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# ASSESSMENT OF NON-NEGATIVE MATRIX FACTORIZATION FOR THE PREPROCESSING OF LONG-TERM ECG

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**Background.** With the advent of health information technology and wearable acquisition systems, **long-term ECG** are more and more used in long-term cardiac tolerability studies of new compounds. Nevertheless, the accurate analysis of such long signals requires reliable and fast signal processing algorithms.

## Objectives

The objective of this study is to assess the practical relevance of innovative matrix factorization **methods for the preprocessing of long-term ECG**. Those signals are generally noisy with complex baseline wander and require preprocessing, such as filtering, to perform a correct analysis. Our goal is to present two innovative algorithms of matrix factorization to detect R-peaks in long-term ECG.

## Methods

The two tested methods are :

- **Independent Component Analysis (ICA)**
- **Non-Negative Matrix Factorization (NMF)**

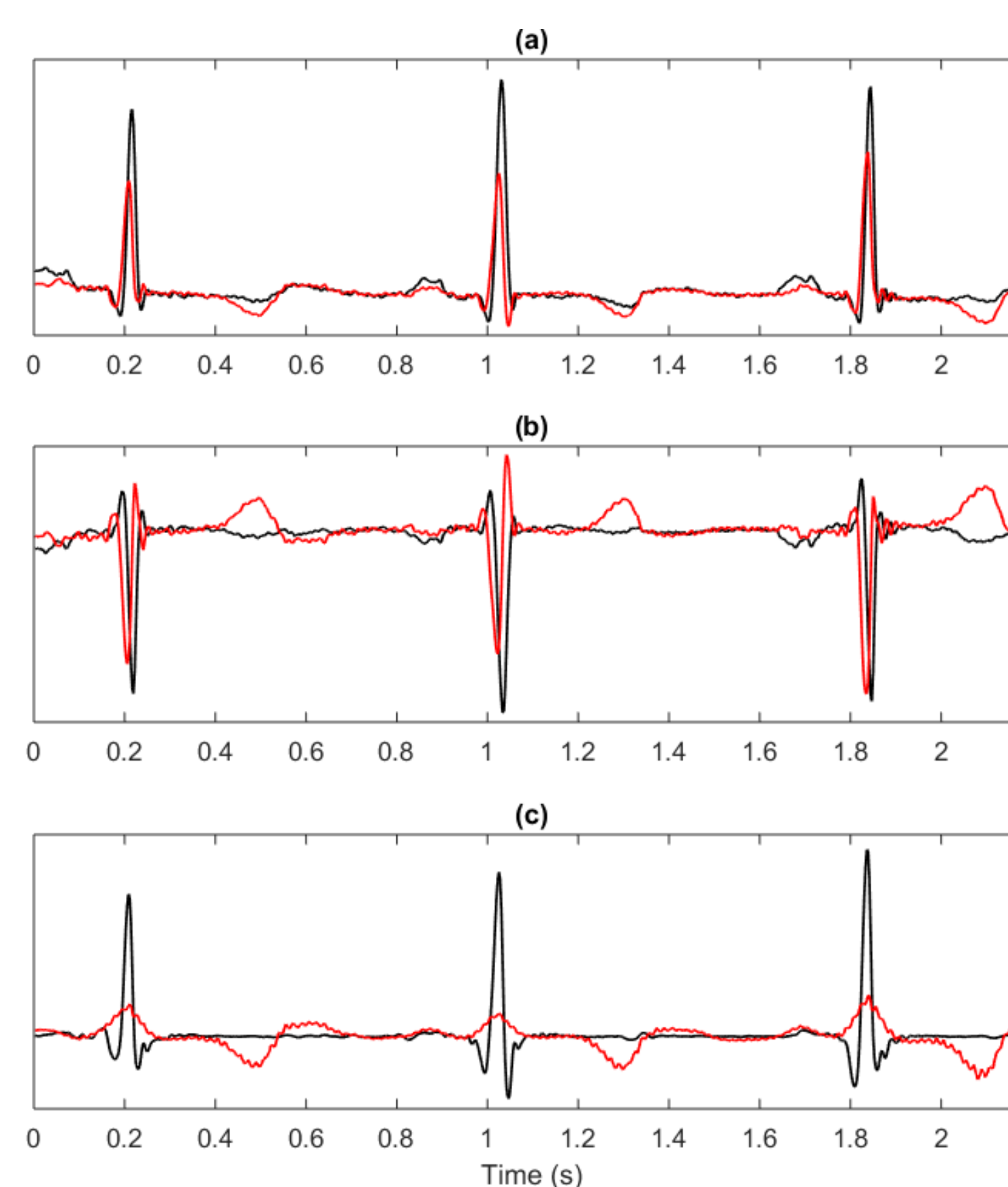
They are both source separation methods whose goal is to isolate each component of an ECG: R-peak, P and T waves, noise, baseline wander etc. On the one hand, ICA assumes that all subcomponents of the signal are statistically independent from each other and on the other hand, Non-Negative Matrix Factorization is a method that uses the non-negativity of the spectrogram of the ECG to separate the different time-frequency patterns. The two signal processing methods were implemented in the Matlab computing environment.

