

OPTIMIZATION OF DAILY CHAIN ACTIVITY FOR TOURISTS: AN APPLICATION OF PRIZE COLLECTING TRAVELING SALESMAN PROBLEM (PCTSP)



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32708-2/2017/INTFIN COURSE MATERIAL SUPPORTED BY EMMI

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1. Introduction

It is known that tourism is currently one of the most important economic and cultural activities that a country or a region can count.

Although good algorithms have been proposed to solve scheduling problems, the development of more efficient algorithms continues to be great motivation for the scientific community.



1. Introduction

Application of Prize Collecting Travelling Salesman Problem (PCTSP) algorithm for touristic activity chain:

- Designate parameters for preferences settings;
- Suggest Points of Interests for the users;
- Analyse the Prize Collecting Traveling Salesman Problem regarding its viability for suggestions of touristic activity chain.



2. Literature Review

The Prize Collecting Traveling Salesman Problem can be formulated as follows: a traveling salesman who wins a prize in each visited city and pays a penalty for each city he fails to visit, and travels between cities for a cost wants to minimize the sum of their travel costs and penalties paid, and must include in their trajectory enough cities to earn a minimum amount of prize. (Ribeiro, 1997)

According to (Alcântara da Silva, 2017), is possible to define the profile of visitors, and especially their intentions to change the order of the usual tourist route. In the search for a suitable place, where data collection could be performed, the city of Belém do Pará was chosen due to the proximity of the researcher to the local actors involved in the tourism activity.



2. Literature Review

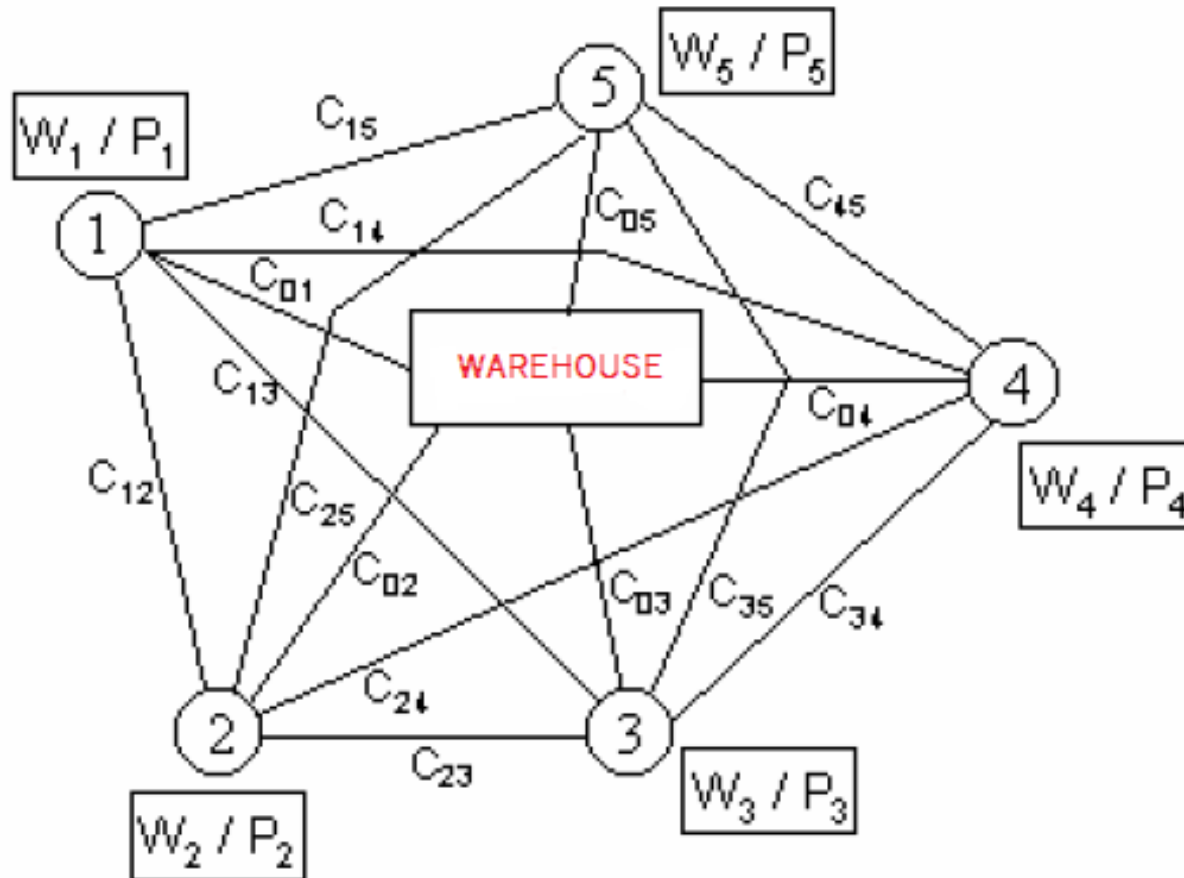


Figure 6: Representation of PCTSP
(Chaves, 2003)



