A Case for Space: Physical and Virtual Location Requirements for Internet-based Social Networks

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ABSTRACT
This paper describes a Location Based Social Network (LBSN) built upon activities that combine virtual and physical location. While many modern social networks are based in the virtual world and strengthen pre-existing connections, the CouchSurfing social network is built upon creating new face-to-face connections between members across the world. The network has connected travelers to cost-free lodging for over 5 years with over 1 million current members. Now it provides a large user database where each user is tagged with a location. This is useful for spatial data mining and knowledge discovery as recommendations about locations are left in user reviews of one another. These are drawn upon to find interesting locations and discover new places, people and activities. Techniques from the field of time geography are used with LBSN information about individual member location to show how spatiotemporal constraints combine the virtual and physical worlds. Additionally, mobile devices afford flexible utility for the LBSN and applications are presented that take advantage of this.

Categories and Subject Descriptors
K.4.0 [**Computers and Society**]: Location Based Social Networks – *spatial data mining and knowledge discovery, opinion mining location related information*

General Terms
Management, Measurement, Design, Experimentation.

Keywords
location based social network couchsurfing time geography

1. INTRODUCTION
The Internet and social networks are bringing individuals around earth closer together in a virtual world. Their popularity has increased in the past few years with networks such as Facebook (http://www.facebook.com) and Twitter (http://www.twitter.com) allowing users to "interact" with each other after social links are made [1]. These user interactions (messages, comments) are often digital and involve no corporeal or physical presence. Hence interaction among individuals in social networks has quickly become more virtual than physical and explicit location or presence is required in less scenarios. Sale transactions, photographs, videos, books, and more are exchanged via the Internet without the need for face-to-face communication. These modern social networks are based in a virtual world where biographies and pictures need to be maintained with a computer. However, physical location and space do still matter and are key elements in today's LBSNs. The necessity of accounting for physical location in modern, internet-based social networks is addressed here. We utilize a web-based social network for travelers called CouchSurfing (CS, http://www.couchsurfing.org) as a case study. With this network we hypothesize which different spatial and temporal components are required for the functionality of such network. We also present a framework for capital dependent upon spatio-temporal aspects.

The CS network is a collection of people around the world who are willing to be guests and hosts in new environments. Members allow guests to stay for free at their home on a couch, in an extra bedroom, or on the floor. A guest first contacts a host via e-mail. The host resides in a desired location and a guest may also specify search criteria, such as age and gender, for potential hosts. There is additional information on each member's profile about the individual such as favorite activities, life philosophies, pictures, and references left by other members. Once guest and host meet in person they can share a variety of activities. After face-to-face meeting in a physical location the social network moves back to the virtual world as reviews are left for one another that will affect future usage of the service. Members often start using the network by either exclusively being a guest or hosting others but later engage in both as is necessary for the network to succeed [2]. While members initially interact through virtual messages, the core purpose of the network is an affordance of physical interaction, blending physical and virtual social networks.

In this LBSN physical location is key as some larger cities are more popular places to travel. This may be due to accessibility with airports, large train stations, cultural activities, or other pursuits that affect the amount of tourism at a destination. Travelers may also crave a more "authentic" trip and stay with hosts in remote locations that do not experience much tourism. This type of tour at no cost is another advantage available through this network that has grown to over one million worldwide members from over 200 countries in 2009.

The next section presents related work concerning modern social networks. The third section discusses the LBSN CouchSurfing, its available information, spatiotemporal data visualization, methods for mining and discovery, and mobile device

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applications. The final section presents conclusions and further research directions.

2. RELATED WORK

The continuous growth of online social networks has instigated many research projects by people around the world. Social networks allow a user to create an abstract version of an individual that is presentable to the world. Online identities vary in different degrees when compared to who the person is and depending on what they wish to portray or gain from an online presence. This and other social network research has led to special sections of journals [3] and conferences (IEEE Social Computing Conference). An amalgamation of skills in varying disciplines is helpful in studying social networks. This includes, but is not limited to: sociology, psychology, communication, computer science, geography, and mathematics. The scope of digital social networks is large and different disciplines are needed to contribute to social network studies concerning language and friendship [4], ethnicity [5], religion [6], and gender [7].

Traveling purely in cyberspace [8] is possible too. Hence a travel destination can be presented through the eyes of the programmer or virtual world creator. This provides an initial view of the environment in digital form. It is also an introductory look at the spatial layout and topology of a given place. Incorporating cultural value is difficult in the CS network, especially with travelers who have large amounts of social and cultural capital. While cultural value in the CS network may be a future research topic, Molz [9] presents work on mobile hospitality with CS as one of the examples and Pultar and Raubal [10] describe CS as progressive, transformative tourism. Additionally, Lauterbach et al. [2] as well as Bialski and Batorski [11] examine trust and reputation within the CS network.

