RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

Inria

~~(Don't you) Forget about me:~~
~~On the importance of time in data~~
Smart compression is bad

~~Too much data to handle? Let's see what we can do!~~
Don't overthink it, truly

Rémy Raes

01
Context

Time series

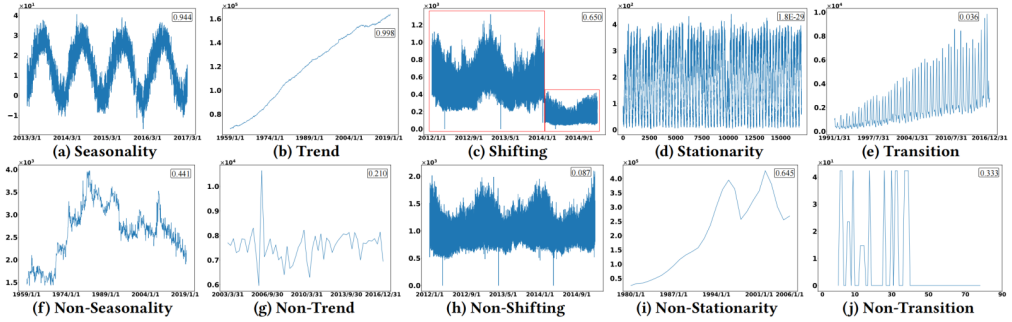
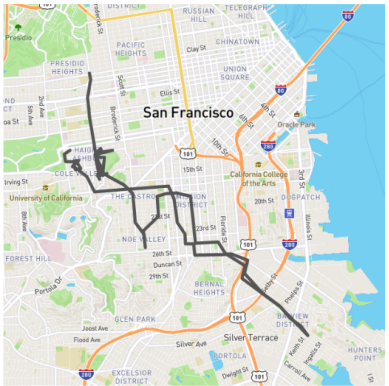
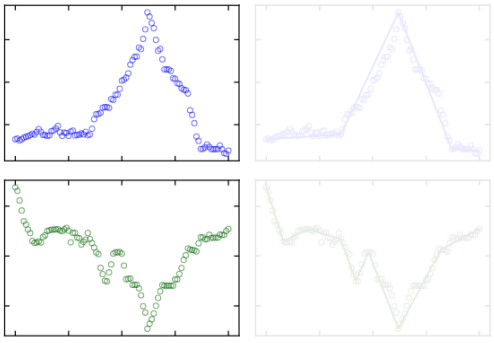


Figure 1: Visualization of data with different characteristics.

Qiu et al. TFB: Towards Comprehensive and Fair Benchmarking of Time Series Forecasting Methods. *Proceedings of the VLDB Endowment, Vol. 17, No. 9 ISSN 2150-809* **(10.14778/3665844.3665863)**

Fast linear interpolation (FLI)





Rémy Raes, Olivier Ruas, Adrien Luxey-Bitri, Romain Rouvoy. Compact Storage of Data Streams in Mobile Devices. *DAIS'24 - 24th International Conference on Distributed Applications and Interoperable Systems, Jun 2024, Groningen, Netherlands.* **(hal-04535716v3)**

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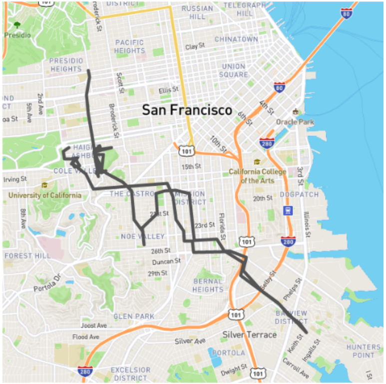

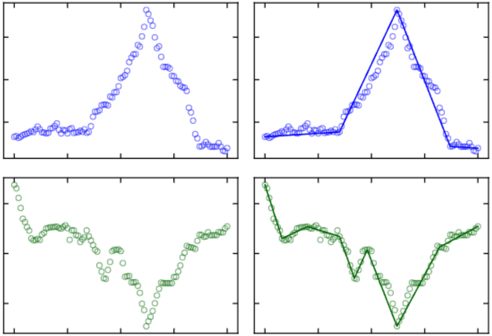

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- Location data is sensitive
- Can be mined to extract **Points of Interest** *(POIs)*

