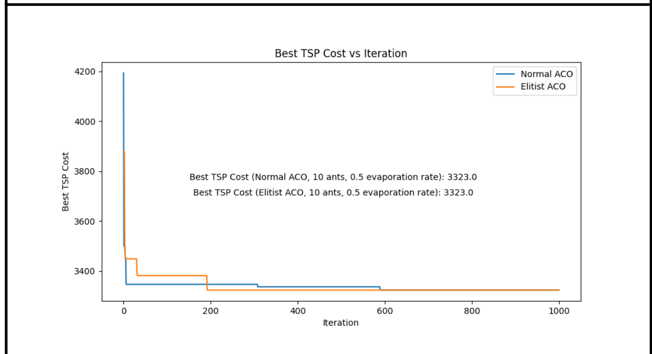
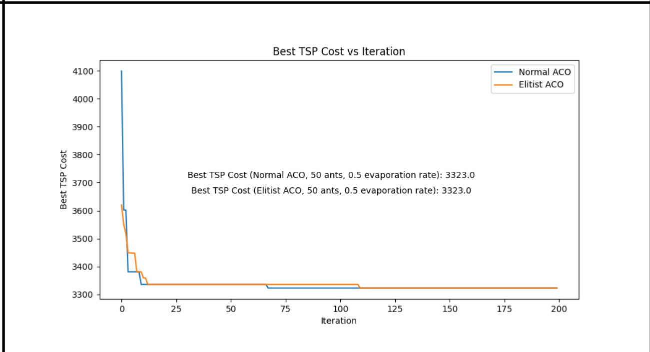
Burma Results

