

University of Minnesota

# KAMEL: A Scalable BERT-based System for Trajectory Imputation

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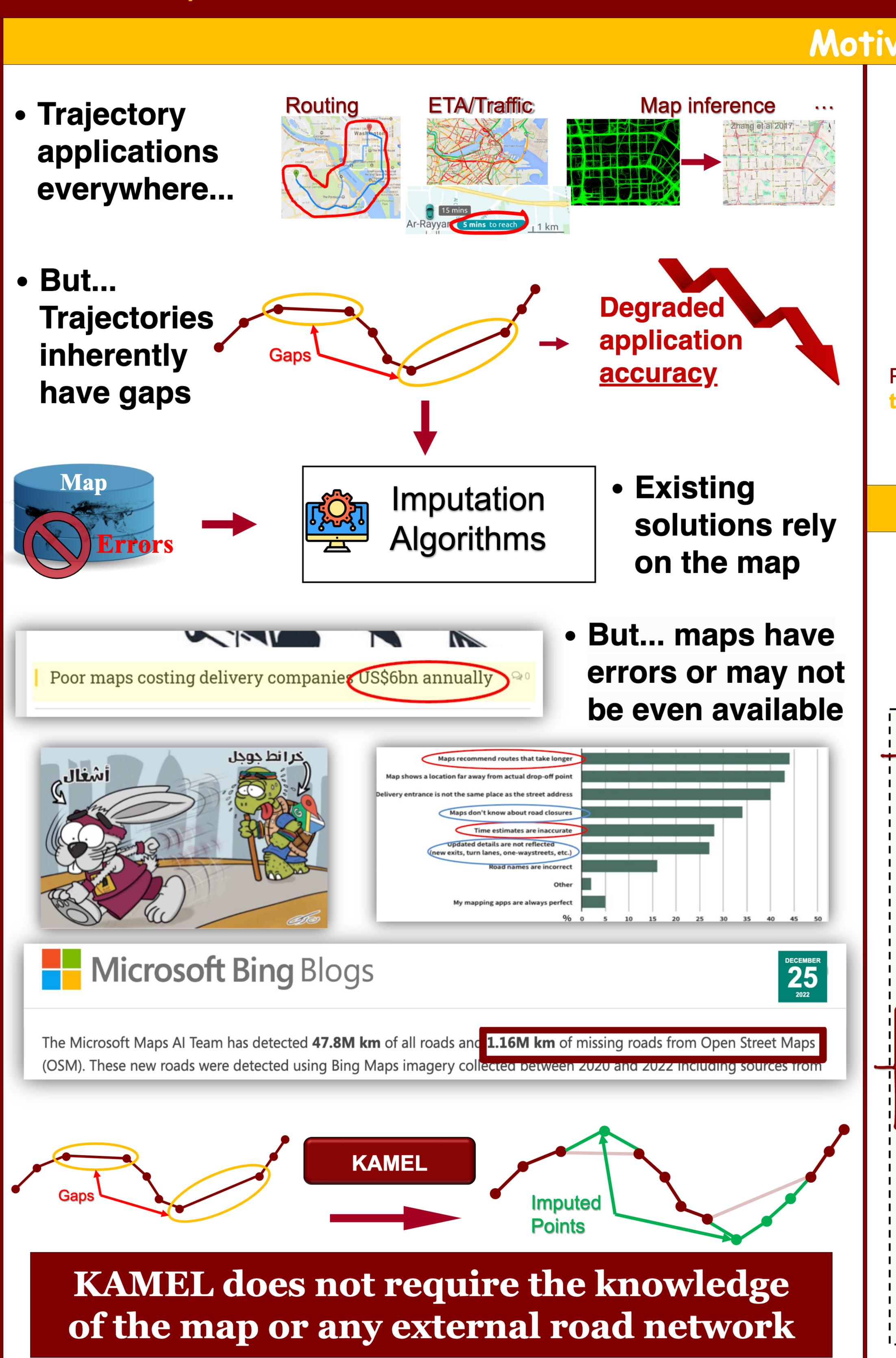
Merge Existing Models