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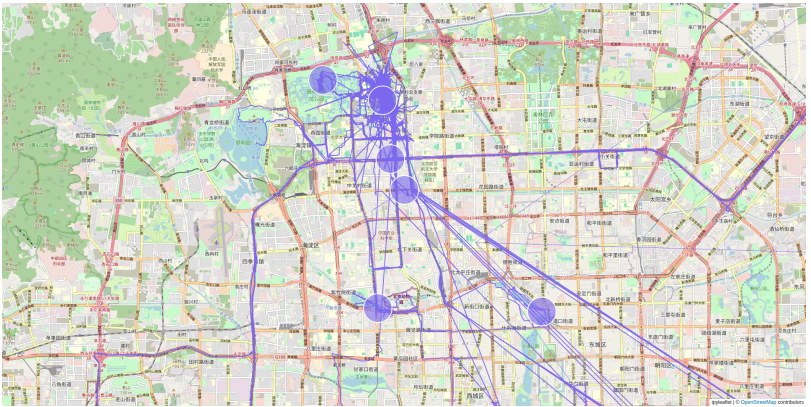
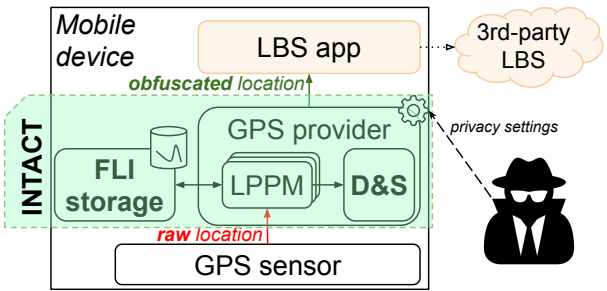


Embedded, mobile privacy framework

- INTACT: *in situ* location protection



- Local storage of private data
- Local attack and protection mechanisms
- Locally ensure data is safe before sharing it

Rémy Raes, Olivier Ruas, Adrien Luxey-Bitri, Romain Rouvoy. INTACT: Compact Storage of Data Streams in Mobile Devices to Unlock User Privacy at the Edge. *Journal of Internet Services and Applications* **(hal-05126130v1)**

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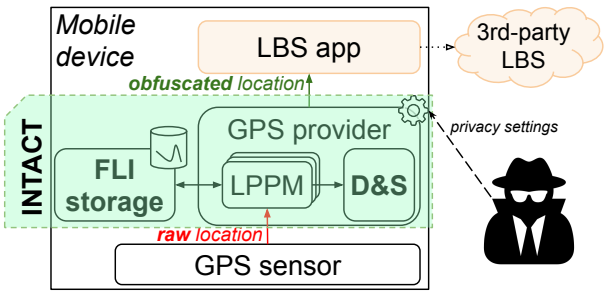

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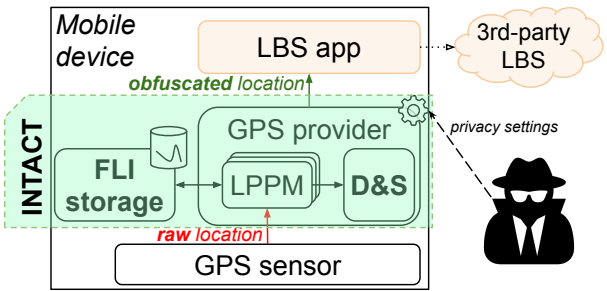

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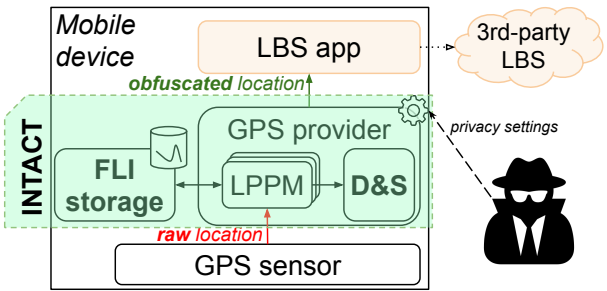

