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A Review Article of Transportation Vehicles Routing Scheduling using Genetic Algorithm

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***Abstract* - The paper proposes a technique for the development of ''optimal'' transit route networks (for example, a bus route network) given the information on link travel times and transit demand. The proposed method, unlike previous techniques, primarily uses optimization tools for the development of the transit route network—the reliance on heuristics is minimal. In the proposed method, genetic algorithms, an evolutionary optimization technique, is used to develop the ''optimal'' set of routes. Results show that the proposed procedure performs better than the existing techniques.**

***Keywords* - Optimal routing; Public transportation; Genetic algorithms.**

I. INTRODUCTION

The globalization and the associated transport is apparent in our everyday life when we look at the bottom of a coffee cup and it says"Made in China". Many of the products we use every day are or contain parts which are manufactured on different continents. Also the passenger transport service is, especially in Europe, part of our daily life when our children takes the bus to school and we go to work by public transport or our grandparents take a wheelchair taxi to their activities. Even when accessing the internet and when planning out heating lines or optic fiber lines routing occurs. To ensure cheap prices of products and good mobility of the workforce it is important to ensure a cost efficient transport with the desired service level.

This can be done by planning the routes of the transporting objects well. Such route planning can also involve reducing the CO2 emission to comply with regulations and achieving an environmentally friendly image for a company. A large area in operations research involves routing and scheduling. This field involves everything from routing public transport over routing containers to routing optic fibers for data

Transport. Routing can be defined as selecting a path of travel. Operations research is often applied in real-life to generate valid and profitable routes. In the last decade, mathematical modeling has been applied to real-life routing problems and large gains are reported using these systems, see e.g. [7] for Swedish home care and [10] for Missouri lottery distribution. This thesis covers a variety of different routing problems which all have non-standard constraints inspired by real-life problems.

Some of these routing problems include scheduling. Due to the significant cost of fuel, cost efficient routes often also end up reducing the CO2 emission

- Network design a sub set of connections satisfying some requirements.
  The requirements to be satisfied in the network design problem can be to select a set of links Connecting a given set of points to each other or find a set of connections which generates a path through a given set of points. In real-life, network design problems often include:
- Routing selection of a path by which an object will travel.
- Scheduling assignment of tasks or commodities to objects often including a time aspect. Note that in practise the term network design is often used for a complete set of routes on a fixed schedule for an extended period of time satisfying some combined requirements. Scheduling can be used for time dependent routing where a schedule for when the vertices are visited is created and it is often used for connections which have a limited capacity.
  Many things can be routed such as the commodity of a demand, vehicles, vessels, cables, railway tracks and water pipes. Routing can also be to select a path of travel for a demand on a predesigned network. However, when there are several demands to be routed the routing of The demand also involves scheduling. The scheduling becomes nontrivial when capacity or time is constrained.

- Transportation object routing: the routing of transportation objects such as vehicles, vessels, cables and personnel.
- Demand routing: the routing of the commodities of the demands on a given network.
- The given network can be transportation objects carrying the demand.
  When optimizing routing and scheduling, knowledge of the demand is important especially in Problems where increasing the capacity of the network is costly or time requirements are tight. Finding an attractive route for a demand on a predesigned network will aim at low cost and a good service level. A low cost may result in increased profit or more competitive prices. A good level of service often involves the time of arrival.
- Passenger transport: For passenger transport the cost is obviously important but the travel time and availability is also part of the objective to ensure a constant or increasing demand.
- Freight transport: For freight the cost is very important, however for perishable goods or on demand freight there may be some requirement to the transportation time. For some routing problems two different problems are considered depending on whether it is people or freight cargo which is transported (see [18] and [19]). Naturally passenger and freight transport problems can both be separated into many more demand subgroups which have specific criteria attached to them.

II.THE OPTIMAL ROUTING PROBLEM

The problem here is to find a path which achieves some pre-defined purpose and is desirable (i.e., it is optimal or good in some way). There are two major classes of routing problems, namely the vehicle routing problem, and the transit (or bus) routing problem. Figure 1, for example, shows a part of the Vishakhapatnam road network with the bus route system superimposed (in purple); the job of optimal transit routing would be to determine such a bus system which is optimal from various different standpoints (described later).

