Machine learning approaches to classify Atrial Arrhythmias from Intracardiac Electrograms

M. Rodrigo[1,2], A.J. Rogers[1], M.I. Alhusseini[1], T. Baykaner[1], S.M. Narayan[1]

[1]Stanford University School of Medicine, Stanford, California, USA
[2]Universitat Politècnica de València, València, Spain

Atrial arrhythmias have been characterized extensively on the surface ECG, but they are less well classified for intracardiac Electrograms (EGM). Here we develop multiple classification algorithms which we compare to distinguish non-organized arrhythmias (atrial fibrillation, AF) from organized atrial flutter (AFL).

Bi-atrial endocardial electrograms of 86 patients (61 male, 65±11 years) were recorded with 64-pole catheters during AFL (N=43) and AF (N=43 fig A) labelled by experts. We examined 23±6 EGM channels per patient in non-overlapping 4 seconds segments sampled at 400 Hz (1600 samples), for a total of 29.340 signals. We used 10 cross-validation sets comprising a random sample of 80% of patients for training, and 20% for validation.

We found that deep learning on raw electrograms provided a c-statistic of only 0.73 ± 0.07 for dense layered nets and 0.85 ± 0.07 for convolutional combined with dense layers. A linear model using 4 EGM features based on autocorrelation indices (mean, variance, maximal value and number of peaks, Fig B) had similar performance (c-statistic 0.86 ± 0.08). Inclusion of 5 additional EGM features (Cycle Length, Dominant Frequency, number of signal peaks after filtering in 3 different frequency bands) in a Support Vector Machine improved the c-statistic to 0.94 ± 0.04 (fig C).

We conclude that to classify atrial fibrillation from organized atrial flutter on intracardiac electrograms, classic machine learning based on featurized signals was more accurate than deep learning based on raw signals. Well-known features representing signal periodicity and organization such as signal autocorrelation present a robust marker for EGM classification.