



ATENEO DE DAVAO UNIVERSITY
Computer Studies Division

Thesis Title

**Implementing a Heuristic Algorithm of an
Optimization Model for Itinerary Generation**

Group Name:

85rs

Proponents:

DAGATAN, CALBERT P.
DELA ROSA, RIZZA MARIE T.
UY, JACQUELINE CHRISTI B.

Course:

Bachelor of Science in
Computer Science

School Year:

SY 2006 -2007

**Implementing a Heuristic Algorithm of an
Optimization Model for Itinerary Generation**

**An Independent Research Presented to
The Faculty of the Computer Studies Division
Ateneo De Davao University**

**In Partial Fulfillment
Of the Requirements for the Degree
Bachelor of Science in Computer Science**

BY

DAGATAN, CALBERT P.
DELA ROSA, RIZZA MARIE T.
UY, JACQUELINE CHRISTI B.

**SCHOOL OF ARTS AND SCIENCES
ATENEO DE DAVAO UNIVERSITY**

MARCH 2007

~ TABLE OF CONTENTS ~

CHAPTER 1: INTRODUCTION

1.1	Background of the Study	1
	Complexity of Itinerary Generation	
	Current Approaches Undertaken	
	Heuristic Algorithm and Optimization	
1.2	Statement of the Problem	3
1.3	Objective of the Study	3
1.4	Scope and Limitation of the Study	4
1.5	Significance of the Study	4
1.6	Definition of Terms	5

CHAPTER 2: LITERATURE REVIEW

2.1	Review of Related Works	6
2.2	Theoretical Framework	10
	Comparison of Various Tourist Guide Concepts	

CHAPTER 3: METHODOLOGY

3.1	Conceptual Framework	12
	Comparison between Other Tourist Guide Concepts and I-Maker	
3.2	Research Design and Methodology	14

CHAPTER 4: THEORETICAL BACKGROUND

4.1	Traveling Salesman Problem (TSP)	17
	The Traveling Salesman Problem with Time Windows (TSPTW)	
	The Prize Collecting Traveling Salesman Problem (PCTSP)	
4.2	Orienteering Problem (OP)	19
4.3	Combinatorial Optimization	20
4.4	Heuristic Algorithms	21
	A. Local Search	
	B. Simulated Annealing	
	C. Quantum Annealing	
	D. Greedy Randomized Adaptive Search Procedure (GRASP)	
	E. Particle Swarm Optimization	
	F. Tabu Search	
	G. Genetic Algorithms	
	H. Ant Colony Optimization	

I. Reactive Search

CHAPTER 5: RESULTS AND DISCUSSIONS

5.1	Relative Concepts Gathered from Research Conducted on Tourism	26
5.1.1	Factors that affect Tourist's Decision in Planning Trips	26
	A. Preferences	
	B. Resources	
	C. Objective of Trips	
5.1.2	Simple Trip Planning Process	27
5.2	Identification of Tourism Major Categories	28
5.2.1	Classification of Nodes	28
5.3	Evaluation of Existing Design Approaches of Optimization Model	30
5.3.1	Evaluation of Heuristic Algorithms	30
5.3.2	Rating to Quantify Evaluation Output	35
5.3.3	CHOSEN ALGORITHM – SIMULATED ANNEALING	40
5.4	Computational Experiment with Simulated Annealing	42
5.5	Conversion of Codes from Turbo Pascal to PHP Syntax	43
5.6	Design of I-MAKER model	44
5.7	Development of I-MAKER	46
5.8	Testing Results	55

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1	Conclusion and Recommendation	61
-----	-------------------------------------	----

APPENDIX

A	User Manual	63
B	Program Codes	67
C	List of Nodes	197

Thesis Summary

Implementing a Heuristic Algorithm of an Optimization Model for Itinerary Generation

by

Calbert P. Dagatan
Rizza Marie T. dela Rosa
Jacqueline Christi B. Uy

Abstract:

This paper discusses several design approaches of combinatorial optimization and implements Simulated Annealing, a heuristic algorithm commonly applied to solve NP-Hard problems, in this case utilized for an itinerary generation employed on tourism. This paper as well shows the integration of the said implementation to an optimization model, which captures various considerations in trip planning process such as financial and time constraints other than tourist preferences. Moreover, this paper shows the development of an online application that makes use of the studied implementation and modeling.

Keywords:

Combinatorial Optimization, Heuristic Algorithm, NP-hard Problem, Itinerary Generation, Trip Planning Process

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

COMPLEXITY OF ITINERARY GENERATION

In real-life situations, limited resources confront us. In trip-planning alone, one has to make several considerations upon deciding on places to visit. Both financial and time constraints serve as determinants on this aspect, other than considering travel preferences such as likes and dislikes. Due to several conditions at hand, itinerary generation is indeed complex and thus it needs to resolve with intricacy and specialty. In Tourism for instance, rule of thumb is to make most of available sources and at the same time enjoy a remarkable travel experience. This line qualifies itinerary generation for tourism as an optimization problem, which yields the highest level of value, whatever objective it pursues. Thus, employing proven mechanisms used to resolve optimization cases, to that of itinerary generation is not a farfetched possibility. The endeavor is essential in as much as inability to reconcile intrinsic factors involved in the trip-planning process, may result to inappropriate, suboptimal and inflexible travel scenarios.

