

The Interplay of Places and Human Social Networks

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Scientists have long studied the relationship between geography and social structure and for my PhD thesis I would like to address the interplay of places and human social networks. I am in particular interested in how places shape social interactions and how people shape places. I am, however, hardly the first one to ask those questions as researchers have long studied the relationship between space and the social realm and have found various connections between the two.

For example, Backstrom et al *1* have found that the probability of friendship with a person decreases with distance. Scellato et al. *6* have studied the properties of location-based social networks and found that about 40% of all links in location-based social networks are shorter than 100km. Others *5,7* used the social and spatial properties of location-based social networks to propose a link-prediction model. While Brown et al. *2* developed a model for the evolution of city-wide location-based social networks, it remains unclear whether the qualities of a place itself fosters tie formation, or the fact that friends tend to meet at specific—more “social”—places.

Furthermore, Backstrom et al. *1* utilize the relationship between various geographic features and friendship the location of an individual from a sparse set of known user locations using the relationship between geography and friendship. Wang et al. *8* discover that the more similar two individuals are in their mobility the closer they are in the social network. However, the interplay between the pattern of places one visits and network formation is not yet well understood.

Last but not least, De Domenico et al *4* have used the mobility data of friends to consequentially improve user movement prediction, while Cho et al. *3* have built a mobility model incorporating both periodic movement of individuals as well as travel due to the social network structure. The exact interplay of the social struc-

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ture and the human mobility patterns remains however unclear. In other words, are you becoming friends with somebody because you happen to visit the same places regularly, or do visit the same places because you are already friends?

Consequently, for my thesis I would like to explore and understand the interplay and feedback processes between geographic places and settings, and the social network. In particular, I would like to answer the following three questions:

1. What role do places play for network formation and interaction? In particular, does it matter that we met at a certain venue, or is the important factor that we met and the type of place does not matter?
2. How does the pattern of places one visits and the social network co-evolve over time, or in other words what is the influence of behavior on the network structure and, vice versa, what is the effect of the network on behavior?
3. If places play an important role for network formation and if place behavior and networks indeed co-evolve, can we apply this knowledge then in turn to improve our mobility models as well as our models for the evolution of the social network?

In expanding on earlier work *5,7,10*, I already addressed the role places play for tie formation in a social network. In particular, I propose a novel, global link-prediction algorithm that predicts whether two nodes will interact in a given time window based on the type of place and the setting the nodes have met before.

While preliminary results point towards a rather small role that place plays for predicting future interactions, the role of place appears to be still significant. This fits in well with the observed periodicity of human behavior *9*. If most of your interactions are routine, context information about where, when, and with whom those meetings have occurred will not improve or alter your prediction about whom you will meet next for your routine interactions, but helps in predicting your more irregular interactions.

In order to answer the question of the interdependence of human mobility behavior and the evolution of the social network, I am planning to develop a mobility model that allows me to predict the places a person will most likely visit next. The idea is then to use this model in conjunction with my link-prediction algorithm. By using the output of one model as the input to the other model, we can measure the interdependence of the two models and thus effectively gauge the interdependence between human mobility and human social networks.

Last but not least I am optimistic that with a better understanding of the co-evolution of human mobility behavior and the human social network, we can improve our mobility predictions as well as link-predictions in the social realm. A predicted outcome that is of relevance for urban planning, location-based advertisements, context-aware computing, modeling of infectious diseases, and mobile networks.

References

1. Backstrom L, Sun E, and Marlow C (2010). Find me if you can: improving geographical prediction with social and spatial proximity. Proceedings of the 19th international conference on World wide web, 61-70
2. Brown C, Noulas A, Mascolo C, and Blondel V (2013). A Place-Focused Model for Social Networks in Cities. 2013 International Conference on Social Computing, 75-80
3. Cho E, Myers S A, and Leskovec J (2011) Friendship and mobility: user movement in location-based social networks. Proceedings of the 17th ACM SIGKDD, 2011.
4. De Domenico M, Lima A, and Musolesi M. (2013) Interdependence and predictability of human mobility and social interactions. Pervasive and Mobile Computing, 9(6):798-807
5. Noulas A, Shaw B, Lambiotte R, and Mascolo C. (2015) Topological Properties and Temporal Dynamics of Place Networks in Urban Environments
6. Scellato S, Noulas A, Lambiotte R, and Mascolo C (2011) Socio-spatial properties of online location-based social networks. Proceedings of ICWSM, 11:329-336
7. Scellato S, Noulas A, and Mascolo C.(2011) Exploiting Place Features in Link Prediction on Location-based Social Networks Categories and Subject Descriptors. Kdd, (Section 3):1046-1054
8. Wang D and Song C (2015) Impact of Human Mobility on Social Networks 17(2):100-109
9. Williams M J (2013) Periodic patterns in human mobility. PhD thesis, Cardiff University.
10. Yang Y, Chawla N V, Basu P, Prabhala B, and La Porta T (2013) Link prediction in human mobility networks. 1(c):380-387