TraMSNET: A mobile social network application for tourism

Jorge Gaete-Villegas
Department of Computer Science
KAIST
Daejeon, Republic of Korea
jorge@kaist.ac.kr

Dongman Lee
Department of Computer Science
KAIST
Daejeon, Republic of Korea
dlee@cs.kaist.ac.kr

Meeyoung Cha
Graduate School of Culture Technology
KAIST
Daejeon, Republic of Korea
meeyoungcha@kaist.ac.kr

In-Young Ko
Computer Science Department
KAIST
Daejeon, Republic of Korea
iko@kaist.ac.kr

ABSTRACT

By leveraging location data in online social networks, Location-based Social Networks (LBSNs) can support diverse human activities such as tourism. Different applications aim to aid tourists and provide better experience in their travels by matching co-located users based on what they have in common. However, users with little in common but with potential to help each other given the context and place could not be matched. In this paper we introduce traMSNet, a LBSN that implements a matching algorithm considering homophily, as well as users complementary skills in a touristic location. Our idea is validated with a survey that asked potential travelers about their needs when looking for a travel partner. Moreover, we present a matching algorithm that is evaluated it with real tourists. The evaluation shows that considering complementarity when matching individuals is preferred by users. Therefore, by only considering similarities, important issues are left aside.

ACM Classification Keywords

J.0 Computer Applications: General—*Mobile computing, user recommendation*

General Terms

Algorithms, Human Factors

Author Keywords

Location-Based Social Networks, Homophily, Human Factor, Matching algorithm

INTRODUCTION

Recent advancements in location-acquisition and mobile communications are allowing the emergence of Location-based Social Networks (LBSN) [19]. By enabling users to leverage online social networks with location data, these emerging technologies are supporting the most diverse human activities [9], in particular, tourism [20].

Amongst the elements playing a role into tourists' experiences, human factors and place characteristics are key to achieve a rewarding touristic experience [15]. Tasks such as, interaction with local residents and other tourists and to have a cultural understanding of the location, have demonstrated to be important goals for tourists [11]. These lead to the problem of matching tourists to other people (locals or tourists), in order to enhance their touristic experience and understanding of the location.

Existing applications for tourism [7, 17, 5] implement user matching algorithms from online social networks. The core of these matching algorithms is the concept of homophily, which states that similar individuals are likely to associate with each other more than others [10]. By using this idea, current applications recommend users based on their similarities [12].Nevertheless, relationships between users and places, expressed as knowledge of the place or the locally supported activities, are missed. These relationships, defined as complementary skills, might be beneficial for users that do not have them [14]. However, homophily-based approaches do not consider such relationships.

Considering the above, we state as our research hypothesis that: "In LBSN applications focused on tourism, matching users only in terms of their similarities does not fulfill the needs of tourists." Based on our work, we identify as requirements of the solution: (1) Support on-site serendipity among tourists, (2) Consider the user-place relationship when matching users, and (3) Allow users to communicate on a mobile environment.

In particular, our main contribution is to propose a mechanism that matches users in consideration of their comple-

UbiComp '12, Sep 5-Sep 8, 2012, Pittsburgh, USA.
ACM 978-1-4503-1224-0/12/09

mentary skills for a given a place. These skills are inferred from the characteristics not shared by the different users.

We evaluate our approach by means of an online survey to real users. This study faces the respondants to a fictional touristic scenario, and presents five different lists of users to instantiate a LBSN. Each list considering different values oft homophily and complementarity. The results show that consider complementarity is preferred by the users (77% of the sample), therefore, considering only similarities leaves important issues aside.

The rest of the paper is organized as follows. We first survey related work, pointing out how our approach differs from others. Secondly, we introduce the tackled problem and our research hypothesis by a motivation scenario, to later infer the solution requirements out of user survey. Our approach is introduced by presenting the functionalities to match the found requirements and our matching algorithm. After this, we describe our evaluation design, settings and threats to validity in order to clarify the extensions of our conclusion. Then, we present the evaluation results and discussed them to finally, conclude the paper and present future research directions.

RELATED WORK

In this section we briefly introduce relevant study fields related with our work. We first introduce the Location-Based Social Networks, to locate our work in the community. Then, we introduce the concept of homophily into the online social networks, to finally, describe the existing applications supporting the touristic activities.

