Asia-Pacific
Economic Cooperation

2023/CTI/WKSP1/004
Session 3a

Advanced Technologies and Recent Applications in Smart Ports

Submitted by: Kobe University

Utilizing Digital Technology in the Field of Trade Facilitation Under the Current COVID-19 Pandemic and Beyond: Best-Practices Sharing Workshops (Phase II) – Third Workshop on Port Digitalization for Efficient Supply Chains
17 January 2023

Advanced Technologies and Recent Applications in Smart Ports

Utilizing Digital Technology in the Field of Trade Facilitation under the Current COVID-19 Pandemic and Beyond: Best-Practices Sharing Workshops (Phase 2) :

~ 3rd Workshop – Port Digitalization for Efficient Supply Chain ~

18 January 2023

Virtual Workshop

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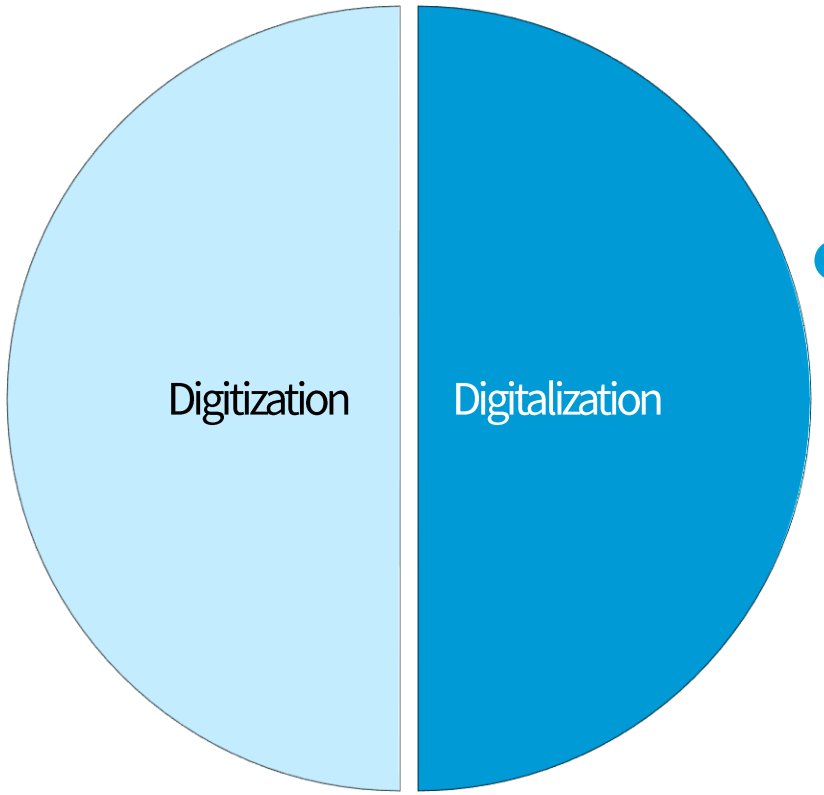
Two aspects of DX

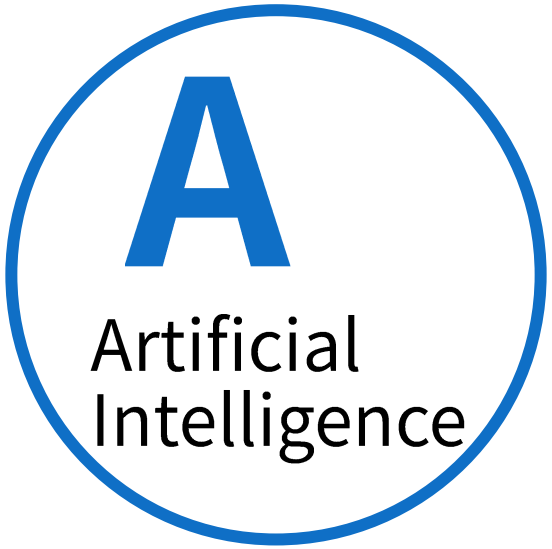


Turning analog to digital

Utilizing digitized materials (data) to improve operational efficiency / add value

Source: Hirata (2021)

