ITINERARY PLANNING SYSTEM USING GENETIC ALGORITHM

TAN WEI HAN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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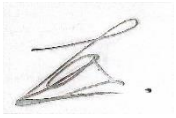

(TANDATANGAN PELAJAR)

Alamat tetap: 20-8-1, Midah Ria Condo,

Jln Midah 8, Tmn Midah, 56000, KL.

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ITINERARY PLANNING SYSTEM USING GENETIC ALGORITHM

TAN WEI HAN

This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Artificial Intelligence) with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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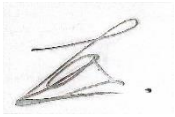

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DEDICATION

This project is dedicated to my parents. Thank you for your unconditional love and constant support throughout my life. Your sacrifices, wisdom, and belief in me have been a constant source of inspiration. This project is a testament to the values you instilled in me and the opportunities you have provided.

To my supervisor, Ts. Dr. Ngo Hea Choon, I am grateful for your guidance, expertise, and patience. Your insightful feedback, constructive criticism, and mentorship have pushed me to grow both academically and personally. Your dedication to my development as a researcher is deeply appreciated.

To my dear friends, thank you for being there through thick and thin. Your support, encouragement, and laughter have kept me motivated during the ups and downs of this project. Your friendship has enriched my life, and I am grateful for the memories we have created together.

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ABSTRACT

Travelling for pleasure, recreation, or business is referred to as tourism. It entails travelling to and staying in locations that are different from one's typical environment. During their trips, tourists frequently partake in several activities, including sightseeing, cultural encounters, outdoor leisure, and shopping. The tourism sector includes a wide range of companies, including tour operators, lodging and transportation providers, restaurants and food services, hotels and lodging, and other attractions and services. Generally, the arranging of tourism routes can be described as a travelling salesman problem (TSP). TSP is a well-known problem in computer science and optimization that involves finding the shortest possible route that visits a set of cities and returns to the starting city. The problem is NP-hard, which means that it is computationally expensive to solve for large numbers of cities. The TSP is often described as follows: Given a list of cities and the distances between each pair of cities, the goal is to find the shortest possible route that visits each city exactly once and returns to the starting city. Hence, the choice of route is a main concern for the itinerary planning process. This project is designed mainly to propose a system that provides itinerary planning features. It is also aimed to evaluate the path planned on its performance. This project is expected to plan the best route for the users, reducing the time taken for the itinerary. The optimization algorithms involved in this project to be compared are Genetic Algorithm, Firefly Algorithm, and Ant Colony Optimization. The result of the comparison of optimization algorithms states that the average fitness value is 55.1920 for Genetic Algorithm, 50.7961 for Firefly Algorithm, and 34.4488 for Ant Colony Optimization. The result shows that Genetic Algorithm is better than the other algorithms in terms of quality of solutions

ABSTRAK

Perjalanan untuk keseronokan, rekreasi atau perniagaan dirujuk sebagai pelancongan. Ia melibatkan perjalanan ke dan tinggal di lokasi yang berbeza daripada persekitaran biasa seseorang. Semasa perjalanan mereka, pelancong kerap mengambil bahagian dalam beberapa aktiviti, termasuk bersiar-siar, pertemuan budaya, masa lapang luar dan membeli-belah. Sektor pelancongan merangkumi pelbagai syarikat, termasuk pengendali pelancongan, penyedia penginapan dan pengangkutan, restoran dan perkhidmatan makanan, hotel dan penginapan, serta tarikan dan perkhidmatan lain. Pelancong serta kawasan yang mereka lawati mungkin mengalami kesan negatif yang besar terhadap ekonomi, masyarakat dan alam sekitar akibat daripada pelancongan. Secara umumnya, penyusunan laluan pelancongan boleh disifatkan sebagai masalah jurujual kembara (TSP). TSP ialah masalah terkenal dalam sains komputer dan pengoptimuman yang melibatkan mencari laluan terpendek yang mungkin untuk melawati set bandar dan kembali ke bandar permulaan. Masalahnya adalah NP-hard, yang bermaksud bahawa ia adalah mahal dari segi pengiraan untuk menyelesaikan sejumlah besar bandar. TSP selalunya diterangkan seperti berikut: Memandangkan senarai bandar dan jarak antara setiap pasangan bandar, matlamatnya adalah untuk mencari laluan terpendek yang mungkin melawat setiap bandar tepat sekali dan kembali ke bandar permulaan. Oleh itu, pilihan laluan adalah kebimbangan utama untuk proses perancangan jadual perjalanan. Projek ini direka bentuk terutamanya untuk mencadangkan sistem yang menyediakan ciri perancangan jadual perjalanan. Ia juga bertujuan untuk menilai laluan yang dirancang pada prestasinya. Projek ini dijangka merancang laluan terbaik untuk pengguna, mengurangkan masa yang diambil untuk jadual perjalanan. Algoritma pengoptimuman yang terlibat dalam projek ini untuk dibandingkan ialah Algoritma Genetik, Algoritma Firefly dan Pengoptimuman Koloni Semut. Hasil perbandingan algoritma pengoptimuman menyatakan bahawa nilai kecergasan purata ialah 55.1920 untuk Algoritma Genetik,

