ON THE DESIGN OF PUBLIC TRANSPORT FOR EQUALITY OF ACCESSIBILITY

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INTRODUCTION

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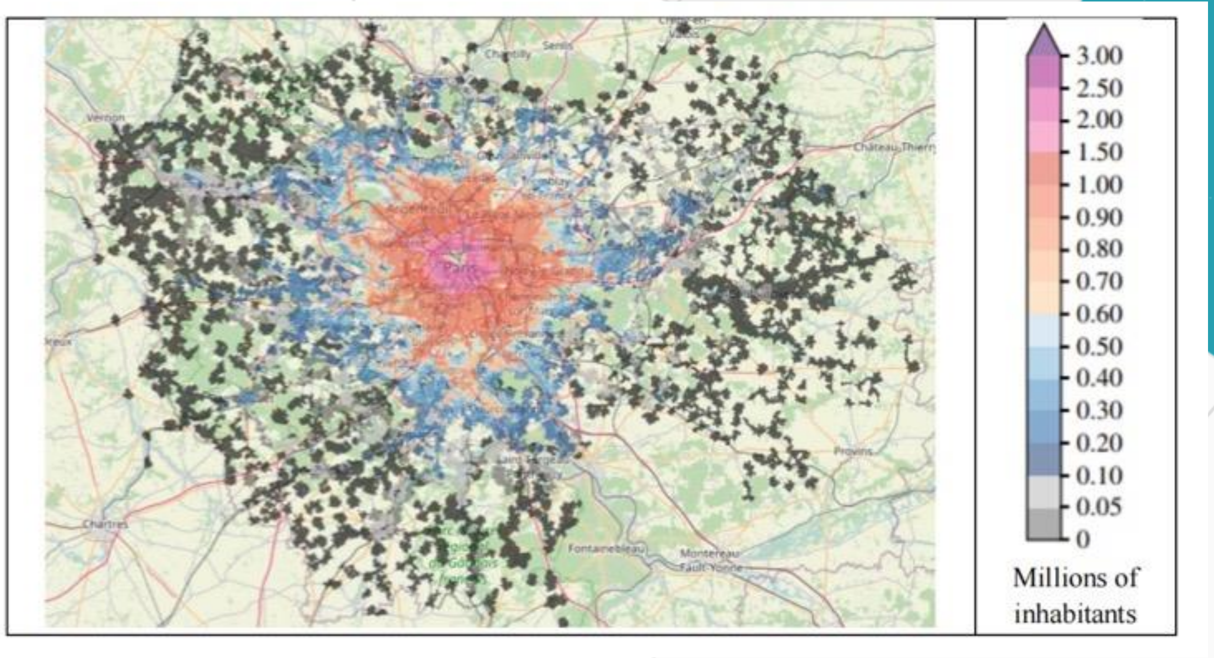

Accessibility: ease of reaching surrounding opportunities.
Inequality: suburbs suffer from poor accessibility from public transit.

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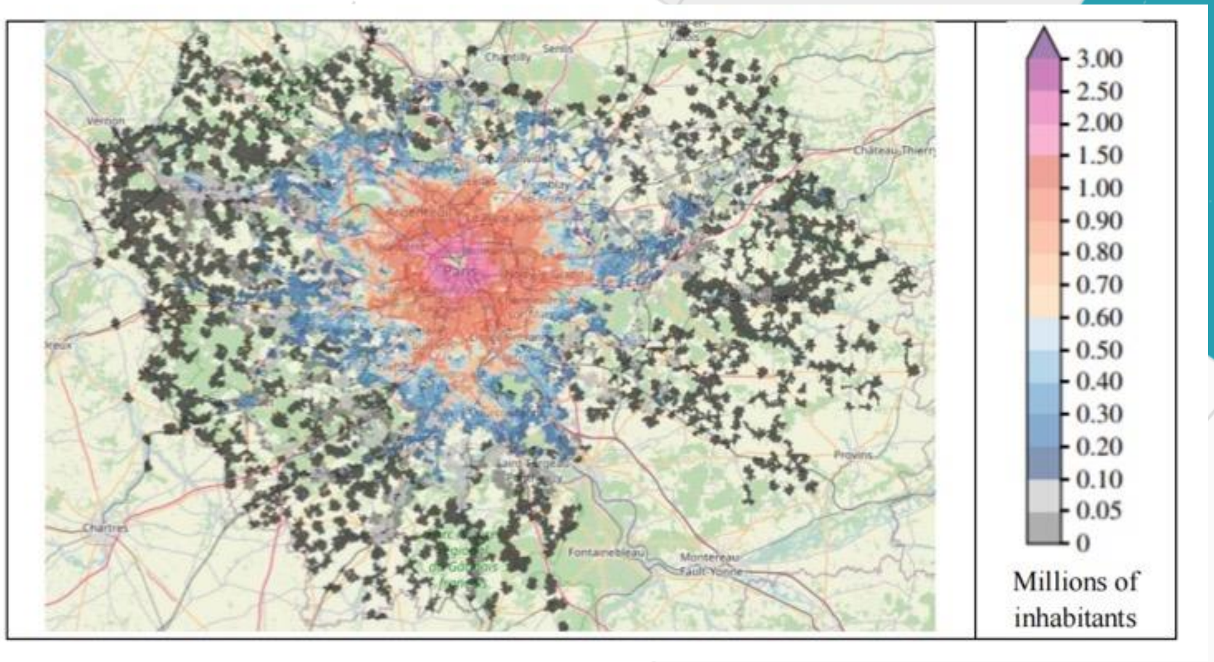