ABCD Technology

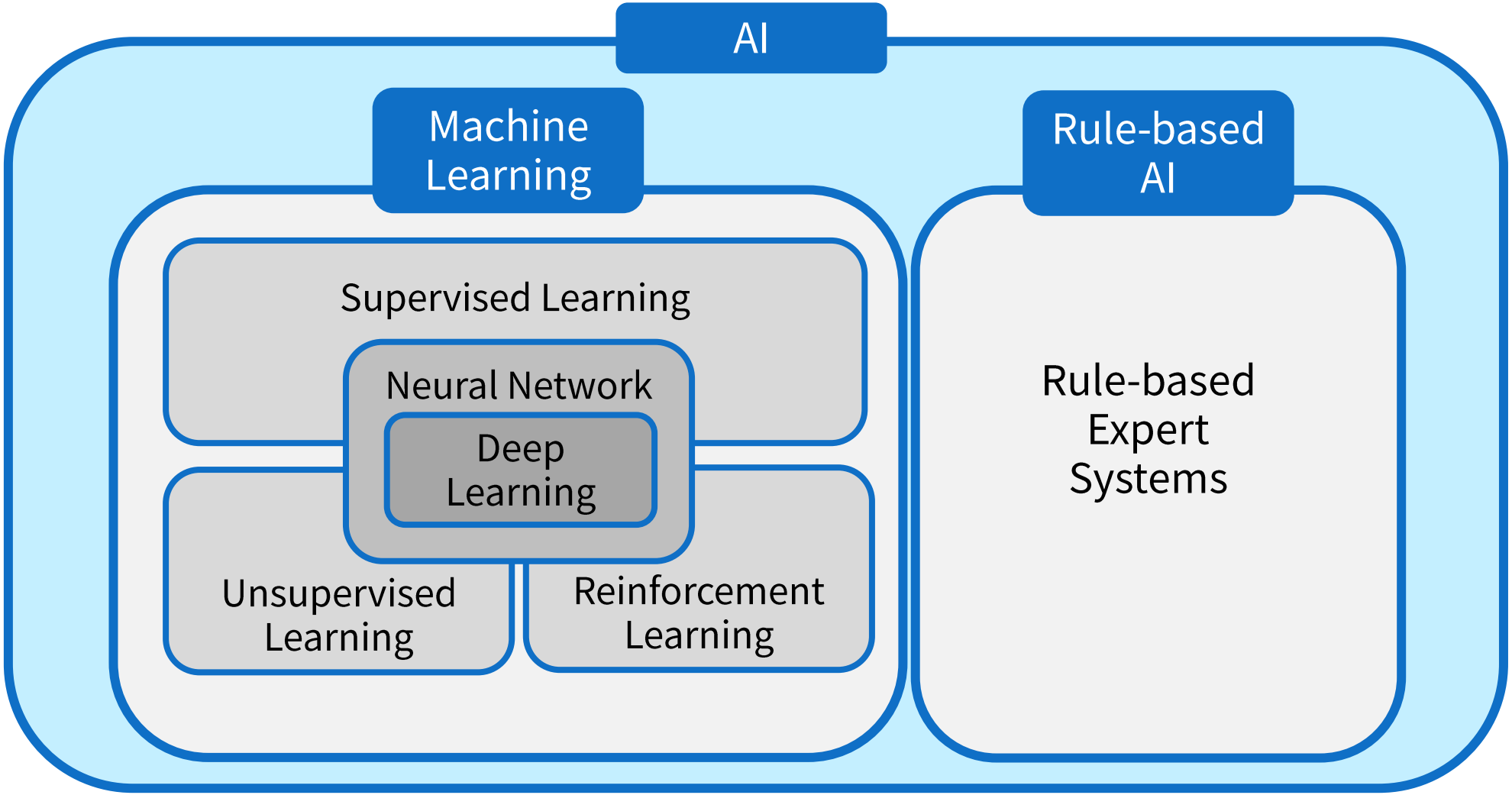


B
Blockchain

C
Cloud
Computing

D
Data

AI and Machine Learning

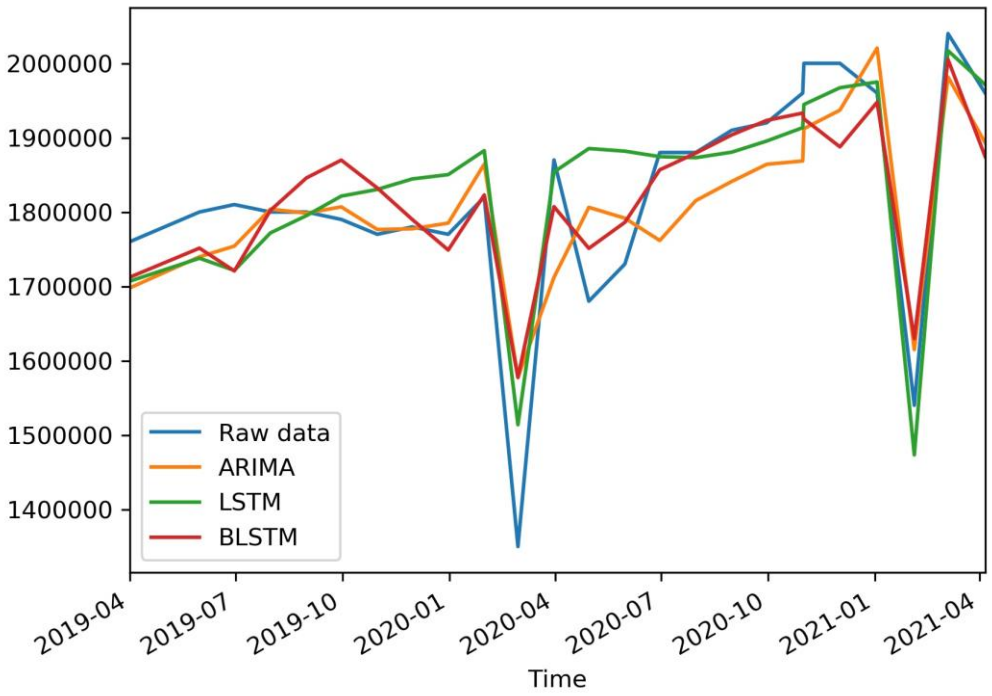


Source: Hirata et al. (2022)

Supervised Learning

- Preparing training data with a set of "input" and "correct output" in advance, and having the computer learn to produce correct output when given a certain input