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Error selection

- Use a function to pick tolerated error
- Function is time-indexed
- Different behaviours:
  - Constant value (FLI)
  - Decreasing value:
    - Linear
    - by step
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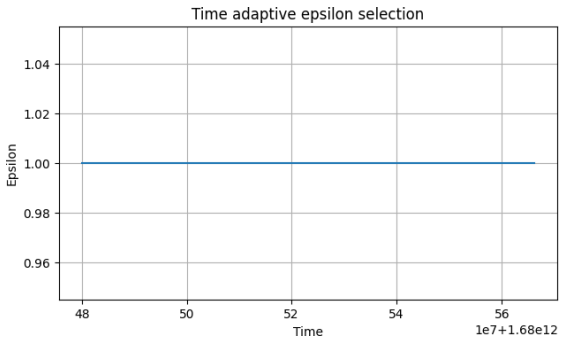

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02
Works

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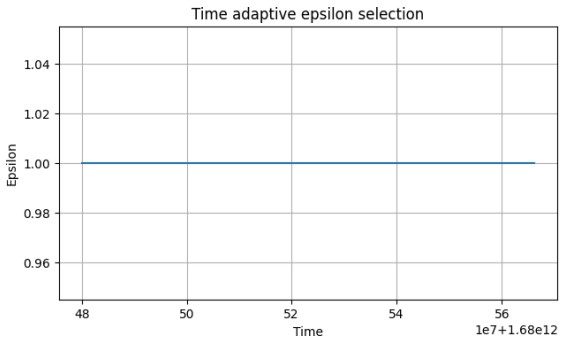

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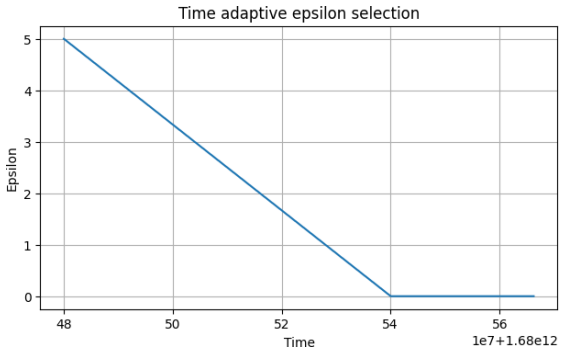

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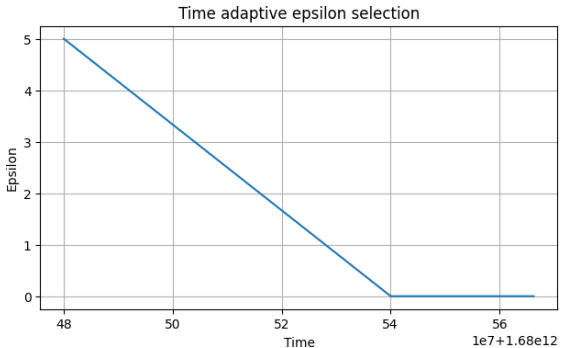

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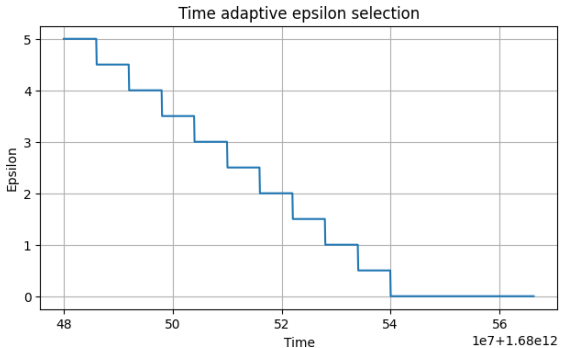

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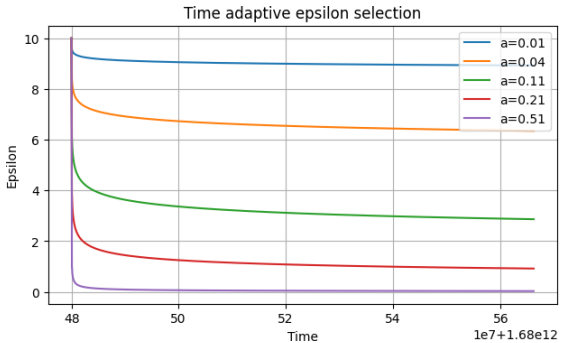

