Multimodal Logistics

Application of Optimization Methods and Future Usage of Artificial Intelligence

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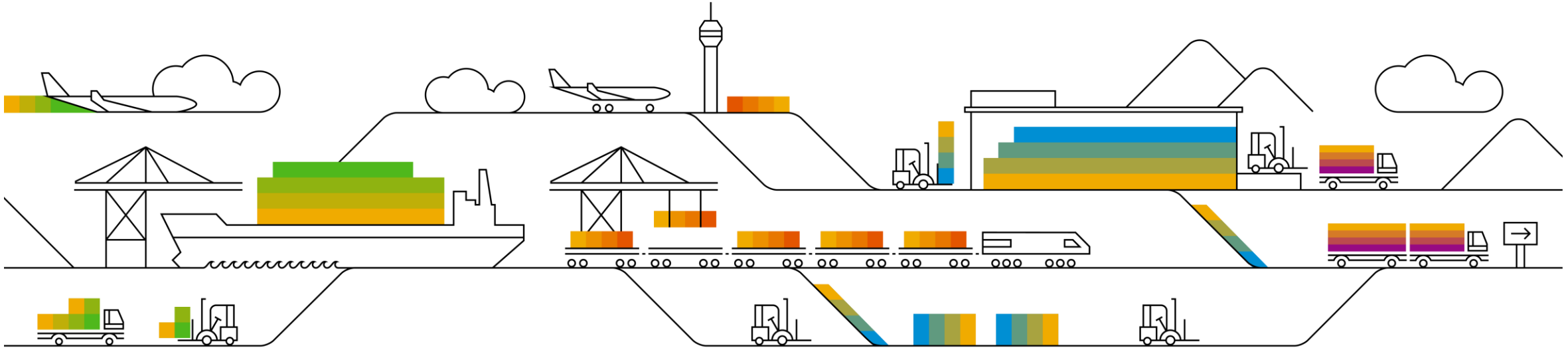
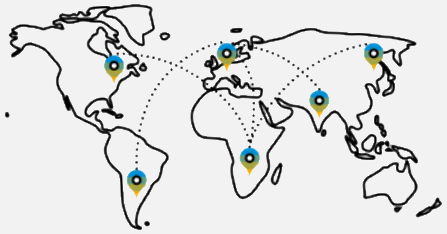
What is Logistics?

“Planning, execution, and control of the procurement, movement, and stationing of personnel, material, and other resources to achieve the objectives of a campaign, plan, project, or strategy. It may be defined as the 'management of inventory in motion and at rest.’ ”

Read more: http://www.businessdictionary.com/definition/logistics.html



The Mathematical Optimization of SAP Supports Global Industrial and Logistics Companies in Planning and Optimizing their Business



Value Chain Optimization

Planning and **optimization** of our customers' business, **worldwide**.

46

46 of the 50 **largest logistics companies** in the world optimize their entire portfolio of logistics services daily and in real time.

98%

98 of the 100 largest manufacturing companies use **SAP software** for external and internal **logistics** and **production** planning.

Logistics Reality Poses Mathematical and Technological Challenges to Optimization Software

Complexity of logistics business is reflected in a large amount of business **constraints** and constantly growing **data volume**.

Scalability as well as **high performance** are therefore basic requirements for the optimization services.

High **solution quality** of the optimization results is expected, since the **cost savings** achieved by process optimization are essential.

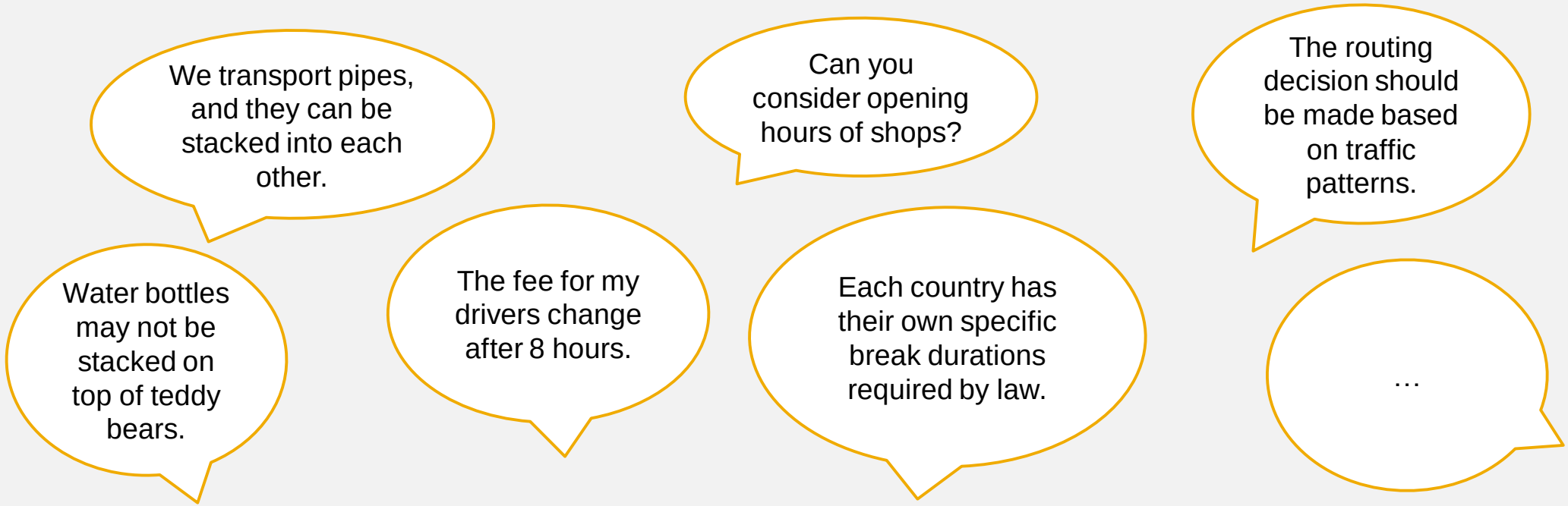
Data consistency is the basic prerequisite.

