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FNSNF

Efficiently gathering contextual information for health studies

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GSN Global Sensor Networks

Health studies
Towards automated information gathering

Collecting phenotyp and behavioral data of the participants to find correlations between those and health issues.

- Until recently mostly relying on diaries, written by the participants
- But often incomplete or difficult to get highly motivated people

The solution:
- Use people's smartphones to automatically gather the contextual information
- Including their location, activity and environment
- Data is aggregated anonymously and fused with other sources, like pollution maps in our example.

Challenges
What makes it not trivial

Leveraging user's own devices as part of the "infrastructure"
Rich sensors environment (internal + external + virtual)

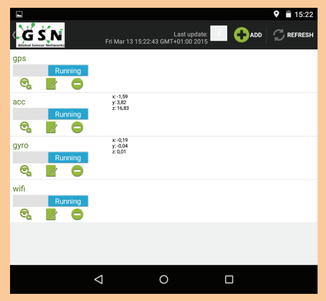
Competing for system resources like CPU, memory, battery, ...
... but also user's attention
The goal is to minimize the load on the device and the user.

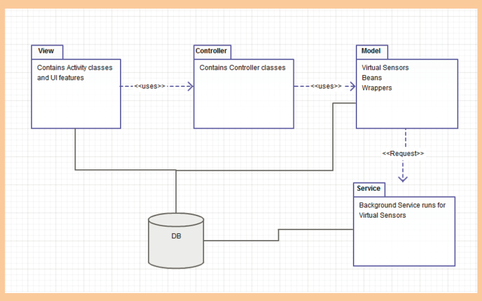
Two approaches :

Adaptively enable sensors	**Continuously sense everything**
Driven by application need and sensor availability	Richer dataset, training data
Collaborate with other devices	Performing data-mining offline

TinyGSN

TinyGSN is an Android background application with a front-end to change the parameters and select the sensors to use. It is based on the same principles as GSN (Global Sensor Networks): wrapper, virtual sensors, streamElements. A scheduler, optimized for gathering continuous location without depleting the battery, is managing the Android Services and Alarms to allow the device to sleep between the measurements.

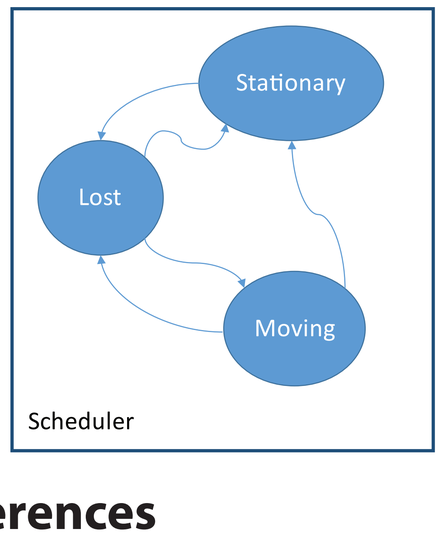




Sensor scheduling
When to turn the sensors on and off

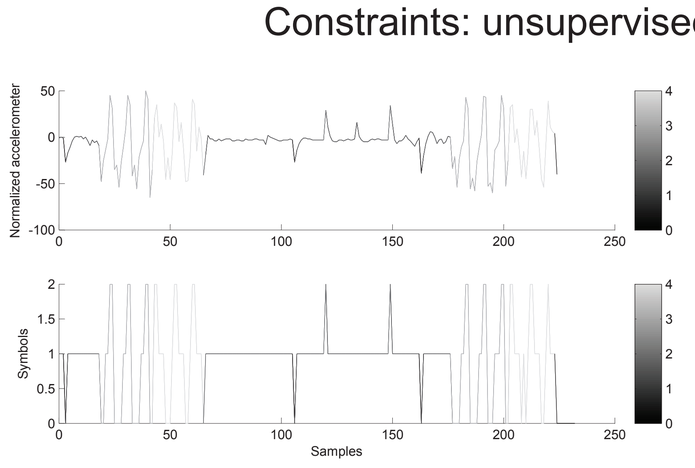
Based on a state machine, reflecting the user's state.
Turns off the GPS when not needed:
- unavailable for a certain period (indoor)
- user is not moving
- WiFi access point doesn't change

