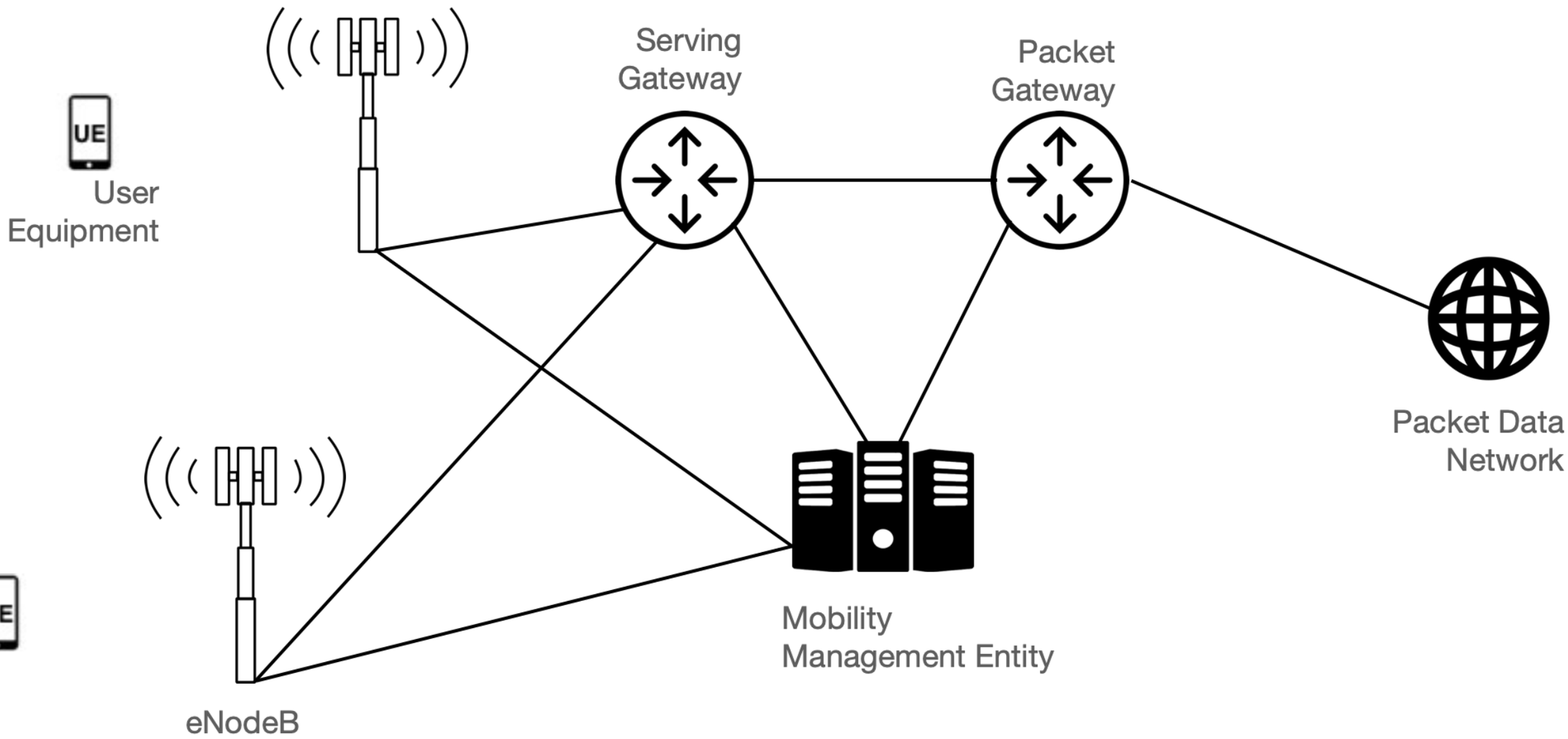
Spatio-temporal Analysis of Mobile Traffic Data

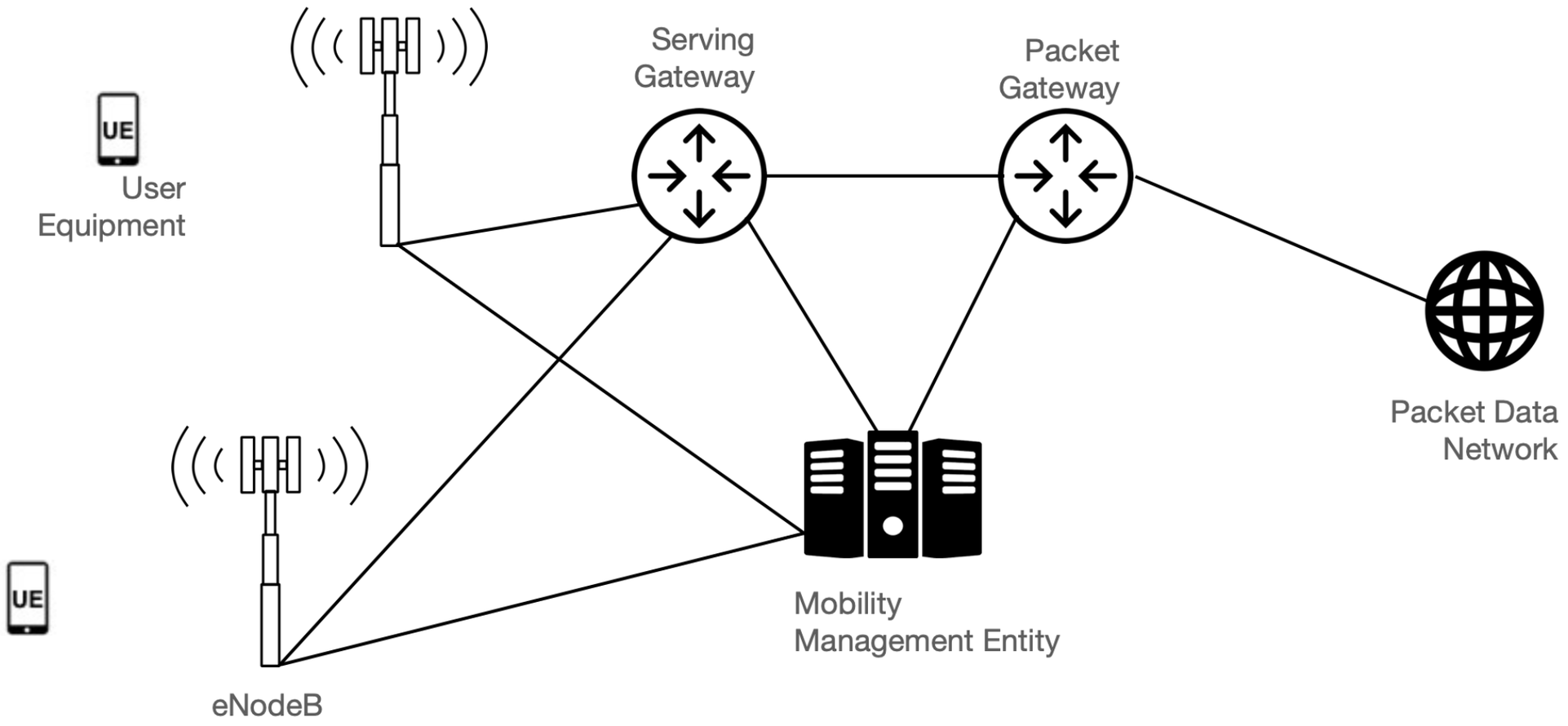
SACI 2025, Timișoara

Razvan Stanica – INSA Lyon, Inria Agora

Mobile operator network

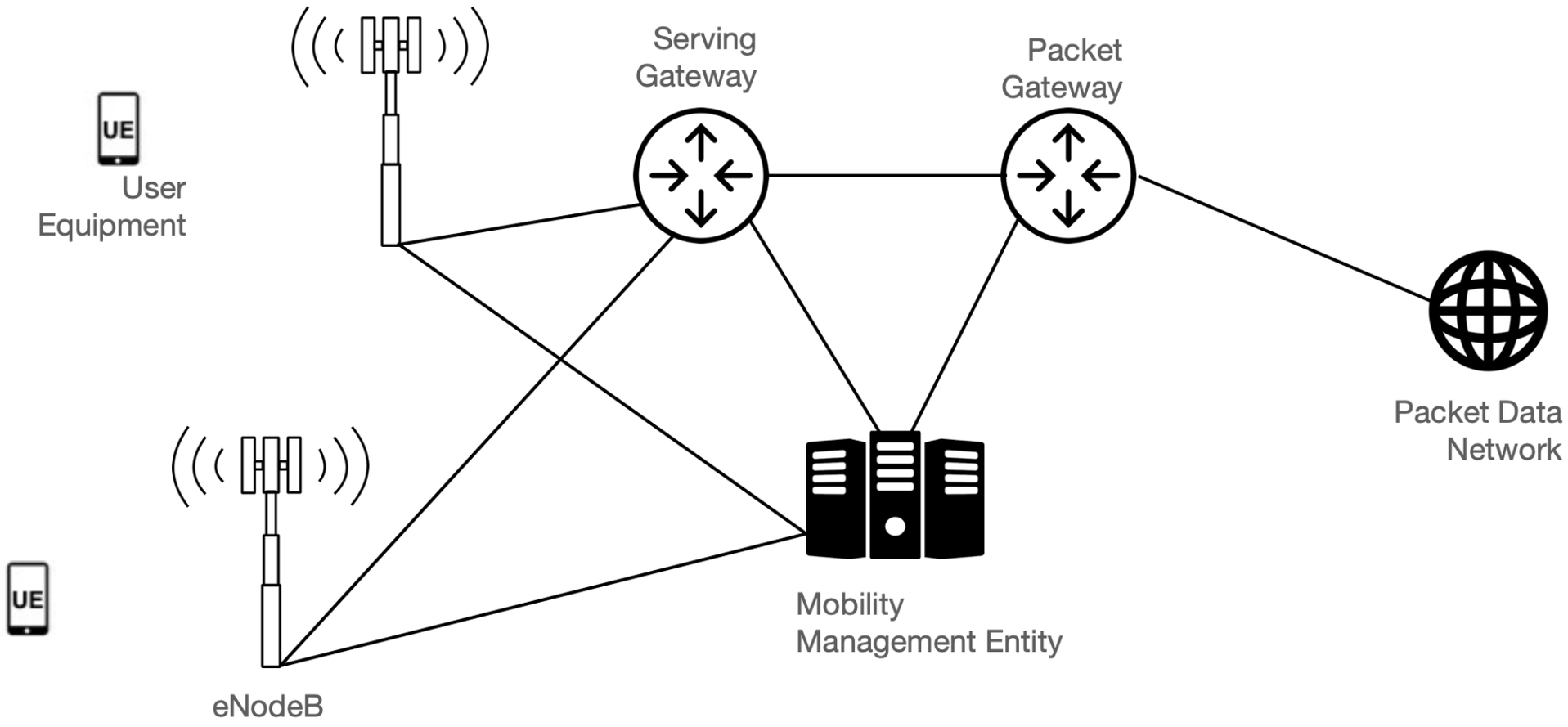


Mobile operator network



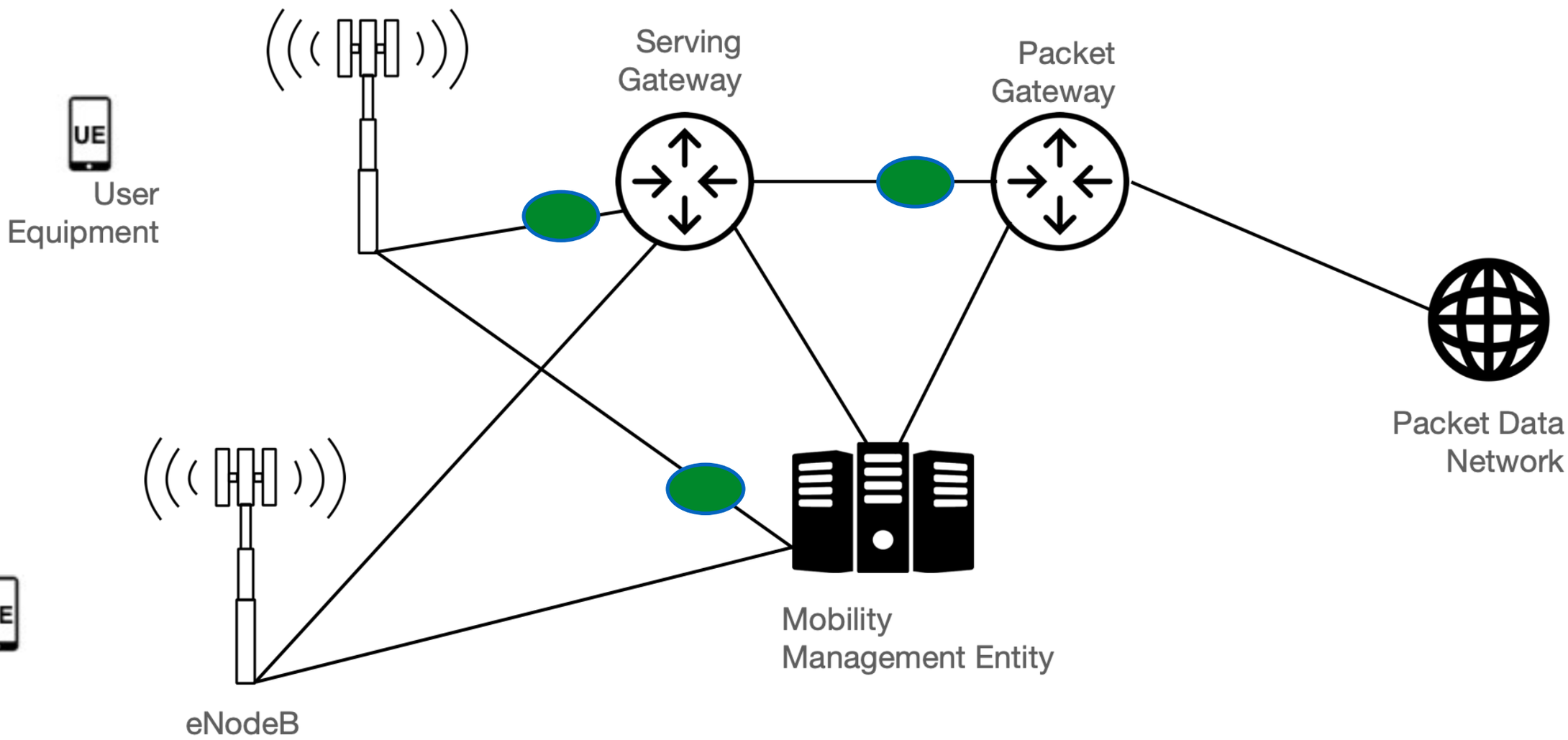
- **User location known by the network only when the smartphone is active**
- **User location known at the granularity of the base station**

