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Finding map regions with high density of query keywords

Key words: Map search; Region search; Region recommendation; Spatial keyword search; Geographic information system; Location-based service

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Motivation

- A large amount of geographic object data is available on the Web such as shops, restaurants, and parking lots. More and more online businesses are incorporating the geographic data in their services.

- However, current location-based services offer only search for isolate locations on a map (known as points-of-interest, POIs for short).

Motivation

- Frequently, users are searching for regions instead of locations.
  - Customers would have various demands not easily met in a single spot.

- To address this issue, we resort to finding regions instead of isolated locations.
  - Region search is a more challenging problem than location search.

Main Idea

- We propose a density-based search algorithm to find regions of interest (ROIs), i.e., regions densely populated with locations labeled with query keywords.
  - By partitioning a map into small grids, neighboring grids densely populated with target locations can be merged iteratively to form a larger region, so we can efficiently retrieve the dense regions matching the query keywords.
  - The algorithm is further extended to find top-*k* dense regions and to accommodate multiple query keywords.

Single keyword dense region search

- **Preprocessing** step:
  - Partitioning the map into tiny square grids
  - For each keyword q_i calculating the keyword region relevance for each grid
- **Search** step:
  - Using a greedy search algorithm to retrieve a dense region from the map.

Workflow of DRS and extensions

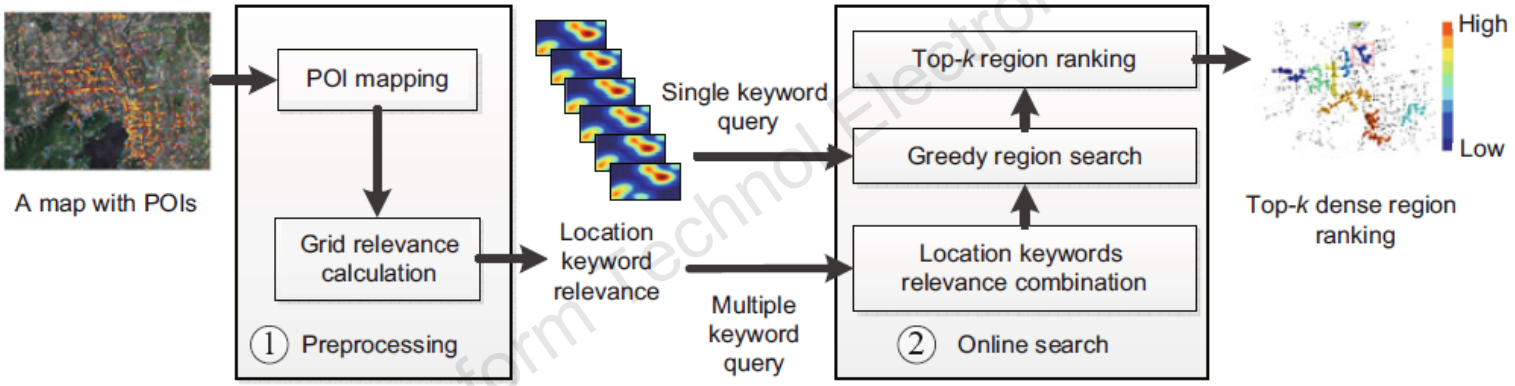
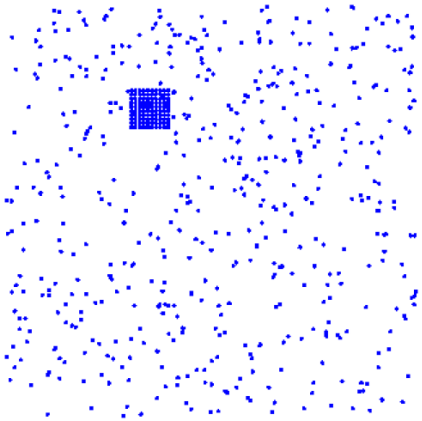
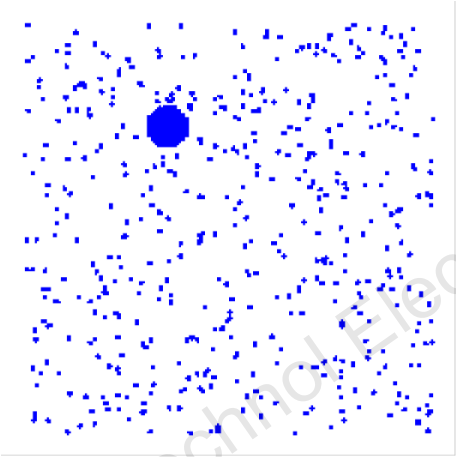
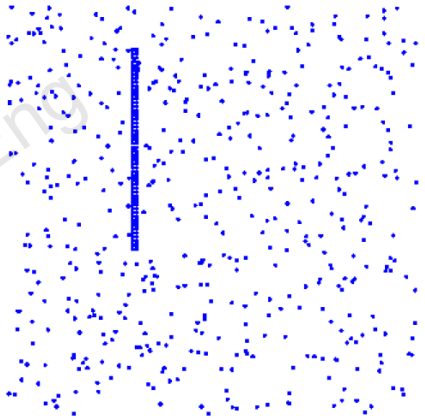