2. Literature Review

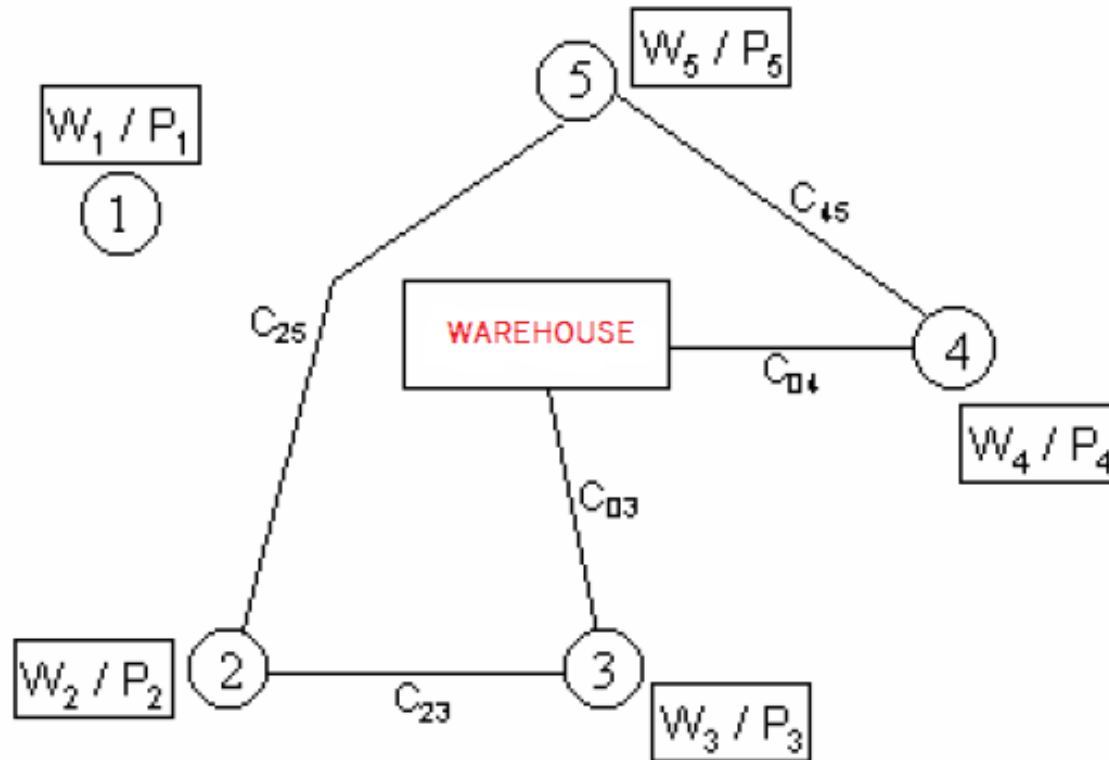


Figure 7: A possible solution to PCTSP
(Chaves, 2003)



2. Literature Review

A very important aspect in the Local Search method is the use of data structures and algorithms that allow the efficient computation of the cost of neighbouring solutions. The more efficient the local search method is, the more ILS iterations can be done. (Lourenço et al., 2003)

1. GenerateInitialSolution
2. LocalSearch
3. Perturbation
4. AcceptanceCriterion

(Lourenço et al., 1996)



