Harbor Logistics: Berth Allocation Problem for Inter-Related Terminals

Maarten Hendriks, Eindhoven University of Technology

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Introduction

- Last decades: rapid grow of containerization
- Ports need methods to optimize logistics operations
BAP for Inter-Related Terminals

Consider:

- Port with a number of terminals
- Terminals are inter-connected
- Each terminal has a restricted quay length
- Each terminal has a restricted number of quay cranes
- Each terminal has a restricted storage capacity
- Vessels arrive once a week
- Vessels need to be unloaded and loaded
- Each specific vessel transports its specific containers
Objective

Assign arriving vessels to terminals by trading off:

1. Processing vessels within preferred time window,
2. Balancing the workload among the terminals and among the days,
3. Reducing inter-terminal transport.
Model

MILP formulation

Binary variables:

\[ a_{tv}(k) \in \begin{cases} 1 & \text{if in terminal } t \text{ vessel } v \text{ arrives during } [k, k+1), \\ 0 & \text{otherwise.} \end{cases} \]

\[ d_{tv}(k) \in \begin{cases} 1 & \text{if in terminal } t \text{ vessel } v \text{ departs during } [k, k+1), \\ 0 & \text{otherwise.} \end{cases} \]

\[ b_{tv}(k) \in \begin{cases} 1 & \text{if in terminal } t \text{ vessel } v \text{ berths during } [k, k+1), \\ 0 & \text{otherwise.} \end{cases} \]
Model

Continuous variables:

\[ q_{tv}(k) = \text{Workload assigned in terminal } t \text{ to vessel } v \]
\[ \text{during } [k, k + 1). \]

\[ f_{prz}(k) = \text{Amount of containers transported from terminal } p \text{ to} \]
\[ \text{terminal } r \text{ with destination } z \text{ during } [k, k + 1), p \neq r. \]

\[ w_{tz}(k) = \text{Number of containers in terminal } t \text{ with destination } z \]
\[ \text{during } [k, k + 1). \]
Current Issues

Find appropriate heuristics for 1 and 2+3.

1. Berth Allocation
   - vessel to terminal
   - # cranes to vessel

2. Vessel to specific location in terminal

3. Specific cranes to vessel
Similar Problems

- BAP for 1 terminal: Tabu Search
- Cyclic Machine scheduling: Tabu Search
- Train scheduling: Decomposition Methods