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Introduction

Problem statement

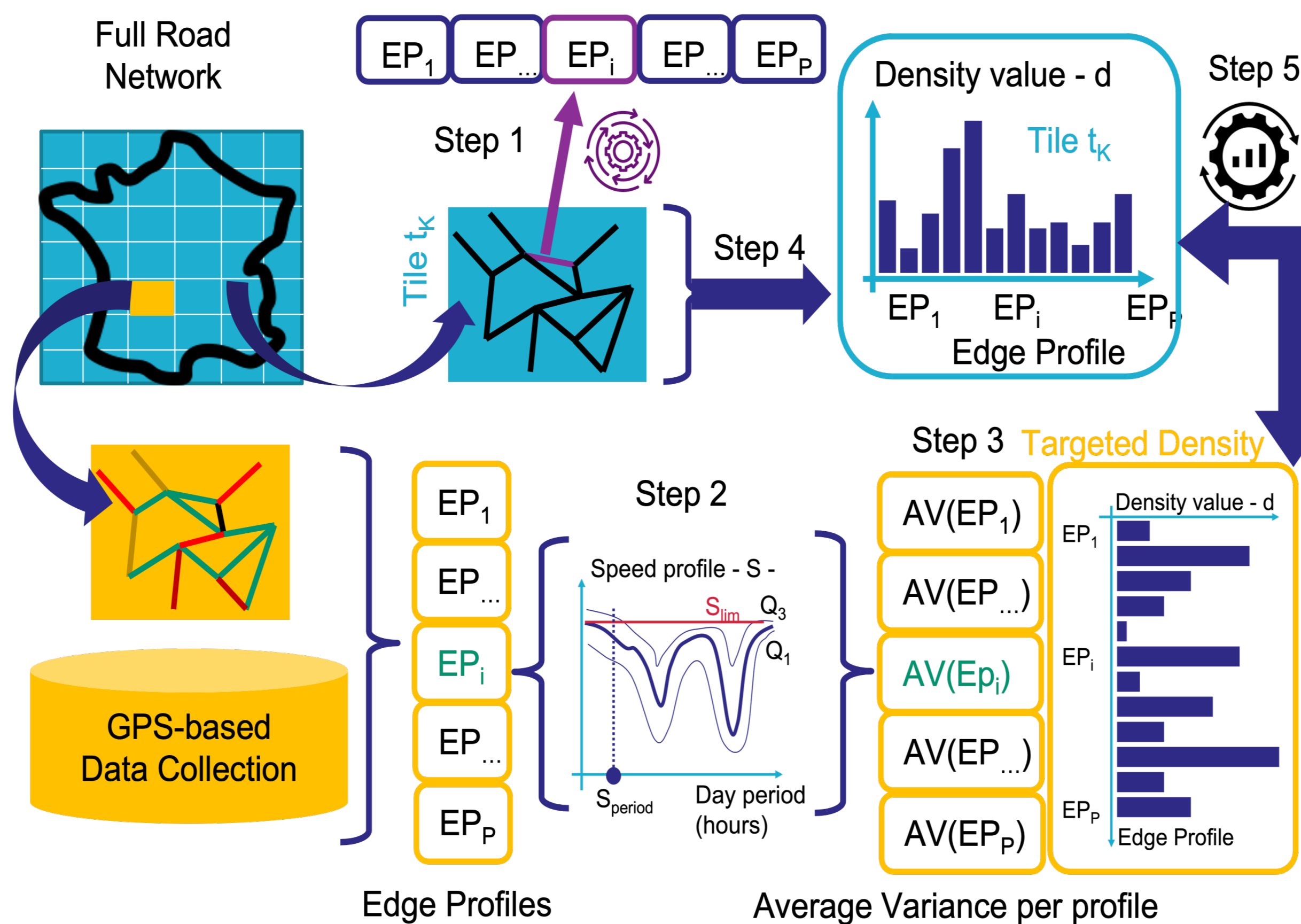
Floating Car Data (FCD) is a usual and convenient resource to generate traffic speed indicators, but it comes with an expensive cost to cover large road networks.

