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Development of heuristic approaches for Liner Shipping Scheduling Problem

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1 Introduction

In this report, we describe the steps of six heuristic algorithms developed to select sport orders for the case of the Speed Scheduling and Order Selection Problem (SSOSP). The heuristic algorithms are based on: (a) the size of a spot order (V) in TEUs, (b) the length of the order trip (T) defined by the number of ports along the trip, and (c) the income related to the spot orders (I).

2 Overview of the heuristic algorithms

Each heuristic algorithm is characterized by two phases.

In the *phase 1*, the heuristic algorithm aims to select appropriately spot orders at each port. Initially the orders are sorted by one of the above three order characteristics, and then orders are added to the schedule of the ship, until the available vessel capacity or the available time to travel between ports is exhausted. The latter is constrained by the upper limit of the sailing speed and the necessary dwelling times at each port for loading/unloading. The orders are sorted by one of the following six rules:

1. Highest Size First (HSF): Order ranking in descending order size (TEUs)
2. Lowest Size First (LSF): Order ranking in ascending order size (TEUs)
3. Longest Trip First (LTF): Order ranking in descending order of trip length (nm)
4. Shortest Trip First (STF): Order ranking in ascending order of trip length (nm)
5. Highest Income First (HIF): Order ranking in descending order of income
6. Lowest Income First (LIF): Order ranking in ascending order of income

In the *phase 2*, the sailing speeds between ports are selected to achieve the lowest sailing/fuel costs within the inter-port time constraints imposed by the order selection.

3 Steps of the heuristic algorithms

The heuristic algorithm may be described by the following steps:

Phase 1

Step 1. Set as current port the first port of the liner shipping schedule.

Step 2. Create a list of the spot orders that have the current port as the origin port, sorted by the aforementioned ranking rules (i.e. HSF, LSF, LTF, STF, HIF, LIF)

Step 3. If the list of the spot orders is not empty:

Step 3.1. If the first spot order of the list of the spot orders may be inserted feasibly to the liner shipping schedule based on the ship residual capacity and the highest possible traveling speed, then add it to the liner shipping schedule and remove it from the list of the spot orders and go to Step 3

Step 3.2. Otherwise remove it from the list of the spot orders and go to Step 3

Step 4. If the current port is not the second-last port, set as current port the next one in the liner shipping schedule and go to Step 2

Phase 2

Step 5. If necessary, for each port, change the earliest arrival times, so that there is at least one feasible transition between ports based on the time required for the un/loading operations, and considering the possible highest sailing speed

Step 6. Set the arrival time at the last port of the liner shipping schedule to be equal to the latest time of arrival at the port

Step 7. Set as current port the last port of the liner shipping schedule

Step 8. If the current port is the first port of the liner shipping schedule go to Step 11

Step 9. Set the traveling speed from the previous to be the slowest possible such that the ship will depart from the previous port after the earliest possible departure (due to un/loading operations) and will arrive at or after the earliest arrival time of the current port

Step 10. Set as the new current port the previous port of current one and go to Step 8

Step 11. Return the current/updated liner shipping schedule and the corresponding sailing speeds