

# ANALYSING RAILWAY INFRASTRUCTURE UTILISATION

A Geospatial Approach

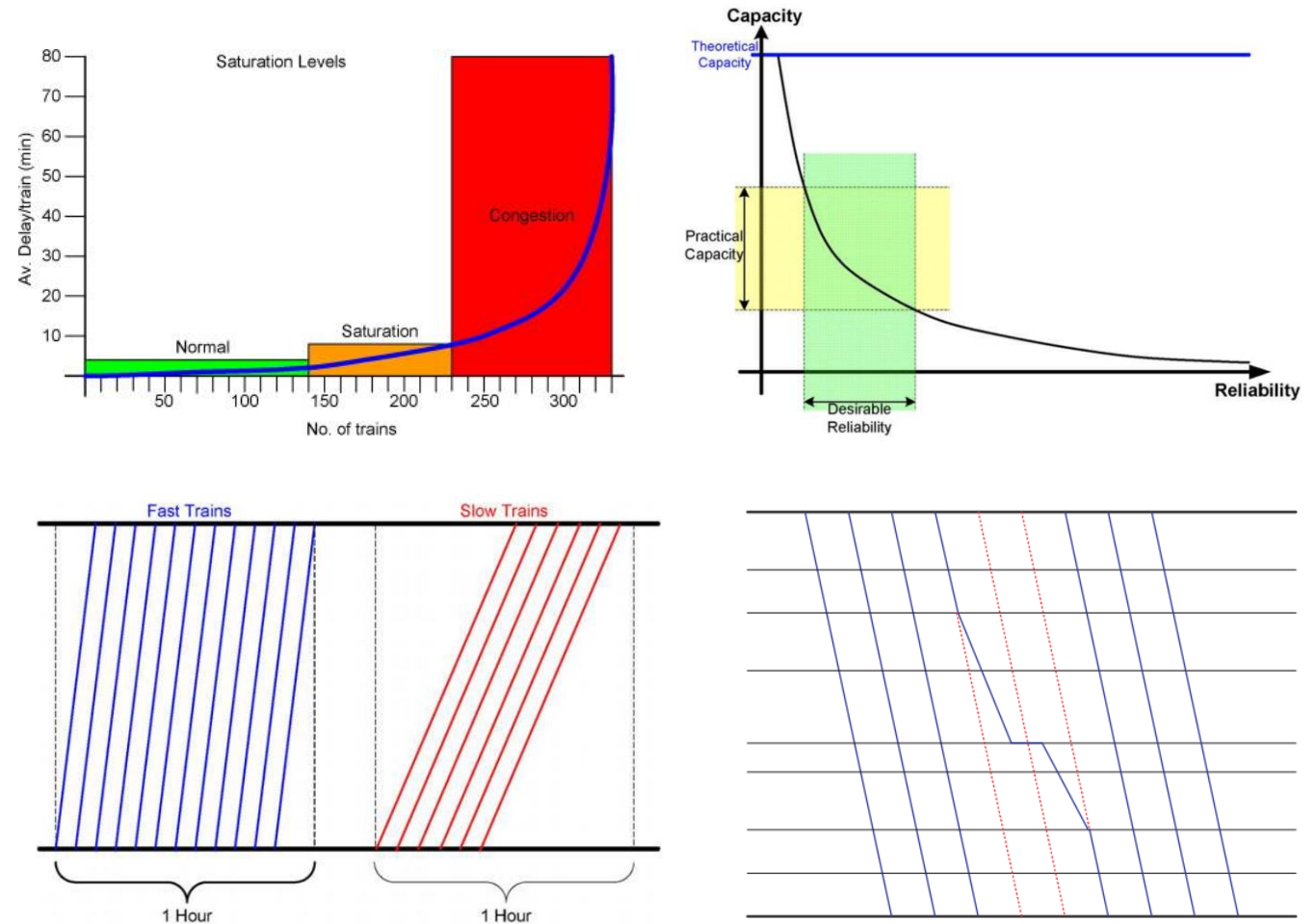
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*Supervisors: Dr Craig Robson, Professor Roberto Palacin*