Where should we focus the data collection when reproducing speed profiles for any road section on an extensively large road network with limited resources?

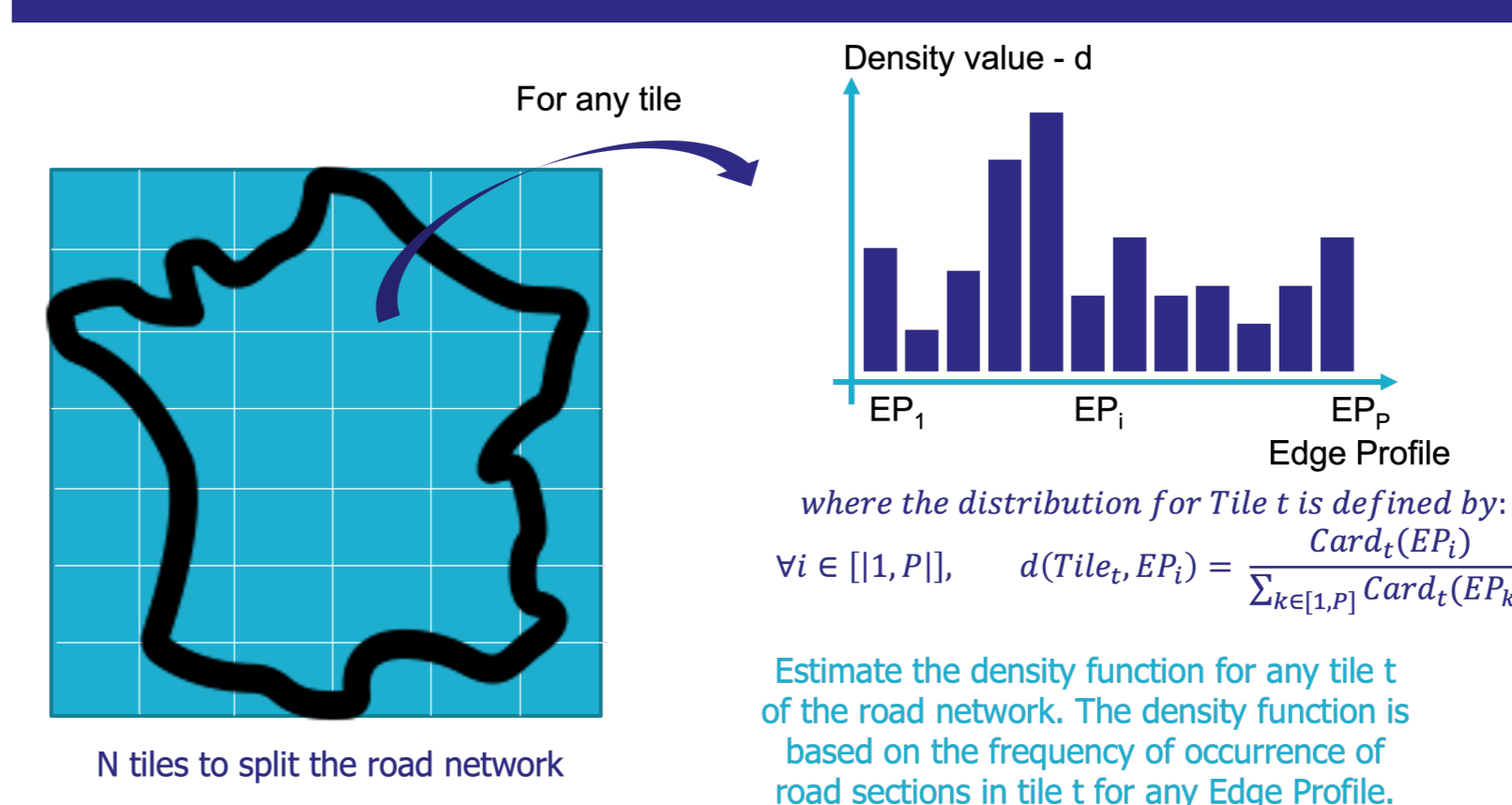
Most studies involving FCD focus on issues related to sparse data collection, and the Sensor Location Problem is only considered from the road manager's perspective, assuming controlled Mobile Sensors.

