RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

Inria

(Don’t you) Forget about me : On the importance of time in data

Too much data to handle ?
Let’s see what we can do !

Rémy Raes

01
Context

Questions

- Mobile devices are producers of data
- Training data better stay local

What are the limits preventing *in situ* computing?

1. Data processing
2. Data storage

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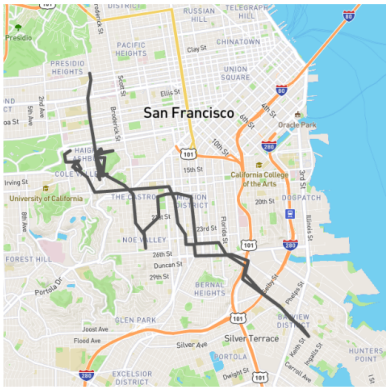

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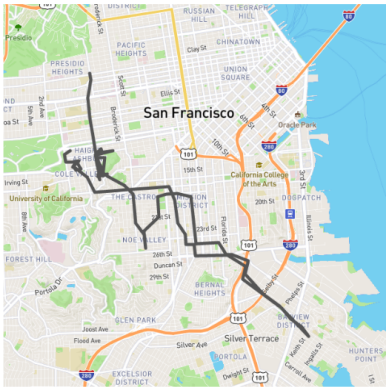
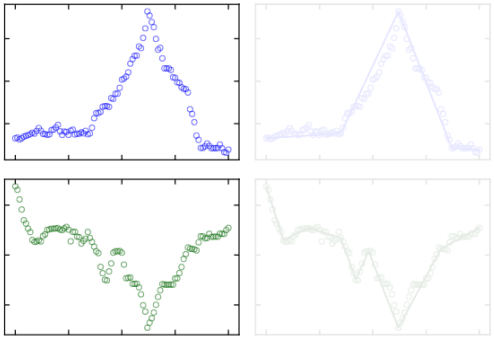
Fast linear interpolation (FLI) + time series





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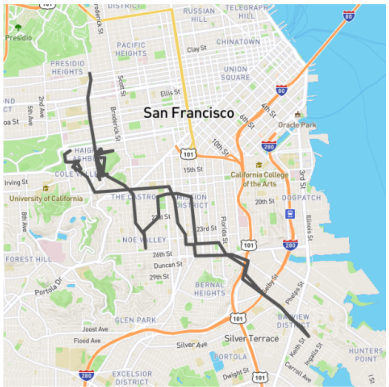

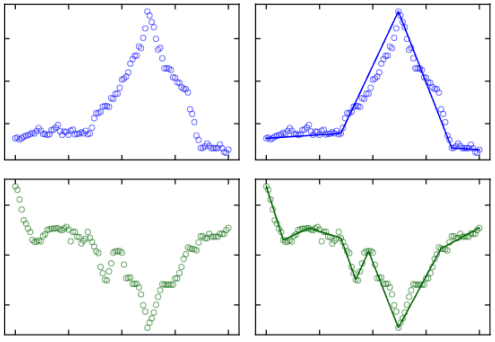

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02
Works

Additional questions

Can we go further on with time series compression?

- Can we do better than straight data removal?
- "Right to be forgotten" hint from law community

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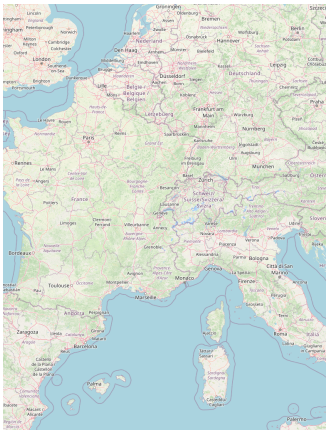
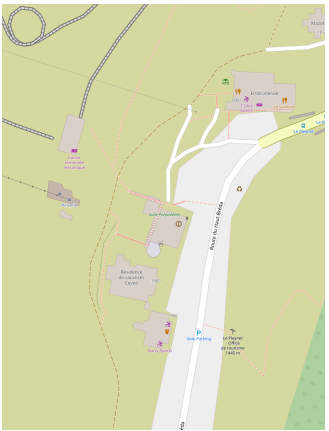
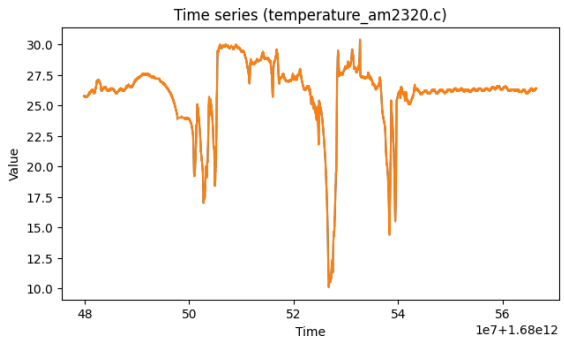




