Urban Mobility Flows from Mobile Phone Data

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About Me

- Associate professor with the Telecom department at INSA Lyon
- Researcher at CITI lab, a joint INSA-INRIA research unit
- Member of the INRIA UrbaNet team, focused on wireless networks in urban environments

- Context
- Datasets
- Methodology
- Mobility Flows

Our motivation

- Global mobile data traffic grew 81% in 2013*
- 526M mobile devices and connections were added in 2013*
- Global mobile data traffic is expected to increase nearly 11-fold by 2018*

* Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013-2018

Our motivation

- Global mobile data traffic grew 81% in 2013*
- 526M mobile devices and connections were added in 2013*
- Global mobile data traffic is expected to increase nearly 11-fold by 2018*
- A need to enhance current wireless infrastructure

* Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013-2018

Our approach

- Understand human dynamics

- Understand customers' demand

- Adapt networking services

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Analyse mobile phone data

Data

- Orange Data for Development Challenge 2013
- Anonymized Call Detail Records (CDR) of Orange customers in Ivory Coast
- Data interval: 05/12/2011 - 22/04/2012

Datasets

- D1: Hourly antenna-to-antenna aggregated calls
- D2: Small subset of individual trajectories with a high spatial resolution
- D3: Large subset of individual trajectories with a reduced spatial resolution
- D4: Individual communication subgraph

Approach

- Goal: Understand how people move over time in a typical day in an urban environment

