SET09117 report

# Introduction

The travelling salesman problem is a mathematical problem which seeks to find the best, or ‘cheapest’ solution for a tour of cities. Cheapest refers to a solution which visits each city on the tour only once and only once with the shortest overall distance. (Applegate, et al., 2007) This problem suffers from an exponential increase in possible results as the number of points on the tour increases. This can best be represented with the equation where n equals the number of points and shows that as the number of cities or points increases, the number of possible permutations increases exponentially. While no one is sure of the origin of this problem it is believed that one of the earliest descriptions of the travelling salesman problem can be found in an 1832 German handbook “Der Handlungsreisende—wie er sein soll und was er zu thun hat, um Aufträge zu erhalten und eines glücklichen Erfolgs in seinen Geschäften gewiss zu sein—Von einem alten Commis-Voyageur” and Princeton university started making developments in TSP in the 1930s. (Applegate, et al., 2007)

The simplest solution in terms of complexity is to just attempt all the possible permutations and to see which one is the ‘cheapest’. This brute force search is suffers from an exponential increase in running time as the number of points on a tour increases, illustrated by the equation . this means that this method of calculating the cheapest solution is impractical for larger point sets. This therefore was the first algorithm to be implemented in the form of the nearest neighbour algorithm. This algorithm takes in an array list of Point2D points that represent cities on a tour. The first city is selected from the list, set to be the current city and added to the results Hashmap which holds the cities in the order they are visited. Then the algorithm iterates through all of the other sets of points and calculates which one is the closest to the first point. This city is then added to the Hashmap and is set to be the current city. This process is then repeated for that city, and every other city until all the cities have been added. The first city is then added again to complete the tour of the cities. Once this is complete each of the cities is iterated through using a function which calculates the distance between the selected city and the next one and these numbers are added together to give the total distance of the tour. While this algorithm does work and give an adequate result, it gives a less than optimal result and for much larger point sets it is a rather slow algorithm. For smaller point sets however. It is a useful algorithm to give a quick and useable, if not the best, result.

A possible simple improvement that was attempted was to randomise the starting point of the algorithm which may allow a shorter path depending on the start location, this however presents a problem as it may also start in a location which would create a longer route through all points. An attempted modification to this was to use the randomised starting point within a loop which allows a set amount of randomised starting points which are calculated and the cheapest one is kept. The downside to this method as it is more time intensive and on larger problems requires a very large amount of time.

The next algorithm is an improved version of nearest neighbour, which functions on the same basic principal as the normal algorithm but in this one there is a function that picks the 3 closest points to the current city and looks forward an number of steps ahead of those 3 cities. Once it has done so it calculates the distance of these 3 separate routes and returns the closest one. The algorithm then moves on to the next city and repeats this method. This method should allow the computer to pick a route that would have a shorter distance for the number of turns it looks ahead. This however, causes problems if there are a collection of close points and more outlying points or if there are some points. In those circumstances, the algorithm goes through all the close points before having to make inefficient moves which may go back through other points or intersect with other lines in order to reach further away points. This can lead to inefficiencies within the route that is calculated and in some cases can even make it longer than the standard nearest neighbour.

The final algorithm in this comparison is the Hybrid Nearest Neighbour algorithm. This algorithm utilises the normal nearest neighbour and then uses the pathfinding that is used in the previous algorithm. To start, the standard nearest neighbour algorithm is ran and the route and distance is stored. Then the pathfinding is looped through, increasing the number of steps that the algorithm looks forward. If the route distance is shorter, that route is stored instead. If it is not, then the route is not stored and the loop increases the amount of steps into the future. The loop can be stopped by entering “x” into the command prompt. Once this is entered the algorithm stops once its current calculation is complete and it returns the shortest route that it has found up to that point. This allows the user to stop the algorithm early if they want a quick solution, or leave it running to find a more efficient route. The use of the nearest neighbour algorithm as a first step means that the route returned can never by more expensive than the nearest neighbour calculation. Once the calculation has been completed or stopped the user can then opt to use a swapping algorithm that is part of Hybrid Nearest Neighbour. This looks at groups of points to assess if swapping them would provide a more efficient route. If this is so it keeps the swap and moves on to the next group of points. This allows for a correction in some of the problems of the pathfinding and is not very time intensive.

{\displaystyle O(n!)}

# Method

# Result

# Conclusions & Reflections

# Appendix

# References

Applegate, D. L., Bixby, R. E., Chvátal, V. & Cook, W. J., 2007. [Online]   
Available at: http://press.princeton.edu/chapters/s8451.pdf  
[Accessed 23 October 2016].