Using smartphones for crowdsourcing research

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Some background

• Is the crowd’s wisdom biased?
  – Analysis of Amazon, IMDB, BookCrossing
  – (SocialCom, 2009)

• Human-algorithm hybrid analysis (of Twitter)
  – CrisisTracker
  – Attacked (?) by Libyan government
  – Using to track the Syrian civil war
  – Adopted by IBM
  – (ICWSM, ECSCW, IBM)

• Situated crowdsourcing
  – Using public displays, tablets, mobile phones
  – (UbiComp, CSCW, CHI, UIST)

• Crowdsourcing decisions & policy
  – Arbitrary questions: racism, back pain, policy
  – (UbiComp, B-HCI, ACM TIT, Policy & Internet)
Reading list

• The big hole in HCI research

• Pitfalls to avoid when using Machine Learning in HCI studies

• Effects of intrinsic vs. extrinsic motivation on crowdsourcing

• CrisisTracker: crowds & algorithms for curating Twitter

• Crowdsourcing on public displays

• Crowdsourcing on public kiosks/tablets

• AWARE: Crowdsensing for smartphones

• Motivating people to contribute their data

• A cognitive test for assigning workers to tasks
Brief history of computing

1960’s

1980’s

2000’s
3 “Waves” of computing
Understand people -> build better technology

Study technology -> better understand people
Modus operandi

1. Smartphone/Facebook data
2. Behaviour, attitudes, questionnaires, etc.
3. Calculate metrics
4. Establish correlations
5. Describe behaviour

Calculate metrics
Sources
Social Media
Smartphone use
Smart city
Interaction

Methods
Smartphone instrumentation
Crowdsourcing
In-the-wild methods

Insights
Happiness
Personality
Habits
Exposure
Smartphones for science
Scientific instruments
Non-invasive sensing
Sensor growth in smartphones

- **Galaxy S1**
  - Ambient Light
  - Accelerometer
  - Magnetometer

- **Galaxy S2**
  - Gyroscope
  - Proximity

- **Galaxy S3**
  - Pressure
  - RGB
  - Gyroscope
  - Proximity
  - Ambient Light
  - Accelerometer
  - Magnetometer

- **Galaxy S4**
  - Temperature
  - Humidity
  - Hall Effect
  - Pressure
  - RGB
  - Gyroscope
  - Proximity
  - Ambient Light
  - Accelerometer
  - Magnetometer

- **Galaxy S5**
  - Heart Rate
  - Fingerprint
  - Temperature
  - Humidity
  - Hall Effect
  - Pressure
  - RGB
  - Gyroscope
  - Proximity
  - Ambient Light
  - Accelerometer
  - Magnetometer

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Over the next 10 years

1 200

590 000 000

3 500 000 000

18 000 000 000
40 x
What to analyse?

How to analyse?

Start from scratch
Hardware
Software
Human

“LEGO” - context

Accelerometer

Calendar

Questions

Step-counter

Calorie counter

Diet

Well-being
Individuals: Record your own data

No programming skills are required. The mobile application allows you to enable or disable sensors and plugins. The data is saved locally on your mobile phone. Privacy is enforced by design, so AWARE does not log personal information, such as phone numbers or contacts information. You can additionally install plugins that will further enhance the capabilities of your device, straight from the client.

Scientists: Run studies

Running a mobile related study has never been easier. Install AWARE on the participants phone, select the data you want to collect and that is it. If you use the AWARE dashboard, you can request your participants’ data, check their participation and remotely trigger mobile ESM (Experience Sampling Method) questionnaires, anytime and anywhere from the convenience of your Internet browser. The framework does not record the data you need? Check our tutorials to learn how to create your own plugins, or just contact us to help you with your study! Our research group is always willing to collaborate.

Developers: Make your apps smarter

Nothing is more stressful than to interrupt a mobile phone user at the most unfortunate moments. AWARE provides application developers with user’s context using AWARE’s API. AWARE is available as an Android library. User’s current context is shared at the operating system level, thus empowering richer context-aware applications for the end-users.
Demo (online)
Earthquake_japan

Status: Closed [ ] Open

Join study: https://api.lawareframework.com/index.php/webservice/index63/dlRYUr4
Show QRcode

Description: Earthquake sensing using smartphone accelerometer.