*Oliver Bratton (Network Rail)*

# RAILWAY CAPACITY & UTILISATION

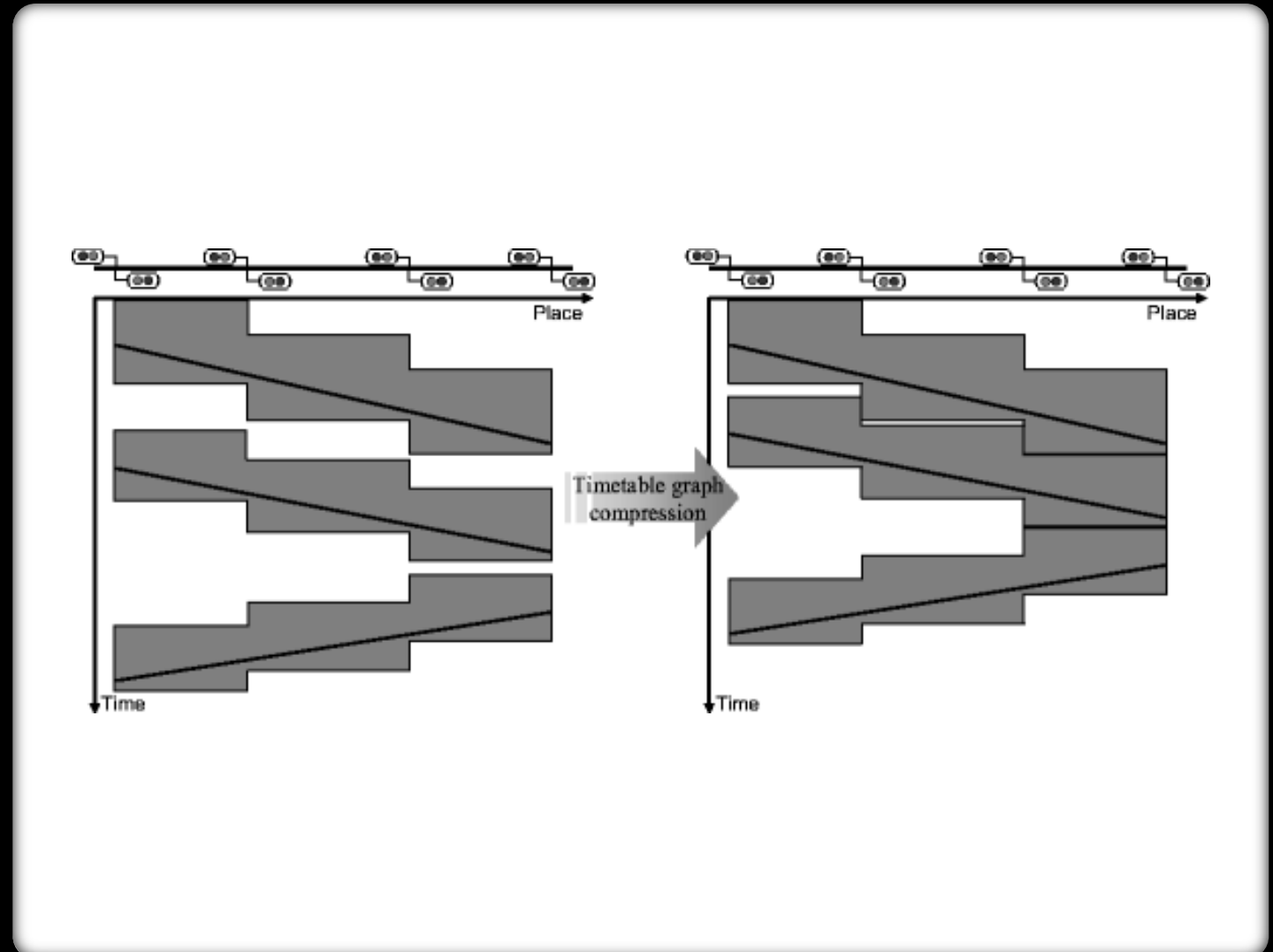
- Capacity
  - Infrastructure
  - Systems
  - Train Service
- Utilisation
  - Efficiency
  - Performance vs Capacity
- Uses
  - Investment
  - Planning
  - Performance Monitoring



Abril et al, 2008. An assessment of railway capacity. Transportation Research Part E: Logistics and Transportation Review, 44(5), pp.774-806.

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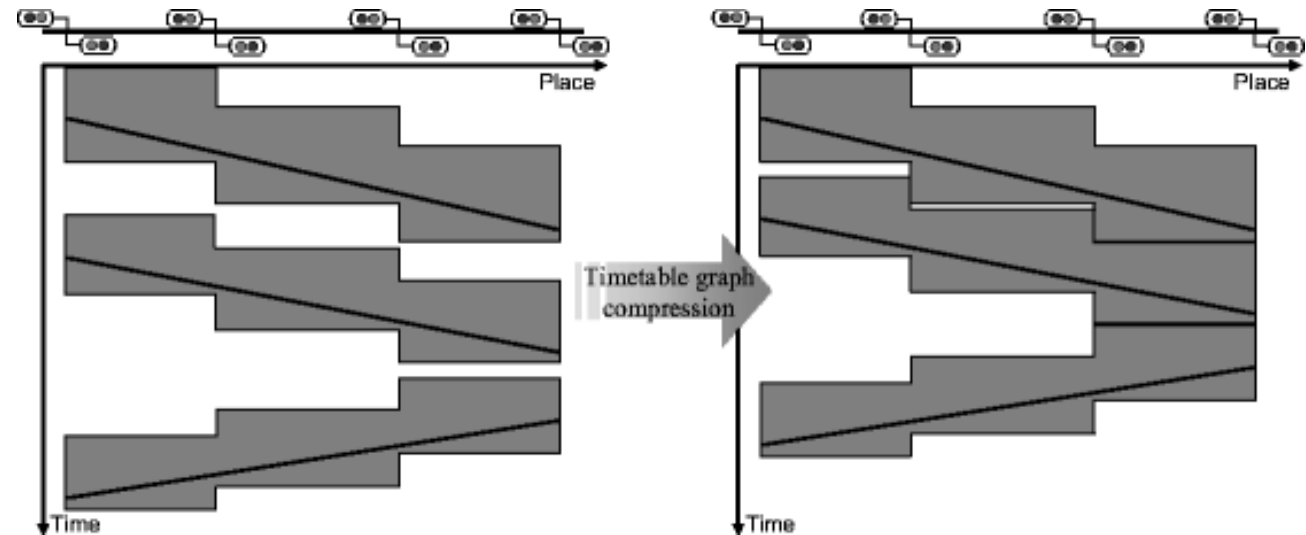
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Landex, A. Evaluation of Railway Networks with Single Track Operation Using the UIC 406 Capacity Method. *Netw Spat Econ* 9, 7–23 (2009). <https://doi.org/10.1007/s11067-008-9090-7>

# EXISTING METHODS

- Timetable Compression
- Analytical Methods
- Optimization
- Modeling & Simulation based
- Topological Network Models