3. THE COUCHSURFING LBSN

3.1 Volunteered Geographic Info and Capital

Through a LBSN travelers collect and share spatio-temporal information or volunteered geographic information (VGI) [12]. Specifically in CS, references are left for people, places, and activities that are publicly viewable by other network members. For example, after a stay a guest leaves a reference such as:

"I stayed with X for 5 days. I planned on staying 3 days but the collection of temples and parks in his city is incredible. The town had a relaxed atmosphere with plenty of activities (such as hiking and ziplining) to do during the day and X was able to take me out for great Asian food at night."

Here a positive reference is left for the host, increasing the host's network capital and encouraging others in the network to either host X or be hosted by X. Recommendations are also made for the location where this LBSN member lives. Last, there are suggestions of activities applicable in this space. Given the dynamic nature of data on the internet, this review may be written one month before another traveler considers a trip to this place. Therefore this service provides a more up-to-date source of location information versus a travel guide that went to press one or more years previous. In this way travelers seeking a primary goal of practicing a language, e.g. Spanish in Argentina, can rank possible destination cities within a country based on the new people, places, and activities possible.

Activities such as skiing, foreign language conversation, and swimming necessitate real-world experiences that spawn from digital social networks. Hence to grow one's network capital social communication skills are applicable in both virtual and physical settings. Transit capital is also needed to facilitate mobility between locations. In order to discover and experience new places a LBSN member has to be able to transport oneself. This can happen by any number of means such as cars, airplanes, and buses but without this critical physical component the LBSN is non-functional.

In this network the overall capital measure can be broken down to the following components:

- Network capital – references of people, places, activities
- Transit capital – mobility
- Social capital – social communication skills, existing connections on the LBSN

Combining these measures affords a member differing levels of abilities based on their adeptness and resources. Network capital is described here as the information made available to members of the LBSN regardless of their location. This includes locations and activities that are highly recommended by other members. This information is not widely available in other sources such as books and magazines therefore giving an advantage to members of the network. Transit capital is quantifiable in terms of available money (even if it is minimal to none in the case of a hitchhiker) whereas social capital is based on the number of social connections a person has and the strength of those connections. Communication skills can be taught and learned through experience and while they are needed for interaction they are more complicated to quantify than train costs or amount of positive references.

In the CouchSurfing LBSN there are three main components to gaining capital within the network.

- Initial search for CouchSurfers and e-mail communication [Virtual]
- Corporeal meeting, communication, lodging [Physical]
- After meeting a negative, neutral, or positive reference is left and a friendship link may be created [Virtual]

Location plays a role in all of these steps, but is most restrictive in the second step containing the face-to-face meeting. Search and initial communication can be performed at a network member's convenience from any device with access to the web. Similarly the final step can be completed at a user's home or on the road. A time-geographic approach is used here to iterate these constraints and visualize the variable locations.

3.2 Time Geography

Time geography was developed by Hägerstrand [13] to stress the importance of the individual in regional science. In a typical time geography perspective the xy-plane represents an individual's physical movement and the z-dimension represents time. Following an individual through time this creates a 3-dimensional space-time path that conforms to three constraints:

- Capability – Ability to move via different modes at varying speeds, e.g., plane vs. train
- Coupling – Individual's requirement to be at a specific location at a certain time, e.g. two individuals meeting for lunch at a café
- Authority – Beyond the control of the individual, e.g., opening and closing hours of a museum

In Figure 1 space-time paths are shown for an example CouchSurfer guest and host. In this scenario the guest begins in Moncada, Spain, and travels to Alboraya, Spain, on 13 July, 2009. The traveler spends a day exploring Alboraya before meeting their

CS host in Valencia. The host has stayed in the same location (for this geographic scale) doing work until the guest arrives. Once the guest arrives the two independent space-time paths merge as the two CS members eat meals and sleep in the house. The next day the host takes the guest on a tour around town and to the pier and back. After this the two individuals go their separate ways with the host going back to work and the traveler continuing to the north. Further contact is maintained in a virtual manner until the hospitality is reciprocated or a repeat stay happens.

Figure 1. Space-time paths of host (blue), guest (red), and both host and guest (green).