Location-Based Social Networks

LBSN emerge from the technical advances in location acquisition and mobile communication, which enable users to leverage online social networks with location data [19]. In fact, the user experience in a location can be enhanced with the features of online social networks by, discovering relevant users and supporting serendipitous interactions between them [9]. The goal is to match users sharing similar characteristics within a certain geographic range. Individuals are ranked between them according to the level of similarity they have. Final recommendations are conducted by using stable marriage matching-type algorithms [12].

The generation of LBSN is usually driven by homophily and based on profile information, as hobbies and preferences [7, 5], or information form the location and recurrent visited places [17, 18]. For example, in [1], the authors propose a method to extract similarities between co-located users based on location history. This is later leveraged in [13] to generate a friend recommender amongst co-located users. In [16], the authors extend the user matching problem to the place category (i.e., restaurants, shopping malls, bars, amongst others).

Nevertheless, how to match users with little in common but with potential synergies given their location is not usually considered. This point is what we aim to examine.

Homophily in online social networks

The concept of homophily has been widely studied in the social sciences [10], and extended into the online social network as a driver to generate matching between users [14]. This has been carried out particularly in terms of similar preferences, profiles [8] and behaviours [18]. However, recent literature indicates that online communities are not necessarily formed by homophily between users [6]. In addition, it has been stated that the homophily phenomena from the real world cannot be directly extended to the virtual world [3].

In [14], it is shown how homophily between users is useful to replicate known social patterns, but fail at fostering serendipity. Even more, it is also shown that by reflecting and reinforcing the real life social structures, homophily leads to segregation of users. As a consequence, important synergies between individuals with different interests, preferences and capabilities are missed.

Mobile applications to support tourism

In [2], tourists in a location are identified in terms of the familiarity with the place and the travel distance to get there. A tourist to a place is then characterized as an outsider with little knowledge of the place and the locals. Considering this, the touristic activity represents an interesting yet, challenging domain for supporting users' goals. By one hand, tourism is an activity highly dependent on the place [11]. On the other hand, tourists in a given place share the interest to discover it, but are unfamiliar with each other and the place [15].

The above has fostered the existence of multiple applications supporting LBSN and, in general, aiding the user to achieve his touristic goals. In [18], the authors propose an itinerary recommender system by using location history of past tourists. Other series of applications serving as mobile tourist guides are summarized in [20], offering services such as ticketing to local attractions, virtual tours, and communication tools between co-located users.

In general, the place is always considered as a source of similarities. Nevertheless, how the place characteristics align the differences of users into synergies is not well studied. This representing an interesting issue addressed in this paper.

HYPOTHESIS AND REQUIREMENTS

In this Section we firstly introduce our research hypothesis through a motivation scenario. Then, we infer the requirements for the solution from a prospective survey.

Motivation scenario and requirements

Consider the following scenario, introduced to better ilustrate our research hyphotesis:

"Benjamin is a medicine student backpacking through Europe. He speaks French and Spanish, loves football and barbecue. Nevertheless, he is too shy to just randomly talk to anyone. Barbara is an art student from Spain, vegetarian.

Concern	Answer	Included answer (examples)
Language	20	Speaks the native language, English
Age/Gender	11	Age, gender
Experience in the place	9	Experience in the place or similar places
Personality	10	Is he open minded, funny?
Nationality	9	Local, native
Knowledge background	10	Understanding the place and culture

Table 1. Survey results and concerns derived

Concern	Objective 1	Objective 2
Language	Partner communication	Interaction with locals
Age/Gender	Similarity	——
Experience in the place	Understanding the place	——
Personality	Similarity	——
Nationality	Partner communication	Understanding local culture
Knowledge background	Saftey and similarity with partner	Understanding the place and culture

Table 2. User concerns vs user objective

She doesn't likes sports and can't speak French. They are strangers to each other.

She is in the Louvre, just a couple of blocks away from Benjamin, looking for someone to share the Louvre, a place she knows well in advance since she studies Art. She looks up her smart phone where a suggestion for chatting with Benjamin pops up.

Since Benjamin needs someone to guide him and Barbara needs someone who can speak Spanish, they get connected and enjoy the day at the museum".

The above scenario presents the issue of matching users engaged in a touristic situations. The main problem is to match users that do not share interests necessarily, but may benefit from each other in the touristic domain.

In consideration of the above, we state as our research hypothesis that: "In a LBSN applications focused on tourism, matching users in terms of their similarities does not fulfil the needs of tourists".

