International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 11, Issue 10, 2020

Solving the Travelling Problem of Thai Tourism, by Improved Ant Colony Optimization

Punyapas Chawaratthanarungsri[a], Sutep Tongngam[b], [a,b]The School of Applied Statistics (Computer Science and Information Systems), National Institute of Development Administration (NIDA), Bangkok Thailand, Email: [a]punyapas.ch@gmail.com, [b]sutep@as.nida.ac.th

Most industries focus on how to profit from processing and transmitting, even in tourism. Technology has met travellers' need to access information on problems regarding matters such as flights, routes, hotels, and transportation, by themselves. Computer science can help solve such problems, through Artificial Intelligence and animal simulations. This research applies Ant Colony Optimization to travelling problems. Brute Force computing was juxtaposed against the Ant Colony System. Some routes obtained from that System match the Brutes Force's shortest distance, but some do not. Generating all possible Brute Force paths takes more time than Ant Colony System "algorithms". The efficiency of the Brute Force algorithm is termed "Big O2" while the Ant Colony System is only "Big O". Other conditions were added to that System, such as by changing vehicles at each tourist attraction, adding break points such as gas stations or restaurants, to complete planning. The Ant Colony System can be further expanded into one of tourist advice for tourist attractions' recommended plans.

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

Introduction

The information revolution has dramatically affected the economy. All industries now focus on how to benefit from information and reduce cost of obtaining, processing, and transmitting information. It can change the fundamental way that some businesses operate. Tourism is an industry which changes through technology. Travelers tend to access more information such as flights, routes, accommodation, transportation etc., by themselves. These behaviours show that travellers focus more on information for their plans. Travellers choose all facilities and set

activities by themselves without the service of tourism agencies. Although they have already determined the places and activities, some problems persist, such as choosing the best way to travel, managing time, and transportation, because they lack information to support themselves. Integrating all information with some processing techniques would be very useful. Some computer science techniques offer solutions. In particular, Artificial Intelligence and animal simulations are used to imitate ant behaviour. Previously, many researchers tried to improve the performance of Ant-like algorithms.

Artificial Intelligence (AI) is an area of computer science that focuses on simulation and reacts to human thinking. A Genetic Algorithm, for example, is used for finding and also for searching, optimizing and learning. It simulates animal behaviour such as frogs, birds or ants etc. Many researches develop its performance. In this research we will focus on only Ant Colony optimization.

Ant Colony optimization solves combinatorial optimization problems such as the Travelling Salesman problem, and graph coloring problems. It is applied in this research. However, Ant Colony algorithms are not very optimal because they still take a long time when searching. Many researches derive from Ant Colony Systems. Its original form is most popular as a tool for routing problems, simulating ant behaviour to find the shortest path from food to nest.

Given travellers' behaviours, there are some requirements for their planning. For example, the opening and closing times of attractive destinations are needed, as are vehicles that travellers choose, suitable hotels or restaurants, and different activities when they arrive. The inspiration for this research comes from problems in their planning. Some websites such as Agoda give only resort and hotel services. They do not give distances to tourist destinations. The information is insufficient for travellers. Routing problem technique is very applicable to this problem, and so the Ant Colony System was chosen for solve it. We also apply this technique to travelling in Thailand and travel awareness generally.

In this research, each node of an Ant Colony System will be replaced by a hotel, resort or attractive place. Paths are replaced by streets or routes. An original Ant Colony System is adapted for other research; a Multi Objective ant colony optimization algorithm for example. This technique weights each node in different objectives and uses, to calculate the best way to solve specific problems. As shown above, all constraints are weighted in each node, because each node has different constraints. This research has more options for travellers such as hotels and vehicles that release different levels of carbon.

Materials and Methods

Task 1: Time dependent vehicle routing problem with a multi ant colony system, along with Thailand travelling. Propose methods for analysis, design, and develop 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) Analyzing 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 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 optimization algorithm with Thailand travelling. Propose methods for analysis, design, and develop multi-objective ant colony optimization algorithm along with Thailand travelling.

Activity:

(1) Gathering personal behaviour 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 hotel in area to stay in each province.
(5) Weighted ant colony optimization by using different objective.
(6) Analyzing method with multi-objective ant colony optimization algorithm along with Thailand travelling.
(7) Developing application to represent multi-objective ant colony optimization algorithm along with Thailand travelling.
(8) Evaluating performance.

Deliverables:

An application that represents Time-Dependent Vehicle Routing Problem along with a multi ant colony system to solving Thailand travelling.