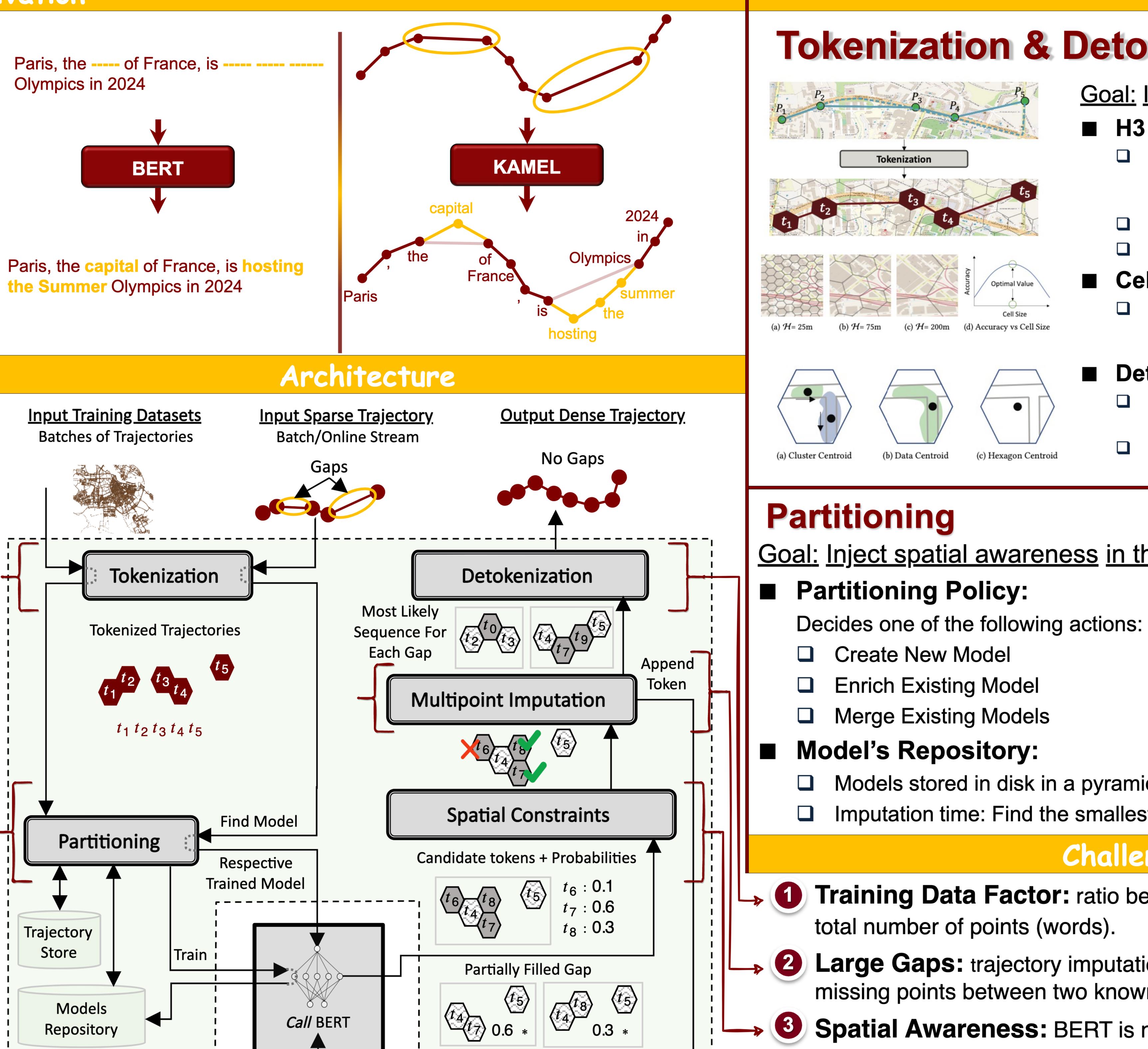
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Addresses 3 challenge #

Addresses 2 challenge #





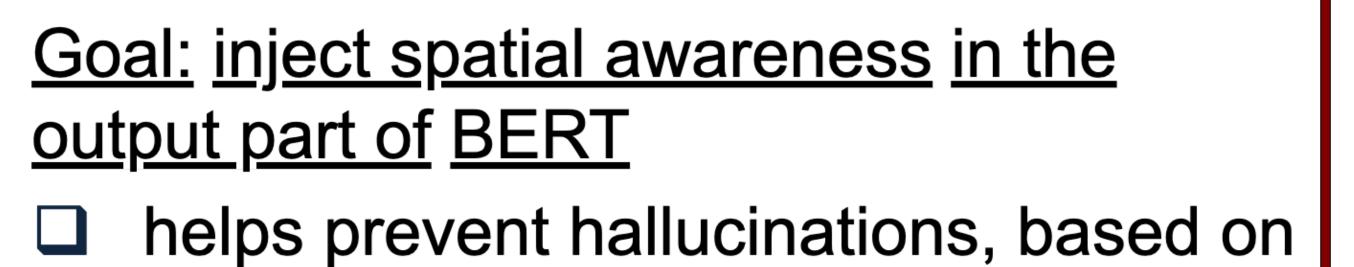
## **■ H3 Hexagonal Partitions. Why?** Regular neighbors structure - distance between centroids, length of shared borders). ■ No need for hierarchy. Cost is constant. Cell Size Optimization Optimization for each dataset. Detokenization: Offline: clustering algorithm for points within (e.g. DBSCAN). Use points direction. Online: find the closest cluster.