Optimization methods must be **legally compliant** and follow Industry standards and regulations, like GDPR.

Planning is **business critical**, so permanent **availability** of the optimization service must be guaranteed.

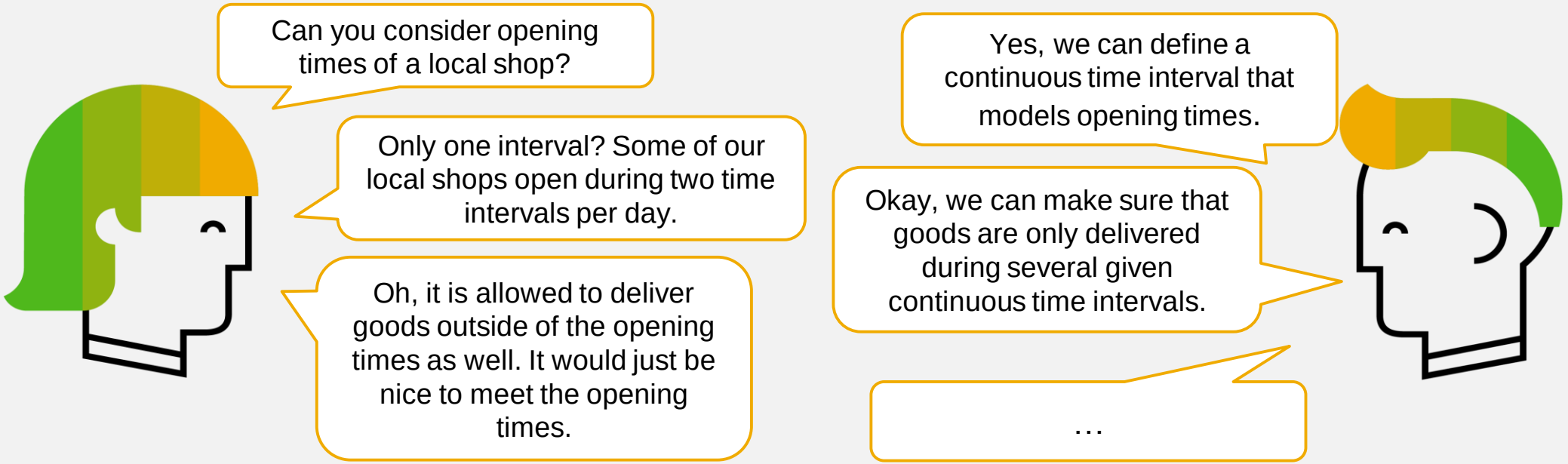
The Art of Modelling: Identification of Real-World Business Requirements

A Planning Solution Can Only Bring Valuable Decision Support to a Planner, if it Solves the Concrete Planning Problem.



The Art of Modeling: Mapping the Real-World Requirements to the Mathematical Model

The Correct Identification and Modelling of Business Requirements is a Continuous Dialogue Between Planner and Modeler.



Planning Problem to Optimization Problem

A Planning Problem may Contain Several Optimization Problems.

Example: Route planning in a multimodal network

- Network Flow Problem
- Vehicle Routing Problem
- Scheduling Problem
- Bin Packing Problem

Optimization Algorithm: It Is Not Only About Finding an Optimal Solution!

