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AGENTIC ANALYTICS SYSTEMS:

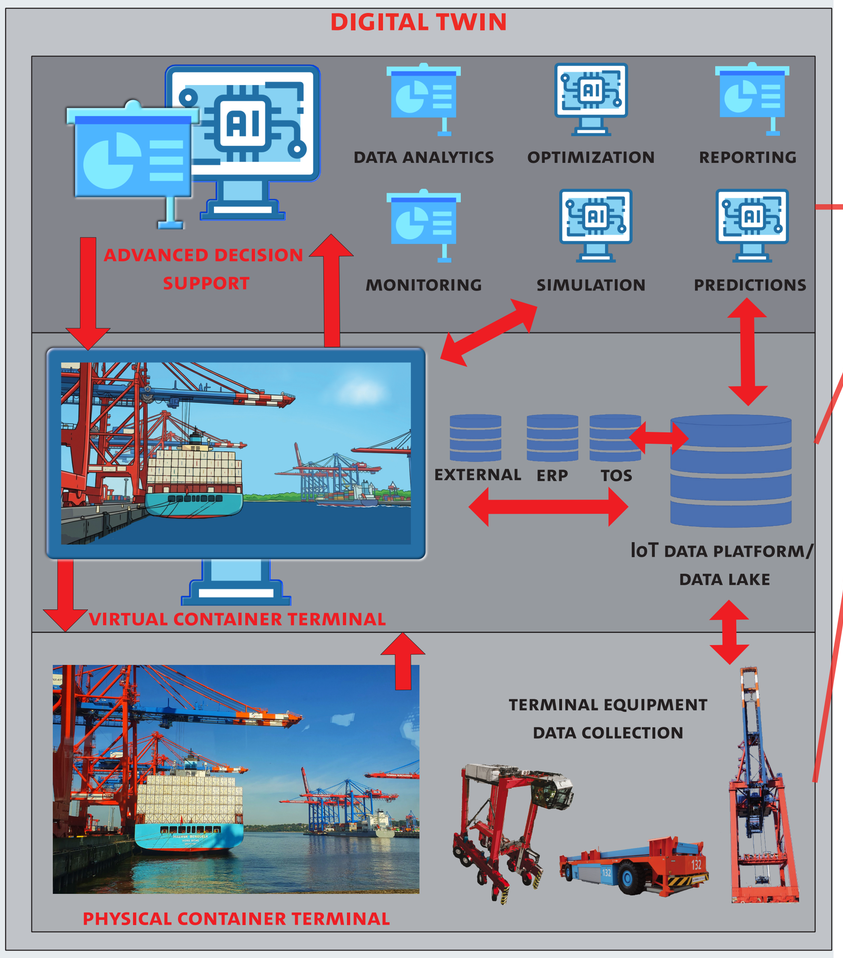
THE NEXT STAGE OF DECISION SUPPORT SYSTEMS AT CONTAINER TERMINALS

PROF. DR. STEFAN VOß, MICHAEL PALK

DECISION SUPPORT SYSTEMS (DSS) BASED ON DIGITAL TWINS AT CONTAINER TERMINALS

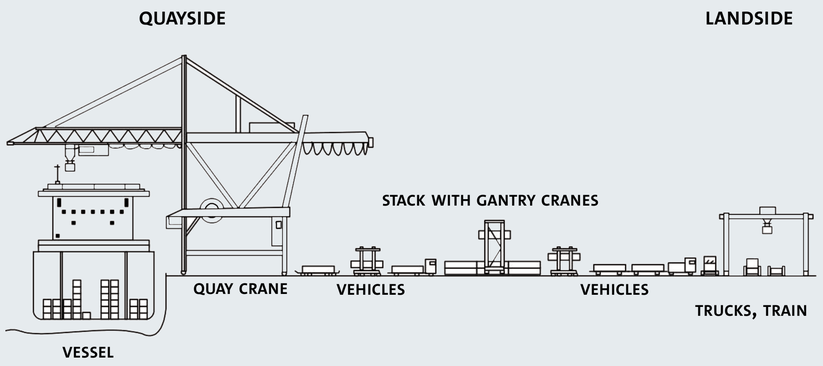
Current stage of DSS at container terminals

Digital twins of seaports provide a virtual representation of real-world processes at container terminals. They replicate and visualize terminal operations, enabling monitoring, simulation, and analysis of operational processes. This form of depiction facilitates the application of data-driven methods across **descriptive, predictive,** and **prescriptive** analytics.



