Best Vancouver Daily Tour

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1 Introduction

1.1 Background

The aim of the project is to investigate the best day trip schedule in Vancouver, and we assume "best" means that in this project, which could visit as many places as we can in a single day. As a result, this typically develop a timetable that allows people to visit the most sights possible in the allotted eight hours.

In terms of eight hours and twelve attractions, we estimate that's the amount of time most individuals spend each day for travel. The project's journey duration is restricted to eight hours due to the time and effort required for scenic locations and transportation. In order to assist tourists experience the beauty of Vancouver and make their trip worthwhile, the main data resource was from Outscraper which provides data from Google Map, and popular travelling website, Tripadvisor, we've selected top twelve of the most popular locations sorted by number of reviews.

The visiting and travelling time spent between tourist locations are the two components of the time spent on our Vancouver trip for this assignment. We included a list of Vancouver's major sights along with an estimation of the tour duration. We also predicted that families of first-year students would rent a car as driving is the main method of mobility in Vancouver.

1.2 Analysis Data and Travel Time

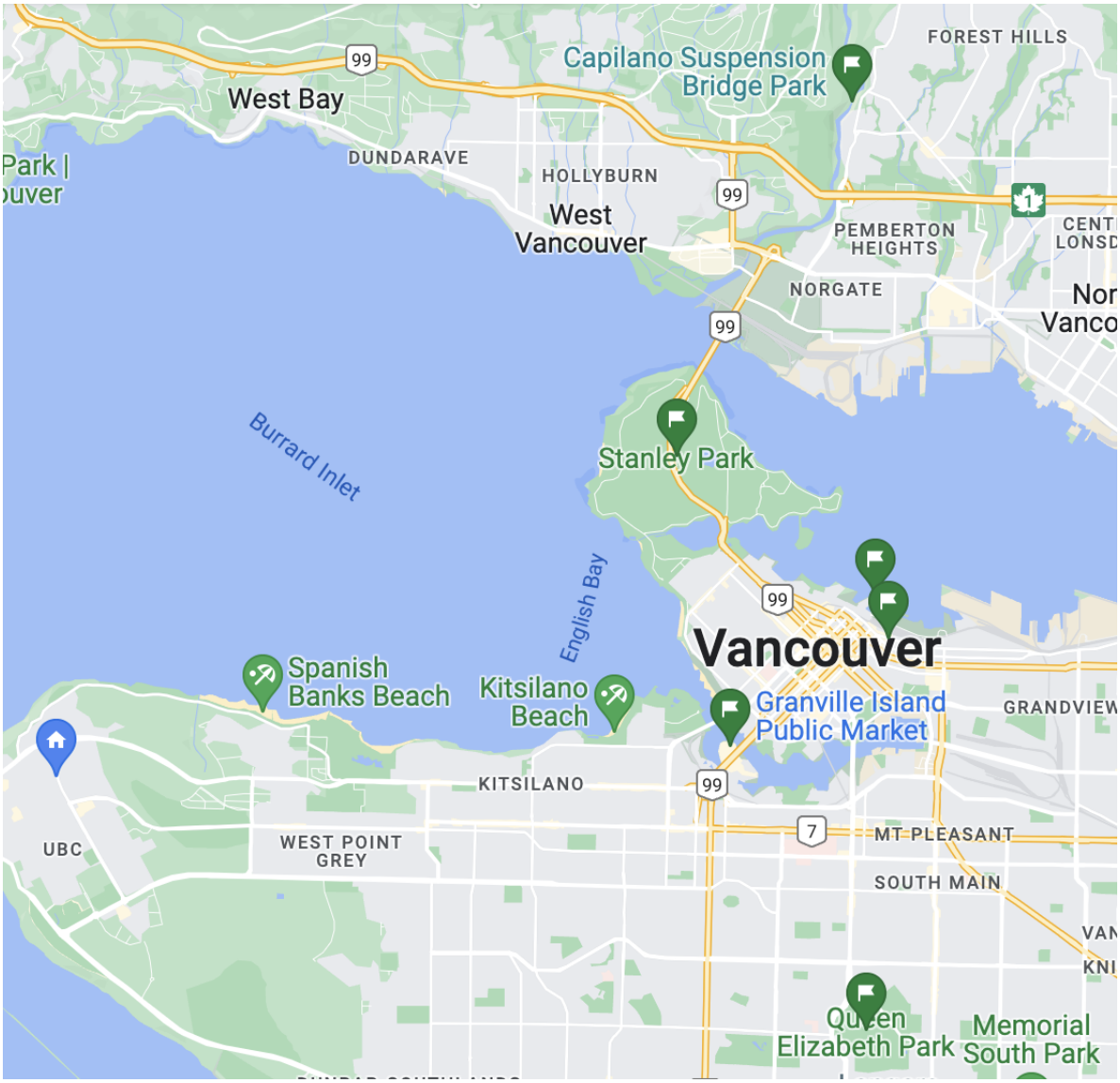
The data is gathered from Outscraper, which is the website provides spots data from Google Map. At first, to collect the data this project required, and to find the best Vancouver tour. To collect the information needed, these are columns "name", "type", "city", "full address", "working hour", "rating", and "reviews". In this case, rating is not enough to evaluate the attraction, since rating is subjective, hence we stated the popularity of attraction by the number of reviews. Therefore preparing the data by filtering by "city" is Vancouver, and sorted them by "reviews". For he visiting time, we took the average of recommended visiting times from the data of Google Map and Tripadvior to minimize deviation. The information of 12 attractions are shown in table below:

