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Solving the Travelling Problem of Thai Tourism by Using Improved Ant Colony Optimisation

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Most industries focus on how to get profit from processing, and transmitting even in tourism industry. Technology has been used to meet the need of travellers in order to access information on flights, routes, hotels, transportation and others by themselves. There are some techniques of computer science to solve the travelling problem such as Artificial Intelligence and Animal stimulation. Thus, this research proposes how to apply Ant Colony Optimisation to the travelling problem. As the result, brute force was taken in to consideration to compare with the capabilities of The Ant Colony System. The obtained results from Ant Colony System have some routes that match the Brutes Force's shortest distance, but some do not. When looking at the performance of the algorithm, the processing time to generate all possible paths of the Brute Force takes more time than Ant Colony System. The efficiency of the Brute Force algorithm is Big O2 while Any Colony System only Big O. Ant Colony System by adding other conditions such as changing vehicles at each tourist attraction, adding break point such as gas stations or restaurants which is able to complete the planning. It can be further expanded into a system of advice tourism for tourist attractions recommended plan.

Key words: *Ant Colony, Travelling Problem, and Brute Force.*

Introduction

The information revolution is dramatically intense to the economy. All industries focus on how to get the benefits from information and reduce cost of obtaining, processing, and transmitting information. It can change the way some businesses operate. The tourism industry is an industry that changes through technology. Travelers trend to access more information such as flight, route, accommodations, transportation etc. by themselves. From

these behaviors show that travelers focus more information for their plan. Travelers choose all facilities and set activities by themselves without utilizing the service of tourism agencies. Although they already have determined the places and activities, they still have some problems such aschoosing the best way for travelling, managing time, and transportation, because of the lack of information to support travelers. It will be very beneficial if we can integrate all information together with some processing technique to support travelling. There are some techniques of computer science that may solve the travelling problem. Artificial Intelligence and Animal stimulation are used by imitating ant behavior. Previously, many researchers tried to improve the performance of Ant algorithm.

Artificial Intelligence (AI) is an area of computer science focusing on stimulations and reactions as human thinking. A Genetic Algorithm is one of Artificial Intelligence. It is used in finding and making the performance of searching, optimising and learning. It is stimulated from animal behavior such as frogs, birds or ants etc. There are many researches that develop the performance of GA. In this research we will focus on only Ant Colony optimisation.

Ant Colony optimisation works by solving combinatorial optimisation problems such as traveling salesman problem and graph coloring problems. This technique is applied in this research. However, the Ant Colony algorithm is not perfect because it still has a problem for searching. There are many researches that have applied the Ant Colony System. The original Ant Colony System is most popular in using a tool for routing problem. It stimulates from ant behavior to find the shortest path from their food to their nets.

According to travelers' behaviours, there is some requirement for the traveler's planning, for example, time open and close of attractive places, a vehicle that travelers choose, suitable hotel or restaurant, different activity. Thus, the inspiration for this research comes from problems in planning. In some websites such as Agoda which offers only resorts and hotels but do not include distance from attractive places. The information service is not enough for travellers. From this problem, it is very useful to solve the routing problem technique. Therefore, Ant Colony System is chosen for solve this problem. Furthermore we use this technique with travelling in Thailand.

In this research, in each node of Ant colony System will be replaced by hotel or resort and attraction places. Paths are replaced by street or route. From the original Ant Colony System, it is applied for more efficiency by other researchers. For example, the Multi Objective ant colony optimisation algorithm in each node is weighted in different objective and is used for calculations to the best way to solve specific problem. As all constraints that we showed above, all constraints will use weigh in each node because different node has different constraints. This research has more options for travelers such as vehicles that release different level of carbon and hotels.

Materials and Methods

Task 1: Time dependent vehicle routing problem with a multi ant colony system along with Thailand travelling proposes methods for analysis, design, and develops time dependent vehicle routing problem with a multi ant colony system with Thailand travelling.