Task 3: Time-Dependent Vehicle Routing Problem with a multi ant colony system and multi-objectives ant colony optimization algorithm combination.

Propose combination between Task 1 and Task 2

Activity

(1) Analyzing methods both Time-Dependent Vehicle Routing Problem along with a multi ant colony system and multi-objective ant colony optimization algorithm combination.
2. Developing application which combines two techniques.
3. Evaluating the performance.

Results

The result from the experiment will compare efficacy with a brute force algorithm. In addition to the various Ant Paths, the CO2 released depending on the type of vehicle used to travel, will also be calculated.

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

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

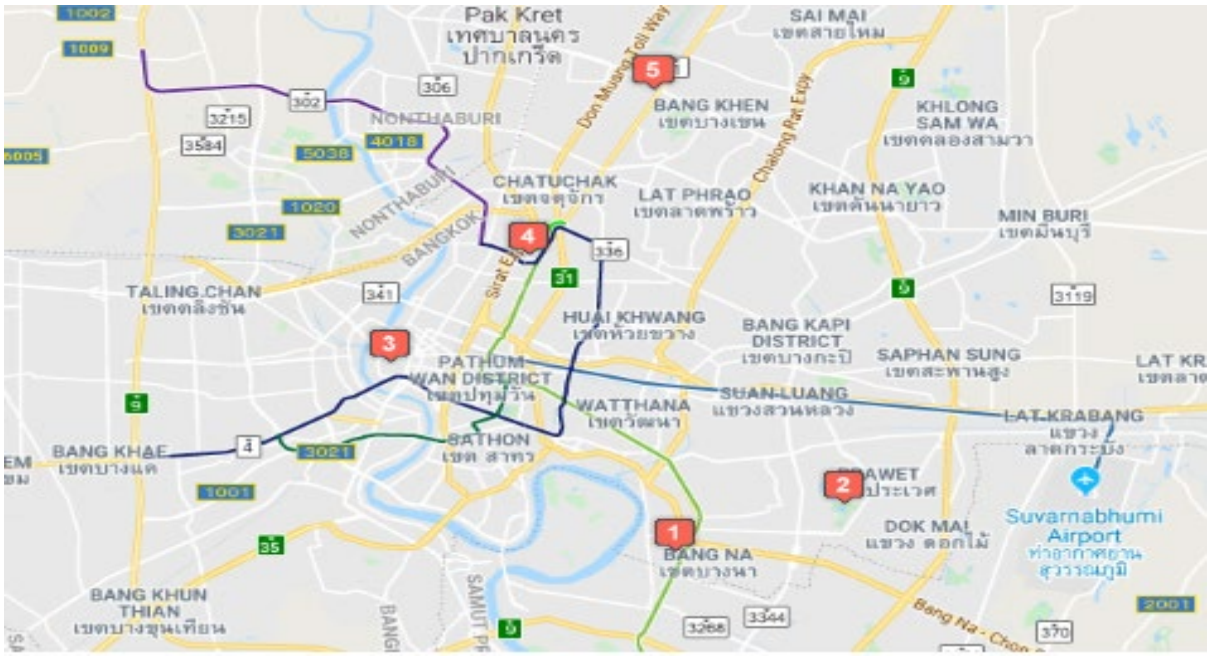
Table 1: Input Information of Time-Dependent Vehicle Routing Problem with ant colony system along with Thailand Green Travelling Problem

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

Figure 1 shows location on a map which returns data from Google API. Then use possible route from a real street in Google, to be an input for the Ant Colony System. Under the Ant Colony

System principle, the beginning and final point must be the same (it is like their nest). In this point the beginning and end will be the accommodation.