Schedules the other sensors according to the state of the user:
moving or stationary, indoor or outdoor



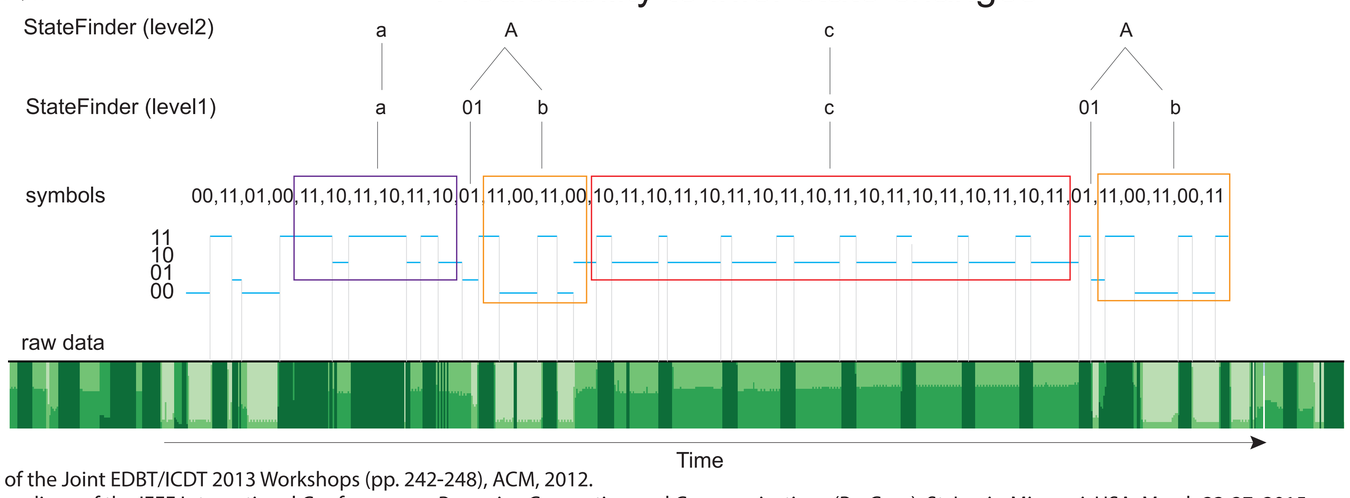
Data Processing
Extracting the information from the raw data

Use the smartness of the device to reduce communication, processing and storage load.
The idea: aggregating the data into meaningful symbols and perform the usual processing and machine learning tasks on them. [2]
Several levels of symbolic representation (abstraction level).
Constraints: unsupervised, online, limited memory and computation.



Symbols mapped to semantic meaning (not always)
Level-0: from global data distribution
- Using clustering, quantiles, expert knowledge,…
- Suitable for data-mining

Level-i: patterns composed of level-(i-1) symbols [3]
- Using online state recognition
- Maintain the recent history in a transition matrix
- Predictability to infer state changes



References

[1] GSN, Global Sensor Networks, available on Github : http://gsn.epfl.ch, https://github.com/lsir/gsn
[2] Tri Kurniawan Wijaya, Julien Eberle, Karl Aberer. Symbolic representation of smart meter data. In Proceedings of the Joint EDBT/ICDT 2013 Workshops (pp. 242-248), ACM, 2012.
[3] Julien Eberle, Tri Kurniawan Wijaya, Karl Aberer. Online Unsupervised State Recognition in Sensor Data. In Proceedings of the IEEE International Conference on Pervasive Computing and Communications (PerCom), St. Louis, Missouri, USA, March 23-27, 2015.