Activity

(1) Gathering opening time from each attractive place, hotel check in/check out time and vehicles speed limit.
(2) Setting location for each attractive place and hotel.
(3) Analysing method with time dependent vehicle routing problem with a multi ant colony system along with Thailand travelling.
(4) Developing application to represent time dependent vehicle routing problem with a multi ant colony system along with Thailand travelling.
(5) Evaluate the performance.

Deliverables

An application that represents time dependent vehicle routing problem with a multi ant colony system for solving Thailand travelling problem.

Task 2: Multi-objective ant colony optimisation algorithm with Thailand travelling. Proposes methods for analysis, design, and develop multi-objective ant colony optimisation algorithm along with Thailand travelling.

Activity

(1) Gathering personal's behavior as activity.
(2) Gathering provinces which represent identity forest, beach and coral area, culture or city.
(3) Gathering individual information such as age, vehicles
(4) Gathering hotels in areas to stay in each province.
(5) Weighted Ant colony optimisation by using different objective.
(6) Analysing method with Multi-objective ant colony optimisation algorithm along with Thailand travelling.
(7) Developing applications to represent multi-objective ant colony optimisation algorithm along with Thailand travelling.
(8) Evaluating the performance.

Deliverables

An application that represents the time dependent vehicle routing problem along with a multi ant colony system to solving problems with travelling in Thailand.

Task 3: Time dependent vehicle routing problem with a multi ant colony system and multi-objectives ant colony optimisation algorithm combination.

Propose combination between Task 1 and Task 2

Activity

(1) Analysing methods both time dependent vehicle routing problem along with a multi ant colony system and multi-objective ant colony optimisation algorithm combination.
2. Developing an application that combines 2 techniques.
3. Evaluating the performance.

Results

The result from the experiment will compare the efficacy with brute force algorithm. In addition to the various Ant Path, the results of CO2 that is released depending on the type of vehicle used to travel.

Time Dependent Vehicle Routing Problem with Ant Colony System Along with Thailand Green Travelling Problem

Start with choosing an accommodation, tourist attractions including the time spent at each location. In this step call API to Google and show location on map then choose the vehicle.

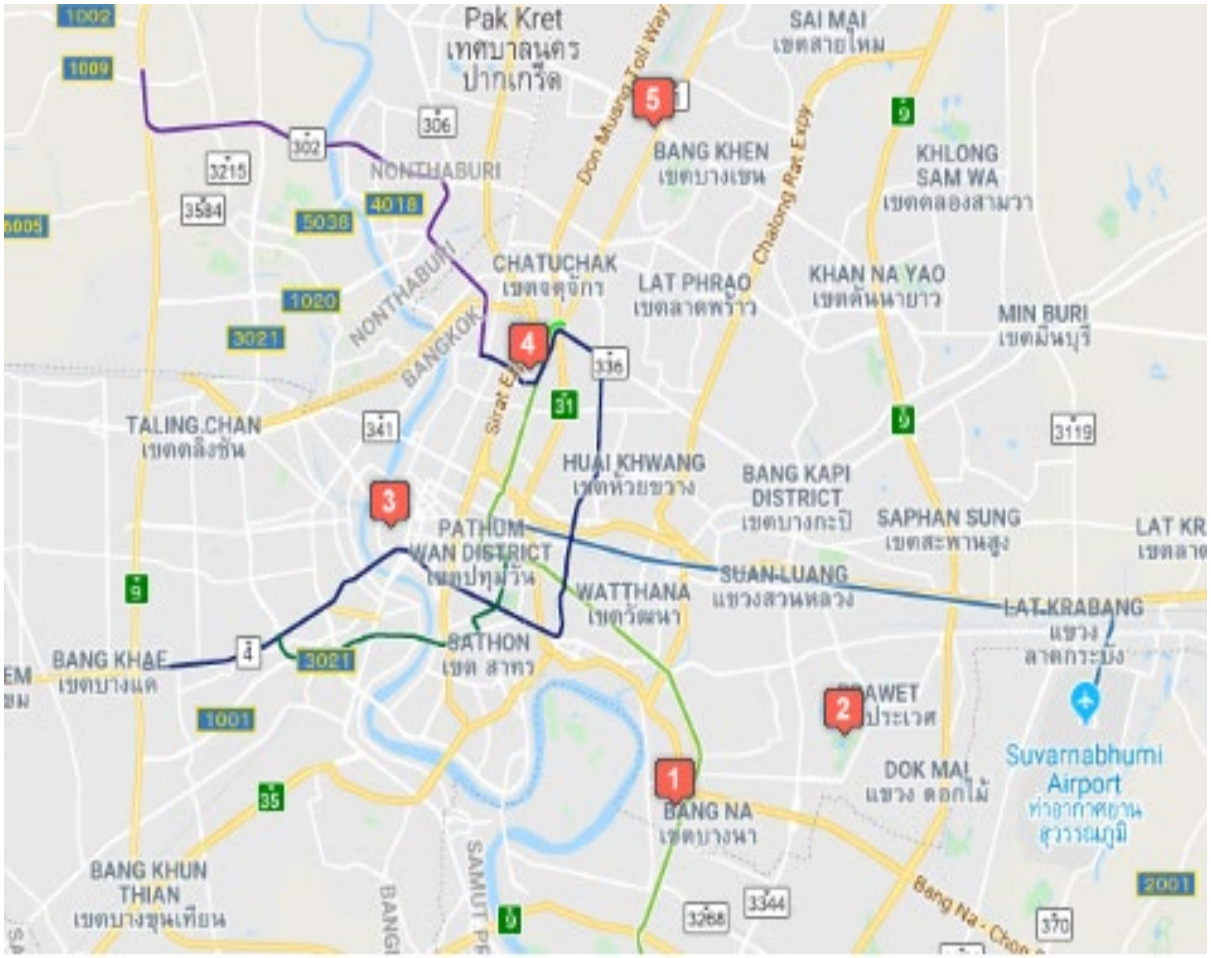
Table 1: Input Information of Time dependent vehicle routing problem with ant colony system along with Thailand Green travelling Problem