Mobile operator network



- **The operator has the legal obligation to keep user records for 1 year**
- **User data is also used for network management and troubleshooting**

Mobile operator network

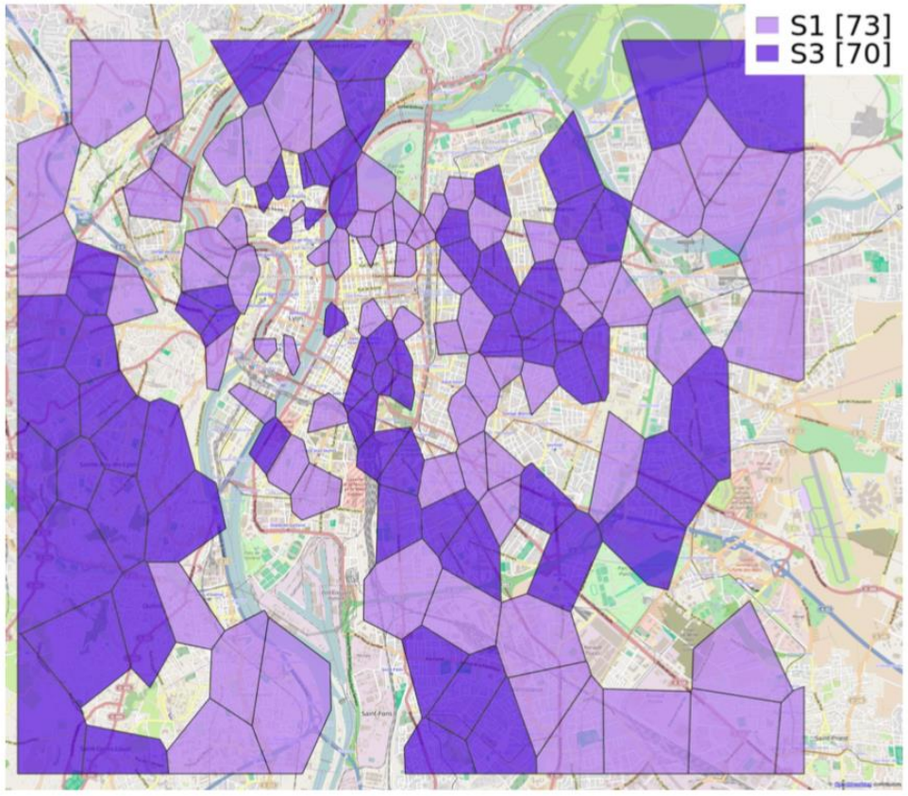


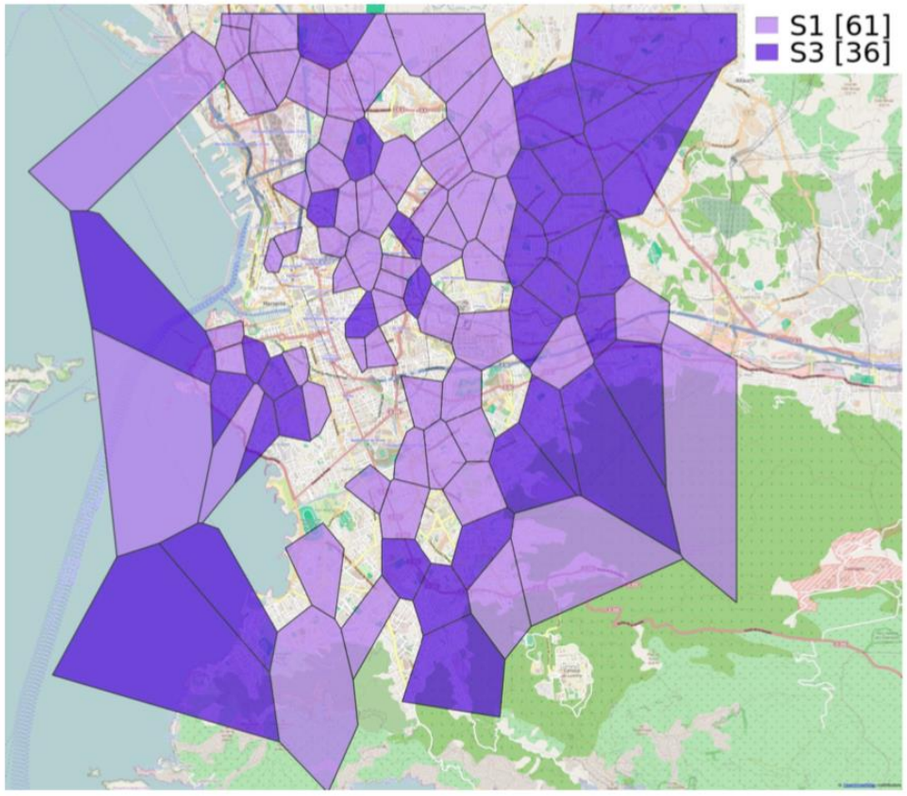
Mobile phone data

- **Per user data**
  - **The original format of the operator data**
  - **Very heterogeneous frequency, related to the user activity**
  - **More and more points per user as we go from 2G to 5G**
  - **Difficult to access from a legal point of view (especially post GDPR)**
  - **Not always very precise**

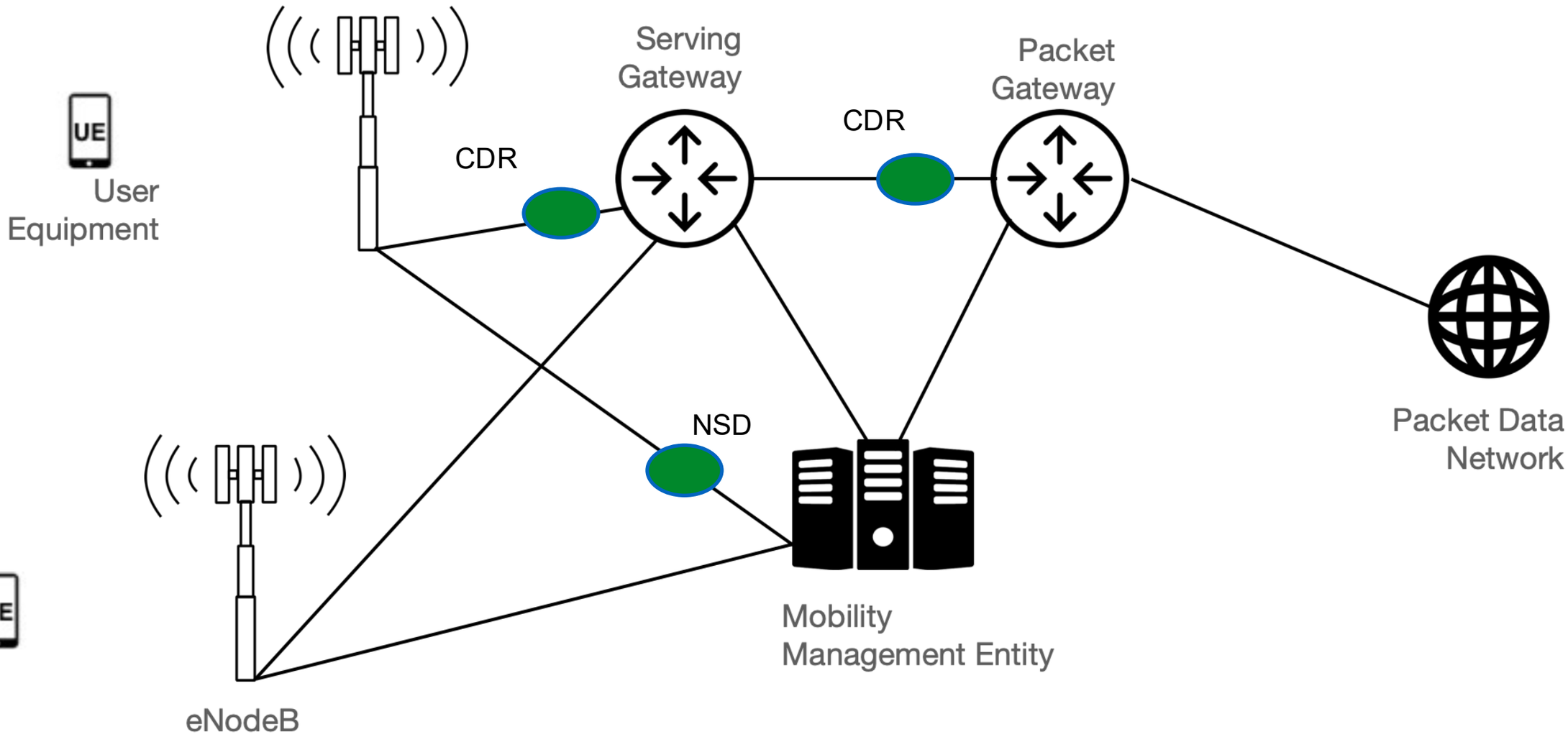
Mobile phone data

- **Per base station data**
  - **Aggregated data for all the users associated during a given time**
  - **A format which can be acquired from operators (Fluxvision, GeoStatistics)**
  - **Periodic, controlled data collection**
  - **Vague mobility information (flows)**
  - **Spatial granularity depends on the geographical area**





1. Per user data analysis



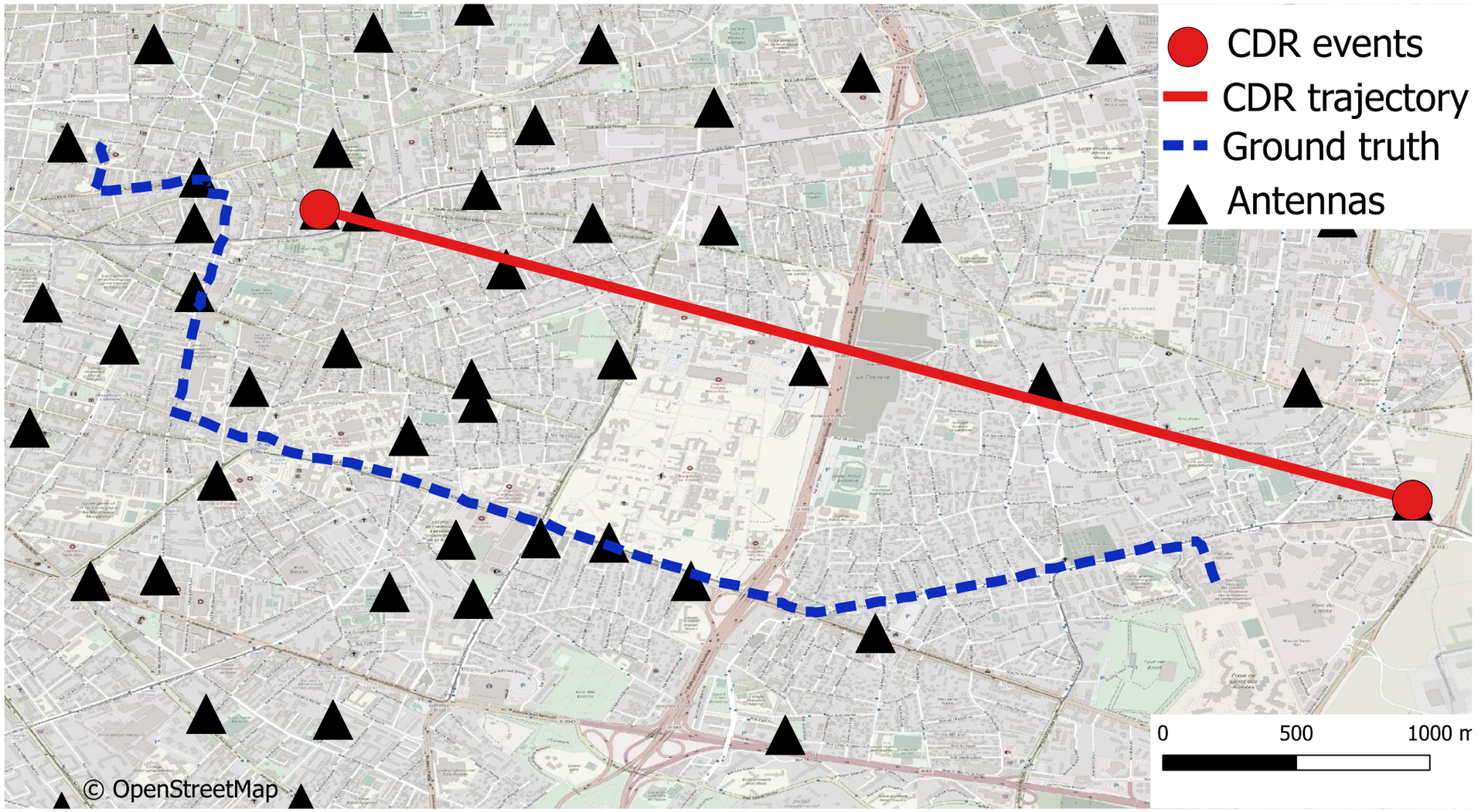
1. User trajectory reconstruction

- **GPS data collected from 4 voluntary users**
- **Orange collected data shared with user agreement**

L. Bonnetain et al. - "TRANSIT: Fine-grained Human Mobility Trajectory Inference at Scale with Mobile Network Signaling Data", Transportation Research Part C: Emerging Technologies.