Accessibility: ease of reaching surrounding opportunities.
Inequality: suburbs suffer from poor accessibility from public transit.

Consequence: car-dependency → pollution

Need for designing more equitable public

INTRODUCTION

OBJECTIVE

Improve equality while preserving PT efficiency by serving or skipping PT stops

METHODOLOGY

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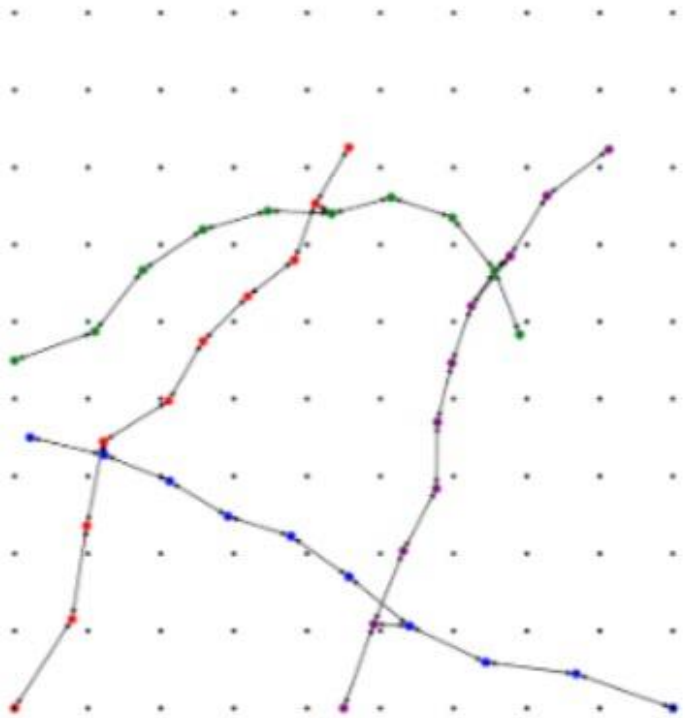
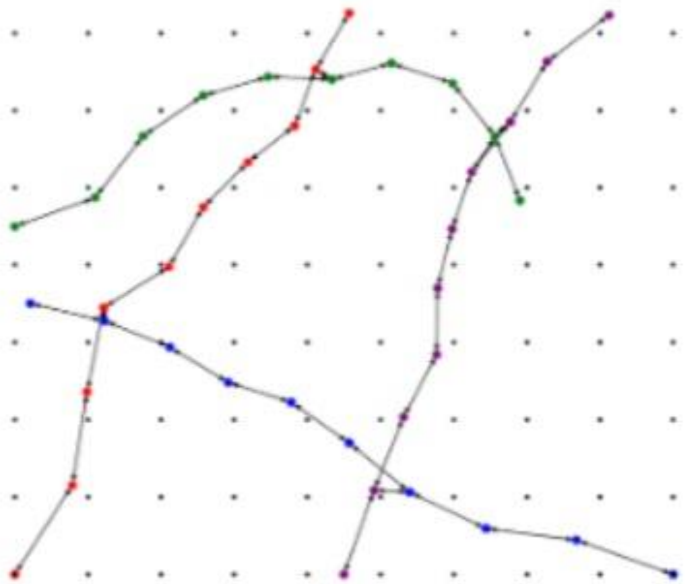


