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Location Based Recommender Systems (LBRS) – A Review

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Abstract: Recommender system has a vital role in everyday life with newer advancement. Location based recommender system is the current trend involved in mobile devices by providing the user with their timely needs in an effective and efficient manner. The services provided by the location based recommender system are Geo-tagged data based services containing the Global Positioning System and sensors incorporated to accumulate user information. Bayesian network model is widely used in geo-tagged based services to provide solution to the cold start problem. Point Location based services considers user check-in and auxiliary information to provide recommendation. Regional based recommendation can be considered for improving accuracy in this Point location based service. Trajectory based services uses the travel paths of the user and finds place of interest along with the similar user behaviours. Context based information can be incorporated with these services to provide better recommendation. Thus this article provides an overview of the Geo-tagged media based services and Point Location based services and discusses about the possible research issues and future work that can be implemented.

Keywords: Geotagged Media, Point location, Trajectory, Location Based Recommender Systems (LBRS).

1 Introduction

The "ranking" or "preference" a consumer will give to a product is foreseen by a recommender system. The basic classification of the recommendation system consists of content based filtering, collaborative filtering and hybrid filtering (see Fig.1).

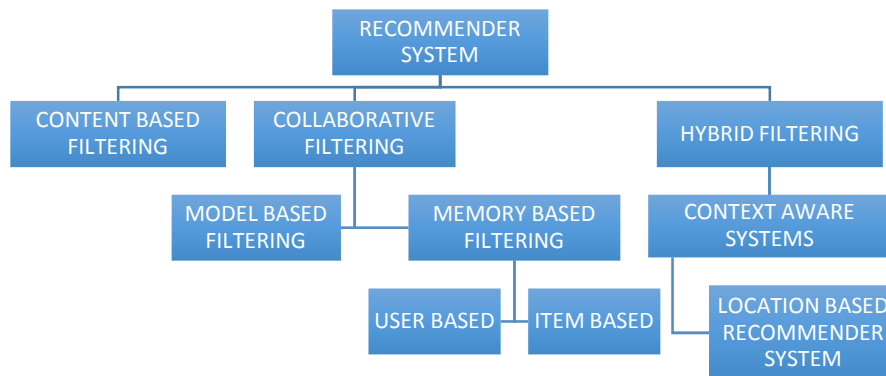


Fig.1.Classification of Recommendation System

Content based filtering method contains providing items, which are acquainted to users. It is also known as cognitive filtering, which suggest items grounded on a contrast between the item content and a user profile. Collaborative Filtering depends on similar user ratings. It is capable of predicting the future preference of the user with top-k recommendations. It is categorised as model based filtering and memory based filtering. In Model based systems, models are created initially and system studies algorithms for doing procedures based on the data trained. Then using this models prediction is being made for definite data. Memory based filtering make use of rating information to compute the similarity among items or users and provides recommendation based on

similarity measure. It is of two types calculating the similarity based on user ratings and item ratings. Hybrid filtering involves the combination of content and collaborative filtering. Context-Aware systems comes under this category, which collects both user ratings of items and their properties. Location based recommender system is an example of context aware system as it uses location, time, etc for providing recommendations.

The involvement of Global Positioning System (GPS) in mobiles made the location based services trendy today. By accessing the location co-ordinates, the user activities can be analysed, and their preferences can be given in a better way. Thus the LBRS offers user with the appealing materials in an effectual way, such that the user can label their location media stuffing like text, photos, videos, etc. Recommender Systems is a vital applications that can be straight fitted into Location Based Services (LBS) field. Providing suitable and adapted recommendation built on the position of the user or location is a salient exploration trick[1].

2. LOCATION BASED RECOMMENDATION SYSTEM (LBRS)

The Location based systems can be separated into classes based on the goal of the recommendation such as Stand-alone location recommender systems, and Sequential location recommender systems. Stand-alone location recommends a user with entity locations that matches their favourites and Sequential location recommender system provides a chain of locations to a user based on their favourites and constraints(time and cost)[2]

STANDALONE RECOMMENDATION SYSTEM

It can be divided into User profile based recommendation, Location histories based recommendation and User trajectories based recommendation.

