ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Estimating Pedestrian Destinations using Traces from WiFi Infrastructures

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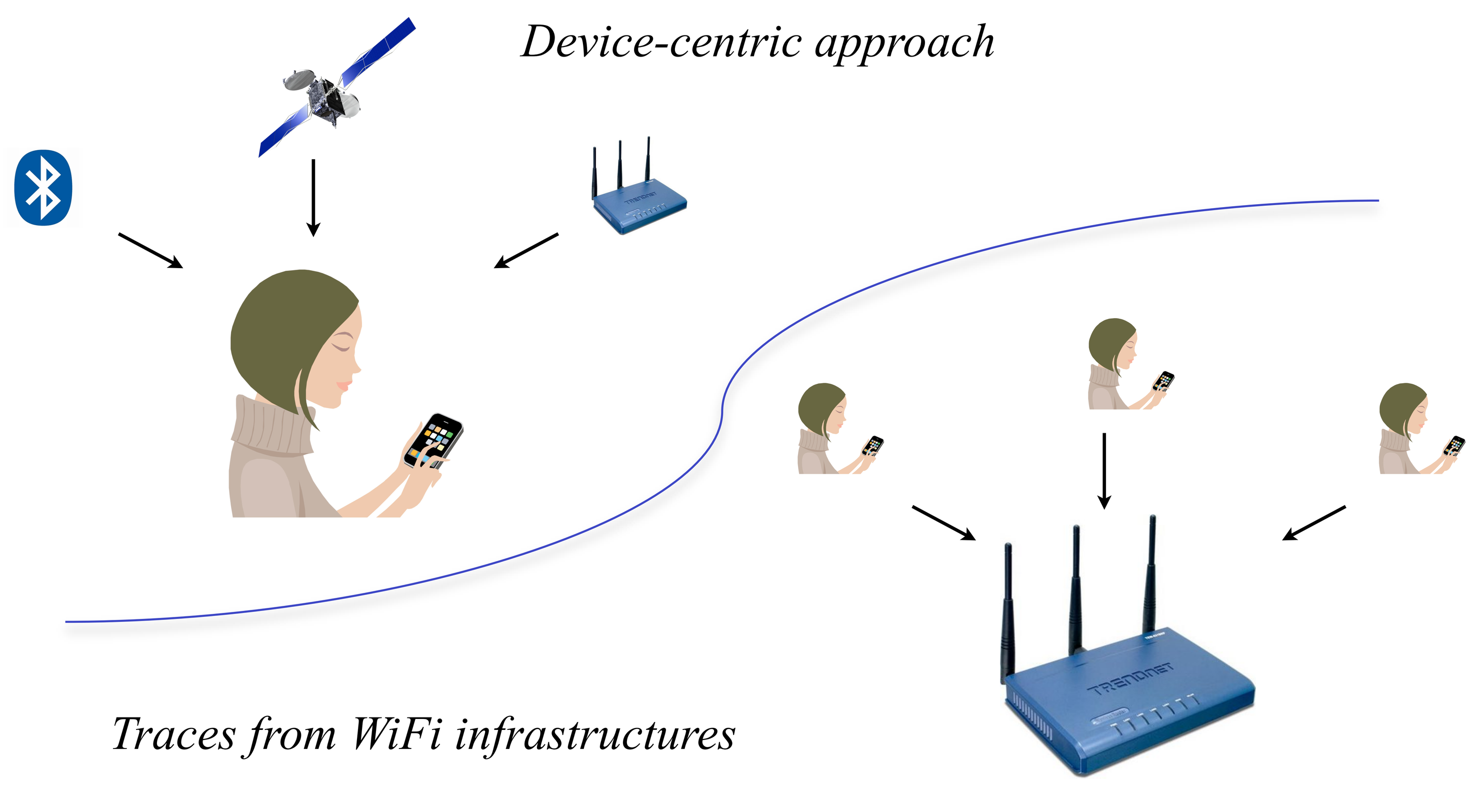
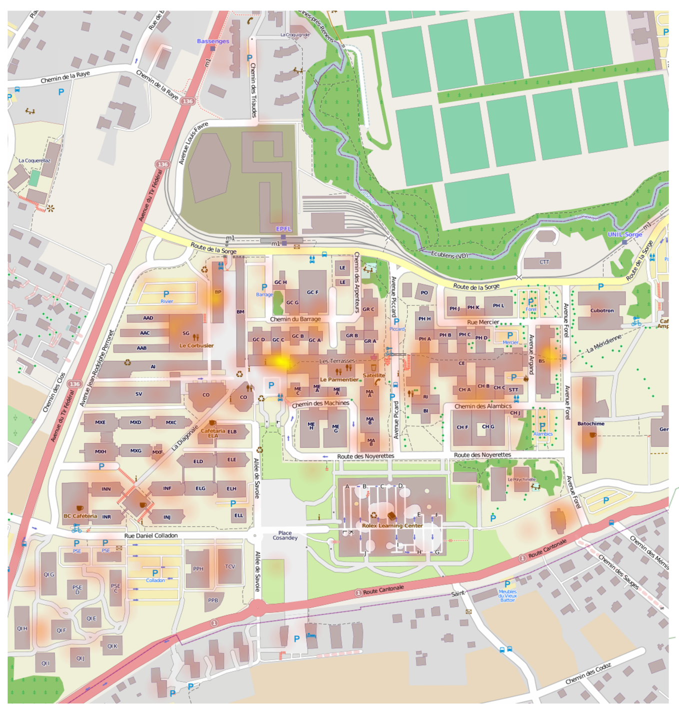
Motivation