- Regression, Decision Tree, Support Vector Machine, Random Forest
- Prediction, forecasting

Forecasting Port Container Throughput (Qingdao)

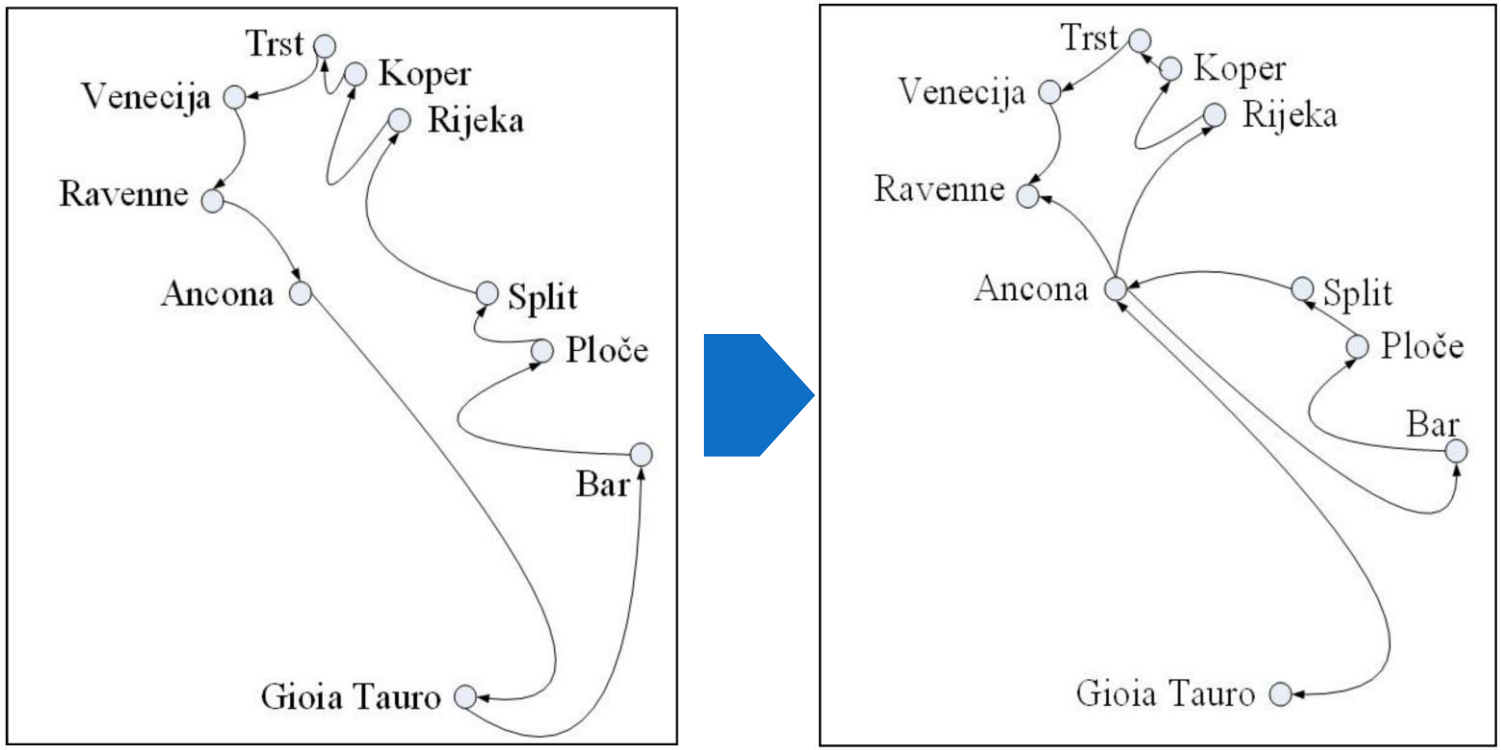


Source: Jiang et al. (2021). Forecasting Port Container Throughput with Deep Learning Approach, in Proceedings of the 5th International Conference on Computer Science and Application Engineering.