50.7961 untuk Algoritma Firefly, dan 34.4488 untuk Pengoptimuman Koloni Semut. Hasilnya menunjukkan bahawa Algoritma Genetik adalah lebih baik daripada algoritma lain dari segi kualiti penyelesaian.

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LIST OF ABBREVIATIONS

ACO	-	**Ant Colony Optimization**
CR	-	**Crossover Rate**
CTSR	-	**Classical Travel Sequence Ratio**
ETR	-	**Elapsed Time Ratio**
FA	-	**Firefly Algorithm**
FYP	-	**Final Year Project**
GA	-	**Genetic Algorithm**
IDE	-	**Integrated Development Environment**
IDR	-	**Interest Density Ratio**
MR	-	**Mutation Rate**
PMX	-	**Partially Mapped Crossover**
RbI	-	**Rank-by-Interest**
RbT	-	**Rank-by-Time**
STR	-	**Stay Time Ratio**
TSP	-	**Travelling Salesman Problem**
TSP-TW	-	**Travelling Salesman Problem with Time Window**
VS	-	**Visual Studio**

CHAPTER 1: INTRODUCTION

1.1 Introduction

Tourism refers to the practice of traveling for leisure, recreation, or business purposes. It involves visiting places that are outside of one's usual environment and staying there for a certain period of time. Tourists typically engage in a variety of activities during their travels, such as sightseeing, cultural experiences, outdoor recreation, and shopping. The tourism industry encompasses a wide range of businesses, including transportation providers, hotels and accommodations, restaurants and food services, tour operators, and various other attractions and services. Tourism can have significant economic, social, and environmental impacts on both the destinations and the travelers themselves.

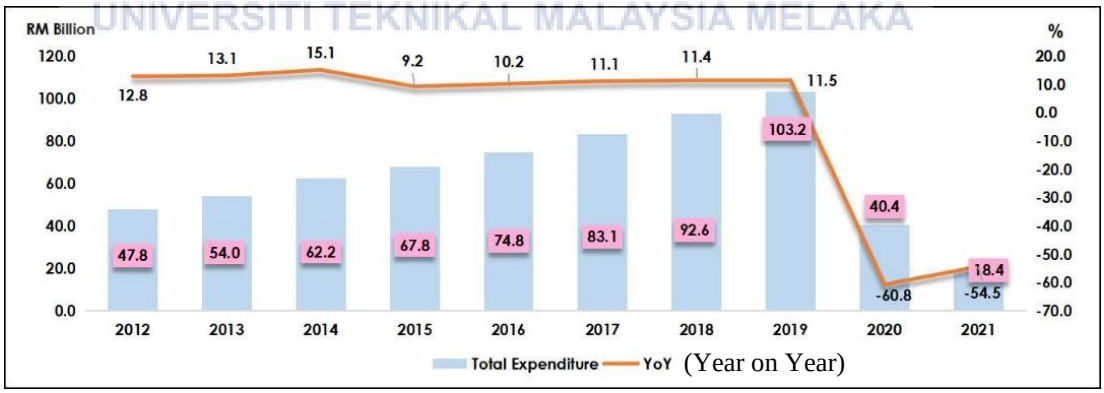

Figure 1.1: Malaysia's Domestic Tourism Expenditure, 2012 – 2021 (Ministry of Economy Department of Statistics Malaysia, 2022)

Based on Figure 1.1, in 2021, the number of visitor arrivals dropped by 49.9% compared to the previous year, with a total of 66.0 million visitors recorded. The volume of total tourism trips decreased by 50.7%, from 147.0 million trips in 2020 to

72.4 million trips in 2021. Domestic tourism expenditure also saw a decline of 54.5%, reaching only RM18.4 billion, the lowest recorded since the compilation of Domestic Tourism Survey statistics in 2008. Shopping remained the largest contributor to domestic tourism expenditure, followed by food and beverage and automotive fuel. Shopping also remained the most popular purpose for domestic visitors, although there was a significant decrease in visits to relatives and friends due to inter-district and interstate restrictions. Selangor was the most visited state by domestic visitors, followed by W.P Kuala Lumpur and Sarawak. Land transport was the preferred mode of transportation for domestic visitors, with air and water transport being less commonly used.

