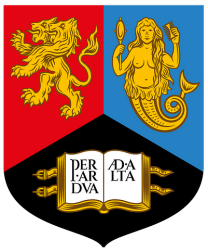

UNIVERSITY OF BIRMINGHAM

A Comparison of Approaches to Combinatorial Optimisation for Multi-Day Route Planning

Jacob Luck
2338114

B.Sc. Computer Science with a Year in Industry
Project Supervisor - Leandro Minku

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Abstract

Write abstract

Contents

1 Introduction

1.1 Motivation

Write about reasoning for this project, can copy a little bit over from presentation slides. Explain problem informally. Link into aims and objectives.

1.2 Aims and Objectives

Explin goals of the project, link in to methodology.

1.3 Methodology

Explain how the project will be carried out.

1.4 Summary

Explain what is in the rest of the report. "In this report I shall...", cover each section, etc.

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. Minimises 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:
  - V: A set of nodes representing locations the tourist would like to visit. $v \in V, v = (x, y, t)$, a triple comprising:
    - 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:

Add equation for W

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

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

Plan (and write) literature review

4 Algorithms Investigated

Paragraph describing different types of algorithm used (Routing then cluster, Cluster then Routing, Genetic, etc.)

4.1 Routing

Explain purpose of routing/goal of algorithms.

4.1.1 Brute Force

Write brute force explanation

4.1.2 Greedy Routing/Insertion

Explain greedy routing algorithm

Explain greedy insertion algorithm

4.1.3 Gift Wrapping

Explain gift wrapping algorithm

Something like: "Once gift wrapping has found a convex hull, a greedy insertion algorithm is used to find the optimal route within the convex hull."

4.2 Clustering

Explain purpose of clustering, how it is used in route planning and the goal of our algorithms.

4.2.1 K-Means

Explain k-means algorithm

4.3 Trip Generation

Explain trip generation, how it is used in route planning and the goal of our algorithms.

4.3.1 Brute Force

Explain how brute force algorithm can be modified for trip generation.

4.4 Genetic Algorithms

Explain basics of genetic algorithms, include how by considering different genomes, the algorithm can be used for routing, clustering or trip generation.

4.4.1 General Clustering

Explain genetic clustering

4.4.2 Centroid-based Clustering

Explain genetic centroid-based clustering and how it differs from general clustering.

4.4.3 Routing

Explain genetic routing

4.4.4 Trip Generation

Explain genetic trip generation

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.

Present comparison of different combinations of algorithms on different inputs.

6 Conclusion

Write conclusion, discuss results, comparison of algorithms, etc.

Project reflection subsection?

6.1 Further work

Discuss further work, what could be done to improve the project, what I would do differently.

7 Bibliography

Fill in bibliography