III. PROBLEM IDENTIFICATION AND FORMULATION

Generally, distribution or collection of goods from customers to depot is called as VRP or Vehicle Scheduling Problem. The distribution of goods concerns the service, in a given time period, to a set of customers by a fleet of vehicles, which are located in one or more depots. These vehicles are operated by a set of crews (drivers), and perform their movements by using an appropriate network. In particular, the solution of a VRP calls for the determination of a set of routes, each performed by a single vehicle that starts and ends at its own depot, such that all the requirements of the customers are fulfilled, with some operational constraints and the global transportation cost is minimized. The operational constraints can be a vehicle capacity, route length, time window, precedence relation between customers, etc. Figure 1.1 illustrates a VRP with 3 vehicles serving 10 customers forming 3 routes

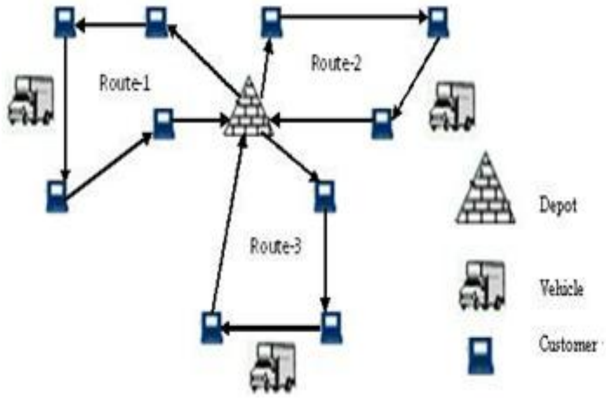

Fig.1. Vehicle Routing Problem.

IV. PROBLEM MOTIVATION

The Work attempts to develop an algorithm which will provide an ‘‘optimal’’ or ‘‘efficient’’ route network for transit system (for example, a bus system) operation on a road network given the following information:

- The road network data (i.e. how the nodes of the network are connected),
- Link travel time data (i.e. data on the travel time on road sections directly connecting any two nodes), and
- The transit demand matrix giving demand between all pairs of nodes in the network in terms of number of trips per unit time (normally a day).

V. ISSUES OF OLD ARTICLE

Pattnaik et al. (2012) formulated an optimization problem of minimizing the overall cost (both user cost and the operator cost) incurred for determining the transit routes and associated frequencies. In this paper they have used genetic algorithms (GA) to solve the route network design problem. The design is done in two phases. First, a set of candidate routes competing for the optimum solution is generated. Second, the optimum set is selected using GA. The GA is solved using the usual fixed string length coding scheme along with a new variable string length coding proposed in this study. The former assumes a solution route set size, and tries to find that many best routes from the candidate route set, using a GA. The route set size is varied iteratively to find the optimum solution. In the newly proposed variable string length coding method, the solution route set size and the set of solution routes are found simultaneously. The model was applied to a case study network.

Borvornvongpitak and Tanaboriboon (2005) developed a Computerized Bangkok Bus Transit Analytical System, (BBTAS), to enhance the performance evaluation of the existing bus system in Bangkok. The bus performance indicators are classified into three performance measurement groups and each group was broken down into the performance class and sub-class. The weights of each performance class and sub-class were conducted mathematically to describe the bus operating performance level. The Analytical Hierarchy Process (AHP) was applied for weighing the bus performance class and sub-class. Finally, the computerized BBTAS package was developed to evaluate the performance of all bus routes in Bangkok. This was demonstrated by applying to a real case involving 88 non-air-conditioned bus routes in India

Yasushi et al. (2005) have emphasised the need to consider not only the evaluation of the economic viability but also the comprehensive characteristics of bus routes. They have developed methods for comprehensive evaluation of efficiency using Data Envelopment Analysis and evaluated efficiency of bus routes in a city.

Hwe et al. (2006) proposed to reduce traffic congestion and to increase bus occupancy by merging bus routes. The analysis showed that merging will lead to an overall benefit for all parties, including government, bus operators, and passengers. The actual merging decisions, which routes to merge and at what frequencies buses should run, are determined by a mathematical model. The model also shows quantitatively the benefits of merging routes and the impact of other factors.

Ibeas et al. (2010) developed a bi-level optimization model for locating bus stops to minimize the social cost of the overall transport system. The work takes into account possible changes in demand due to different bus stop locations considering congestion on buses, interaction with private traffic, operational variables (fleet, frequency, operator budgets), and the socio-demographic characteristics of each zone in the urban area.

