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A heuristic rule for relocating blocks

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Abstract

One of the most important objectives of the storage and pickup operations in block stacking systems is to minimize the number of relocations during the pickup operation. This study suggests two methods for determining the locations of relocated blocks. First, a branch-and-bound (B&B) algorithm is suggested. Next, a decision rule is proposed by using an estimator for an expected number of additional relocations for a stack. The performance of the decision rule was compared with that of the B&B algorithm.

Keywords: Relocation; Block stacking; Branch and bound algorithm; Heuristic rule

1. Introduction

Block stacking, illustrated in Fig. 1, is a popular stacking method for efficiently utilizing storage space. A stack of blocks consists of multiple blocks that are stacked in the vertical direction, and a bay consists of multiple stacks, as shown in Fig. 1. Fig. 1 also shows the pickup sequence of blocks in a bay. Because blocks are stacked in the vertical direction, relocations must be performed for retrieving a block (we call a "target block") that is not on the top tier. Thus, despite the efficiency in the utilization of space in block stacking, the handling cost resulting from relocations is a serious problem.

There are many practical examples of items for block stacking such as boxes, pallets, marine containers, and steel plates. Marine containers are usually stacked in a container yard before (after) they are loaded (unloaded) into (from) a vessel. In container yards, a bay of containers consists of 6–10 stacks each of

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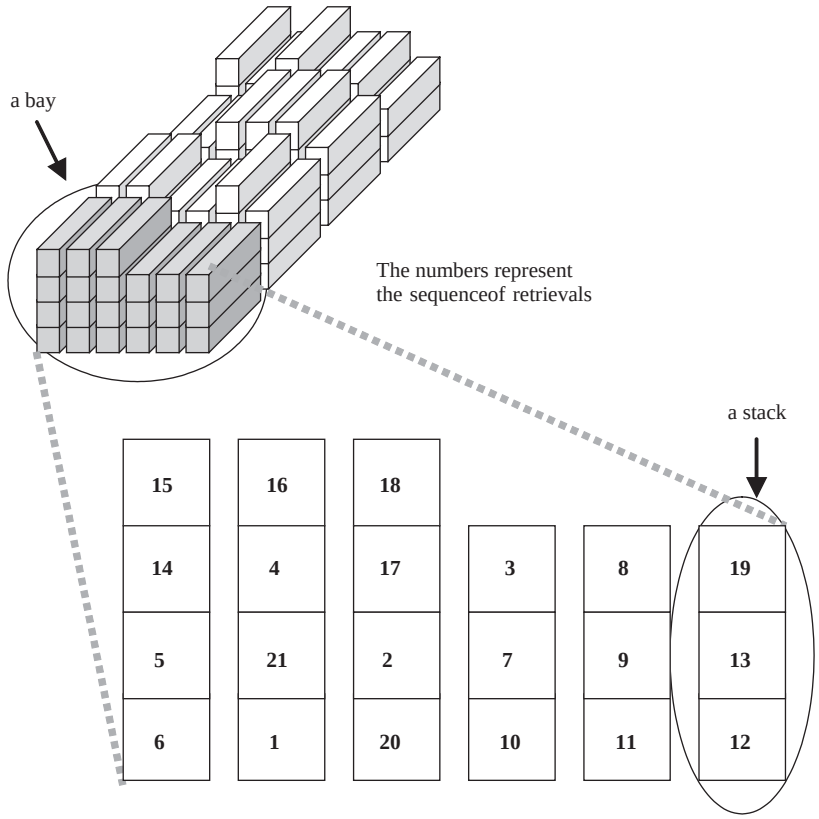

Fig. 1. An illustration of a yard-bay of blocks with a fixed sequence of picks-up.

which consists of 4–7 containers. For steel plates in warehouses, a stack consists of 30–50 plates. It takes about 1–2 min to relocate a marine container or a steel plate by a crane.

The following illustrates a typical example—port container yards—of the process of determining positions of storage locations, pickup sequence, and positions for relocations. The process of determining storage locations of outbound containers can usually be decomposed into three stages: the space allocation stage, the stage of locating individual containers, and the stage of locating relocated containers during pickup operations. In the space allocation stage, the yard-bays, which will be allocated to each vessel for future arrivals of containers, is pre-planned. The decision considers travel distances and congestions of yard trucks and yard cranes during the ship operation. When an outside truck arrives at the gate of container terminals, it is directed to a pre-planned yard-bay for the group of the delivered container. The exact storage slot in the yard-bay for the container is usually determined by the crane operator during the transfer operation. At that time, consideration should be given to the storage location so that heavier containers are located in upper tiers, because heavier containers are likely to be retrieved earlier so that they can be loaded in lower tiers in the vessel. Despite the careful storage of arriving containers, it is possible that heavier containers are located in lower tiers in the yard, then, relocation movements cannot be avoided to pick up heavier containers first. Because storage locations of relocated containers affect the future number relocations during the pickup operations, they also must be determined carefully. For