Location	Latitude, Longitude	Time spend (min)	Vehicle
Like Inn Hotel	13.6675081,100.6015747	-	Petrol
Suanluang RAMA IX	13.6675981,100.6015747	120	Petrol
Sao Ching Cha	13.7518235,100.4990445	200	Petrol
Jatujak Market	13.7999513,100.5486657	360	Petrol
Wat Phra Si Mahathat	13.8738431,100.5942195	20	Petrol

As Figure 1 shows the location on the map which return from Google API. Then use the possible route from real street from Google to be input for Ant Colony System. Ant Colony

System‘s principle, the beginning and final point must be the same which is like their nest. In this point the beginning and end will be the accommodation.

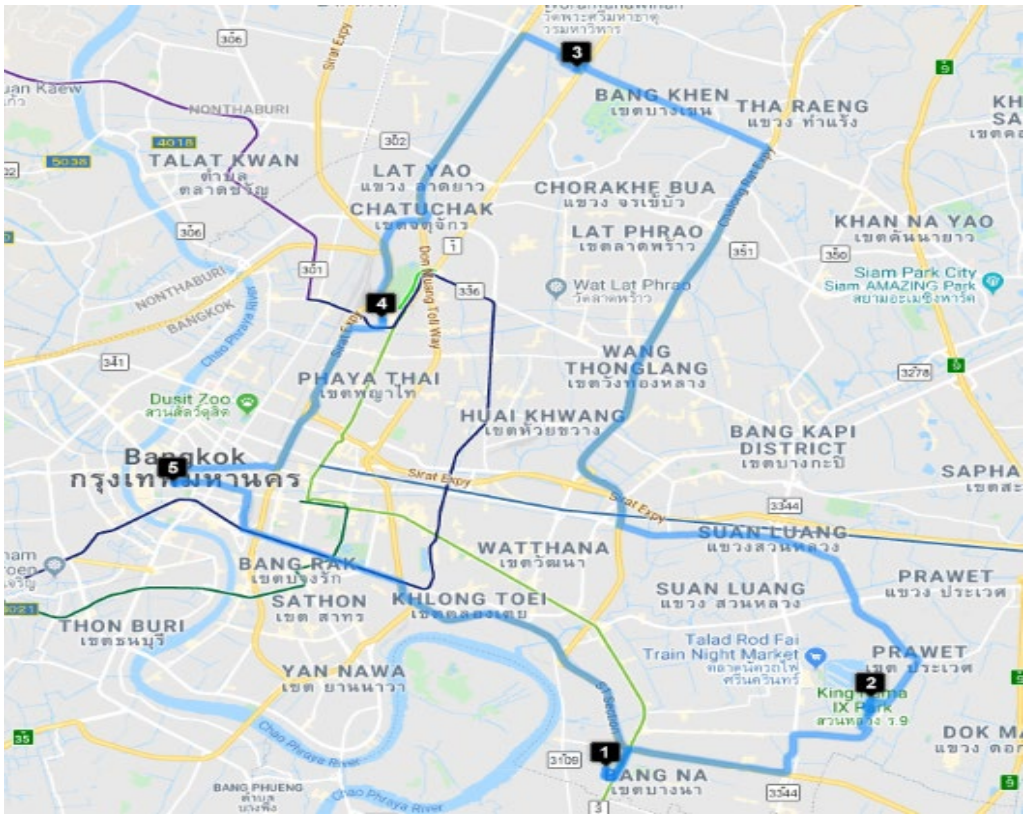
Figure 1. Shows location on map which return from Google API



After processing in Ant Colony system, ant paths are represented in figure 2. As the result Ant path as follows:

Path: [Like Inn Hotel, Suanluang RAMA IX, Wat Phra Si Mahathat, Jatujak Market, Sao Ching Cha, Like Inn Hotel]
Trip Duration: 2 hrs. 25 min and
Trip length: 84 km (52.6 miles),
CO2 (Petrol) are release to atmospheres: 0.0161 tones

Figure 2. Shows Ant path



To compare with Brute Force, the possible path from the example 4 tourist attractions are 25 paths (4!). The result of Brute Force as follow;

Trip length minimum is: 84 km, CO2 release 0.0161 tones
Trip length minimum is: 129 km, CO2 release 0.0247 tones
Trip length average is 109.5417 km, CO2 release 0.0210 tones

Table 2: Show possible path by Brute Force

Brute Force path	CO2 release (tones)
[Like Inn Hotel, Suanluang RAMA IX, Sao Ching Cha, Jatujak Market, Wat Phra Si Mahathat, Like Inn Hotel] = 90 km	0.0172
[Like Inn Hotel, Suanluang RAMA IX, Sao Ching Cha, Wat Phra Si Mahathat, Jatujak Market, Like Inn Hotel] = 93 km	0.0178
[Like Inn Hotel, Suanluang RAMA IX, Jatujak Market, Sao Ching Cha, Wat Phra Si Mahathat, Like Inn Hotel] = 99 km	0.0189
[Like Inn Hotel, Suanluang RAMA IX, Jatujak Market, Wat Phra Si Mahathat, Sao Ching Cha, Like Inn Hotel] = 92 km	0.0176
[Like Inn Hotel, Suanluang RAMA IX, Wat Phra Si Mahathat, Jatujak Market, Sao Ching Cha, Like Inn Hotel] = 84 km	0.0161

