THE APPLICATION OF METAHEURISTICS IN NETWORK ROUTING AND INVENTORY ROUTING PROBLEM

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ABSTRAK

Kaedah Metaheuristik dikenali sebagai salah satu cara yang paling praktikal dalam menyelesaikan masalah besar (atau sangat besar) dalam pelbagai bidang, terutamanya masalah-masalah kombinatorik yang *NP-hard*. Tesis ini mengkaji dua kaedah metaheuristik iaitu *Genetic Algorithm* (GA) and *Variable Neighborhood Search* (VNS). Kedua-dua kaedah metaheuristik ini dikaji dengan mengaplikasikan kepada dua masalah *NP-hard* iaitu *Point to Multipoint Routing Problem* (PMRP) dan *Integrated Inventory Routing Problem* (IRP).

Message Scheduling Problems (MSP) ialah salah satu bidang penting dalam merekabentuk rangkaian telekomunikasi yang efisyen. Secara spesifiknya; masalah PMRP ialah mencari laluan (atau jalan) yang paling optima bagi satu set isyarat penghantaran data (atau mesej). Penghantaran isyarat data ini spesifik untuk satu nod sumber ke berbilang nod destinasi. GA dan VNS yang telah ditambah baik dibina dan kedua-dua algoritma ini diuji untuk masalah kecil, sederhana dan besar. VNS digabungkan dengan pelbagai pencarian tempatan (*local search*): *swap, invert, or-opt* dan *restricted or-opt*. VNS yang digabung bersama *restricted or-opt* member keputusan yang lebih baik dari segi kualiti keputusan, dengan masa pengkomputeran agak lama dibandingkan dengan algoritma lain.

Bahagian kedua tesis ini mengkaji tentang IRP. IRP melibatkan pengkoordinatan inventori dan operasi penghantaran bagi memenuhi permintaan pembekal. Objektif IRP adalah meminimumkan kos keseluruhan yang merangkumi kos inventori serta kos tetap dan kos berubah pengangkutan. Masalah IRP yang dikaji dalam tesis ini mempunyai ufuk terhingga, multi tempoh, multi pembekal, satu kilang pemasangan, beserta sekumpulan kenderaan yang berpusat di depoh bagi menghantar produk daripada pembekal untuk memenuhi permintaan di kilang pemasangan. Kami mencadangkan dua jenis VNS; VNSIRP dengan *Generalized Insertion Method* (GENI) sebagai pencarian tempatan dan juga VNS yang diperbaiki dengan GENI sebagai cara menjana struktur kejiranan, dinamakan EVNS. Kedua-dua algoritma dinilai dengan mengaplikasikannya pada suatu set data, dan EVNS memberikan keputusan yang lebih baik berbanding VNSIRP dengan masa pengkomputeran yang lebih panjang

ABSTRACT

Metaheuristic methods are widely known as one of the most practical approaches in solving large (or very large) problems in many fields, specifically NP hard Combinatorial Problems. In this thesis, we study two powerful metaheuristics method that are Genetic Algorithm (GA) and Variable Neighborhood Search (VNS). In this thesis, we analyzed both metaheuristics methods, GA and VNS by applying to two NP-hard combinatorial problems, Point to Multipoint Routing Problem (PMRP) and Integrated Inventory Routing Problem (IRP).

Message Scheduling Problems (MSP) is one of the important fields in the design of an efficient telecommunication network. Specifically PMRP is to find optimal routes for a set of requests; the message routing from one source nodes to multiple destinations. An enhanced GA and VNS were developed and both algorithms were tested on small, medium and large problems. VNS embeds different local search: swap, invert, or-*opt* and restricted or-*opt*. VNS with restricted or-*opt* performs better in terms of solution quality at the expense of a slightly higher computational time.

The second part of the thesis is devoted to IRP. IRP is concerned with coordinating the inventory and delivery operations to meet suppliers demand with an objective to minimize the total cost which consist of the inventory holding cost and the fixed and variable transportation costs. The IRP addressed in this thesis is based on a finite horizon, multi-period, multi-supplier, and single assembly plant, where a fleet of capacitated vehicles housed at a depot transported products from the suppliers to meet the demand specified by the assembly plant. We proposed two different VNS; VNSIRP with Generalized Insertion Method (GENI) as a local search and enhanced VNS with GENI is used to construct the neighborhood structure. We evaluate both algorithms on a set data and enhanced VNS performs better with a slightly higher computational time.

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LISTS OF FIGURES

ACRONYMS

ACO	Ant Colony Optimization
EAs	Evolutionary Algorithms
EC	Evolutionary Computing
EERO	Enhanced Edge Recombination Operator
ERO	Edge Recombination Operator
GA	Genetic Algorithm
GENI	Generalized Insertion Method
GLS	Guided Local Search
GRASP	Greedy Randomized Adaptive Search Procedure
I&D	Intensification and Diversification
ILS	Iterated Local Search
IRP	Inventory Routing Problem
LS	Local Search
NNM	Nearest Neighbor Method
OX	Order based Crossover
PMRP	Point to Multipoint Routing Problem
PMX	Partially Mapped Crossover
PSO	Particle Swarm Optimization
RVNS	Reduced Variable Neighborhood Search
RWS	Roulette Wheel Selection
SA	Simulated Annealing
SS	Scatter Search
SUS	Stochastic Universal Sampling
SVNS	Skewed Variable Neighborhood Search
TS	Tabu Search
TSP	Traveling Salesman Problem
VND	Variable Neighborhood Descent
VNS	Variable Neighborhood Search
VRP	Vehicle Routing Problem