User profile based recommendation

This will be giving a recommendation by matching the location metadata with the user profile. As an example [3] discusses about Bayesian Network based recommendation system, which reflects the preference of the users by user profile and information obtained from the mobile devices.

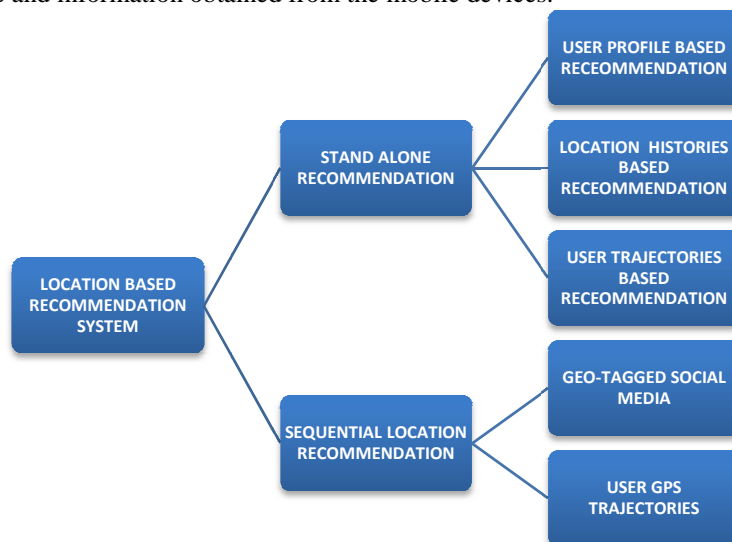


Fig.2.Classification of Location Based Recommendation System

Location histories based recommendation

Location histories based recommendation system considers the rating history and check-in histories thereby it improves the quality of recommendation. Collaborative filtering technique is mostly used for finding the similar user's rating. By considering the rating history a user is capable of rating the location categories [4] When a user is interested in location recommendation, that particular user's ratings are considered and higher predicted location matching with their ratings are recommended. Therefore, deployment of location data involving rating history improves the recommendation accuracy.

User trajectories based recommendation

It contains a richer set of geographical information such as location co-ordinates (latitude, longitude and time). Thus using these trajectory logs and data the user's movement and behaviour in the real world can be collected.

SEQUENTIAL LOCATION RECOMMENDATION

It can be divided into Geo-tagged social media based, and User GPS trajectories based.

Geo-tagged social media

It relies upon the data revealed from geo-tagged photos, which may offer a custom-made trip arrange for a holiday maker, i.e., the fashionable destinations to go to, the order of visiting destinations, the arrangement of time in every destination, and also the typical path travelled at intervals every destination[[5]]. Users can state personal preference like location visited, travel period, time/season visited, Associate in Nursing destination vogue in an interactive manner. Mining techniques can be applied for providing effective results in case of geo-tagged based recommendation.

User GPS trajectories

It includes the length used up at a location and therefore, the sequence of visited locations, which will advance serial location recommendations. GPS trajectories spawned by multiple users, fascinating locations and classical travel sequences at a given geospatial region [6] Such info will facilitate the link among users and locations, and modify recommendation on travel effectively.

3. SERVICES PROVIDED BY LOCATION BASED RECOMMENDER SYSTEMS (LBRS)

Existing LBRS services will be classified as geo tagged media based, point location based, and trajectory-based (see Fig.3). In this paper we are going to discuss briefly about Geo-tagged and Point based services and their future work.

