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Visual Spatial-OLAP for Vehicle Recorder Data on Micro-sized Electric Vehicles

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Big data analysis

- **Big data analysis** have attracted much attentions.
  - Analyzing huge amount of data reveals important facts.
  - Data types: text data, sensor data, moving objects, etc.
    - Target ➔ trajectory data of electric vehicles (EVs)
- **OLAP** is a practical and well-studied analytic tool.
  - Multi-dimensional model (star/snowflake schema)
  - Analytic operations (slice, dice, roll-up, drill-down)

Micro-sized EVs (µEVs) at Tsukuba

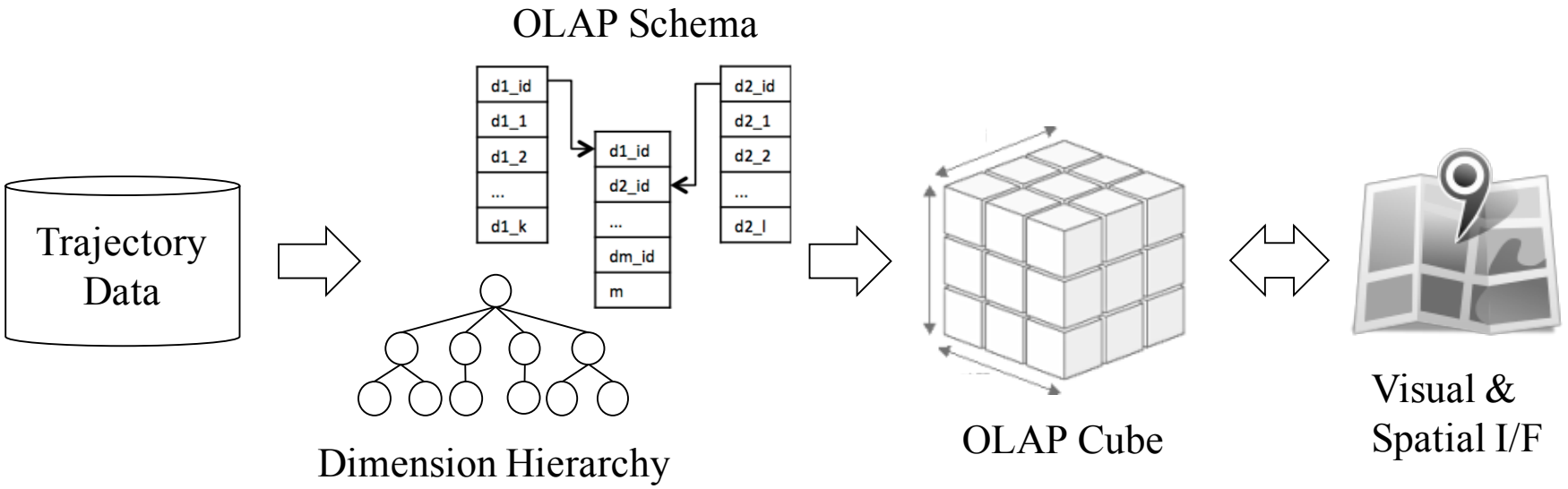
- µEVs is a smaller EVs
  - One or two passengers including one driver
  - At most 100km run w/o charging
- Tsukuba-city introduced in experimental objective.
  - Find potential requirements of µEVs.

Question to answer in this paper.
How µEVs are used?

Contributions

- Develop a general framework for OLAP analysis over trajectory data.
- Apply the framework to real-world data (i.e., trajectory data on µEVs at Tsukuba city)
- Analyze how µEVs are used in Tsukuba city.