Unsupervised learning (self-supervised learning)

- Given only the input data, used to understand the inherent structure of the data
- Apriori, K-means clustering
- Port service optimization, competitiveness comparison

Optimize service, port calls



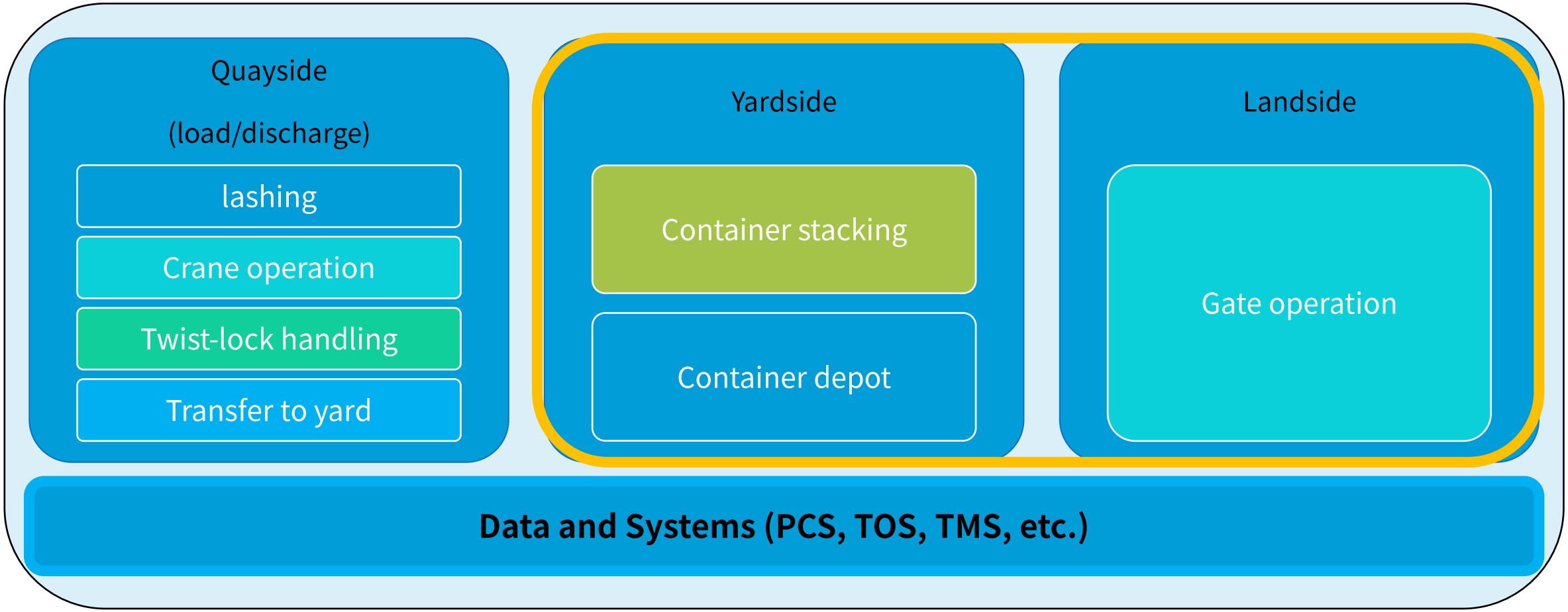
Source: Medić et al. (2021). Adriatic Sea Hub Ports Feeder Service Optimization Using Multi-Criteria Decision-Making Methods. *Sustainability*, *13*(21), 12325.

Reinforcement Learning

- Reinforcement learning is a model that learns to maximize future value instead of giving the correct answer
- Q-learning, DQN (Deep Q Network), and A3C (Asynchronous Advantage Actor-Critic)
- AlphaGo, autonomous driving