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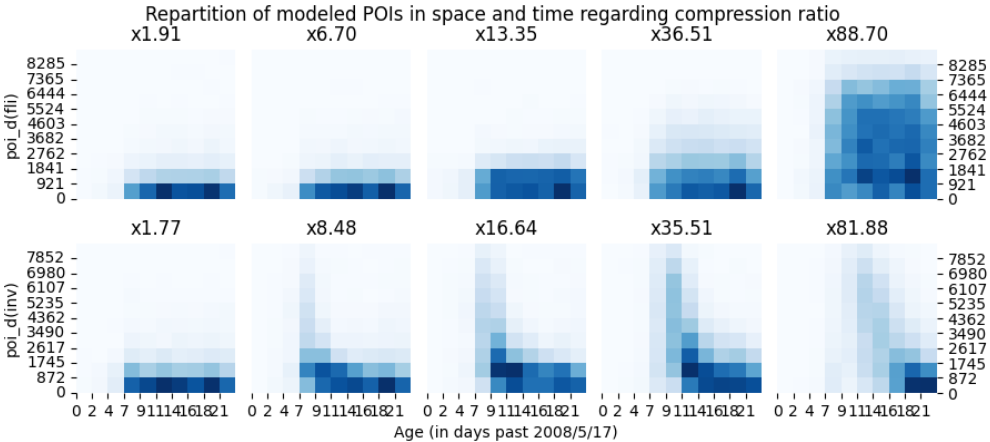
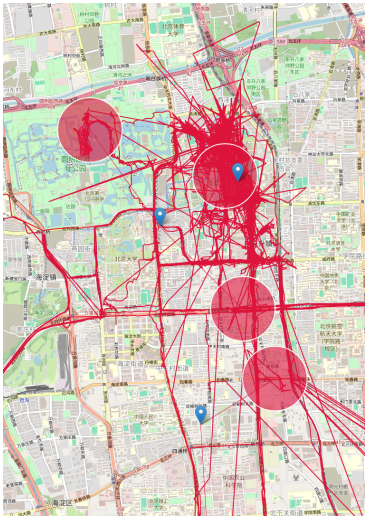
Old data degradation hint



Benchmark

- POI prediction
  - Split traces in *train* and *test* datasets
  - Extract POIs from *train*
  - Extract POIs from compressed *test*
  - Compare both POI sets
- Several compression techniques
  - Modelling (with constant and varying error)
  - Removal (of newer or older data)



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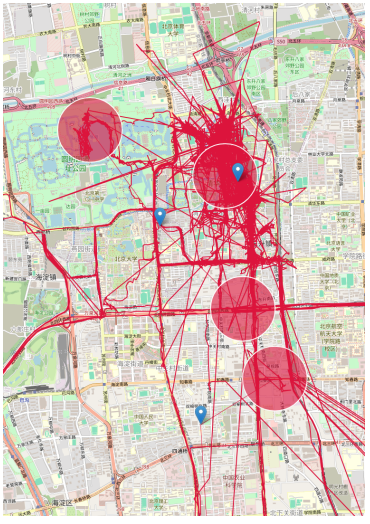
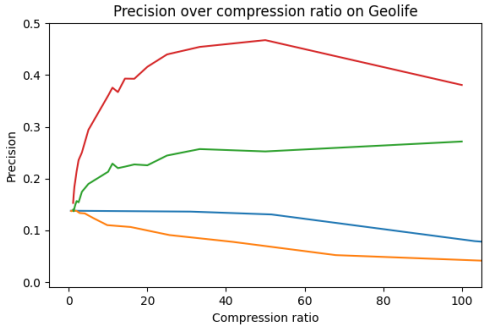
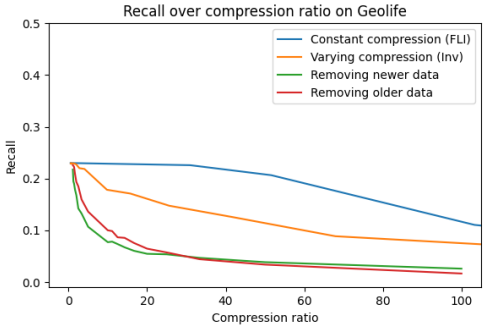