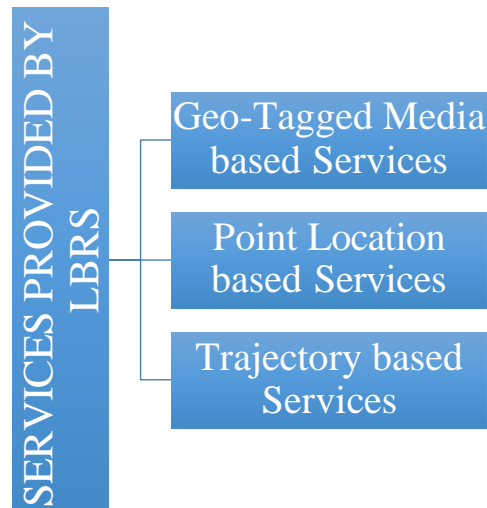


Fig.3.Services Provided by LBRS

GEO TAGGED MEDIA BASED SERVICES

This services permit users to feature location with user's broadcasting contents like text, photos and videos that were formed within the real world. Passive tagging happens once a user expressly makes and increases the contents of location[7].Geo-tagged media-based services permit a user to look at alternative users content during a geographical content by using digital maps incorporated in phones [8]Common applications that offer LBRS services embrace Flickr, Twitter and Panoramio [9].

Table 1. Survey of Geo-tagged media based services

| Related Work | Dataset Used | Techniques Used | Inference |
|-----------------------|--|---|---|
| Zhang et al,2017[10] | Twitter API. | Novel Bayesian mixture clustering model | TrioVecEvent methodology that leverages multimodal embeddings to attain correct on-line native event detection. |
| Yang et al,2017[11] | Flickr | Network motifs | Geo-Infa novel motif-based clustering framework using the behaviour patterns of the tourists is proposed. |
| Sun et al,2018[12] | Flickr and other contextual information. | Candidate generation and candidate matching techniques | It provides a recommendation system that matches with user's preferences. |
| Bujari et al,2018[13] | Flickr | Social networks, crowd sourcing and gamification method | User feedback based recommendation system was proposed. |
| Cai et al,2018[14] | Flickr | Semantic trajectory pattern mining algorithm. | It proposed a recommendation system by considering the semantic trajectory pattern of |

| | | | |
|-----------------------|--------|---|---|
| | | | other user's sequences and preferences. |
| Mor et al,2018[15] | Flickr | Cell-based clustering and bi-directional constrained pathfinder Nearest Neighbour route calculation algorithm | Popular tourist's destinations are recommended using photographer's activities and tourism context features. |
| X.Wu et al,2018[16] | Flickr | Clustering by Fast Search and Find of Density Peaks clustering algorithm | This work proposes a Spatially-installed hotspot system utilizing web based life information (geotagged). |
| Barros et al,2019[17] | Flickr | Analysis of geotagged data | This work proposes the application of geotagged data in finding behaviour of the visitors in endangered area. |
| Sun et al,2019[18] | Flickr | Candidate generation, candidate ranking ,SVM and gradient boosting algorithm | This work provides personalized recommendation by resolving cold start and long tail problem. |

POINT LOCATION BASED SERVICES

These services make users to share user's locations like restaurants, cinemas or mall [19]The foremost common applications of this services include Facebook, Instagram and Foursquare that promote users to share their current location. Users of such application's area unit abounding with choices to achieve arrival at totally different locations that users visited area in their regular routine to share knowledges and information by providing a feedback [20].One among those services that enable period location track of users is they will find their friends round their locations that ease in improving a user's social activities . As an example, when discovering a friend's location from their social network, we can give the opinion for lunch or searching activity. The use of feedback permits users to share their suggestions. Such feedbacks can help in accumulating recommendation. Unlike geo tagged media, some extent location (venue) is that the main element related to the purpose location [9] [21]The following explains the various Point Location based services works and the **Table 2.** explains various Point Location based services.

Table 2 .Survey of Point Location based services

| Related Work | Dataset Used | Techniques Used | Inference |
|-------------------------|--------------------------------|--|---|
| Wang et al,2018[22] | Foursquare and gowalla. | Multinomial distribution | Proposed method on modelling users' past check-ins and supporting information to facilitate POI recommendation |
| Ding et al,2018[23] | Foursquare. | A Matrix Factorization method | It is utilized to display connections among highlights and acquire include vector portrayals of clients and POIs. |
| Guoqiong et al,2018[24] | Real check –in dataset from WW | Latent Dirichlet Allocation(LDA) topic model and Higher Order Singular Value Decomposition (HOSVD) Algorithm | A POI recommendation system for solving data sparsity by mining time aware topic preference of the user is used. |