3. Problem Modelling

I. Parameter Definition

Table 1: Query parameters for the app

Rating	Budget
1	\$
2	\$\$
3	\$\$\$
4	
5	



3. Problem Modelling

II. Database Design

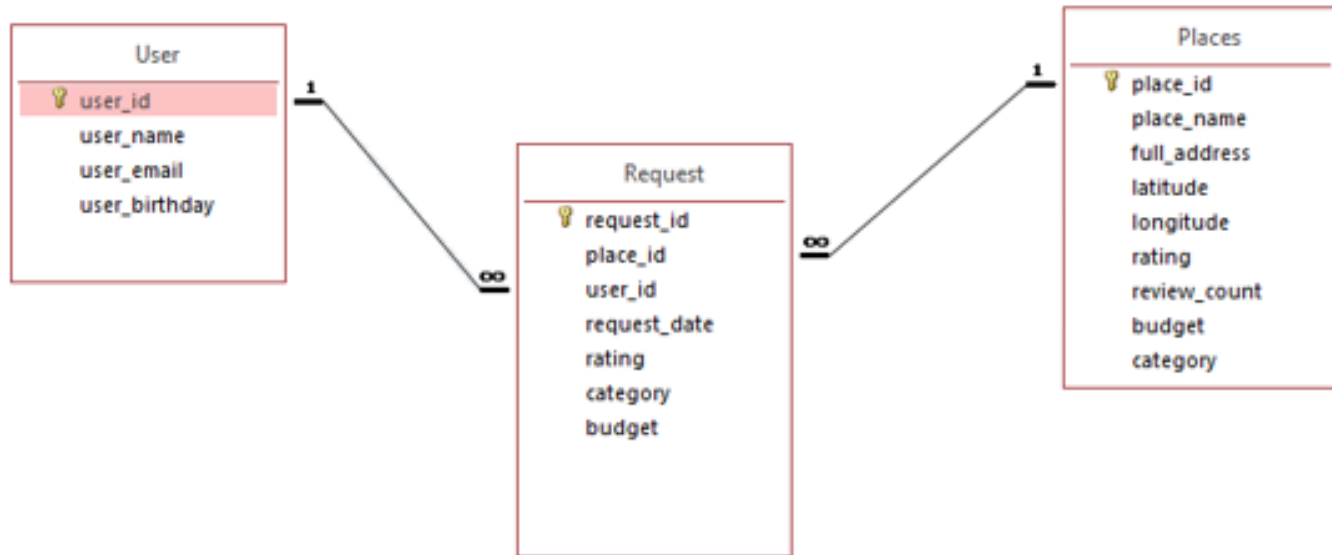


Figure 13: Database model



3. Problem Modelling

III. PCTSP Definition

According (Balas, 1987)

$$X_{ij} = \begin{cases} 1, & \text{if the arch } (i,j) \text{ is traversed} \\ 0, & \text{if not} \end{cases}$$

$$Y_i = \begin{cases} 1, & \text{if the node } i \text{ is visited} \\ 0, & \text{if not} \end{cases}$$

Z_i = auxiliary variable to avoid sub - cycles

$$\max \sum_i p_i Y_i - \sum_{i \neq j} \sum_j c_{ij} X_{ij}$$

$$\sum_{i \neq j} X_{ij} = Y_j, \quad \forall_j$$

$$\sum_{i \neq j} X_{i1} = 1$$

$$\sum_{j \neq i} X_{ij} = Y_j, \quad \forall_i$$

$$\sum_{j \neq 1} X_{1j} = 1$$

$$Z_i - Z_j + nX_{ij} \leq n - 1, \quad \forall_i, \forall_j, i \neq j, i \neq 1$$

$$\begin{cases} X_{ij}, Y_i & \in \{0,1\} \\ Z_i & \text{is unrestricted} \end{cases}$$