Image: https://www.alphagomovie.com

Areas of port digitalization



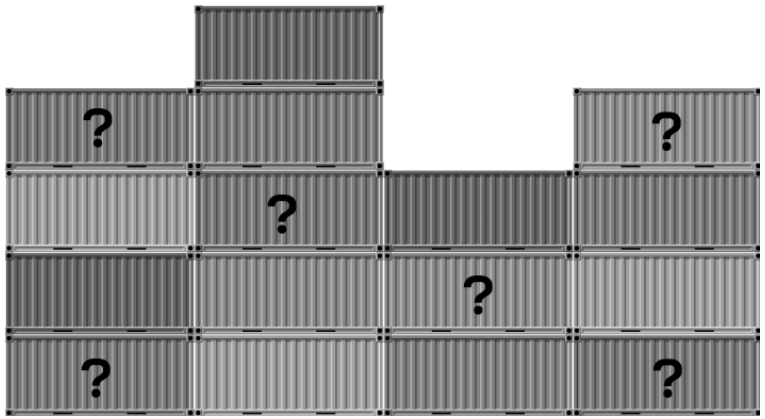
Source: Hirata et al. (2022)

Case 1: Import Dwell Time Prediction

Trialed with
100+ AI models

The Solution

Collecting and analyzing available data



Applying state-of-the-art **Artificial Intelligence**

- ✓ Analyzing existing and available date
- ✓ Use AI to assign each container automatically its optimal position
- ✓ Predicting schedule and stowage layout for outbound vessels

Predicting the dwell time of Import containers

The Benefits

>30%
Saved Shuffle Moves

>20%
Faster Truck Turnaround Time

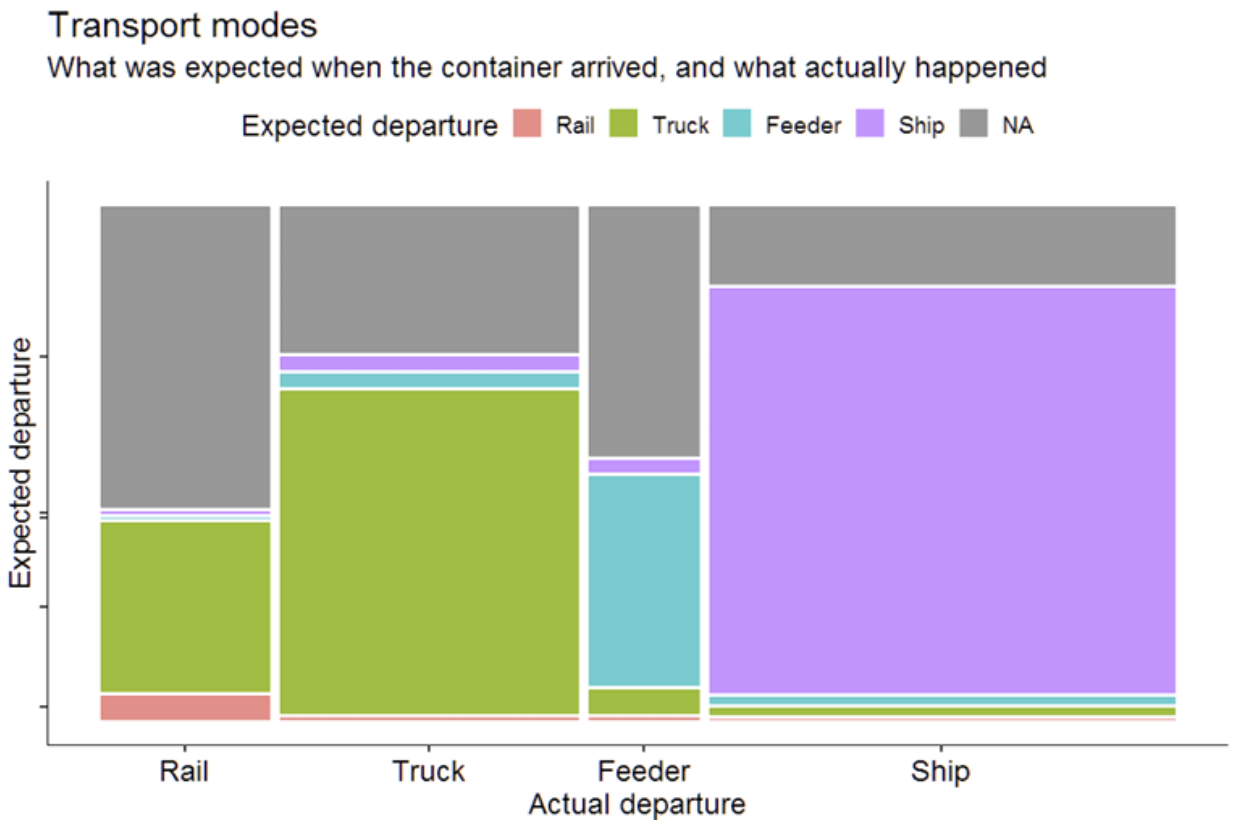
2.5M kg of CO2
Saved anually for a medium-sized port of 1.3M TEU