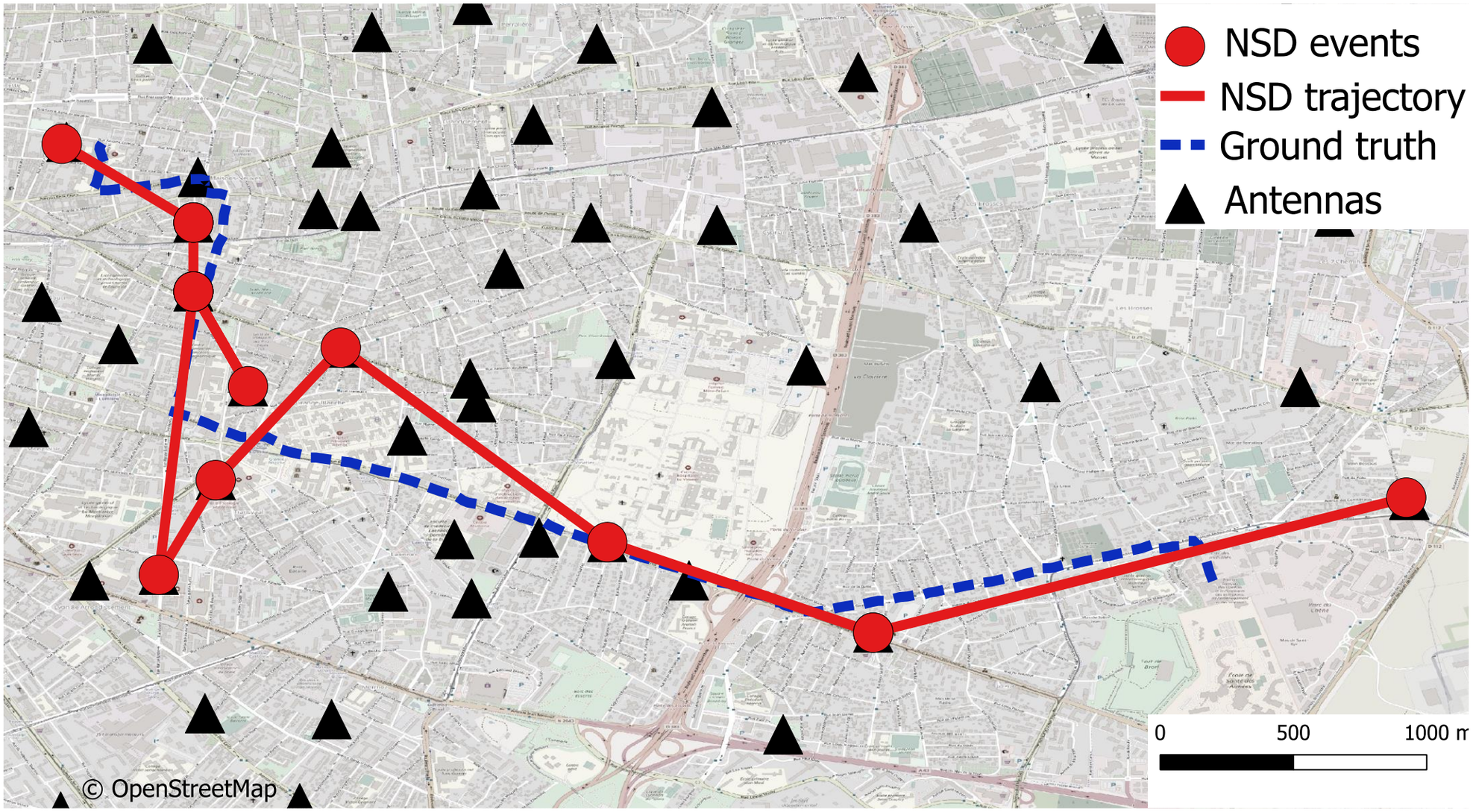
1. User trajectory reconstruction

- **Trajectory using CDR only (user data logs)**



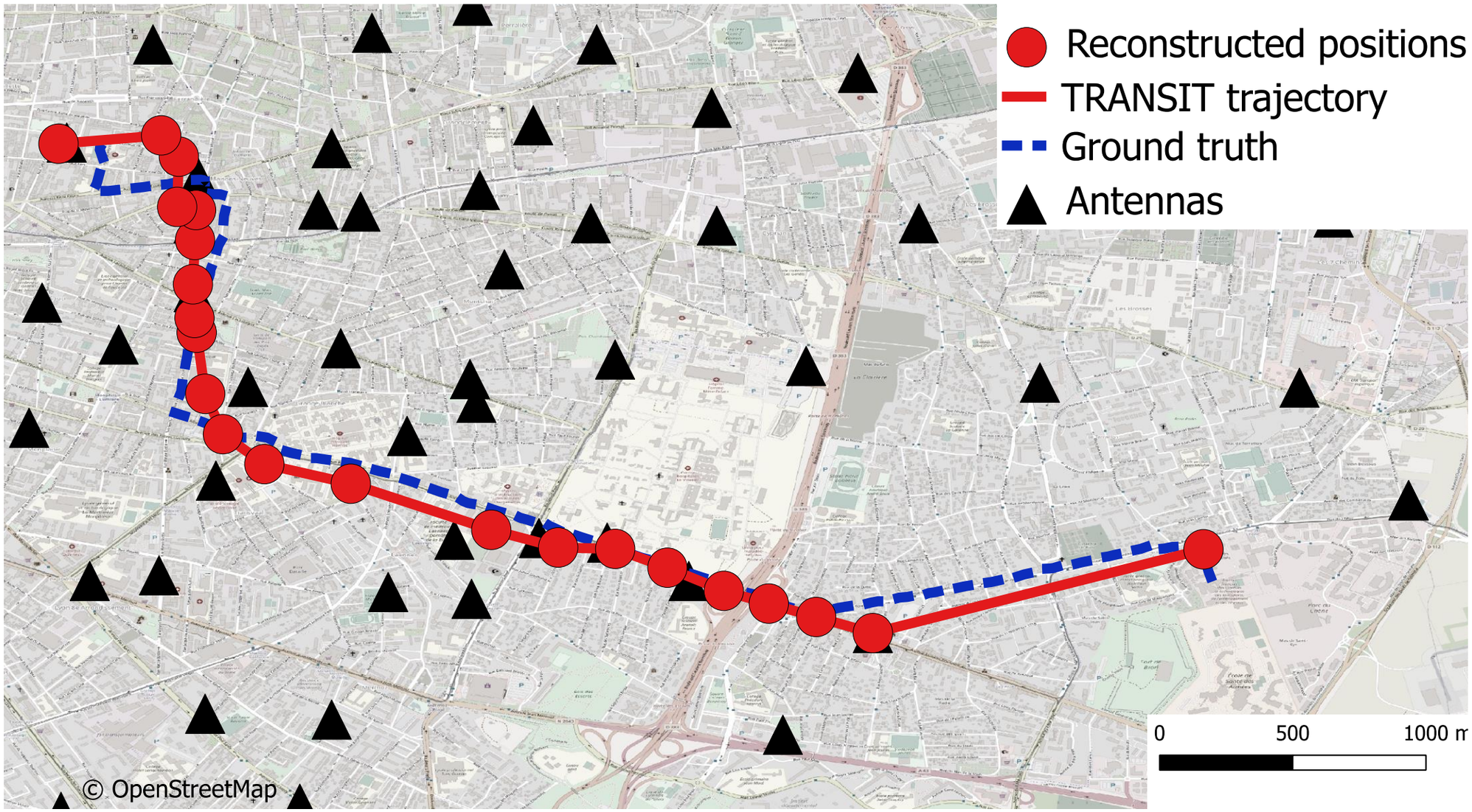
1. User trajectory reconstruction

- **Trajectory using NSD (control data logs)**



1. User trajectory reconstruction

- **Reconstructed trajectory (TRANSIT framework)**



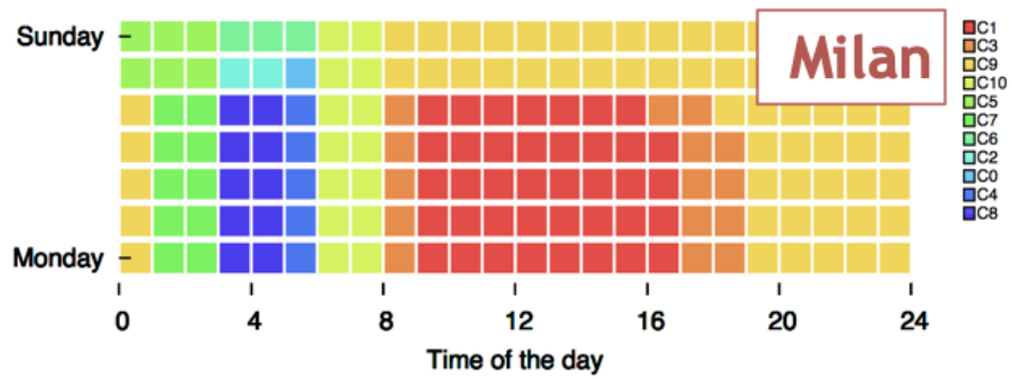
2. Temporal urban life classification

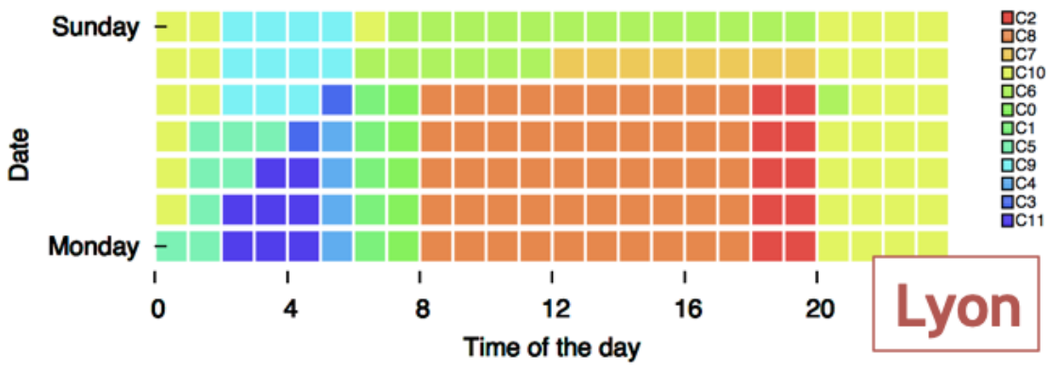
- **Orange data for 6 major cities in France**
- **TIM Big Data Challenge data for 4 cities in Italy**

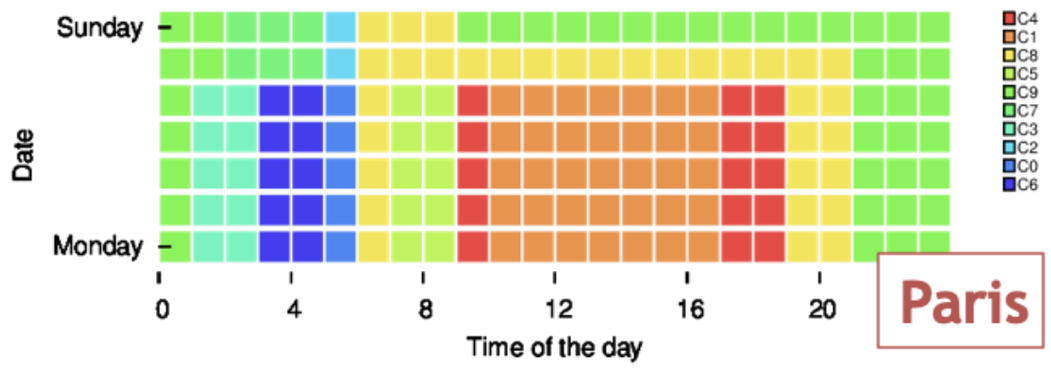
A. Furno et al. - "Mobile Demand Profiling for Cellular Cognitive Networking", IEEE Transactions on Mobile Computing