Approach

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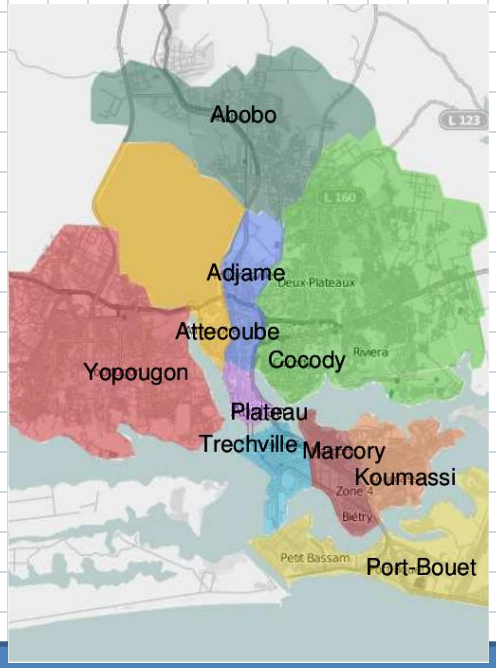
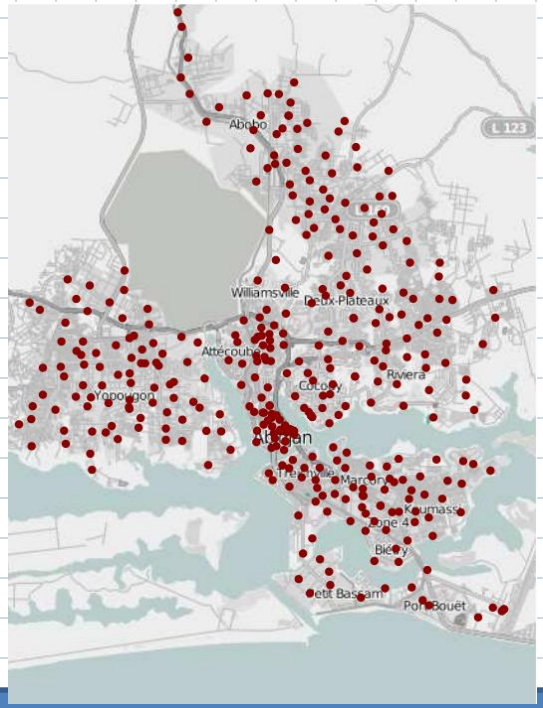
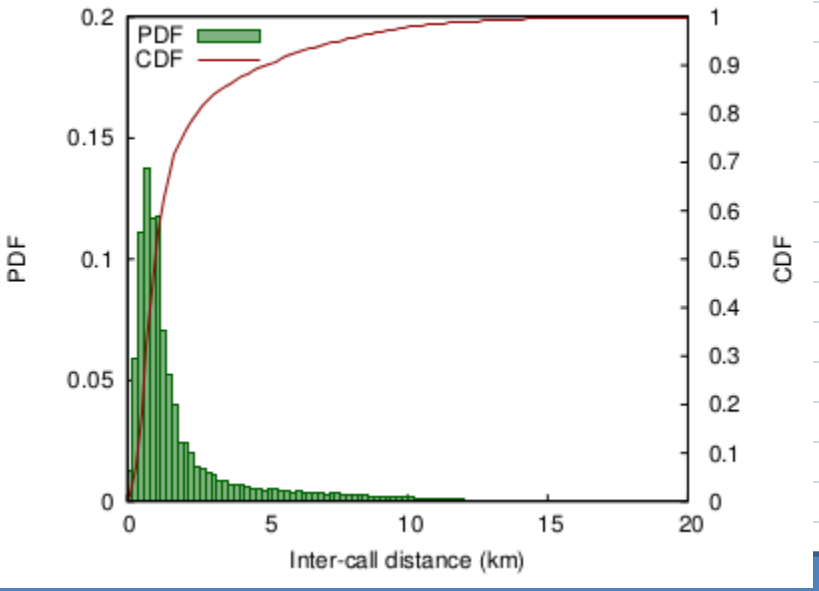
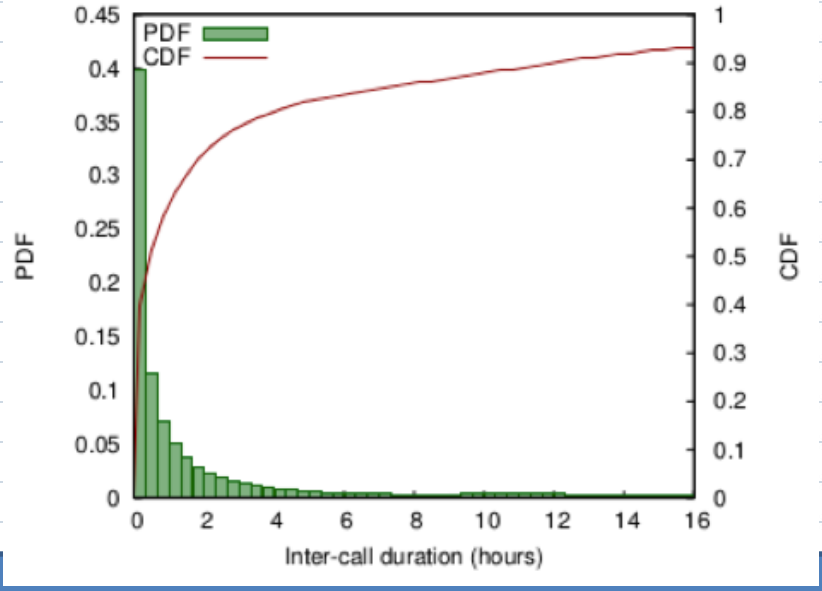




Approach

- Goal: Understand how people move over time in a typical day in an urban environment – Dataset D2
  - Consecutive calls from the same base station are filtered out





Approach

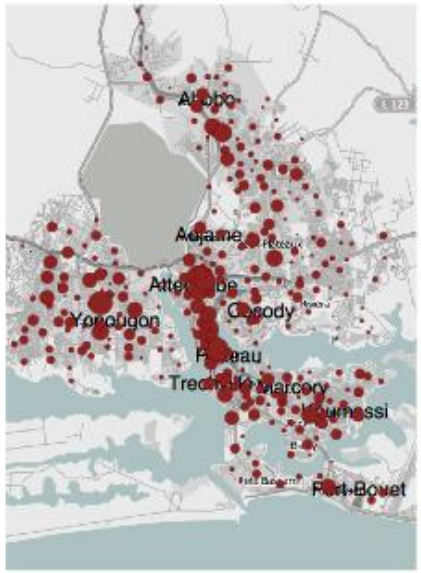
- Goal: Understand how people move over time in a typical day in an urban environment – Dataset D2
  - Consecutive calls from the same base station are filtered out
  - Hourly O/D matrices
  - A movement duration is variable
  - Each movement is assigned a weight of $1/\Delta t$, where Δt is the movement duration

