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A Q-LEARNING SYSTEM FOR CONTAINER TRANSFER SCHEDULING BASED ON SHIPPING ORDER AT CONTAINER TERMINALS

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Abstract. *In this paper, we address the material handling problem at marine container-yard terminal in order to reduce the ship waiting time. A Q-Learning algorithm based on the number of container-movements for the material handling in the container yard terminal is thus proposed. In the proposed method, each container has several desired positions based on its shipping order, so that the learning performance can be improved. In container yard terminals, containers are brought by trucks in random order. Since each container has its own destination and it cannot be rearranged after shipping, containers have to be loaded into a ship in a certain order. Therefore, containers have to be rearranged from the initial arrangement into the desired arrangement before shipping. In the problem, the number of container-arrangements increases by the exponential rate with increase of total count of containers. Therefore, conventional methods have great difficulties to determine desirable movements of containers in order to reduce the run time for shipping.*

Keywords: Scheduling, Learning, Dynamic programming, Container transfer problem, Q-learning, Block stacking, Multi-objective optimization, Reinforcement learning

1. **Introduction.** In recent years, the total number of containers treated at marine container-yard terminals continues to grow so that the run time of material handling operation occupies a large part of container logistics. Thus, in order to reduce the ship waiting time, designing a high-efficiency method for material handling operation is important [1,2,3]. Containers are brought by trucks into the yard area and are stacked in random order. They are stacked in a certain area called a bay, and a yard area consists of several bays. Since each container has its own destination and it cannot be rearranged after shipping, containers have to be loaded into a ship in a certain order. Therefore, bays have to be rearranged from the randomly stacked initial arrangement into the desired arrangement before shipping [4,5]. By the rearrangement, containers are moved into an area called a buffer. The objective of this research is to find destinations of removed containers and the order of rearrangement of containers that can reduce the run time of the shipping process being occupied a large part of itself by the material handling operation.

In the yard, each container is recognized by an unique name, and the number of bays depends on the number of containers. A position of a container is discriminated by discrete numbers. The state of the bay is thus described by the positions of all the containers. In this case, the number of states of the bay increases by the exponential rate with the increase of containers. In realistic situations the number of containers is often large, then required memory size to store information for all the state of the yard also becomes large. Therefore, the conventional methods using GA, reinforcement learning