Urban growth and its pressure on infrastructure causes congestion in pedestrian facilities and asks for tools to design and optimize infrastructure.

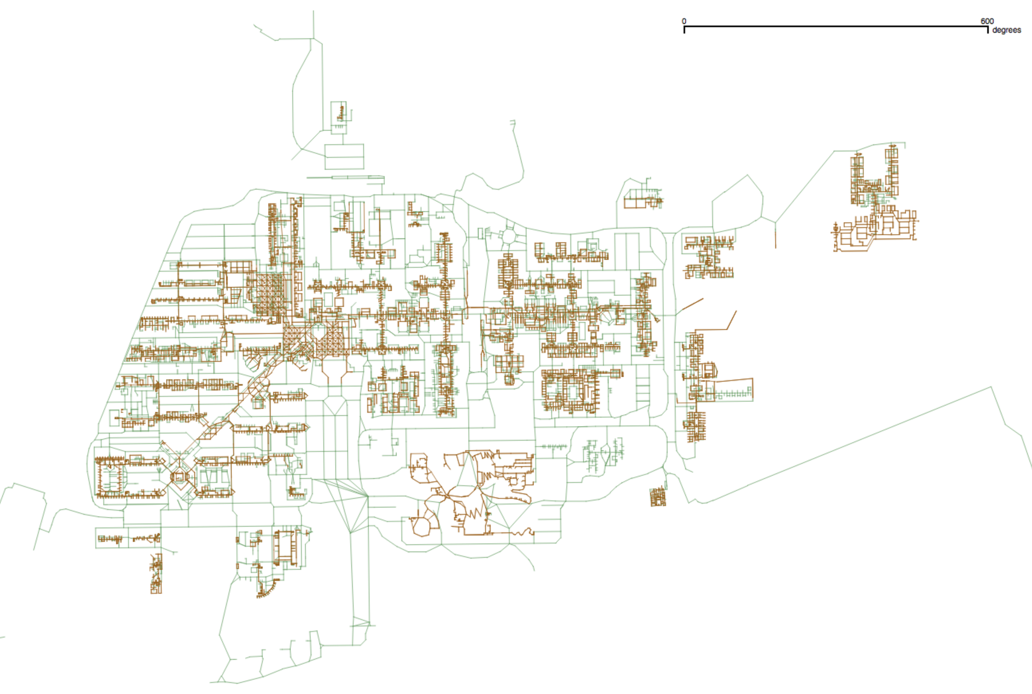
Goal

Estimate and forecast pedestrian demand using data at the scale of pedestrian infrastructures.





Heatmap of the localization of points of interest on campus



Pedestrian network on campus

What sensors to collect data at this scale?