Our problem statement and formulation are distinct as it aims at optimizing the spatial coverage to achieve high representativeness of the diversity of road link speed profiles. Consequently, our methodology is inspired by Optimal Spatial Coverage strategies for Sensor Networks, developed in distinct domains, especially the works developed by Hoffman *et al* (2013).

Methodology overview



STEP 4: Computation of tile's utility



STEP 5: Optimization to select K tiles

$$\min \left(\sum_{j \in [1, P]} A_j \right)$$

subject to:

$$A_j \geq Ref_{EP_j} - P_j$$

$$A_j \geq P_j - Ref_{EP_j}$$

$$K \times P_j = \sum_{i \in [1, N]} x_i \times \frac{Card(Tile_i, EP_j)}{Card(Tile_i)}$$

$$\sum_{i \in [1, N]} x_i = K$$

$$\left(\sum_{i \in [1, N]} x_i \times Card(Tile_i) \right) \geq \left(\sum_{i \in [1, N]} Card(Tile_i) \right) \times \frac{K}{N}$$

where P_j is the probability for Edge Profile EP_j resulting from the average over the K selected Tiles.

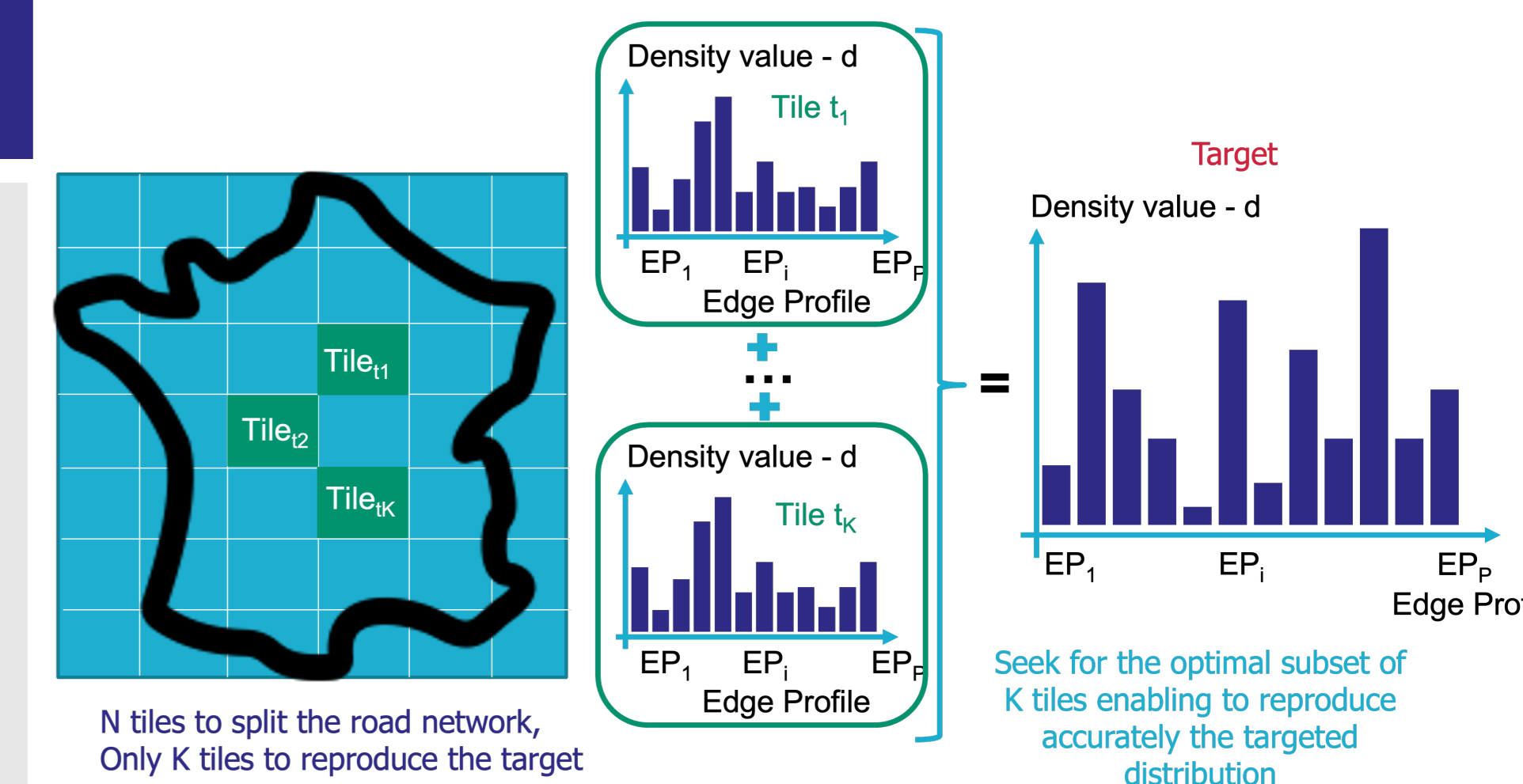
$x_i = \begin{cases} 1 & \text{if the tile } i \text{ is kept as input} \\ 0 & \text{else} \end{cases}$