	name	type	subtypes	city	full_address	latitude	longitude	working_hours	rating	reviews
0	Vancouver Aquarium	Tourist attraction	Tourist attraction, Education center, Non-prof...	Vancouver	845 Avison Way, Vancouver, BC V6G 3E2	49.300488	-123.130877	{"Sunday": "10a.m.-5p.m.", "Monday": "10a.m.-5...	4.5	8497.0
1	VanDusen Botanical Garden	Tourist attraction	Tourist attraction, Park, Botanical garden	Vancouver	5251 Oak St, Vancouver, BC V6M 4H1	49.239569	-123.132541	{"Sunday": "10a.m.-3p.m.,4-10p.m.", "Monday": ...	4.6	8668.0
2	CF Pacific Centre	Shopping mall	Shopping mall	Vancouver	701 W Georgia St, Vancouver, BC V7Y 1G5	49.283398	-123.117540	{"Sunday": "11a.m.-7p.m.", "Monday": "10a.m.-7...	4.2	9601.0
3	Science World	Tourist attraction	Tourist attraction, Event venue, Non-profit or...	Vancouver	1455 Quebec St, Vancouver, BC V6A 3Z7	49.273376	-123.103834	{"Sunday": "10a.m.-5p.m.", "Monday": "10a.m.-5...	4.5	10601.0
4	Grouse Mountain	Tourist attraction	Tourist attraction, Hiking area, Ice skating r...	North Vancouver	6400 Nancy Greene Way, North Vancouver, BC V7R...	49.370244	-123.098686	{"Sunday": "9a.m.-9:30p.m.", "Monday": "9a.m.-...	4.6	11742.0
5	Queen Elizabeth Park	Tourist attraction	Tourist attraction, Playground, Park	Vancouver	4600 Cambie St, Vancouver, BC V5Z 2Z1	49.241757	-123.112619	{"Sunday": "6a.m.-10p.m.", "Monday": "6a.m.-10...	4.7	12822.0
6	English Bay Beach	Tourist attraction	Tourist attraction, Park, Public beach	Vancouver	Beach Ave, Vancouver, BC V6C 3C1	49.286311	-123.143486	{"Sunday": "6a.m.-10p.m.", "Monday": "6a.m.-10...	4.7	13521.0
7	Gastown Steam Clock	Tourist attraction	Tourist attraction, Historical landmark	Vancouver	305 Water St, Vancouver, BC V6B 1B9	49.284409	-123.108872	{"Sunday": "Open 24 hours", "Monday": "Open 24...	4.4	16170.0
8	Canada Place	Convention center	Convention center, Tourist attraction	Vancouver	999 Canada Pl, Vancouver, BC V6C 3T4	49.288825	-123.111121	{"Sunday": "8a.m.-12p.m.,1-4p.m.", "Monday": "...	4.6	16243.0
9	Granville Island Public Market	Market	Market, Fresh food market	Vancouver	Public Market, 1689 Johnston St, Vancouver, BC...	49.272701	-123.135215	{"Sunday": "9a.m.-6p.m.", "Monday": "9a.m.-6p....	4.6	18953.0
10	Capilano Suspension Bridge Park	Tourist attraction	Tourist attraction, Bridge	North Vancouver	3735 Capilano Rd, North Vancouver, BC V7R 4J1	49.342861	-123.114924	{"Sunday": "11a.m.-9p.m.", "Monday": "11a.m.-9...	4.6	24457.0
11	Stanley Park	Tourist attraction	Tourist attraction, Park	Vancouver	Vancouver, BC V6G 1Z4	49.304258	-123.144252	{"Sunday": "9a.m.-5p.m.", "Monday": "9a.m.-5p....	4.8	40284.0

Attraction Data

1.3 Map

This picture is from Google Map, the sights are labeled with green flag.