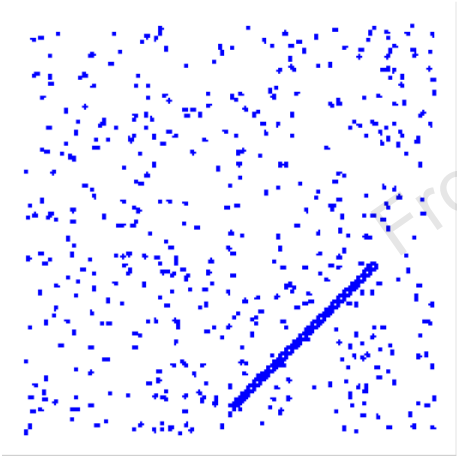
Fig. 3 The workflow of DRS and its extensions

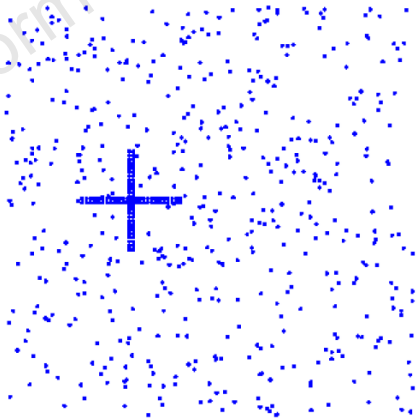
Synthetic dataset

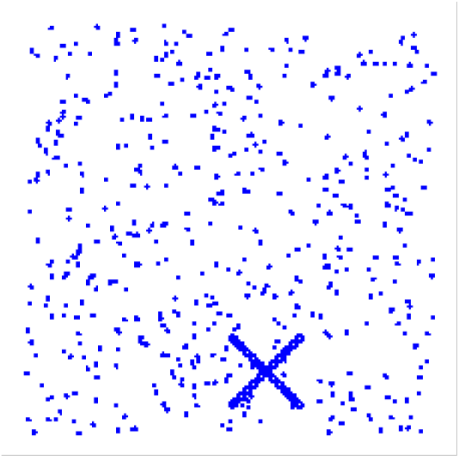




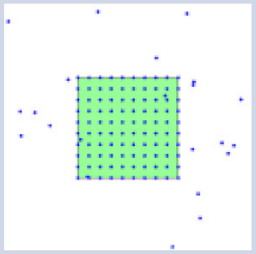
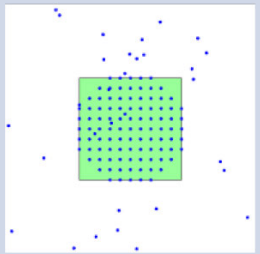
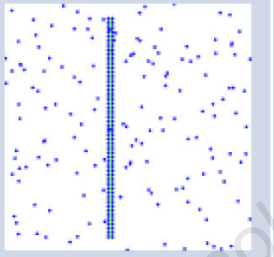
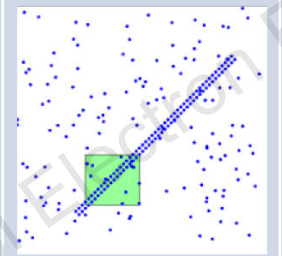
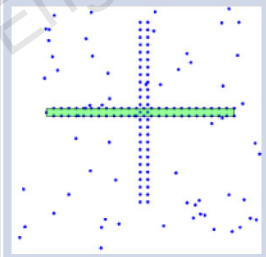
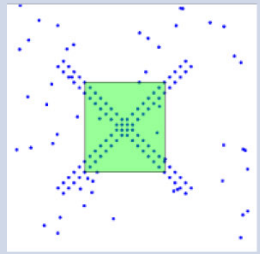
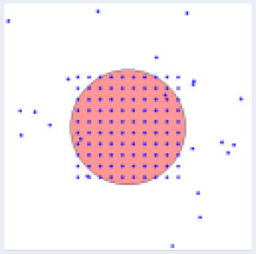