An example of PT network: 4 PT lines containing 40 stops and 100 centroids

PUBLIC TRANSPORT (PT) AND ACCESSIBILITY

1. G: PT network
2. V: set of centroids
3. S: set of bus stops

METHODOLOGY



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PUBLIC TRANSPORT (PT) AND ACCESSIBILITY

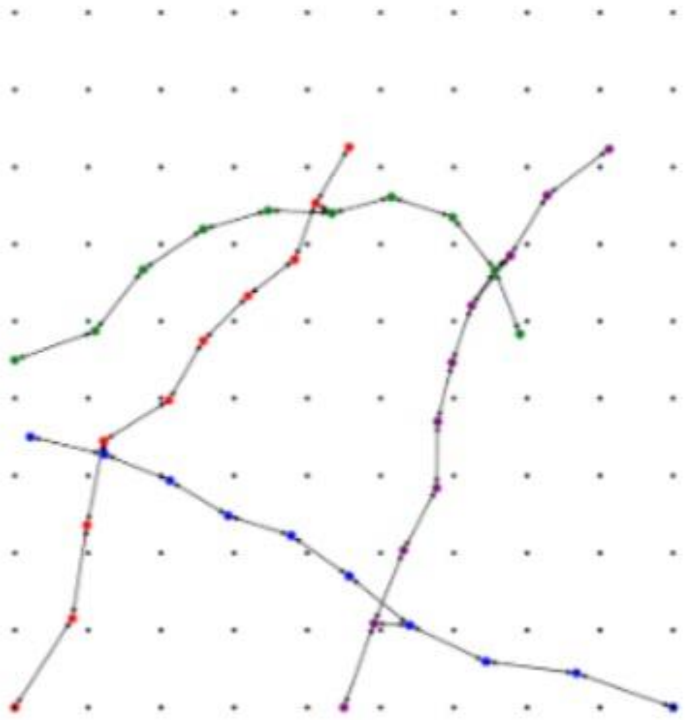
1. G: PT network
2. V: set of centroids
3. S: set of bus stops
4. The accessibility of centroid $v \in V$,

$$acc(v) = \sum_{u \in V} \frac{X(u)}{T(v,u)}$$

$T(v,u)$: shortest time to go from v to u,

$X(u)$: amount of the opportunities of the u.

METHODOLOGY



An example of PT network: 4 PT lines containing 40 stops and 100 centroids

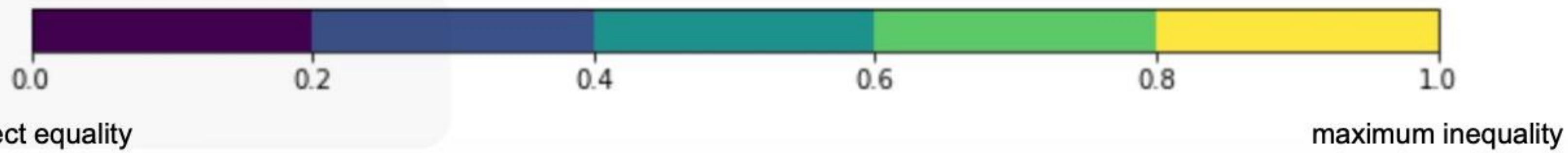
PUBLIC TRANSPORT (PT) AND ACCESSIBILITY

$V^{\%}$: set of centroids with the worst accessibility. The accessibility of graph G as:

$$Acc(G;m) = \frac{1}{|V^{\%}|} \sum_{v \in V^{\%}} acc(v)$$

The Atkison inequality index is

$$Atk(G) = 1 - \frac{1}{\overline{acc}(G)} \cdot \left(\frac{1}{K} \sum_{i=1}^{k} y_i^{-1} \right)^{-1}$$