2. Temporal urban life classification

- **Temporal profiles**



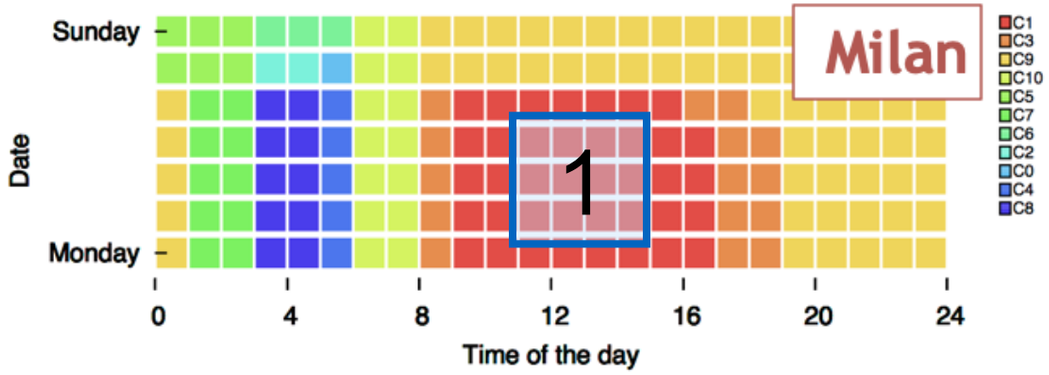


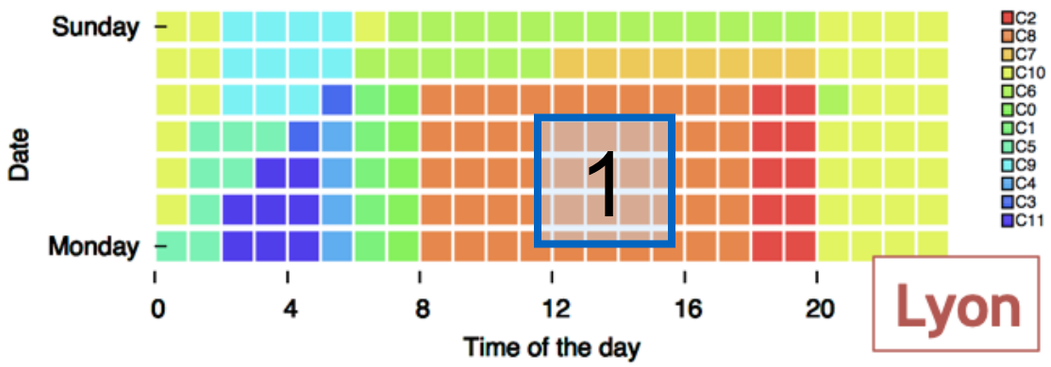


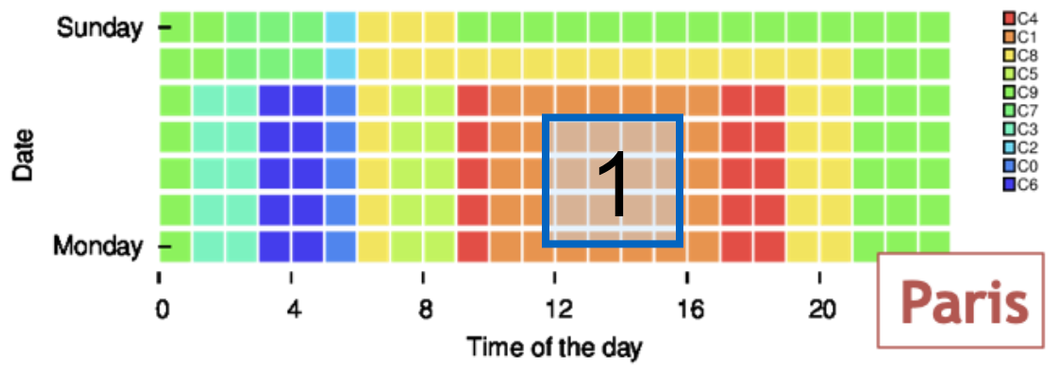
2. Temporal urban life classification

- **Temporal profiles**

  1. Working hours



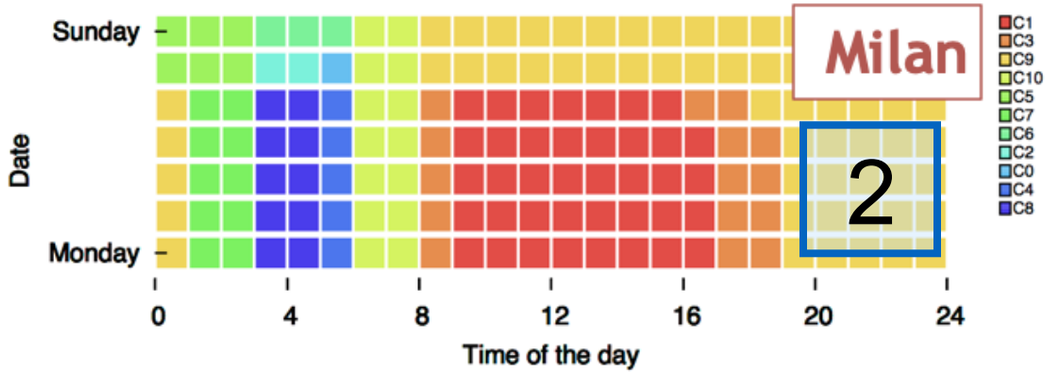


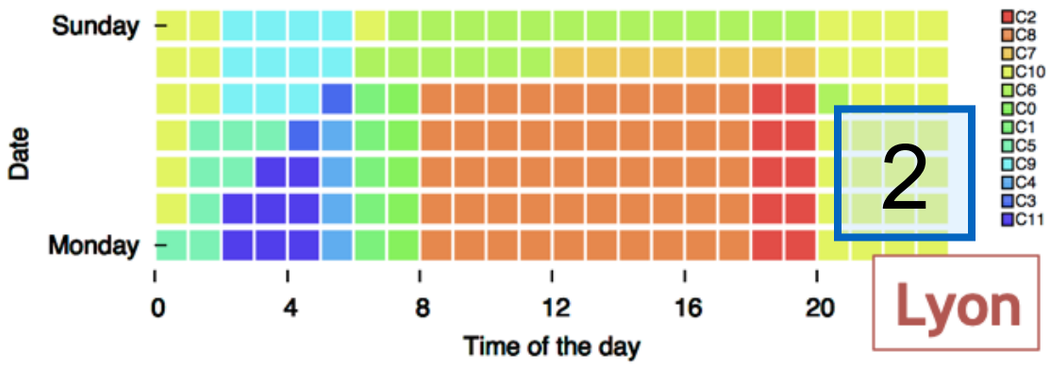


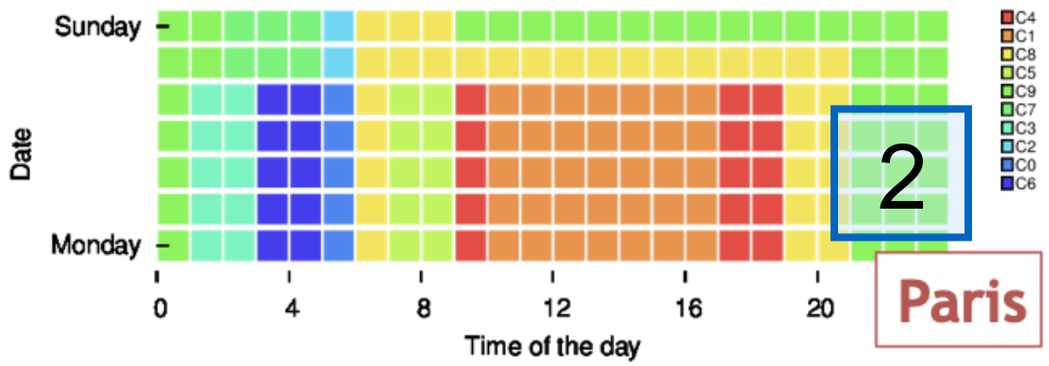
2. Temporal urban life classification

- **Temporal profiles**

  1. **Working hours**
  2. **Evening hours**



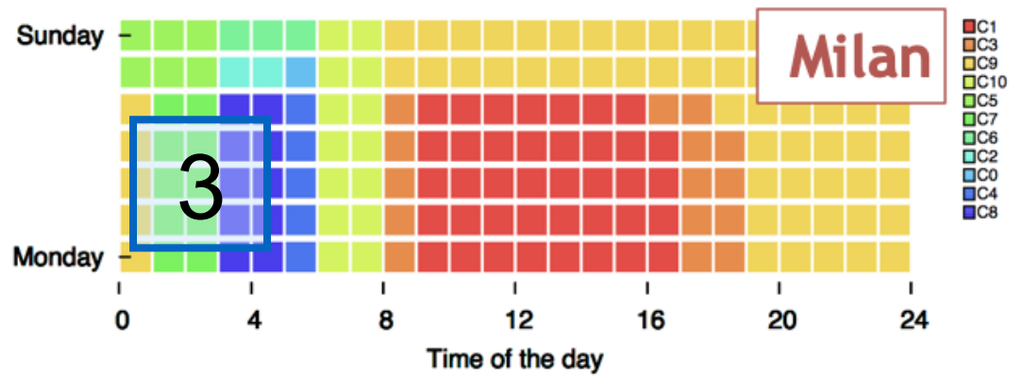


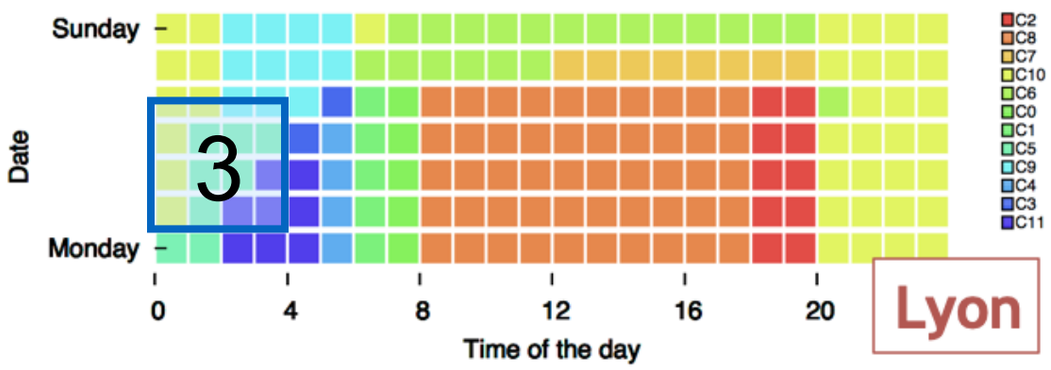


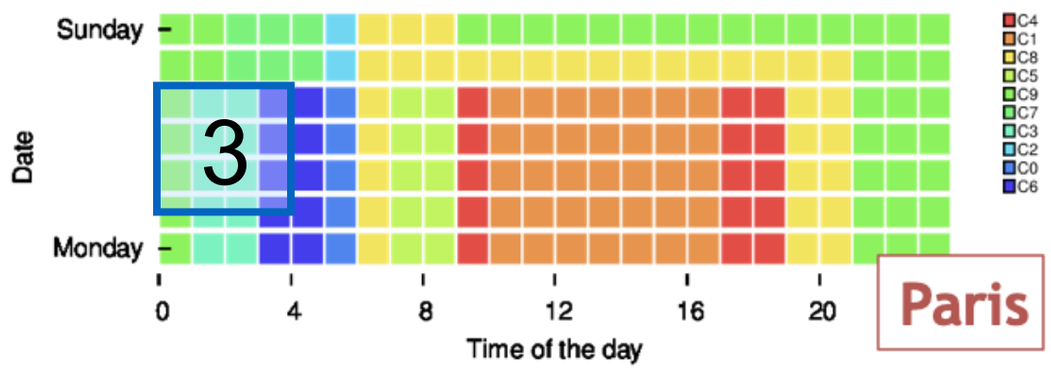
2. Temporal urban life classification

- **Temporal profiles**

  1. **Working hours**
  2. **Evening hours**
  3. **Night**



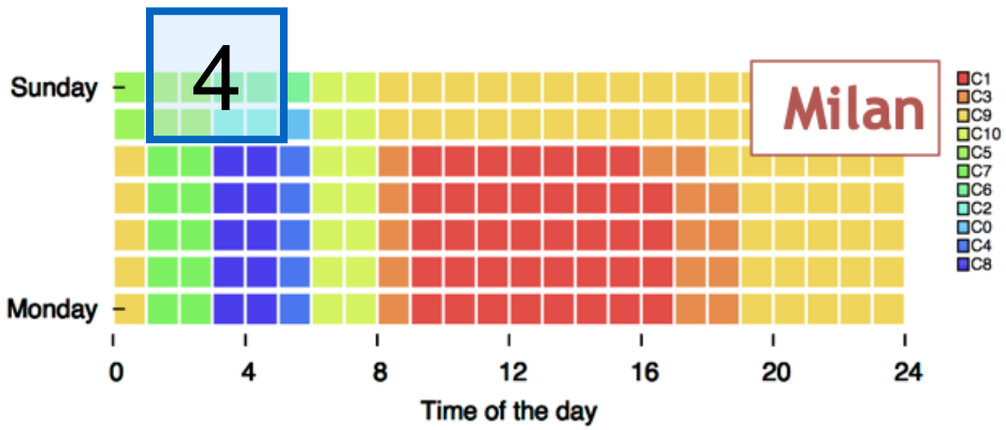


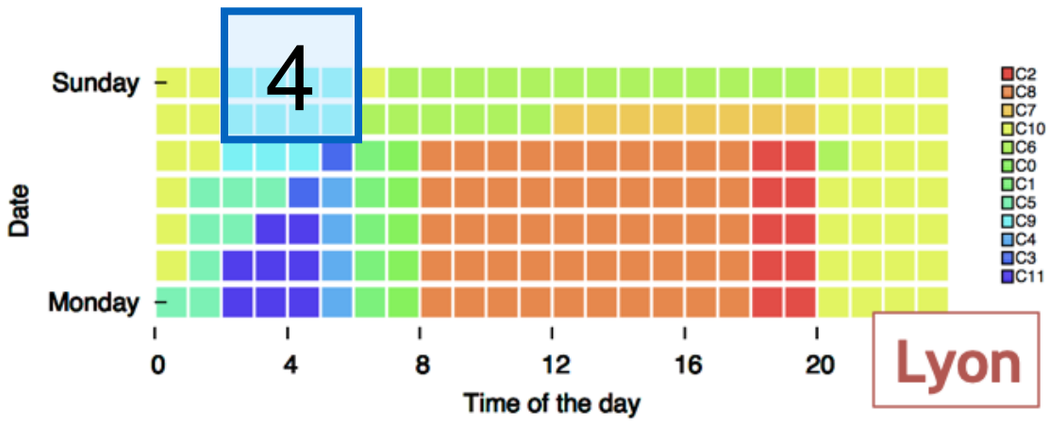