Performance

- Fast response rates, even for huge data sets

Explainability

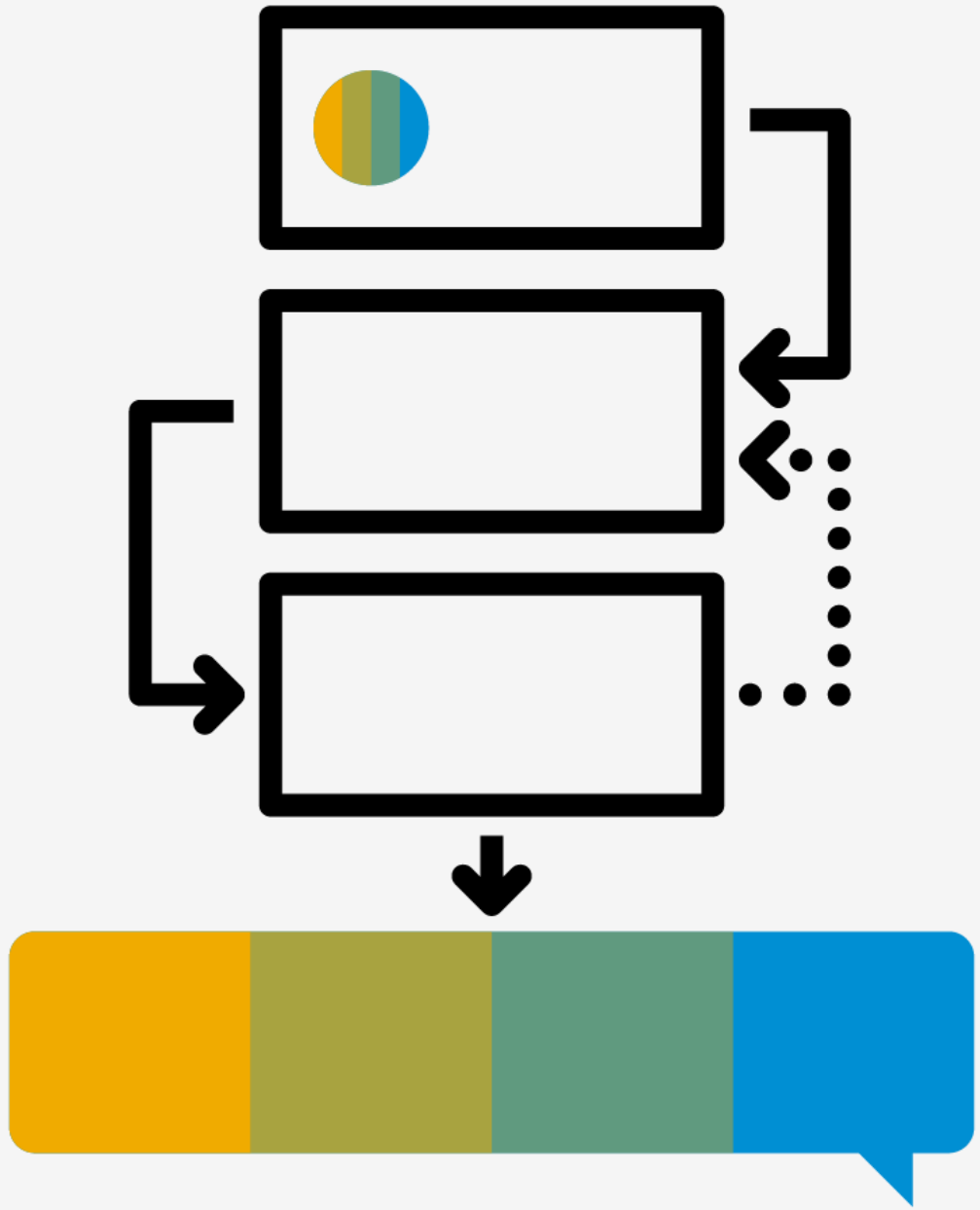
- Why did the algorithm choose this solution?

Robustness

- Similar problems should have similar solutions

Adaptability

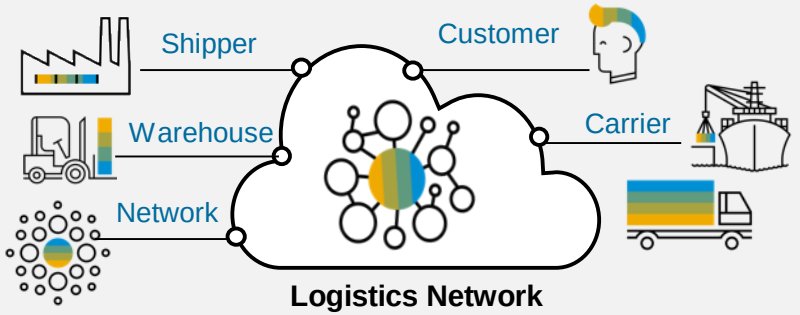
- Final test in concrete, real business environment



The Increasing Complexity in Logistics Changes the Requirements Dramatically

Today's logistics chains are **static** and are optimized along **fixed constraints** to generate deterministic delivery schedules.

