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# Optimal Holiday Destination Selection

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## ABSTRACT

***It is important for people to select the proper leisure destinations to spend their vacations. Each vacation location would have its own expenses, own entertainment, and own risks. Thus, wisely selecting the proper destination to spend a vacation is of paramount importance for any person for phycological reasons. In this paper, we formulate the holiday destination selection as a mixed-integer programming model (MILP). We also show how to solve this problem using a simple meta-heurstics, a max-mint ant syste (MMAS). The MMAS shows that it is an effective way that people can use to select holiday destiations. The suggested algorithm can be used as a base for a mobile application that people all over the world can use for their holiday planning.***

***Keywords:*** *Max-min Ant System, Holiday, Selection Problem*

## 1. INTRODUCTION

Most people are under tremendous pressures at work, and spending holiday is a necessity for everyone. For each holiday destination, there is a high risk of spending money without having a proper feedback. In this paper, we develop a mathematical model for the optimization problem that people can use to select their holiday destination. We then develop a max-min ant system (MMAS) to solve the developed model [1]. The developed model is then applied to a university professor in an industrial engineering department.

## 2. MATHEMATICAL MODEL

In this section, we develop a mix-integer linear program (MILP) to model the holiday destination selection optimization problem. The objective function of any person is to maximize the objective function represented in Equation 1. In this equation, $w_i$ and $x_i$ represet the number of expected relaxation and the number of days that can be spent in destination $i \in N$, where $N$ is the set of destination. $p_i$ is the level of enjoyment in $i \in N$.

For each possible destination, there is expenses related to the destinaiton, which definitely would include travelling, statying, et.c. Thus, for each destination $i \in N$ a person needs to invest $t_i$ money in researching the topic. Money is a major concern for any people, and the time invested in destination in set N should not exceed T. Eequation 2 represent money constraint. Moreover, a person might selecte a minimum number of days to spend in the different destination; thus, the sum of days should be greater than T, as shown in Equation 3. The decision variable of the professor model is $x_i$ which shows the number of days spent in destination $i \in N$.

$$\max Z = \sum_{i=1}^{N} w_i p_i x_i \quad (1)$$

$$\sum_{i=1}^{N} t_i x_i \leq T \quad (2)$$

$$\sum_{i=1}^{N} p_i x_i \geq P \quad (3)$$

$$x_i \epsilon Z \quad (4)$$

## 3. A MAX-MIN ANT SYSTEM

This problem was modeled using Equation 1-4, we use a meta-heuristic algorithm to solve this problem [2]. The algorithm used is a MMAS that have been successfully applied to several problems, for example, travelling salesman problem [3], scheduling [4], and covering problems [5].

Ants in nature have collective intelligence. To find the shortest route from point A to point B, ants lay a chemical called pheromone to know their path their nest. Pheromones have an evaporation rate; thus, if the path is long, time for pheromone evaporation increase and not much chemicals are laid along this path. When an ant from a later bach wants to select its path, it selects paths with more pheromones with higher probabilities. So, pheromone trails along short paths tend to increase and a long short paths tend to decrease. After a while, ants abandon the long path and only follow the short paths. This foreaging ant behavior is imitated in our MMAS algorithm.

A typical implementation of a MMAS starts with developing a construction graph as shown in Figure 1. Ant are divided into G generations. An ant in the first generation, go through the construction graph and at each step, the ant selects a research topic. This topic reduces the available time to spend on researching other topics. Thus, an ant keeps adding topics as long as time is available. Once all ants from the first generation find a time feasible solution, the best solution, the one that maximizes the objective function shown in Equation 1, increases the pheromone trails along the path it took while pherome trails along other paths are reduced as shown in Equation 2. The $\tau_{is}$ is the pheromone trail algong the path to node representing topic $i \in N$, whereas $0 < \rho < 1$ represent the evaporation rate. The indicator function $1.\{condition\}$ has a value of 1 if the condition is satisfied. Thus, the first term of Equation 1 shows that $\Delta\tau$ pheromones are added to arcs belonging to the best solution.

$$\tau_{is} = \Delta\tau 1.\{if\ topic\ i\ is\ selected\ in\ step\ s\ by\ the\ best\ ant\} + \rho\tau_{is} \quad 5$$

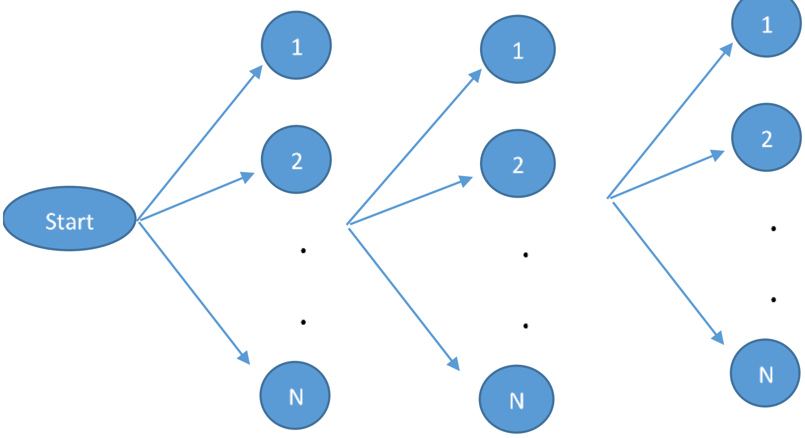


**Figure 1. A construction graph for the professor optimization problem**

An ant belonging to a later generation probabilitically selects an arc as shown in Equation 6. The selction probability of topic $i \in N$ is step s, $P_{is}$, depends on both the pheromone trails along this path $\tau_{is}$ and heuristic information about this path, $\pi_{is}$. In Equation 6, $\alpha$ and $\beta$ show the importance of the pheromone trail and heuristic information, respectively. To avoid convergence to a single solution and force ants to keep exploring new solutions, a MMAS enfoces a lower and upper limits for $\tau_{is}$, which we denote by $\rho_{min}$ and $\rho_{max}$, respectively.

$$P_{is} = \frac{\tau_{is}^{\alpha}\pi_{is}^{\beta}}{\sum_{i=1}^{N}\tau_{is}^{\alpha}\pi_{is}^{\beta}} \quad 6$$

## 4. CONCLUSION AND FUTURE RESEARCH

This paper introduces a MILP that a person or family problem to plan its holdiday. We capture this problem as an MILP model. We solve the MILP using a MMAS. For the heuristic information, we use a measure that consider the ratio of acceptance probability to research time. The MMAS was capable of finding the optimal solution for a case study problem presented in the work. Researchers can extend this work and consider other inputs to the problem based on the university or country context. For example, ability to get funding needs to be considered. Graduate student selection might also be included in the problem.

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