Translation into real world



- Time series to be compressed
- Prioritize old data for compression
- Need for a time-dependent compression method

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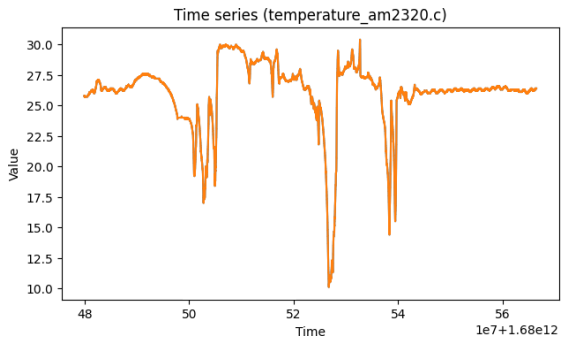

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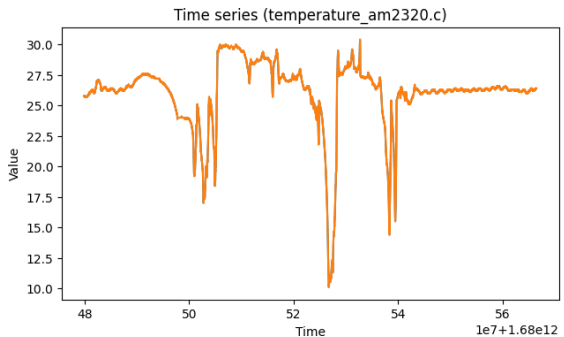

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- Use a function to pick tolerated error
- Function is time-indexed
- Different behaviours:
  - Constant value (FLI)
  - Decreasing value:
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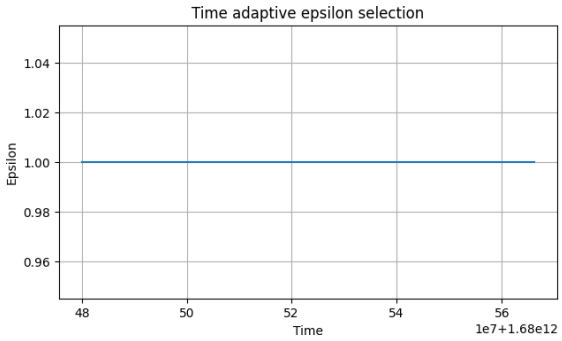

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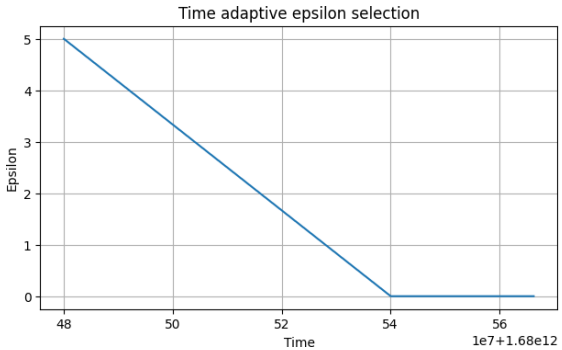

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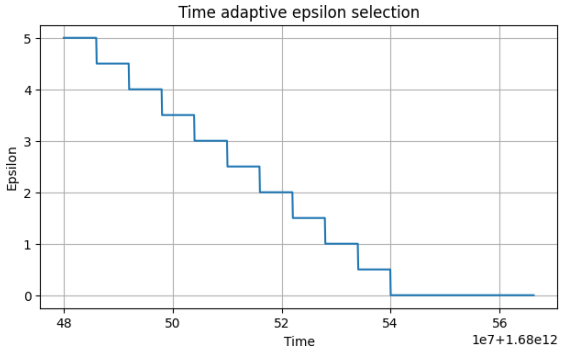

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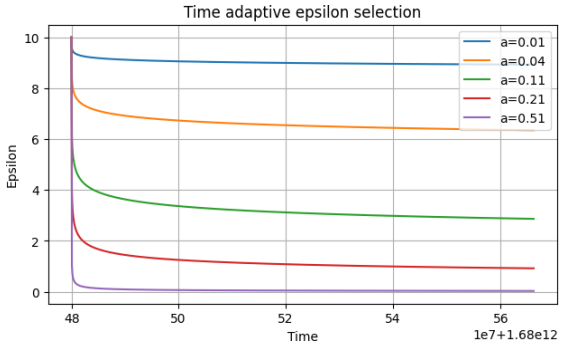

