

## CHAPTER 3

# THE PERFECT PLAN FOR WEEKEND GETAWAYS

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### 3.0 INTRODUCTION

Five female students from Department of Information and Technology were tasked with planning weekend trips to several locations in Johor and Malacca, including Pagoh, Muar, Parit Sulong, Semerah, Tangkak, Jasin, Ayer Keroh, Taming Sari, and Merlimau. Their goal was to visit each location only once and minimize their total travel distance, a problem of optimizing routes. This scenario can be modelled as a *spanning tree* problem, where the aim is to connect all locations with the least total distance [1].

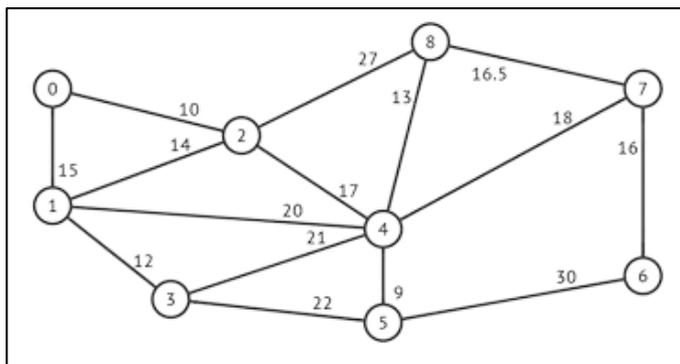
A *minimum spanning tree* (MST) approach is ideal for this and can be efficiently solved using either Prim's algorithm or Kruskal's algorithm [2,3]. Both algorithms help in constructing the MST by choosing the shortest possible connections between the locations, with Prim's algorithm gradually growing the tree from an initial location, while Kruskal's

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algorithm considers all possible connections in increasing order of weight [4,5]. By applying these algorithms, the students can ensure they minimize the travel distance while visiting each location exactly once [6].

### 3.1 METHODOLOGY

For this study, an undirected, weighted graph was constructed using VisuAlgo [6], a tool that visualizes various algorithms. VisuAlgo supports visualized solutions for problems involving sorting, graphs, algorithms, recursion trees, and more, aiding in learning data structures and algorithms while also facilitating the solution of complex problems. In Figure 3.1, the nine nodes represent the nine locations the students will visit, and the edges represent the roads connecting them. The weights on the edges indicate the distances in kilometers (km) between the locations.



**Figure 3.1:** An undirected graph weighted graph representing the nine places in Johor and Malacca

Here is how each location is numbered.

- 0-Pagoh
- 1-Parit Sulong
- 2-Merlimau

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- 3-Semerah
- 4-Muar
- 5-Tangkak
- 6-Jasin
- 7-Ayer Keroh
- 8-Taming Sari

Figure 3.1 shows a graph with nine vertices and 15 edges. The edges and their weights are detailed in Table 3.1.

**Table 3.1:** All edges and weight.

No.	Edges	Weight (km)
1	(0,1)	15
2	(0,2)	10
3	(1,2)	14
4	(1,3)	12
5	(1,4)	20
6	(2,4)	17
7	(2,8)	27
8	(3,4)	21
9	(3,5)	22
10	(4,5)	9
11	(4,7)	18
12	(4,8)	13
13	(5,6)	30
14	(6,7)	16
15	(7,8)	16.5
Total weight of all edges		260.5

The graph in Figure 3.1, as detailed in Table 3.1, has 15 edges with a total weight of 260.5 km.

This study aims to minimize the total travel distance required to visit all nine locations: a problem addressed by finding a

minimum spanning tree. Prim's and Kruskal's algorithms will be applied to solve this.

### **3.1.1 PRIM'S ALGORITHM**

In this subsection, Prim's algorithm will be used to determine the minimum travel distance for the weekend trip. We can start at any node; in this case, we'll begin with node 1. The next step is to select the edge with the smallest weight connected to node 1. This process repeats, selecting the smallest edge connected to any of the already-visited nodes, until all nodes have been traversed, ensuring that no cycles are created.