- Smartphones generate information about the user:
  - on the phone (device-centric approach)
  - in the communication infrastructures
- Traces in comm. infrastructures have major advantages (e.g., size of the sample)

→ ***Localization using traces from WiFi infrastructures***

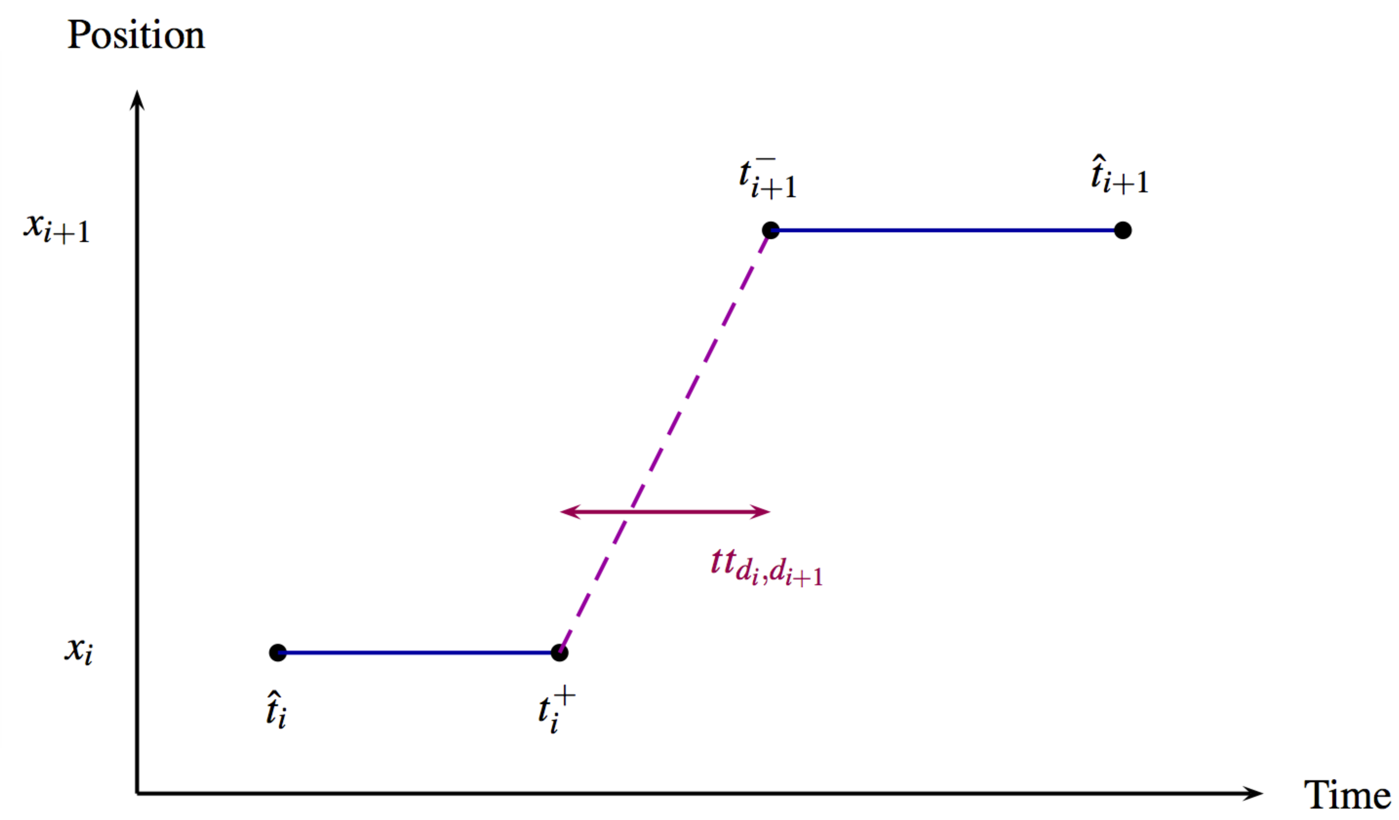
Methodology

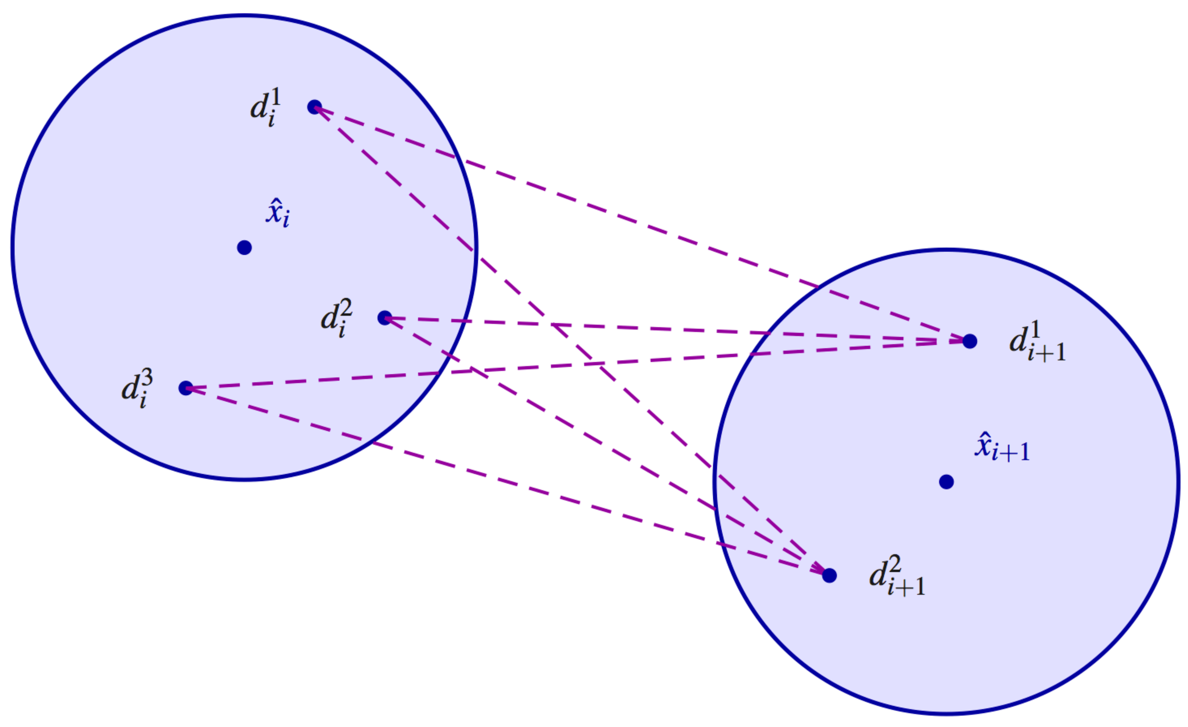
Input : - Measurements $\hat{s} = (\hat{x}, \hat{t})$ (position and time)
- Pedestrian network

Ouput: - Candidate lists of destinations $d_i = (x_i, t_i^-, t_i^+)$ (position, time of arrival and time of departure) with probability of each list being the true one.

Step 1: Generation of candidate lists of destinations

Step 2: Application of a probabilistic measurement model





Step 1: Candidate lists of destinations

1. Generating position of the destination x

For each signal $\hat{s}_i$, we select all neighboring destinations, and connect them with all possible next destinations for signal $\hat{s}_{i+1}$

2. Generating trip departure and arrival times

Trip between x_i and x_{i+1} defines t_i^+ and t_{i+1}^-

Travel time between x_i and x_{i+1}: $tt_{x_i,x_{i+1}}$

