Analysis of Three Dimensions of Human Relations: Mobility, Social and Communication Interactions

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Motivation

Opportunistic Networks [1, 2] use human mobility and consequent wireless contacts between mobile devices to disseminate data in a peer-to-peer manner (via Bluetooth or WiFi Ad Hoc). Such networks can keep information flowing in case of lack or outage of mobile communication infrastructure (3G, WiFi). E.g. in the event of

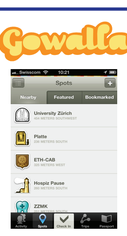
- natural disasters (floods, earthquakes, etc.)
- political censorship (Egypt, Libya)
- or in rural regions.

Designing appropriate networking algorithms and protocols (e.g., routing) for Opportunistic Networks is challenging as it requires understanding patterns of

1. mobility (who meets whom ☞ forwarding opportunities)
2. social relations (who knows whom ☞ trust, altruism to forward data)
3. communication (who communicates with whom ☞ need to forward data).

So far, research is limited to considering these dimensions separately (or two of them at most) [3,4] and uses datasets with small numbers of nodes. We use publicly available information from the geo-social network Gowalla (for meeting data) and the social network Twitter (for social and communication ties) to analyze the three types of relations on the same set of nodes. Here, we present a study of how a tie between a pair of nodes affects probabilities of having links in the other dimensions between the same pair.

Datasets



Contact event:
Two users checking in to the same spot within 1h.
Data:
~16'000 events between ~3'600 node pairs.

+

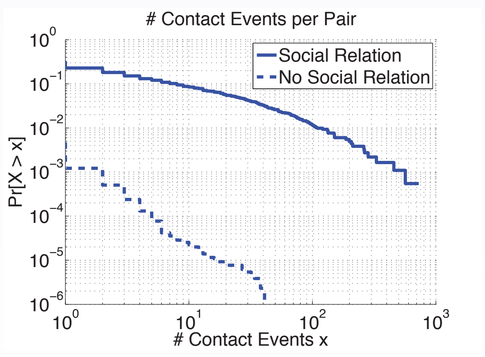
Three dimensions of human relations on the same set of 1140 power users, checking in and tweeting at least 5 out of 7 days (on average), during the 6 months of April - September 2010.

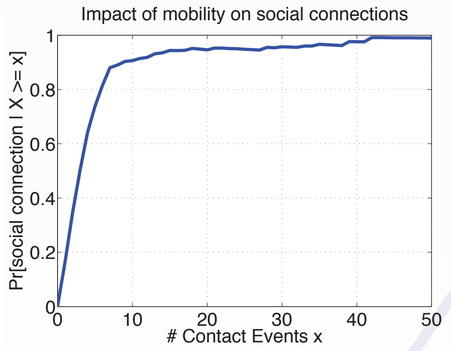
Communication event:
Reply, retweet or @ mention.
Data:
~15'000 events between ~2'000 node pairs.

Social relations:
Two users following each other (bi-directional).
Data:
~3'600 connected pairs.

Mobility vs. Social

Question: How does a social relation impact the probability of meeting and vice versa?





Observations:
- ☞ 23% of all pairs with social connection have at least one contact.
- ☞ Pairs with social connection are more than 100x more likely to meet.
- ☞ 90% of pairs with 7 or more contacts have a social connection

Conclusion for Opportunistic Networking:
Social connections are good predictors for meetings and can be useful information to base routing decisions on.

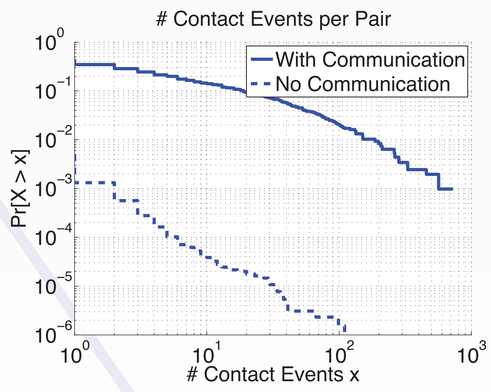
Mobility

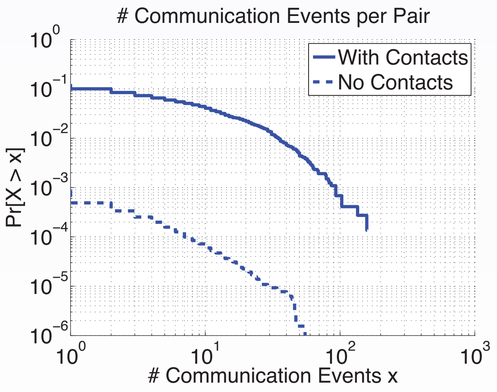
Social

Communi-cation

Mobility vs. Communication

Question: How do contacts affect the probability of communicating and vice versa?



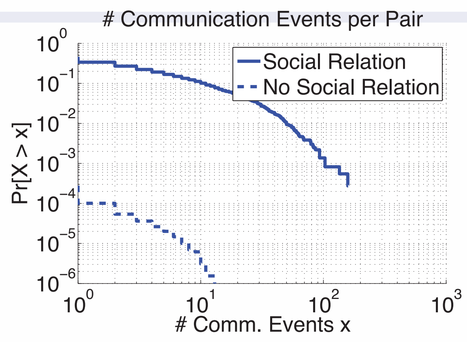


Observations:
- ☞ Having a communication tie multiplies the probability of meeting by more than 100.
- ☞ Similarly, having a mobility tie increases the probability of communication by more than two orders of magnitude.

Conclusion for Opportunistic Networking:
Communication largely happens between people who meet also face-to-face. For such "local" communication Opportunistic Networks are a viable solution which could manifest short message delivery delays.

Social vs. Communication

Question: How does a social relation affect the probability of communicating?



Observations:
- ☞ 33% of all pairs with social connection communicate at least once.
- ☞ Pairs with social connection are more than 1000x more likely to communicate.

Conclusion for Opportunistic Networking:
"Fast" opportunistic routes must be established between socially connected pairs.

Conclusion

All three analyzed dimensions of human relations are strongly related to each other. While this is not surprising as such, the strength of these associations is astonishing: having a tie in one dimension typically increases the probability of having ties in the other dimensions by factors of 100 to 1000. These results have implications on the design of algorithms and protocols for Opportunistic Networks.

In the future, we plan to analyze the structure of the three networks and relate them to each other: Are the communities structures in all three networks comparable? Are the central nodes the same accross dimensions?

Acknowledgement

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References

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