A user requierements survey

A survey was conducted in order to validate the hypothesis introduced above, and to understand the user requirements to be considered when matching travel partners.

The study was conducted through an online questionnaire to 20 potential users [1], 9 female (45%) and 11 males (55%). In terms of age, the sample is composed by 3 under 19 years old (15%), 11 between 20 and 25 years (55%), 4 between 26-30 years old (20%) and, 2 between 31-35 years old (10%). Demographically, the sample is divided as follows: 9 Americans (45%), 5 Europeans (25%), 4 Africans (20%) and 2 Asians (10%). Participants were asked about their top five concerns when looking for a travel partner. Since this is an exploratory survey, the questionnaire had no fixed answer. For analysis purposes, the answers were manually classified into six concerns [2] as shown in Table 1.

[1]A potential user was considered to be an individual with experience in a foreing country for a short period of time in typical touristic activities as described in [2, 11]

[2]These appeared out of the data and where not defined in advance

Based on these concerns, we can infer the underlying motivations of users when they look for these characteristics in a travel partner. For instance, while (i) "Does he speaks English?" and (ii) "Does he speaks the local language?" account for a language concern, in (i) the user is assessing the communication potential with his travel buddy, and in (ii), he is looking to improve his communication with locals through his travel partner. Table 2 presents an interpretation of the underlying objectives of users for each found category.

Considering the above, an important question arises: How well does homophilly as a matching criteria accounts for these concerns? Table 3 presents a qualitative analysis on the feasibility of similarity and complementary to support the objectives listed in Table 2.

In Table 3 it is shown that, as mentioned in the literature [14], similarity is not enough to support all of the user needs. Moreover, supporting four out of six user's objectives, complementarity proves its importance as a matching criteria.

The mayor conclusions from the survey are: (i) language is the most important characteristic -*it was common to every surveyed, regardless of gender, nationality or age*-, (ii) the rest of the categories are equivalently important -*therefore only considering similarity leaves relevant issues aside*-, and (iii) in this touristic context, potential partner's knowledge on the place itself and/or related activities is, at least, as important as personality aspects -*this, since the number of responses for "Experience in the place" and "Knowledge backgrounds" equals the number of responses for "Personality"* -.

Finally, considering our hypothesis and motivation scenario, our requirements survey and the related work drawbacks [14], we deduce the following three requirements for our solution:

1. **Consider the user-place relationship when matching users :** To meet the concerns of users related with the place characteristics, such as "Experience in the place" and "Knowledge background".
2. **Support on-site serendipity among tourists:** To exploit the capabilities of other unknown co-located users.
3. **Allow users to communicate on a mobile environment:** To allow interactions occur dynamically.

Concern	Homophily	Complimentarism
Language	Yes	Yes
Age/Gender	Yes	No
Experience in the place	No	Yes
Personality	Yes	No
Nationality	Yes	Yes
Knowledge background	Yes	Yes

Table 3. User concerns vs how homophily and complementarism support these

PROPOSED SOLUTION

In this section we present the proposed schema to match the inferred requirements. We firstly present the set of functionalities needed by the application to account for the mentioned requirements. Then we present the data used to model both, the user and the place. Finally, propose a matching algorithm considering our research question and the results from the user requirements survey.

Functionalities

Functionalities identified are common to many applications found in the literature [9, 20]. Following is a brief presentation of these and how they respond to our functional requirements.

- *Local map generation and display:* Its two main objectives are: (i) allow tourista to locate other co-located users and, (ii) identify interesting touristic places. By doing this, the map fosters the communication between co-located users while provides the user with a better knowledge of the sorroundings. The provided map shows touristic points in the nearby and recommends partners according to a ranking algorithm.
- *Mobile social network:* Its objective is to materialize the interaction between users through a chat service. By doing this, it encourage on-site serendipity and communication amongst users.
- *User filtering, ranking and recommendation:* This is the core application of our work. It supports on-site serendipity amongst users by considering the location where the interaction is taking place. This is done by ranking users considering different parameters, accounting for complementary skills given the place (i.e. language) and, by regular homophily driven parameters (i.e. preferences).

Data for the modeling of users and locations

In the following, we present the data used for modeling the users and places. These data respond to the results of our conducted survey. They reflect the identified user concerns, while being used as inputs to the matching algorithm.

