

SOLVING AN OPTIMAL ROUTE FOR TOURIST AT LANGKAWI USING HEURISTICS TECHNIQUE

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ABSTRACT

Tourism is an important industry for this country because it is one of a major contributor to the economics of Malaysia. In this paper, we focus Langkawi Island as the case study because normally, tourist travel to Langkawi Island will drive the rented car as the primary mode of transport. Thus, the aim of this paper is to develop a mathematical modelling to find an optimal route for tourist to travel to their interesting places around Langkawi Island. Heuristic technique was applied in this study which emphasized on several greedy heuristic methods in order to solve the problem. MATLAB version 7.8 has been used to get the solution for all greedy heuristic method. The result obtained shows that nearest greedy method gives better result compared to the nearest greedy insertion method. The minimum value of the route selection gives effect to the cost of travelling. Therefore, from this study, the best route that connect from one interesting place to others place can be suggested to the tourist as a guidance. In addition, tourist can save their time and money to pay for tourist guide.

Keywords: *heuristic technique, optimal route, shortest route, travelling cost, MATLAB*

INTRODUCTION

Tourism is an important industry for this country because it is one of a major contributor to the economics of Malaysia. Tourism is seen as an industry that contributes to the economic growth of government and the private sector, especially after the Second World War (1939-1945). According to World Tourism Organization, tourist will be travelling to a place that is outside from their home and stay at there for leisure or other purposes. Meanwhile, Burkart (1981) denotes tourism the temporary, short-term movement of people to destinations outside the places where they normally live and work, and their

activities during the stay at these destinations. The purpose of travelling is to visit an interesting and attractions places with a new experience around the selected location. The tourist will visit all the places that can entertain them and hereby, it will generate a country income. In addition, tourism is not only involving local people, but it also involves tourist from other countries. People like to travel either in domestic or international. There are many interesting places that tourists can visit. For example, in domestic, tourists can go to Cameron Highland, Sunway Lagoon, and Langkawi. While for international place, tourists can go to Thailand, Korea, China and else.

For improving the services for tourist, a shortest route model need to be create. From this model it can help tourists to plan their trips of holiday wisely. The purpose of this study is to provide a better plan for tourist that based on shortest route by driving their own vehicles to interesting places that they want to go. Therefore, tourists can save their time, and cost to pay tourist guide. By having this model, tourist can choose the best route that can connect from the destination to the next destination based on shortest route. Shortest route or path can be defining as the total distances that have minimum value to be travelled from one node to another node. Normally, tourists will choose the best route that connects a destination to the next destination by looking the route that has the shortest distance. A study by Wen (2004) interpreted the shortest route as the minimum total distance to be traveled from one node to another node. The minimum value of this route selection will affect the cost of travel. If the tourist make mistake for choosing the minimum route, it will affect their time and cost. When the tourist travelling by themselves, they will get more satisfaction and can enjoy unlimited time at that place. According to Taplin and McGinley (2000), for most tourists travelling by car, the pursuit of satisfaction and enjoyment is limited by the length of time available and by travel distance. Meanwhile, Carson et al. (2002), determine that self-drive tourist has advantages in terms of: greater control over itinerary; often greater comfort and lower cost.

People love to travel, and they always want to make their holiday meaningful. Besides that, they also want to go to every interesting place with optimizing the time and distance between the interesting places. Langkawi have been selected to this study because it has more interesting places and had its own history. Dominating an archipelago of more than one hundred islands and islets, Langkawi Island is synonymous with sandy shores, jungle-cloaked valleys, bargain shopping, world-class infrastructure, mangroves rich in flora and fauna, and fascinating legends. Blonde beaches are the biggest draw, but this 478.5-square-km island has been duty free since 1987, making low-cost kitchenware a close second. As the tourists coming to Langkawi did not bring their own vehicles, so a lot of car services available here. Tourists can rent a car based on the type of vehicle and the rental price per day depends on their ability. If they want convenience and do not want to be bound by the traveling schedule, they can drive the car by own without the tourist guide and as self-drive tourists can develop their own personal itineraries. Because of that, this study need to find the shortest route for the tourist that can takes them to every interesting place and need to bring them back to the place that they stayed. In this problem, the tourist must minimize the total distance that must be taken, thereby it will

minimize travelling cost. According to Bruce (2000), increase the distance travelled will generally lead to increase transportation costs and it is an important factor for the calculation of the overall cost of the trip. The potential for interaction between any two places increases as the cost of movement between them either in terms of money or time decreases (Dziauddin et al.,2013). Although there are many interesting places to visit in Langkawi, but often tourists will not visit all the places due to time constraints and costs. Normally, the travelling cost is the main important thing that tourists need to consider when they decided to travel. The travelling cost here include the transportation cost, which is relate to the travel distance and accommodation cost.

This study focusing the application of greedy heuristic technique to find shortest route for tourist in Langkawi Island. Section 2 of this paper discusses about the literature review, section 3 discuss about the scope of this study and section 4 discuss about the methodology. Meanwhile section 5 shows the result and discussion with section 6 giving the conclusion and recommendation.

