Master thesis : Exploring physiological indicators of pregnancy outcomes using machine learning and longitudinal patient data

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Faculté : Faculté des Sciences appliquées
Diplôme : Master en ingénieur civil électricien, à finalité spécialisée en "electrical engineering"
Année académique : 2017-2018
URI/URL : http://hdl.handle.net/2268.2/4603

Exploring physiological indicators of pregnancy outcomes using machine learning and longitudinal patient data

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Master in Electrical Engineering - University of Liège - Academic year 2017-2018
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Abstract

Bloomlife is a Belgo-American start-up founded in 2014 that develops a sensor, called *Blommlife*, to improve the health of moms and babies worldwide. The current product actually enables expecting moms to discreetely track their contractions at any time and anywhere. The society, however, is on track for unlocking more features such as the maternal sleep detection. Maternal sleep quality is actually thought to belong to the set of influence factors that could be related to preterm birth. The main objective of this work is therefore to develop algorithms for analyzing sleep quantity and quality based on the signals recorded by *Bloomlife*.

Two main classification problems are considered: sleep detection and sleep stages classification. The first classification problem consists in differentiating between the sleep and the wakefulness states while the second one involves the classification between the five main sleep stages, which are the light sleep (N1), the moderate sleep (N2), the deep sleep (N3), the rapid-eye-movements sleep (REM) and the wakefulness state.

The first step of the work is to analyze how the standard sleep monitoring technique, i.e., the polysomnography, works and which signals of the data set that has been collected especially for this master thesis can be exploited to perform sleep monitoring with *Bloomlife*. Around 13 non pregnant and pregnant subjects have been called on to wear simultaneously the investigational device (*Bloomlife*) and a reference polysomnography system (Sleep Profiler^{TM}).

Next, the extraction of the main sleep physiological indicators that can be found in the signals recorded by *Bloomlife* is addressed. It has indeed been chosen to process the data and to summarize them into features on which the classification algorithms are built. These features are either derived from the electrophysiological activity recorded on the belly skin or derived from the data of the *Bloomlife* embedded accelerometer. Among the different feature categories that were highlighted, the spectral analysis of the heart rate variability, which is highly related to the autonomous neural system activity, seems to give the most promising results as much for the sleep detection as for the sleep stages classification. As a huge amount of characteristics has been investigated to track the most representative as possible physiological information in the recorded signals, a feature selection is also performed.

And finally, the predictions obtained with the three learning algorithms that have been selected, a K-nearest neighbors, a random forest and a conditional random field algorithms, are evaluated. Among these three classifiers, the conditional random field algorithm was the most promising algorithm for performing sleep monitoring since it takes into account the cycling structure of the sleep architecture. A bigger data set has however to be collected to improve its overall performances.