Ubiquitous Inference of Mobility State of Human Custodian in People-Centric Context Sensing

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QoL
Motivation

• Some people-centric sensing challenges
  • capture of person’s mobility
  • understanding of context changes
  • preservation of user privacy
Goal

• Infer **mobile-fixed context** of the **human custodian**

• accurately and efficiently (battery)

• enable *dynamic* changes of the sensors’ duty cycle length
Mobility Sensor
Raw Data Collection
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Raw Data Collection
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Raw Data Collection
Mobility Sensor
Raw Data Collection

Sessions numbered consecutively from 1 to N

Cell ID
RSSI (dBm)
Mobility Sensor

Raw Data Collection

Sessions numbered consecutively from 1 to N

Cell ID

RSSI (dBm)

7 scans per session

2s
Mobility Sensor
Raw Data Collection

<table>
<thead>
<tr>
<th>CellID</th>
<th>Alive sessions</th>
<th>Last session scans</th>
</tr>
</thead>
<tbody>
<tr>
<td>64567</td>
<td>4</td>
<td>-90, -95, -89, -90, -86, -91, -87</td>
</tr>
<tr>
<td>65784</td>
<td>5</td>
<td>-75, -80, -72, -74</td>
</tr>
<tr>
<td>61254</td>
<td>2</td>
<td>-81, -86, -89</td>
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</table>
Mobility Sensor
Derive 3 features
Mobility Sensor
Derive 3 features

Features

Median life time of cells
Average euclidean distance of signals
Average fast wavelet transform signal range
# Mobility Sensor

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7 scans

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## Mobility Sensor

**7 scans**

Derive 3 features

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<th>Fixed</th>
<th>Mobile</th>
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<tr>
<td>Median life time of cells</td>
<td>+</td>
<td>-</td>
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Mobility Sensor
Tree Classifier

3 features
Mobility Sensor

Tree Classifier

3 features ➔ Tree Classifier
Mobility Sensor
Tree Classifier

3 features

Tree Classifier

FIXED

or

MOBILE
Preliminary Experiments

- Android phone
- 1 user, 5 days, 1 phone operator
- Mobility Sensor vs. accelerometer, network location and GPS
  - *mobile* and *fixed* states predictions
- battery consumption
- User labeled the data (ESM with widget)
Results

• 539 predictions
• 52% Fixed
• 48% Mobile
• 750 battery measurements
Results
Results

![Box plot showing energy consumption steps (mA * s) for Accelerometer, Network, Mobility Sensor, and GPS.]
Results

![Box plot showing energy consumption steps in mA*s for different devices: Accelerometer, Network, Mobility Sensor, and GPS.](image)
Results
Results
Results

![Box plot of energy consumption steps for different devices](image)

- **Accelerometer**
- **Network**
- **Mobility Sensor**
- **GPS**

Energy consumption steps [mA * s]

- 0
- 100
- 200
- 300
- 400

Values range from 7600 to 7900
Results
Results

- Mobility methods:
  - Accelerometer
  - Network
  - Mobility Sensor
  - GPS

- Accuracy categories:
  - correct
  - wrong
  - n/a

- Accuracy distribution for each method:
  - Accelerometer
  - Network
  - Mobility Sensor
  - GPS

- Graph shows the distribution of accuracy for each mobility method, with green representing correct, red representing wrong, and gray representing n/a.
Results

Accuracy

Mobility methods

Accelerometer
Network
Mobility Sensor
GPS

Correct
Wrong
n/a

Mobility methods

Accelerometer
Network
Mobility Sensor
GPS

Accuracy

0 20 40 60 80 100
Results
Identified Problems

- Network coverage
- When fixed, network cell ping / pong
- When mobile, minimum number of cells
Ongoing Work

• Improve the algorithm

• Large case study involving real users

• Mobile phone heterogeneity
  • neighbor CellIDs not always available
  • hardware battery consumption details

• Experience Sampling Method
Thank you!

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