Patient-Adaptive Ectopic Beat Classification using Active Learning

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A major challenge in applying machine learning techniques to the problem of heartbeat classification is dealing effectively with inter-patient differences in electrocardiograms (ECGs). Inter-patient differences create a need for patient-specific classifiers, since there is no *a priori* reason to assume that a classifier trained on data from one patient (or even many patients) will yield useful results when applied to a different patient. Unfortunately, patient-specific classifiers come at a high cost, since they require a labeled training set. Using *active learning*, we show that one can drastically reduce the amount of patient-specific labeled training data required to build a highly accurate patient-specific binary heartbeat classifier for identifying ventricular ectopic beats. Tested on all 48 half-hour ECG recordings from the MIT-BIH Arrhythmia database, our approach achieves an average sensitivity of 96.23% and specificity of 99.97%. The average number of beats needed to train each patient-specific classifier was only 37 beats, approximately 30 seconds of data.

We compare the classification performance of our algorithm to a classifier trained on the first portion of each record. This *passive* selection of the training set is common in the literature. The histogram shows the fraction of each record one must label when the training set is *actively* selected. If instead the training set were passively selected, one would have to label the first 90% of each record, to achieve the same average sensitivity as the proposed method.