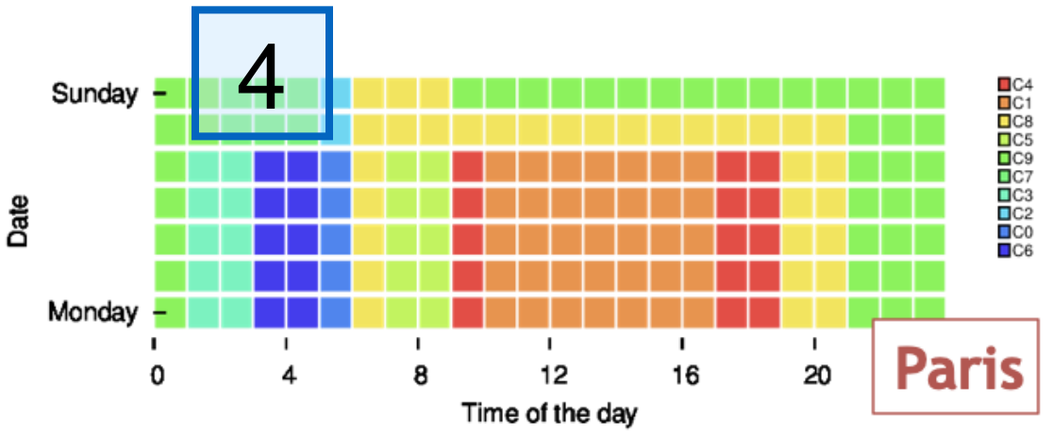
2. Temporal urban life classification

- **Temporal profiles**

  1. **Working hours**
  2. **Evening hours**
  3. **Night**
  4. **Week-end nightlife**



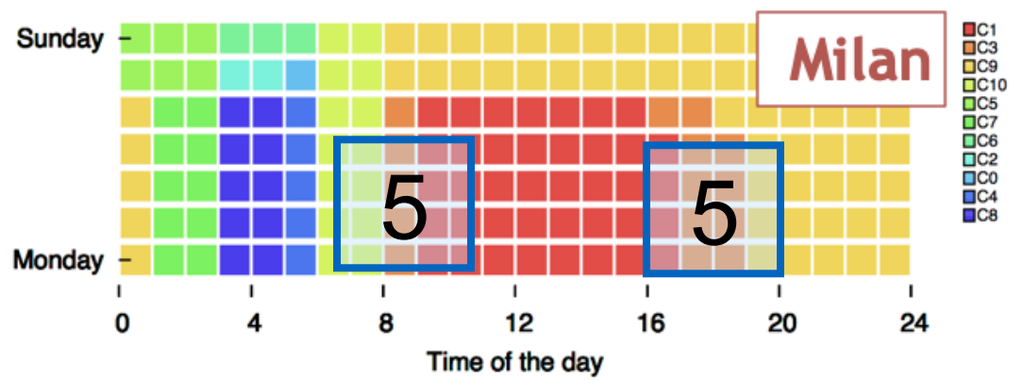


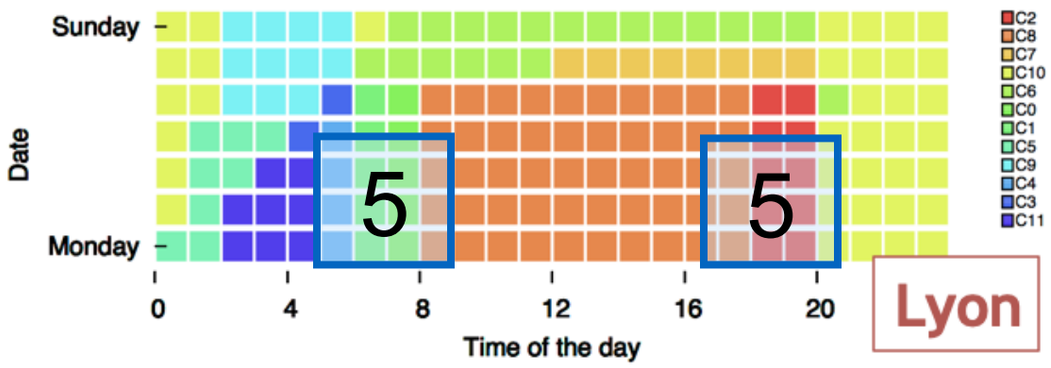


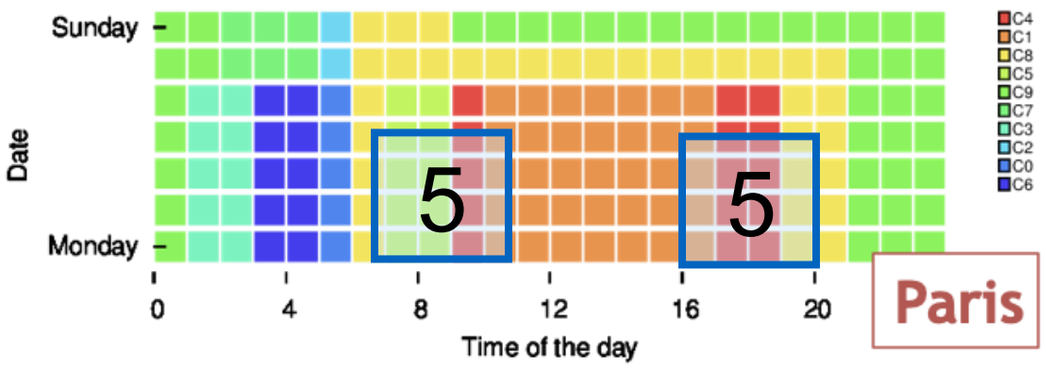
2. Temporal urban life classification

- **Temporal profiles**

  1. **Working hours**
  2. **Evening hours**
  3. **Night**
  4. **Week-end nightlife**
  5. **Commuting**

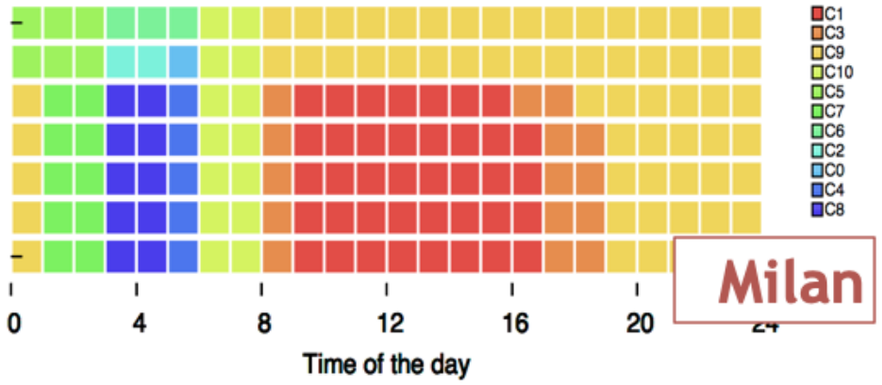


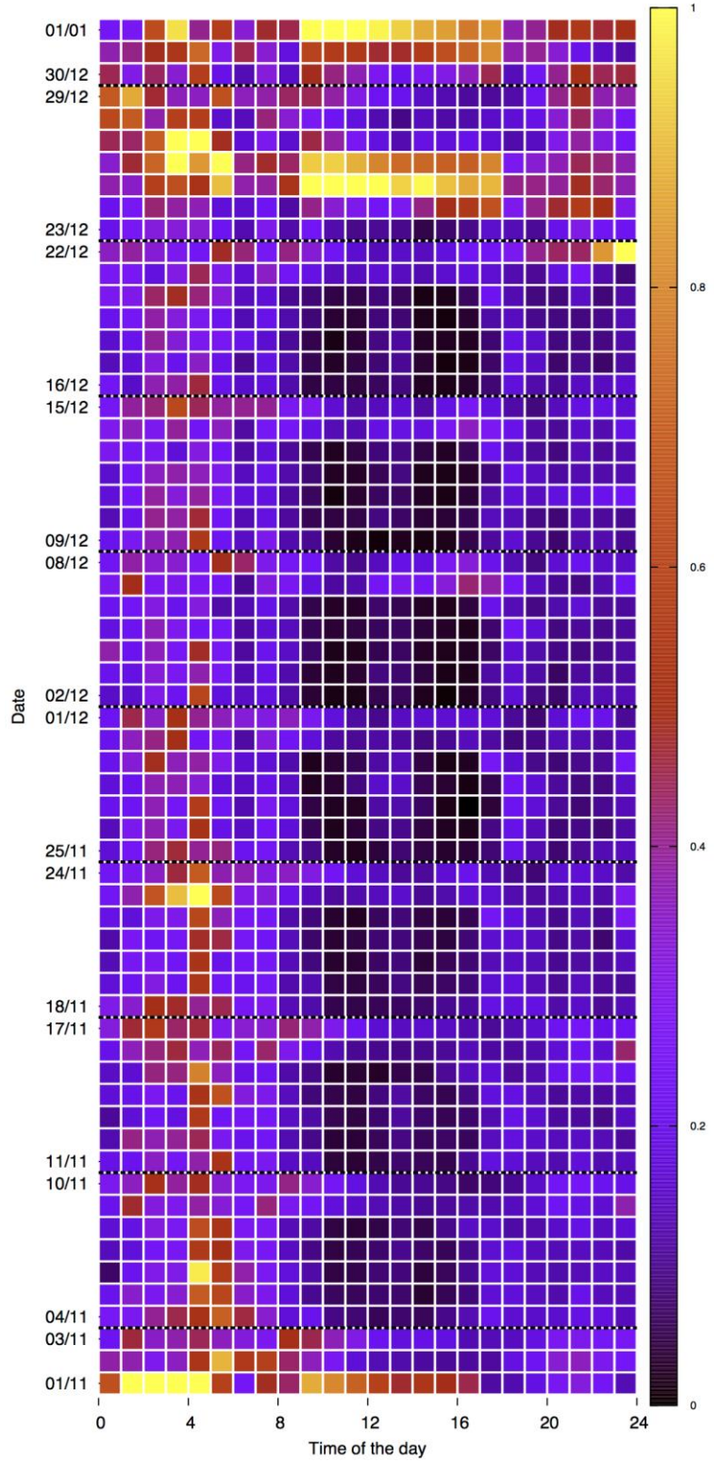




2. Temporal urban life classification

- **Outlier detection**





Halloween night, Milan patron saint day, opening of opera season at La Scala, Christmas holidays and events, several public holidays, football matches of AC Milan and Inter Milan, one collection probe crash, etc.