METHODOLOGY

RANDOM SEARCH OPTIMIZATION ALGORITHM

1. Ef-Opt: maximize the average accessibility
2. Eq-Opt: maximize the accessibility of the worst centroids

Algorithm 1: Random search optimization algorithm

Input Public transport graph $\mathcal{G}$ with stops $\mathcal{S}$.
    Parameter m of the accessibility formula (2).
For search instance $i \leftarrow 1$ to n :
    Initialize $\mathcal{G}_0 \leftarrow \mathcal{G}$ and $\mathcal{S}_0 \leftarrow \mathcal{S}$.
    For step $t \leftarrow 0$ to ∞ until **termination condition**:
        Select a random stop $s_t \in \mathcal{S}_t$ and deactivate it.
        Set $\mathcal{S}_{t+1} \leftarrow \mathcal{S}_t \setminus \{s_t\}$ and let $\mathcal{G}_{t+1}$ the resulting PT graph.
        Compute the new accessibility: $Acc(\mathcal{G}_{t+1};m)$
    EndFor
    Record $\mathcal{G}^i = \arg\min_{\tau=0}^{t+1} Acc(\mathcal{G}_\tau, m)$.
EndFor
Return PT graph $\mathcal{G}^* = \arg\min_{i=1}^{n} \mathcal{G}^i$.

RESULTS

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RESULTS

Performance on the entire data set

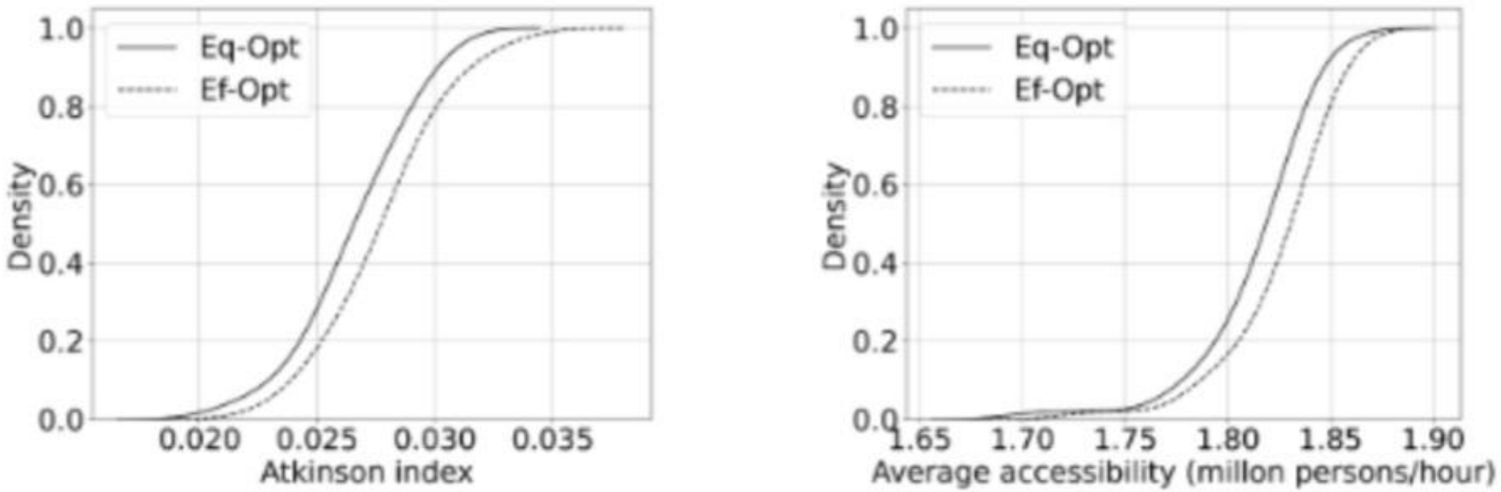

Figure 2: Cumulative Distribution Functions (CDFs) of Atkinson index and average accessibility after Eq-Opt and Ef-Opt