Figure 1 shows location on a map which returns from Google API

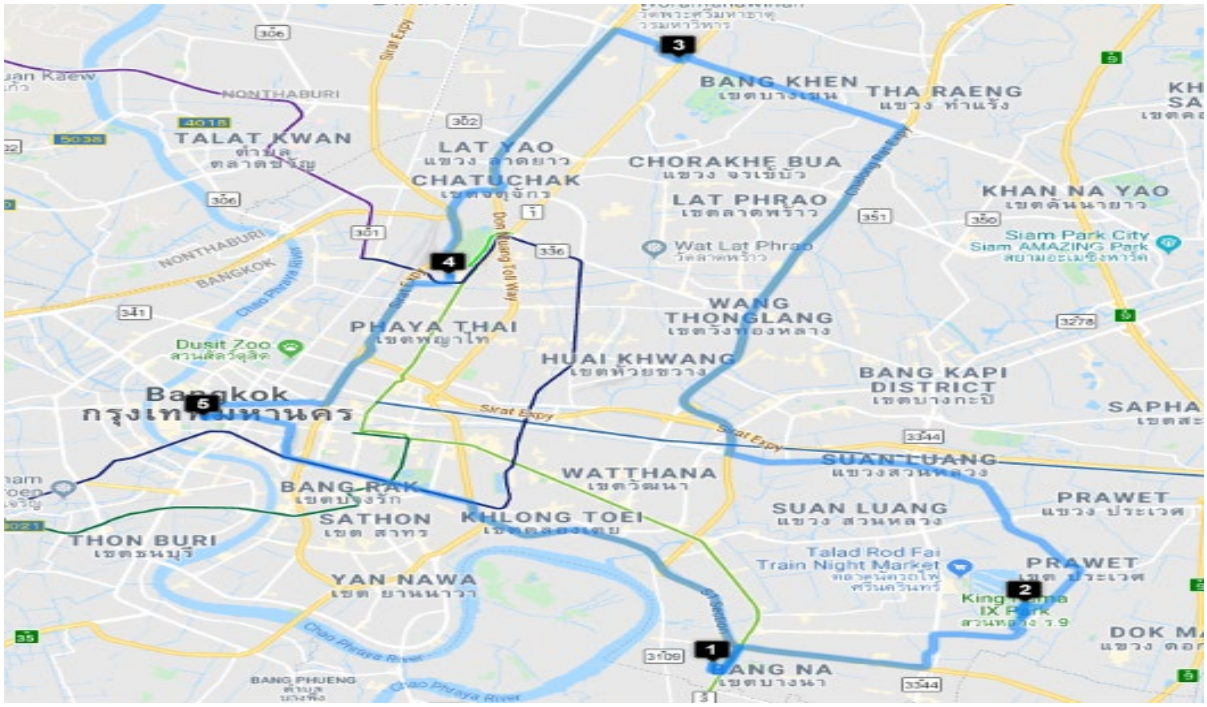


As a result the ant path is as follows:

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) released to atmosphere: 0.0161 tonnes

Figure 2 shows the ant path.



To compare with Brute Force processing, the possible path from the example 4 tourist attraction number 25 paths (4!). The result of Brute Force is as follows:

Trip length minimum is: 84 km, CO2 released 0.0161 tonnes
Trip length minimum is: 129 km, CO2 released 0.0247 tonnes
Trip length average is 109.5417 km, CO2 released 0.0210 tonnes

Table 2: Show possible path by Brute Force

Brute Force path	CO2 releasd (tonnes)
[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 Optimization Along With Thailand Green Travelling Problem

Multi-objective ant colony optimization, along with the Thailand Green Travelling Problem, start as a normal Ant Colony system. Travellers start from an accommodation. For tourist attractions, the assessment depends on the type of tourist attraction, which uses weighted multi-objective ant colony optimization, to prioritize.

Table 3. Input Information of Multi-objective ant colony optimization 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 optimization path