Vancouver Map

2 Methodology

2.1 TSP

The goal of the project is to investigate the minimum visiting and travelling time to visit places as much as possible, from UBC and back again. To be specific, the objective function is to discover the minimum spent of travelling each possible routine, and with maximum number of spots with time cost less than 8 hours. This can be solved bu TSP, which used to find the shortest path to visited all nodes and return to the original node.

First, a TSP model was performed on a complete list of 12 attractions, since the total visiting time greater than 8 hr, we delete each one attraction to create 12 new attraction lists, and calculate the total with 11 attractions of each new list (Google OR-Tools), if the cost time less than 8 hours, then find the combinations with minimum travelling time related on our 11 attractions, then delete another and continuing. Once we find the path with time cost less than 8 hours, We set the possible solution with smallest cost time as the optimal solution, otherwise continue the recursion until find the path with time cost in the constrain. To sum up, the maximum number of attractions that could visit in 8 hours is 8, with 13 possibilities. It is established that this result need to improve, since it is best to

find the "best" Vancouver 8-hour tour.

The TSP Model was shown below:
Assume there are n attractions in the list. Let $x_{ij} = 1$ if the edge from attraction i to j is the optimal solution, otherwise $x_{ij} = 0$. $x_k = 1$ if the optimal path visited attraction k, otherwise $x_k = 0$. To minimize the sum of travelling time from attraction i to attraction j $t_{ij}x_{ij}$ and the sum of visiting time of each attraction $v_k x_k$

$$\text{Mini} \sum_{i=0}^{12}\sum_{j=0}^{n} t_{ij}x_{ij} + \sum_{k=1}^{n} v_k x_k$$

To visit each attraction once, and there is no repeated path, therefore there are

$$\text{s.t.} \sum_{i=0}^{n} x_{ik} = \sum_{j=0}^{n} x_k \leq 1$$

Since in daily life,it is necessary to go from UBC and back to UBC.