Overall, the statistics highlight the negative impact of COVID-19 on domestic tourism in Malaysia, with a significant decline in visitor numbers, tourism expenditure, and trips. The data provides insights into the changing trends and patterns of domestic tourism during the pandemic (Ministry of Economy Department of Statistics Malaysia, 2022).

But recently, global tourism in 2023 is predicted to reach approximately 80% to 95% of 2019 levels. International tourist arrivals are recovering fastest in the Middle East and Europe. With the progress of vaccination campaigns and the implementation of health and safety protocols, many countries have started to ease travel restrictions and reopen their borders. This has led to a gradual recovery in tourism activity in some regions.

The tourism route can be modelled as the Traveling Salesman Problem (TSP), which is a well-known optimization problem in computer science. The seeks to find the shortest possible route that visits a set of cities exactly once and returns to the starting city. It is a challenging problem, especially for a large number of cities, as it is NP-hard, which means it requires a computationally expensive solution (O., Nurdiawan et al., 2020). To solve TSP, one needs to find the shortest route that connects all cities, taking into account the distances between each pair of cities. Hence, the choice of route is a main concern for the delivery process.

1.2 Problem Statement

Travel has merged seamlessly into our lives in today's fast-paced society. People frequently find themselves organizing travels to other locations, whether for leisure or work. However, when planning the ideal trip that satisfies tastes, maximizes experiences, and takes into account practical considerations may be difficult, challenging, and time-consuming (Lim, K.H. et al., 2015). A sophisticated itinerary planning system that streamlines the procedure and enables users to easily construct customized trip itineraries is required to solve this problem. The manual techniques of itinerary planning could be more effective and time-consuming since they demand substantial investigation, comparison, and organization of travel-related data. As a result, people frequently come up with less-than-ideal itineraries that might not suit their preferences, resulting in missed chances or causing them to overspend.

An itinerary planning system that can simplify the procedure, optimize travel schedules, and improve the user's overall travel experience is thus urgently needed. To create personalized itineraries that consider various aspects such as user preferences, time restraints, financial constraints, and destination-specific information, the system should use technology and data-driven approaches.

1.3 Objectives

i. To propose a system that provides route planning features using Genetic Algorithm (GA).

ii. To evaluate the path planned on its performance.

1.4 Scope

A system that provides a route planning function which works based on Genetic Algorithm and will give an optimal route as an output. The optimal output will be based on user preferences.

1.5 Project Significance

This project can provide tourists with a personalized itinerary that optimizes their time, budget, and preferences. This can significantly improve their experience by reducing the time spent on planning and finding the best routes and attractions. Tour operators can benefit from a tourism route planning system by optimizing their tour scheduling and reducing the cost and time spent on planning and organizing tours. By offering destination information and travel planning tools, a tourist recommender system application will be of tremendous use to travelers. This system contributes to the advancement of conversational recommender systems in the tourism industry (F. H. Prabowo et al., 2018). This can lead to more efficient and profitable operations, reducing the risk of overbooking and underutilization of resources.

1.6 Expected Output

This project is expected to provide route planning feature to plan the best route for the users for their travelling purposes.

1.7 Conclusion

In short, this project is aimed to help people in arranging routes and schedules in their travel plan using an evolutionary algorithm. With the help of this system, much time can be saved as the schedules and routes will be planned automatically.

CHAPTER 2: LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

This chapter studies and presents the results of the system that is now in place as well as the approach that will be applied to creating this project. In this section, additional methods or approaches are also mentioned.

2.2 Facts and Findings

In this section, the domains, existing systems, and the techniques related to this project will be introduced and explained in detail.