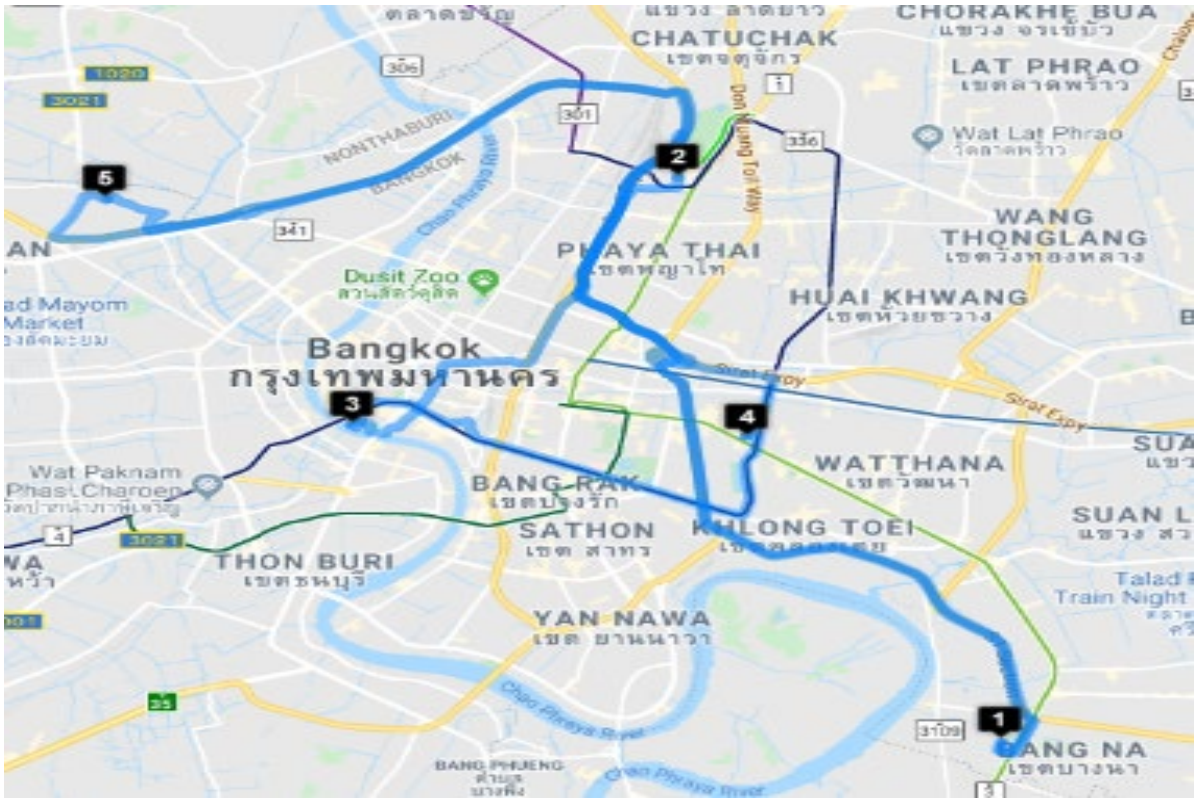


Figure 3 shows that the result of the multi-objective ant colony optimization path assessment, depends on prioritizing the weight of various tourist attractions. That optimization path and trip information is as follows:

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)
The CO2 (Hybrid) released into the atmosphere is 0.0128 tonnes.

To compare with Brute Force, the possible paths from the example are tourist attraction and one prioritized, so in this case there are two paths (3!). The result of Brute Force is as follows:

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

Table 4: Show possible path by Brute Force prioritization

Brute Force path	CO2 released (tonnes)
[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 Optimization Combination Along With Thailand Green Travelling Problem

The objective of applying ant colony system analysis and multi-objective ant colony optimization, to the Time-Dependent Vehicle Routing Problem, is to increase planning ability. Highlights of the combination include tourists' ability to plan, by prioritizing types of tourist attractions with the working hours of those attractions.

The combinations of the original concepts are as flows: start with accommodation, tourist attraction, duration time and prioritize them according to the type of attraction.

Table 5: Time-Dependent Vehicle Routing Problem with ant colony system and multi-objective ant colony optimization 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 departure time is 6.00 AM, in relation to the Time-Dependent Vehicle Routing Problem, with an ant colony system, and multi-objective ant colony optimization combination. The result is as Table 6.

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

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

Discussion

This study applies the Ant Colony System to the Thailand Green Travelling Problem. The proposed framework begins by preparing a dataset of accommodation and tourist attraction locations in a JSON file, according to specific latitudes and longitudes. The dataset from representatives of the four types of tourist groups are as follows: Chiang Mai is a representative of forest, Phuket is a representative of beach and coral areas, Sukhothai is a representative of culture, and Bangkok is a representative of city. The dataset is taken from DASTA, an organization that supports low carbon tourism. It provides accommodation and tourist attraction locations and descriptions. The methods in this thesis are applied to solve the Thailand Green Travelling Problem.

Information for accommodation requests and tourist attractions is prepared by collecting latitude, longitude, and hours of operation including 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 the Google API service, to get all real, passible routes. The route is then calculated using the Ant Colony System, by adding in the part opening time. In this section, first get the route along the Ant Colony System. Each stop point will determine whether it is possible. If that place is closed, the next location will be taken into consideration. Tourists can manage starting times for their journeys, to easier manage the time. In the second part, each tourist attraction will be specified according to its type of tourist destination, in which tourists can select the type of destination they prefer to prioritize. Destinations prioritized by tourists will thereby be placed in the top priority list. The final part combines time dependency and the multi-objective Ant Colony System. The priority and time frames will be used as conditions, to get the places according to the type that tourists prefer, considering the possible arrival time for each tourist location. Tourists will choose the start time of the trip when planning. They will also choose the CO2 emissions, according to the vehicle type selected, assuming that if the distance is short, CO2 emissions will decrease accordingly. Included in the accommodation is the NASTA dataset, which organized the “CO2 Reduction Tour” campaign.