[Like Inn Hotel, Suanluang RAMA IX, Wat Phra Si Mahathat, Sao Ching Cha, Jatujak Market, Like Inn Hotel] = 102 km	0.0196
[Like Inn Hotel, Sao Ching Cha, Suanluang RAMA IX, Jatujak Market, Wat Phra Si Mahathat, Like Inn Hotel] = 120 km	0.023
[Like Inn Hotel, Sao Ching Cha, Suanluang RAMA IX, Wat Phra Si Mahathat, Jatujak Market, Like Inn Hotel] = 120 km	0.0229
[Like Inn Hotel, Sao Ching Cha, Jatujak Market, Suanluang RAMA IX, Wat Phra Si Mahathat, Like Inn Hotel] = 125 km	0.024
[Like Inn Hotel, Sao Ching Cha, Jatujak Market, Wat Phra Si Mahathat, Suanluang RAMA IX, Like Inn Hotel] = 90 km	0.0173
[Like Inn Hotel, Sao Ching Cha, Wat Phra Si Mahathat, Jatujak Market, Suanluang RAMA IX, Like Inn Hotel] = 96 km	0.0183
[Like Inn Hotel, Sao Ching Cha, Wat Phra Si Mahathat, Suanluang RAMA IX, Jatujak Market, Like Inn Hotel] = 127 km	0.0243
[Like Inn Hotel, Jatujak Market, Sao Ching Cha, Suanluang RAMA IX, Wat Phra Si Mahathat, Like Inn Hotel] = 126 km	0.024
[Like Inn Hotel, Jatujak Market, Sao Ching Cha, Wat Phra Si Mahathat, Suanluang RAMA IX, Like Inn Hotel] = 99 km	0.019
[Like Inn Hotel, Jatujak Market, Suanluang RAMA IX, Sao Ching Cha, Wat Phra Si Mahathat, Like Inn Hotel] = 129 km	0.0247
[Like Inn Hotel, Jatujak Market, Suanluang RAMA IX, Wat Phra Si Mahathat, Sao Ching Cha, Like Inn Hotel] = 127 km	0.0244
[Like Inn Hotel, Jatujak Market, Wat Phra Si Mahathat, Suanluang RAMA IX, Sao Ching Cha, Like Inn Hotel] = 113 km	0.0215
[Like Inn Hotel, Jatujak Market, Wat Phra Si Mahathat, Sao Ching Cha, Suanluang RAMA IX, Like Inn Hotel] = 100 km	0.0191
[Like Inn Hotel, Wat Phra Si Mahathat, Sao Ching Cha, Jatujak Market, Suanluang RAMA IX, Like Inn Hotel] = 107 km	0.0204
[Like Inn Hotel, Wat Phra Si Mahathat, Sao Ching Cha, Suanluang RAMA IX, Jatujak Market, Like Inn Hotel] = 135 km	0.0257
[Like Inn Hotel, Wat Phra Si Mahathat, Jatujak Market, Sao Ching Cha, Suanluang RAMA IX, Like Inn Hotel] = 94 km	0.018
[Like Inn Hotel, Wat Phra Si Mahathat, Jatujak Market, Suanluang RAMA IX, Sao Ching Cha, Like Inn Hotel] = 116 km	0.0222
[Like Inn Hotel, Wat Phra Si Mahathat, Suanluang RAMA IX, Jatujak Market, Sao Ching Cha, Like Inn Hotel] = 120 km	0.0229
[Like Inn Hotel, Wat Phra Si Mahathat, Suanluang RAMA IX, Sao Ching Cha, Jatujak Market, Like Inn Hotel] = 125 km	0.0239