| | | | |
|----------------------|--------------------------------|--|---|
| Baral et al,2018[25] | Yelp Dataset | Dense subgraph extraction and ranking-based techniques | A ReEL (Review aware Explanation of Location Recommendation) using deep neural network. It can be used for providing group recommendations. |
| Ri et al,2018[26] | Foursquare and Yelp. | Ranking model (GSBPR) | Geo-Social Bayesian Personalized Ranking model (GSB- PR), which is based on the pairwise ranking. |
| Cheng et al,2018[27] | Foursquare and Gowalla dataset | Context Graph Attention (CGA) Model | POI recommendation system supporting heterogeneous context information. |
| Zhu et al,2018[28] | Review website. | Distance-based pre-filtering and distance-based ranking adjustment | POI based group recommendation is proposed. Context factors for group Recommendation can be considered. |
| Xu et al,2019[29] | Foursquare and Gowalla dataset | This model concentrates on preference and geographic factors of the user in providing recommendation | This system addresses two issues such as city guidelines for traveller categories and recommendations for a single traveller inside city POI. |

4. HIGHLIGHTS FOR IMPROVEMENT

The geotagged media based recommendation service can be given in a better way by incorporating with GPS, sensors to accumulate info and interaction among diverse users in movable environment. The context aware attributes like time, weather can be added to the system for providing better recommendation. The cold start problem and data sparsity problem can be overcome by proposing some new hybrid recommendation system, which is the amalgamation of content and knowledge based system. Even Bayesian Network model also gives an effective response to cold start and data sparsity problems.

Point Location media based recommendation system can be incorporated with chronological effect, geological influence, temporal cyclic effect and semantic effect (Graph based embedding model) for making ease of data sparsity and cold start problem. Clustering around the user by their fondness on categories and context factors such as (time aware scenarios, traffic, and consumption level) is useful for providing group recommendations and regional based recommendation. Geo-diversification concept can also be integrated for providing better recommendation.

5. CONCLUSION

Recently, the usage of Location has been a growing trend in the recommendation system. This paper covers all Location based recommender systems and the services provided by them, such as Geo-tagged media based services, Point location media based services. Geo-tagged media offers travel recommendations based on travel preferences combined with social geo-tagged images linked to a user's visit context. The key goal behind the Point location based recommendation is to help users accurately in locating Point Of Interests with overall positive reviews thereby providing Geographical, temporal, categorical and social recommendation. It is used to find the similarity of user behaviour through the travel paths. Group identification can be carried out as it identifies group

similarities apart from clustering. The datasets and techniques used in these services are discussed and arrived at a conclusion that this Location based recommendation system which is a hybrid method involves in the improvement of the prediction quality for various social media services like Flickr, Foursquare and Twitter etc. We can conclude that the location details also provides added advantage to a recommendation system.