4. Simulation

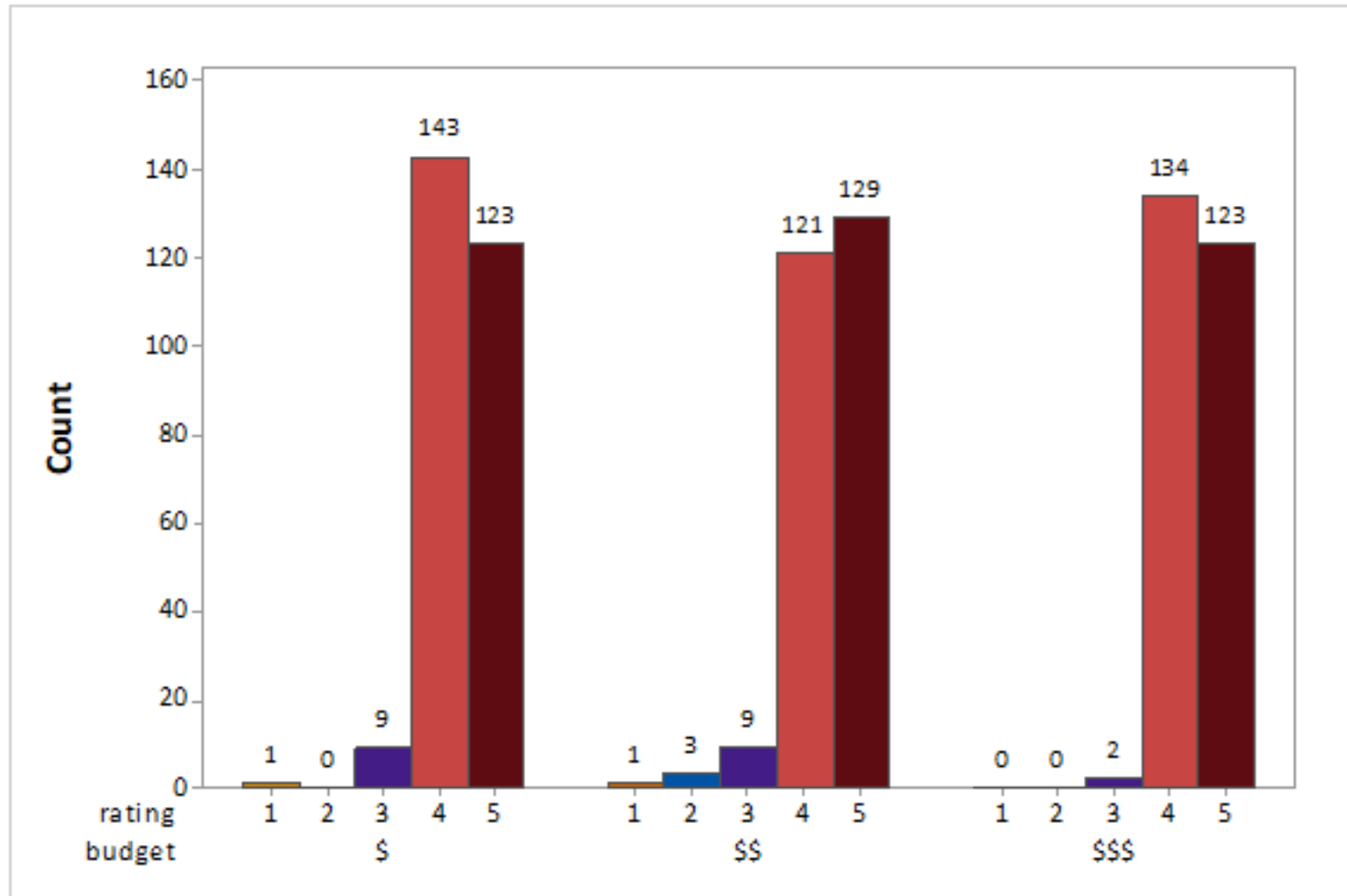


Figure 18: Bar-chart count of places considering rating and budget parameters



4. Simulation

It was considered for this study data of places from Budapest, Hungary. The following POIs were collected for the database: restaurants, bars, squares, monuments, parks, churches, castles and thermal baths.

- Simulation for 20 POI/day, for each possible scenario.
- Simulation for 4 POI/day in each scenario, considering for it 5 days in the city, comparing the data obtained as the output of the code, against data from Google Maps.
- Simulation Statistical Analysis.



