Leif Sörnmo, March 18, 2018

The BSP 2018 Task:
Detection of Atrial Fibrillation

Background

Monitoring of atrial fibrillation (AF) is performed, e.g., in patients with cryptogenic ischemic stroke (i.e., stroke of unknown cause), patients undergoing an interventional ablation procedure, and patients under pharmacological treatment, and provides valuable information on the efficacy of treatment strategies. Ultimately, continuous long-term monitoring, lasting from several weeks to months, should be performed so that all episodes of paroxysmal AF are detected, including the very brief ones. Therefore, it is essential that reliable detection techniques are developed.

The detection of brief ("occult") episodes of AF, i.e., episodes shorter than 30 s, has recently received special attention since clinical studies have shown that brief episodes are associated with increased risk of stroke. However, the vast majority of published AF detectors require at least a 30-s episode for accurate detection and therefore cannot detect occult episodes.

The majority of existing detectors take the RR interval series as their starting point, whereas a few detectors also involve information on P wave and f wave morphology. However, the latter type of detector is associated with much higher computational demands which makes them unsuitable for implementation in a low power device. Somewhat surprisingly, it has been demonstrated that increased complexity through inclusion of morphologic analysis does not necessarily mean better performance.

Project task

Your task is to develop an AF detector using the RR interval series as input. You are free to choose any method you consider interesting.

But how to find a method that you want to study? You may want to search the PubMed database http://www.pubmed.com, an excellent resource for publications on AF detection (and much more). You are also encouraged to read the chapter which I recently authored on AF detection (to be published by Springer). Another possibility is to propose your own detector choice!

You are always welcome to discuss any idea you may have on detector design!

Dataset

A subset of signals from the MIT-BIH AF database (AFDB) is used in this project, saved in mat-format in the downloaded format. The subset is further divided into a development subset (4 patients) and an evaluation subset (3 patients):

- Development dataset (afdb_X.mat, where X=1,2,3,4)
- Evaluation dataset (afdb_X.mat, where X=5,6,7)

The development subset contains the RR interval series (vector "rr") and the PAF episodes annotated (vector "targetsRR"); note that the elements of "targetsRR" are equal

to 1 if the RR interval belongs to an AF episode, otherwise it is 0. The output of your detector is a vector (named "detectRR") whose elements contain 1 when an RR interval has been detected which is considered to be part of an AF episode, otherwise 0. Note that the two vectors "detectRR" and "targetsRR" have the same length.

Performance is determined by comparing "detectRR" to "targetsRR". The comparison can be made in different ways. In this course, simple performance measures are used, namely,

- Count the number of elements which, for the same index, both contain 0 in "targetsRR" and "detectRR" and normalize it with the total number of 0's in "targetsRR" so that the resulting performance has a range from 0 to 1. The resulting performance measure, known as *sensitivity*, will tell you something about correct detection of non-AF.
- Count the number of elements which, for the same index, both contain 1 in "targetsRR" and "detectRR" and normalize it with the total number of 1's in "targetsRR" so that the resulting performance has a range from 0 to 1. The resulting performance measure, known as *specificity*, will tell you something about correct detection of AF.

The evaluation subset should be analyzed by the detector you have implemented. Since vector "targetsRR" is not disclosed, performance on the evaluation set is determined by e-mailing the results to Leif S together with the project report **no later than May 16**. Please save the vectors, "detectRR_5", "detectRR_6" and "detectRR_7" in a separate mat-file entitled "PAFresults" and email them.

Make sure to **include a table** in your report that describes the performance for **each** of the four patients in the development set.

Information about the MIT-BIH AF database from which the and its characteristics can be found on: http://www.physionet.org/physiobank/database/afdb/

Some observations

- The detector structure can be divided into two parts: feature extraction and classification. Since both these parts can become quite complex (requiring a work effort that exceeds the 7.5 credits), you are recommended to spend most of the time on feature extraction, whereas the classification part may be implemented as simple threshold tests.
- Remember that AF detection is a largely unsolved problem taken from real life! Hence there is no single solution which is correct, but your solution may very well be the one destined for implementation in a future product!