3-5M USD $
Saved anually for a medium-sized port of 1.3M TEU

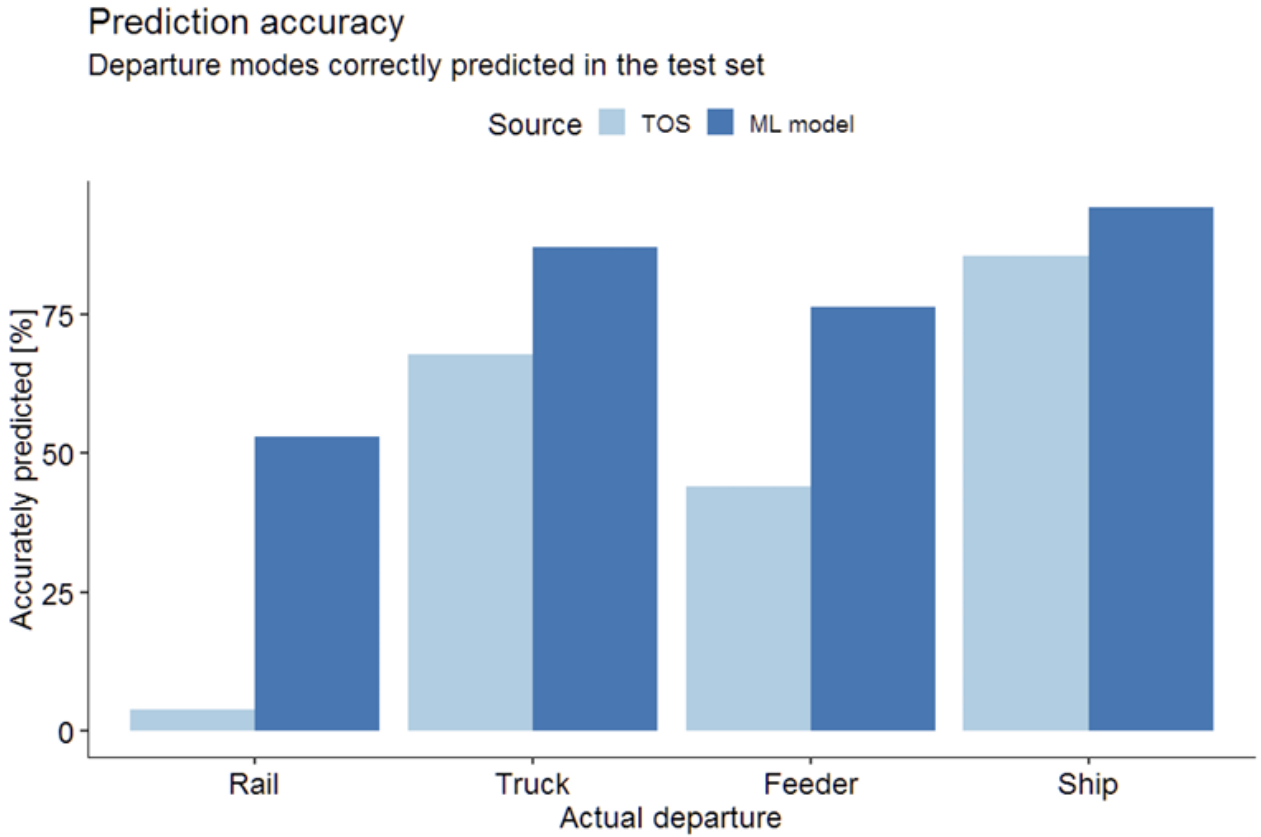
Source: https://blockshipping.net/

Case 2: Yard Optimization

THE FINDINGS
The accuracy of ML prediction model reaches 83.6, corresponding to a relative improvement in prediction accuracy of 33.

