UNIVERSITY OF BIRMINGHAM

A Comparison of Approaches to Combinatorial Optimisation for Touristic Route Planning

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Abstract

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1 Introduction

Write introduction

2 Problem Formulation

2.1 Problem Description

Given a positive integer d and a graph $G = (V, E)$, where V is set of locations including a designated starting point s and E is a set of weighted edges linking every location to every other location, find a route that:

1. Visits all nodes $V \setminus c$ once.
2. Starts and finishes at s, having visited it d times, without ever visiting consecutively.
3. Minimizes both the cumulative edge weights in the route and the variance in cumulative weight between each visit to s.

2.2 Inputs and Outputs

Inputs:

- d: The number of times s should be visited in a route. Contextually, d represents the number of days a tourist will spend on their trip. $d \in \mathbb{Z}, d > 0$
- $G = (V, E)$: A pair comprising of:
  - V: A set of nodes representing locations the tourist would like to visit. $v \in V, v = (x, y, t)$, a triple comprising of:
    - x: Longitude, indicating the location's geographic east-west position on the earth[1].
      $x \in \mathbb{Q}, -180 \leq x \leq 180$.
    - y: Latitude, indicating the location's geographic north-south position on the earth[2].
      $y \in \mathbb{Q}, -90 \leq y \leq 90$.
    - t: Duration, in minutes, indicating how much time to spend at this location.
      $t \in \mathbb{Z}, t > 0$.
  - E: A set of edges $e \in E$ that connects every node to every other node, bidirectionally. $e = (v_1, v_2, w)$, a triple comprising of:

[1]While the coordinates of our locations are included in V, they are not directly tied to the weight of our edges E, which are based on time and not distance.

[2]See footnote 1

- v_1: A location representing the origin of the edge.
  $v_1 \in V$.
- v_2: A location representing the destination of the edge.
  $v_2 \in V$.
- w: A weight indicating the sum of the time it takes to travel from v_1 to v_2 and the time the tourist wishes to spent at v_2.
  $w \in Z, w > 0$.

- s: Starting point that should be visited d times. Contextually, s represents where the tourist is staying and will return to at the end of each day.
  $s \in V$.

Outputs:

- R: A valid route satisfying all constraints, represented as an ordered sequence of locations.
  $R = [r_1, r_2, \ldots, r_n]$, $r_i \in V$.

2.3 Optimisation

As previously mentioned in the Problem Description, our goal is to find a route that minimises the cumulative weight and the variance in route weight between each visit to s. To accomplish this the following cost function is applied to each route:

$$Cost(R) = W \times (1 + \sigma) \tag{1}$$

Where W is the sum of the weights of all edges traversed in the route and σ is the standard deviation of the sum of weights between each visit to s:

$$\sigma = \sqrt{\frac{\sum_{i=0}^{d}(x_i - \mu)}{d}}, x_i \in X \tag{2}$$

Where R is divided into sections between each visit to s and X is a list of the sum of weights within these sections. μ is the mean cumulative weight of each x_i.

3 Literature Review

Write literature review

4 Algorithms Investigated

Paragraph describing different types of algorithm used (Routing, Cluster and Routing, Evolutionary, etc.)

4.1 Brute Force

Write brute force explanation

4.2 Clustering

Write clustering explanation

Once divided into clusters, each cluster can be solved using our brute force method (with $d = 1$) or with traditional TSP algorithms. TSP algorithms implemented in this project include:

4.3 Greedy

Write greedy explanation

5 Evaluation and Comparison

Write paragraph about experiment process. Comparison based on computation time and route evaluation. Describe how route is evaluated. Describe data being tested on.

6 Conclusion

Write conclusion

7 Bibliography

Fill in bibliography