REFERENCES

- [1] S. Tiwari, S. Kaushik, and P. Jagwani, "Location based recommender systems: Architecture, trends and research areas," in *Wireless Communications and Applications (ICWCA 2012)*, IET International Conference on. IET, 2012, pp. 1–8, DOI: 10.1049/cp.2012.2096
- [2] J. Bao, Y. Zheng, D. Wilkie, and M. Mokbel, "Recommendations in Location-based Social Networks: A Survey," *GeoInformatica*, 2015, Volume 19, Issue number 3, pp. 525-565, DOI: <https://doi.org/10.1007/s10707-014-0220-8>
- [3] M. Park, J. Hong, and S. Cho, "Location-Based Recommendation System Using Bayesian User's Preference Model in Mobile Devices," *Expert Systems with Applications*, Volume 39, Issue number 11, 2012, pp. 1130–1139, DOI: <https://doi.org/10.1016/j.eswa.2012.02.038>
- [4] R. Logesh, V. Subramaniaswamy, V. Vijayakumar, and X. Li, "Efficient User Profiling Based Intelligent Travel Recommender System for Individual and Group of Users," *Mob. Networks Appl.*, vol. 24, no. 3, pp. 1018–1033, 2019, DOI: 10.1007/s11036-018-1059-2.
- [5] X. Lu, C. Wang, J. Yang, Y. Pang, and L. Zhang, "Photo2Trip: Generating Travel Routes from Geo-Tagged Photos for Trip Planning", *Proceedings of the 18th ACM international conference on Multimedia*, 2010, pp.143-152, DOI: <https://doi.org/10.1145/1873951.1873972>
- [6] Y. Zheng, L. Zhang, X. Xie, and W. Ma, "Mining Interesting Locations and Travel Sequences from GPS Trajectories," *Proceedings of the 18th international conference on World wide web*, 2009, pp.791-800, DOI: <https://doi.org/10.1145/1526709.1526816>
- [7] A. Majid, L. Chen, G. Chen, H. T. Mirza, I. Hussain, and J. Woodward, "International Journal of Geographical A context-aware personalized travel recommendation system based on geotagged social media data mining," 2012, pp. 37–41, DOI: 10.1080/13658816.2012.696649.
- [8] Y. Chon and H. Cha, "LifeMap: A Smartphone- Based Context Provider for Location-Based Services", *IEEE Pervasive Computing*, Volume 10 , Issue 2 , April-June 2011, pp.58-67, DOI: 10.1109/MPRV.2011.13
- [9] F. Rehman, O. Khalid, and S. Madani, "A Comparative Study of Location Based Recommendation Systems", *The knowledge Engineering Review* ,Volume 31, 2017, pp.1-30, DOI: 10.1017/S0269888916000308
- [10] C. Zhang, L. Liu, D. Lei, H. Zhuang, T. Hanra, and J. Han, "TrioVecEvent: Embedding-Based Online Local Event Detection in Geo-Tagged Tweet Streams.", *Knowledge Data and Discovery*, August 13-17, 2017, pp.595-605, DOI: <http://dx.org/10.1145/3097983.3098027>
- [11] L. Yang, L. Wu, Y. Liu, and C. Kang, "Quantifying Tourist Behavior Patterns by Travel Motifs and Geo-Tagged Photos from Flickr," *SPRS Int. J. Geo-Informatica*, volume 6, Issue number 11, Article number 345, 2017, pp. 1–18. DOI: <https://doi.org/10.3390/ijgi6110345>
- [12] X. Sun, Z. Huang, X. Peng, Y. Chen, and Y. Liu, "Building a model-based personalised recommendation approach for tourist attractions from geotagged social media data," *Int. J. Digit. Earth*, pp. 1–18, 2018. DOI: <https://doi.org/10.1080/17538947.2018.1471104>
- [13] A. Bujari, M. Ciman, O. Gaggi, and C. E. Palazzi, "Using gamification to discover cultural heritage locations from geo-tagged photos," *Pers. Ubiquitous Computing*, Volume 21, Issue 2, 2017, pp.235–252, DOI: <https://doi.org/10.1007/s00779-016-0989-6>
- [14] G. Cai, K. Lee, and I. Lee, "Itinerary recommender system with semantic trajectory pattern mining from geo-tagged photos," *Expert Syst. Applications*, vol. 94, 2017, pp. 32–40, DOI: <https://doi.org/10.1016/j.eswa.2017.10.049>
- [15] Matan Mor and Sagi Dalyot, "Computing Touristic Walking Routes using Geotagged Photographs from Flickr", *ETH Zurich Research Collection* ,2018, pp.1-7. DOI: <https://doi.org/10.3929/ethz-b-000225591>
- [16] X. Wu, Z. Huang, X. I. A. Peng, and Y. Chen, "Building a Spatially-Embedded Network of Tourism Hotspots From Geotagged Social Media Data," *Cyber-Physical-Social Computing and Networking*, Vol 6, 2018, pp.21945 - 21955. DOI: <https://doi.org/10.1109/ACCESS.2018.2828032>
- [17] C. Barros, B. Moya-Gómez, and J. Gutiérrez, "Using geotagged photographs and GPS tracks from social networks to analyse visitor behaviour in national parks," *Curr. Issues Tour.*, vol. 0, no. 0, pp. 1–20, 2019, doi: 10.1080/13683500.2019.1619674.
- [18] X. Sun, Z. Huang, X. Peng, Y. Chen, and Y. Liu, "Building a model-based personalised recommendation approach for tourist attractions from geotagged social media data," *Int. J. Digit. Earth*, vol. 12, no. 6, pp. 661–678, 2019, doi: 10.1080/17538947.2018.1471104.
- [19] H. Wang, W. Ouyang, H. Shen, and X. Cheng, "ULE: Learning user and location embeddings for POI recommendation," *Proc. - 2018 IEEE 3rd Int. Conf. Data Sci. Cyberspace, DSC 2018*, pp. 99–106, 2018,