Sensors:

- Accelerometer
  - Status accelerometer: [ ]
  - True or false to activate or deactivate accelerometer sensor.
  - Frequency accelerometer: [200000]

- Ambient Noise
- Android Wear
- Applications
- Barometer
  - Status barometer: [ ]
  - True or false to activate or deactivate sensor.
  - Frequency barometer: [20000]

- Battery
- Bluetooth
- Communication
- Device Usage
- ESM
  - Status esm: [ ]
  - True or false to activate or deactivate ESM sensor.
- Google Activity Recognition
- Gravity
- Gyroscope
- Installations
- Light
- Linear Accelerometer
- Locations
- Lux Meter
- Magnetometer
- MQTT
- Network
- NTPtime
- OpenWeather
- Processor
- Proximity
- Rotation
- Screen
  - Status screen: [ ]
  - True or false to activate or deactivate sensor.
**Owner:** Kostakos, Vassilis

**Co-researchers:** Ferreira, Denzil ☒ Gonçalves, Jorge ☒ Pandab, Pratyush ☒  

**Database name:** Kostakos_63

**Created:** 23 May 2014

**API key:** dRWYUlt4

**Visualization:**

### November 2014

<table>
<thead>
<tr>
<th>Su</th>
<th>Mo</th>
<th>Tu</th>
<th>We</th>
<th>Th</th>
<th>Fr</th>
<th>Sa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Type</th>
<th>Total records</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>accelerometer</td>
<td><strong>171653610</strong></td>
</tr>
<tr>
<td>12</td>
<td>magnetometer</td>
<td>169680505</td>
</tr>
<tr>
<td>22</td>
<td>esms</td>
<td>111</td>
</tr>
<tr>
<td>29</td>
<td>battery</td>
<td>1</td>
</tr>
</tbody>
</table>

**Devices:**

Displaying 1-8 of total 8 devices. Total of 0 devices selected.

<table>
<thead>
<tr>
<th>Device ID</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>00b9246d-8ce0-4c9e-b92b-547244b17446</td>
<td>kolabtab13-v2</td>
</tr>
<tr>
<td>2601c4be-8934-4bf6-9668-bc289996d87d</td>
<td>kolobtab13</td>
</tr>
<tr>
<td>5e70f7b-23bd-4d2b-80fb-60dc84bd77ef</td>
<td></td>
</tr>
<tr>
<td>6a0a257b-8af6-4a53-b58d-8613310b8483</td>
<td></td>
</tr>
<tr>
<td>6c2210d3-601b-4623-b9d4-0e2378eb3690</td>
<td>kolobtab14</td>
</tr>
<tr>
<td>ab17f1b5-c65a-4016-872d-3957475ac3b6</td>
<td>kolobtab14-v2</td>
</tr>
<tr>
<td>b95da1f5-7038-4e6f-948e-27a7b5da862d</td>
<td>Denzil phone</td>
</tr>
<tr>
<td>bf3940fb-2767-4ac7-9ae1-9f1fd116eda2</td>
<td>kolobtab14-v3</td>
</tr>
</tbody>
</table>

Displaying 1-8 of total 8 devices. Total of 0 devices selected.
Send to device(s):

<table>
<thead>
<tr>
<th>Message type</th>
<th>Free text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>ESM Freetext</td>
</tr>
<tr>
<td>Instructions:</td>
<td>The user can answer an open ended question</td>
</tr>
<tr>
<td>Time to answer:</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>

**ESM Queue**

<table>
<thead>
<tr>
<th>Type</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your ESM queue is empty.</td>
<td></td>
</tr>
</tbody>
</table>

**MQTT history**

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 June 2014</td>
<td>esm</td>
<td>How are you?</td>
</tr>
<tr>
<td>18 June 2014</td>
<td>esm</td>
<td>Hello Tokyo</td>
</tr>
<tr>
<td>11 June 2014</td>
<td>esm</td>
<td>Testing</td>
</tr>
<tr>
<td>26 May 2014</td>
<td>broadcast</td>
<td>ACTION_AWARE_SYNC_DATA</td>
</tr>
<tr>
<td>26 May 2014</td>
<td>broadcast</td>
<td>ACTION_AWARE_SYNC_DATA</td>
</tr>
</tbody>
</table>

[Add to queue][Send ESM(s)]
Create a new chart.
Scientific instrument

Experience Sampling Method
Passive sensor collection

Behavioural studies
(Personality prediction)

Medical studies
(Parkinson’s / Cancer / Pain)

Environmental exposure studies
(Urban mobility)

Transport engineering
(Crowd simulation, queue modelling)

Economics
(Power consumption modelling)
Role of UbiComp/HCI Scientists?

• We need scientists who can build market-ready technology
  • Our software is deployed into the hands of patients/users/consumers

• Who have experience with human-subjects studies
  • Our software is used on a daily basis, in-situ

• Who can “speak” the language of other disciplines
  • Large multidisciplinary teams

• Who can understand the nuances of interaction
  • Separate “noise” from “valuable” data
Phenomena

Measurement

Sample data

Analysis/Statistics
Measurement instrument

- Bias
- Reliability
- Transparency
- Repeatability
- Privacy
- Battery life
- Convenience
Repeatability: automated testing

Calculate metrics
Reliability: ESM/EMA accuracy

[Diagram showing people and a smartphone with graphs]
Reliability: situational impairments
Privacy: on-board inference

Calculate metrics
Sensor growth in smartphones

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Convenience: gamification

Calculate metrics

Citizen Science
Convenience: crowdsourcing

Calculate metrics
Convenience: crowdsourcing

Calculate metrics
The end!

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