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# AIMS



Investigate Utilisation



Compare Planned against  
Actual Utilisation



Identify Events or Incidents

# OBJECTIVES



Geospatial Infrastructure



Spatial Temporal Graphs



Identify Differences in Utilisation



Realtime Processing



# METHODOLOGY

- Data Preparation
- Data Processing
- Calculation

## Railway Infrastructure Utilization Analysis

### Daily Train Service

#### Planned Timetable

##### Train Service

- Logical Timetable
- Geospatial Route
- Predicted Path

#### Infrastructure Utilization

- Geospatial Heatmap

#### Train Service Utilization

- Logical Network Heatmap

#### Timetable Utilization

- Time-based occupancy

#### Actual Timetable

##### Train Service

- Actual Timetable
- Geospatial Route
- Actual Path

#### Infrastructure Utilization

- Geospatial Heatmap

#### Train Service Utilization

- Logical Network Heatmap

#### Timetable Utilization

- Time-based occupancy

### Validation

- Planned vs Actual Route
- Predicted vs Actual Path

### Disruption Events

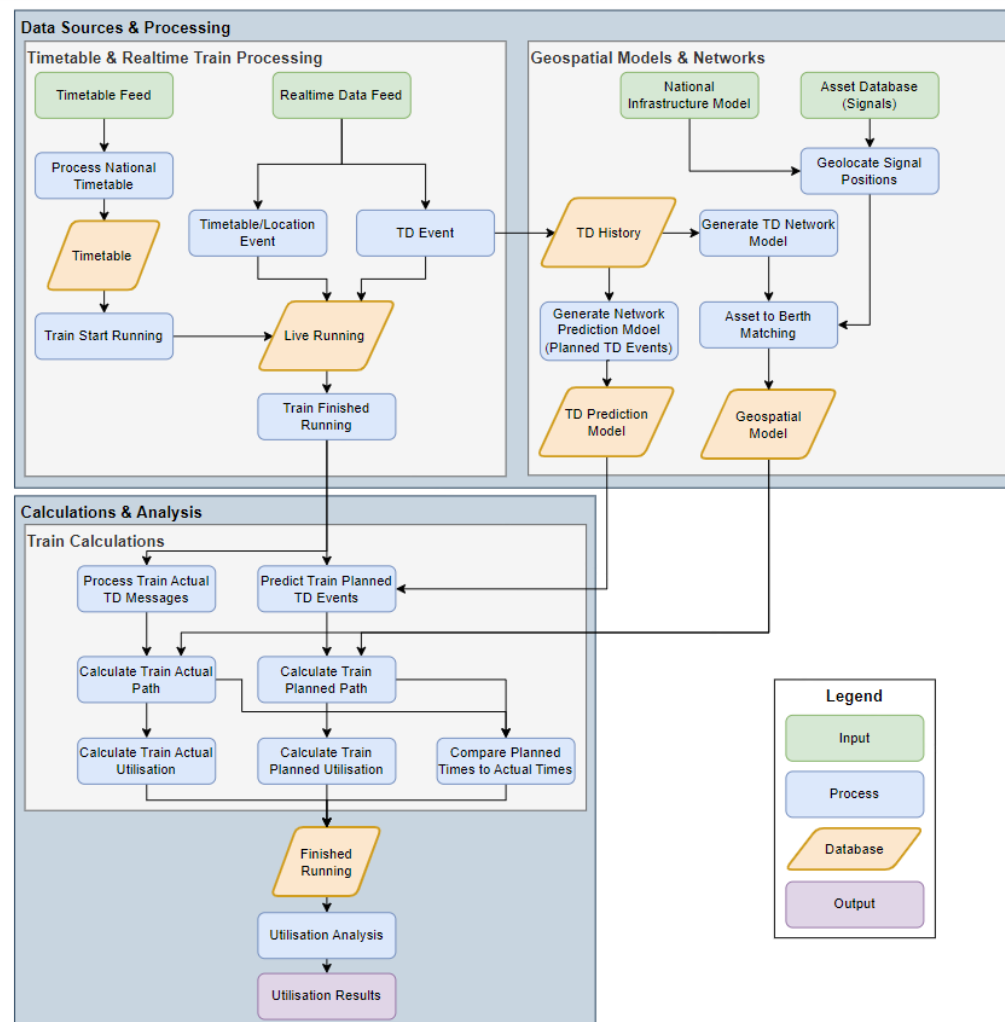
- Event Detection
- Event Analysis
- Event Visualisation

### Utilization Analysis

- Planned Utilization
- Actual Utilization
- Comparison (inc. considering disruption events)