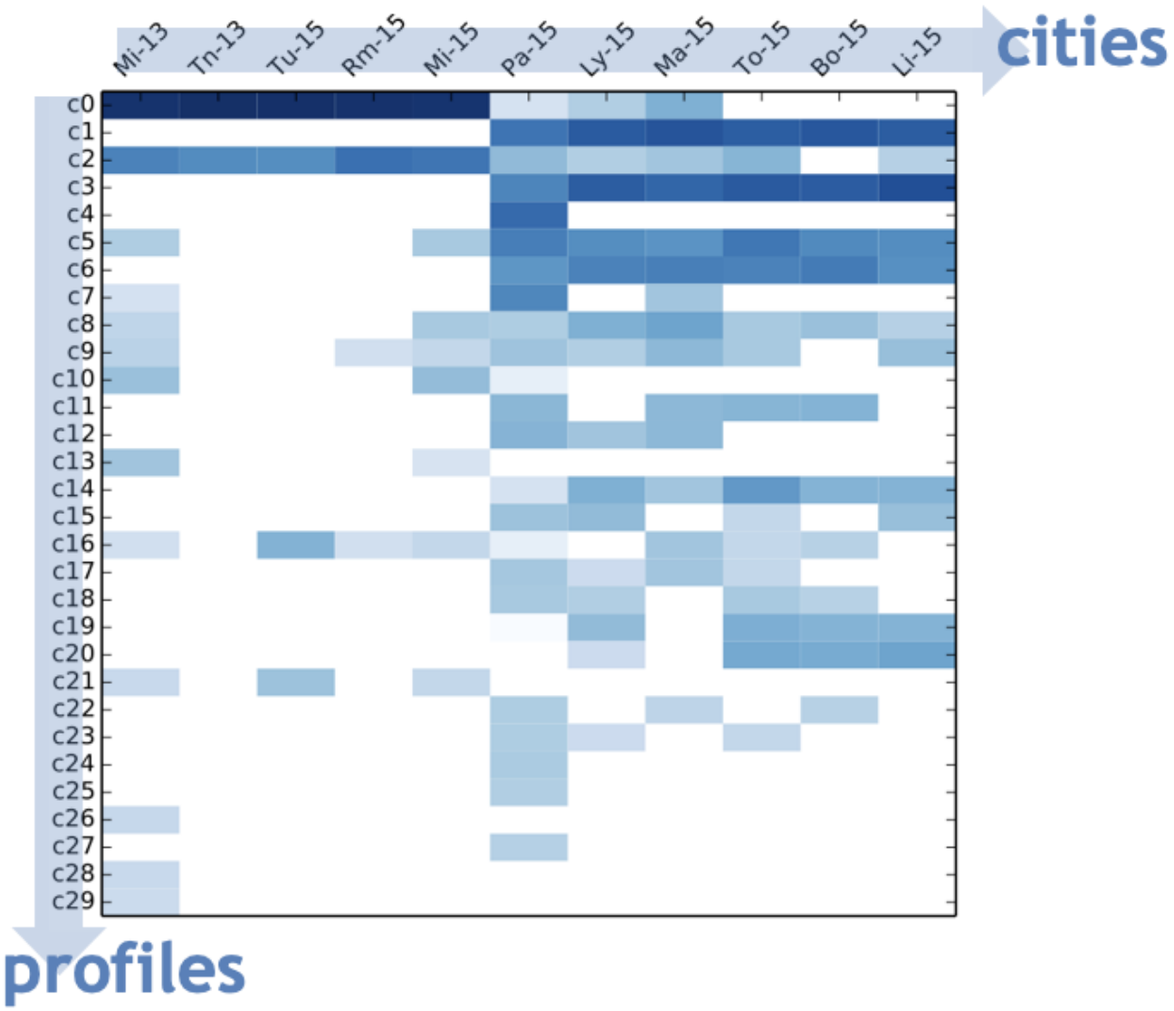
3. Land use detection

- **Orange data for 6 major cities in France**
- **TIM Big Data Challenge data for 4 cities in Italy**
- **Methodology applied several times on Orange and SFR data**

A. Furno et al. - "A Tale of Ten Cities: Characterizing Signatures of Mobile Traffic in Urban Areas", IEEE Transactions on Mobile Computing

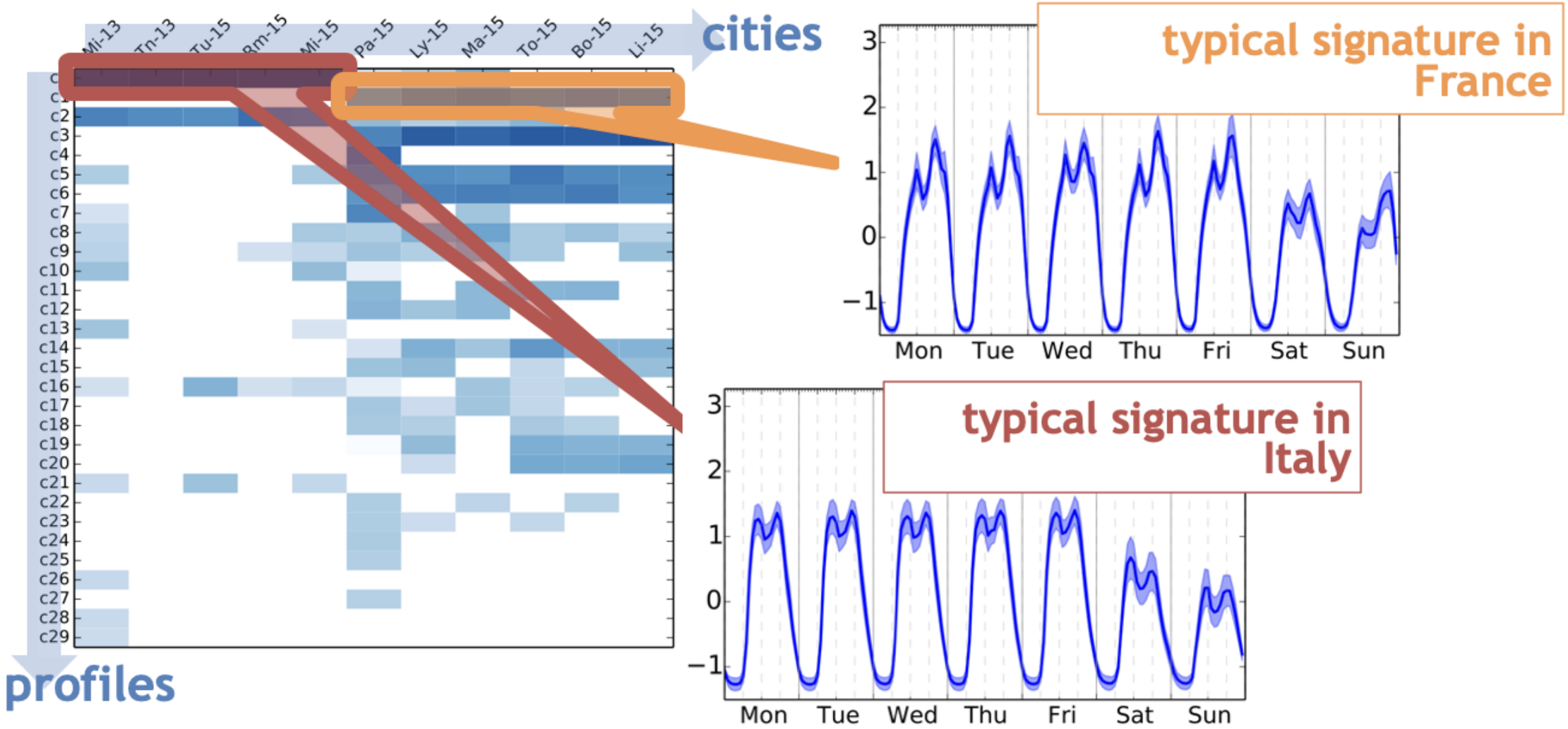
3. Land use detection

- **Spatial profiles = signatures**



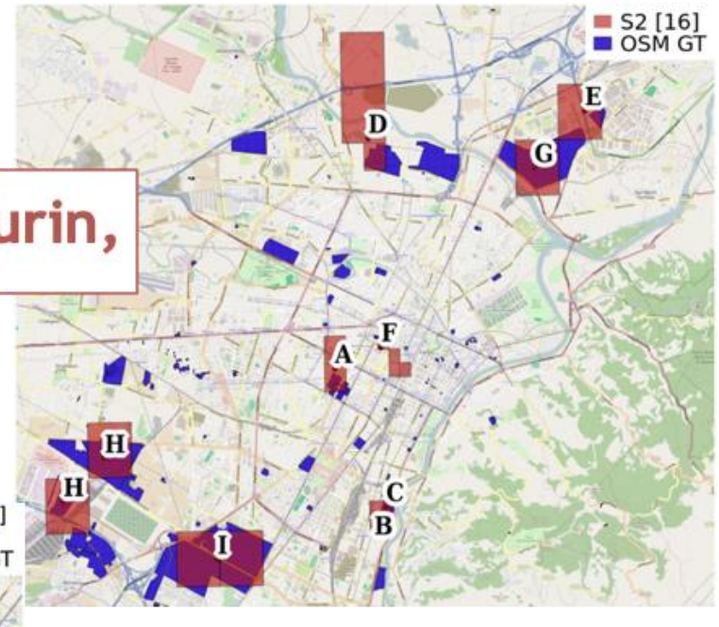
3. Land use detection

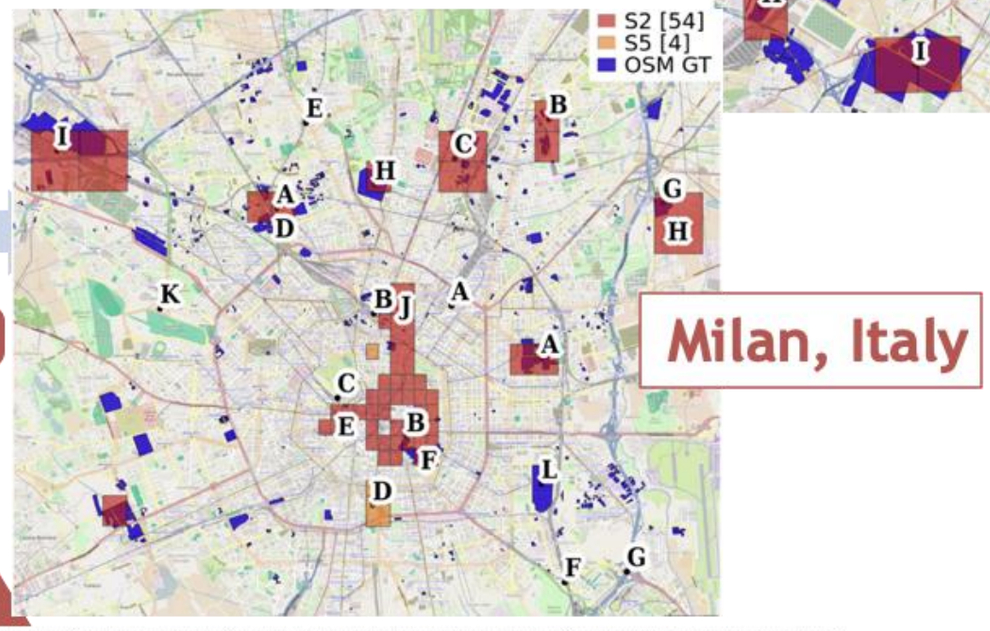
- **Baseline signatures (residential areas)**