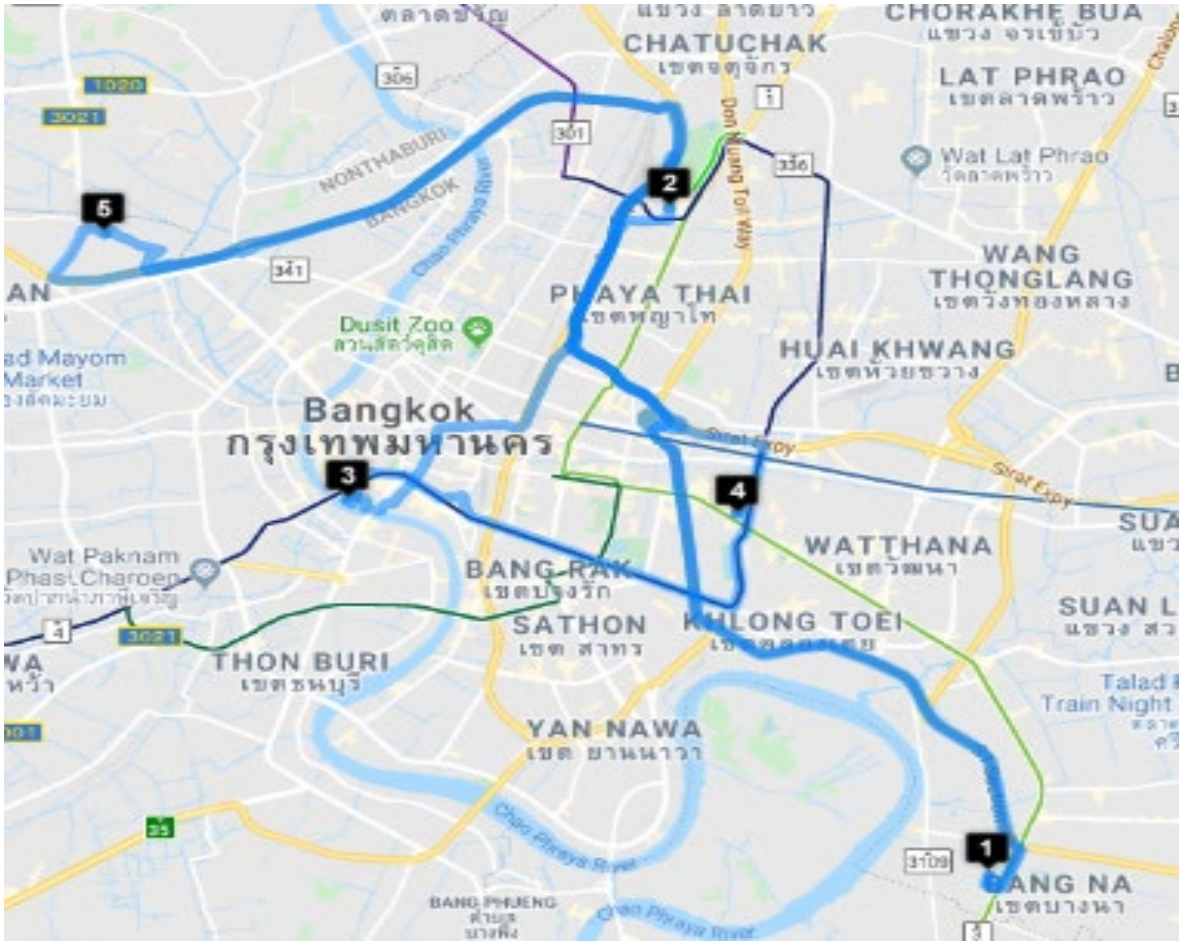
Multi-Objective Ant Colony Optimisation Along With Thailand Green Travelling Problem

Multi-objective ant colony optimisation along with Thailand Green travelling problem starts as a normal Ant Colony system. Travellers start from an accommodation. For tourist attractions, it depends on type of tourist attraction that is sued for weighted in Multi-objective ant colony optimisation to order in priority.

Table 3: Input Information of Multi-objective ant colony optimisation along with Thailand Green travelling Problem

Location	Tourist attraction type	Time spend (min)	Vehicle	Priority
Like Inn Hotel		-	Hybrid	
Baan Kamthieng	Art Attraction	120	Hybrid	-
Baan Jakrayan	Art Attraction	100	Hybrid	-
Jatujak Market	Recreation Attraction	360	Hybrid	First
Pak Klong Talad	Cultural Attraction	200	Hybrid	-

Figure 3. Shows Multi-objective ant colony optimisation path



As shown in figure 3 a result of Multi-objective ant colony optimisation path is dependent on the priority of the weighted on tourist attraction. Multi-objective ant colony optimisation path and trip information is as follows;

Path : [Like Inn Hotel, Jatujak Market,บ้านคำเที่ยง, Pak Klong Talad,บ้านจักรยาน, Like Inn Hotel]
Trip duration: 2 hrs 23 min Trip length: 97 km (60.7 miles)
CO2 (Hybrid) are release to atmospheres 0.0128 tones