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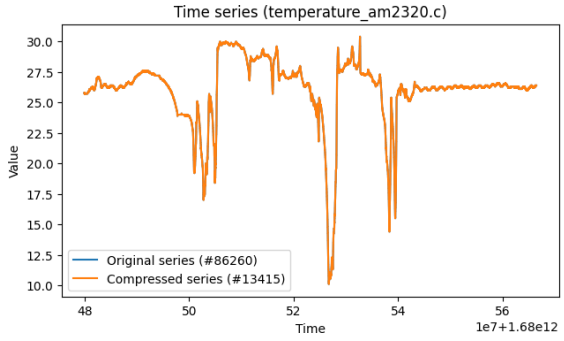

Knobs to control them all

- Double target
  - Size
  - Data quality

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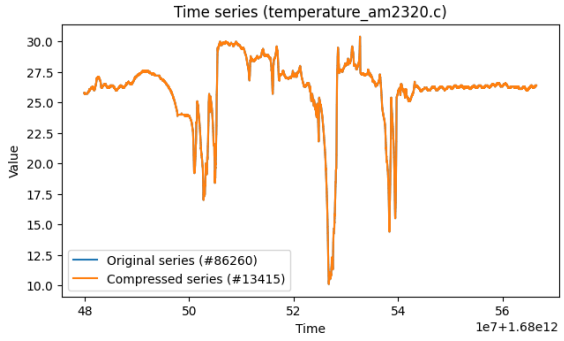

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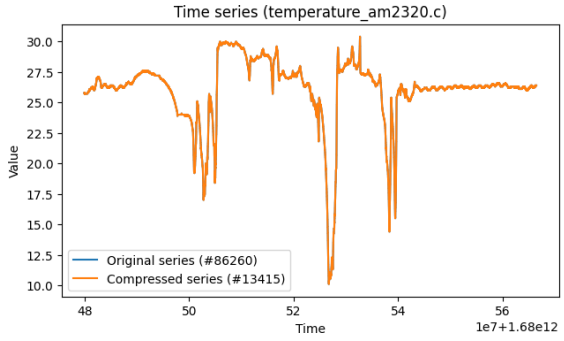

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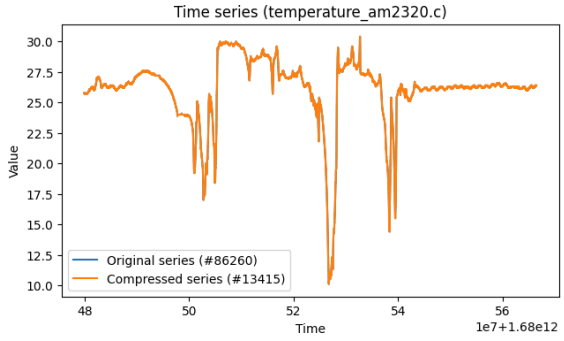

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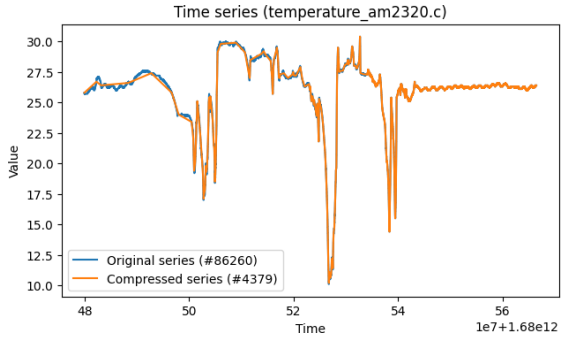

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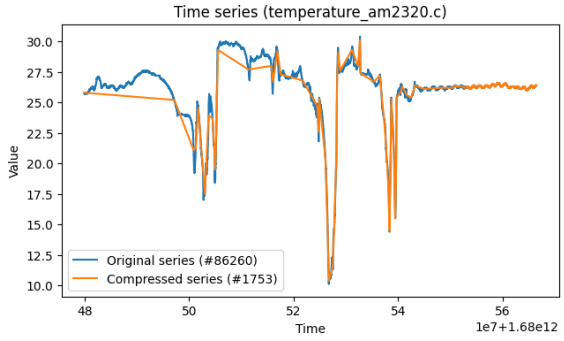

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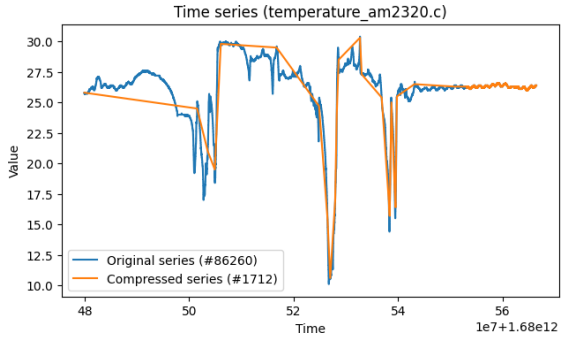

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03
Future works

(Future) Evaluation

- Time series tasks: forecasting, anomaly/pattern detection
- Compressing training dataset should have an impact on the model accuracy
- Study prediction error with transformed training dataset

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- TranAD
  - Anomaly detection
  - Real-world water treatment plant sensor data (water level, flow rate, etc.)