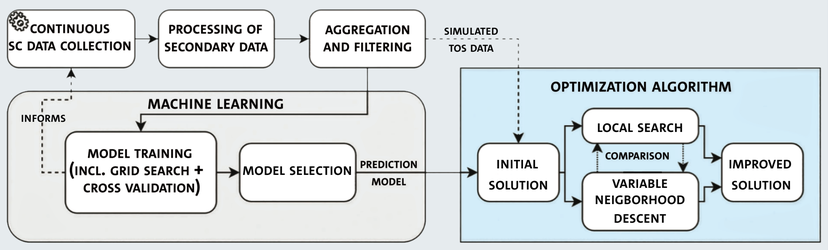
Exemplary problems in container terminals

- Straddle carrier (SC) routing optimization
- Vessel turnaround time predictions
- Berth allocation and quay crane assignment
- Restricted block relocation problem
- Platooning of automated ground vehicles



Descriptive, predictive and prescriptive analytics

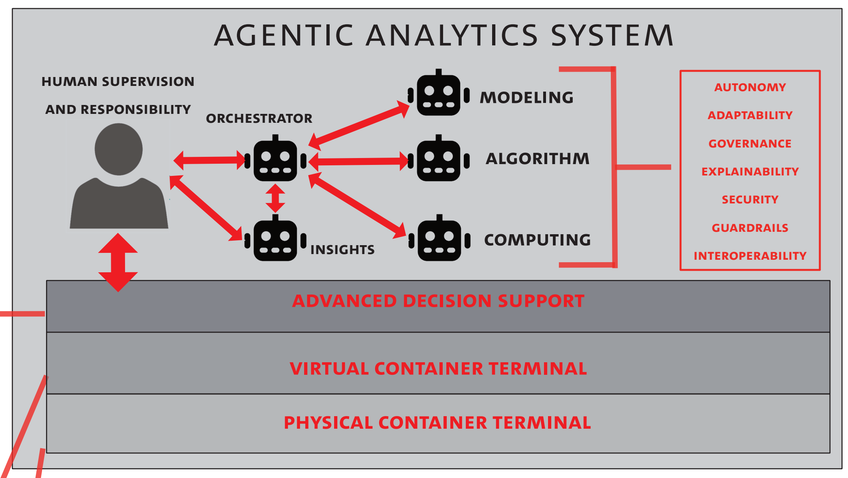
- Interplay between methods from data science, machine learning and operations research
- Descriptive analytics is used to assess the current status of container terminals
- Forecasts based on machine learning (predictive analytics) can be integrated into optimization models (prescriptive analytics)



INTEGRATION OF AGENTIC ANALYTICS SYSTEMS

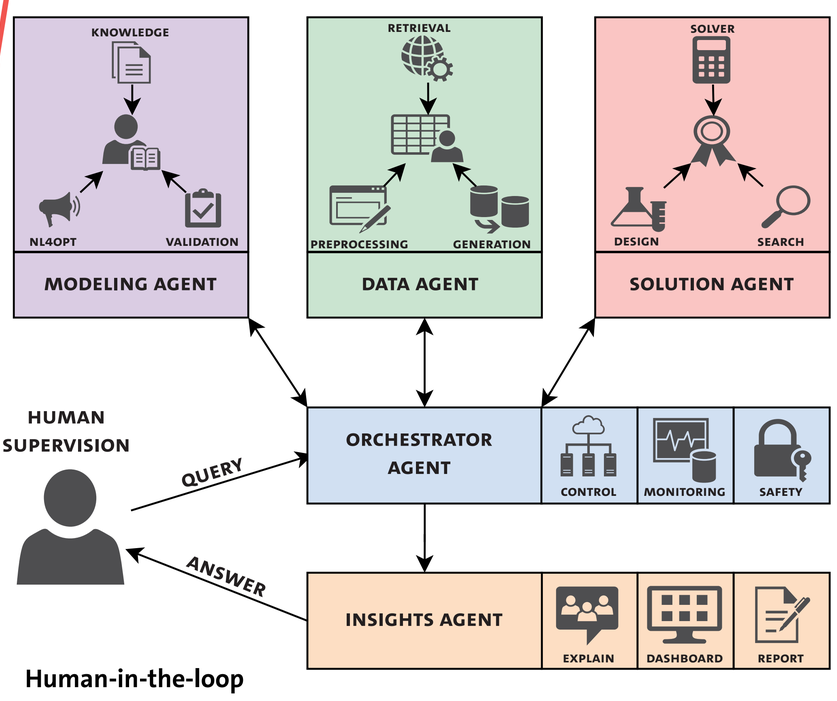
Next stage of DSS at container terminals