1. User profile
    - Age(numeric): User Age
    - Gender(string): User gender
    - Nationality(string): User nationality
    - Spoken language(string list): User spoken language
    - Major(string): User highest academic degree
    - Hobbies(string list): User hobbies
    - Past touristic experience (string list): Touristic locations visited by the user.
2. Place profile
    - Country (string): Country of location of the touristic place.
    - Spoken language (string list): Native languages spoken at the location.
    - Major activities (string list): Major activities performed at the location.
    - Related places (string list): Similar locations based on the above characteristics.

Given this characterization for users and places, users can be compared between them and with places. Comparisons between users are done by matching the correspondent fields of the two vectors representing them. On the other hand, users and places are compared only in the fields defined as equivalent between them. These are: (i) location country and user nationality, (ii) location spoken language and user spoken language, (iii) location major activities and user major and hobbies and, (iv) location related places and user past touristic experience.

Matching algorithm

Considering *u* as the target user, our matching algorithm returns a ranked list of the users nearby him, in consideration of his affinities and needs given his current location and, commonalities and synergies with the nearby users.

The algorithm first calculates the needs of *u* given the place *l* (See Algorithm 1, line 2). These needs are represented as a complementary user to *u* in *l*. This new user, *u*‘, is generated by eliminating from *l* all the characteristics already possesed by *u*, (i.e. same language or nationality). The resultant is a new characteristics vector, containing the needs of u in the place l, as defined in Equation 1.

$$\vec{u'}(u,l) = \vec{l} - \vec{u} \tag{1}$$

Later, similarities and complementary skills are calculated between *u* and *j* [3] (Algorithm 1, lines 4 and 5). Similarities are calculated as the percentaje of fields sharing the same metric between the descriptive vector for users *u* and *j*, while complementary skills are computed in the same way but between *j* and *u*‘, the complement of *u*. Both metrics are calculated by the Homophily function H, evaluated as [5, 9]:

[3]They are both calculated as explained in the footnote number 2

Algorithm 1 UserMatching(homophily, user, users, place)

```
Require: Homophily value α
Require: User characteristics vector u
Require: Place characteristics vector l
Require: Other users characteristics matrix J
1: β ← 1 − α
2: u′ ← diff(l, u)
3: recommendation ← Array[5][2]
4: for all collumn j in J do
5:     homophily ← sim(u, j)
6:     complementarity ← sim.2(u′, l)
7:     rank ← α ∗ homophily + β ∗ complementarity
8:     for all n in {1...5} do
9:         if recommendation[n][2] < rank then
10:            recommendation[n][1] ← j
11:            recommendation[n][2] ← rank
12:        end if
13:    end for
14: end for
15: return recommendation
```

$$\vec{H}^{n}_{i,j} = \begin{cases} 1 - (i(n) - j(n))/i(n) & \text{if n is numeric value} \\ 1 - (\max i(n) - \min j(n))/N & \text{if n is a numeric range} \\ \sum_{n=1}^{N} (i(n) \wedge j(n))/N & \text{if n is a list of strings} \end{cases} \quad (2)$$

Finally, the matching algorithm implements the ranking function presented in Equation 1. Initially this function is expressed as in Equation 3:

$$\vec{R}(u, j) = \alpha \vec{H}(u, j) \cdot \vec{W}^{H}_{m} + \beta \vec{P}^{l}(u, j) \cdot \vec{W}^{P}_{n} \quad (3)$$

The right side of the Equation (3) is composed by a measurement of homophily between *u* and *j* (multiplied by α) and a measurement of complementarity between *j* and *u* given a place *l* (multiplied by β). α and β represent the relative importance between homophily and complementarity, thus $\alpha + \beta = 1$. Both sides of Equation 3 are multiplied by weight vectors $\vec{W}^{H}$ and $\vec{W}^{P}$, accounting for the importance of the features compared by the functions *H* and *P*.

While *H* compares similarities and *P* compares complementary skills between users considering a place, by considering Equation (3) we can express the ranking function only in terms of homophily. By considering *u'*, *P* can be expressed in terms of the function *H* as $\vec{P}^{l}(u, j) = \vec{H}(u', j)$. In turn Equation (3) can be represented as:

$$\vec{R}(u, j) = \alpha \vec{H}(u, j) \cdot \vec{W}^{H}_{m} + \beta \vec{H}(u', j) \cdot \vec{W}^{P}_{n} \quad (4)$$

Finally, with this representation, the implemented UserMatching algorithm returns a recommendation by considering the top ranked users by Equation 4 (line 9 and 10 in Algorithm 1).

