Abstract

1 Introduction

* 1. Problem Outline

At the time of the information age, the invention of smartphones and the fifth generation of mobile network allow internet users to access products and services online unrestricted by the geographic limitation in a split of a second. Many retailers seek this opportunity to promote their products via popular online retailing platform and social media and find their success in reaching a much larger customer base compared to traditional physical shop retailing.

With the ever-growing E-commence industry, the demand for postal service grows drastically over the past few years, with the pandemic acting as the major accelerant. However, as the demand for postal services rises, many problems have floated up to the surface. The relatively low-paid, long-working-hour nature of the postal industry often meets a shortage of staff members to meet the high demand. Shortage of staff such as postal truck drivers leads to lower number of trucks to service one postal area thus the reduced efficiency and accuracy of customer’s postage arriving on time. The increasingly long distance one single truck is required to travel also increases the uncertainty on estimated arrival time due to the higher chance on encountering live traffic incidence. Due to these circumstances, postal service companies often produce vague estimation on their arrival time and many customers found staying home waiting for their parcel to arrive for the entire day unacceptable. This leads to many incidences of missing delivery, or posted packages being stole only because the customers are not present to retrieve the delivered parcel.

One way to improve the estimation of a postal service arrival time, is to improve the route taken by the postal truck during deliveries. Reducing the route distance and time needed for one truck to complete not only help reducing the uncertainty of predicting arriving time, but also increases the effectiveness and supply of postal service in general. Solving the problem of optimizing delivery route is in fact, the Traveling Salesman Problem (TSP).

* 1. Project Objective

While there were many existing attempts, there was never an optimized solution introduced to solve TSP with less than O(n^2) complexity. This leads to the introduction of machine learning algorithm to tackle TSP as machine learning model, if learnt successfully, can be re-fit to similar problem with unseen data to provide similar high accuracy solution achievable by other algorithms. The objective of this project is to focus mainly on solving TSP with machine learning algorithm and compare the result with other existing algorithms. By the end of the project, we hope to implement multiple machine learning model to compare each of their effectiveness on TSP problem, as well as applying them onto TSP of difference size to study their versatility with increasing problem dimension. The final aim of this project is to study whether a pretrained model can be applied to new, unseen TSP data to achieve machine learning algorithms’ most significant advantage.

* 1. Report Structure

1. Context
   1. The TSP Problem

The Traveling Salesman Problem (TSP)[1] stands as one of the most renowned and extensively studied problems in the field of computational mathematics. The problem involves finding the cheapest route between a map of locations, in which each pair of locations is connected by a weighted path. The ‘traveling salesman’ is required to start at one location, arrive every other single location on the map exactly once, and finally returning to the starting location. The ‘cheapest’ route in this sense is free for interpretation. It can be the cost of the ‘traveling salesman’, the postal truck in our project’s term, the total distance travelled, or the total time travelled. Despite the freedom of interpretation, the goal is to minimize the obtained value. The final output for an attempt to tackle the problem includes the obtained cost and the order of locations travelled, often referred to as a tour, or circuit.

Variations of TSP also exist. General TSP can be classified as a symmetric or asymmetric problem. A symmetric problem refers to the weight of traveling from a location to another is equal to the weight of traveling back from the destined location to the starting location. While an asymmetric problem implies that the travelled path and return path between any pair of locations are different. Asymmetric problem is usually a more realistic interpretation of TSP due to traffic constraints and geometric differences, but it doubles the domain of the problem thus its complexity. TSP can also be classified as static or dynamic. A static problem implies that the weights between each pair of locations are kept constant throughout the tour, while a dynamic problem will have changing weights based on actions such as arriving at a new city after some certain amount of time. In order to keep a comparatively low runtime and computational memory required for this project to run on common household machines, this project focus on solving a static symmetric TSP.

Although the first mention of TSP was made by Karl Menger as early as 1930, there is yet an optimised general solution to tackle this seemingly simple task. TSP therefore became popular among computer scientists to test new technologies and algorithms.

* 1. Existing Solution
  2. Greedy Algorithm
  3. Heuristic Algorithm

1. Machine Learning
2. Requirement Analysis
3. Implementation