2.2.1 Domain

2.2.1.1 Itinerary Planning

The optimal path planning is usually done by meeting a single objective, such as travelling time or distance. However, in planning an optimal tourism route, single objective way is no more suitable as there are many factors influencing the optimality of the travel plan (Damos et al., 2021). Tourism route planning involves creating a travel itinerary that maximizes the enjoyment of a trip while minimizing the time and cost required to get from one place to another. Itinerary planning is the process of creating a detailed travel plan for a trip or vacation. This plan typically includes information such as travel dates, transportation arrangements, lodging

accommodations, sightseeing activities, and other important details. It involves researching and selecting the best travel options based on factors such as budget, travel preferences, and time constraints. It also involves coordinating different elements of the trip, such as flights, hotel reservations, and transportation, to create a cohesive and enjoyable travel experience. A well-planned itinerary can help travelers make the most of their time and budget by maximizing opportunities for sightseeing and minimizing travel time between destinations. It can also help to reduce stress and ensure that all important details of the trip are taken care of in advance.

2.2.1.2 Travelling Salesman Problem (TSP)

The travelling salesman problem is a well-known problem in computer science and optimization that involves finding the shortest possible route that visits a set of cities and returns to the starting city. The problem is NP-hard, which means that it is computationally expensive to solve for large numbers of cities. The TSP is often described as follows: Given a list of cities and the distances between each pair of cities, the goal is to find the shortest possible route that visits each city exactly once and returns to the starting city (Encyclopaedia Britannica 1998). The TSP has many practical applications, including route planning, logistics, and scheduling. It has been studied extensively in computer science, and there are many algorithms for solving it, including exact algorithms, heuristic algorithms, and metaheuristic algorithms. Some popular algorithms for solving the TSP include the brute-force algorithm, the nearest neighbour algorithm, and the 2-opt algorithm. Figure 2.1 illustrates an example of a TSP.

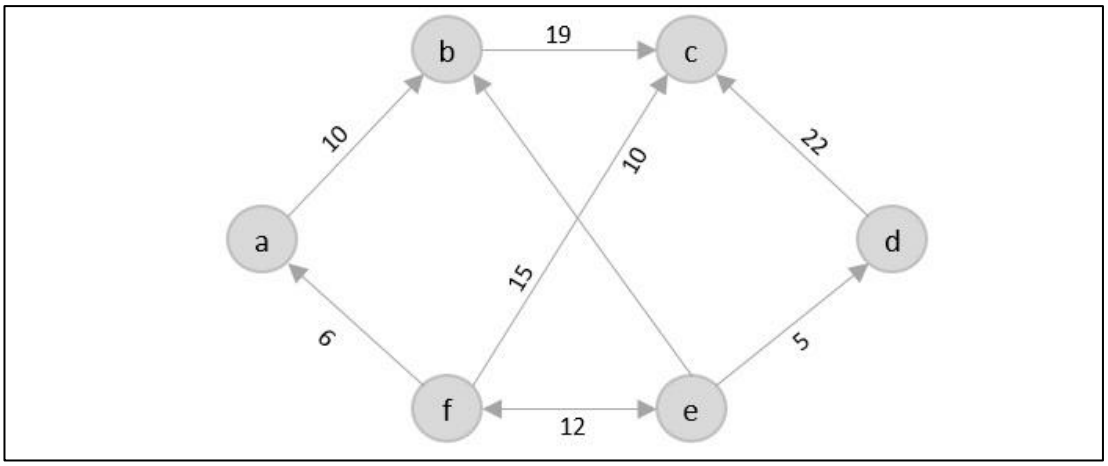

Figure 2.1: An Example of a Travelling Salesman Problem

In Figure 2.1, taking into account that the salesman begins at vertex 'a,' he must pass via each of the other vertices b, c, d, e, and f in order to return to 'a' while ensuring that the cost incurred is as little as possible, where the cost of each route is stated.

2.2.1.3 Hard Constraints and Soft Constraints

In GA, the techniques used to manage constraints throughout the optimization process are referred to as constraint handling. Constraints are requirements or restrictions that the solutions to a certain problem must meet. Because many real-world optimization problems have limitations that must be satisfied, GA requires handling constraints. These constraints represent the limitations, requirements, or conditions the solutions must satisfy. Physical, resource, logical, and legal restrictions are a few examples of limits. Finding excellent solutions that maximize an objective function or fitness metric is the main goal of a GA. Meanwhile, optimizing the objective function may result in solutions that go against the constraints when there are constraints present. This is undesirable because solutions that defy the limits are frequently regarded as impractical or useless.

Constraints can be categorized as either hard constraints or soft constraints when discussing constraint handling. The priority or strictness given to each constraint determines whether a restriction is considered hard or soft. The difference between the