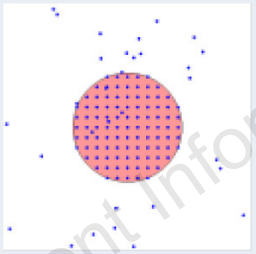
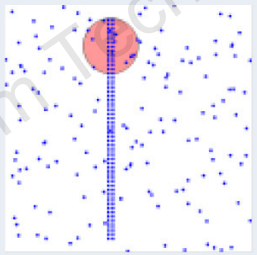
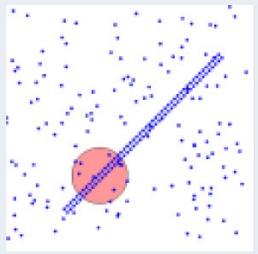
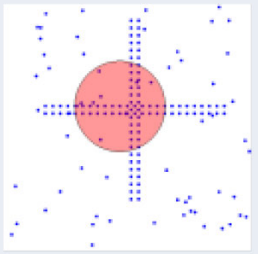
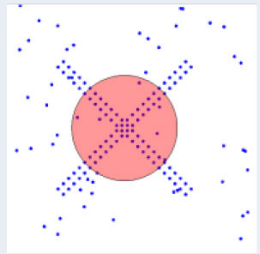
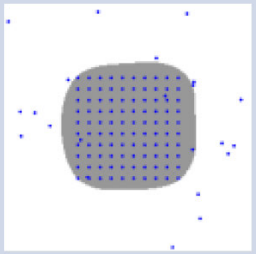
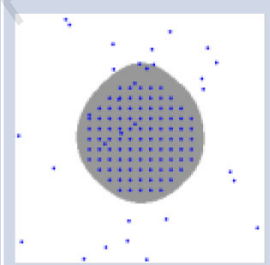
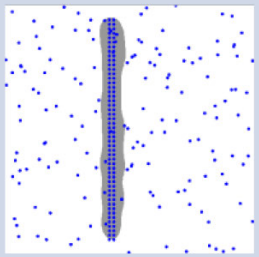
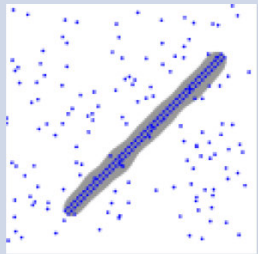
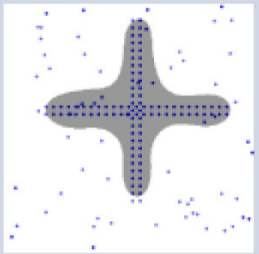
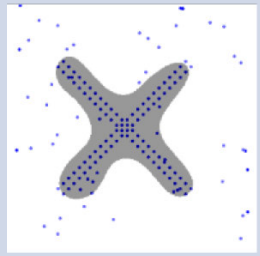




