Location-Based Social Network Capital

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1. Introduction

The use of social networks with both physical and virtual location requirements (e.g., real world and Internet sites) leads to changes in people's travel behavior. There is still little knowledge about the relationships connecting social and spatial interactions (Axhausen 2005, Winter and Robins 2007), yet Internet-based social networks are pervasive in the present day. "The Internet leads to new forms of social capital that cannot be easily captured with existing forms of measurement" (Quan-Haase and Wellman 2004, p. 124). In social networks based on physical and virtual components we do not have an objective measure of a member's social network capital. Measurement approaches have been suggested for Facebook (Ellison et. al 2007) and mental health (Congdon 2010) but for social networks with physical and virtual location requirements (Pultar and Raubal 2009) techniques for assessing social capital have not been explored. This research fills the gap by explicitly combining spatial behavior with social networks.

The CouchSurfing (CS, www.couchsurfing.org) network has 1.8+ million members that manage network capital by either hosting visiting other members from around the world. Each person in the digital social network maintains a profile with his or her current location and locations previously traveled, which can be browsed by other members. If an individual finds a suitable host they may contact the other member for a place to stay. This may be in the form of a couch, floor space, or an extra room. Upon completion of the trip members write references for each other that affect their social capital and ability to use the network in the future. This is the last step in the three-step process consisting of initial virtual contact via electronic correspondence through the network, physical face-to-face meeting between guest and host, and post-travel reference writing in a virtual environment.

Time geography (Hägerstrand 1970) has been used to represent paths of individual movements through physical space for various periods of time (Frändberg 2008). Although in this network both travel movements as well as stationary hosting activities are key components for an individual using the network. The stationary hosting activities can be interpreted as virtual travel instances where culture, language, and other information are exchanged similar to physical travel. Hence time geography principles will be used here to represent this combination of physical and virtual travel. However, a person is at one place at one time in the physical travel sense. Yet here we are suggesting a host can perform virtual travels by hosting someone from another place as they experience language, culture, food, and so on. Since a person can host

more than one person at a time, in a sense being at multiple locations at 1 time, this one-to-one relationship for physical travel is different for virtual travel.

A 3-D spatiotemporal visualization technique utilizing these concepts is implemented. This demonstrates a user's social network capital growth with respect to their participation level and travel movements. In addition, formulas are presented as a complementary quantitative approach for measuring social network capital combining virtual and physical spaces. This work specifically addresses the following research questions:

- o How is an individual's social network capital represented in a setting combining physical and virtual spaces?
- o How do geographical distances influence measures of social capital?
- o How can different roles of a member in a social network affect social capital gain?

2. Related Work

With increasing availability and coverage of Information and Communication Technologies (ICT), time geography and its integrations with ICT is an active topic among researchers. Raubal et al. (2004) use location-based services (LBS) and theories of affordances with time geography to focus on an individual's specific preferences. An overview of the interaction between human travel behavior and ICT is given by Kwan et al. (2007). Couclelis (2009) presents a new conceptual framework for time geography with a focus on ICT.

Putnam (1995) defines social capital "by analogy with notions of physical capital and human capital—tools and training that enhance individual productivity—'social capital' refers to features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit." (p. 67) Social capital can offer a different perspective to economic methods: "Current interest in the concept of social capital in the field of national development stems from the limitations of an exclusively economic approach toward the achievement of the basic developmental goals…" (Portes and Landolt 2000, p. 529).

The precise definition of social capital has been debated and that evolution has been well analyzed (Fulkerson and Thompson 2008, Schafft and Brown 2003). A theoretical framework has been developed (Coleman 1988) but some present social capital as a process (Putnam et al. 1993) and others as a resource (Bourdieu 1983, Loury 1977). From the *Journal of Economic Psychology* there is the evolutionary psychologist's view that "Social relationships that do not even indirectly or remotely contribute toward individuals' reproductive success do not count as social capital" (p. 877, Kanazawa and Savage 2009). The final, lasting definition of social capital may use ideas from multiple camps, but for now the term remains heavily disputed.