LITERATURE REVIEW

Travelling Salesman Problem

The Traveling Salesman Problem (TSP) is one of the most widely studied combinatorial optimization problems. Even though this problem is look like a simple deceptively but it also the most challenging problem in Operational Research. A common application of TSP is the movement of people, equipment and vehicles around tours in aiming to minimize the total traveling cost. The objective of the TSP is to find the optimal route for the tourists visit all the cities. The problem was posed centuries ago and has enjoyed constant attention and consistent progress en route for better solutions. Generally speaking, the optimal solution can be found for sets larger than that, and due the non-polynomial growth of tours permutations with set size, solutions to the TSP are approximate in this case one is satisfied with finding a good tour instead of the best tour (Barach et al., 2012). TSP is widely used in engineering, design of metal tools, electronic equipment and communications network. TSP also was applied in the tourism industry in order to determine the optimum route to visit the tourist destinations such as the research that has been done by Neto et al. (2012).

Shortest Route

Time need for the vehicle to move from one location to another can define the distance between two nodes. For this problem, TSP method can be used to solve the problem of finding the shortest route for the vehicle with minimizing the time of pickup (Matai et al., 2010). TSP refer to salesman who want to find the shortest route that he will go there exactly once and return back to the place that he started. Based on this study, the given task is to find the shortest route but must go to all places even if only once. While the

starting point and the ending is the same, researchers have established that the Hamiltonian cycle is a cycle in a graph which visits each vertex even once (Sahalot & Shrimali, 2014). Gopika (2014) find out the paths with the minimum distance is between the nodes. Based to the minimum distance nodes, the shortest route was found between the paths and the nodes are joined using backward join algorithm.

Nearest Greedy Method

Bolzoni & Helmer (2014), did not use the simple greedy heuristic method but they used to find the realistic way for tourist trip planning by adding some categories to point of important (POI) thing. This is useful for the tourist to provide the feedback on preferred types and numbers of POIs to be included in a trip schedule. By using POIs, the result is not optimal as by using greedy method. Mohammad & Khidhir (2016) was solved the TSP by the nearest neighbor principle to find the minimum distance of route connecting some shops in an area. The shops were built in a town with an area of 20 km in map, the average of town area. The nearest neighbor algorithm follows a very simple greedy procedure. The procedure are starts the tour of the city randomly and adding many more city that they want to visit. This algorithm will stop if all the cities have been visited. This algorithm will extend if want to repeat the travelling from the starting point and return back. This heuristic is called repetitive nearest neighbor (Hahsler & Hornik, 2007).

SCOPE OF THIS STUDY

Although there are more than 30 tourist destinations in Langkawi (refer Figure 1), but this study only covers 8 of the most attractive tourist destinations around Langkawi. The tourist destinations were selected based on recommendations acquired from the Ministry of Tourism Malaysia website. In addition, we only consider the tourist destinations that can be reached by road networks, because of the scope of our study focused on self-drive tour. The place that involve in this study is Bayview Hotel, 'Makam Mahsuri', Langkawi Eagle Square, Cable Car, Langkawi Sky Bridge, Underwater World, Bird Paradise, 'Pekan Kuah', and lastly is 'Pantai Cenang'.



Figure 1
Map of Langkawi Island

METHODOLOGY

Description of the Case Study

According to the tourist who went to Langkawi said that they need to choose where they need to go because of limited time and they cannot go every place if they only stay for 2 or 3 days. From this problem, this study need to find the solution that can satisfied the tourist. To solve this problem, this paper used Greedy method. A greedy method is a mathematical approach that is very easy to use. This greedy method has four types, that is:

1. Nearest Greedy
2. Cheapest Arc Greedy
3. Nearest Greedy Insertion
4. Ordinal Insertion Greedy

Chosen Method

For this study, the we only choose Nearest Greedy and Nearest Greedy Insertion because this method is suitable to use for our problem. This method is used to find the best solution and repeatedly visits the nearest place until all have been visited. To solve this method, we used MATLAB version 7.8 and also manual calculation to compare both

results. MATLAB is a good software package. MATLAB name is get from the MATrix LABoratory which related to matrix (array). It is useful for math computation, modeling and simulation, data analysis and many more things that related to heuristic techniques.

i. Nearest Greedy

Also called Best-First Search. It follows a single path, don't need to generate all competing paths and doesn't get caught in loops or dead-end paths. It also explores the most promising path seen so far.

Nearest Greedy Algorithm:

Step 1: Start at node 1, let $k = 1$.

Step 2: *Visit node j , which is the closest to node k .

- If node j has been chosen previously, then choose the other closest node which has not been chosen (to eliminate loops/sub cycles)
- Else go to Step 3

Step 3: Move to node j . Let $k = j$.

Step 4: Repeat (*) until all nodes are visited.

Step 5: Return to node 1. End.

ii. Nearest Greedy Insertion

Nearest Greedy Insertion Algorithm:

Step 1: Start at node 1, let $k = 1$.