To compare with Brute Force, the possible path from the example 4 tourist attractions and one priority, so in this case there are 2 paths (3!). The result of Brute Force as follow;

Trip length minimum is: 80 km, CO2 release 0.0105 tones
Trip length maximum is: 109 km, CO2 release 0.0123 tones
Trip length average is 94 km, CO2 release 0.0210 tones

Table 4: Show possible path by Brute Force prioritize

Brute Force path	CO2 release (tones)
[Like Inn Hotel, Jatujak Market, Baan Kamthieng House Museum, Pak Klong Talad, Baan Jakrayan, Like Inn Hotel] = 97 km	0.0128
[Like Inn Hotel, Jatujak Market, Baan Kamthieng House Museum, Baan Jakrayan, Pak Klong Talad, Like Inn Hotel] = 94 km	0.0123
[Like Inn Hotel, Jatujak Market, Pak Klong Talad, Baan Kamthieng House Museum, Baan Jakrayan, Like Inn Hotel] = 109 km	0.0143
[Like Inn Hotel, Jatujak Market, Pak Klong Talad, Baan Jakrayan, Baan Kamthieng House Museum, Like Inn Hotel] = 86 km	0.0113
[Like Inn Hotel, Jatujak Market, Baan Jakrayan, Pak Klong Talad, Baan Kamthieng House Museum, Like Inn Hotel] = 80 km	0.0105
[Like Inn Hotel, Jatujak Market, Baan Jakrayan, Baan Kamthieng House Museum, Pak Klong Talad, Like Inn Hotel] = 98 km	0.0128

Time Dependent Vehicle Routing Problem with Ant Colony System and Multi-Objective Ant Colony Optimisation Combination Along with Thailand Green Travelling Problem

The objective of combination between time dependent vehicle routing problem with ant colony system and multi-objective ant colony optimisation is the increase the ability of planning. Highlights of the combination, tourists able to plan by prioritise the type of tourist attraction with condition of tourist attraction working hour.

The combination of the original concept is as follows: starting with accommodation, tourist attraction, duration time and prioritise them according to the type of attraction.

Table 5: Time dependent vehicle routing problem with ant colony system and multi-objective ant colony optimisation combination along with Thailand Green travelling Problem

Location	Tourist attraction type	Time spend (min)	Vehicle	Priority
Like Inn Hotel		-	Motorcycle	
Bangkhuntian canal	Cultural attractions	120	Motorcycle	-
Pak Klong Talad	Cultural attractions	100	Motorcycle	First
The National Theatre	Art attractions	100	Motorcycle	
Safari World	Recreation attractions	200	Motorcycle	-

Suppose that the start time of departure is 6.00 AM for time dependent vehicle routing problem with ant colony system and multi-objective ant colony optimisation combination, the result as table 5.

Table 6: Comparison of Ant Path and Brute force with time dependent and Multi-objective

Ant Path				**Brute force**			
From Like Inn Hotel		arrive	close	From Like Inn Hotel		arrive	close
To	Bangkhuntian canal	06:40:56	17:00:00	To Path 1	Bangkhuntian canal	06:40:56	17:00:00
	Pak Klong Talad	09:07: 59	23:59:00		Pak Klong Talad	09:07:48	23:59:00
	The National Theatre	11:00:34	16:00:00		The National Theatre	11:00:22	16:00:00
	Safari World	13:43:05	17:30:00		Safari World	13:42:52	17:30:00
Back to Like Inn Hotel Trip length: 88 km Carbon Emissions:0.146 tones				Back to Like Inn Hotel Trip length: 88 km Carbon Emissions:0.0168 tones			
				To Path 2	Bangkhuntian canal	06:40:56	17:00:00
					Pak Klong Talad	09:07:48	23:59:00
					Safari World	11:53:36	17:30:00
				Back to Like Inn Hotel Trip length: 86 km Carbon Emissions:0.0165 tones			
				To Path 3	Pak Klong Talad	06:34:26	17:00:00