This time geography approach can quickly visualize the overall travel behavior (location and temporality) of the LBSN members described here. Additionally indicated here is the switching of the spatial relationship type (virtual to physical) between the two individuals by their space-time paths merging into the green path around Valencia. This example also demonstrates the utility of the framework's constraints for these types of scenarios. The capability constraints affect the velocity and route a traveler takes. The authority constraints determine when an individual is able to dine out or when movement by bus or train is possible. Coupling constraints requiring people to be at a specific location at the same time is key for the LBSN members to move from virtual to physical space and have a face-to-face meeting.

3.3 Mining and Discovery

Users of the CS network can search for a person that shares similar interests, e.g., juggling. Additionally, activities that a member considers interesting, such as paragliding, can be found by looking at other members' interests and by scraping text from references left for the user. Here is an example reference:

"X hosted me for 5 days and took me out hiking the second day. I also went out hiking my last two days since it was such an accessible activity. Enjoy your trip to China next month."

This suggests the availability of hiking near this host's residence, which may be a smaller town not known for this activity.

By restricting a search of the network by location (e.g., city and country) we can then use data mining to discover interesting activities. Similarly, we can restrict the search by activity and find locations where they are possible. Given an initial list of interesting activities (e.g., scuba, paragliding, climbing, swimming) the references left for network members in a specific location can be used to get an idea of how frequently people engage in the activity at this location. Initially a raw number of references mentioning an activity keyword can be gathered. If desired the number may later be normalized by how many members currently reside in a location to get some idea of the density of the activity in this place.

This is a unique form of spatial data mining and knowledge discovery as it utilizes social network accounts involving both locals and travelers to describe geo-tagged locations around the world. In the future scripts and small programs can be written to extract opinions and reviews of spatial information from social networks as described here. These tools can be used to discover knowledge and as a starting point employ similar methods to those used by geospatial agents for general websites [14].

3.4 LBSN and Mobile Devices With GPS

Mobile devices can be used more and more in the CouchSurfing process as the LBSN can be initially accessed using a web browser on a 3G mobile phone. User preferences for discovering new people, places, and activities can be combined with transportation mode choices to make recommendations [15]. Text messages and e-mails can be exchanged closer to the travel date and eventually voice calls. All of this is possible on one mobile device. Even further, mobile phone programs such as Latitude™ and Loopt™ provide real-time location information that can ease the process of synchronizing space and time between members of the LBSN. This can be especially helpful when a guest is in an unfamiliar environment. Using these services one can see each individual's location on a virtual, interactive map. These types of Location-Based Services (LBS) help in making the transition from virtual to physical presence that is necessary to gain capital in the LBSN described in this paper.

Another vision for the future of LBSNs such as CouchSurfing is to use mobile devices with location-based technology to report nearby network members that are interesting. At the basic level this includes friends and those with similar interests as is done with the programs mentioned above. However, suggestions can be made for friends of friends where two people in the same location can meet based on their pre-existing tie with a middle connection. This gives a common ground and trustworthiness factor as both members know and trust the first-degree friend that links them. With pre-existing social networks where members have built up their connections this can be an effective way to build their network capital. Given the basis that CouchSurfing connects travelers around the world this is a utile, global application. Generally, the members of this LBSN are highly mobile travelers making it quite likely to meet a second-degree

friend, or friend of a friend, in a passive manner through the common, shared friend.

The interface is similar to modern mapping applications on mobile devices where live location feeds of existing friend connections are broadcasted (Figure 2). In addition to existing friends new suggestions are given, based on link strength, of currently nearby individuals that share at least one common friend node. This provides an opportunity to meet face-to-face and establish a new, quality link.

Figure 2. Screenshot from a mobile device where green points are locations of suggested 2nd degree friends or friends of friends with information on the common friend link. The black point is the user's current location and red points are locations of 1st degree or directly connected friends.

4. CONCLUSIONS AND FUTURE WORK

This paper has presented a LBSN of which the functionality requires a blend of virtual and physical locations. Measures of capital and time geography have been discussed in regard to the international CouchSurfing social network for travelers. Further data mining and knowledge discovery techniques can be implemented as described in order to find interesting, new people, places, and activities. Also presented were additional methods for utilizing mobile devices with an LBSN that can lead to casual expansion of capital.

Traditional travel guides are static, whereas here the members of the LBSN can always utilize dynamic information. This information may be categorized according to different temporal scales, e.g., hosting the Olympic games or the World Cup changes a place dramatically for some time. Therefore temporal aspects are quite important when choosing a location or place for traveling and the use of CS makes for unique experiences. Future research is also needed to quantify the capital measure components, which can then be combined to determine the utility of particular CS connections.

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