EVALUATION

In this section we present the evaluation process by explaining its design and implementation. The main goal is to verify our research hypothesis). In order to do so, the object of analysis considered was the user's opinion on the appropriateness of a LBSN for a given tourist situation. In turn, a LBSN is represented as a list of users, ranked by some eligibility criteria.

At this point, the ranking algorithm is introduced to suggest a LBSN. This algorithm is the focus of the evaluation, considering it is our main contribution.

Evaluation design

The main concern for the evaluation design and measurement process is the subjectivity of the analysis object: the user's opinion. By one hand, preferences are hard to capture based on objective metrics [4]. On the other hand, we need to ensure that the user chooses amongst different options with the same background information.

Considering the above, the evaluation was conducted by using a Web-based survey. The survey tool allows to (i) directly measure the user's opinion, avoiding inferences made from qualitative metrics and, (ii) ensure that the respondent evaluates the different suggestions with the same knowledge about the evaluation scenario, since multiple scenarios can be presented simultaneously. The procedure for the evaluation is listed below:

1. The surveyed is presented an online questionnaire asking for his/her profile information.
2. After completion of (1), the user is presented a fictional scenario and asked to read it. The fictional scenario includes country, language, place description, etc.
3. After reading (2), the user is shown simultaneously five LBSN.
4. Finally, the surveyed is asked to choose the lists he would have preferred to receive in the given situation (from step 2).

Implementation of the matching algorithm in the evaluation

The web-based survey presented above, implements the ranking function (Equation 1) to generate the five LBSN presented to the user (step 3).

This is done by computing the function in running time while the survey is being performed. Each list is created by running the matching algorithm and considering the top five ranked users.

Each list considers different values for homophily and complementarity. The values for alpha range from 100% (as any homophily-based algorithm) to 0%. Correspondingly, the values for beta range from 0% to 100%.

The required data for the process is obtained from the surveyed profile (input from step 1) and the tourists profile database gathered as explained in the next subsection.

These five recommendation lists are simultaneously displayed to the user in the same Web pagef. The disposition of these lists in the Web page is randomly assigned, this in order to avoid the questionnaire effect [4] and the effect of users randomly choosing options.

Evaluation settings

The evaluation considers presenting the surveyed possible users for the instantiation of a LBSN. In order to make our survey as realistic as possible, we consider real tourist profiles for the matching generation.

The data was gathered by an online survey and includes the profiles of 57 tourists (34 female and 23 male) between the ages of 19 and 50, from Africa (8), America (11), Asia (20) and Europe (18).

In accordance to the data description in the Proposed solution section, the profile information includes age, gender, nationality, spoken languages, formal studies, occupation and hobbies. Respondents were asked about their travel experience as well. They were presented 10 major touristic cities and asked if they have: i) been there as tourists and ii) what activities they performed.

The cities are[4]: Paris (28), London (23),Tokyo (18), New York (20), Dubai (10), Singapore (21), Kuala Lumpur (19), Hong Kong (19) and Seoul (51).

The activities considered are: attendance to museums or expositions, attendance to theatrical or musical performances, attendance to sport events, cultural/traditional sightseeings, eco tourism, other. Given that the option "other" was prefered in a 5% in average (min 3%, max 11%), the given response options made the respondents felt identified by the given alternatives.

Since the great majority of the respondants had visited Seoul, the location for conducting the evaluation is the GANA Art Gallery, located in Seoul, South Korea. Specifically near Gwanghwamun Gate in downtown Seoul, a district known for its afluence.

Threats to validity

The evaluation objective is to validate the importance of considering complementarity between users as a matching criteria. Therefore, some aspects of our approach and the effect of these in the user's preferences are not considered in the current evaluation.

The above mentioned threats are challenging issues for future work. Nevertheless, given the scope of this paper, keeping these unknown effects as constant for the entire sample allows us to evaluate the relative importance between homophily and complementarism.

Evaluation model

The model is tested by modifying the values of α and β in Equation (2) *ceteribus paribus*. By keeping the rest of the variables fixed, the effects of these on the user's opinion is not considered. For instance, giving more importance to spoken language rather than hobbies, may lead the user to choose differently, even for the same values of α and β.