# Addresses 3 challenge # Goal: Inject spatial awareness in the training process of BERT Non-maintained Models stored in disk in a pyramid structure Imputation time: Find the smallest model that cover the trajectory



- Training Data Factor: ratio between distinct points (words) to the total number of points (words).
- (2) Large Gaps: trajectory imputation may need to find several missing points between two known points.
- Spatial Awareness: BERT is not spatially aware, where it may poorly train its model by including spatially unrelated datasets

### **Spatial Constraint**



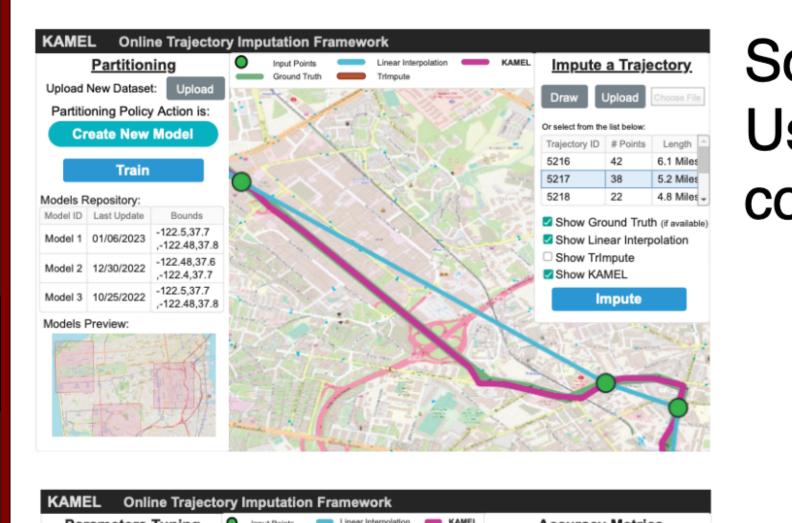
- spatial and physical constraints. Green are accepted, red are rejected, based on:
- Speed constraints
  - Direction constraints
  - Cycles prevention

### Multipoint Imputation



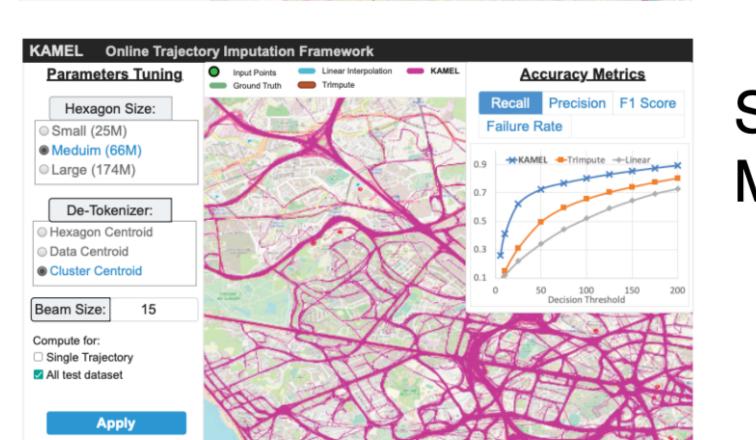
- Approach 1: Iterative Calling
- ☐ Greedy. May return less probable sequences than other.
- Approach 2: Beam Search
  - ☐ Computes joint probability by multiplying the probability of each token, which is provided by BERT.
  - $\Box$  Closely similar to breadth-first search, but keeps only the top B results instead of all results.
  - ☐ B is a parameter as a trade-off between accuracy and computational cost.

#### Demo Scenarios



Use KAMEL for imputation and compare it with state-of-the-art

> Scenario 2.A Compute for: Single Trajectory Experiment different parameters



Scenario 2.B

Scenario 3

2.2.2 Check spatial Cons.
2.2.3 Partially fill the gap Visualize and explain internals

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