## Results

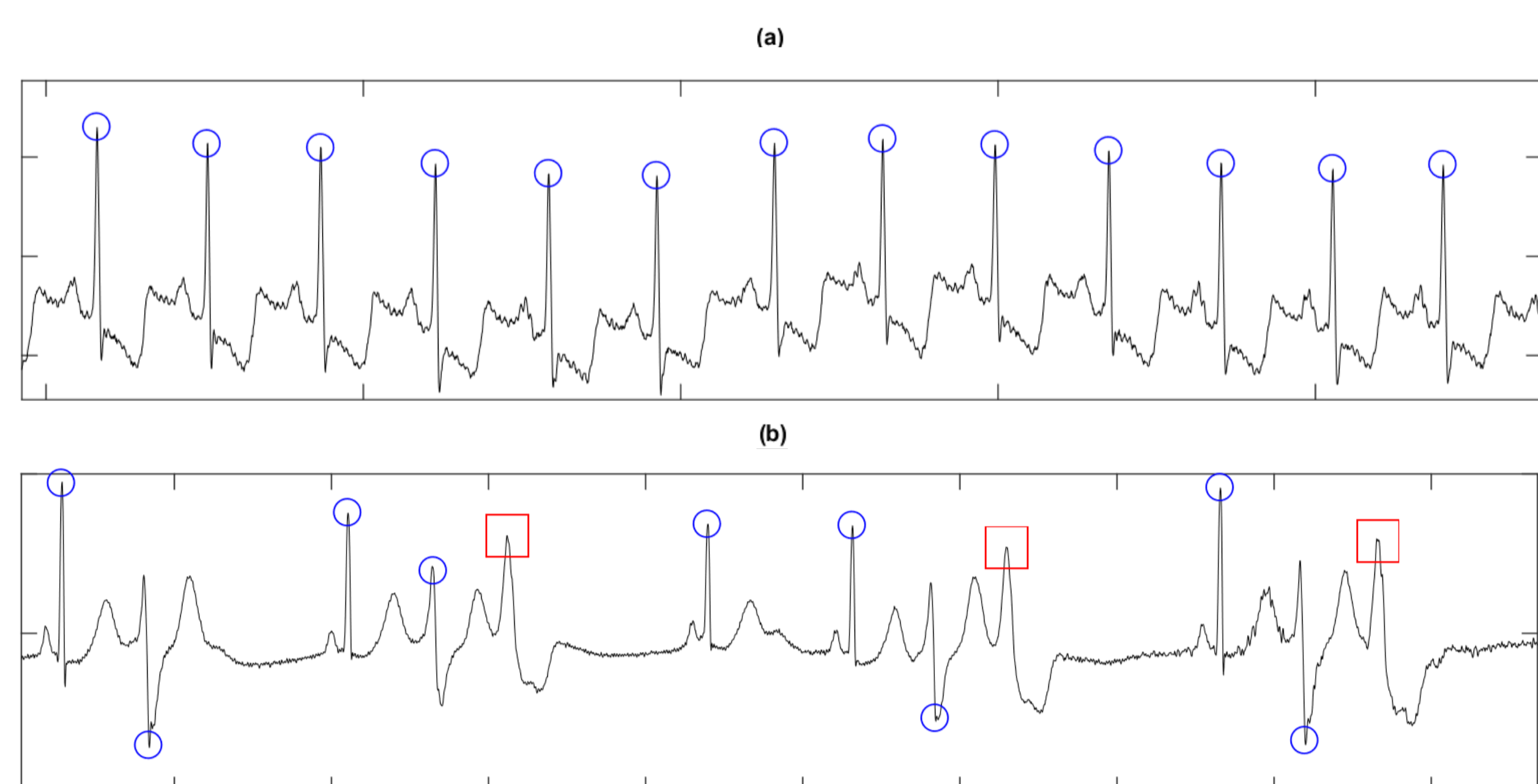
The proposed approaches are tested on the MIT-BIH Arrhythmia and Noise Stress Test databases: ICA shows a strong drawback by returning the different sources in a random order making compulsory a reconnaissance step or the action of a specialist. Whereas NMF achieves high results in terms of sensitivity and specificity in general even in case of complex baseline wander and highly noisy signals.