Approach

- Goal: Understand how people move over time in a typical day in an urban environment
  - Reduced number of movements in dataset D2
  - The only period with all antennas present: 2 weeks in April
  - Idea: aggregate D2 movements from multiple similar days
  - Questions: what is “similar”? what is “typical”?

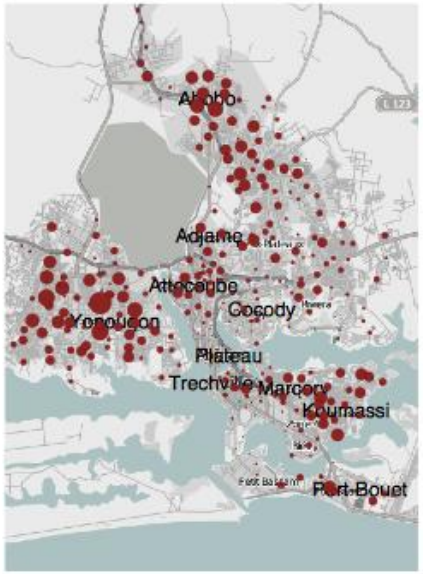
Typical behavior

- The notion of snapshot: representation of the load generated by mobile users on the access network during a certain time period



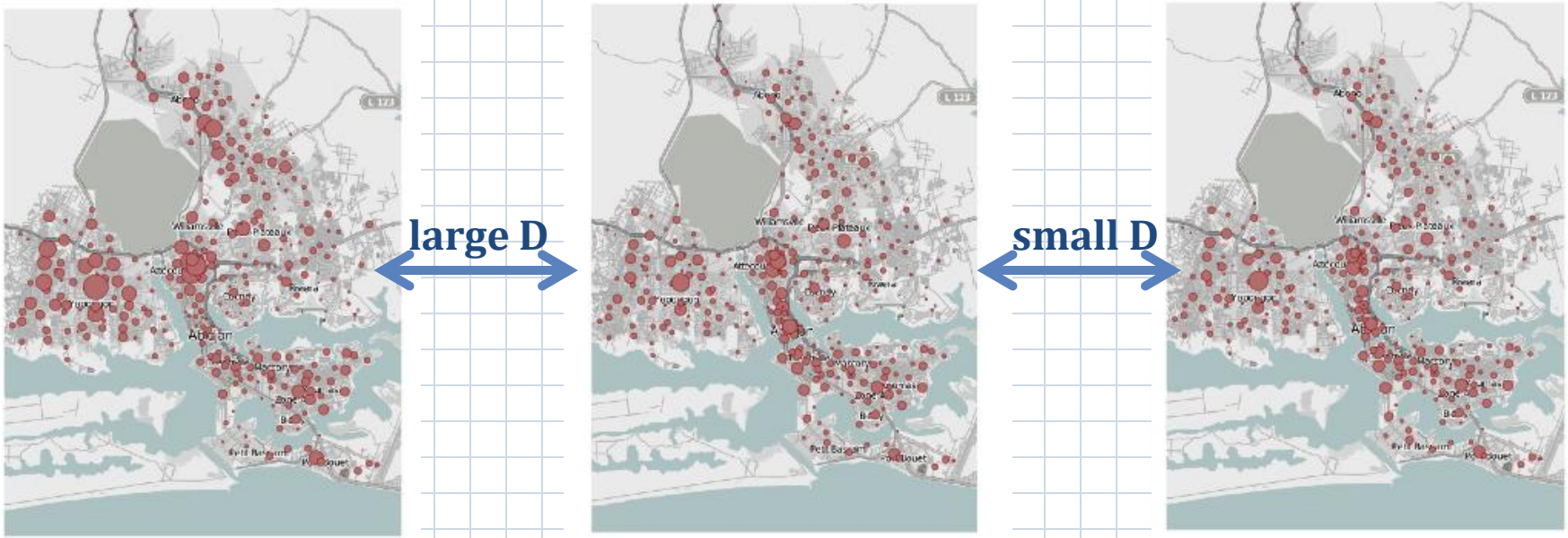
vs.

similar or not?