CURRENT APPROACHES UNDERTAKEN

Prevalent among present structures are the deployment of travel agencies with human agents who facilitates in catering traditional travel packages for tourists. However, despite the presence of mediators between tourists and travel packages, the latter remains predetermined

and not customized to meet the peculiarity of various travel situations. The emergence of some tourist guide applications, both mobile and stand-alone attempted the automation of trip-planning, but its output is inadequate, as most of it does not meet the several significant issues of creating an itinerary such as adequate event insertion and availing padding activities. Though there are big leaps on very few studies utilizing modules and embedding some sort of artificial intelligence, nevertheless it is unable to address efficiency in path selection and run time calculations.

HEURISTIC ALGORITHM AND OPTIMIZATION

Heuristic algorithms are methods used to solve optimization problems. Itinerary generation with its nature is best to be solved using Heuristic Algorithms which are usually used in solving NP hard problems (problems still to be found out as solvable or not). Combinatorial optimization algorithms is a particular kind which aims at achieving optimal output by reducing the effective size of the space (span area of consideration for solving), and by exploring the space efficiently. The implementation of a Heuristic Algorithm to that of an optimization nature like the itinerary generation will be appropriate and feasible.

1.2 STATEMENT OF THE PROBLEM

The present study answered the following general problem: How to implement a heuristic algorithm of an optimization model for itinerary generation?

In particular, it answered the following questions:

- What are the major components of itinerary generation, tourism and the trip planning process?
- What are the approaches in combinatorial optimization that are applicable to itinerary generation?
- How to create a model that generates an optimal itinerary?
- How to implement a heuristic algorithm as part of the model?
- How to develop an application based from the above implementation and model?

1.3 OBJECTIVE OF THE STUDY

The general objective of this study was to implement a heuristic algorithm of an optimization model for itinerary generation. The specific objectives were:

- To understand and identify factors involved in itinerary generation.
- To automate the tourism trip planning process for the tourists.
- To evaluate existing design approaches and identify what to utilize for itinerary generation.
- To implement a heuristic algorithm that generates an itinerary.
- To develop a model with the implemented heuristic algorithm.
- To develop an online application based from the above implementation and model.

1.4 SCOPE AND LIMITATION OF THE STUDY

The study focused on the development of a model and implementation of a heuristic algorithm for an itinerary generation. The application can produce a maximum of 12 hours itinerary with time estimate allocations on every node of suggested path. The model served as the core system of the application that was available online.

The tourist destinations, as nodes in terms of graphic algorithm, were limited in Davao City and Samal Island. It did not cover all tourist spots available, and only considered a number of those as potential destinations that were part in the creation of the itinerary. Routing was not covered as well by this study, thus actual distances among destinations are not considered in the decision-making process.

1.5 SIGNIFICANCE OF THE STUDY

Everyone engaged in traveling including visitors, tourists and excursionists who travel for the purpose of holidays, pleasures, etc. were deemed to benefit in this study. At large, it was also for the welfare of tourism sector and the country's economy as a whole, for the study has definitely revolutionized the tourism industry, which yields millions of dollars each year.

Moreover, the study addressed the need of present times to sophisticate even the travel experience in putting travelers as the central focus of considerations in crafting their travels – giving them the opportunity to decide on a venture the way it pleases them, over than the usual interests of travel agencies and its agents. This empowers the travelers who other than enjoying their time are also indirectly helping others with their expenditures. It also took

into concerns the real life scenarios of multiple constraints that a traveler faces such as financial and time limitations in each travel, and answered those instances with efficiency in the formulation of the most favorable itinerary.

Above all, the implementation of a heuristic algorithm and the development of the model, benefited to several advantages such yielding to an efficient selection of path and reducing the run time upon calculations of the itinerary, compare to that complex and added run times of several algorithms in a module, which were being used by existing ones. The introduction of a hybrid model can be of several uses in other fields of similar principle and purpose such as camping, intra-building store hoping, school facility checking and many more.

1.6 DEFINITION OF TERMS

Heuristic Algorithm - A mathematical rule or procedure for solving a problem whose general purpose is to find an approximate solution where resources are limited. They are not practical to find perfect solutions.

Itinerary Generation - A production of an established line of travel or access; A guidebook for travelers; A proposed route of travel.

Optimal Solution- Best, by whatever criterion decisions are being made; thus yielding the highest level of utility, profit, economic welfare, or whatever objective is being pursued.

Tourism - the act of travel for predominantly recreational or leisure purposes, and also refers to the provision of services in support of this act.

Combinatorial Optimization - is a branch of optimization that solves instances of problems that are believed to be hard in general, by exploring the usually-large solution space of these instances.

NP-hard Problem (Nondeterministic Polynomial-time hard) -A class of problems that is polynomial time Turing-reducible to H, i.e. $L \leq_T H$. NP-hard problems may be of any type: decision problems, search problems, optimization problems.

Trip Planning Process - A process consisting of selecting and combining possible attractions, lodges, services-facilities, and transportation modes in a manner that optimizes the tourist's preferences and satisfies the tourist's resources of time and money.