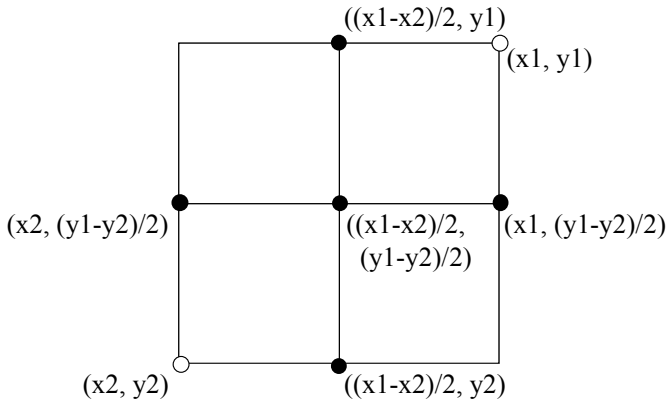
Framework: overview



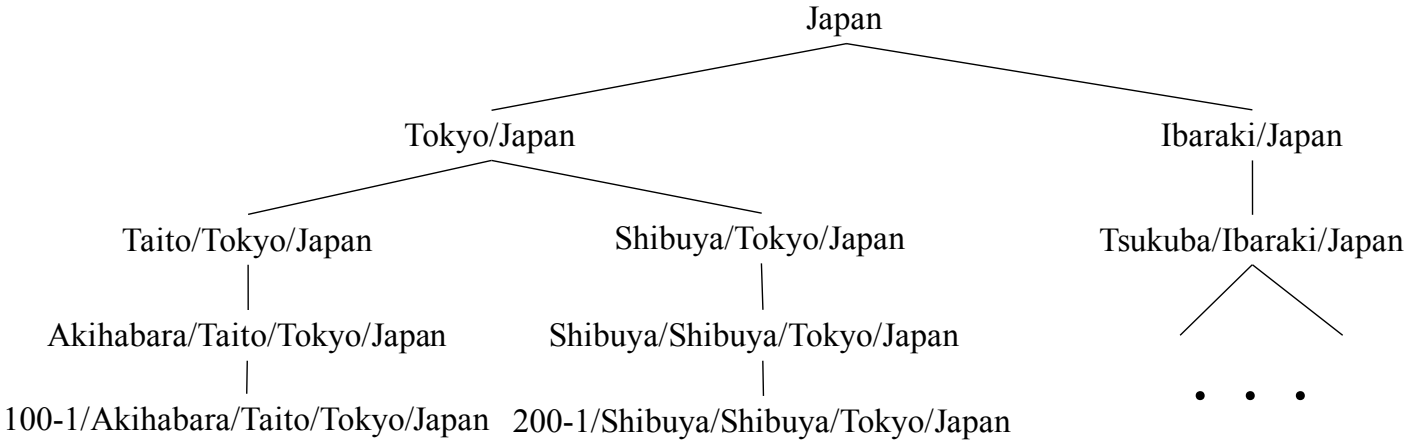
- Issues
  - Hierarchy design on spatial & temporal dimensions
  - Design of aggregation function for noisy GPS data
  - User interface: map interface (i.e., Google Maps)