The quantity of road sections in the K selected Tiles has to be higher than K/N percent of the global quantity of sections.

Results

Key Performance Indicators

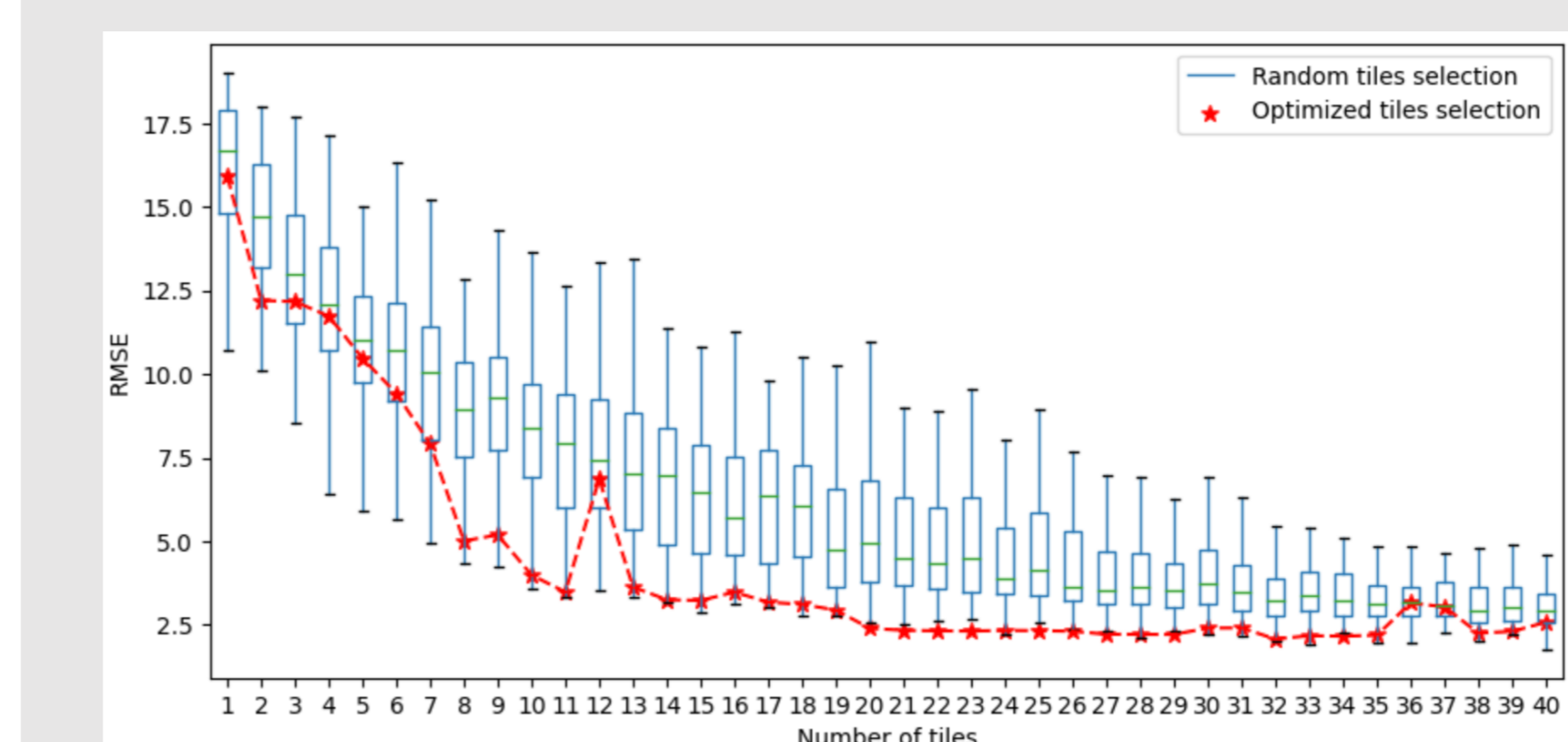
- Systematic bias** = gap between the ground-truth median speed profile & the one issued by the k selected tiles;
- Coverage bias** = gap between the ground-truth variance and the one issued by the k selected tiles.