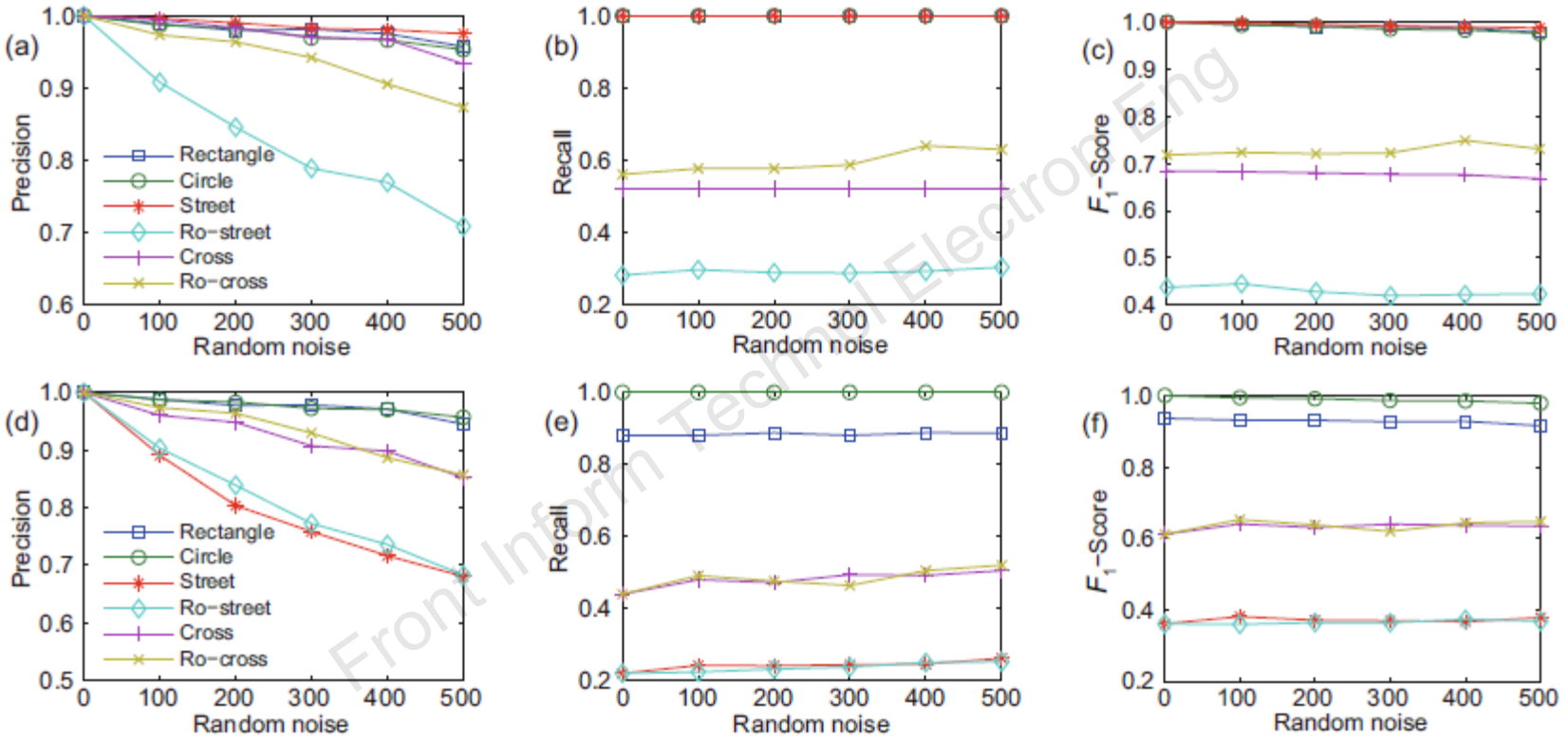




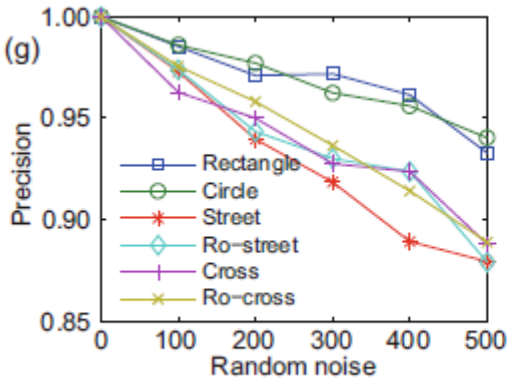
Comparison of the dense regions retrieved

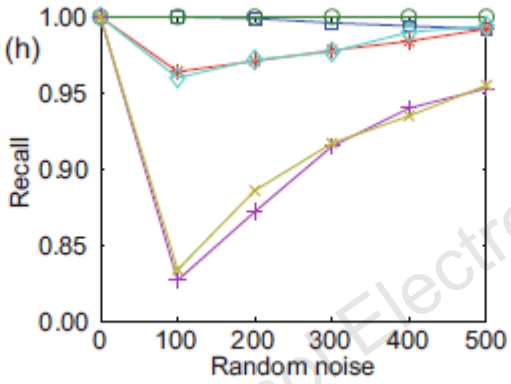
	Rectangle	Circle	Street	Ro-Street	Cross	Ro-Cross
MBR						
MCR						
DRS						

