The Solution Travelling Salesman Problem With C++ Program

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Abstract: In terms of the distribution of goods, each post office must have a distribution area for destinations. Likewise with the Post Office on Jl. Sutomo no. 2 Pematangsiantar, where they are in charge of distributing goods in the Pematangsiantar City area which is the peak of the Simalungun. In order for these goods to be distributed quickly, an efficient route is required in terms of distance. The distribution of goods begins and ends at the Post Office in Pematangsiantar city. This problem can be categorized as the Traveling Salesman Problem (TSP), which is a problem where a salesman has to visit all areas where each area has only been visited once and must return to the hometown. The purpose of this study is to determine the shortest time in submitting orders, assist companies in reducing operational costs, get the shortest path using two ways, namely by manual calculation and programming language so that it becomes a reference material for students of the HKBP-N Pematangsiantar University, Post Office, and efficiency comparison using C++.

Index Terms: TSP, C++ Program.

1. INTRODUCTION
The Traveling Salesman Problem is a very well-known problem in graph theory. Multiple-Traveling Salesman Problem (m-TSP) which is the development of the Traveling Salesman Problem (TSP). Pos Indonesia is an Indonesian state-owned company (BUMN) engaged in postal services. Pascal was developed from the ALGOL language, which is a scientific computing programming language. There were two events that caused PASCAL to become very popular at that time, namely the use of PASCAL as a language to create applications/software for examination purposes in several schools, and the release of the Turbo Pascal Compiler by the Borland International company for IBM computers. Until now, Turbo Pascal has reached the release of 7.0 and it even runs on the Windows platform (Turbo Pascal for Windows). There is also a variant of Turbo Pascal, which is more open source, namely Free Pascal. However, at this point, PASCAL has started to be abandoned a lot. Most programmers today prefer C++ because it's more support for object-oriented programming. The purpose of this research is to determine the shortest time to deliver orders, help companies reduce operational costs, get the shortest path using two methods, namely by calculating the manual method and C++ program language so that it becomes a reference material for students UHKBPNP and Post Office.

2. LITERATURE REVIEW
This research is a descriptive study that provides an overview of how to solve the problem of traveling salesman problems using the C++ program. As for what is used as a subject in this study is the delivery route of PT. Post Pematangsiantar with goods delivery routes in the Upper Simalungun area which includes: Pematangsiantar, Panei Tongah, Pematang Raya, Tiga Runghi, Saribudolok, Sipintuangin, Sari Matondang, Parapat, Tiga Dolok, and Tigabalata which are a total of 318 Km away. As for who is the object of this research is to determine the shortest path in the delivery of goods belonging to PT. Post Pematangsiantar-Indonesia. After presenting the problem in the form of a graph and each side is given a distance value then build a matrix M measuring 10x10 where the element is the distance of each post office point in the research subject area. As for determining the shortest path can be completed by the following steps:
1. Record the distance between post offices in the Upper Simalungun area
2. Determine the basic route of delivery of goods PT. Post
3. Make an alternative path that may exist as the shortest path
4. Creating the C++ program
5. Input the distance of each post office
6. Run the program (run) using the C++ program
7. Obtain the result of completing the shortest path

3. DISCUSSION
The matrix above is a symmetrical matrix because distance from equals distance from. Next, we will reduce the matrix above to make it simpler with the branch and bound algorithm. Reduction is done by subtracting all elements in a certain row and column so that there is a value of 0 or zero in that row and column, then the M Matrix is obtained which is stated as follows.

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The above data is then made into a tree diagram to determine the basic route and alternative routes which may be the shortest path as shown in Figure 1 below.

**Figure 1. Tree Diagram for Determining the Shortest Route**

Based on the tree diagram above, the shortest possible path is: Pematangsiantar - Tiga Balata - Tiga Dolok - Parapat - Saribudolok - Tiga Runggu - Sipintuangin - Sari Matondang - Panei Tongah - Pematangsiantar. In the form of the track it is stated as follows: 1 - 5 - 6 - 7 - 10 - 9 - 8 - 4 - 2 - 3 - 1 with a total distance of 196 km.

