

### Cambridge Network of Networks

**Cecilia Mascolo** Computer Laboratory



### Interests

Human Mobility:

- Instrumentation for data collection
- Mobility modelling
- Data analysis
- Exploitation of knowledge in systems





## Tagging Animals EPSRC WILDSENSING







**Evolution and Sustainability of a Wildlife Monitoring Sensor Network.** Vladimir Dyo, Stephen A. Ellwood, David W. Macdonald, Andrew Markham, Cecilia Mascolo, Bence Pasztor, Salvatore Scellato, Niki Trigoni, Ricklef Wohlers, Kharsim Yousef..In Proceedings of the 8th ACM Conference on Embedded Networked Sensor Systems (Sensys 2010). Zurich, Switzerland. November 2010.



### Understanding Animal Movement











### **Tagging Humans**



Proximity Sensor Ambient Light Sensor Camera Microphone GPS Accelerometer Magnetometer

In addition to various radios:

Wifi Bluetooth Cellular





## EmotionSense EPSRC UBHAVE



Collaboration with social psychologists to understand the daily interactions and movements of people under study.

### guardian.co.uk

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### PDA THEDIGITALCONTENTBLOG

EmotionSense: How your mobile can

interpret your mood

Cecilia Mascolo thinks of mobile phones rather differently to most of us. To her the mobile, as the most definitive, ubiquitous personal device that we carry, can give unique insights into our state of mind.

### The Telegraph

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Cambridge scientists prove 'home is happiest' with help from mobile phones

The home might be associated with doing the chores or undertaking menial tasks to many but British scientists appear to have finally proved the old saying the "home is where the heart is".





Blog home

EmotionSense: A Mobile Phones based Adaptive Platform for Experimental Social Psychology Research. Kiran K. Rachuri, Mirco Musolesi, Cecilia Mascolo, Peter J. Rentfrow, Chris Longworth, Andrius Aucinas. In Proceedings of the 12th ACM International Conference on Ubiquitous Computing (Ubicomp 2010). Copenhagen, Denmark. September 2010.



### Data Analysis

The data harvested through these instrumentations is **very fine grained** in **time** and often also in **space**.

The existing analysis techniques developed in complex and social network theory are often **inadequate**.



## Time-varying Social Networks EPSRC MOLTEN





Static Shortest path (A,G) = [A,B,D,E,G] Shortest path length (A,G) = 4 hops Temporal Shortest path (A,G) = [A,C,B,D,E,F,G] Shortest path length (A,G) = 6 hops Time=3 windows







### Temporal Measures

Static measures **overestimate** the ability of the network to allow communication.

We devised new metrics such as temporal clustering coefficient, temporal centrality, temporal components, (now working on temporal communities).

Applications: Information flow, Malware patching.



**Small-world behavior in time-varying graphs**. John Tang, Salvatore Scellato, Mirco Musolesi, Cecilia Mascolo and Vito Latora. In Physical Review E. Vol. 81 (5), 055101, American Physical Society. May 2010.

# Spatio-temporal Analysis (partly) sponsored by Yahoo!



How do we improve existing social network measures to include knowledge of space?

We are studying data from geographical online social networks





**Distance Matters: Geo-social Metrics for Online Social Networks**. Salvatore Scellato, Cecilia Mascolo, Mirco Musolesi, Vito Latora. In Proceedings of the 3rd Workshop on Online Social Networks (WOSN2010). Co-located with USENIX2010. Boston, MA. June 2010.



### Geo-social Measures

How close are the neighbours of a given node to the node itself?

Node locality  
$$NL_{i} = \frac{1}{k_{i}} \sum_{j \in \Gamma_{i}} e^{-l_{ij}/\beta}$$

How spatially inter-connected are the neighbours of a given node?







### Applications

Applications of these metrics are many

**Improving systems**: study on how information flows in social network and predict local vs global cascades to improve content caching.

**Improving link prediction**: who will be friend with whom? How will a geographic network grow? Places have a vital role in the prediction.

**Recommender systems** 



Track Globally, Deliver Locally: Improving Content Delivery Networks by Tracking Geographic Social Cascades. Salvatore Scellato, Cecilia Mascolo, Mirco Musolesi, Jon Crowcroft. In Proceedings of 20th International World Wide Web Conference (WWW 2011). Hyderabad, India. March 2011.

**Exploiting Place Features in Link Prediction on Location-based Social Networks**. Salvatore Scellato, Anastasios Noulas, Cecilia Mascolo. In Proceedings of 17th ACM International Conference on Knowledge Discovery and Data Mining (KDD 2011). San Diego, USA. August 2011.



### Use of Spaces

Analysis of Human Mobility through Geo-social Networks











## Thanks! Questions?

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News

Joined the Editorial Board of IEEE Pervasive Computing

Paper SociableSense: Exploring the Trade-offs of Adaptive Sampling and Computation Offloading for Social Sensing accepted at Mobicom 2011

Cecilia Mascolo

http://www.cl.cam.ac.uk/users/cm542/