RESULTS

Performance on each graph

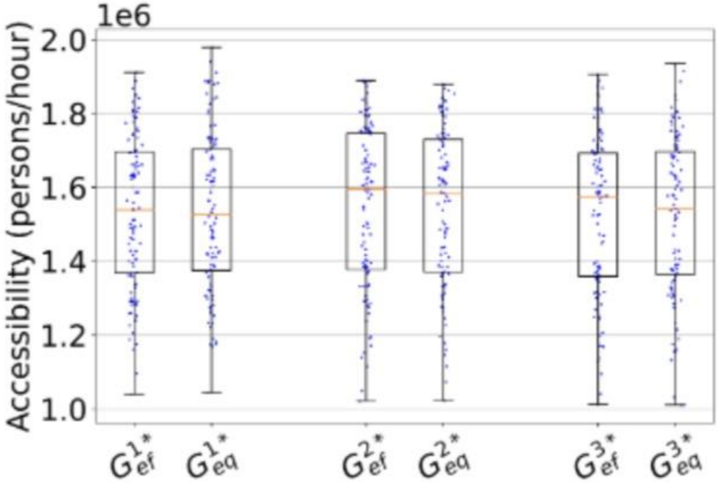

Figure 3: Change in the distribution of accessibility across centroids in three exemplary graphs.

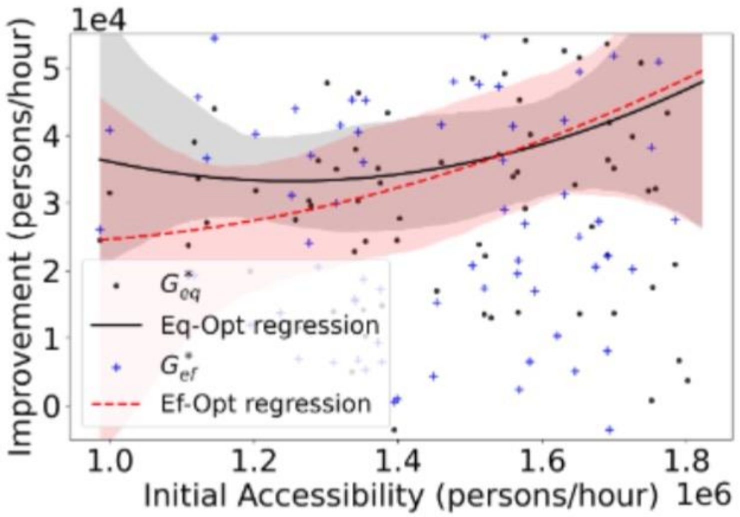

Figure 4: Change in accessibility on one exemplary graph.

RESULTS

The difference between selection strategies

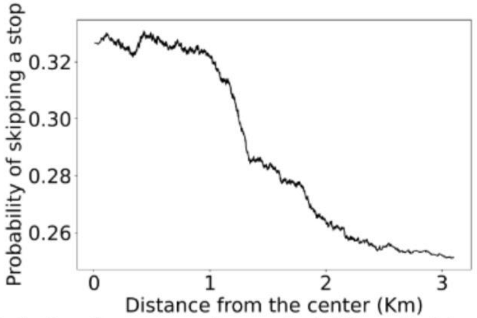

Figure 5: Relation between the probability of skipping a stop and distance from the center by Eq-Opt

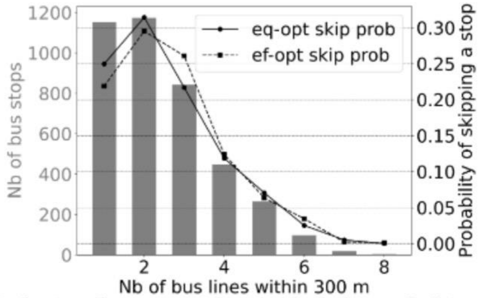

Figure 6: Relation between the probability of skipping a stop and the Nb of bus lines nearby

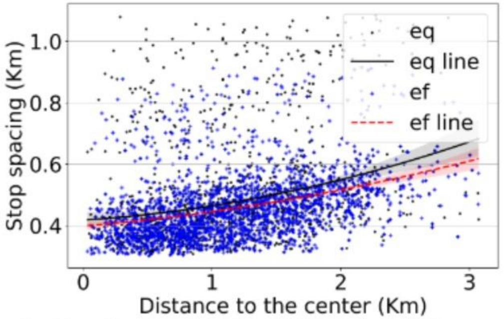

Figure 7: Relation between the distance to the nearest stop and the distance to the center

FUTURE WORK

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1. Apply optimization to real PT network data (GTFS)
2. Consider the deployment of shared mobility
3. Use Deep-Q learning to select stops