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A GENETIC APPROACH FOR TWO-DIMENSIONAL LOADING CAPACITATED VEHICLE ROUTING PROBLEMS

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Abstract. In this paper, a genetic approach is proposed to solve the two-dimensional loading capacitated vehicle routing problem (2DL-CVRP), for meeting the customer requirements in the logistics industry. A 2DL-CVRP consists of two sub-problems, namely the two-dimensional packing problem and the routing problem, which are both NP-hard. In our proposed approach, the packing problem, which is also known as the bin-packing problem, is tackled with a hybrid genetic approach while the vehicle routing is achieved by the branch-and-bound method. By combining these two approaches with an order-based genetic algorithm, it is demonstrated that better solutions for 2DL-CVRP can be duly obtained as compared with the existing ones.

Keywords. branch-and-bound, genetic algorithm, logistics, optimization, vehicle routing problem

1 Introduction

Hong Kong is a major logistics hub in Mainland China and southeast asia, and also is one of the largest and busiest container ports in the world. Just in the second quarter of 2008, there were about 68.2 million tones of port cargo going in or out Hong Kong [12]. A large portion of them in fact is originated from or will be further delivered to Mainland China via the land.

In oder to control the flow of goods or products between different sites, it is important to have a good management scheme so that customer's requirements are duly met. Recently, intelligent computational methods have been largely explored in this area and promising results are noticed [4,6,16,18,22].

In this paper, we are interested in a complex but practical land transportation problem, called capacitated vehicle routing problem (CVRP). It is one of the most frequently encountered issues in logistics, handling the delivery/collection of goods to/from a set of customer sites using a fleet of vehicles. The major objective is to minimize the transmission cost or maximize the customers' satisfaction. It is known to be NP-complete [9] and commonly solved by heuristic methods [2,3].

Usually, the formulation of CVRP considers the weight of the goods (or items as used in this paper) as the sole loading constraint, while their dimensions are ignored. However, physical dimension in fact plays an important role in cargo packing. If the sizes exceed the capacity of the cargo, goods cannot be delivered by a single vehicle. Therefore, the two-dimensional loading (2DL) constraints are recently included in CVRP [10,13].

The 2DL itself is an optimization problem generally known as 2D bin packing [1], which is to pack items into a number of identical rectangular bins, such that the total number of bins is minimized. It belongs to the class of Cutting and Packing (C&P) problems [7] which is also NP-hard. Other common C&P problems include 2D strip packing problems [15], job-shop scheduling [8,17,19], traveling salesman problem [5], and so on.