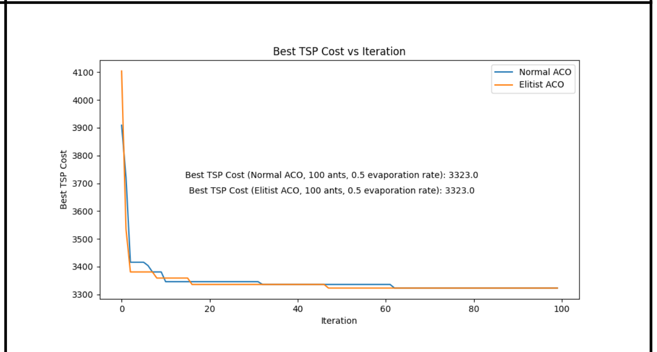


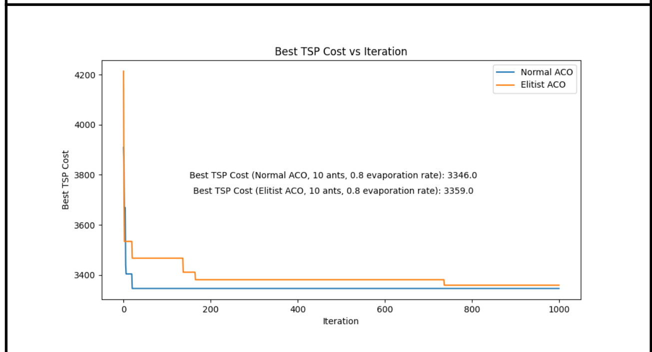


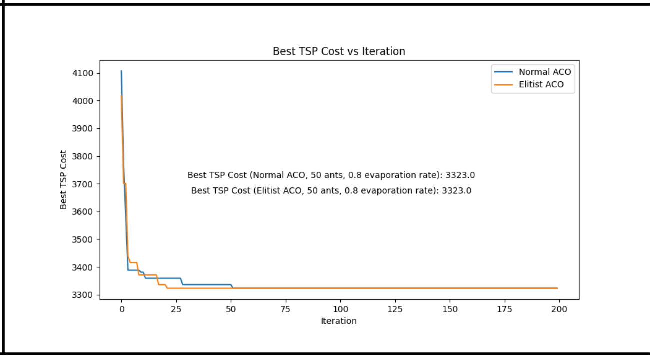


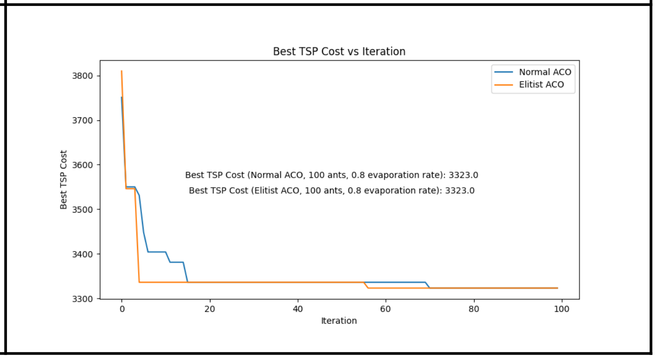




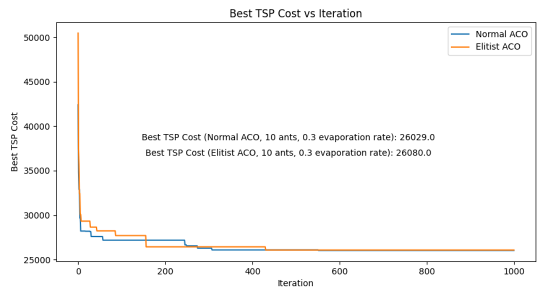


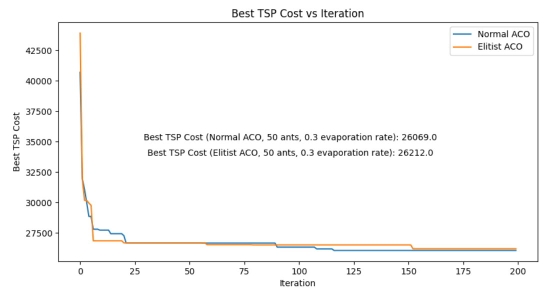


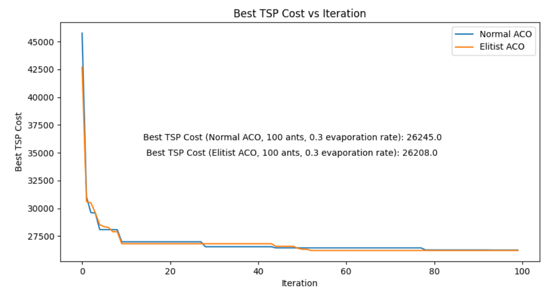


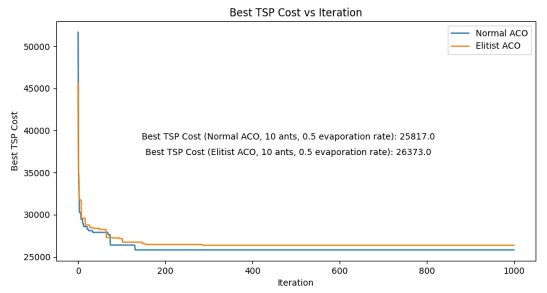


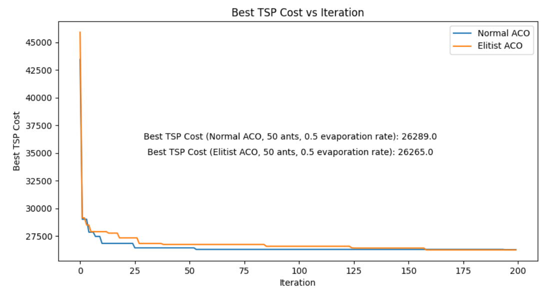
Brazil Results

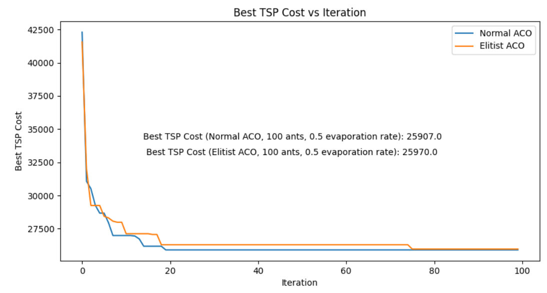


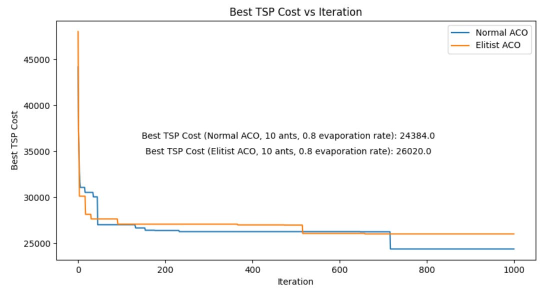


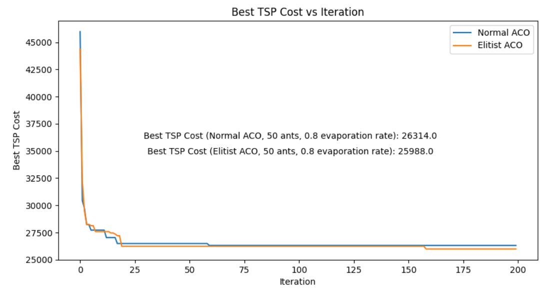


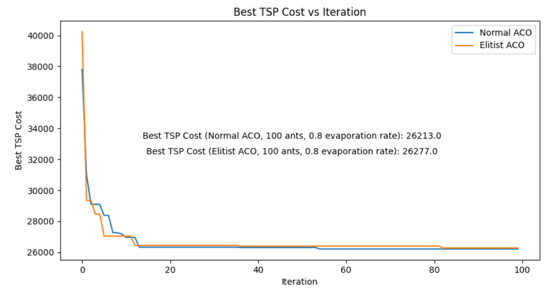












Experimentation

For my experimentation to explore how different parameters and operators would affect the Ant Colony Optimisation's (ACO) performance on the Travelling Salesman Problem (TSP), I used three different variations for the ant colony size, 10, 50, and 100. I also used three different variations for the pheromone evaporation rate, 0.3, 0.5, and 0.8.

I ran the algorithm with these parameters using the regular Ant System, and also using the Elitist Ant System to compare the results. Due to randomness within the algorithm, I ran the algorithm ten times for each parameter change and captured the path with the lowest total cost.

I have presented my findings in line graphs which displays how the best path was found over the number of iterations. The results for Burma can be found on page 1, and for Brazil on page 2.

Analysis

Question 1: What combination of parameters produces the best results?

For Burma, most of the parameter variations found the best result, a lowest total path cost of 3323, therefore it was more difficult to determine the optimal parameters. However for Brazil, using regular Ant Colony Optimisation, an evaporation rate of 0.5 and an ant colony of 10 ants provided the best result, a lowest total path cost of 25817.

Question 2: What do you think is the reason for your findings in Question 1?

Having an evaporation rate of 0.5 provides the best exploitation vs exploration trade off in this case, helping to prevent premature convergence to suboptimal solutions, while also allowing ants to exploit promising paths more effectively. A smaller colony of 10 ants would emphasise exploitation over exploration, so searching known promising paths which was optimal in this Brazil TSP, possibly as it may have had relatively clear and distinct optimal paths. Regular ACO might have performed better than the Elitist variation here because elitism tends to reinforce the exploitation of a small set of highly pheromone-rich paths. The Brazil TSP could have had multiple local optima, and sticking too closely to a subset of paths can lead to convergence on a suboptimal solution, therefore regular ACO was better here by encouraging ants to explore a broader range of paths.