Chuanjiao et al. (2008) have studied the headway optimization and scheduling combination of bus rapid transit (BRT) vehicles. A model has been established to minimize passenger's travel costs and vehicle operation cost, with constraints on passenger volume, time, and frequency. The model was solved by genetic algorithm of variable-length coding. The result of the numerical case showed that the optimization results can save up to 69.92% cost. The sensitivity analysis showed that, under higher traffic volume or lower speed, the travel cost can be reduced through reasonable scheduling combination.

Verma and Dhingra (2006) developed optimal integrated schedules for urban rail and feeder bus operation. It consists of two parts: train scheduling sub-model and schedule coordination sub-model, which are formulated as combinatorial type optimization problems. The objective function for train scheduling sub-model is fixed as minimization of sum of operating cost of trains (operator cost) and total waiting time cost of passengers boarding the train (user costs) subject to load factor and waiting time constraint, whereas the objective function for schedule coordination sub-model is fixed as minimization of sum of total operating cost of feeder buses (operator cost), total transfer time cost for passengers transferring from train to feeder buses, and total waiting time cost of passengers boarding enroot (user costs) subject to load factor and transfer time constraint. The coordination is done for two cases; Case 1 for mixed fleet buses, considering all types of buses and Case 2 for single-decker fleet buses, considering only standard single-decker buses. The results are compared to adopt the best strategy. Thane City, which is a part of Mumbai Metropolitan Region, India, is taken as the case study.

Kliewer et al. (2006) described vehicle scheduling problem, arising in public transport bus companies, which addresses the task of assigning buses to cover a given set of timetabled trips with consideration of practical requirements, such as multiple depots and vehicle types as well as depot capacities. An optimal schedule is characterized by minimal fleet size and minimal operational costs, including costs for unloaded trips and waiting time. This paper discusses the multi-depot, multi-vehicle-type bus scheduling problem (MDVSP), involving multiple depots for vehicles and different vehicle types for timetabled trips. They used time–space based instead of connection-based networks for MDVSP modeling. This lead to a crucial size Reduction of the corresponding mathematical models compared to well-known connection-based network flow or set partitioning models. The proposed modeling approach was useful in solving real-world problem instances with thousands of scheduled trips by direct application of standard optimization software.

Shrivastava and Dhingra (2006) have studied feeder routes and tried to develop coordinated schedules for integrated feeder public buses with suburban trains. A Heuristic Feeder Route Generation Algorithm was developed for generation of feeder routes. Optimal coordinated schedules for feeder buses were developed in coordination with the existing given schedules of suburban trains. Genetic algorithm was used for the optimizing coordinated schedules. Andheri and Vileparle suburban railway stations of Mumbai, India, were selected as case study areas. Feeder routes for public buses and coordinated schedules of public buses for the existing given schedules of suburban trains at the two suburban railway stations were successfully developed in this research.

Sun et al. (2008) discussed Scheduling combination and Headway optimization of Bus Rapid Transit. A model has been established to minimize passenger travel cost and vehicle operation cost with constraints on passenger volume, time and frequency. The scheduling combination was composed of normal, zone and express scheduling. The model was solved by genetic algorithm of variable–length coding. The result showed savings of 62% cost. The sensitivity analysis has been done by changing traffic.

Ernst et al. (2004) have presented a review of staff scheduling and roistering problems, an area that has become increasingly important as business becomes more service oriented and cost conscious in a global environment. The review was related to roistering problems in specific application areas, and the models and algorithms that have been reported in the literature for their solution. Also surveyed commonly used methods for solving roistering problems.

Huisman and Wagelmans (2006) discussed the dynamic vehicle and crew scheduling problem and proposed a solution approach consisting of solving a sequence of optimization problems. Furthermore, they explained why it is useful to consider such a dynamic approach and compare it with a static one. Moreover, they performed sensitivity analysis on their main assumption that the travel times of the trips are known exactly before a certain amount of time of actual operation. They provided an extensive computational result on some real-world data instances of a large public transport company in the Netherlands. Due to the complexity of the vehicle and crew scheduling problem, they solved only small and medium sized instances with such a dynamic approach. They showed that the results are good in the case of a single depot. However, in the multiple-depot case, the dynamic approach does not perform so well. They investigated why this is the case and concluded that the fact that the splitting of instances into several smaller ones has a negative effect on the performance.