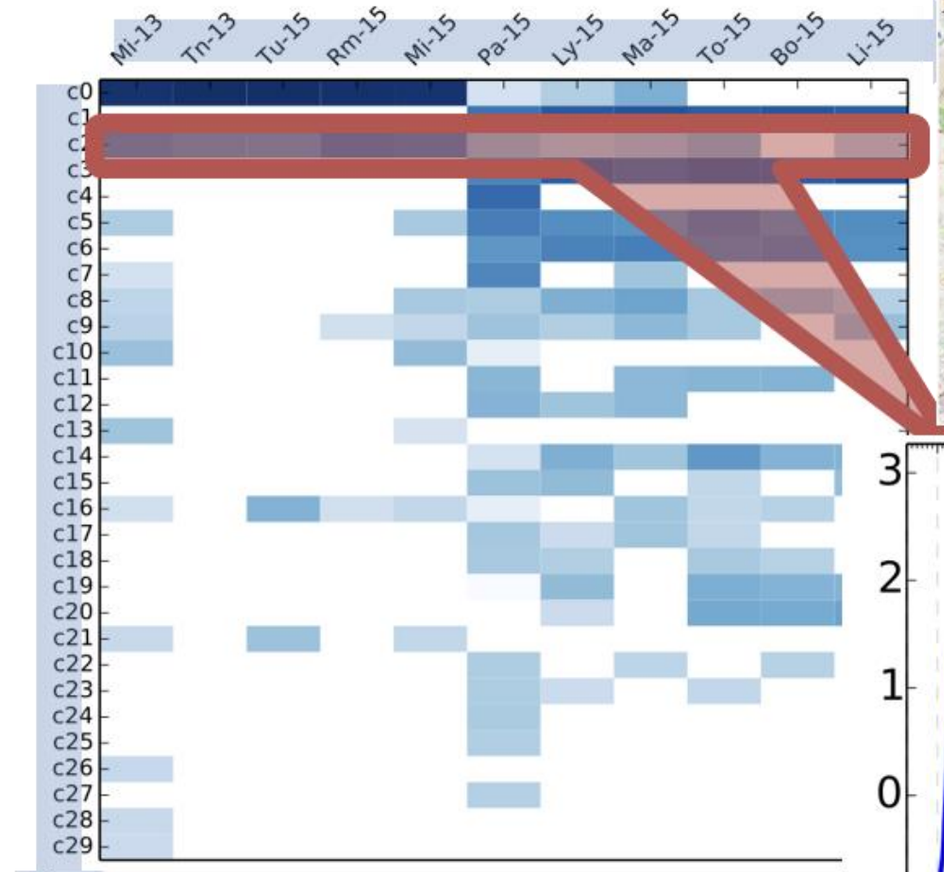


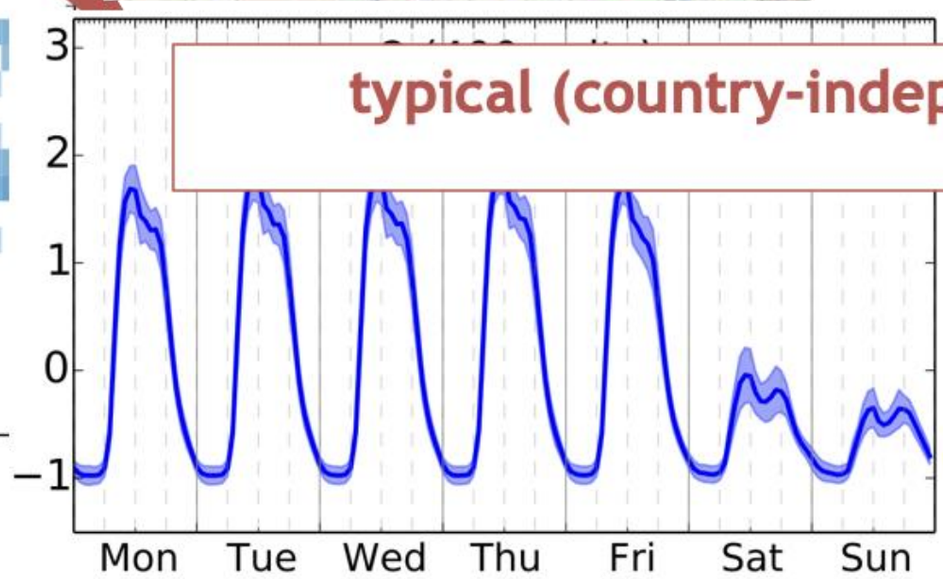
3. Land use detection

- **Office signature**



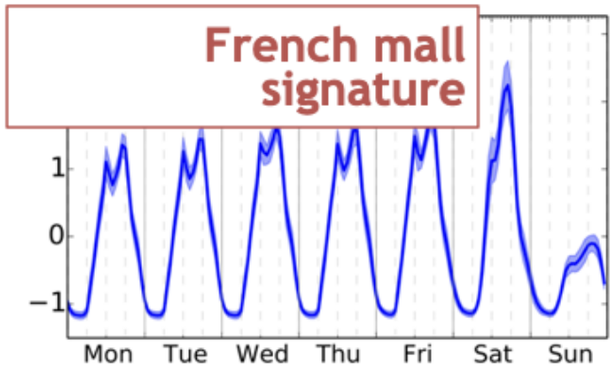


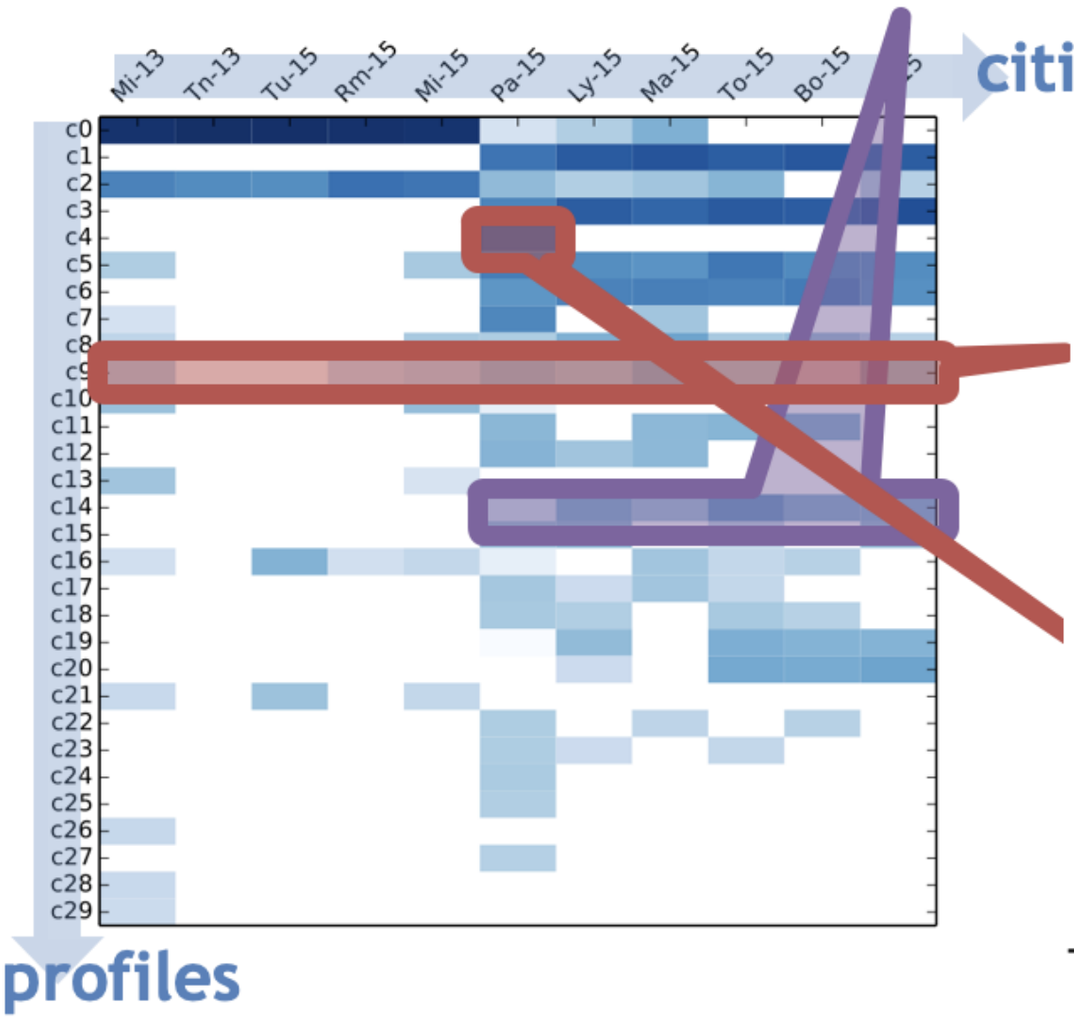


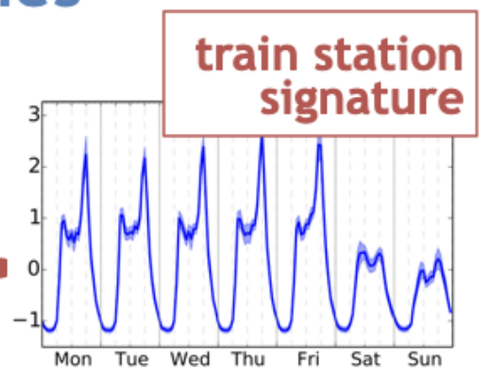


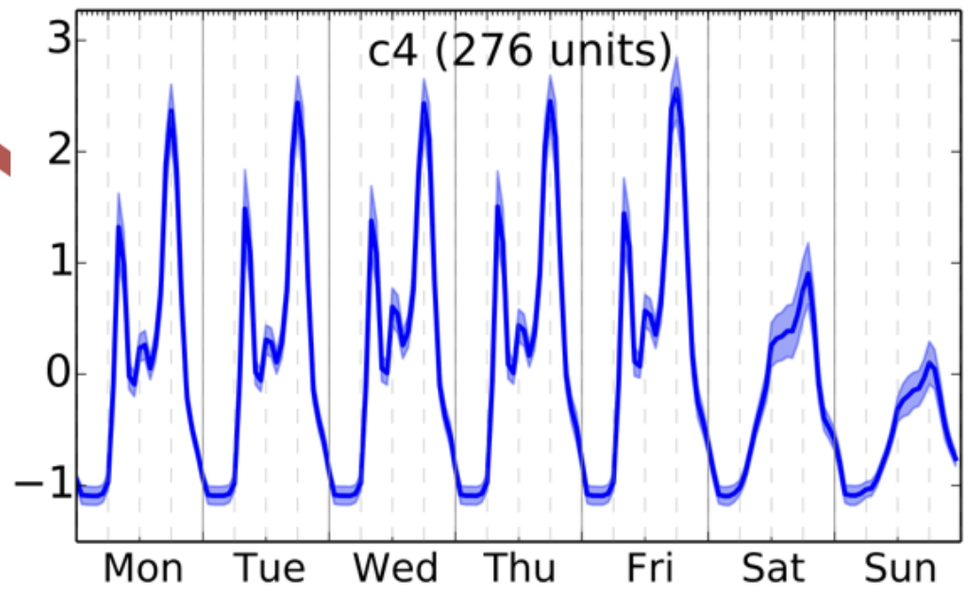
3. Land use detection

- **Other signatures**



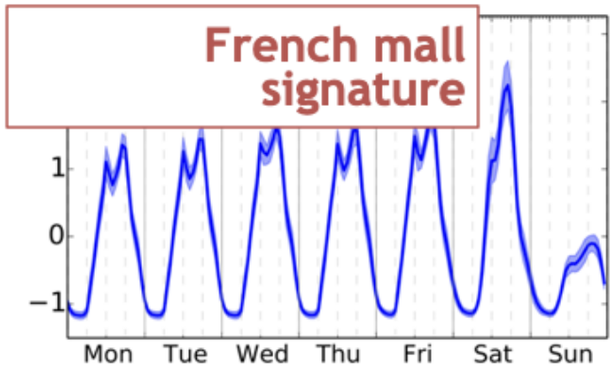


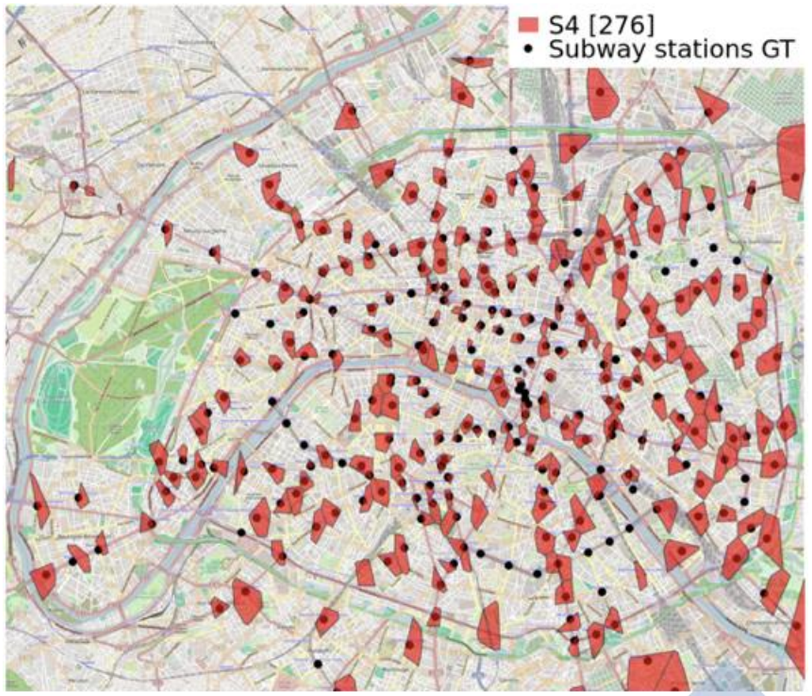


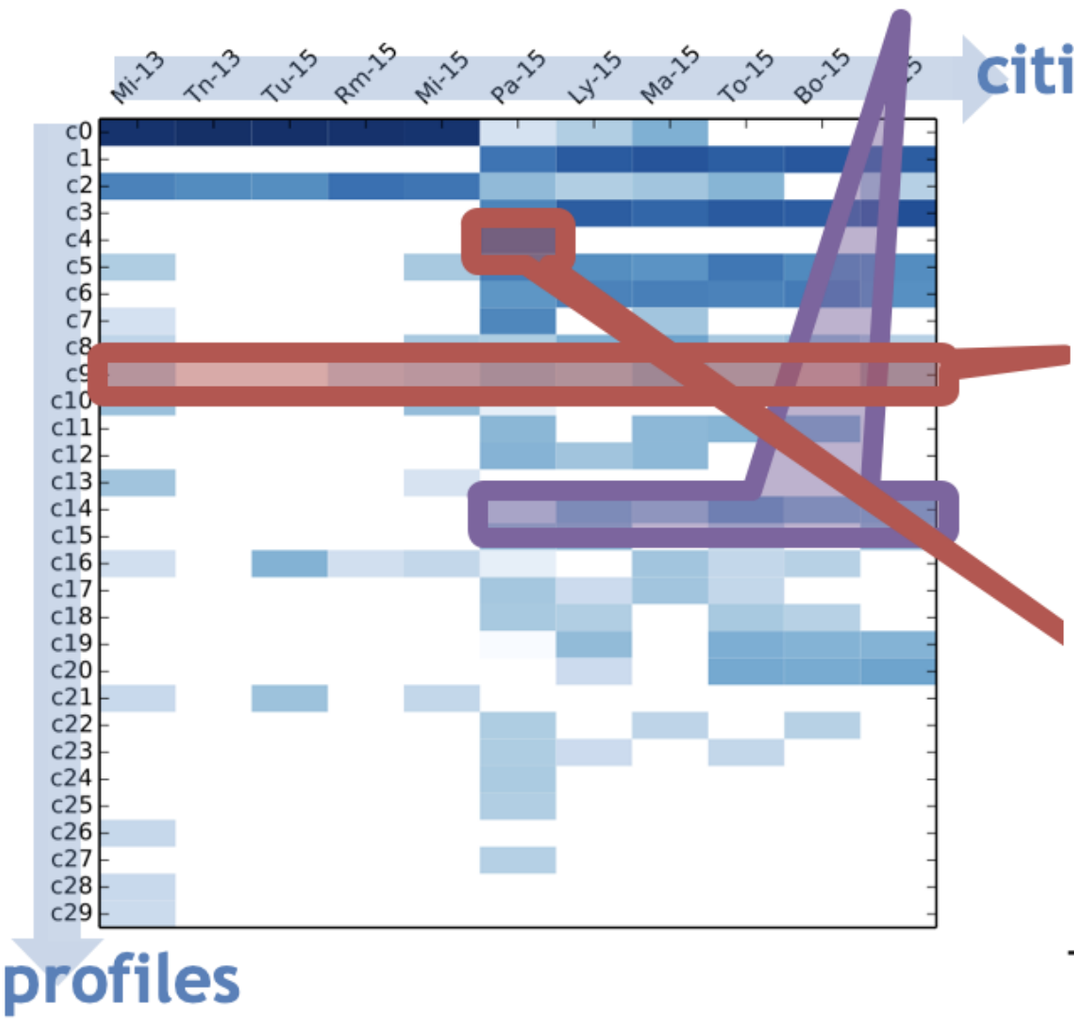


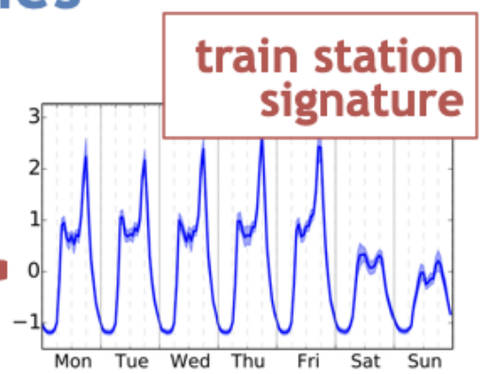
3. Land use detection

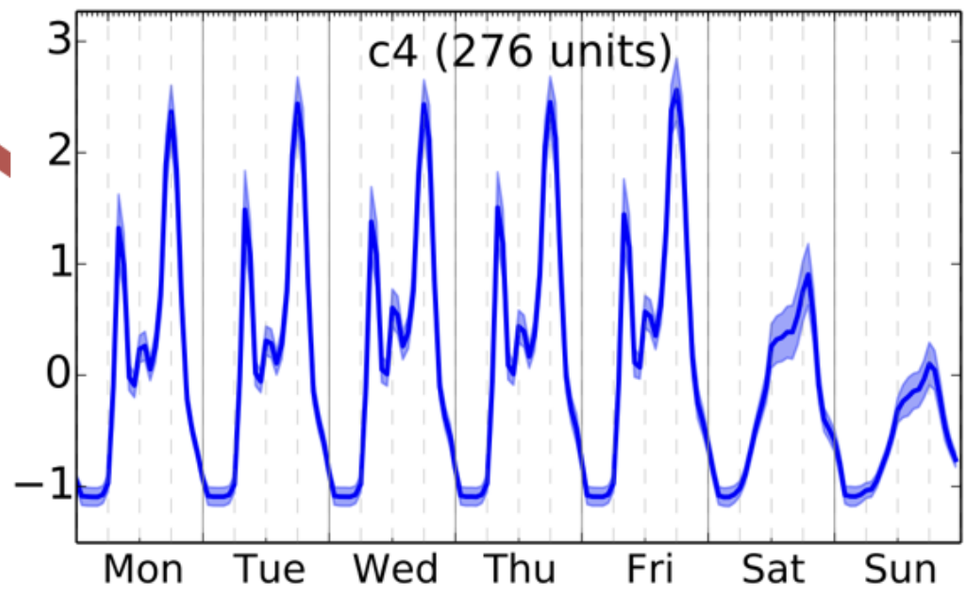
- **Other signatures**





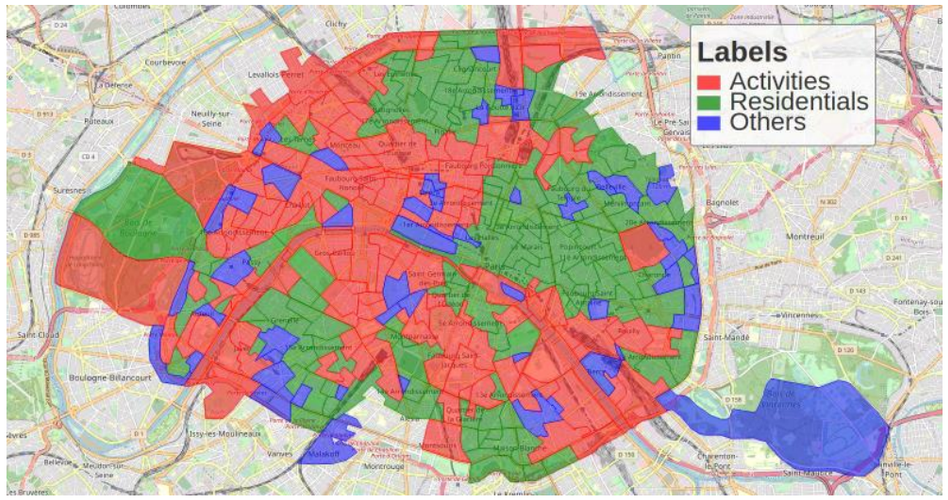




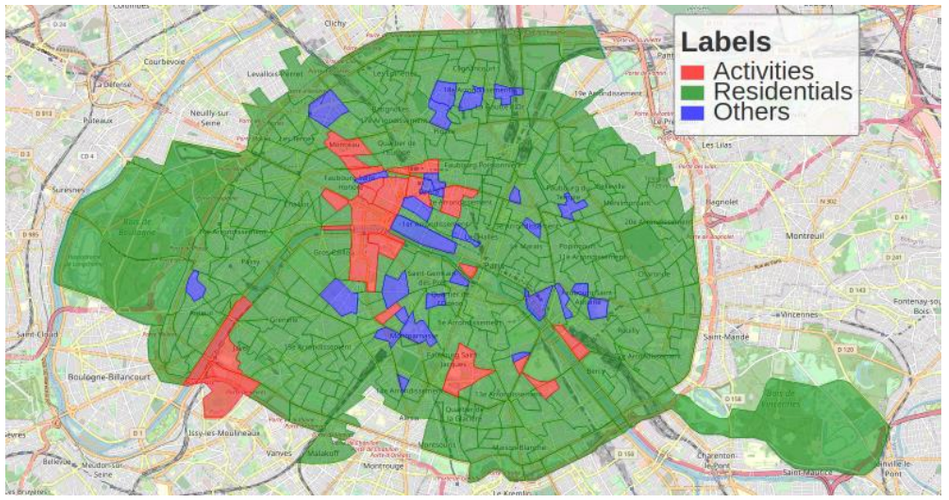


3. Land use detection

- **Application on SFR data to study the impact of Covid lockdown**



Paris before lockdown



Paris during first lockdown

