SLEEP-WAKE PATTERNS DETECTION

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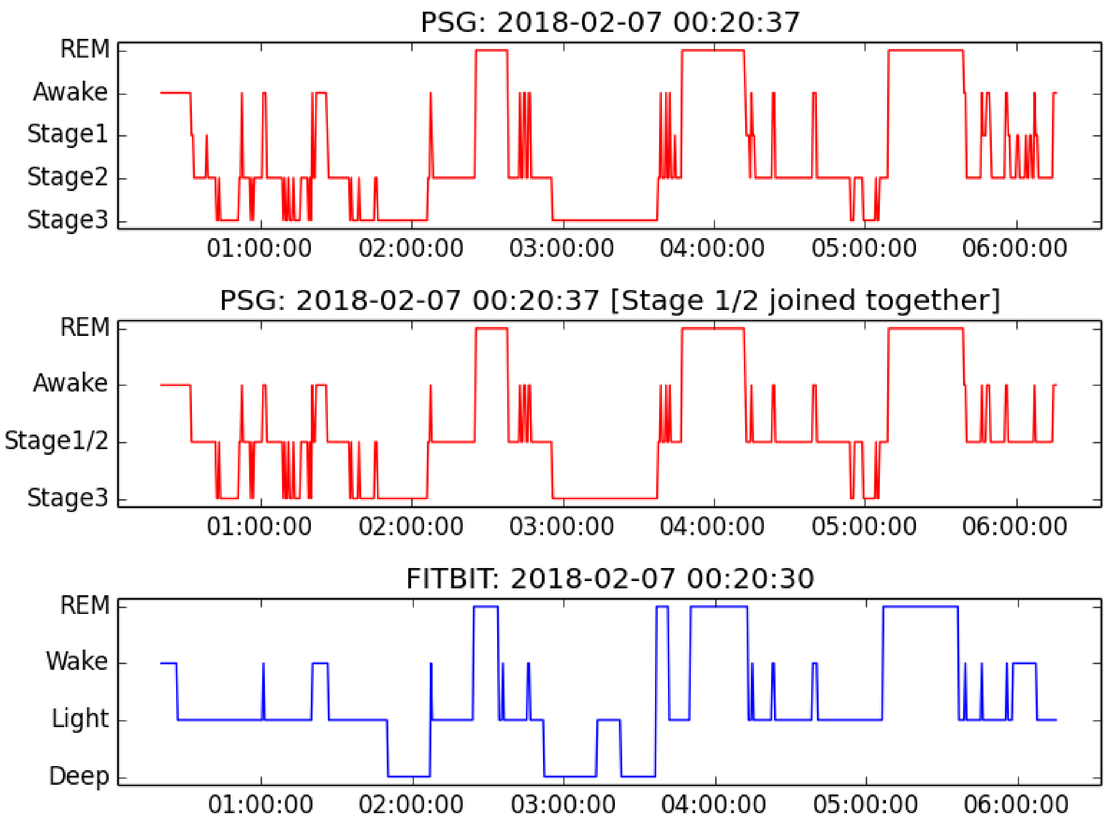
PROBLEM STATEMENT

- **Main Goal:** to be capable to measure the sleep quality by continuosly monitoring the patients, using data obtained from theirs smartphones.
- **Problems to address:**
  - **Heterogeneous data**: the collected data comes from different sources.
  - **Low reliability** of the available data types separately.
- The gold standard to asset sleep quality (Polysomnography, PSG) has disadventages (expensive, unfamiliar enviornment, etc).
  - PSG will be used as a baseline to asset the system's performance.