- doi: 10.1109/DSC.2018.00023.
- [20] M. Sarwat, J. J. Levandoski, A. Eldawy, and M. F. Mokbel, "LARS *: An Efficient and Scalable Location-Aware Recommender System," *IEEE Transactions on Knowledge and Data Engineering*, vol. 26, no. 6, pp. 1384–1399, 2014. DOI: 10.1109/TKDE.2013.29
 - [21] V. W. Zheng, Y. Zheng, X. Xie, and Q. Yang, "Towards mobile intelligence: Learning from GPS history data for collaborative recommendation," *Artif. Intell.*, vol. 184–185, pp. 17–37, 2012. DOI: <https://doi.org/10.1016/j.artint.2012.02.002>
 - [22] H. Wang, W. Ouyang, H. Shen, and X. Cheng, "ULE: Learning User and Location Embeddings for POI Recommendation," 2018 IEEE Third Int. Conf. Data Sci. Cybersp., pp. 99–106, 2018. DOI: 10.1109/DSC.2018.00023
 - [23] R. Ding and Z. Chen, "RecNet: a deep neural network for personalized POI recommendation in location-based social networks," *Int. J. Geogr. Inf. Sci.*, Volume 32, Issue 8, pp. 1–18, 2018. DOI: <https://doi.org/10.1080/13658816.2018.1447671>
 - [24] L. Guoqiong, Z. Zhou, W. Changxuan, and L. Xiping, "POI Recommendation of Location-Based Social Networks Using Tensor Factorization," 2018 19th IEEE Int. Conf. Mob. Data Manag., pp. 116–124, 2018. DOI: <http://doi.ieeecomputersociety.org/10.1109/MDM.2018.00028>
 - [25] R. Baral, X. Zhu, S. S. Iyengar, and T. Li, "ReEL: Review aware Explanation of Location Recommendation," Proceedings of the 26th Conference on User Modeling, Adaptation and Personalization, 2013, Pages 23-32 .DOI: <https://doi.org/10.1145/2509230.2509237>
 - [26] Gao, R., Li, J., Du, B., Li, X., Chang, J., Song, C., & Liu, D, "Exploiting geo-social correlations to improve pairwise ranking for point-of-interest recommendation", *China Communications* , Volume: 15 , Issue: 7 , July 2018 , pp.180-201. DOI: 10.1109/CC.2018.8424613
 - [27] S. Z. B and H. Cheng, "Exploiting Context Graph Attention for POI Recommendation in Location-Based Social Networks," *International Conference on Database Systems for Advanced Applications*, volume 10827, pp. 83–99, 2018. DOI: https://doi.org/10.1007/978-3-319-91452-7_6
 - [28] Q. Zhu et al., "Context-Aware Group Recommendation for Point-of-Interests," *IEEE Access*, Volume 6, pp. 12129–12144, 2018. DOI: <https://doi.org/10.1109/ACCESS.2018.2805701>.
 - [29] X. Jiao, Y. Xiao, W. Zheng, H. Wang, and C. H. Hsu, "A novel next new point-of-interest recommendation system based on simulated user travel decision-making process," *Futur. Gener. Comput. Syst.*, vol. 100, pp. 982–993, 2019, DOI: 10.1016/j.future.2019.05.065.