H.C. Fanticelli et al. - "Data-driven Mobility Analysis and Modeling: Typical and Confined Life of a Metropolitan Population", ACM Transactions on Spatial Algorithms and Systems

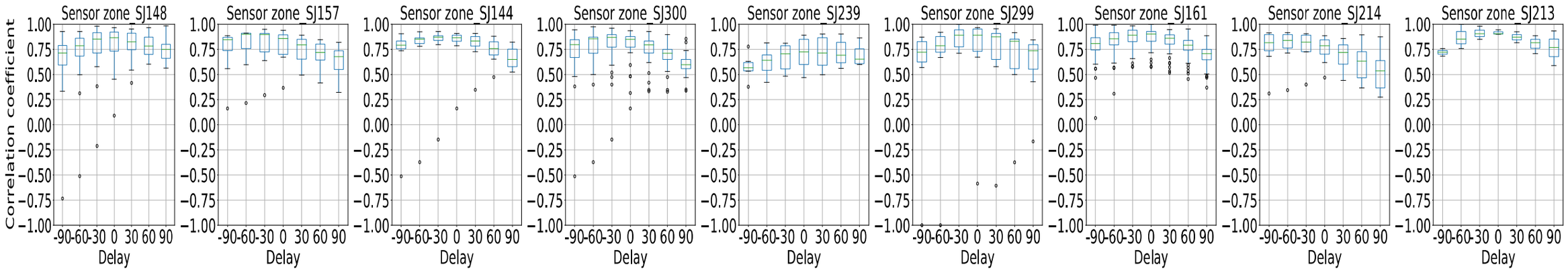
4. Comparison with sensor data

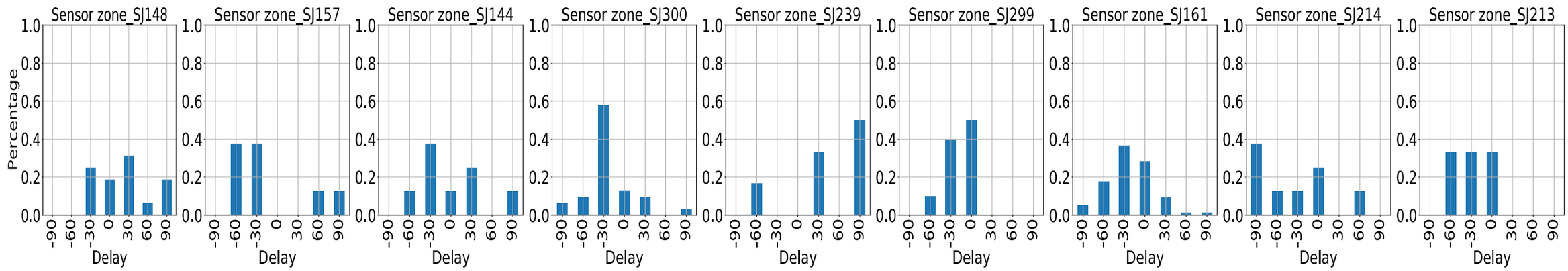
- **Commercial Orange data from an activity area in Cognac (2020 – 2021)**
- **Motion detection sensors deployed in the same area**

S. Rabenjamina et al. - "Comparison of User Presence Information from Mobile Phone and Sensor Data", ACM MSWiM

4. Comparison with sensor data

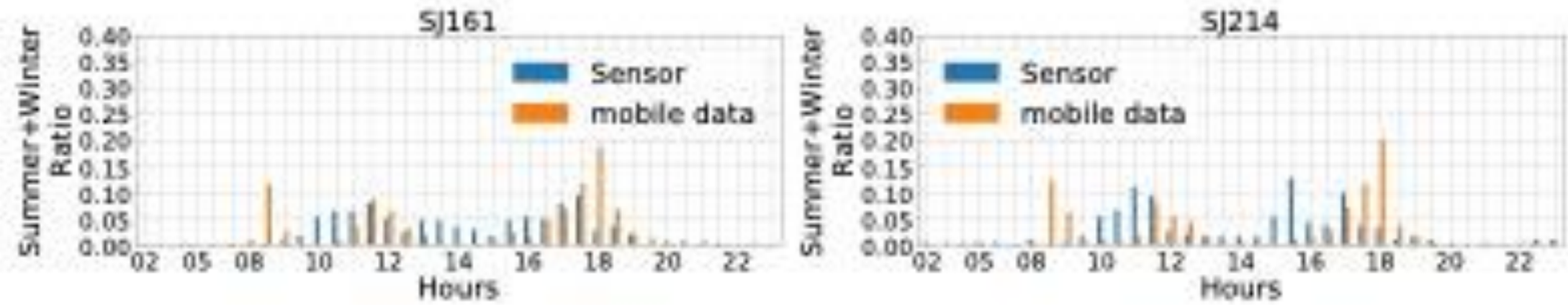
- **Correlation between the two datasets**

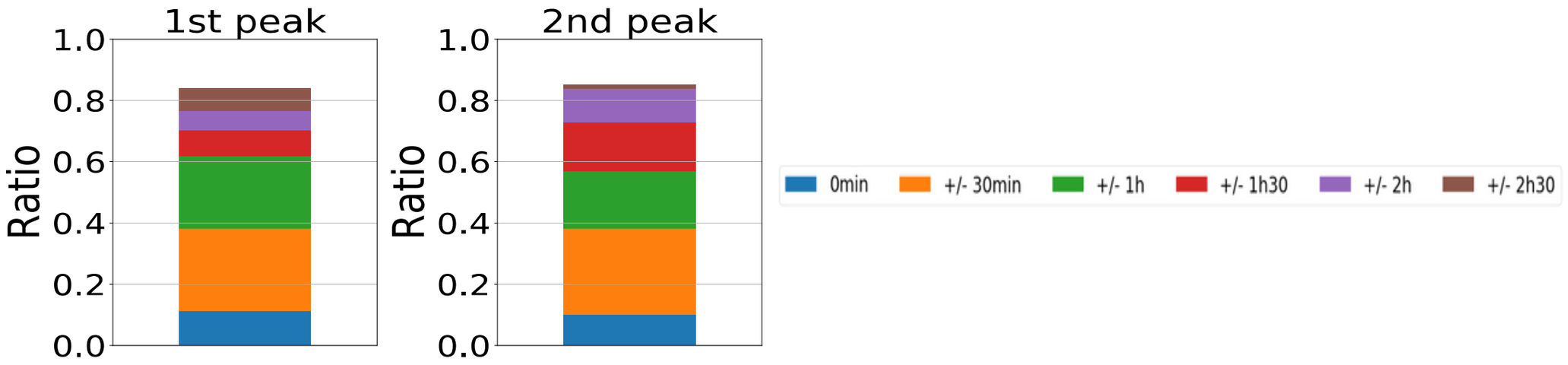




4. Comparison with sensor data

- **Synchronisation between peaks in the two datasets**





Product Placement

https://netmob.org/www25/

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SACI 2025, Timișoara

Razvan Stanica – INSA Lyon, Inria Agora