IDEAS2016

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

<u>Takahiro Komamizu</u>, Toshiyuki Amagasa, Hiroyuki Kitagawa University of Tsukuba, Japan

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 .

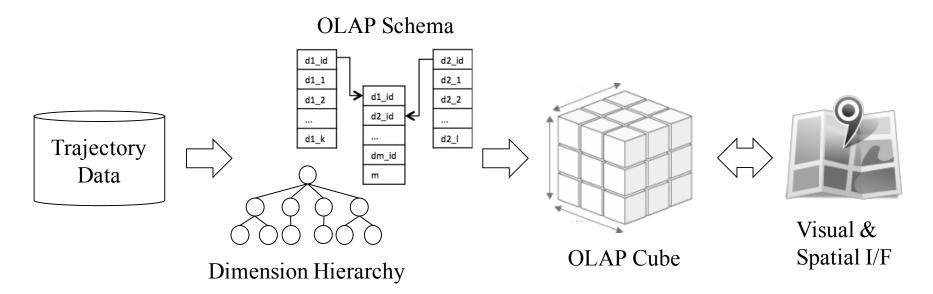
Question to answer in this paper. How µEVs are used?



Contributions

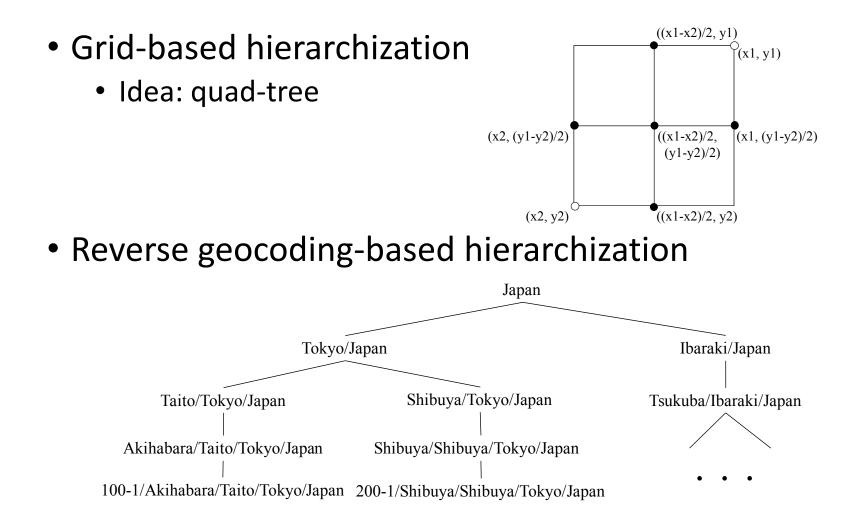
- Develop a general framework for OLAP analysis over trajectory data.
- Apply the framework to real-world data (i.e., trajectory data on μEVs at Tsukuba city)
- Analyze how µEVs are used in Tsukuba city.

Framework: overview



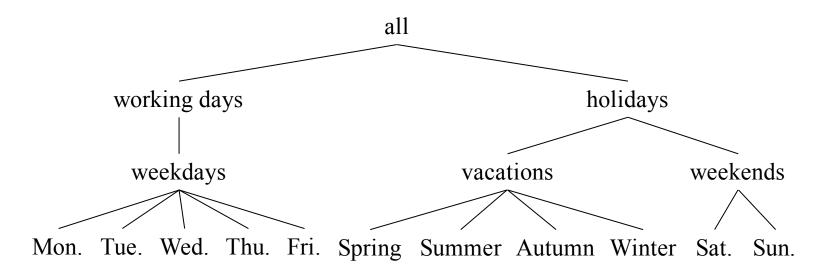
- Issues
 - Hierarchy design on spatial & temporal dimensions
 - Design of aggregation function for noisy GPS data
 - User interface: map interface (i.e., Google Maps)