Typical behavior

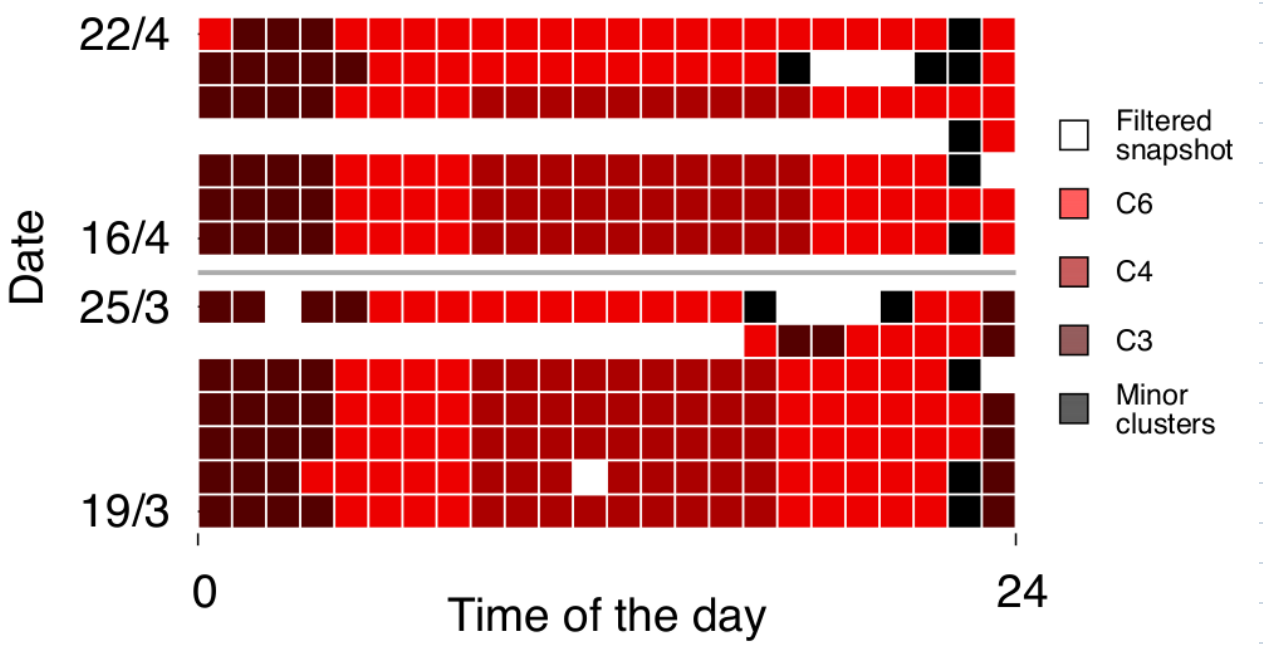
- This allows us to calculate distances between snapshots to detect similar user distributions



* D. Naboulsi, R. Stanica, M. Fiore – "Classifying Call Profiles in Large-Scale Mobile Traffic Datasets", Proc. Infocom 2014

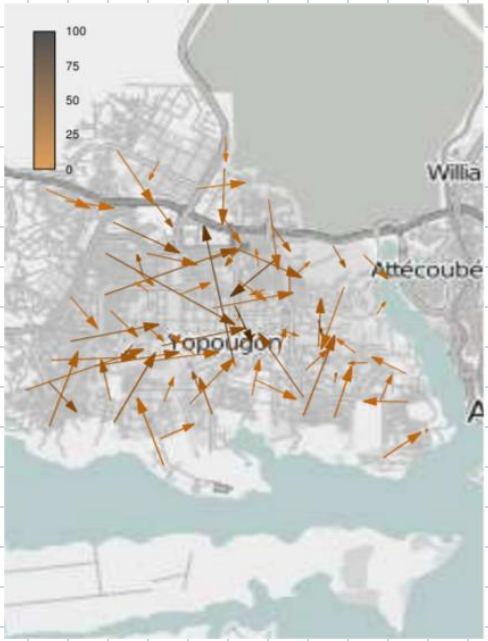
Typical behavior

- We obtain clusters of snapshots, and can distinguish typical and outlying behaviors



