Travel Salesperson Problem Optimiser for Mauritius

Report Name	Project Outline
Author (User Id)	Jty
Supervisor	Zaj2
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1. Project description

The traveling salesman problem (TSP) is well studied problem in the field of mathematics, computer science and operations research. It is an optimisation problem on finding the shortest optimal route from a given list of nodes. It was defined in the 1800s by the Irish mathematician W.R.Hamilton and British mathematician Thomas Kirkman [3]. The TSP is a NP-hard problem, firstly proven in 1972 by Karp. NP-Hard problems are those problems for which every problem in NP has a polynomial time reduction to. These could contain problems which are not in NP and in fact need not even contain decidable problems like the halting problem.

The TSP optimiser for Mauritius project is a stand-alone computer software with a graphical user interface (GUI) for finding the shortest path between cities in Mauritius based on the Travelling salesman problem. The software focusses the tourism industry in Mauritius however it can also target food delivery company such as Domino's Pizza that just open their branch in December 2018.

During these few years the tourism industry has expanded quickly with the development of new technology. An annual increase of 5.2% [4] has been noted in the annual tourist arrival in 2017. Based on my personal experience, many tourists still like to visit the island by themselves instead of following the travel agency tours. This project fits my interest for Artificial intelligence and can be used to solve the tourist problem on finding the optimal tour travel experience during their stay in Mauritius.

This project will develop a software application to help the tourist and other users to find the shortest path to travel between cities. The user will need to key in their cities of interest and then a choice of algorithm will be available for them to choose. This scope provided might infringe the complexity aspects of the UI design. Therefore, the project will need to determine a way to how to solve it or target a different end user.

The project will develop a GUI allowing the user to enter and save their results as a CSV or txt file. An additional function for animation of the heuristics search can provide a visual understanding of the process. This idea can be further explored as an excellent additional feature since the project descriptions is silent about visualisation.

The project will use a modified form of Feature Driven Development (FDD) and Kanban methodology to manage the different tasks. It is a lightweight Agile method for software development while taking an emphasis on continual delivery and not overburdening the process.

2. Proposed tasks

The following tasks will be performed on this project:

- **Research on the heuristic algorithm and simulation for the TSP.** This project involves some research on the hill climbing and simulated annealing algorithm used for finding the shortest route in the TSP. It will also be necessary to have a knowledge of using animation in JavaFx.

- **Design process.** The specification of the user interface needs to be discussed with the supervisor since there is no specific criteria. A draft or prototype can be presented during the first presentation to provide a better illustration of the project to the second marker.

- **Setting up the version control system and test documents.** The project will run an Agile approach, there is need to set up the test data for the test-first approach since find it is more beneficial in improving the software. A GitHub repository will be set up to hold the software coding and is also a form of backup in case of any system failure. The repository will be a strong point when we defend the originality of the project.

- **Development process.** The software will be written in Java and JavaFx library will be used for the GUI part. The first development process includes establishing the framework of the application and implantation of the hill climbing algorithm to the TSP. This is made as a baseline for the content to be presented for the first presentation. The second part will include the implementation of the simulated annealing to the TSP optimiser. The features to be added include reading user input and cross platform usage in other countries.

- **Project meetings.** The weekly meeting with the supervisor will be documented in the meeting minutes. Good minutes are vital to the success of any meeting. After the meeting, attendees should be able to verify what decisions were made and what actions are to be take. A draft version will be made available and be sign off later on by the supervision.

- **Presentations of the proposed system.** The first presentation will be during the week before Easter. It mainly focuses on the brief introduction of the software and showing some running codes to the examiner. The second presentation will be after the submission of the final report. At the final presentation, we need to present the working software and be prepared for any questions being asked. A presentation can be done among other students beforehand to simulate the real situation.

3. Project Scope

The following project scope is expected throughout the project.

- Number of cities/towns in Mauritius that can be simulated by the software should be minimum 8 and maximum 60 cities/towns.
- The data must be real data that can be retrieved from google map or any other sources.
- The three optimisation methods to be implemented are Random Mutation Hill Climbing (RMHC), Random Restart Hill Climbing (RRHC), and Stochastic Hill Climbing (SHC). Implementation of workable advance methods such as Simulated Annealing (SA) can be considered for excellent grading.
- Number of iterations (within simulation) is minimum 1,000 and can be up to 100,000 iterations. Users are allowed to terminate the search at any time for a result.
- Simulation can only be run once at one time. No parallel simulation is allowed.
- A result of simulations is to be captured and save to a file (txt or csv format)

4. Project deliverables

The following project deliverables are expected.

- **Design specification**: A set of requirements for the user interface of the proposed system. The criteria will be discussed with the supervisor beforehand. The design specification will be included as appendix in the final report.

- **Prototype.** A prototype of the system is to be presented during the mid-presentation.

- **Mid-Project Demonstration Notes**: A presentation slides will be produced to summarise the current status of the project and a brief introduction of the project to the second marker. A draft version will be review by the supervisor before the Mid-project presentation.

- **Test documents**: A set of test data will be provided as part of the technical submission covering unit testing and some manual tests. A draft list of tests will be discussed with the supervisor beforehand.

- **Final Report**: A written report consisting of the design specification, user interface specification and the test report. Associated appendices and acknowledgement for any 3rd party libraries, framework and tools will be included in this document.

- **Final Demonstration**: A set of presentation slides with visual aids will be produced to illustrate on the system being presented.

5. Project Lifecycle

The Table below shows an initial time management of workload for this project.

Tasks	Weeks											
	1	2	3	4	5	6	7	8	9	10	Easter	11
Introduction												
Project Outline												
Planning												
Design												
Implementation												
Mid presentation												
Testing												
Prototype												
Final Document												
Final Presentation												

6. Initial annotated bibliography

The list consists of research work done so far and the references.

[1] Lin, S., & Kernighan, B. W. (1973). An effective heuristic algorithm for the traveling-salesman problem. *Operations research*, *21*(2), 498-516.

This paper discusses a highly effective heuristic procedure for generating optimum and near-optimum solutions for the symmetric traveling-salesman problem. The procedure is based on a general approach to heuristics that is believed to have wide applicability in combinatorial optimization problems.

[2] Matai, Rajesh & Singh, Surya & Mittal, M.L. (2010). Traveling Salesman Problem: An Overview of Applications, Formulations, and Solution Approaches. 10.5772/12909.

This paper discussed about the application of various algorithm that can be used to solve the travelling salesman problem.

[3] Michael Jünger, Gerhard Reinelt, Giovanni Rinaldi, Chapter 4 The traveling salesman problem, Handbooks in Operations Research and Management Science, Elsevier, Volume 7,(1995),Pages 225-330, ISSN 0927-0507, ISBN 9780444892928, from https://doi.org/10.1016/S0927-0507(05)80121-5 (Accessed on 4th January 2019)

This book shows a detailed history and the various algorithm that can be used to solve it. the theory of NP-completeness developed, the TSP was one of the first problems to be proven NP-hard by Karp in 1972.

[4] Travel & Tourism Economic Impact 2017 Mauritius, World Travel Tourism Council (2017). Available at: https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2018/mauritius2018.pdf (Accessed on 7th January 2019)