**Table 3.2:** Calculation by using Prim's algorithm

Iteration	Edges	Visited vertices	Unvisited vertices	Weight (km)
1	(3,1)	3,1	0,2,4,5,6,7,8	12
2	(1,0)	3,1,0	2,4,5,6,7,8	15
3	(0,2)	3,1,0,2	4,5,6,7,8	10
4	(2,4)	3,1,0,2,4	5,6,7,8	17
5	(4,8)	3,1,0,2,4,8	5,6,7	13
6	(8,7)	3,1,0,2,4,8,7	5,6	16.5
7	(4,5)	3,1,0,2,4,8,7,5	6	9
8	(6,7)	3,1,0,2,4,8,7,5,6	-	16
Total weight				108.5

Table 3.2 demonstrates the steps of Prim's algorithm, resulting in a minimum spanning tree connecting all nine locations in Johor and Malacca. This tree consists of eight edges with a total weight of 108.5 km.

### **3.1.2 KRUSKAL ALGORITHM**

Next, Kruskal's algorithm was applied to determine the minimum travel distance. This algorithm begins by selecting the edge with the smallest weight. The process then repeats,

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adding edges in increasing order of weight, until all nodes have been visited, while ensuring that no cycles are created.

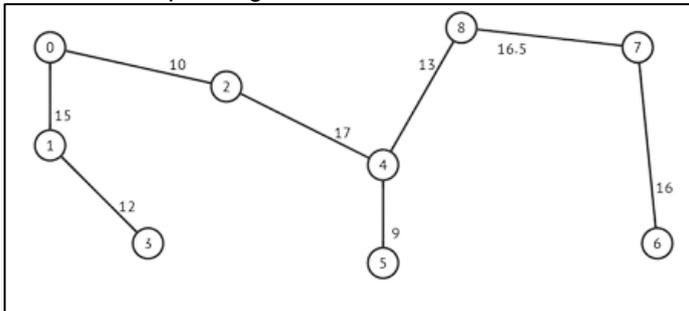
**Table 3.3:** Calculation by using Kruskal algorithm

Iteration	Edges	Visited vertices	Unvisited vertices	Weight (km)
1	(4,5)	4,5	0,1,2,3,6,7,8	9
2	(0,2)	4,5,0,2	1,3,6,7,8	10
3	(1,3)	4,5,0,2,1,3	6,7,8	12
4	(4,8)	4,5,0,2,1,3,8	6,7	13
5	(0,1)	4,5,0,2,1,3,8	6,7	15
6	(6,7)	4,5,0,2,1,3,8,6,7	-	16
7	(7,8)	4,5,0,2,1,3,8,6,7	-	16.5
8	(2,4)	4,5,0,2,1,3,8,6,7	-	17
Total weight				108.5

The results of Kruskal algorithm, tabulated in Table 3.3, show a minimum spanning tree connecting all nine locations in Johor and Malacca. This tree has eight edges with a total weight of 108.5 km.

**3.2 MINIMUM SPANNING TREE**

Both Prim's and Kruskal's algorithms were used to generate a minimum spanning tree (MST) with a total weight of 108.5 km, as shown in Figure 3.2. This MST fulfils the requirements of a minimum spanning tree.



**Figure 3.2:** Minimum spanning tree for the weekend  
getaways' problem

### 3.3 CONCLUSION

The shortest total distance connecting all nine locations in Johor and Malacca was calculated using both Prim's and Kruskal's algorithms, resulting in a minimum spanning tree. This solution helps the students determine the most efficient route for their weekend trip.

### 3.4 REFERENCES

- [1] Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). *Introduction to Algorithms* (3rd ed.). MIT Press.
- [2] Prim, R. C. (1957). *Shortest Connection Networks and Some Generalizations*. Bell System Technical Journal, 36(6), 1389-1401.
- [3] Kruskal, J. B. (1956). *On the Shortest Spanning Subtree of a Graph and the Traveling Salesman Problem*. Proceedings of the American Mathematical Society, 7(1), 48-50.
- [4] Tarjan, R. E. (1983). *Data Structures and Network Algorithms*. SIAM.
- [5] Kleinberg, J., & Tardos, E. (2006). *Algorithm Design*. Pearson.
- [6] VisuAlgo. (n.d.). *Visualization of data structures and algorithms*. Retrieved January 31, 2025, from <https://visualgo.net/en>