Results (1/2)


Precision over compression ratio on Geolife
Precision
Compression ratio
0.0
0.1
0.2
0.3
0.4
0.5
0
20
40
60
80
100


Recall over compression ratio on Geolife
Recall
Compression ratio
Constant compression (FLI)
Varying compression (Inv)
Removing newer data
Removing older data
0.0
0.1
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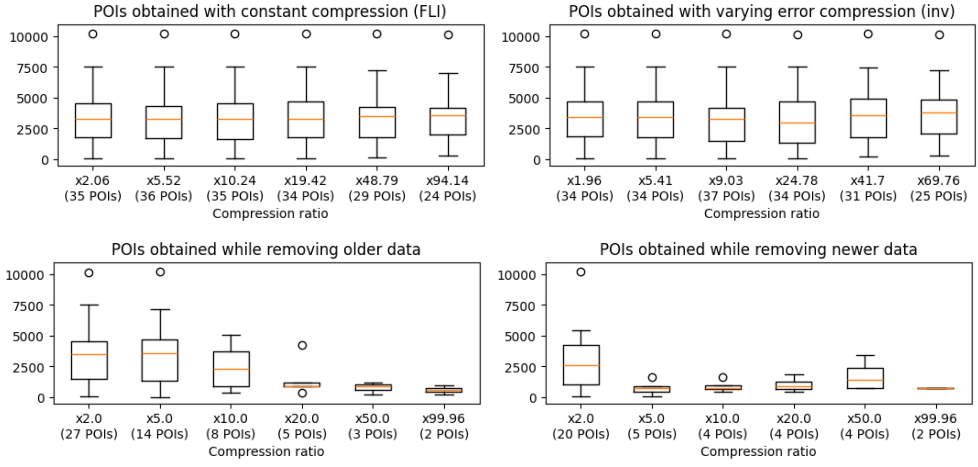
Results (2/2): Distance of modeled POIs to closest raw POI



03
Future works

What's next

- Looks like smart compression is not good
- Is there a use case requiring keeping a highly degraded version of the data rather than its removal?
  - "Right to be forgotten"?

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”Right to be forgotten” hint

Data days old

Data months old

Data years old

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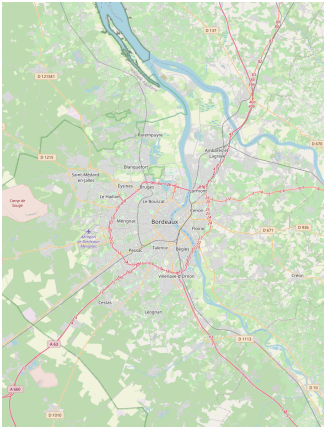

Data months old

Data years old

Take away

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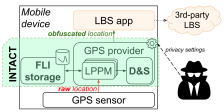

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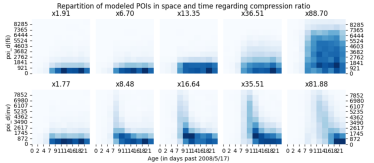
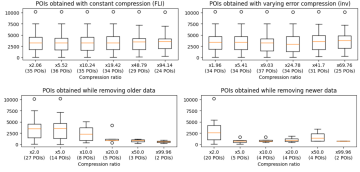
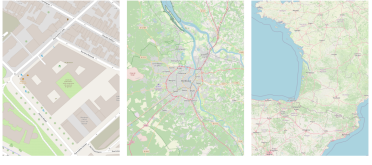


Results (2/2): Distance of modeled POIs to closest raw POI



"Right to be forgotten" hint



Merci.

Research questions

Distributed Machine Learning in Ubiquitous Environments using Location-dependent Models

- How to store unbounded data streams on constrained mobile devices?
- How to exchange relevant model samples among nearby devices?
- How to program DML algorithms for the masses?

About the *epsilon* value

- Selecting a good ϵ value requires data domain knowledge
- Drift between consecutive values (x_1, y_1) and (x_2, y_2): $|y_2 - y_1|/|x_2 - x_1|$.