Spatial hierarchization



Temporal hierarchization

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



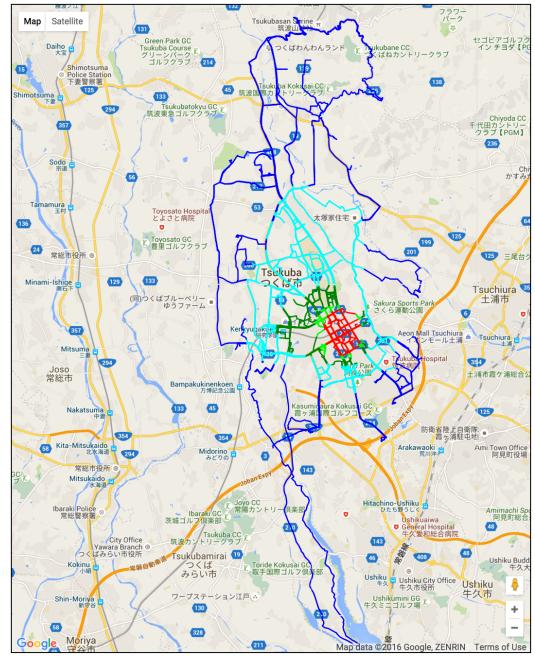
Aggregation function

- 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/ coloringby-popularity.
- Ordinary interaction interface.
 - Menu for OLAP operations.

(not depicted here)



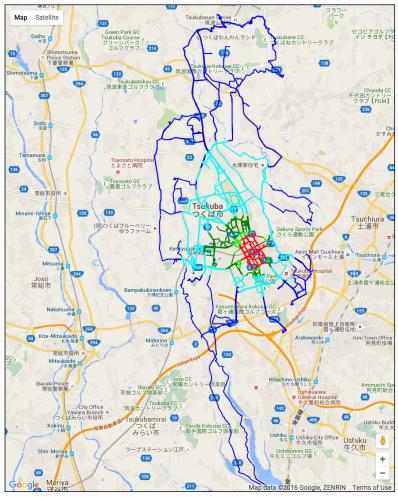
Case study: µEVs at Tsukuba city

• 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 フラワーパーク Map Satellite Tsukubasan Shrine 131 筑波山 Green Park GC Tsukuba Course グリーンパーク ゴルフクラブ セゴビアゴルフィ イン チヨダ【P Daiho 大宝 わんラン Nukubane CC 人ばねカントリークラブ 214 Shimotsuma 15 Police Station 下妻警察署 138 45 125 Shimotsuma 下妻 133 Tsukubatokyu GC 筑波東急ゴルフクラブ Chiyoda CC 千代田カントリー クラブ【PGM】 236 Sodo 宗道 Ch かすみ 213 Tamamura 53 Toyosato Hospital とよさと病院 太塚家住宅 136 • 125 Toyosato GC 豊里ゴルフクラブ 199 24 201 常総市役所 125 三尾台 200 Tsukuba 24 133 Minami-Ishige 129 つくば市 Tsuchiura ୟ (同)つくばブルーベリー ゆうファーム Ð 土浦市 Sakura Sports Par さくら運動公園 408 6 A 1-72 Kenkyugakuen 日 研究学園 Aeon Mall Tsuchiura イオンモール土浦 201 Mitsuma 123 ■ Tsukuba 筑波病院 ospita 354 Joso 土浦市霞ケ浦総合: 常総市 Bampakukinenkoen 万博記念公園 45 Kasumigaura Koku 霞ヶ浦国際ゴルフ Nakatsuma 125 274 354 防衛省陸上自衛隊 354 19 58 Kita-Mitsukaido 北水海道 Arakawaoki 荒川沖 月 Ami Town Office 阿見町役場 Midorino みどりの 3 常総市役所 143 Mitsukaido 水海道 Hitachino-Ushiku ひたち野うしく Joyo CC 常陽カントリー倶楽部 Ibaraki Police 常総警察署 Ibaraki GC Amimachi Su 阿見町総合 . 茨城ゴル Jshikuaiwa 48 ■ General Hospital 牛久愛和総合病院 Tsukuba CC City Office Yawara Branch @ つくばみらい市役所 筑波力 143 Tsukubamirai 💷 48 408 46 Ushiku Budd 牛久大 C Toride Kokusai GC 取手国際ゴルフ倶楽部 Kokinu つくば みらい市 0 Ushiku City Office 牛久市役所 Ushiku **^** 牛久市 ワープステーション江戸・ Shin-Moriya Ushikumini GG で キ久ミニゴルフ場で 130 ÷ 58 _ 328 Moriya Google 211 Map data ©2016 Google, ZENRIN Terms of Use ----

Conclusion

- Contributions
 - Develop a general framework for OLAP analysis over trajectory data.
 - Apply the framework to real-world data (i.e., trajectory data on μ EVs 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).