Evaluating infrastructure capacity using Multiscaling Analysis

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Introduction and Motivation

Computer applications for modeling Railway operation require:
- Railway infrastructure models
- Models for train operation processes

Intention of Multiscaling Analysis:
- Offering suitable models for analysing requests

Different types of infrastructure models:
- Microscopic models (high accuracy)
- Macroscopic models (low accuracy)
Application areas of railway infrastructure models

- Microscopic model of railway infrastructure

- Exact railway infrastructure reproduction
  - Link attributes:
    - Maximum speed
    - Track length
    - Gradient
  - Node attributes:
    - Signal
    - Releasing Contact
Application areas of railway infrastructure models

- Macroscopic model of railway infrastructure

- Average railway infrastructure reproduction
  - Link attributes:
    - Average speed
    - Track length
    - Average gradient
  - Node attributes:
    - Location of station
    - Location of point
Application areas of railway infrastructure models

Microscopic models are used for:
- Train running time calculation
- Timetable calculation
- Simulation of synchronal train operation
- ...

Macroscopic models are used for:
- Long term capacity planning
- Vehicle allocation
- Train path visualisation
- Timetable statistics
- ...

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Application areas of railway infrastructure models

- Necessity of detailed infrastructure modelling

![Diagram showing a macroscopic model with a station, stopping train, and passing train.]
Application areas of railway infrastructure models

- Necessity of detailed infrastructure modelling

→ Route exclusion only visible in microscopic model
Principles of Multiscaling Analysis

Transforming detail level of railway infrastructure models
Principles of Multiscaling Analysis

Attributes:
- Signals
- Connected stations
- Accessibilities
- Platforms
- Timing points
- Speed boards
- Block sections

Generation of artificial microscopic infrastructure based on mesoscopic network
Adoption of Multiscaling Analysis for timetable feasibility confirmation purposes

Project “Railway slot allocation”

Network size: 1300 km
Height balance: 200 m
Adoption of Multiscaling Analysis for timetable feasibility confirmation purposes

Project “Railway slot allocation”

Conflict protocol is used for calibration of macroscopic infrastructure model and timetable settings, e.g. headway times.
Adoption of Multiscaling Analysis for timetable feasibility confirmation purposes

Project “Railway slot allocation”:

- No conflicts! Train paths can be sold
- Conflict! Train paths can not be sold

→ No Conflict: Spare time displayed in conflict protocol
→ Conflict: Time, train number, station of conflict displayed
Detection of capacity resources

NEMO - RailSys

RailSys
Server
- Microscopic network
- Train parameters

Composition of Macroscopic Network
- Calculation of:
  - Running times
  - Minimum headways

Microscopic analysis of capacity

NEMO
Client
- Train amount
- Train services

Macroscopic evaluation of various scenarios

Selection of the most useful scenarios

Calculation of required train paths

Evaluating infrastructure capacity using Multiscaling Analysis
Multiscaling Analysis using RailSys

- **RailSys® CRM** (Sales platform)
- **RailSys® Classic/Enterprise** (Planning platform)
- **RailSys® Map** (Information platform)

**Infrastructure data management**

**Evaluation management**

**Simulation management**

**RailSys® database**

**RailSys® interfaces**

- **Timetable management (timetable construction)**
- **Possession planning (Operation of track possessions)**
- **Rolling stock circulation planning**
Detection of capacity resources

- RailSys Map: Visualisation of limited availability of infrastructure
  - Track closed
  - Track with speed restriction section
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- RailSys CRM: Train Path Search and Sale via the internet

Detection of capacity resources

Currently implemented for train slot management in the port of Hamburg / Germany
Results and impact on railway business

Opportunities for using Multiscaling Analysis

- Macroscopic models
  - Vehicle scheduling
  - Long term capacity planning
  - Traffic generation and assignment
- Mesoscopic models
  - Transformation with Multiscaling analysis
  - Short term capacity planning
  - Simulation of train operation
- Microscopic models
  - Transformation with Multiscaling analysis
  - Running time calculation

Data complexity:
- Low
- High

Detail level:
- Low
- High
Conclusion

- Three different models can be used for railway engineering purposes
  - Macroscopic model
  - Mesoscopic model
  - Microscopic model

- Multiscaling Analysis allows working with relative high accuracy on low accuracy data
  - Mesoscopic network

- System Railsys provides Multiscaling features
Thank you for your attention
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