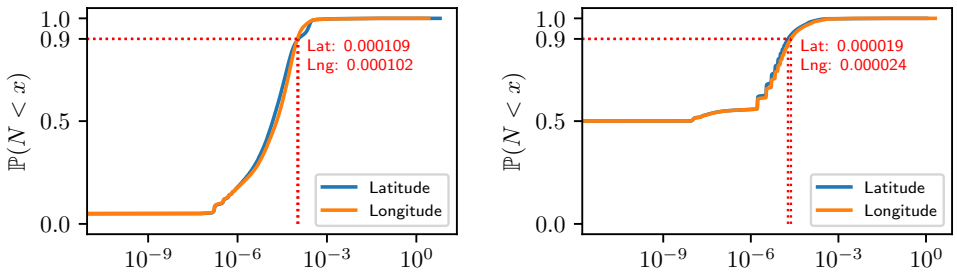


Figure – CDF of latitude and longitude variations of successive locations in CABSPOTTING and PRIVAMOV.

- We used $\epsilon = 10^{-3}$ as a baseline value in the FLI paper

Data utility with location data

Size results

- $\epsilon = 10^{-3}$
- From 7.2 GB to 25 MB

Data utility

- Latitude
  - Tolerated error: 10^{-3} *deg* ≈ 111 *m*
  - Median error: 5.33×10^{-5}
  - RMSE: 3.72×10^{-4}
- Longitude
  - Tolerated error: 10^{-3} *deg* ≈ 88 *m*
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- Privacy utility

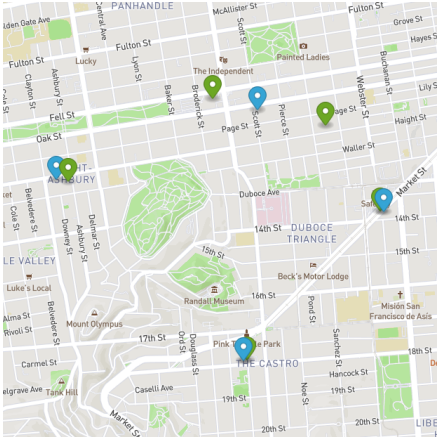

Figure – Points of Interest computed using raw data and FLI-modeled data.

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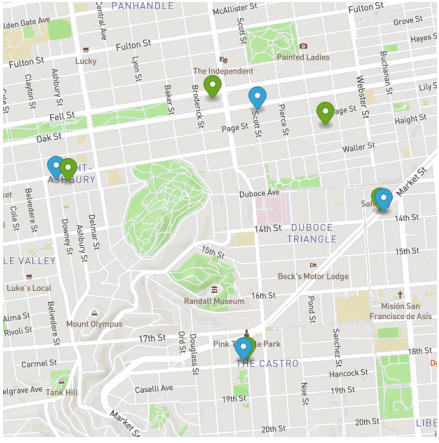

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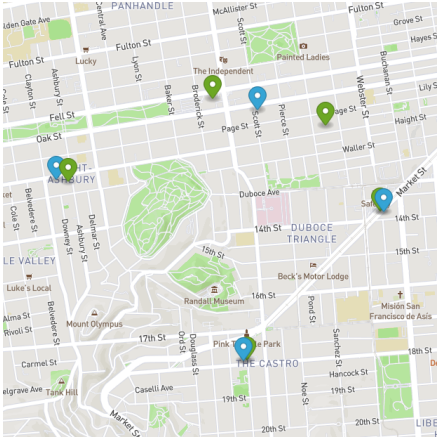

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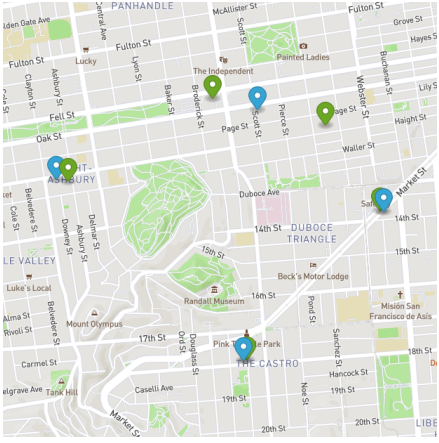

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