As a result, Brute Force is taken into consideration, to compare the capabilities of the Ant Colony System. The results obtained from the System have some routes equal to the shortest

distances of Brute Force, but some Brute Force routes have the shortest distance. However, the Ant Colony System route is less than the Brutes Force's worst route. Importantly, the distance using the Ant Colony System is better than the average distance using Brute Force. Under the conditions of time dependency and the Multi-Objective Ant Colony System, the Ant Colony System can go to places that tourists prefer, more than Brute Force. In some routes, the number of tourist attractions of Brute Force is less than that of the Ant Colony system. As for algorithmic efficiency, the Ant Colony System outperforms BigO, while Brute Force has BigO2 efficiency.

Further Recommendations

Future work will develop the Ant Colony System. Other conditions will be added, such as changing vehicles at each tourist attraction, adding break points such as petrol stations or restaurants, to complete planning. Capacity will be increased by integration with public transport systems to get the best route, reduced cost, and minimal release of CO2 into the atmosphere. In terms of tourism planning, one-day trips will continue to be developed, to accommodate more than trips of longer periods.

The algorithm can also be used in other evolutionary-based algorithms. These include the Particle Swarm Optimization algorithm and the Shuffled Frog Leaping algorithm, or it may be developed using hybrid methods. In addition, tourist behaviour in choosing a place to be a dataset that be developed, to learn the behaviour of selecting tourist attractions. At this point, it can be developed in terms of searching speed, to find direction, rather than calling the Google API service. Today, Google's call service has a service charge. The algorithm propagated by this research can be further expanded into a system of tourist advices, for tourist attractions' recommended plans.

REFERENCES

M. Dorigo and T. Stützle, Ant Colony Optimization. Cambridge,UK:MIT Press, 2014.

K. Socha, Ant Colony Optimization and Swarm Intelligence. Brussels, Belgium: Springer, 2004.

L.M. Gambardella, E.D. Taillard, and G.C. Agazzi, "cMACS-VRPTW: A multiple ant colony system for vehicle routing problems with time windows, in New Ideas in Optimization," 1999. [Online]. Available: http://www.actapress.com/PaperInfo.aspx?PaperID=14090&reason=500

A.V. Donati, R. Montemanni, N. Casagrande, A.E. Rizzoli, L.M. Gambardella, "Time dependent vehicle routing problem with a multi ant colony system," Eur. J. Operat. Res., vol, 185, pp. 1174-1191, June. 2006.

K. Doerner, R.F. Hartl, and M. Reimann, "CompetAnts for problem solving— the case of full truckload transportation," Cent Eur J Oper Res., vol11, pp. 115–141. Nov. 2003.

S. Iredi, D. Merkle, and M. Middendorf, Evolutionary Multi-Criterion Optimization. Brussels, Belgium: Springer, 1993.

K.F. Doernera, W.J. Gutjahrb, R.F. Hartla, C. Straussa, C. Stummerc, "Ant colony optimization in multi objective project portfolio selection with ILP preprocessing," Eur. J. Operat. Res., vol. 171, pp. 830–841. Nov. 2006.

M.L. Ibnez, L. Paquete, and T. Stutzle, Ant Colony Optimization and Swarm Intelligence. Brussels, Belgium: Springer, 2004.

L. Manuel, and S. Thomas, "An experimental analysis of design choices of multi- objective ant colony optimization algorithms," Swarm Intell, vol.6., Springer database. 2006. doi:10.1007/s11721-012-0070-7.

V. T'kindt, N. Monmarche, F. Tercinet, and D. Laugt, "An ant colony optimization algorithm to solve a

2-machine bi-criteria flow shop scheduling problem," Eur. J. Operat. Res., vol.142, pp. 250–257, 2002.

TAT Intelligence Center, "Travelling Situation in 2014 and trend in 2015," November, 2013. [Online]. Available: http://intelligencecenter.tat.or.th/ewt_news.php?nid=1772&filenam e=index. [Accessed Jan. 14, 2019].

K. Hayamin, “The factors that impact of travelling to Sukhothai Historical Park,” July, 2012. [Online]. Available: http://proceedings.bu.ac.th/index.php/comphocadownloadcontrolpanel/grc [Accessed Jan. 14, 2019].