4. Simulation

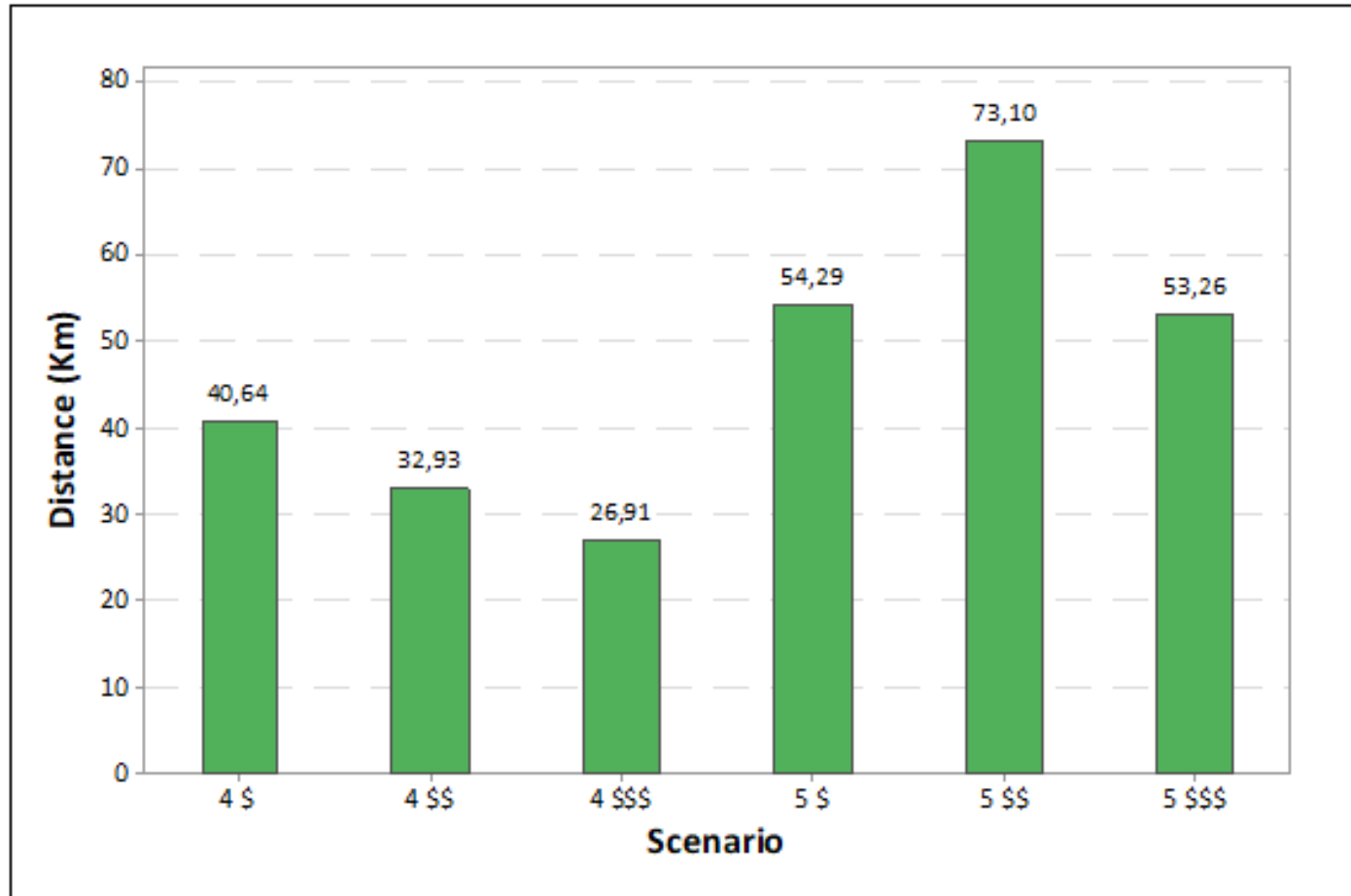


Figure 26: Comparison of distances for each simulation



4. Simulation

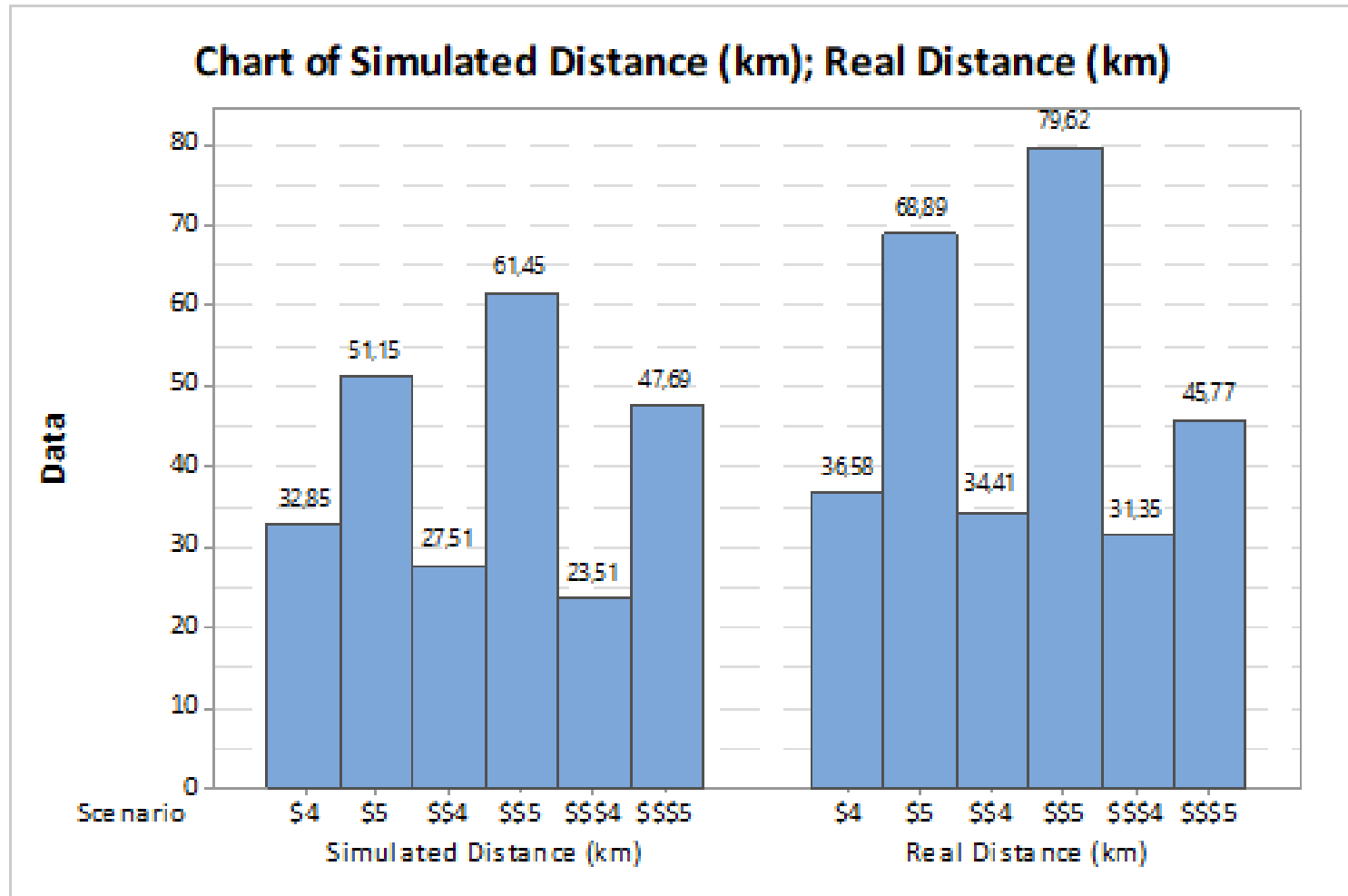


Figure 51: Bar Chart for Simulated Distance (km) and Real Distance for each scenario