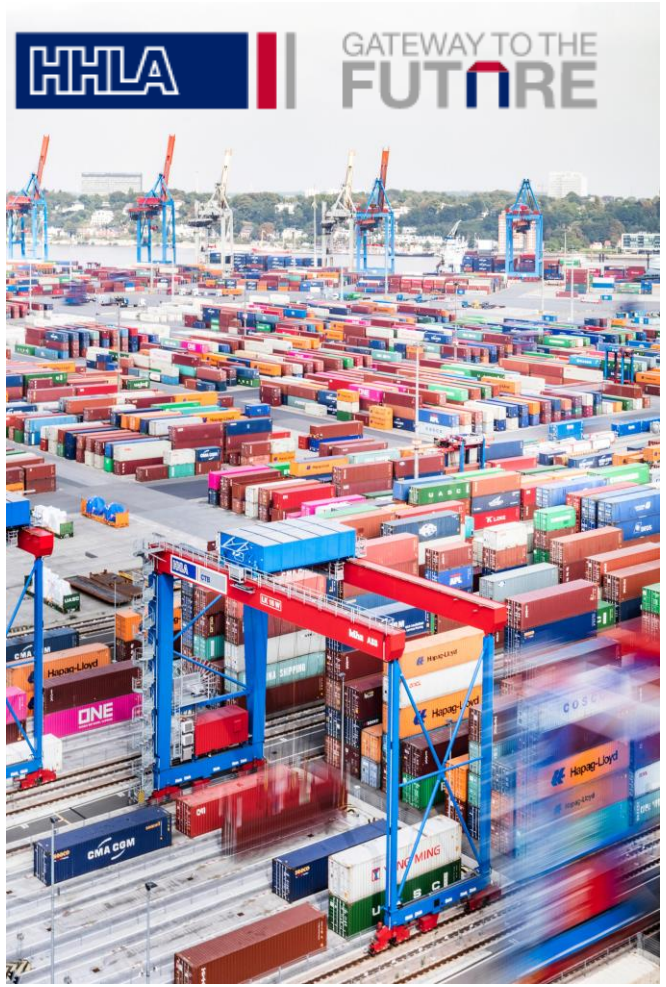


Source: Inform



TOS: Terminal Operating System

Case 3: Machine learning in Stacking



Source: Hamburger Hafen und Logistik AG

"Even when the yard is only 80 percent full, with 100 different dwell times we are left with 100^{1900} possibilities for stacking the containers in the yard"

- Trained with 1,000,000 dataset
- Able to determine the correct dispatch area for 77.5% of the containers lacking information
- The rate of restacks decreased by 8 percentage points
- Share of optimal stacking increased from 57% to 70%
- Distance covered by straddle carriers shorted by 25%+

Case 4: Smart Container Inspection

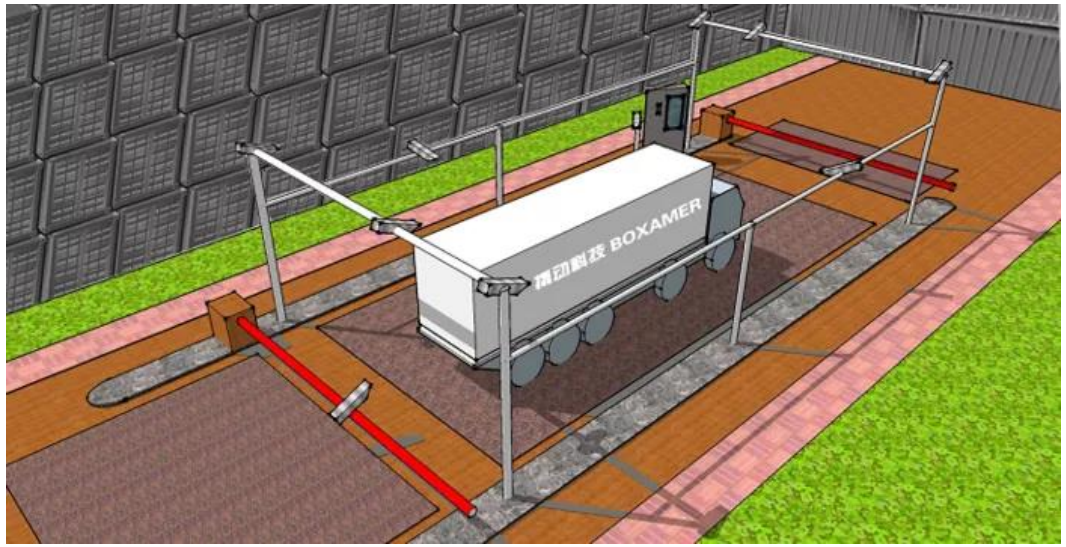


Image: Boxamer

- Driver scans the QR code using mobile device to check in
- Preinstalled camera takes photos and send to backend where container condition is checked by AI
- Result is sent to driver's device

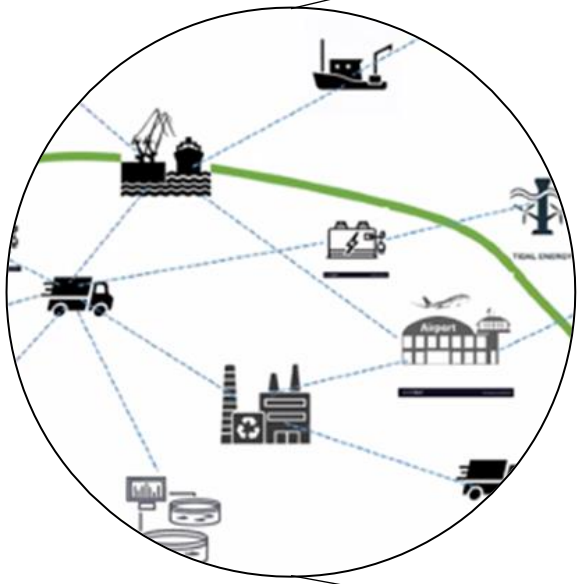
Case 5: Autonomous Driving

- Level 4 autonomous driving
- 40,000+ containers in 2021
- 1-4 platooning
- Parking < 70 seconds
- Positioning error <3cm

