Coursework1 CST3170 - Traveling Salesman Problem

Travelling Salesman Problem

Finding an optimal solution for the Traveling Salesman Problem, which is an NP-hard problem and so there is no polynomial-time algorithm that is known to efficiently solve every travelling salesman problem, making it all about optimisation. The algorithm is expected to find the best path from the starting city around all the others cities only once and then back to start. This makes it an optimisation problem as bruteforcing a solution takes an unreasonable length of time to calculate as the input scales up.

Algorithm

As for the algorithm a Dynamic Programming solution was used taking advantage of heap memory to cache the distances between cities and find the minimum therefore avoiding duplicate calculations. This algorithm as a time complexity of O(n^2*2^n) and a space complexity of O(n^2) for all the cities and nodes.

As a first solution Depth First Search was tried but as a bruteforce algorithm with O(n!) it quickly slows down with an increase in the number of cities, meanwhile the first algorithm scales better but quickly occupies a lot of space in memory.

Dynamic Programming

In this algorithm, we take a subset N of the required cities needs to be visited, distance among the cities and starting city as inputs. Each city is identified by unique city mask using a bytestring mask. This require us to use bitshifting ops to change the mask value.

Initially, all cities are unvisited, and the visit starts from the city. Next, the TSP distance value is calculated based on a recursive function. If the number of cities in the subset is two, then the recursive function returns their distance as a base case. Otherwise, then we'll calculate the distance from the current city to the nearest city, and the minimum distance among the remaining cities is calculated recursively.

Finally, the algorithm returns the minimum distance as a TSP solution. We also go over the cached data to reverse the optimal path and time the algorithm in ns.

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