		Bangkhuntian canal	08:46:43	23:59:00
		The National Theatre	11:20:48	16:00:00
		Safari World	14:03:18	17:30:00
	Back to Like Inn Hotel Trip length: 99 km Carbon Emissions:0.0190 tones			
	To Path 4	Pak Klong Talad	06:34:26	23:59:00
		Bangkhuntian canal	08:46:43	17:00:00
		Safari World	12:01:10	17:30:00
	Back to Like Inn Hotel Trip length: 92 km Carbon Emissions:0.0176 tones			

Performance Measurement between Ant Colony System and Brute Force

Although the Ant results for the distance are not the shortest path compared to the Brute Force, the results of Ant Colony System are not the worst. However, when looking at the performance of algorithm, the processing time to generate all possible paths of the Brute Force takes more time than Ant Colony System. The efficiency of the Brute Force algorithm is Big O2 while Any Colony System only Big O.

Discussion

The proposed framework begins by preparing dataset of accommodation and tourist attraction location in on file by specific latitude and longitude. Dataset used from representatives of the 4 types of tourist groups as follows: Chaing Mai is a representative of forest, Phuket is a representative of beach and coral area, Sukhothai is representatives of culture and Bangkok is a representative of City. The dataset is taken from DASTA, an organisation that supports low carbon tourism provides information on accommodation and tourist attraction locations and descriptiosn. These methods in this thesis to solve Thailand Green Travelling Problem.

In the process of preparing the information for the accommodation request and tourist attractions by collecting latitude, longitude, hours of operation including with types of tourist attractions. For the route after selecting both hotels and tourist attractions, the latitude and longitude of each location will be passed using Google API service to get the real passible

route. The route using the Ant Colony System is added in the part opening time is calcuated. In this section, first get the route along Ant Colony System and each stop point will determine if it possible or not. If that place is closed, the next location will be taken into consideration. Tourists can manage the starting time for their journey for easier to manage the time. In the second part, each tourist attraction will be specified according to the type of tourist destination. In which tourist can select the type of tourist destination that they prefer to prioritise. Therefore, prioritised destinations will be placed in the top priority list. In the final part, it is a combination of time dependency and multi-objective Ant Colony System. The priority and time frames will be used as conditions. In order to get the places according to the type that tourists prefer, consider the possibility of arriving time for each tourist location which tourists will choose the stat time of the trip in planning. Also, CO2 emissions according to the vehicle type selected which assume that if the distance is short, the CO2 emission will decrease accordingly. Including the accommodation is in the NASTA dataset, which organized the campaign "CO2 Reduction Tour".

As the result, Brute force is taken in to consideration to compare the capabilities of The Ant Colony System. The results obtained from Ant Colony System have some routes equal to the shortest distance of Brutes Force, but some Brute Force routes have shortest distances. However, the Ant Colony system route is less than the Brutes Force's worst route. The distance from Ant Colony System is better than the average distance from Brute force. Under the conditions of Time dependency and Multi-Objective ant Colony System, Ant Colony System can go to places that tourists prefer more than Brute Force. In some routes, the number of tourist's attractions of Brute force is less than Ant Colony system. As for the efficiency of the algorithm, Ant Colony System outperforms BigO while Brute Force has the BigO2 efficiency.

Further Recommendation

The future work development of Ant Colony System can be expanded by adding other conditions such as changing vehicles at each tourist attraction, adding break point such as gas stations or restaurants to complete the planning. Also increasing capacity by integrating public transport systems to get the best route, reduced cost, including CO2 released into the atmosphere. In terms of tourism planning, it is currently a one-day trip which tends to continue to be developed to accommodate more than one-day trips.

As for the algorithm that is used, it can be used in other Evolutionary-base algorithms such as The Particle Swarm Optimisation algorithm, Shuffled Frog Leaping algorithm or may be developed using Hybrid methods. In addition, if the development of the behaviour of tourists in the matter of choosing a place to be a dataset that can be used to learning the behaviour of selecting tourist attractions. At this point, it can be developed in terms of searching speed to

find direction than calling Google API service because nowadays, Google's call service has a service charge. It can be further expanded into a system of advice tourism for a tourist attractions recommended plan.

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