# PROCESS

- Data Preparation
- Data Processing
- Calculation





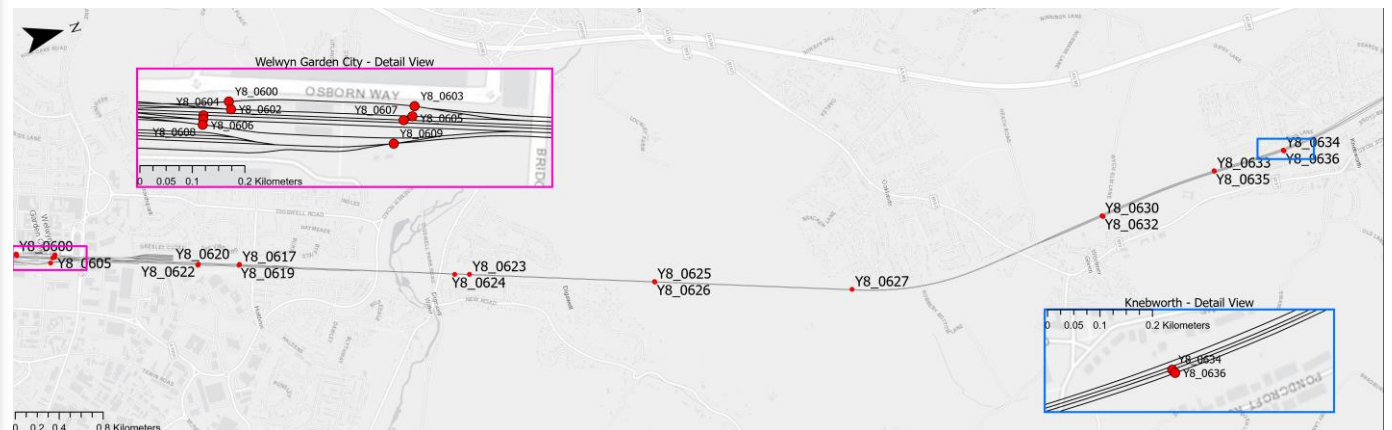
# SCOPE

- Over 20,000 Miles
- 15,416 edges

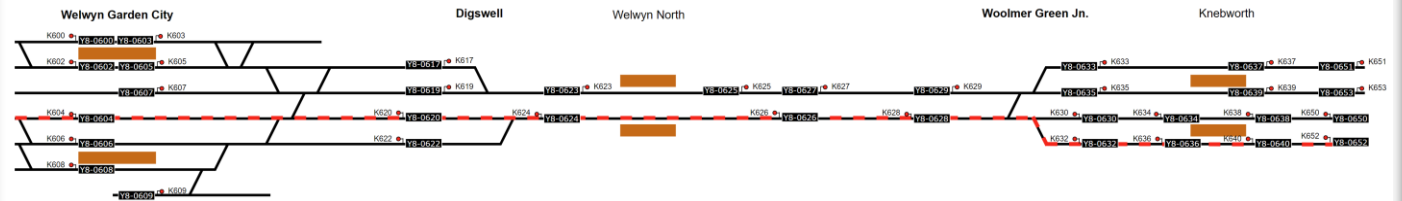


# DATA PREPARATION

- Geospatial Model
- Physical Assets

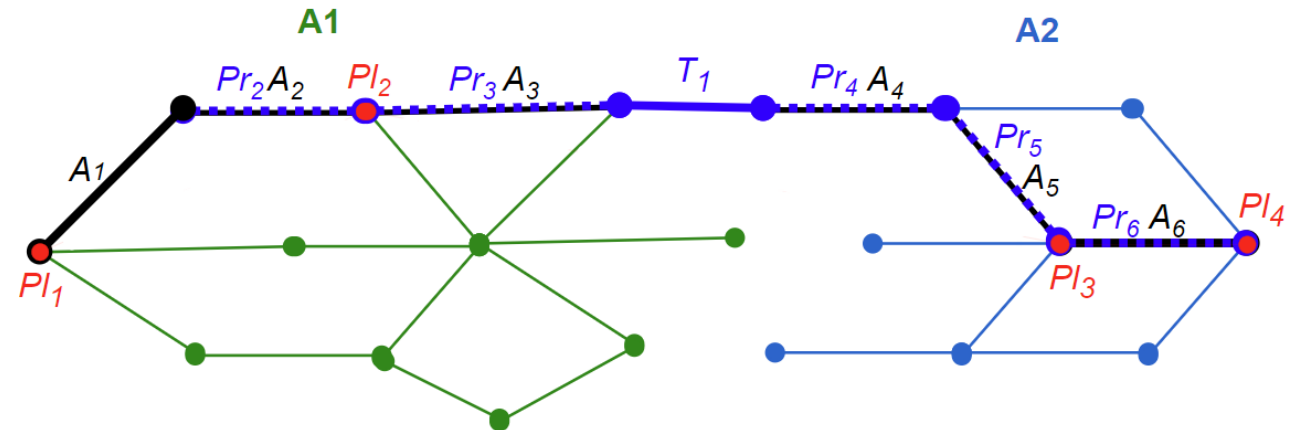


- Logical Diagram
- Logical Path



# DATA PROCESSING

- Actual Network Path
- Predict Planned Path
  - Probabilistic Prediction Model
  - Modal next edge
  - Mean edge duration