Spatial hierarchization

- Grid-based hierarchization
  - Idea: quad-tree

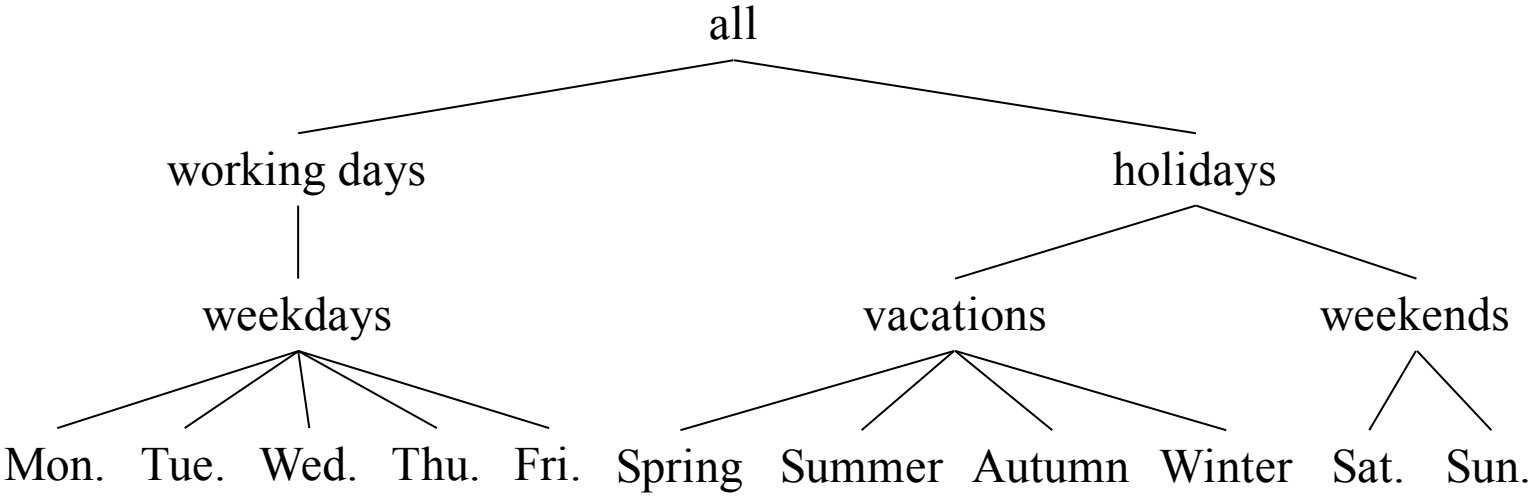


- Reverse geocoding-based hierarchization



Temporal hierarchization

- Duration-based hierarchization
  - e.g., second/minute/hour/day/month/year
- Day type-based hierarchization