With the advent of generative and agentic AI - particularly large language models (LLMs) - new possibilities arise. Integrating LLM-based agents into DSS, gives rise to the concept of agentic analytics systems, potentially facilitating the usage of DSS by non-technical users.



LLM-based multi-agent systems architectures

- Multiple architectural designs can be considered for LLM-based multi-agent systems
- Specialized agents are used for each task; they communicate with each other
- An orchestrator agent coordinates all activities between the agents



Human-in-the-loop

- Human supervision and responsibility remain crucial when using autonomous agents
- Future research needs to address human-AI collaboration and the degree between augmentation, automation and autonomization
- Governance, security and guardrails need to be considered from the beginning

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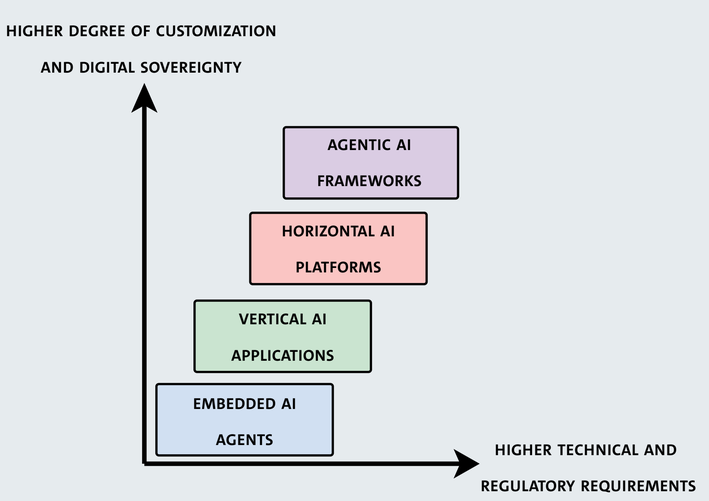
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SOURCING OF AGENTIC ANALYTICS SYSTEMS

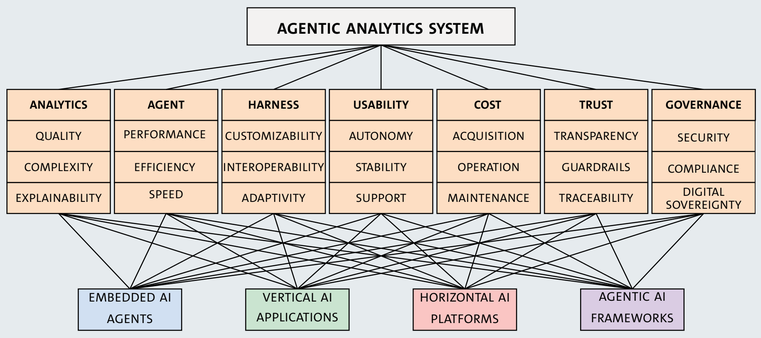
Next stage of DSS at container terminals

Outsourcing agentic analytics systems is a rather complex issue, compared to traditional IT-outsourcing. Unlike traditional software, current agentic systems consist of multiple interacting components.



Several criteria for choosing a suitable sourcing option

- Holistic assessment of the whole agentic analytics system, including the DSS and the agentic part
- Besides performance, usability, costs, trust and governance are also important aspects



Multi-criteria decision making for decision support

- Using multi-criteria decision-making methods to support sourcing decisions
- Inherent uncertainty necessitates robust methodologies
- Overall problem can be examined across multiple layers