**A1 A2**

**$A_n$**

**$PI_n$**

**$Pr_n$**

**$T_n$**

Train Descriptor Networks

Actual Network Path

Timetabled locations

Predicted Planned Path

Transitions between Networks

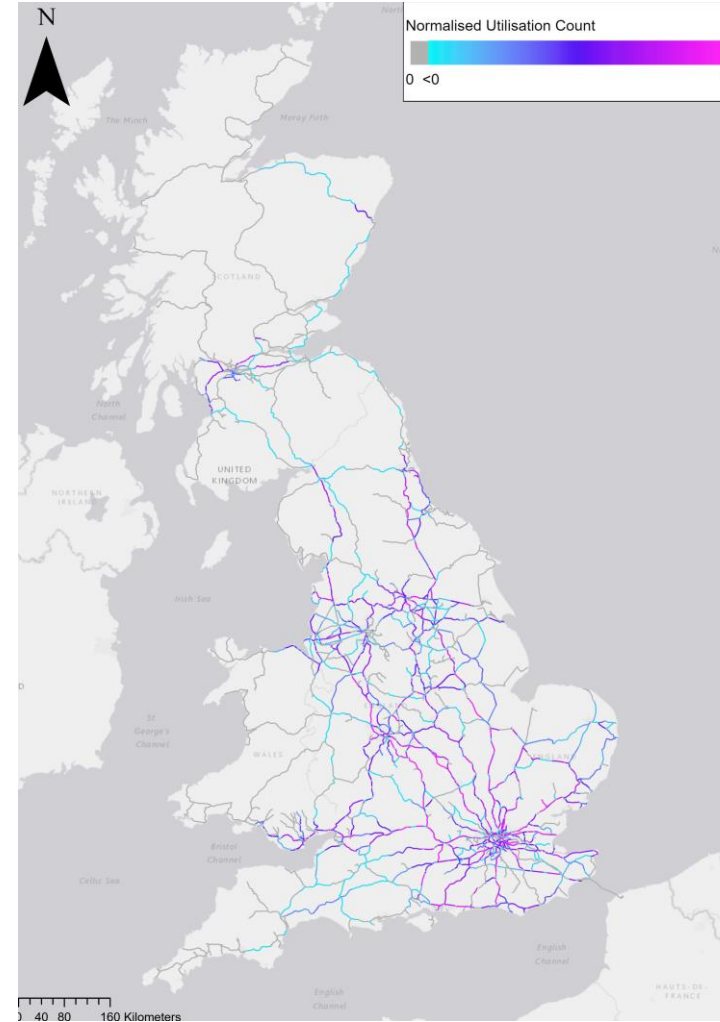
# CALCULATION

- Geospatial Route
- Utilisation



# CALCULATION

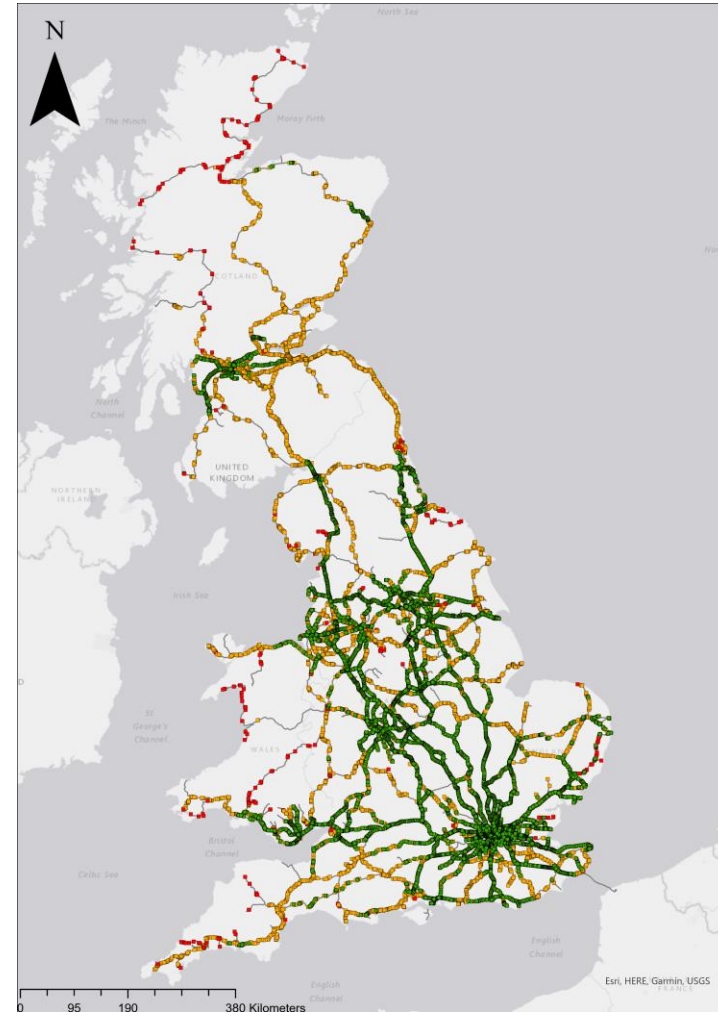
- Geospatial Route
- Utilisation





# CHALLENGES

- Data quality
- Data availability
- Impact of Poor Data



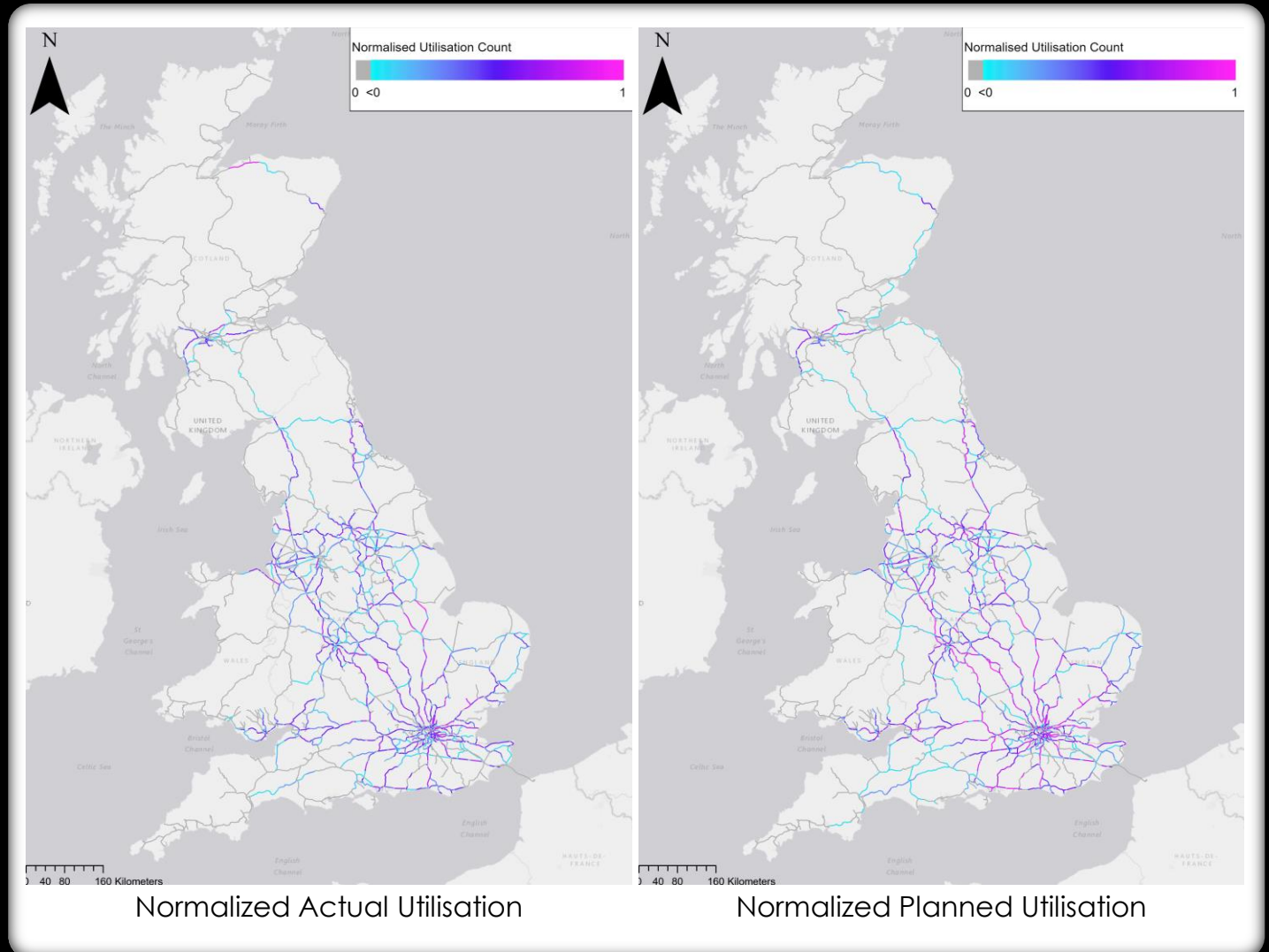
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# RESULTS