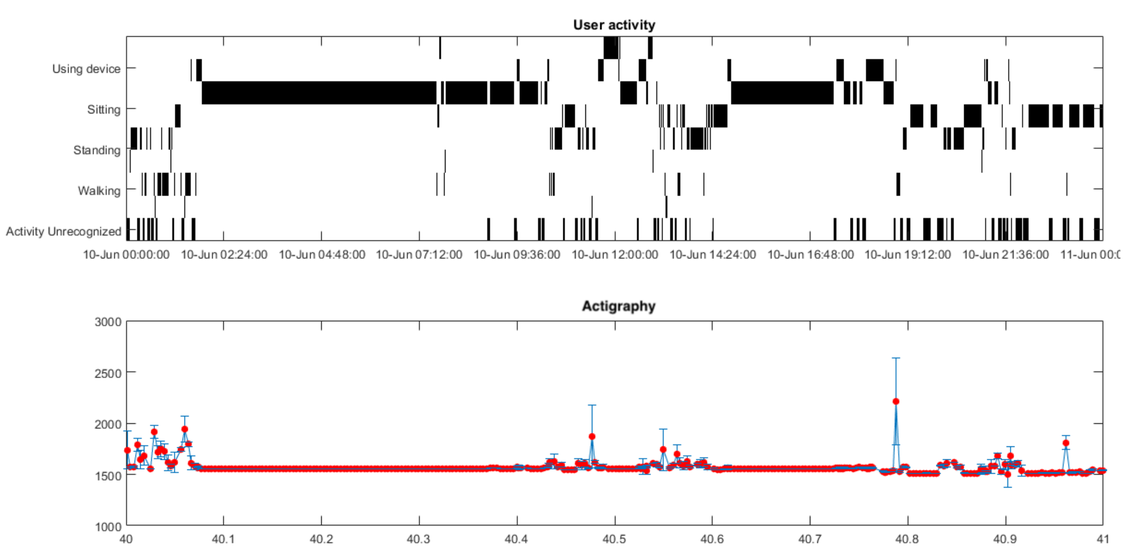
AVAILABLE DATA

Data types that will be merged, obtained from the users smartphones:

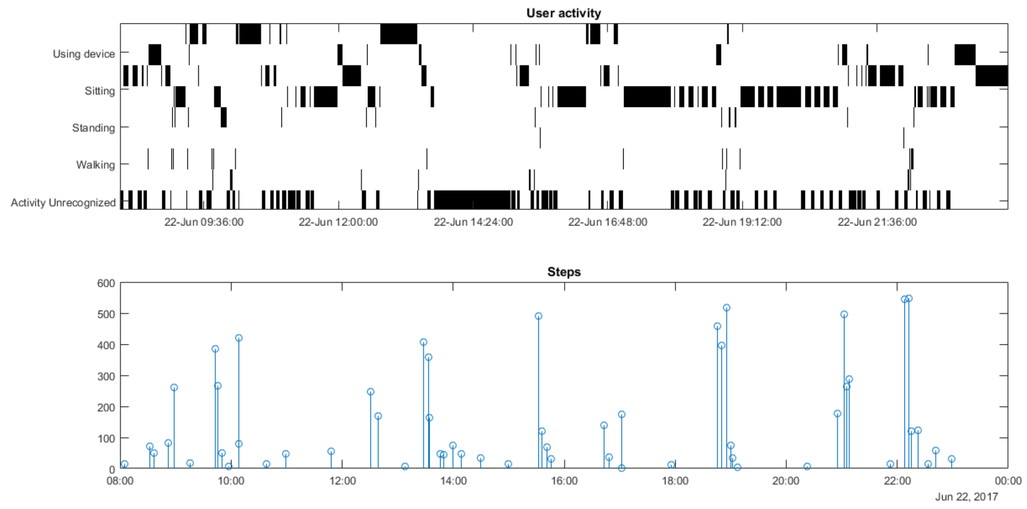
- **Location:** list of all possibles locations which its related likelihood.
- **Activity:** list of possible activities performed by the user for a defined moment.
- **WiFi:** list of the WiFi networks near the user.
- **Bluetooth:** list of Bluetooth devices present near the user.
- **Light Level:** list of light levels detected by the light sensor of the smartphone.
- **Actigraphy:** list of samples produced by the integration of the module of acceleration each 10 seconds.
- **Steps:** information of the steps walked during a certain time interval.
- **Call Register:** information of the calls made with the smartphone, with its duration, type(incoming, outcoming, missed or unkown) and destination number.
- **Wearables:** using a combination of the movement and the heart-rate patterns we obtain the transitions between different sleep states.