$$\sum_{i=0}^{n} x_{i0} = 1$$

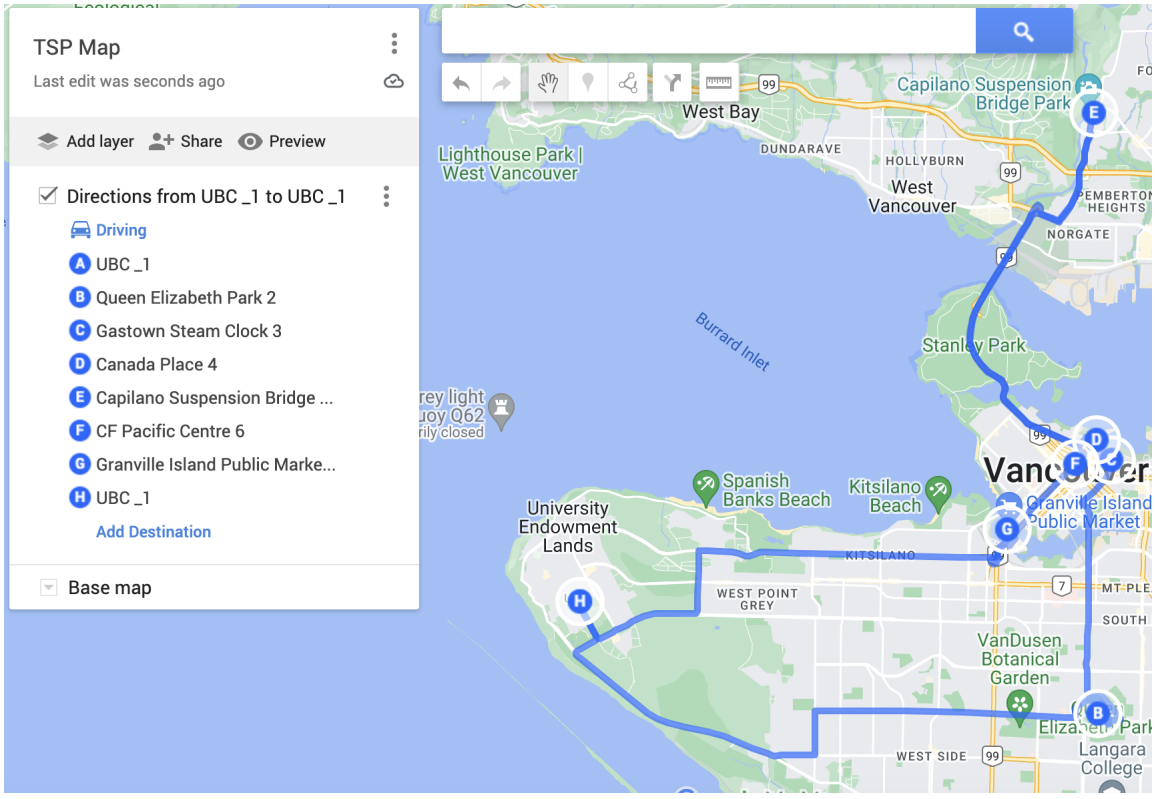
$$\sum_{j=0}^{n} x_{0j} = 1$$

The total edges in our map should be equal to

$$\sum_{i=0}^{n}\sum_{j=0}^{12} x_{ij} = n$$

$$x_{ij}x_{ji} = 0 \quad \text{for } j, i \in 0, 1, \ldots, n$$

With time cost less than 8 hours, there are 13 possible routines with 8 attractions, the shortest cost time is approximate 6.92 hours:



Optimal Solution of TSP

Optimal solution: **UBC →Granville Island Public Market → Science World → Gastown Steam Clock → Canada Place → CF Pacific Centre → English Bay Beach → UBC**.

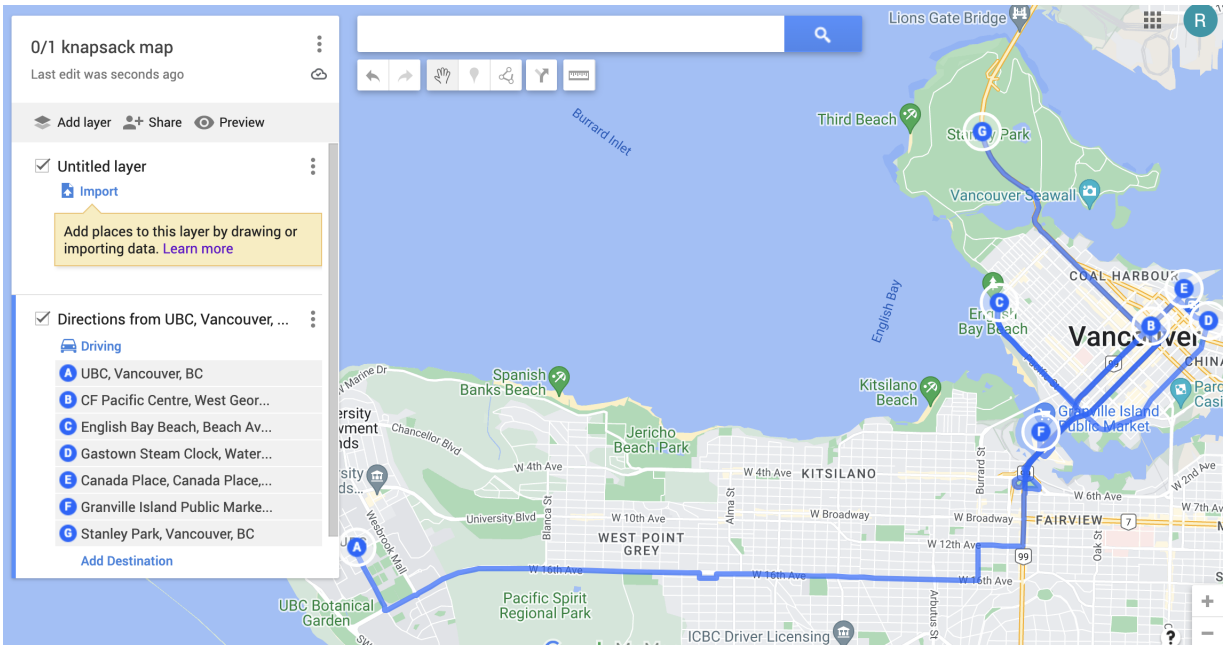
2.2 0/1 Knapsack to Further Improve the Result

Based on the result from our previous TSP result, instead of identifying the routine with the highest rating of attractions, Due to the limited time and desire to see sites with the highest ratings, Building 0/1 Knapsack Model might be helpful here, to treat the time cost as capacity constrain, and our objective function is to maximize the sum of rating of attractions in optimal solution. Also, the approximate travel time is removed at this time. This method is more flexible than TSP, since the order of visiting is not fixed.
To further improve the result, to use the average of total time cost from TSP result as capacity b, we only consider the rate of attraction. Then objective function change to maximize the sum of rates of attractions that in the optimal solution. By using 0/1 knapsack Model, find the tour with maximum rates, with constrain of approximate visiting time. [Gre93].