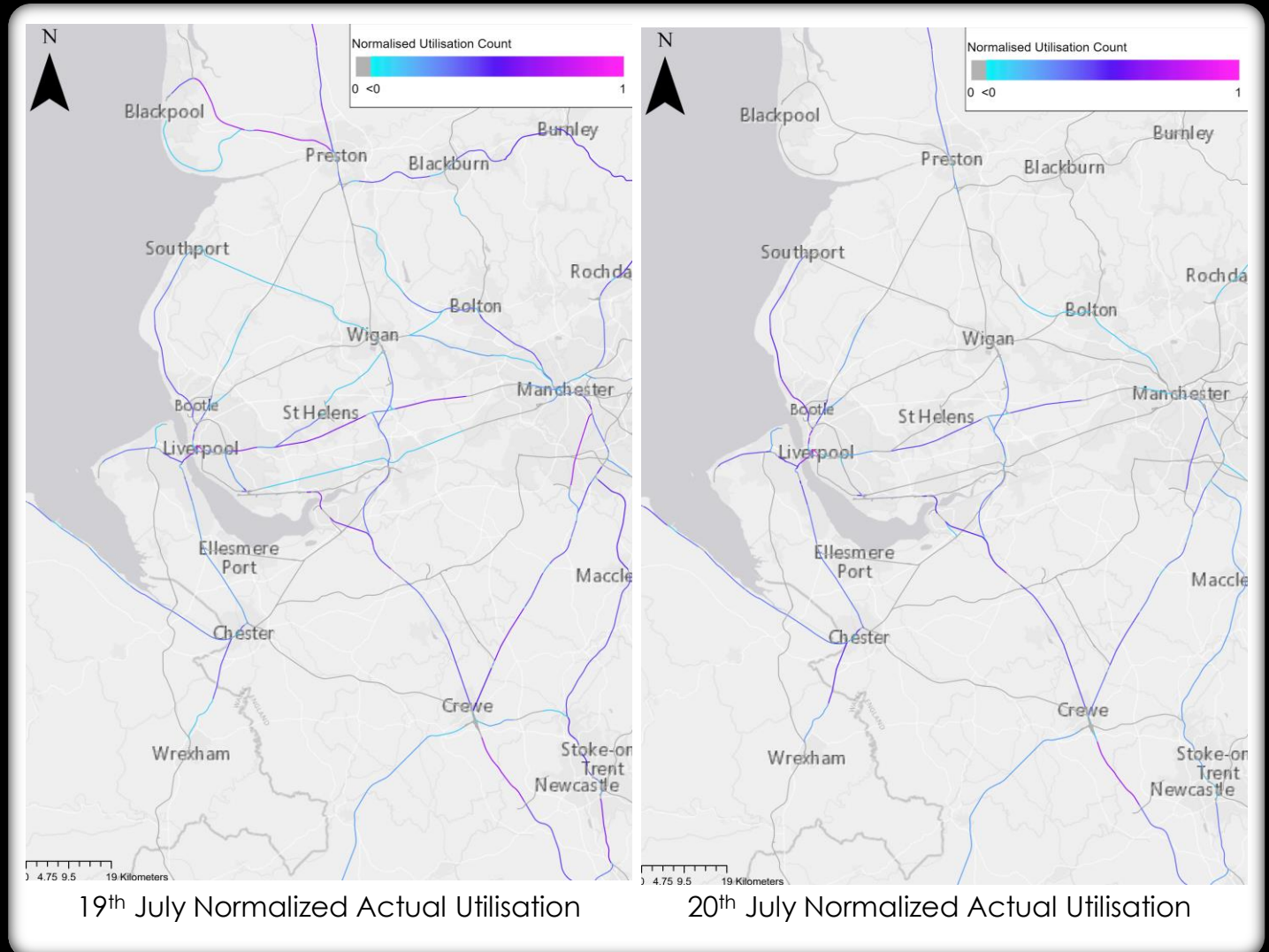
- 11<sup>th</sup> to 23<sup>rd</sup> July 2023
- 26.5 million train movements
- 7.8 million planned locations
- 149,473 out of 181,181 trains successfully calculated (82.50%)