4. Simulation

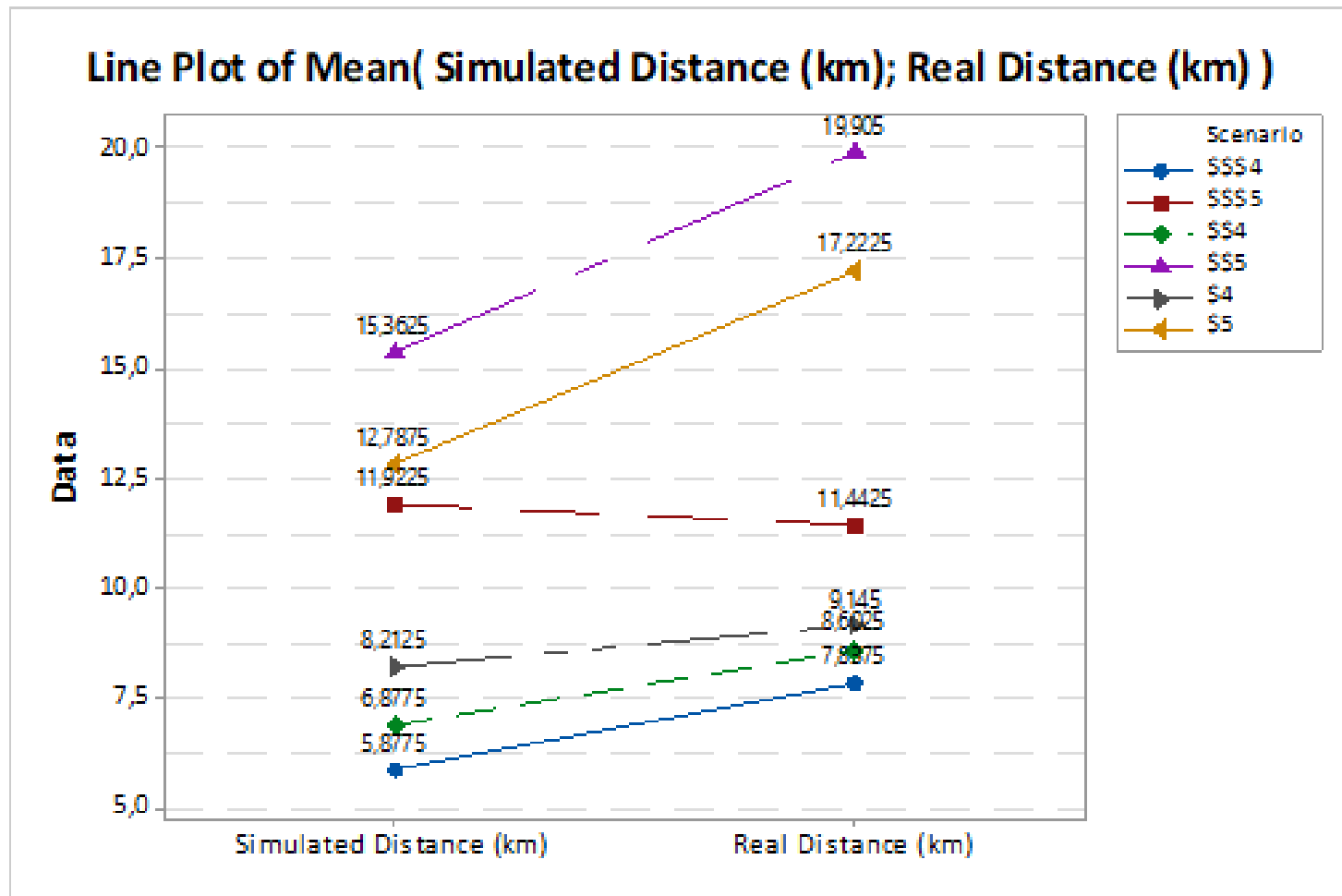


Figure 52: Line Plot of Mean for Simulated and Real Distances



4. Simulation

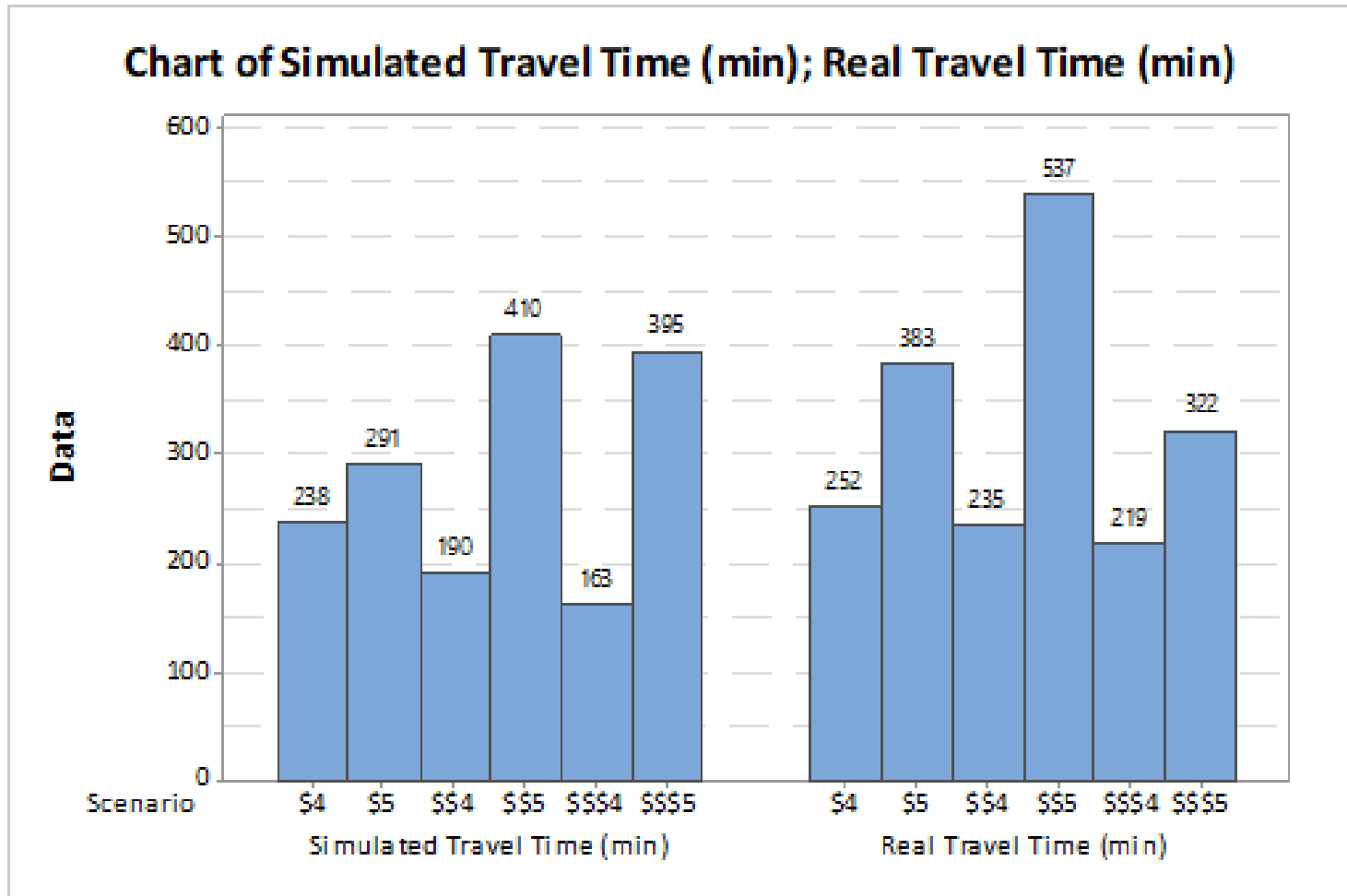


Figure 55: Bar Chart for Simulated and Real Travel Time



4. Simulation

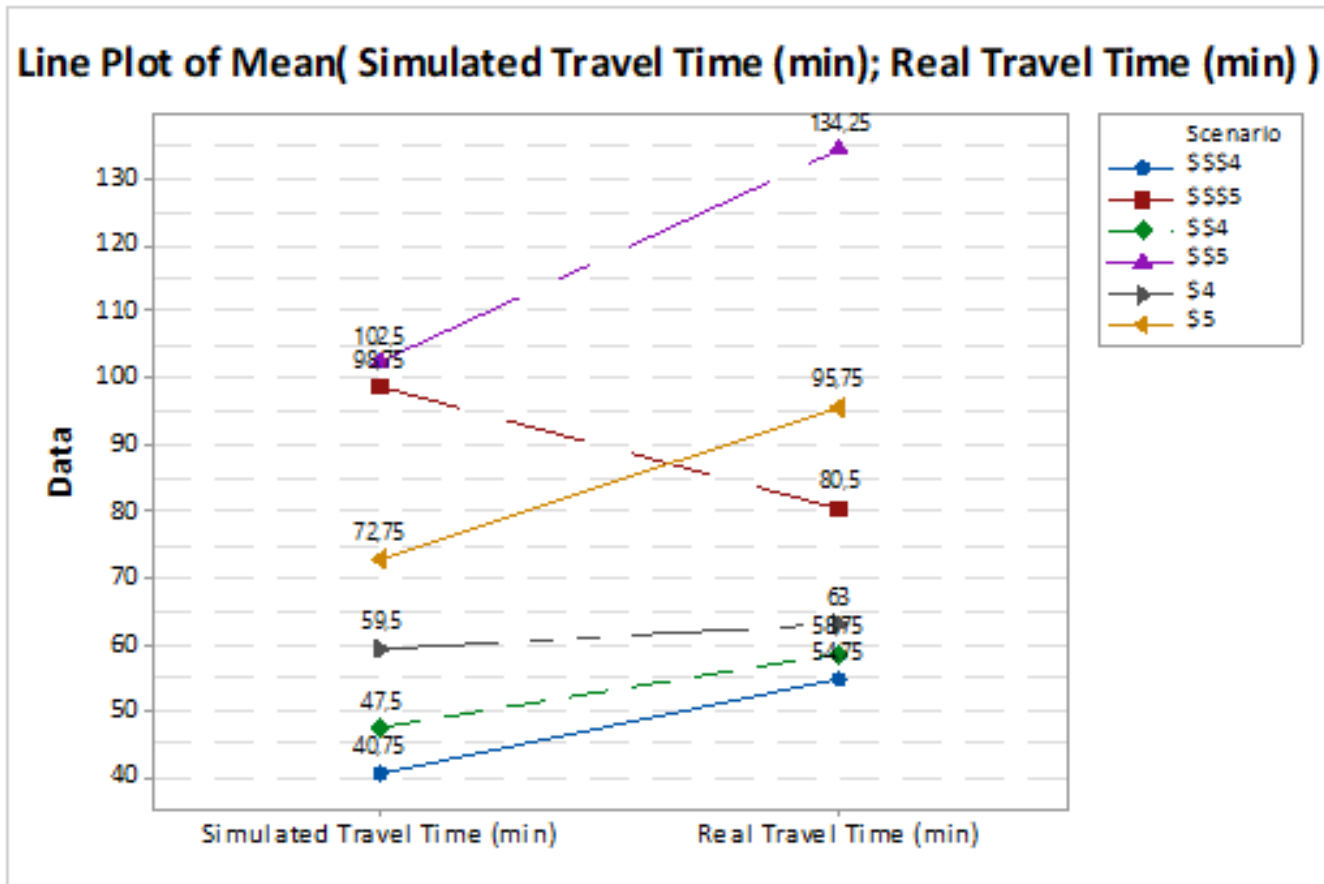


Figure 56: Line Plot of Mean for Simulated and Real Travel Times