Local optimization of the **individual company** on the basis of a objective function, while fading out the upstream and downstream value-added stages.



In the future, logistics companies will have to be **flexible** in meeting changing customer demands and external influences and will have to react even **more promptly** and **in realtime**.

In order to optimize these adaptive delivery networks, there will be a multitude of **decentralized planning**, which will be **optimally** coordinated on a higher level.

There is a great **Need for Research** to enable this flexibility and mutability of production and logistics systems, but also their objects such as drones, autonomous vehicles or forklifts, and to integrate them adequately into existing supply landscapes.

Technologies of the 4th Industrial Revolution Create a New Dimension of Real-time Transparency in the Supply Chain

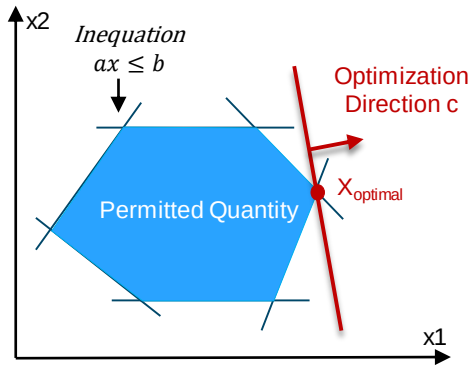
The tools of **Industry 4.0** can be applied to objects in logistics such as trucks, forklifts, pallets or packages.

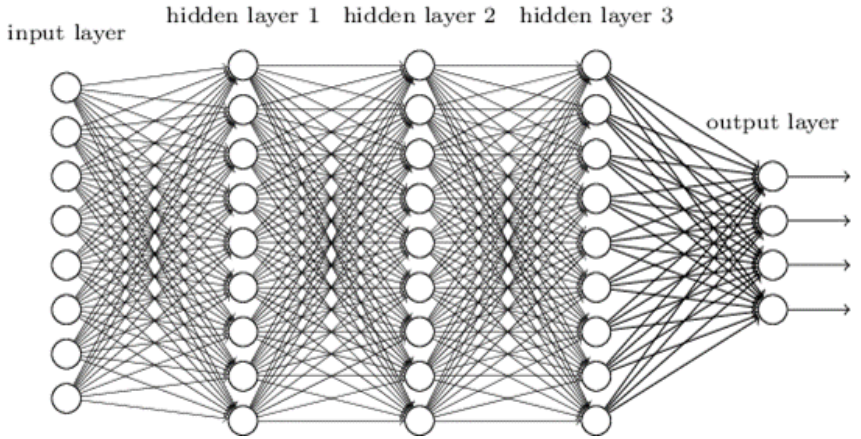
The **"digital twin"** of these objects allows structured data collection and analysis during their life cycle.

Suitable standards for data exchange then allow these **real-time data** of **high granularity** to be integrated into the **planning algorithms**.

This will significantly **improve** the **optimization** of logistics, e.g. to significantly reduce empty runs in the future.

Classic, Mathematical Optimization Methods are Gradually Supplemented and Enriched by further AI Methods and Simulation





Current optimization methods are based on **classical mathematical** methods.

These methods are enriched **with forecasts** and **empirical values from the past**, such as sales figures or transport intensities, in order to develop optimization models that maximize a complex objective function under boundary conditions.

Uncertainties exist for the parameters of the models, which are compensated **by safety margins and flexibility buffers**.

This leads to unused **excess capacities** and **stocks**.

In the future, **AI tools** that access the data of the digital twin, e.g. trucks and containers, and **extract patterns** from historical planning data will **significantly improve the quality of these prognosis and experience parameters**.

Simulation models will become indispensable for planning in order to understand the quasi-stochastic behaviour of logistics networks and to be able to optimise their design.

Examples:

- Deep-Learning extraction of planning costs for transportation planning
- Deep-learning forecasts of congestion times and travel times for the optimization of the route and delivery times

Quelle: http://www.rsipvision.com/exploring-deep-learning/

Digital Platforms Allow the Optimization of Logistics Networks Beyond Company Boundaries

Supply chains and networks span a variety of **company boundaries**, from the preliminary products to the tier 1 suppliers to the OEM and end customers.

Digital platforms will coordinate the processing of logistics tasks via the value creation network; Data will be saved in these platforms

These digital logistics platforms allow the use of **artificial intelligence** methods for **pattern recognition** and **process optimization**

The platforms will merge the data and thus allow meaningful pattern recognition.

Future Logistic Solutions Need to Tackle Social, Technical, and Ecological Challenges

- Decarbonization
- Overburdened infrastructure
- Pollution by microparticle emissions in cities or metropolitan areas
- Autonomous vehicles for the last mile and for optimization of driving times
- Supply chain management for the circular economy
- Supply chain resilience – Covid-19
- Recent addition: optimization on quantum computers

Thank you.

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