C++ is a general-purpose programming language created by Bjarne Stroustrup as an extension of the C programming language, or "C with Classes". C++ was designed with a bias toward system programming and embedded, resource-constrained software and large systems, with performance, efficiency, and flexibility of use as its design highlights.

The program C++ with algorithm branch and bound:

```c++
#include <bits/stdc++.h>
using namespace std;

const int N = 10;

// final_path[] save the last solution for start seller
int final_path[N+1];

// Track nodes that have been visited on a certain path
bool visited[N];

// Stores the final minimum weight of the shortest path.
int final_res = INT_MAX;

// Serves to copy a temporary solution, the final solution
void copyToFinal(int curr_path[])
{
    for (int i=0; i<N; i++)
        final_path[i] = curr_path[i];
    final_path[N] = curr_path[0];
}

// Looking for the minimum edge cost, ending at the knot 'i'
int firstMin(int adj[N][N], int i)
{
    int min = INT_MAX;
    for (int k=0; k<N; k++)
        if (adj[i][k]<min && i != k)
            min = adj[i][k];
    return min;
}

// Look for the minimum cost edge both ending at the vertex 'i'
int secondMin(int adj[N][N], int i)
{
    int first = INT_MAX, second = INT_MAX;
    for (int j=0; j<N; j++)
    {
        if (i == j) continue;
        if (adj[i][j] <= first)
            { second = first; first = adj[i][j]; }
        else if (adj[i][j] <= second &&
                 adj[i][j] != first)
            second = adj[i][j];
    }
    return second;
}

// functions that take arguments:
// curr_bound - lower boundary of the root node
// curr_bound - lower boundary of the root node
// curr_weight - save the road load so far
// level - current level while moving in the search for tree space
// curr_path[] - where the solution is stored, it will later be copied to final_path[]
void TSPRec(int adj[N][N], int curr_bound, int curr_weight, int level, int curr_path[])
{
    ...
    ...
    ...
    ...
    int main()
    {
        // Matrix from graph
        int adj[N][N] = {{ 0, 33, 14, 24, 14, 26, 50, 0, 0, 0},
                         {33, 0, 14, 36, 0, 0, 43, 22, 50, 0},
                         {14, 14, 0, 29, 19, 0, 0, 17, 0, 0},
                         {24, 36, 29, 0, 24, 57, 0, 17, 0, 0},
                         {14, 0, 19, 24, 0, 6, 0, 70, 0, 0},
                         {26, 0, 0, 57, 6, 0, 26, 48, 42, 0},
                         {50, 0, 0, 0, 26, 0, 38, 70, 40, 0},
                         {0, 43, 31, 17, 70, 48, 38, 0, 14, 0},
                         {0, 22, 0, 0, 42, 70, 14, 0, 15, 0},
                         {0, 50, 0, 0, 45, 40, 31, 15, 0, 0}};
        TSP(adj);
        cout << "======= PROGRAM OUTPUT
        ========
        
```
```
The output using program C++ we get the optimal route of goods distribution with minimum cost 196 km and the route 1-5-6-7-10-9-8-4-2-3-1.

After that the following display will appear:

```
Optimal Route of Good Distribution
minimum cost : 196
Taken : 156710984231

Fig. 3. Program Output Using Program C++
```

After inputting the distance data for each post office point, the results of the run will appear as follows which indicates the solution for distributing goods at the PT. Upper Simalungun Regional Post.

4. CONCLUSION
Based on the results and discussion obtained, it can be concluded that the solving of the traveling salesman problem using the branch and bound algorithm provides an optimal route 1-5-6-7-10-9-8-4-2-3-1 with a total distance of 196 Km by searching for node 30. Using the program C++ language with an output size of 1.2623850250244 MiB with a compile time of 17.53s. In addition, the traveling salesman problem method to get the shortest path helps companies reduce their operating costs. And very profitable to use a programming language.

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REFERENCE