KI in der Disposition für eine modernere Bahn

German Data Science Days 2024

March 7th, 2024 | Munich
AI in dispatching for a more modern railroad

Agenda

1. AI in dispatching
2. KI Dispo – railway company dispatching
3. ADA-PMB
While ADA-PMB aims to improve overall punctuality within the railway network, KI Dispo improves passenger/customer punctuality.

**Goals & Procedures of KI Dispo & ADA-PMB**

**ADA-PMB**

**Goals:** Improving overall punctuality within the railway network through algorithm-based dispatching recommendations for infrastructure dispatchers.

**Procedure:** Mix of different AI methods with a focus on mathematical optimization.

**KI Dispo**

**Goals:** Improving of passenger/customer punctuality by dispatching suggestions for railway company dispatchers with a focus on traffic and resource dispatchment.

**Procedure:** Artificial intelligence/ reinforcement learning in combination with simulation.

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**Dr. Hannah Richta**  
Head of Algorithms for Operations (DB InraGO)  
Responsible for implementation of algorithmic train scheduling in the network.

**Torsten Deutsch**  
Head of Lane Rail Operations, AI Factory  
Responsible for expansion of existing AI approaches in dispatching.
Dispatching is a team sport – decision-making and data are distributed between railway and infrastructure companies

Overall Dispatching Process

**Railway Company Dispatching**

- Staff planning & -dispatching
- Vehicle planning & -dispatching

**Infrastructure Dispatching**

- Availability of infrastructure

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Status Quo: the typical tasks and challenges of a traffic dispatcher in a railway company

Traffic Dispatcher railway company

**TASKS**
- Monitoring of the current operational situation to secure the traveller chain
- Responsible for train changes & schedule to increase the punctuality

**CHALLENGES**
- Increasing traffic volume
- Network extensions
- Limited resources

**RESULTS**
The traffic dispatcher is under high pressure. At some point, the human eye is no longer able to keep track of everything and calculate the impact of every decision.

Current tools only help to a limited extent in finding the „best“ decision.

AI SUPPORTS VIA…
1. Creation of recommendation through learning algorithms
2. Data-based and quantitative evaluation of recommendation
3. Integration in the relevant IT-Landscape of the DB

THE DISPATCHER RETAINS FULL AUTHORITY TO ACT
Clear structuring of the system reduces complexity

Digital Twin
- Digital twin of the railway network
- Analysing optimal traffic flow
- Identification of conflicts

Recommender
- Training and evaluation workflow that interacts with the Simulation
- Generation of proposals to solve possible conflicts in advance through preventive actions

User Interface
- Integrate the tool into the daily routine of the dispatcher
- Combination of simulation and AI enables to visualize the impact of an action up to one hour in the future
Continuous collaboration with end users

**AMBITION**

- **Acceptance** and **enthusiasm** by creating an aligned understanding of AI solutions
- Ensure effective project support through **user-centric product development**
- **Connecting** train production and AI **expertise** for a sustainable process integration
- **Product is effective and accepted**
- **User involvement from day one!**

**PATH**

- Bringing together the experts of train production and AI within different formats
  - Intensive test phases
  - Visit control centres on a monthly basis
  - Integration of feedback opportunities in UI
- **Sharing information via different channels to ensure knowledge exchange**
  - Online updates
  - Tutorials
  - E-learning videos

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Dispatching is a key factor for short-term optimization of railway infrastructure – main challenge is the lack of systemic assistance

Dispatching Goals & Challenges

Goals & functions

Ensuring maximum operational quality to achieve a high level of overall planning reliability

dispatchers...

- determine the order of trains & monitor the execution of their decisions
- give advice on the operating behavior of trains & pay attention to the dispatching implementation
- inform the traffic controller and the infrastructure dispatcher in the case of delays & transmit traffic controller requests for deviations from train characteristics to the dispatcher

Challenges

- No systemic support for conflict detection and optimized dispatching solutions
- Complexity of the situations to be managed not represented in the dispatching system
- High workload under time pressure, especially in degraded situations
- Loss of expertise due to demographic change & shortage of skilled professionals
ADA-PMB calculates the minimum delay solution and translates dispatching recommendations into comprehensible displays

Display of Dispatching Recommendations

**Overtaking**

<table>
<thead>
<tr>
<th>Train &amp; delay</th>
<th>Track change</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFS Ffm Süd</td>
<td>FFO U</td>
</tr>
<tr>
<td>ICE A 692 [+10]</td>
<td>DGS 69495 [+48]</td>
</tr>
<tr>
<td>508</td>
<td>3660-2</td>
</tr>
<tr>
<td>506</td>
<td>30303</td>
</tr>
<tr>
<td>Tzf (D) 79686 [+18]</td>
<td>3660-1</td>
</tr>
<tr>
<td>05:27 min</td>
<td>07:31 min</td>
</tr>
</tbody>
</table>

Remaining time for communication with traffic controller

**Crossover**

<table>
<thead>
<tr>
<th>Dispatching center</th>
<th>Threading</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHW Hanau West</td>
<td>FH N Hanau Nordseite</td>
</tr>
<tr>
<td>02:12 min</td>
<td>02:42 min</td>
</tr>
<tr>
<td>EZ 51165 [+190]</td>
<td>ICE 77 [+1]</td>
</tr>
</tbody>
</table>

Anonymous feedback for further improvement

In the function of a co-pilot, ADA-PMB indicates conflicts and offers a recommendation for an optimized solution.
ADA-PMB uses live data from the dispatching system to generate recommendations based on optimization with additional AI input.

**ADA-PMB Process Steps**

1. **Input data**
   - Original data from dispatching centers
   - Infrastructure, its availability restrictions, schedule and train data

2. **Pre-process**
   - Setting up the optimization model (mathematical model of variables and inequalities)
   - Supplementary creation of hints to accelerate optimization using heuristics and machine learning (AI method mix)

3. **Optimizer**
   - Minimization of the total delays through mixed integer optimization
   - Optimal solution in the operating area
   - Complies with non-discrimination requirements

4. **Post process**
   - "Translating" the solution into comprehensible dispatching recommendations
ADA-PMB implemented in 4 regions – measurable reduction of delay minutes & positive feedback from dispatchers

ADA-PMB in Practice

2020 first pilot with S-Bahn Berlin dispatching center on a section of the Berlin S-Bahn network launched

2022 Pilot Frankfurt – Hanau: first time use of a dispatching assistance system in mixed traffic in Germany and extension by the Riedbahn access line in June 2023

2023 further expansion of piloting with the support of the "Digitaler Produktionsverbund" (DPV): Stuttgart – Plochingen and Munich S-Bahn main line

Mainly positive feedback from dispatchers. Continuous development of ADA-PMB based on the feedback.

Measurement of effectiveness in Frankfurt/Main based on threading recommendation shows:

- In 70% of the cases analyzed, trains were dispatched as suggested by ADA-PMB
- Disposition according to the order suggested by ADA-PMB leads to an improvement of the relative position by 100 seconds compared to an order deviating from the recommendation
Thank you.

Any questions?

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