Mobility flows

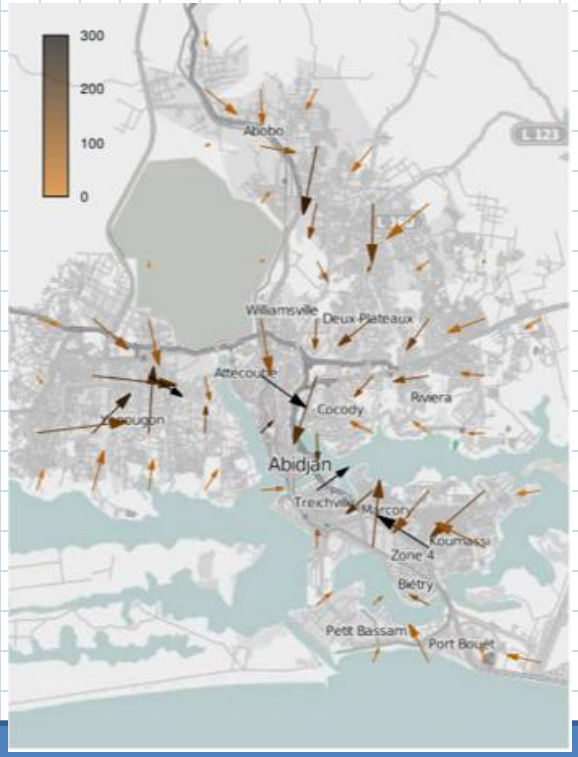
- We aggregate data from D2 to increase the mobility information
- Smallest geographic area: the cell covered by a base station

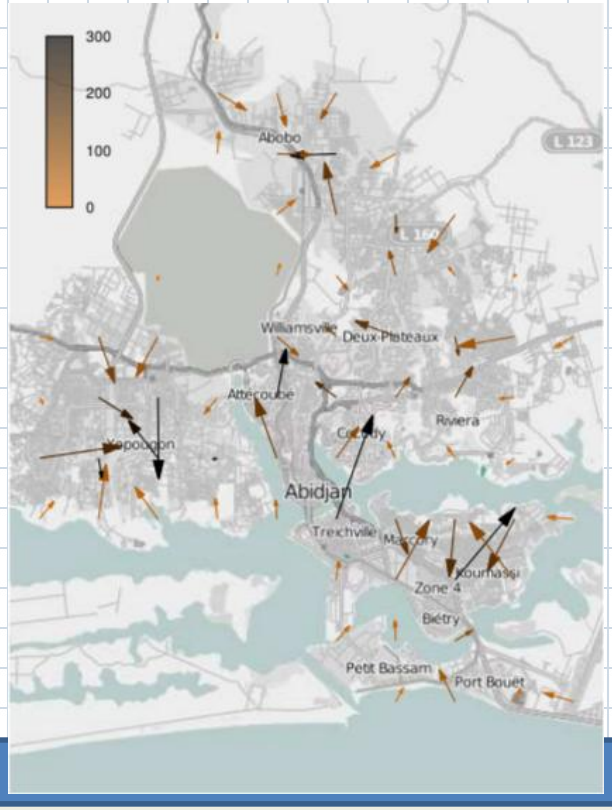


Mobility flows

- We also aggregate spatially (per region), to filter some of the noise

8am





7pm

To summarize

- Promising use of Call Detail Records
- Mobile phone data gets richer and richer (your smartphone connects without your knowledge)
- Not (yet) capable of providing a "standardized" O/D matrix
- A different reasoning, in terms of flows, might be better suited

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