Then:

$$t_i^+ \sim U(\hat{t}_i, \hat{t}_{i+1} - tt_{x_i,x_{i+1}})$$

$$t_{i+1}^- \sim U(t_i^+ + tt_{x_i,x_{i+1}}, \hat{t}_{i+1})$$

Step 2: Probabilistic measurement model

Computes destination probability:

$$P(d_1, d_2, ..., d_n | \hat{s}_1, \hat{s}_2, ..., \hat{s}_n)$$

using: - measurement likelihood (taking into account inaccuracy in the WiFi traces)
- prior knowledge about destinations (travel model and activity model)

Proof-of-concept on EPFL campus

Model			Truth			Δx
Time spent	Floor	Location	Time spent	Floor	Location	(in m.)
8.35am - 10.38am	0	Office	8.32am-10.30am	1	Classroom	58
10.39am - 11.51am	2	Office	Until 11.47am	3	Author's office	6
11.56am - 12.53pm	1	Restaurant	From 11.55 am	1	Restaurant	0
12.58pm - 1.33pm	3	Office	Around 1pm	3	Author's office	8
1.39pm - 2.00pm	1	Office	Around 2pm	3	Cafeteria	11
2.01pm - 7.40pm	0	Classroom	Until around 7.45pm	1	Author's office	13

Ref. *Danalet et al. (2012). Estimating Pedestrian Destinations using Traces from WiFi Infrastructures. Proceedings of the 6th International Conference on Pedestrian and Evacuation Dynamics (PED) June 6-8, 2012.*