3. Capital Measures

As discussed in the related work section, social capital means different things to different people. Generally social capital has an effect on a person or group's abilities and a higher amount of social capital increases their productivity. With an egocentric approach the number of connections an individual has is an indicator of their social capital. In a modern digital social network such as LinkedIn or Facebook a raw count of "friends-links" is a measure of social capital. This is represented as:

$$C_t = N_l$$
(Equation 1)

where C_t is the total measure of an individual's social capital as defined by N_l, the number of links or connections an individual has.

We will use the CouchSurfing (CS) network described in Section 1 as a case study. CS is used since it has been in existence for over 5 years and has seen rapid growth in the last year. In addition there are distinct network roles that individuals perform in a dichotomous nature, e.g., being a guest vs. being a host. Additionally there is the breadth of international network members with individuals on each continent. This provides a geographically spread network with which to study the influence of location on social capital with the following methods.

For an individual in the CS social network, the total measure of social capital (C_t) is calculated according to the following equation:

$$C_t = \alpha C_g + \beta C_h \qquad \text{(Equation 2)}$$

where C_g is an individual's network capital measured by how many guests an individual has had and the proximity of each guest. The number of hosts an individual has had and the proximity of those hosts determine the value for C_h. The weights, α and β, are used to put more influence on having guests or having hosts. The sum $\alpha + \beta = 1$ and an equal weighting would signify both weights to be 0.5 whereas other values for α and β would stress the significance of one activity over another. The initial magnitudes for α and β are derived empirically from a survey of experienced network members. The components C_g and C_h are defined by the following equations:

$$C_g = N_g \sum_{i=0}^{i=N_g} D_g(i) \qquad \text{(Equation 3)}$$

where
$\quad$ N_g = Number of guests an individual has had for the given time interval
$\quad$ D_g = Distance function to compute distance of guest i from the individual

$$C_h = N_h \sum_{j=0}^{j=N_h} D_h(j) \qquad \text{(Equation 4)}$$

where
$\quad$ N_h = Number of hosts an individual has had for the given time interval
$\quad$ D_h = Distance function to compute distance of host j from the individual

The reasoning behind these equations is that distance has an influence on social capital. Raw distances in any units, international border crossings, or any combination of these and other human or physical geographical measures may define the distance function so long as it is applicable to the social network of interest. These formulas provide an objective measure of social capital explicitly taking into consideration an individual's role in the network and the distance between members. This allows for better matching of social network members and an objective measure of experience and trustworthiness based upon previous actions. Additional work including an experiment with expert users is currently underway and is further described in the next section.

Associated spatiotemporal geovisualizations are provided in Figures 1 and 2. These show explicitly the geographical distribution of an individual's connections. The individual's home location is shown as a black line, a hosting activity is shown as green, and a traveling activity is red.
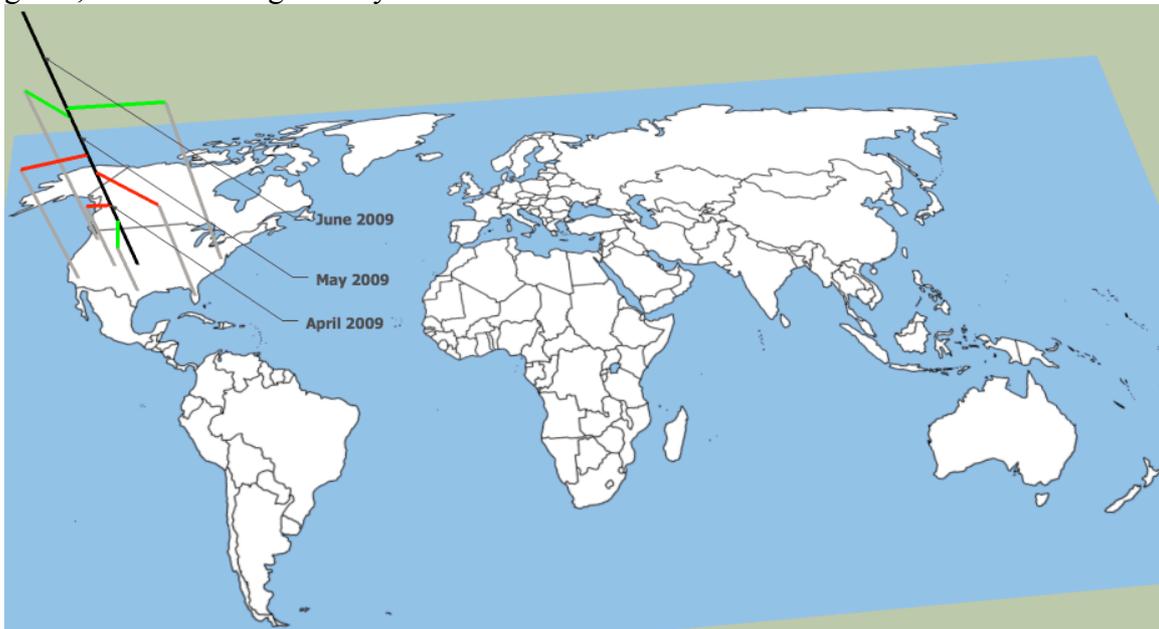