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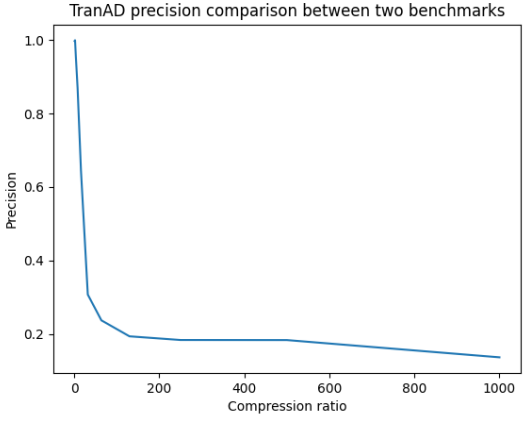

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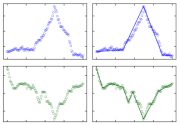
Take away

Fast linear interpolation



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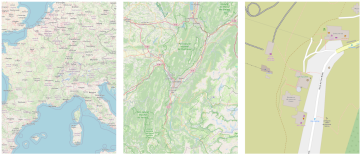

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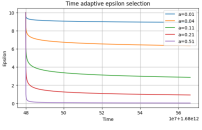

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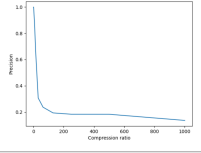

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Merci.

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?

Removing data: first VS last

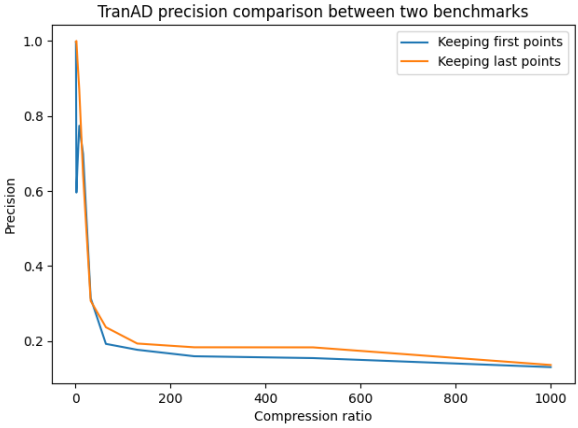

Figure – *Shreshth Tuli, Giuliano Casale, Nicholas R. Jennings.* TranAD: Deep Transformer Networks for Anomaly Detection in Multivariate Time Series Data. *Proc. VLDB Endow. 15(6): 1201-1214 (2022)* **(vldb.org)**

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): $|y_2 - y_1|/|x_2 - x_1|$.

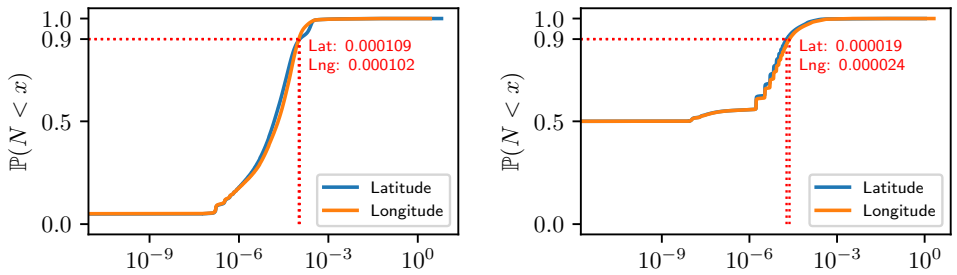

Figure – CDF of latitude and longitude variations of successive locations in Cabspotting and PrivaMov.

- 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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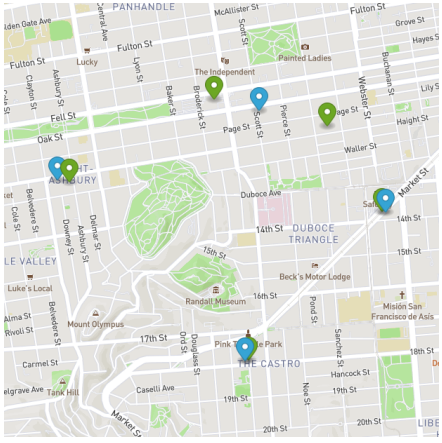

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