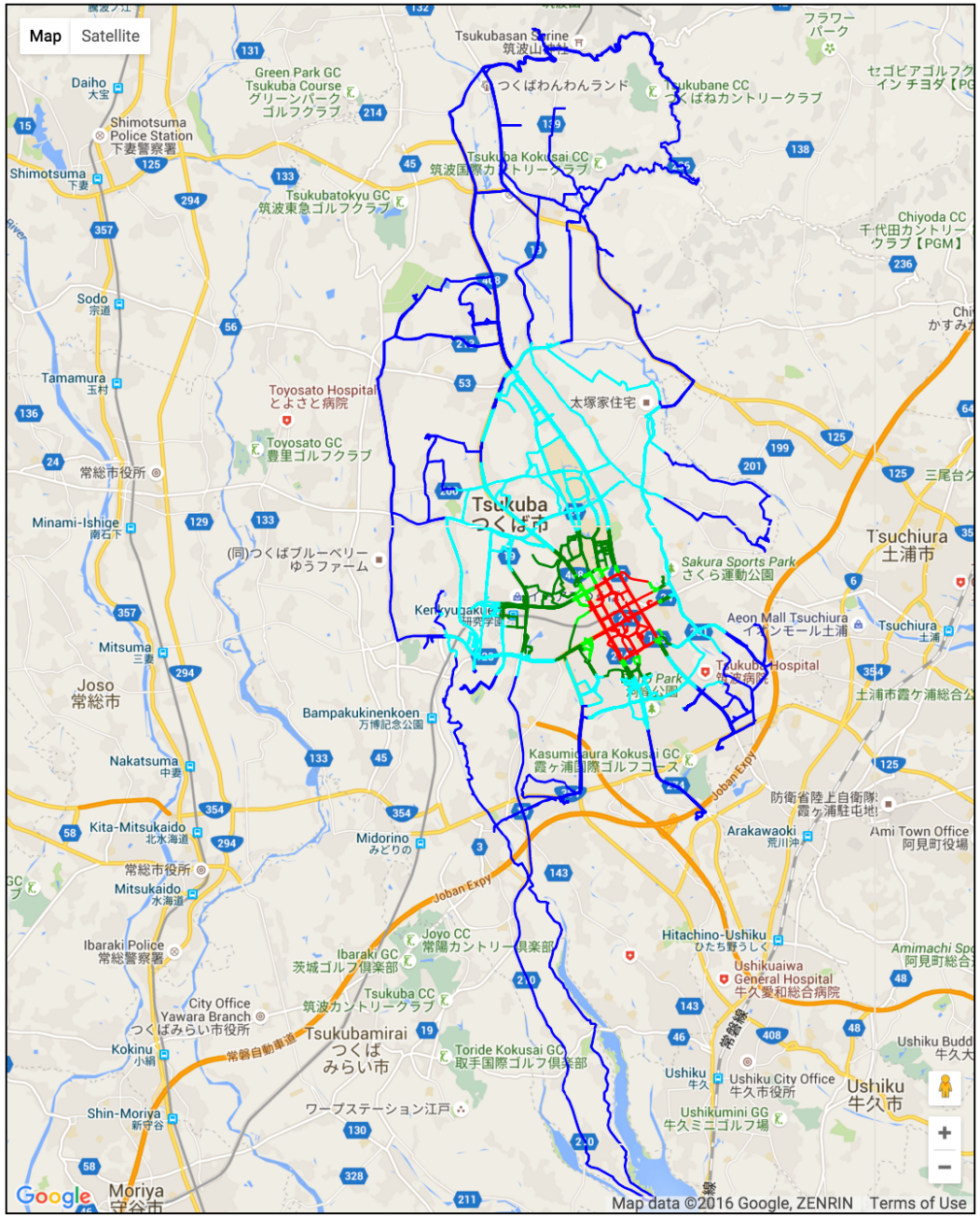
Aggregation function

- Threshold-based aggregation
  - Set a threshold of distance if two points are same points.
  - On a point on a road, sum up the number of trajectories any of which points are same as the point on the road.
- Gaussian kernel-based aggregation
  - Probabilistic approach
  - Evaluate closeness by Gaussian kernel.
  - Sum up the closeness to estimate the number of trajectories which are on a point of a road.

User interface

- Tabular form is infeasible.
- Maps w/ coloring-by-popularity.
- Ordinary interaction interface.
  - Menu for OLAP operations.

  (not depicted here)