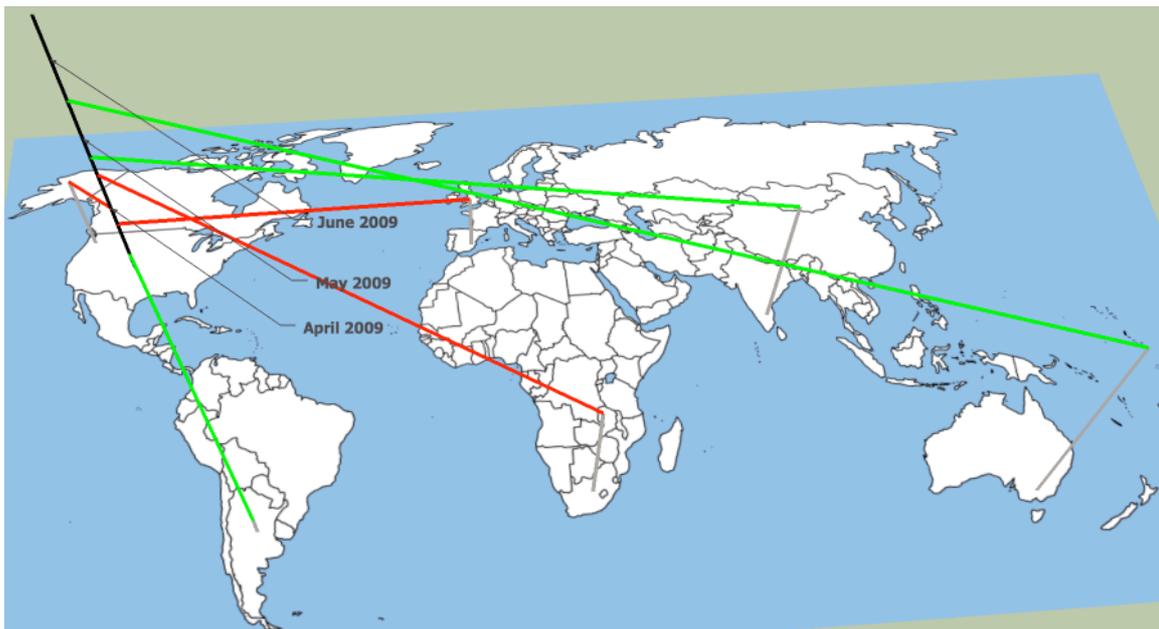**Figure 1.** Spatiotemporal geovisualization of CouchSurfer A's hosting and traveling.

Figure 2. Spatiotemporal geovisualization of CouchSurfer B's hosting and traveling.

4. Conclusions and Future Work

This abstract has presented an overview of computational and geovisualization frameworks for location-based social network capital. The importance of geography and space on social capital has been emphasized. Also, distinctions between different social network individual roles and their influences on social capital were highlighted. Additional work is currently underway surveying expert individuals as to the weights

different roles play in gaining social capital. The experiment has been designed and its results will answer questions pertaining to:

- o The utility of geovisualizations of location-based social network capital
- o How social capital is affected by the distance between network members
- o The effect of different network roles on social capital.

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