Effects on the evaluation display

Presentation effects (such as images and colors) were not considered in the final evaluation visual interface. We aim to take this effects out of the evaluation by showing the information in the most plain and impartial possible fashion. Some of the effects not considered are modifying the visualization interface and the use of pictures for enriching the profiles. For example, if images are available as part of the profile, users may choose based on attractiveness of the user instead of the objective information.

RESULTS AND DISCUSSIONS

This section contains the results obtained from the performed evaluation, as well as a brief discussion on relevant observation. The survey was answered by 21 volunteers, none of these participated in any of the initial surveys included in this paper. The volunteers were considered as tourists according to the criterions defined in [2], this is, (i) they are not from Seoul, and (ii) they have never being in the GANA art gallery.

Results

Results are presented in terms of the values of α and β used for computing the recommendations. Since α and β add 1, as α decreases, homophily is less relevant for the recommendation and the more complementarism is considered. Table 4 presents the overall results obtained from the Web based evaluation.

Homophily and Complementary (α, β)	**Preferences**	%	**Cumulative** %
(0.0;1.0)	3	14.29	14.29
(0.25;0.75)	2	9.52	23.81
(0.5;0.5)	6	28.57	52.38
(0.75;0.25)	5	23.81	76.19
(1.0;0.0)	5	23.81	100
Total	21	100	—

Table 4. Results for abroad toursits vs local tourists

As shown in Table 5, only 23.81% of the preferences include solely homophily while, 76.19% of the users chose a recommendation considering some degree of complementarism. The larger portion of observations are located in the β range between 1.0 and 0.5 (76.19% of the sample)

Another important dimension of the sample is the comparison between overseas tourists and local tourists. We considered as local tourists those having some cultural background on the touristic scenario. Given our data, we consider as local tourists those with Korean nationality and/or declaring proficiency in Korean language. By this criteria, five out of the twenty one samples were considered as local tourists. The results are exposed in Table 5.

[4] In parentesis the number of contestants that have visited as tourists

Homophily and Complementary (α, β)	**Preferences**	**Local tourists**	**Overseas tourists**
(0.0;1.0)	3	0	3
(0.25;0.75)	2	1	1
(0.5;0.5)	6	0	6
(0.75;0.25)	5	1	4
(1.0;0.0)	5	3	2
Total	**21**	**5**	**16**

Table 5. Results for abroad toursits vs local tourists

Four out those five local tourists considered as more appropriate the suggestions highly influenced by homophily. Only one out of the five locals chose a LBSN with high values of complementarity.

Discussion

In general, the results confirm the importance of considering both, the place an the personal characteristics for LBSN in the touristic domain. This can be pointed out since over three quarters of the respondents chose recommendations combining complementary skills and homophily.

It is interesting to notice that our algorithm only considers complementary skills as they are needed. If the user have all the necessary skills to enjoy the location, the complementary user does not exist and the recommendations are only driven by homophily. In particular, this explains the different preferences between local and overseas tourists. Since overseas tourists need more skills (i.e. language), they chose suggestions combining homophily and complementary skills. On the other hand, locals preffered recommendations based solely on homophily since the influence of the complementary user is less important.

CONCLUSIONS AND FUTURE WORK

In this paper we addressed the idea and evaluate the importance of using complementary skills between users as a matching criteria for the generation of spontaneous LBSN in the tourism domain. We successfully verified our research hypothesis, concluding that the complementary skills of users should be considered, when possible, in order to recommend a LBSN.

An important observation is that our matching algorithm behaves as a homophily-based algorithm for locals, which indicates our algorithm is a generalized form for the algorithms based on similarities.

Even when our results are positive, they open new research questions, which constitute our future work. The effect of the variables of the ranking algorithm is still to be evaluated, as well as the extensibility of the model to other domains.

In this way, the calibration and importance of the variables considered in the ranking function (Equation 1) are important towards the provisioning of a personalized Location-Based Social Network.

ACKNOWLEDGMENTS

This research was supported by the KCC(Korea Communications Commission), Korea, under the RD program supervised by the KCA(Korea Communications Agency) (KCA-2012-11911-05005). The authors would also like to thank Angel Jimenez-Molina and Pablo Loyola for their comments on the draft, and Blandine Yochie for her collaboration in the project.

REFERENCES

1. Q. Li, Y. Zheng, X. Xie, Y. Chen, W. Liu, and W.-Y. Ma. Mining user similarity based on location history. In *Proceedings of the 16th ACM SIGSPATIAL international conference on Advances in geographic information systems*, GIS '08, pages 34:1–34:10, New York, NY, USA, Nov. 2008. ACM.

