

**Multimodal Container Logistics
and
Matrices of Sets in the Harbour**

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Overview

01

Container
Logistics

02

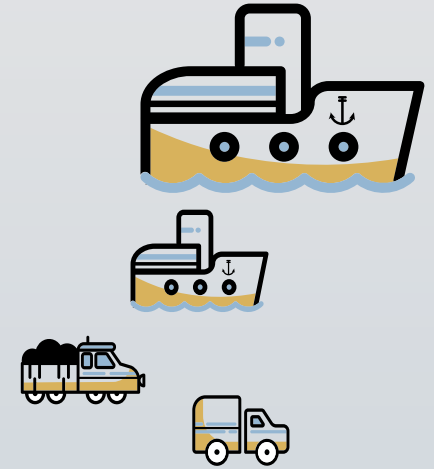
Matrices of Sets

03

Deep Sea
Journey ahead

Container Logistics

- Moving Containers Models, e.g. [[Sönke Hartmann 2002, for Hamburg Harbour](#)]
 - Transport modes are either
 - Deep sea vessel
 - Harbour feeder ship
 - Train
 - Truck
 - Transport mode >> transport mode size
 - Is another level of detail/hierarchical description
 - Time management
 - Arrival time of container t_A
 - Dwell time of container dt
 - Departure time of container $t_D = t_A + dt$
- Optimal Placement and Retrieval of Containers e.g. [[Yachba Khadidja 2017](#)]
 - This is operational research
 - Aiming at categorising containers adequately (Ex: safety for hazardous material, likely retrieval time before departure, storage duration, etc)
- Intelligent Container [[Mohamed Yassine Samiri 2018, for Le Havre harbour](#)]
 - Adaptive PRIoritizing Container Inspection (APRICOIN)



Container Logistics: Matrices of Sets

Moving Containers Models,

Define arrival vector V, departure vector W

1. along dimensions
2. Deep sea vessel
3. Harbour feeder ship
4. Train
5. Truck

Logistical Transport Switch matrix of Sets

$$C = [C_{(i,j)}]_{i=1,\dots,4; j=1,\dots,4}$$

Arrival transport mode i

Departure transport mode j

For instance: line 3 is allocating « everything arrived by train », column 1 is allocating « everything leaving by deep sea vessel »

Vector V is the arrival vector formed of what has arrived by each transport mode, and W what is leaving along each transport mode

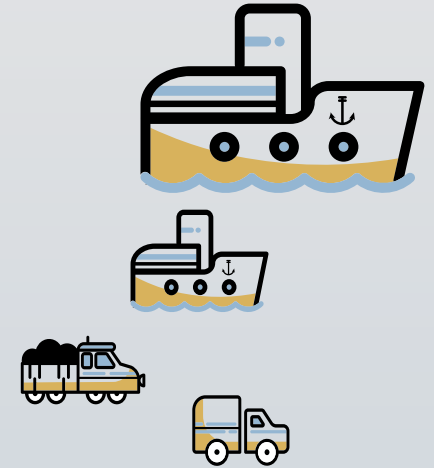
$$\begin{pmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{pmatrix} = \begin{pmatrix} C(1,2) \cup C(1,3) \cup C(1,1) \cup C(1,4) \\ C(2,2) \cup C(2,3) \cup C(2,1) \cup C(2,4) \\ C(3,2) \cup C(3,3) \cup C(3,1) \cup C(3,4) \\ C(4,2) \cup C(4,3) \cup C(4,1) \cup C(4,4) \end{pmatrix}$$

Arrived by deep sea vessel

Arrived by train

$W_j = \bigcup_i C(i, j)$ is the **departure set into** transport medium j

$V_i = \bigcup_j C(i, j)$ is the **arrival set from** transport medium i



Container Logistics: Matrices of Sets

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They can be expressed with:

-set replicating line set vector

$$L_1(X) = (X, X, X, X)$$

and set-replicating column vector

$$K_1(X) = \begin{pmatrix} X \\ X \\ X \\ X \end{pmatrix}$$

$$W_j \times X = C \cdot K_1(X)$$

$$V_i \times X = L_1(X) \cdot C$$

where

$$C = \text{Mat}[C(i, j)]$$