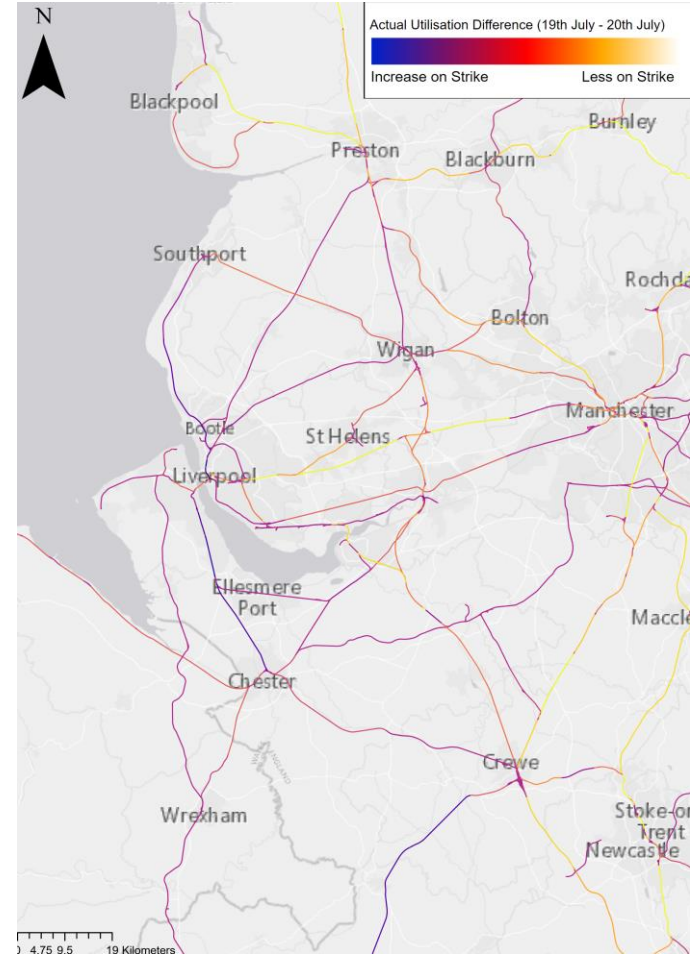
# RESULTS

- Industrial Action 20<sup>th</sup> July
- On Strike:
  - TransPennine Express
  - Northern
  - Avanti West Coast
- Not On strike:
  - Merseyrail
  - Transport for Wales



# RESULTS

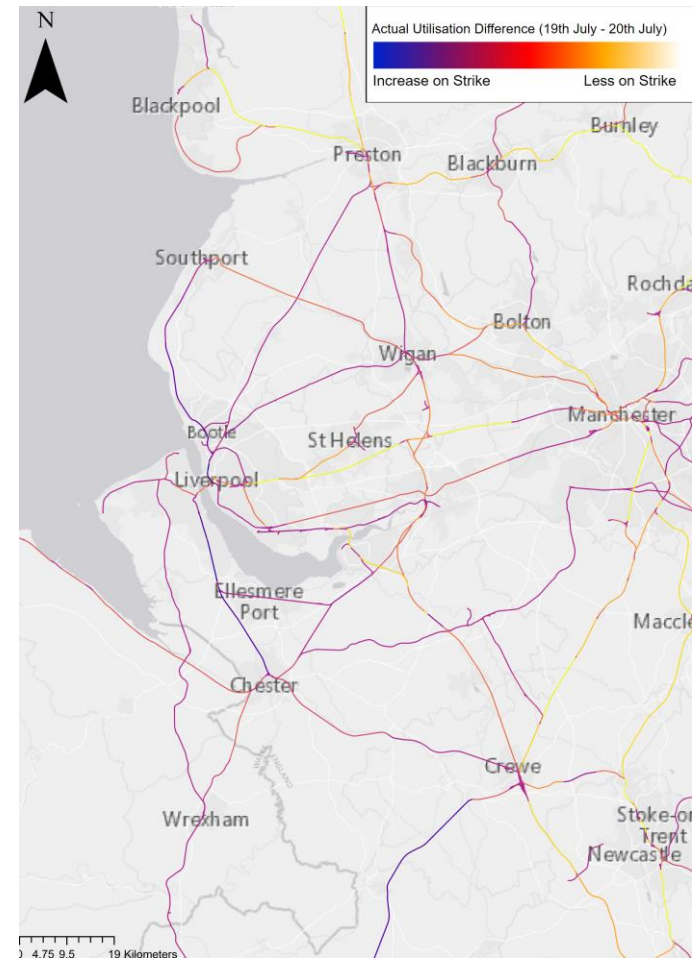
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Actual Difference between 19<sup>th</sup> & 20<sup>th</sup> July 2023

# CONCLUSIONS

- Method has potential, strike days indicate this
- Currently limited by data quality and availability