2. N. Leiper. The framework of tourism: Towards a definition of tourism, tourist, and the tourist industry. *Annals of Tourism Research*, 6(4):390 – 407, Oct.-Dec. 1979.

3. M. A. Ahmad, I. Ahmed, J. Srivastava, and M. S. Poole. Trust me, i'm an expert: Trust, homophily and expertise in mmos. In *SocialCom/PASSAT*, pages 882–887. IEEE, Oct. 2011.

4. C. M. Anderson-Cook. Experimental and quasi-experimental designs for generalized causal inference. *Journal of the American Statistical Association*, 100(470):708–708, 2005.

5. V. Arnaboldi, M. Conti, and F. Delmastro. Implementation of cameo: A context-aware middleware for opportunistic mobile social networks. *A World of Wireless, Mobile and Multimedia Networks, International Symposium on*, 0:1–3, June 2011.

6. H. Bisgin, N. Agarwal, and X. Xu. Investigating homophily in online social networks. In J. X. Huang, I. King, V. V. Raghavan, and S. Rueger, editors, *Web Intelligence*, pages 533–536. IEEE, Aug. 2010.

7. A. Garcia-Crespo, J. Chamizo, I. Rivera, M. Mencke, R. C. Palacios, and J. M. G. Berbis. Speta: Social pervasive e-tourism advisor. *Telematics and Informatics*, 26(3):306–315, Aug. 2009.

8. N. Kayastha, D. Niyato, P. Wang, and E. Hossain. Applications, architectures, and protocol design issues for mobile social networks: A survey. *Proceedings of the IEEE*, 99(12):2130 –2158, Dec. 2011.

9. G. Lugano. Mobile social software: definition, scope and applications. *Proceedings of the IEEE*, 99(12):2130 –2158, Dec. 2011.

10. M. McPherson, L. Smith-Lovin, and J. M. Cook. Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, 27(1):415–444, 2001.

11. E. Wickens. The sacred and the profane, a tourist typology. *Annals of Tourism Research*, 29(3):834 – 851, July 2002.

12. H. Rahnama, A. Madni, A. Sadeghian, C. Mawson, and B. Gajderowicz. Adaptive context for generic pattern matching in ad hoc social networks. In *Communications, Control and Signal Processing, 2008. ISCCSP 2008. 3rd International Symposium on*, pages 73 –78, March 2008.

13. Y. Zheng, L. Zhang, Z. Ma, X. Xie, and W.-Y. Ma. Recommending friends and locations based on individual location history. *ACM Trans. Web*, 5(1):5:1–5:44, Feb. 2011.

14. J. Thom-Santelli. Mobile social software: Facilitating serendipity or encouraging homogeneity? *IEEE Pervasive Computing*, 6:46–51, July-Sept. 2007.

15. M. Su and G. Wall. Implications of host-guest interactions for tourists' travel behaviour and experiences. *TOURISM - An International Interdisciplinary Journal*, 58(1), May 2010.

16. X. Xiao, Y. Zheng, Q. Luo, and X. Xie. Finding similar users using category-based location history. *GIS'10*, pages 442–445, Nov. 2010.

17. Y. Zheng, Y. Chen, X. Xie, and W.-Y. Ma. Geolife2.0: A location-based social networking service. In *Mobile Data Management: Systems, Services and Middleware, 2009. MDM '09. Tenth International Conference on*, pages 357 –358, May 2009.

18. H. Yoon, Y. Zheng, X. Xie, and W. Woo. Smart itinerary recommendation based on user-generated gps trajectories. In *Proceedings of the 7th international conference on Ubiquitous intelligence and computing*, UIC'10, pages 19–34, Berlin, Heidelberg, Oct. 2010. Springer-Verlag.

19. Y. Zheng. Location-based social networks: Users. In Y. Zheng and X. Zhou, editors, *Computing with Spatial Trajectories*, pages 243–276. Springer New York, July 2011. 10.1007/978-1-4614-1629-6_8.

20. M. Kenteris, D. Gavalas, and D. Economou. Evaluation of mobile tourist guides. In *The Open Knowledge Society. A Computer Science and Information Systems Manifesto*, volume 19 of *Comminications in Computer and Information Sciences*, pages 603–610. Springer Berlin Heidelberg, 2008. 10.1007/978-3-540-87783-7_77