Social Sensing for Epidemiological Behavior Change

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Paper Overview

2010

Social Sensing for Epidemiological Behavior Change

Social Sensing: Obesity, Unhealthy Eating and Exercise in Face-to-Face Networks

2011

Using Social Sensing to Understand the Links Between Sleep, Mood, and Sociability
Goal

• Understand connection between behavior patterns and physical and mental health syndroms
  – Possibility for better epidemiological models
  – Basis for early-warning systems

• Use mobile phone sensors to gather data

• Detection and classification of health status without need to „see“ the person
SIR Model

- Transition from Susceptible to Infectious to Recovered
- Expressed by a set of differential equations
- Uses constant number of contacts to other people
Method

• Study with **70 residents** of an undergraduate hall
  – Collected data for **2 months**

• **Social interaction data from mobile phones**
  – Call data records
  – SMS logs
  – Bluetooth co-location sensing
  – WLAN-based location sensing

• **Use of a daily survey for symptom data**
  – Questions designed by an epidemiologist
  – Smartphone unusable if survey not answered after 3 reminders
  – 63% completion rate
Privacy

• Problem of Privacy when collecting a dataset like this
  – Approval by the Institutional Review Board (IRB)
  – Sensing scripts captures only hashed identifiers
  – Collected data is secured and anonymized before use
Results: Behavior Change

Effects of Fever:

(a) Late night calls and SMS decrease **
(b) Late morning Bluetooth counts and entropy decrease *
(c) WLAN based entropy with respect to university WLAN APs decreases ***
(d) WLAN Entropy with respect to external WLAN APs decreases ***
Results: Sympton Classification

• Use of K-nearest-neighbor clustering to infer 4 classes of symptoms
  – stress + depression
  – runny nose + sore throat
  – fever + influenza
  – runny nose + sore throat + fever + influenza

• Classification using a Bayesian-network classifier with MetaCost

• Overall prediction accuracy of 60-80%
Results: Forecasting

Highest ranked PSI (Phase Slope Index) relationships:
Ratings/Reviews

• 10 Reviews with average of 1.7
• Limitations of Paper:
  – Assumption that the samples are independent
  – Does not consider behavior changes due to external events
  – Do people still answer the survey when ill or stressed?
Additional Paper 1

Social Sensing: Obesity, Unhealthy Eating and Exercise in Face-to-Face Networks (2010)

• Goal:
  – Understanding the connection between social interactions and behavior considering eating and exercise

• Method:
  – Same dataset used as for main paper
  – Regular surveys about weight, eating habits and exercise
• **Results:**
  – Most significant correlation of BMI increase and exposure to people with substantial weight gain
  – Exposure to overweight/obese people has influence on BMI
  – Exposure to unhealthy eating habits influences eating habits
  – No correlation with exposure to people with weight loss and healthy diet

• **Limitations:**
  – Does not consider other factors like stress, illness, etc.
  – No interpretation of why these results occur
Using Social Sensing to Understand the Links Between Sleep, Mood, and Sociability (2011)

• **Goals:**
  – Learn more about the associations between sleep, mood and sociability
  – Improve public awareness of connections
  – Set a starting point for behavioral interventions that can improve public health through better social interaction

• **Method:**
  – Study in young-family residential living community
  – Duration of 1 month, 54 participants
  – Social and behavioral software sensing platform „Funf“ used
  – Regular surveys
Additional Paper 2 cont.

- Results:

![Graph 1: Sleep duration for good and poor mood](image1)

![Graph 2: Sleep duration and previous day's sociability](image2)
Additional Paper 2 cont.

• Results:
Contribution

• Use of off-the-shelf phones for social sensing

• Convincing results on connections in different fields:
  – Epidemiology and behavior changes
  – Sleep, Mood and Sociability
  – Obesity, Unhealthy eating, Exercise and face-to-face networks

• Starting point for new epidemiological models considering changes in behavior

• Showing the possibility on inexpensive personal health monitoring
Future Work

• Applications to predict illness based on gathered data
• Give people advice for healthier lifestyle
• Use of findings for a new epidemiologic model
• Application for automatic information of doctors, etc.
  — Privacy issues?
Discussion

• Does one model for epidemiological behavior change hold for all different cultures?

• What future applications could you imagine using the proposed solutions?

• What privacy implications does it have if such applications are widely used?

• What’s the impact of communication channels not covered by the study such as WhatsApp, Skype, etc.?