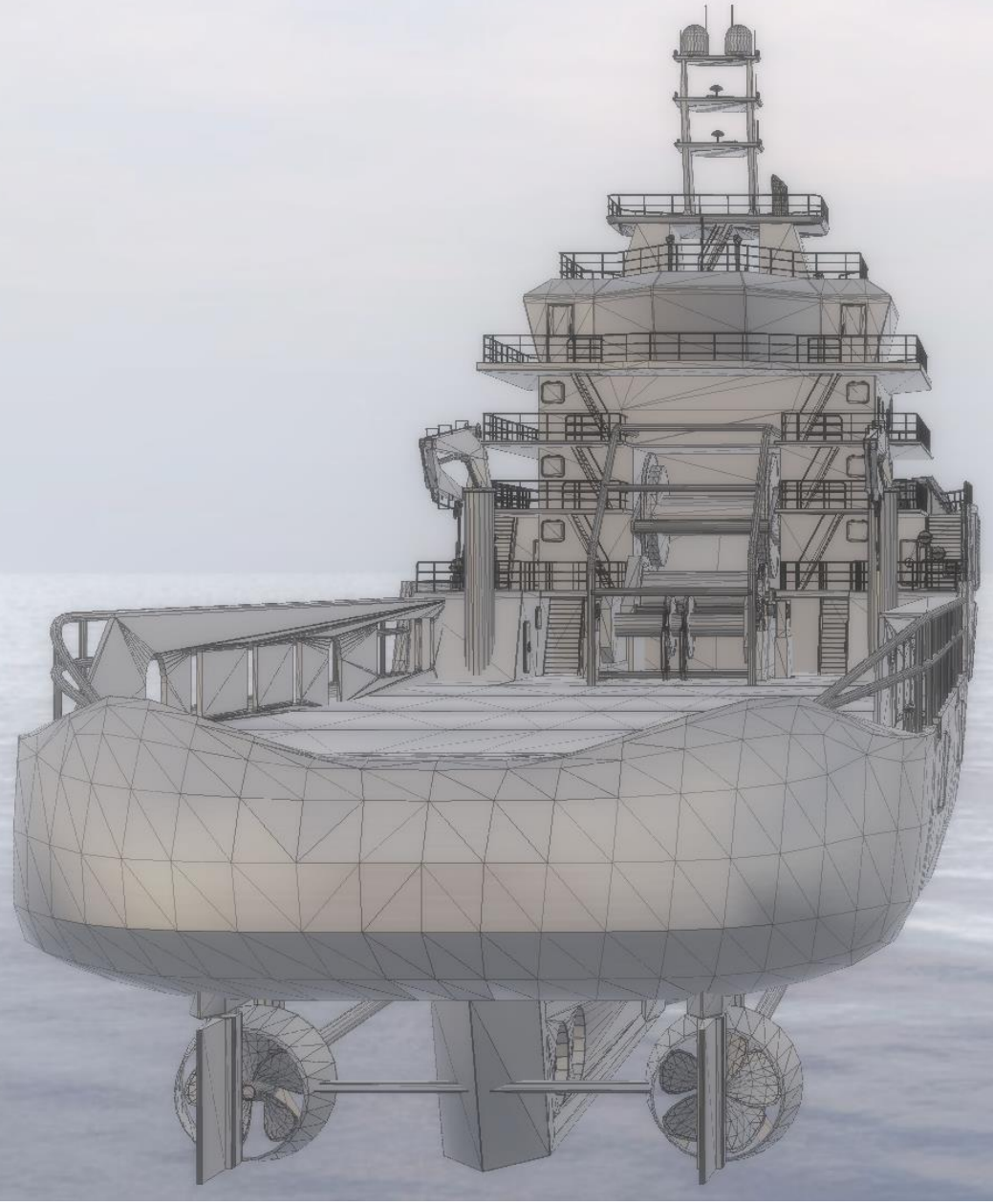
Level of automation

0 – manual	1 – assisted	2 – semi-automated	3 – highly automated	4 – fully automated	5 – driverless

The new normal of port operations



- Cloud-based
- Autonomous equipment and vehicles will increasingly become the standard within the port
- Artificial intelligence will assume increasing responsibility for decision-making and administrative tasks
- People continuing to play a key role in the port



Thank you

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Image: a ship's digital twin
https://www.ssi-corporate.com/digital-shipbuilding/