## Conclusion

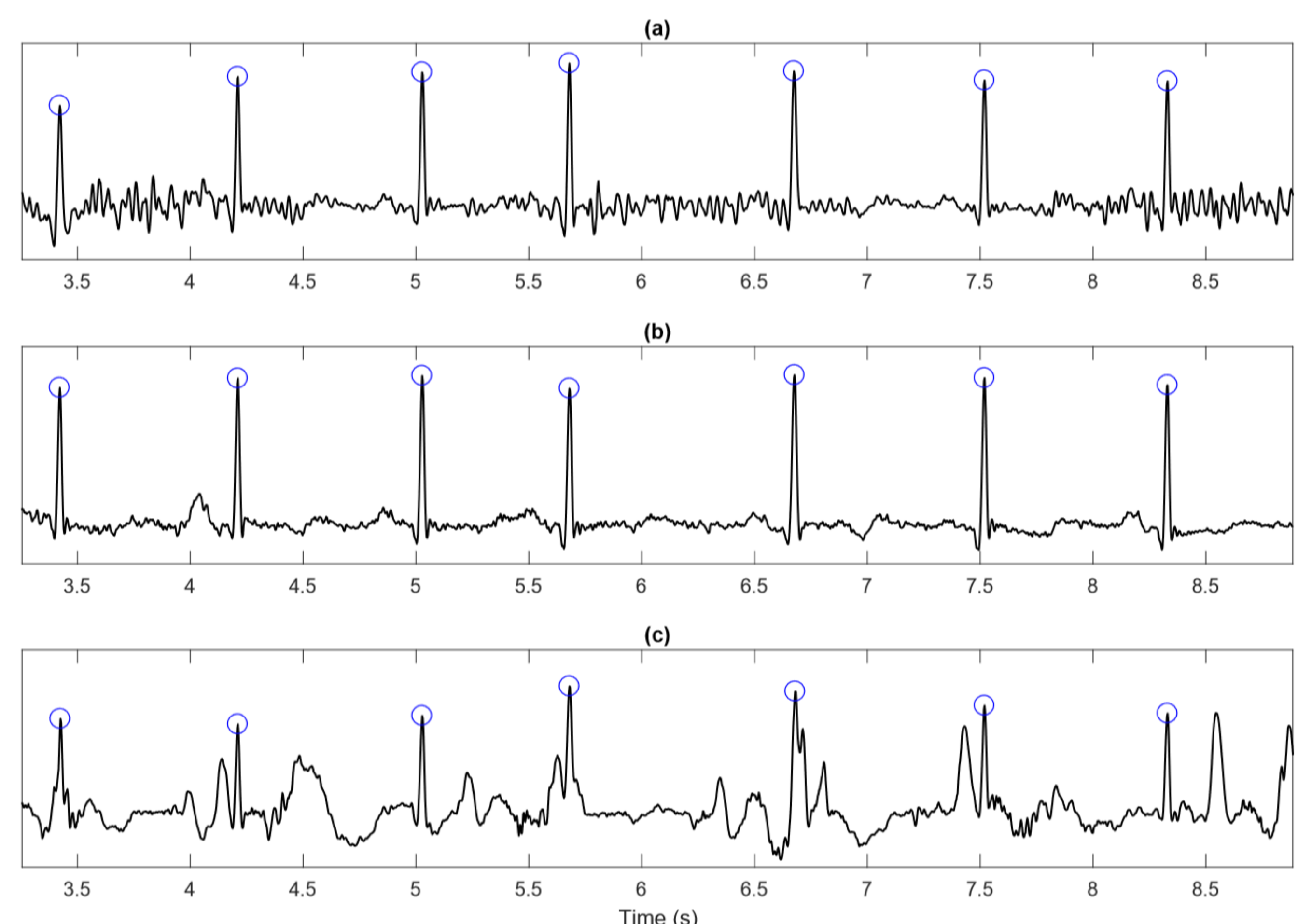
This study emphasizes promising results of a new long-term ECG preprocessing technique based on a matrix factorization method. This approach simultaneously undertakes three tasks: denoising, baseline wander removal and peak R detection.



**Fig.1:** Comparison of separation source methods applied on the first ECG signal of the MIT-BIH Arrhythmia Database :  
(a) Original two-leads ECG signal  
(b) ICA components; R-peaks are shared in both sources when P waves can be mostly found in the first source and T-waves in the second source  
(c) NMF components; the first source only contains R-peaks while the second source contains P and T waves and some low-frequency parts of QRS complexes.



**Fig.2:** Results of R-peak detection using NMF separation on the MIT-BIH Arrhythmia Database, blue circles represent correctly detected peaks and red squares missed peaks: (a) 10 seconds of ECG signal with all peaks correctly detected (b) 10 seconds of ECG signal with three missed peaks because of arrhythmia.



**Fig.3:** Results of R-peak detection using NMF on the MIT-BIH Arrhythmia Database polluted by different kind of noises from the Noise Stress Test Database, blue circles represent correctly detected peaks; (a) ECG signal polluted by muscle artifacts (b) ECG signal polluted by baseline wander (c) ECG signal polluted by electrode movements.