Step 2: *Insert all of the remaining node(s) as a list of cycle's permutations (possible solutions) without violating the node's order of previously chosen cycle

Step 3: Calculate the total distance for all permutations

Step 4: Choose the permutation with the minimum distance

- If all nodes have been chosen, go to step 5
- Else, go to Step 2

Step 5: End.

Data Collection

Table 1 shows the data with the distance from one destination to other destination. The distance from one destination to another are also found using the Google Maps application.

Table 1
Travel distance (km) for selected tourist destination in Langkawi

Place	BH	MM	LES	CC	LSB	UW	BP	PK	PC
BH	0	16	3	35	36	20	9	2	21
MM	16	0	18	19	19	13	23	15	13
LES	3	18	0	31	31	22	11	3	22
CC	35	19	31	0	1	19	26	27	18
LSB	36	19	31	1	0	19	27	30	18
UW	20	13	22	19	19	0	31	19	2
BP	9	23	11	26	27	31	0	10	30
PK	2	15	3	27	30	19	10	0	20
PC	21	13	22	18	18	2	30	20	0

Abbreviation:

BH: Bayview Hotel

LES: Langkawi Eagle Square

CC: Cable Car

MM: Makam Mahsuri

LSB: Langkawi Sky Bridge

PK: Pekan Kuah

UW: Underwater World

PC: Pantai Cenang

Node:

1: BH

2: MM

3: LES

4: CC

5: LSB

6: UW

7: BP

8: PK

9: PC

RESULT AND DISCUSSION

MATLAB software version 7.8 was used in order to solve the Nearest Greedy Method and Nearest Greedy Insertion Method.

Result using Nearest Greedy

When this study uses MATLAB and the manual calculation for Nearest Greedy Method, the result shows the same distance which is 91 km with two different optimal routes. It gives two different starting points which is Cable Car and the other one is Pantai Cenang. When the starting point at node 4, that is Cable Car, the next tourist destinations are Langkawi Sky Bridge, Pantai Cenang, Underwater World, Makam Mahsuri, Pekan Kuah, Bayview Hotel, Langkawi Eagle Square, Bird Paradise and return to Cable Car with the total distance of 91 km. Table 2 shows the route network solutions that minimize the total travel distance for Nearest Greedy when Cable Car was selected as starting point.

Table 2
Route network solutions that minimize the total travel distance (km) for Nearest Greedy when Cable Car was selected as starting point

Node	Destination	Distance (km)	Total Distance (km)
4 → 5 → 9 → 6 →	CC → LSB → PC	1 + 18 + 2 + 13 +	91
2 → 8 → 1 → 3 → 7 →	UW → MM →	15 + 2 + 3 + 11 +	
→ 4	PK → BH → LES	26	
	→ BP → CC		

Then, when the starting point at node 9, that is Pantai Cenang, then it goes to Underwater World, Makam Mahsuri, Pekan Kuah, Bayview Hotel, Langkawi Eagle Square, Bird Paradise, Cable Car, Langkawi Sky Bridge and return to Pantai Cenang with the total distance also 91 km. Table 3 shows the route network solutions that minimize the total travel distance for Nearest Greedy when Pantai Cenang was selected as starting point.

Table 3
Route network solutions that minimize the total travel distance (km) for Nearest Greedy when Pantai Cenang was selected as starting point

Node	Destination	Distance (km)	Total Distance (km)
9 → 6 → 2 → 8 →	PC → UW → MM	2 + 13 + 15 + 2 + 3	91
1 → 3 → 7 → 4 →	→ PK → BH →	+ 11 + 26 + 1 + 18	
5 → 9	LES → BP → CC		
	→ LSB → PC		

From this result, there are two routes that tourist can use to optimize route for their journey.

Result using Nearest Greedy Insertion

For the nearest greedy insertion, this study only used manual calculation. From this result, the total of optimal route is 98 km. This optimal route is when the starting point is at Bayview Hotel.

Table 4
Route network solutions that minimize the total travel distance (km) for Nearest Greedy when Pa Bayview Hotel was selected as starting point

Node	Destination	Distance (km)	Total Distance (km)
1 → 2 → 5 → 4 →	BH → MM → LSB	16 + 19 + 1 + 18 +	98
9 → 6 → 8 → 3 →	→ CC → PC →	2 + 19 + 3 + 11 + 9	
7 → 1	UW → PK → LES		
	→ BP → BH		

CONCLUSION AND RECOMMENDATION

Based on the finding, when this study used nearest greedy and nearest greedy insertion, the nearest greedy give better result compared the nearest greedy insertion. This is because the nearest greedy provides an optimal route which is 91 km, which is tourists have two routes that they can follow to get optimize route when starting point at cable car or starting point at Pantai Cenang. Any weaknesses of this study need to be improved so that the outcomes can make the tourist satisfied. The finding from this study also would help the tourist to find the shortest route from one place to another place. This can make sure that the tourist can go to all the places in Langkawi without skip the place if they do not have enough time. From this study also, the researcher can make sure that the tourist can save their money and also their time if they follow this route.

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