Question 3: How does each of the parameter settings influence the performance of the algorithm?

Having a larger ant colony increases exploration of the solution space, but from my results having more ants didn't prove to yield better results as the algorithm may have struggled to converge on better solutions. A higher evaporation rate reduces the influence of old pheromone trails, allowing the algorithm to adapt to changes in the solution space. For my algorithm, increasing the evaporation rate was only effective with larger colonies of ants. Using Elitism meant that the search was directed to link to the current best route, enhancing the exploration of promising paths. In some cases throughout my results, the elitist variation gained better results than regular ACO. Overall it didn't make a sizable difference to the best solution.

Question 4: Can you think of a local heuristic function to add?

The local heuristic function that I have used calculates the nearest unvisited city. When the ant needs to choose the next city to visit, the distance from the current city to each unvisited city is calculated and provides a measure of desirability for each city based on proximity. The ant uses this information to align with the pheromone levels to make a decision. Another local heuristic function I could have used instead could be favouring cities with fewer neighbouring cities to encourage ants to move toward less crowded regions, essentially exploring different areas of the solution space. This would be very useful in cases where certain cities have more connections and are likely to be part of shorter paths.

Question 5: Can you think of any variation for this algorithm to improve your results? Explain your answer

Apart from the Elitist variation which I used, I could have used a Max-min ant system (MMAS). This regulates the maximum and minimum limits of pheromone levels along each trail. By restricting the addition of pheromones to only the globally best tour or the best tour within the current iteration, the algorithm avoids premature convergence to suboptimal solutions. Like Elitism, this allows for a more thorough exploration of the solution space, potentially leading to better solutions.

Question 6: Do you think of any other nature inspired algorithms that might have provided better results? Explain your answer

A Genetic Algorithm could have provided better results as they are well-suited for global exploration of the solution space. They maintain a diverse population of solutions and use genetic operators to transfer information between individuals to help explore a broader range of potential solutions. They require careful parameter tuning, but may be better suited towards the structure of the Burma and Brazil Travelling Salesman Problems.