Hierarchical Graph Structures for Congestion and ETA Prediction

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Key Challenges

Graph

Data

GNN
Graph Representation - Compaction
Insights 1 - Compaction

![Graph showing validation loss over epochs for compacted and original models.](image-url)
Graph Representation - Hierarchical

Approach 1

Approach 2

Approach 3
Model Overview: Big Picture

Features → GNN → Predictor
Model Overview

Features
- Nodes: counts/position/global statistics
- Edges: length/speed/importance

Model Size
- ca. 5M parameter
Model Overview: GNN Architecture
Training

Madrid

Preprocessing

Training

Evaluation

~ 1.5 days

Melbourne

Preprocessing

Training

Evaluation

London

Preprocessing

Training

Evaluation
Insights 2 - Hierarchical ablation

![Graph showing train loss over epochs for different approaches.](image)

**Approach 1**

**Approach 2**

**Approach 3**
Model Overview: ETA

Features → GNN → Predictors
ETA results

![Graph showing train loss over epochs for different supergraphs. The graph compares the performance of two supergraphs, labeled 1+2 and 2, across various epochs. The y-axis represents train loss, and the x-axis represents epochs. The graph shows that the train loss decreases over epochs for both supergraphs, with slightly different trends.](image-url)
Future directions

More hierarchical (maybe using clustering?)

Routing inspired methods

Other compaction methods
Thanks for your attention!

Questions?
Backup
## Dataset statistics

| Graph          | City     | Nodes  | Edges  |
|----------------|----------|--------|--------|
| Original Graph | London   | 59110  | 132414 |
|                | Madrid   | 63397  | 121902 |
|                | Melbourne| 49510  | 94871  |
| Compact graph  | London   | 39762  | 93718  |
|                | Madrid   | 60366  | 115840 |
|                | Melbourne| 39035  | 73921  |

| Graph          | City     | Nodes  | Edges  |
|----------------|----------|--------|--------|
|                | London   | -      | 8024   |
| Approach (1)   | Madrid   | -      | 7938   |
|                | Melbourne| -      | 6492   |
|                | London   | 4012   | 118999 |
| Approach (2)   | Madrid   | 3969   | 102456 |
|                | Melbourne| 3246   | 82620  |
|                | London   | 4512   | 135047 |
| Approach (3)   | Madrid   | 4431   | 118332 |
|                | Melbourne| 3692   | 95604  |

(a) The graph compaction can reduce the graph size up to thirty percent by removing degree two nodes.

(b) Three different approaches to model the supersegments. The table denotes the number of additional nodes and edges added to the original graph.
Compaction results
Hierarchical results

London

Melbourne

Madrid
ETA results

London

Melbourne

Madrid