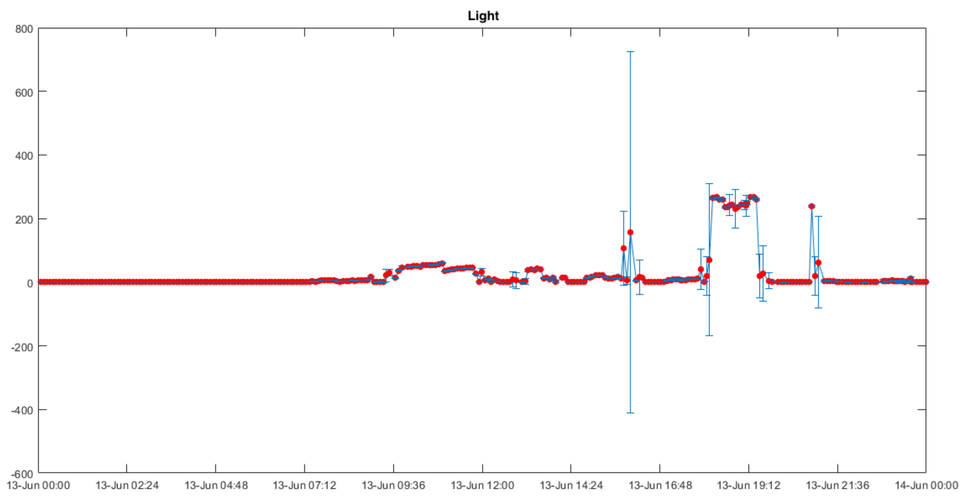
Data collected by the PSG and the fitbit wearable during one sleep session



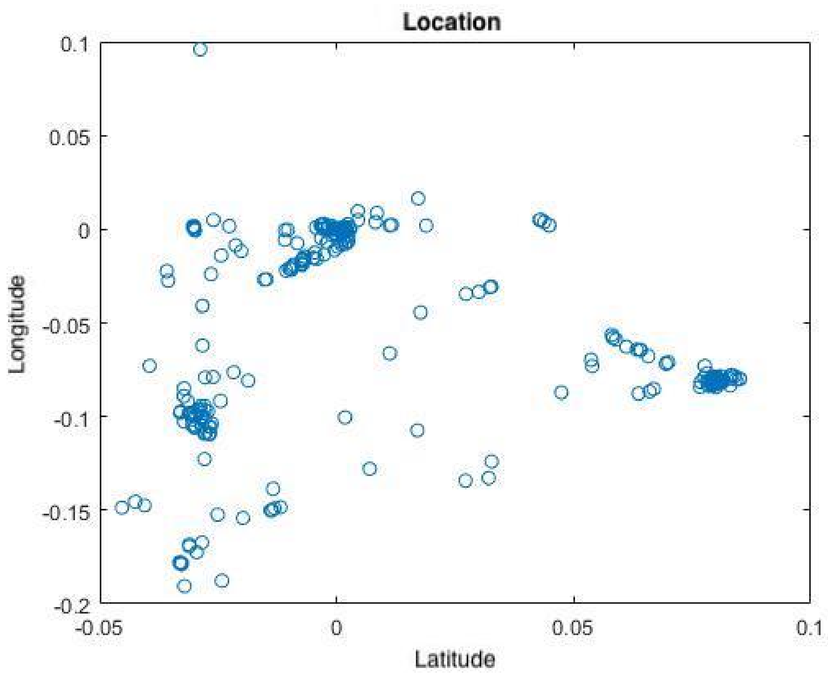
User Activity and Actigraphy Signal



User Activity and Steps



Light Level



Location datapoints

SLEEP QUALITY MEASURES

- **Total Sleep Time** (TST).
- **Wake After Sleep Onset** (WASO): periods of wakefulness occurring after defined sleep onset.
- **Sleep Onset** (SOL): time that takes the transition from an awake state to the lighter sleep state.
- Total time in each one of the possible sleep states (Awake, Light Sleep, Deep Sleep or REM sleep).

APPROACH

- **Hiddden Markov Models** (HMMs).
- **Variational Autoencoders** (VAEs), which perform a stochastic inference, assuming a conditional distribucion $p(x|z)$, where z is a hidden variable whose parameters can be estimated by using neural networks.
- **Generative Adversarial Networks** (GANs), which infer the parameters by minimizing a cost function defined for the training of two models: a generator and a discriminator.
- **Neural Networks**, starting with basic models such as RNNs (Recursive Neural Networks) and also, with more optimized versions which could be capable to detect correlations in time.