Passenger Flow Analysis
UNECE Working Party on Transport Statistics

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Invenium in a Nutshell – What do we do?

Daily 3,2 Mio devices within the A1 Network with 7000+ base stations
Turning data into Insights

With Invenium Mobility Insights, we answer a wide variety of questions from our customers in business, tourism, transport and many more. Join us in exploring human mobility and gain valuable insights into the behaviour of your customers.

Collect data
We collect completely anonymized data generated during the communication of mobile devices with cell towers.

Analyze Data
We rely on modern statistical methods and state-of-the-art machine learning approaches to turn millions of data points into insights.

Visualize data
Get an overview of analysis results with our daily PDF reports or go deeper with our interactive dashboards. We have the right solution for every requirement.

Answer questions
Human movement influences everything. We help you find answers to your questions and thus transform the way you make decisions.

In compliance with the strictest data protection guidelines
Providing governments with lockdown analysis

Examples of Austrian mobility analyses

Departure of tourists from Ischgl on the day of the lockdown start

Mobility change for each municipality during the lockdown

Who is talking about us?

Bloomberg Law

REUTERS

WSJ
Passenger Flow Analysis: Project

What are the objectives and partners?

Cooperation Project

- Project **Passenger Flow Analysis** with the goal:
  - analyzing passenger demand using anonymous Floating Phone Data for 6 different use cases
  - provide the basis for internal planning purposes
  - develop internal analytic tools

- Telco provider **A1 Telekom Austria** provides **anonymized floating phone data** (market share in Austria Q1/2021 ~ 38%)

- **Invenium** creates, maintains and enhances the **algorithm platform**

- **ÖBB Infrastruktur** provides the **actual train timetable** on a daily basis using the Advanced Railway Automation Management Information System (ARAMIS)
Use Cases

- **Entering and exiting passengers** per station
- Station based **Origin-Destination-Matrix** (including transfer passengers)
- **Loads of passengers** on defined cross sections
- Analysis of **delays**
- **Origin-Destination-Matrix** in zonal structure of the National Austrian Transport Demand Model (VMÖ)
- **Catchment areas** of stations (based on Home-Activity)
- **Special analysis**, e.g. demand peaks
Passenger Flow Analysis: Functionality

How is the data determined?

Method

- **Anonymous mobile network events** are used to create trajectories over the day
- A **probabilistic model** is built based on **Machine Learning Algorithms** incl. trajectories combined with the track coordinates and the ÖBB train timetable
- Using this underlying principle, several algorithms are used to estimate the total (passenger) demand
- This procedure is **in compliance with all data privacy regulations** and has the appropriate certification

Processing of Data

- **A1** provides the anonymized raw Floating phone data including sociodemographic data. Each of the 3.2 million A1 clients generates (on average) 1000 mobile phone events per day
- **Invenium** extrapolates the A1 data to calculate the total transport demand. Quality control measures accompany the process
- **ÖBB** verifies, manages, uses and provides the results
Passenger Flow Analysis: Quality
How do we validate? (1)

Empirical Reference Data

- **Manually performed counts** to validate the model
- Establishment of **high-quality assured empirical passenger counts**. Design, organization, implementation, and validation by the ÖBB
- **120 stations** of different size categories, locations, features etc... were **manually validated since 2019**
- ÖBB-Werbung supported with supplying the counting staff

Counting Method and Validation

- Counting of **entering and exiting passengers per train**
- The counting **staff was specifically trained** to ensure **reliable and consistent counts**
- For each count, one person was tasked with managing the counting team. **Only high-confidence counts were used** to validate the model
Passenger Flow Analysis: Quality
How do we validate? (2)

Status of Quality

• Since 2019, the quality of the algorithm was continuously improved (from version 1 to version 5):
  • New Monitoring-System at A1 Telekom Austria
  • Individual parameters for urban areas
  • Improved accuracy in rural areas with low cellular network coverage
  • Focus on the “Vienna Main-Line”
• Slightly higher variance still exists on smaller and less used train stations

Outlook

• Improvement in the raw-data quality from the monitoring system from the A1 cellular network
• Automated validation of the actual train schedule (ARAMIS)
• Optimization of the algorithm in version 5 (current roll-out)
• 5G expansion will further improve the quality in the future
Passenger Flow Analysis: Status 2022

How is the progress?

Strengths

- Passenger demand is **continually calculated** for the entire Austrian railway network using a **consistent method**
- Comprises **entire journey** (from origin to destination)
- The results are available for **different time aggregations** (weekends, events, yearly variation curve, etc.)
- Distinction of **train categories**
- **Pandemic-proof method**, fully automated
- **High quality** results for **medium** and **high categorized stations**

Weaknesses

- **Quality improvements** dependent on **cellular network expansions**
- **Difficulty** in differentiating **parallel traffic flows** (affects some stations with nearby roads)
- **Validation counts** still **necessary** for future algorithm improvement
- **Low quality** results for **low categorized stations** (especially less than 200 passengers per day)
Practical Applications

- **Statistics of passenger numbers** throughout the pandemic - necessary information for the ÖBB Management and CEO
- The line Vienna - Salzburg, which normally operates without public funding, urgently needed public funding to ensure continued operation during the pandemic. The project provided the necessary data for this political decision
- Aggregated data (for an average workday) are used as a basis for internal planning purposes
- Individualized reports are supplied to other departments within ÖBB
- Data is used as an input factor for the National Austrian Transport Demand Model (Verkehrsmodell Österreich - VMÖ)
- Pilot project to supply digital passenger data to rail operating companies