Algorithms for collaborative filtering in Point-of-Interest Recommendation Systems

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POI recommendation

With the increasing popularity of GPS-enabled mobile devices, location-based social networks (LBSNs) have attracted millions of users to share rich information, such as experiences and tips. Point-of-Interest (POI) recommender system can help users explore attractive locations as well as help LSBN providers design location-aware advertisements for POI.

Foursquare
50 million monthly active users

Yelp
69 million mobile visitors

Motivation

The problem of POI recommendations has been widely studied and received significant research attention in the last seven years. While previous works of POI recommendation mostly focused on investigating the spatial, temporal, and social influence, the use of additional content information has not been directionally studied. Such additional information can not only improve the performance of the recommendation system but also help to overcome the so-called "cold start" problem.

User feedback used in POI recommendation

- **Explicit** → Ratings
- **Implicit** → Check-ins

Proposed method

- Matrix factorization as baseline approach

For explicit feedback:

- Adding regularization term based on similarity matrix between POIs

$$\min_{U,V} ||R - UV^T||^2 + \lambda(||U||^2 + ||V||^2) + \beta \sum_{i=1}^{N} \sum_{j=1}^{N} S_{ij} ||v_i - v_j||^2$$

S is similarity matrix where $S(i, j)$ is the similarity between items based on their item attribute information.

- Solving using Stochastic gradient descent approach

For implicit feedback:

- Weighted Matrix factorization

$$w_{ui} = \begin{cases} \mu(c_{ui}) + 1, & \text{if } c_{ui} > 0 \\ 1, & \text{otherwise} \end{cases}$$

$$\min_{U,V} ||W \odot (C^* - UV^T)||^2 + \ldots + \beta \sum_{i=1}^{N} \sum_{j=1}^{N} S_{ij} ||v_i - v_j||^2$$

- Solving using Alternative Least Squares algorithm

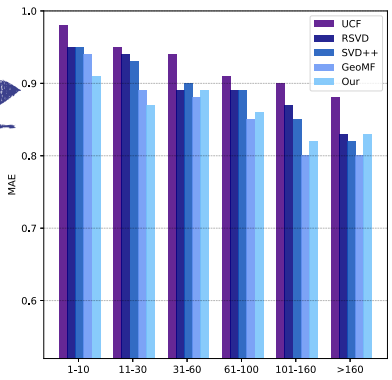
Evaluation

- Comparison with state-of-the-art collaborative filtering approaches
  - ➡ RSVD, WMF, SVD++, UCF and **GeoMF**
- Performance on Cold Start Items

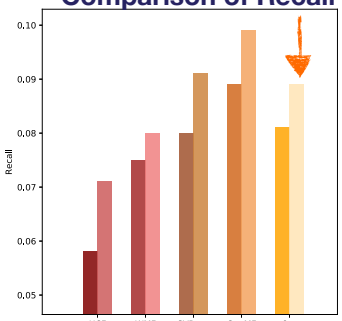
Evaluation

Performance on Cold Start Items in the implicit feedback approach

Mean absolute error

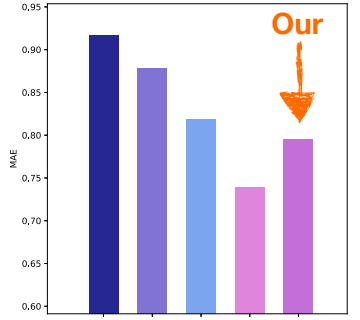


Comparison of Recall



Approach for implicit feedback

Mean absolute error



Approach for explicit feedback

Conclusion

- The proposed method
  - improves the quality of recommendation
  - can effectively cope with the so-called problem
  - outperforms most state-of-the-art CF algorithms
- Of all the algorithms tested, only **GeoMF** algorithm has surpassed our approach.
  - ➡ consider using the geographical influence on users' check-in or rating behaviors