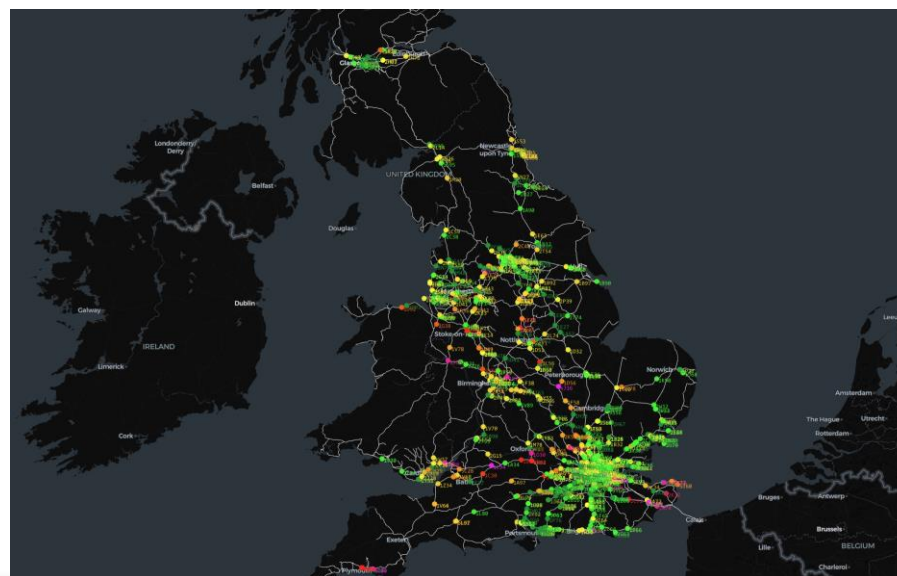
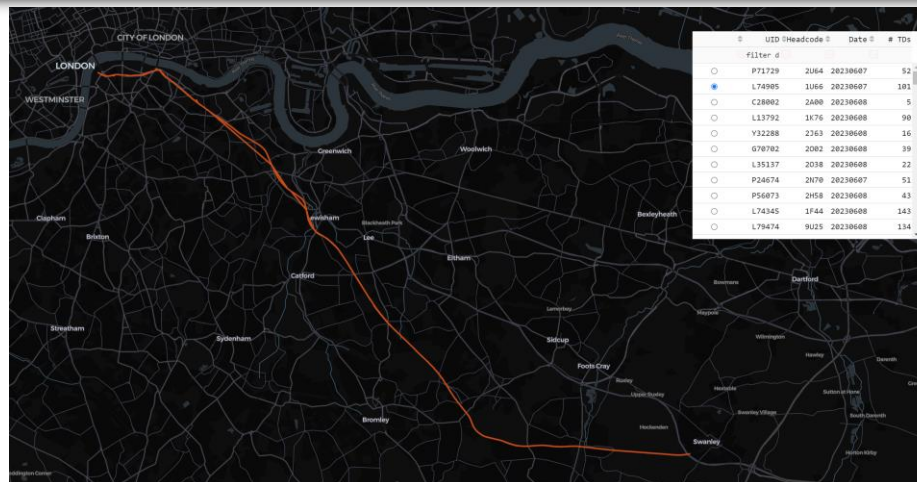


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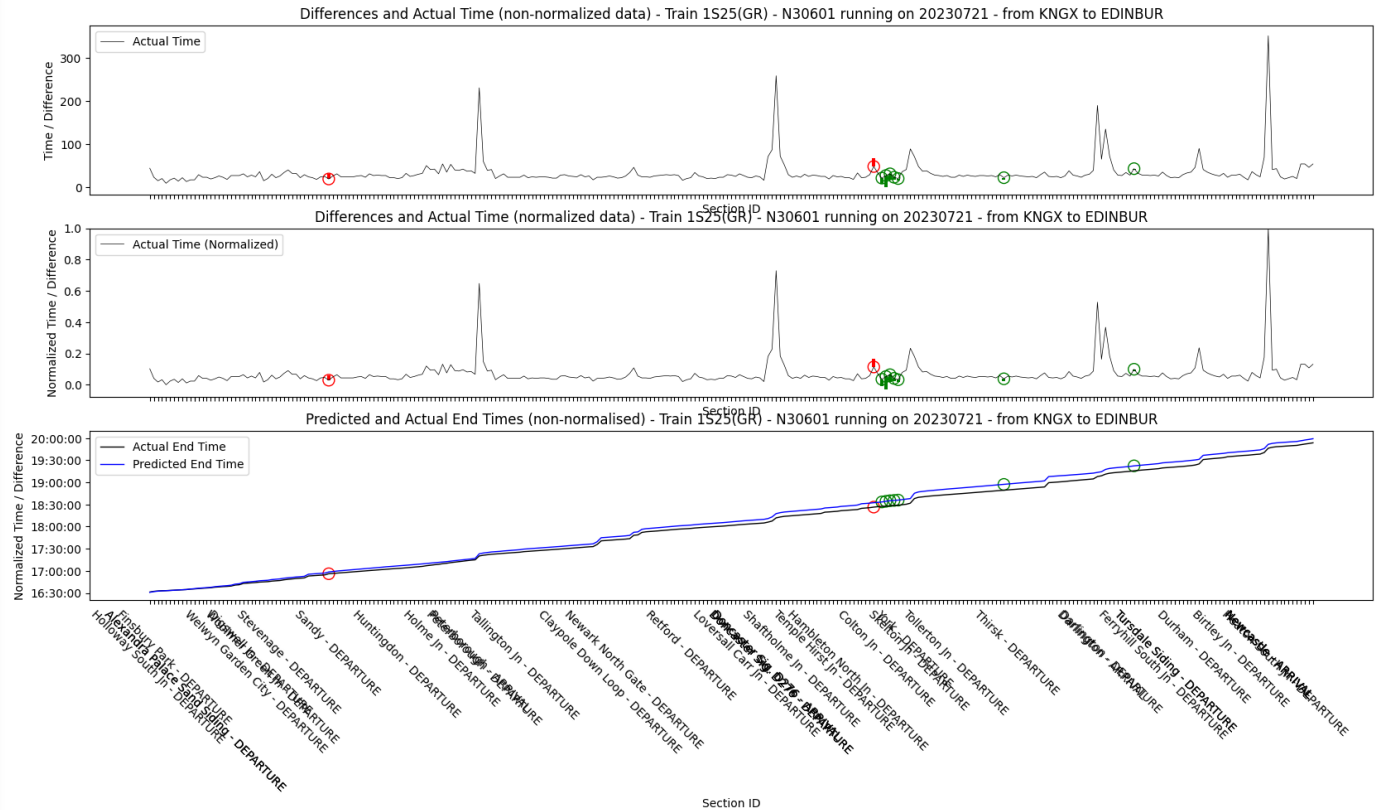


## FURTHER WORK

- Data Quality Improvements
- Utilisation & Capacity Methods
- Realtime
- Incident Detection
  - Historical Analysis
  - Realtime Detection



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# ANALYSING RAILWAY INFRASTRUCTURE UTILISATION A GEOSPATIAL APPROACH

Any Questions?



Further details