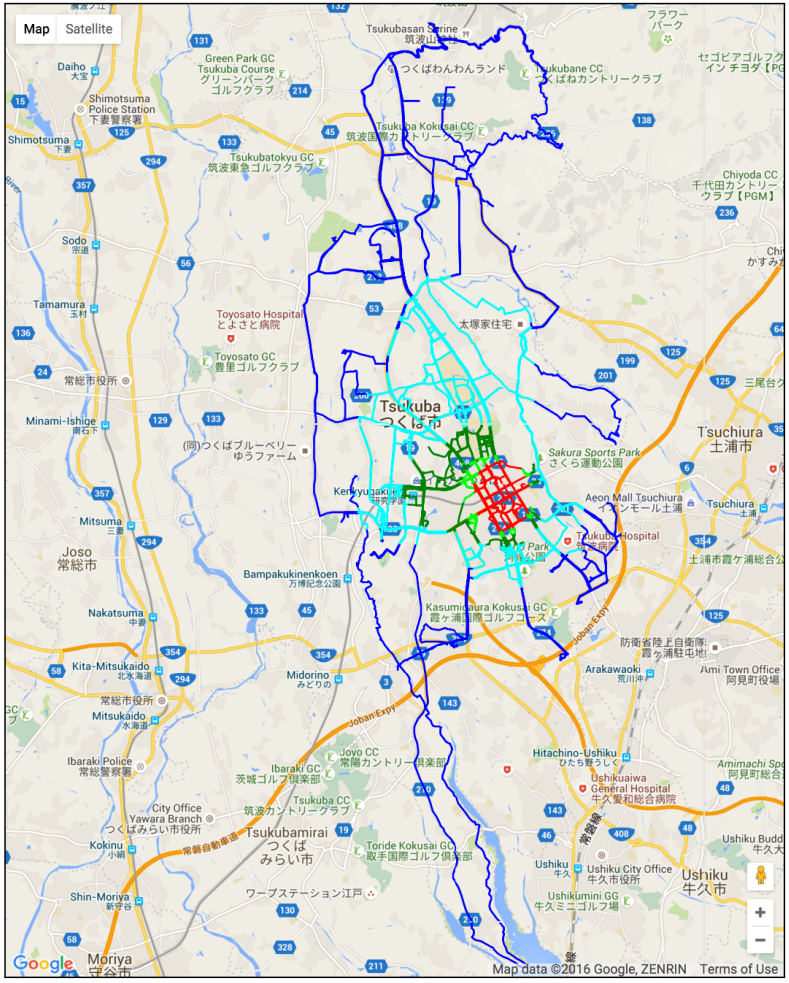


Case study: µEVs at Tsukuba city

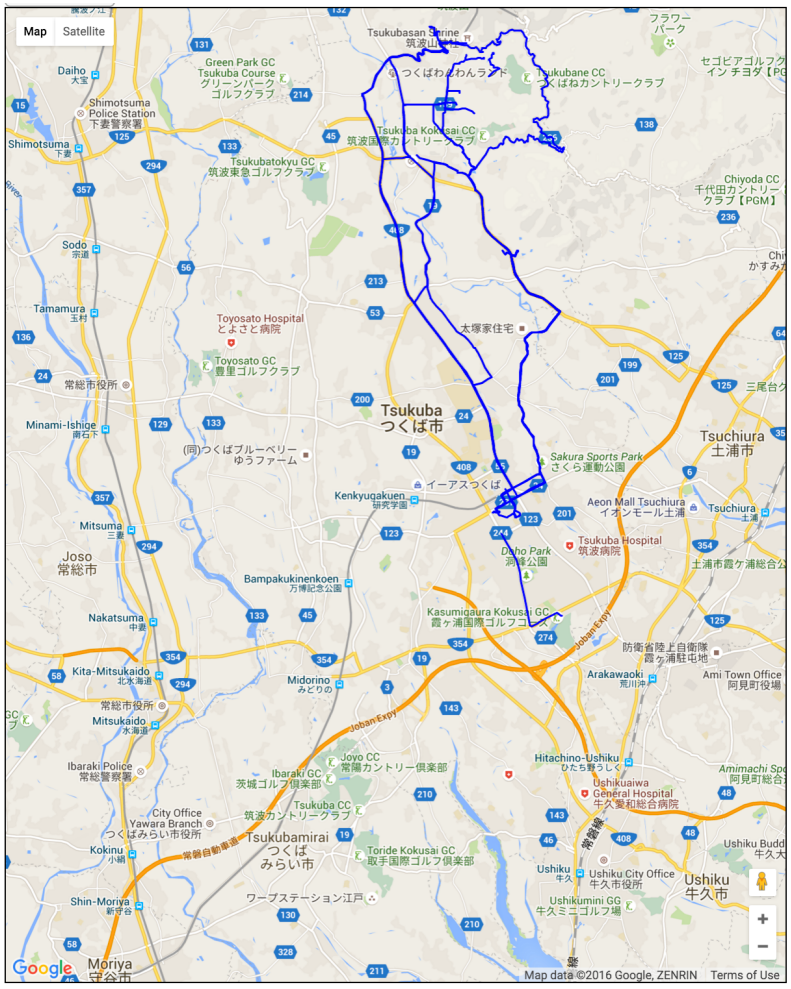
- Scenario
  - Tsukuba city rents µEVs to citizens by free.
  - The usage of µEVs is limited:
    - in-city only
    - no highway
    - one-day rental
  - Users must provide info. for their rentals.
    - purpose, date, etc.
  - Analysis requirements
    - What are the areas µEVs are used?
    - Are there differences of usage of µEVs over purposes?

Results

overall



sightseeing



Conclusion

- Contributions
  - Develop a general framework for OLAP analysis over trajectory data.
  - Apply the framework to real-world data (i.e., trajectory data on µEVs at Tsukuba city)
  - Analyze how µEVs are used in Tsukuba city.
- Future work
  - Comparable interface for different trajectories
    - “Different” means different combinations of OLAP operations (e.g., difference purposes).