Location-Based Data Privacy Solution

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Project Goal:

Location-based Data Privacy Solution

How do you trade-off the accuracy of location data with privacy?

⟶ Matching legally defined terms to use cases of location data.

⟶ Statistical solution to reduce the identifiability of individuals while maintaining most of the usefulness of the data.

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Privacy Legal Frameworks

Anonymization:

A process that removes the association between the identifying dataset and the data subject

Pseudonymization:

The processing of personal information in a manner that renders the personal information no longer attributable to a specific consumer without the use of additional information

De-Identification:

Information that cannot reasonably identify, relate to, describe, be capable of being associated with, or be linked, directly or indirectly, to a particular individual

Aggregation:

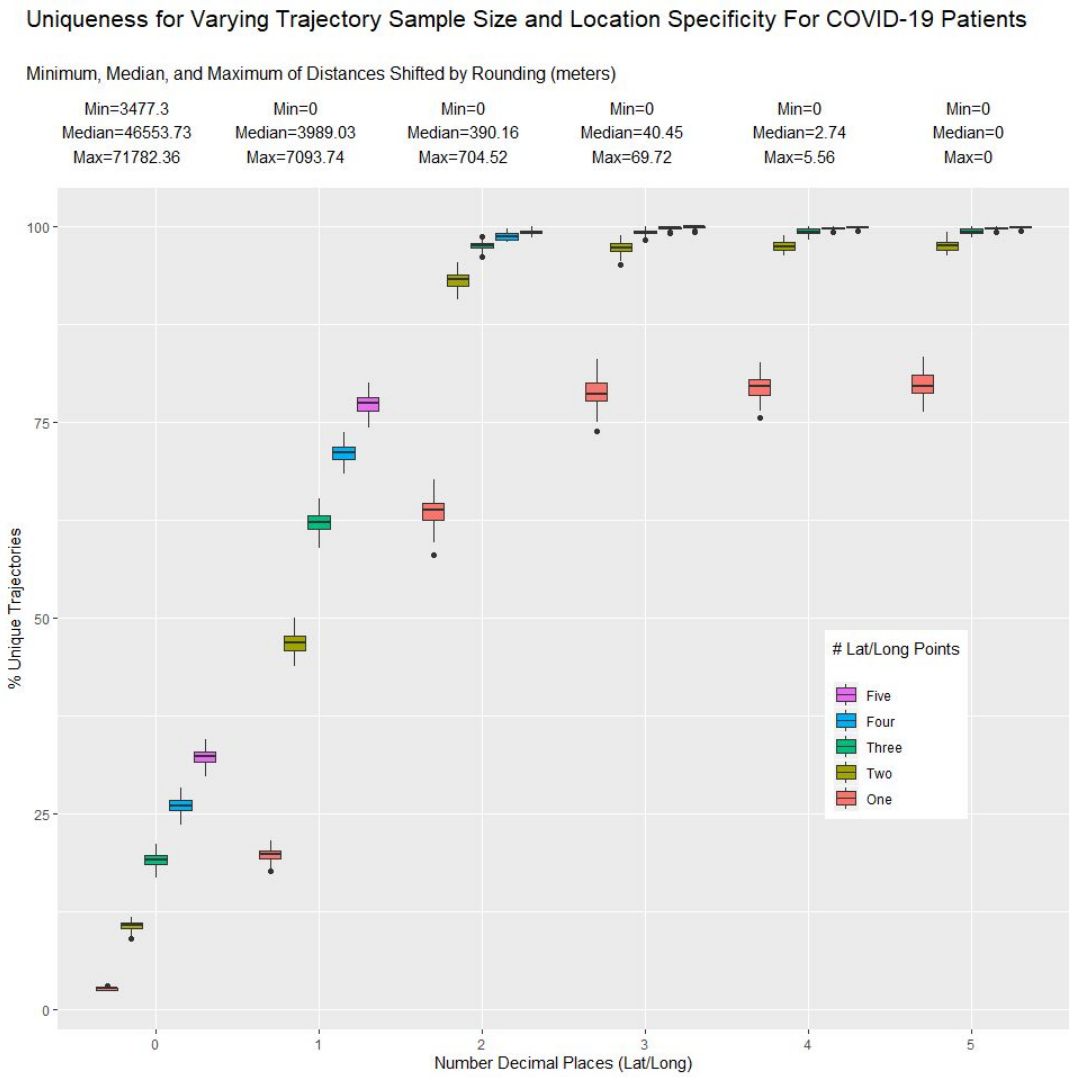
Information that relates to a group or category of individuals, from which individual identities have been removed, that is not linked or reasonably linkable to any individual

Statistical Analysis:

→ Location coursening via rounding:
round latitude/longitude values
to reduce location granularity

→ Improves privacy in two ways:
1. Reduces location uniqueness
2. Alters original locations by
a controllable distance

https://github.com/cdbale/Hackathon



Metric #1: Neighborhood Risk

⟶ The number of COVID-19 persons visiting neighborhood **k** on day **t**

$$Prevalence_{t,k} = \frac{\sum_{i=1}^{i=n} I(GPS_{i,t} \in Neighborhood_k)}{Population_k}$$

⟶ Legal Term: Aggregation (HIGH)

⟶ Examples: South Korea

⟶ Privacy Solution: Location coarsening

Differential privacy-based histogram with noise infusion

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Metric #2: Specific Location Risk

⟶ The number of COVID-19 persons at specific location **k** on day **t**

$$Threat_{t,k} = \sum_{i=1}^{i=n} I(GPS_{i,t} \in GeoFence_k)$$

⟶ Legal Term: Aggregation and De-Identification (MEDIUM)

⟶ Examples: South Korea

⟶ Privacy Solution: Location coarsening

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Metric #3: Contact Tracing

⟶ Did person **i** have contact with person **j** at any time **t** within distance **d** ?

$$If \left\| GPS_{i,t} - GPS_{j,t} \right\| < d \; then \; contact_{i,j} = 1$$

... results in a "social network" data like Facebook

⟶ Legal Term: Anonymization and Pseudonymisation (LOW)

⟶ Examples: South Korea, Israel, Singapore, many others (Bluetooth and GPS)

⟶ Privacy Solution: Privacy-preserving graph degree sequence but fundamental issues remain

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Metric #4: Quarantine Compliance

→ Did person **i** leave location **k** at any time **t**?

$$If\ \left(GPS_{i,t} \notin GeoFence_k\right)\ then\ Violation_i = 1$$

→ Legal Term: None (NON-EXISTENT)

→ Examples: Hong Kong, Poland

→ Privacy Solution: Access Control

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Future Work:

⟶ Identifying and Defining the Privacy Risks

⟶ Further define key legal terms & factors with corresponding statistical analysis

⟶ Differentially private histogram approach for geospatial data which provides a theoretical guarantee to individual privacy

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