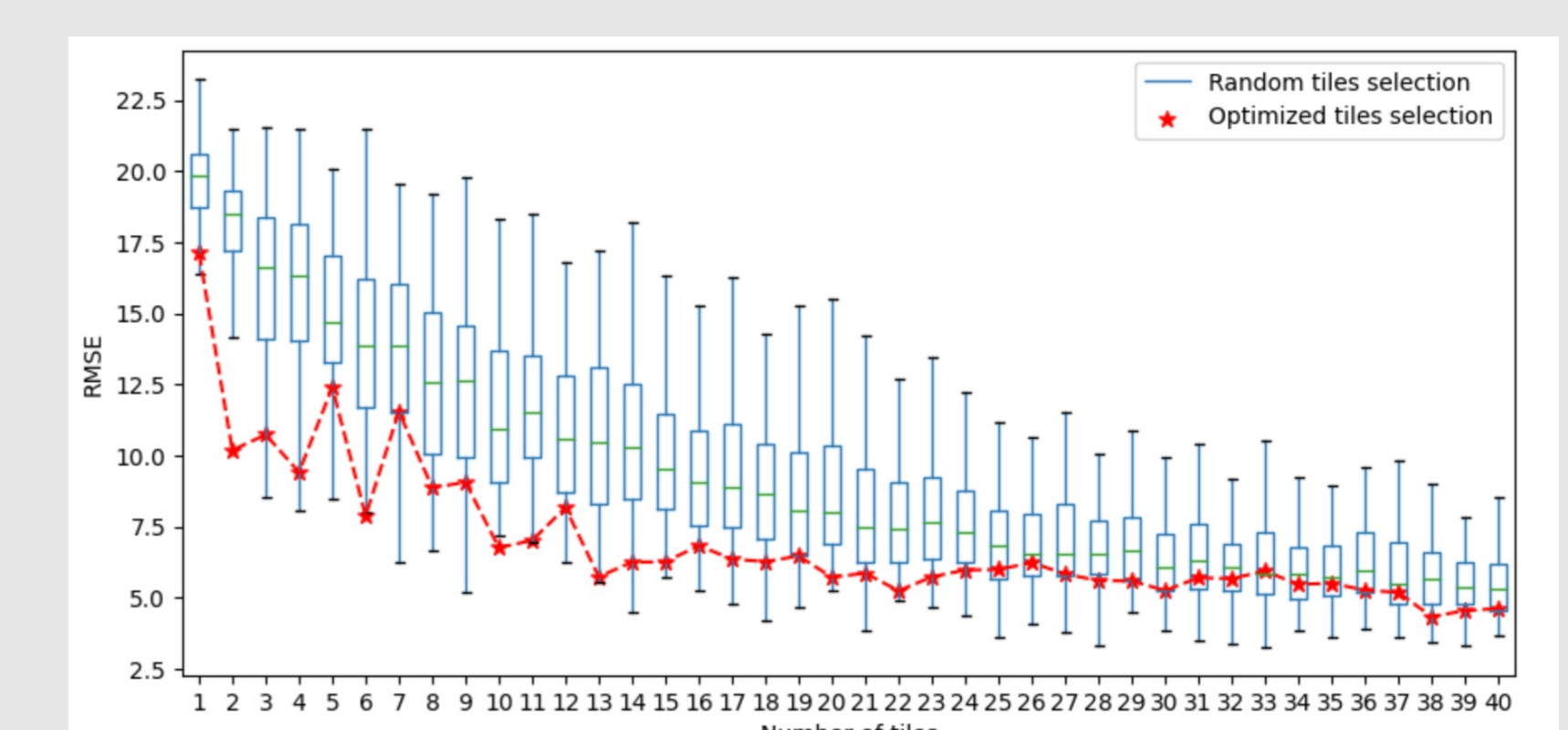
Case study: city of Lyon



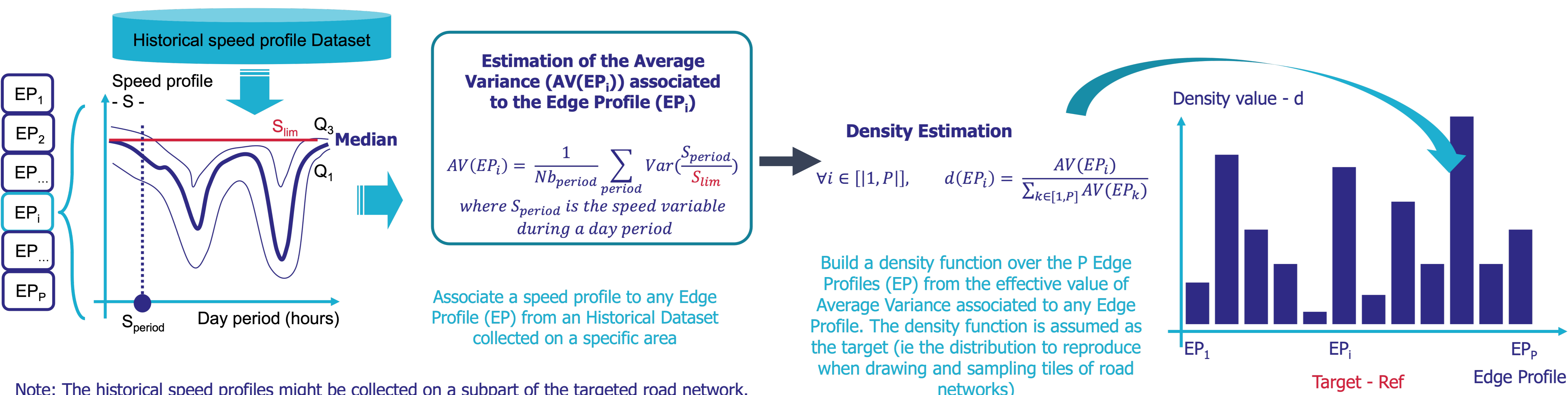
Coverage bias - RMSE



Systematic bias - RMSE



STEP 2 & 3: Determination of the targeted utility per Edge Profile



Note: The historical speed profiles might be collected on a subpart of the targeted road network.

Bibliography

Hoffman, F. M., Kumar, J., Mills, R. T., & Hargrove, W. W. (2013). Representativeness-based sampling network design for the State of Alaska. *Landscape Ecology*, 28, 1567-1586.

Kanaroglou, P. S., Jerrett, M., Morrison, J., Beckerman, B., Arain, M. A., Gilbert, N. L., & Brook, J. R. (2005). Establishing an air pollution monitoring network for intra-urban population exposure assessment: A location-allocation approach. *Atmospheric Environment*, 39(13), 2399-2409.

Lerner, U., Hirshfeld, O., & Fishbasin, B. (2019). Optimal deployment of a heterogeneous air quality sensor network. *J. Environ. Inform.*, 34(2), 99-107.