Let b be the maximum visiting time, w_i is the rate of attraction i, v_i is the visiting time of attraction i. $x_i = 0$ when i is in optimal solution, otherwise 0.

$$\max \sum_{i=0}^{11} v_i x_i \quad \text{for } x_i \in \{0,1\}^n$$

$$\text{s.t.} \sum_{i=0}^{11} v_i x_i \leq b$$



Optimal Solution of Knapsack

Optimal solution: **UBC → CF Pacific Centre → English Bay Beach → Gastown Steam Clock → Canada Place → Granville Island Public Market → Stanley Park → UBC**

2.3 Check Result

In addition, to further developing our Vancouver tour, we check the working hour of each attractions on Weekend(Assume the student only free on weekend). Since we conduct the routine, we need further check whether the working hour fits our routine schedule. Assume the tour starts 10:00am on Sunday,

we abstract the Working-Hour Table from Google, compare the approximate destination time and the working hour, and create the timetable.

Location	Working hour
Vancouver Aquarium	10.am-5.pm
VanDusen Botanical Garden	10.am.-3p.m
CF Pacific Centre	11.am.-7p.m
Science World	10.am-5p.m
Grouse Mountain	9.am.-9:30.pm
Queen Elizabeth Park	6.am.-10p.m
English Bay Beach	6.am.-10.pm
Gastown Steam Clock	Open 24 hours
Canada Place	8.am.-12pm
Granville Island Public Market	9a.m.-6p.m
Capilano Suspension Bridge Park	11a.m.-9p.m
Stanley Park	9a.m.-5p.m

Working Hour

According to the solution from 0/1 Knapsack section, the routine conflicts the working hour of Stanley Park, hence we rearrange our schedule. The Since Gastown Steam Clock open 24 hours, and it is the nearest attraction next to Stanley Park, we exchange their positions in the order of routine. The revised solution was shown below.

Location	Visiting Time
CF Pacific Centre	11.29am
English Bay Beach	12.29pm
Gastown Steam Clock	17.39pm
Canada Place	14.20pm
Granville Island Public Market	15.39pm
Stanley Park	13.12pm

Schedule

Optimal solution: UBC → CF Pacific Centre → English Bay Beach → Stanley Park → Canada Place → Granville Island Public Market → Gastown Steam Clock → UBC

3 Discussion

3.1 Limitation

The reliability of the data is impacted by the variety of data, we didn't consider factors such as traffic and weather. In terms of traffic, the travel times are affected by some traffic restrictions, such

as one-way street and traffic light. We didn't consider the departure time, all travelling data was collected at different time with the average data, which need some improvements in the arrangement. For example, the waiting time will change with the departure time. Departing at 9:00 may have less red light than departing at 9:05. In addition, the rush hour traffic also influence the travelling time. From 9:00am to 10:00am in weekdays, some areas like downtown and No.4 Avenue are heavier than other time period. In aspects of weather, since our transportation is car, the speed highly depends on the weather condition. During rainy day, the fog and heavy rain drops will obstruct the sight of the driver. Similarly, if we visit Vancouver in winter(assume student enrolled in spring term), especially in December and January, drivers need pay attention to snow.

3.2 Future Research

For future research, to expand the project on further tourism with higher traveling time limits. To be more accurate, it is possible to consider the combination of highest number of attractions in BC province restricted by 7 days. In addition, the transportation could be change to mixture of bus and ship instead of car. To make a more intimate schedule, it is much better to consider personal needs, such as including lunch-time and shopping time in our constrains. Moreover, the types of attractions can be further correlated with visitors' preference. To be specific, the attractions selected will all be indoor if the visitor prefer indoor attractions.

References

[Gre93] George D. Greenwade. The Comprehensive Tex Archive Network (CTAN). *TUGBoat*, 14(3):342–351, 1993.