Group Mobility: Detection, Tracking and Characterization

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Mobile Groups

- Groups of entities (e.g., people) who get together, in space and time, for some social reason or common goal.
Groups vs. Social Communities

- Mobile Groups are different from Social Communities.
- Why studying group mobility?
  - Mobility modeling;
  - Alternative measure for social context;
  - More on applications later...
Group Detection

- **Definition of social group:** A group is a community detected from the contact graph of a contact trace time slice, of duration $tw$, after eliminating edges with less contacts than the threshold $wth$.

- **MIT Reality Mining:**
  - $tw = 1$ hour;
  - $wth = 2$ contacts;
  - Community detection: Clique Percolation Method (CPM)
Groups Regularity

6AM

7AM

8AM

9AM

10AM
Groups Tracking

- We want to understand mobile groups’ properties and their dynamics over time.
- Therefore, we must define a criterion to consider that two groups which appeared at different times are in fact the same group.
- $\rho(G_1, G_2) > 0.5$

$$\rho(G_1, G_2) = \frac{|V(G_1) \cap V(G_2)|}{|V(G_1) \cup V(G_2)|}$$
Characterization of Group Dynamics

1. Groups’ sizes throughout day hours;

2. Groups’ evolution considering possibilities of growth, contraction, birth and death;

3. Groups’ meetings inter-contact times and periodicity;

4. Groups’ meetings durations and its correlation with group stability and with group’s social bonds strength.
Groups sizes

Group sizes throughout the hours of the day
Dynamics of group evolution throughout day periods
Dynamics of group evolution throughout day periods

\[ GSCF(G) = \frac{\sum w_{in}(G)}{\sum w_{in}(G) + \sum w_{out}(G)} \]
Group Periodicity
A Case of Study Application

- Opportunistic forwarding:
  - Opportunistic networks rely on the intermittently connected communication structure to deliver data.
  - The opportunity to forward a given packet is given by a contact.
A Case of Study Application

- Why should we use group meetings?
  - Due to the periodical behavior of such meetings.
  - We expect that a group that has met in the recent past has a higher probability of meeting again soon.
  - A group meeting is an opportunity to disseminate the data to the members of such group.
Experiment

1. For each possible origin node we divide the set of nodes in the trace in two groups:
   a. Nodes that have been in groups with the origin through the past month;
   b. Nodes that have not been in groups with the origin through the past month;
2. Emulate an epidemic (a.k.a flooding) message transmission.
3. Compute the percentage of the nodes in each of the two classes receive the message within one week.
Results

Nov. 2008

Dec. 2008

Jan. 2008

Feb. 2008
Results

Mar. 2009

Apr. 2009

May 2009

Jun. 2009
Results
Conclusion

- In this work we go over a sequence of methodological steps to detect and track social groups in mobility traces.

- We perform a characterization of groups’ dynamics considering:
  - Size;
  - structure change rates of growth, contraction, birth and death;
  - group meetings’ periodicity;
  - group meeting durations and its correlation with the strength of group’s bonds and group’s composition stability.

- We discuss and explore the applicability of Group Mobility to Opportunistic Networks
Future Work

- As future work, we plan to use unraveled characteristics to design social-groups-aware opportunistic routing and information diffusion protocols that improve delivery ratio and time, decreasing message duplication and network overhead. We also plan to apply the proposed methodology to other proximity traces.

- "Leveraging D2D Multi-Hop Communication Through Social Group Meetings Awareness".

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  www.dcc.ufmg.br/~ivanolive/pub.html
Thank you!

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