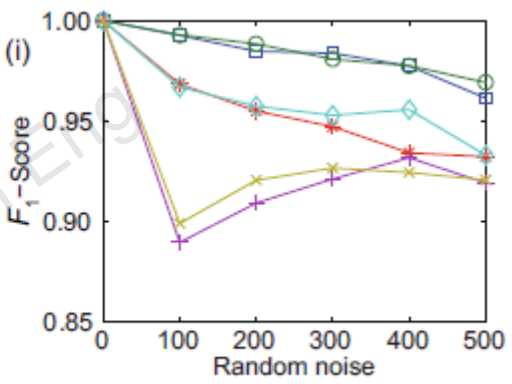
Performance on the synthetic dataset

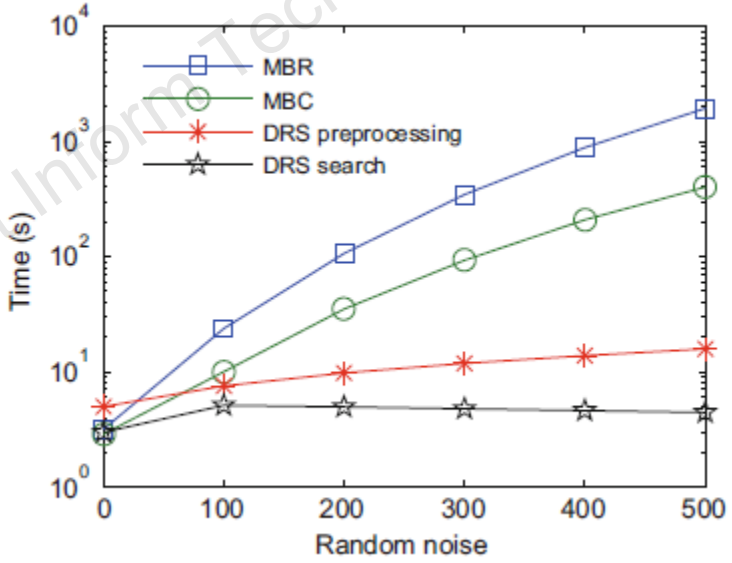


Performance on the synthetic dataset



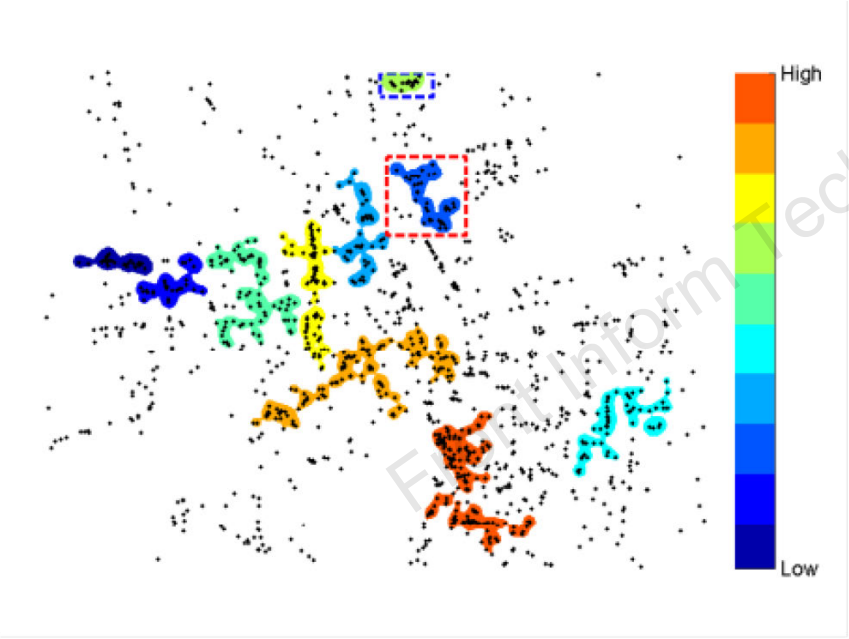




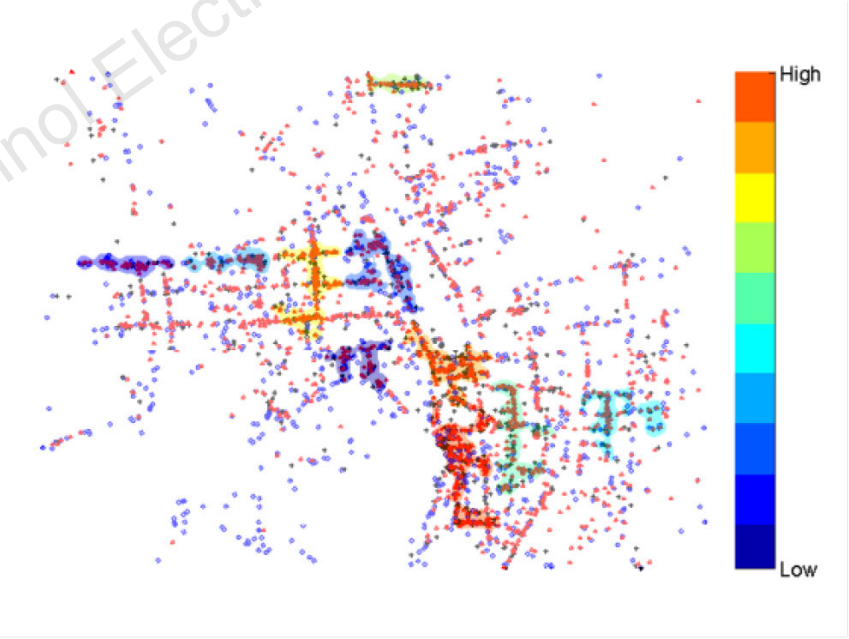


Performance on real-world dataset

Top 10 dense regions from 20 candidate regions



Top 10 dense regions from three-keyword query



Conclusions

- We present a novel dense region search algorithm DRS to find dense regions in location-based services.
  - DRS takes into account the relevance and density for a region in the map.
- Experimental results on synthetic and real social network datasets show that DRS achieves significant improvement in terms of dense region search accuracy and time cost.
  - We believe that DRS can greatly enhance the value of a location-based search engine by using a region as a search result, which could give more information than a single location for users.