Operations Reserach 2 Final Thesis

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1 Introduction

In this thesis we will go over the implementation of the main heuristics involving the famous TSP problem. The entire implementation is done using the C programming language and the CPLEX optimization LP optimization framework.

1.1 The Traveling Salesman Problem

The Traveling Salesman Problem is among the most disucssed and researched problems in the field of Operations Research.

Mathematical Formulation The TSP can be formulated as an optimization problem as follows:

$$\min \sum_{i=1}^{n} \sum_{j=1}^{n} c_{ij} x_{ij} \tag{1}$$

subject to:

$$\sum_{i=1}^{n} x_{ij} = 1 \quad \forall j \in \{1, \ldots, n\} \tag{2}$$

$$\sum_{j=1}^{n} x_{ij} = 1 \quad \forall i \in \{1, \ldots, n\} \tag{3}$$

$$u_i - u_j + n x_{ij} \leq n - 1 \quad \forall i \in \{2, \ldots, n\}, j \in \{2, \ldots, n\} \tag{4}$$

$$x_{ij} \in \{0, 1\} \quad \forall i, j \in \{1, \ldots, n\} \tag{5}$$

$$u_i \in text \quad \forall i \in \{1, \ldots, n\} \tag{6}$$

2 TSP data structure

Throught the implementation of the Metaheuristics and Mathheuristics, we will be using the following data structures:

- instance : A structure that holds the TSP instance data. This is implemented as a C data structure in which we hold all the metadata relevant to the loaded TSP instance.

- solution : A structure that holds the TSP solution data. Normally this is represented as a simple integer array in which we map for every nodex index its successor in the tour. This type of solution representation suits both the indirected and directed graph cases.

The code for the data structures implementation can be found in the appendinx section.

3 TSP Metaheuristics

3.1 Greedy Randomized Adaptive Search (GRASP)

3.2 Extra Mileage

3.3 Two-Opt

3.4 Tabu Search

4 TSP with CPLEX

4.1 Bender's subtour elimination method

4.2 Patching Heuristic

4.3 CPLEX Callback implementation

References