5. Conclusion and Future Research

- The output shows it was worth visiting all the places, for the six scenarios simulated.
- Even with no connection of the data used for the simulation with the application of public transport, it was possible to estimate the distance results.



5. Conclusion and Future Research

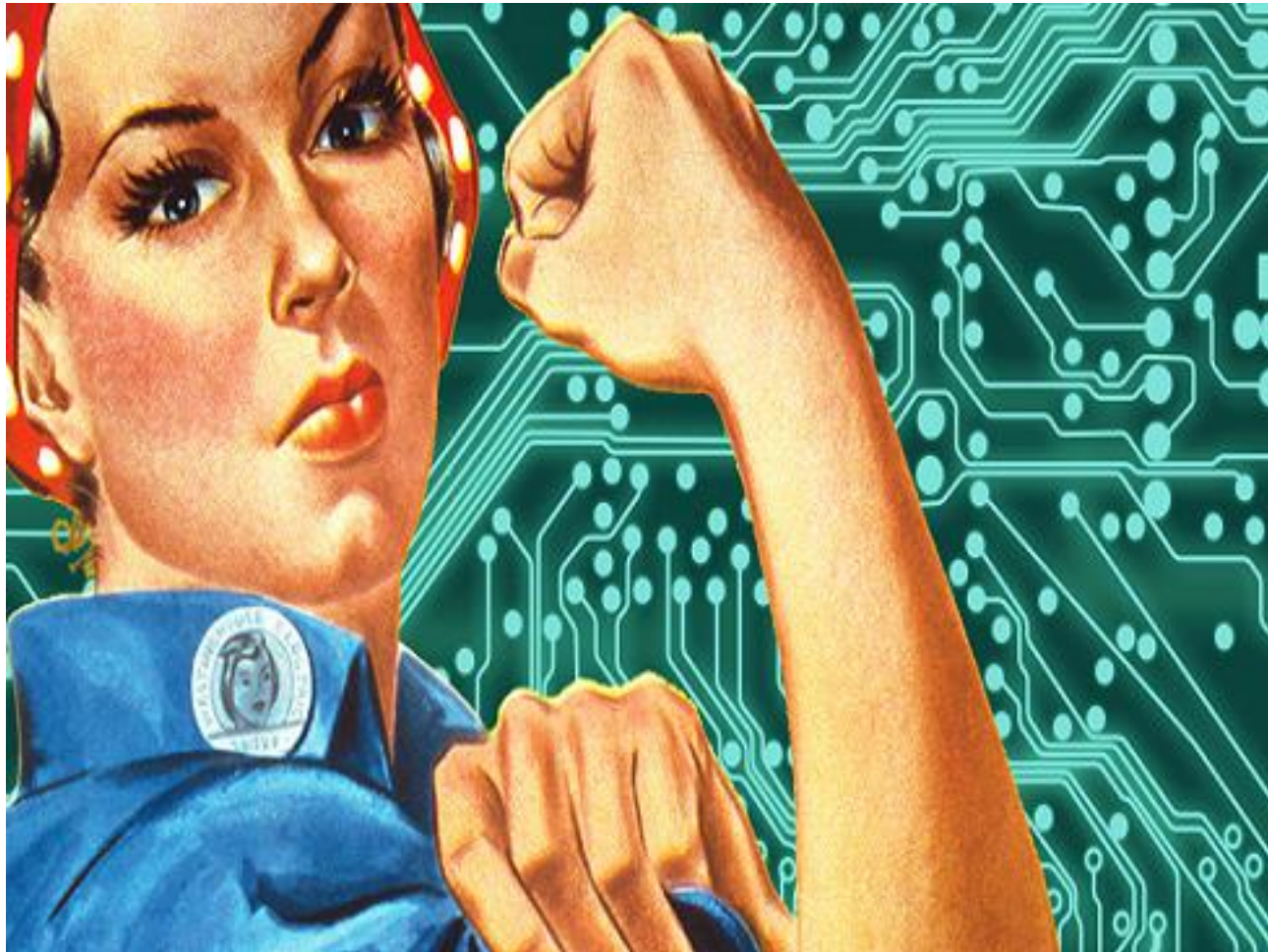
- The goals were accomplished.
- Comparison between both scenarios, simulated and real, showed not big divergences.
- Local Search metaheuristics for Prize Collecting Traveling Salesman Problem shows good results.



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Thank you! 😊