Barnum et al. (2007) have applied DEA for comparing the efficiency of Public Transportation Subunits. This article discusses the need for a performance measure that compares the efficiencies of subunits within a transportation organization, reflects the diversity of inputs and outputs, and is objective and consistent. The study presents a method for developing such a performance indicator, and illustrates its use with an application to the park-and-ride lots of the Chicago Transit Authority. The proposed method applies DEA supplemented by SFA to estimate efficiency scores for each subunit. The research demonstrates how the scores can provide objective and valid indicators of each subunit's efficiency, while accounting for key goals and values of internal and external stakeholders. The scores can be practically applied by a transit agency to identify subunit inefficiencies, and, as demonstrated by several brief case studies, this information can be used as the basis for changes that will improve both subunit and system performance.

Barnum et al. (2008) have used ratio analysis for multiple goals and constraint ratio analysis provides analytical methods for comparing the performance of multiple agencies, as well as the performance of subunits within a particular agency, in order to identify opportunities for
Improvement. This paper makes two contributions to the practice of urban transit performance evaluation using DEA. First, instead of using DEA to compare the performance of multiple transit systems, it uses DEA to compare the performance of multiple bus routes of one urban transit system. Second, it introduces a new procedure for adjusting the raw DEA scores that modifies these scores to account for the environmental influences that are beyond the control of the transit agency.

VI. CONCLUSION AND SUGGESTION

A GA-based unsupervised clustering technique was proposed in [9], which selects cluster centers directly from the data set, thus speeding up the fitness evaluation process by constructing a look-up table in advance and saving the distances between all pairs of data points. Binary representation rather than string representation is used to encode a variable number of cluster centers and more effective operators for selection, crossover, and mutation were introduced.

A novel clustering algorithm for mixed data was proposed in [10].Most of the existing clustering algorithms were only efficient for the numeric data rather than the mixed data set but the proposed GA worked efficiently for datasets with mixed values by modifying the common cost function. A hybrid genetic based clustering algorithm, called HGA-clustering was proposed in [11] to explore the proper clustering of data sets. This algorithm, with the cooperation of fabulists and aspiration criteria, has achieved harmony between population diversity and convergence speed.

A genetic algorithm was proposed in [12] which designed a dissimilarity measure, termed as Genetic Distance Measure (GDM) to improve the performance of the K-modes algorithm which is an extension of k-means. In [16] introduces a new algorithm based on the traditional genetic algorithm, for the traditional GA algorithm the new algorithm has done some improvements: By introducing genetic selection strategy, decreased the possibility of being trapped into a local optimum. Compared the traditional genetic algorithm, the new algorithm enlarges the searching space and the complexity is not high. By analyzing the testing results of benchmarks functions optimization, it is concluded that in the optimization precision, the new algorithm is efficiency than the traditional genetic algorithm. We also use this new algorithm for data classification and the experiment results shown that our proposed algorithm outperforms the KNN with greater accuracy.

REFERENCES

[1]. Baaj, M. H. and Mahmassani, H. (1991). An AI-based approach for transit route system planning and design.
[2]. Journal of Advance Transportation, 25(2), 187–210.
[3]. Baaj, M. H. and Mahmassani, H. (1992). TRUST: A LISP program for the analysis of transit route
[4]. Configurations. Transportation Research Record, 1283, 125–135.
[5]. Byrne, B. F. and Vuchic, V. (1972). Public transportation line positions and headways for minimum cost.
[6]. Proceedings of the Fifth International Symposium on Traffic Flow and Transportation, New York, 347–360.
[7]. Byrne, B. F. (1975). Public transportation line positions and headways for minimum user and system cost in a
[8]. Radial case. Transportation Research, 9, 97–102.
[9]. Ceder, A. and Wilson, N. H. M. (1986). Bus network design. Transportation Research -B, 20B(4), 331–344.
[10]. Chakroborty, P., Deb, K. and Subrahmanyam, P. S. (1995). Optimal scheduling of urban transit system using
[11]. Genetic algorithms. ASCE Journal of Transportation Engineering, 121(6), 544–553.
[12]. Chakroborty, P., Deb, K. and Srinivas, B. (1998). Network-wide optimal scheduling of urban transit networks
[13]. Using genetic algorithms. Journal of Computer Aided Civil and Infrastructure Engineering, 13, 363–376.
[14]. Deb, K. and Chakroborty, P. (1998). Time scheduling of transit systems with transfer considerations using
[15]. Genetic algorithms. Journal of Evolutionary Computation, 6(1), 1–24.
[16]. Dubois, D., Bel G. and Libre, M. (1979). A set of methods in transportation network synthesis and analysis.
[17]. Journal of Operational Research Society, 30(9), 797–808.
[18]. Goldberg, D. E. (1989). Genetic Algorithm in Search, Optimization and Machine Learning. Addison Wesley,