Derived Features from Electrocardiograms

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1 ECG Derived Features

Let $S = \{b_1, \ldots, b_n\}$ be an electrocardiogram (ECG) of n heart beats, each beat represented by a PQRST complex consisting of five points $b_i = \{p_i, q_i, r_i, s_i, t_i\}$. Let ind and amp be two functions such that, for any point $x \in b_i$, $ind(x)$ returns the index of point x in S and $ind(x) \in [0, 4999]$; $amp(x)$ returns the ampititude of point x in S. Let SR be the sample rate of ECG (500 for our ECGs).

Now we define the following features derived from ECG S.

1.1 PR Ratio

The PR ratio PR_S for ECG S:

$$PR_S = \frac{1}{n} \sum_{1 \le i \le n} \frac{amp(p_i)}{amp(r_i)}$$

1.2 RR Distance

The RR distance RR_S for ECG S:

$$RR_S = \frac{1}{n-1} \sum_{2 \le i \le n} (ind(r_i) - ind(r_{i-1}))$$

1.3 P Energy

The P energy PE_S for ECG S:

$$PE_S = \frac{1}{n} \sum_{1 \le i \le n} \int_{ind(p_i)-25}^{ind(p_i)+25} f(x)dx,$$

where $f(x)$ is the ampititudes of the sample points in interval $[ind(p_i) - 25, ind(p_i) + 25]$. Numpy's trapz function can be used here.

1.4 T Energy

The T energy TE_S for ECG S:

$$TE_S = \frac{1}{n} \sum_{1 \le i \le n} \int_{ind(t_i)-25}^{ind(t_i)+25} f(x)dx,$$

where $f(x)$ is the ampititudes of the sample points in interval $[ind(t_i) - 25, ind(t_i) + 25]$. Numpy's trapz function can be used here.

1.5 PQ Distance

The PQ distance PQ_S for ECG S:

$$PQ_S = \frac{1}{n} \sum_{1 \leq i \leq n} (ind(q_i) - ind(p_i))$$

1.6 QT Interval

The QT interval QT_S for ECG S:

$$QT_S = \frac{1}{n} \sum_{1 \leq i \leq n} \frac{ind(t_i) - ind(q_i)}{RR_S}$$

1.7 ST Slope

The ST slope ST_S for ECG S:

$$ST_S = \frac{1}{n} \sum_{1 \leq i \leq n} \frac{amp(t_i) - amp(s_i)}{ind(t_i) - ind(s_i)}$$

1.8 PR Slope

The PR slope $PR - slope_S$ for ECG S:

$$PR - slope_S = \frac{1}{n} \sum_{1 \leq i \leq n} \frac{amp(r_i) - amp(p_i)}{ind(r_i) - ind(p_i)}$$

1.9 QRS Energy

The QRS energy $QRSE_S$ for ECG S:

$$QRSE_S = \frac{1}{n} \sum_{1 \leq i \leq n} \int_{ind(q_i)}^{ind(s_i)} f(x)dx,$$

where $f(x)$ is the ampititudes of the sample points in interval $[ind(q_i), ind(s_i)]$. Numpy's trapz function can be used here.

1.10 R-S-Q

The R-S-Q RSQ_S for ECG S:

$$RSQ_S = \frac{1}{n} \sum_{1 \leq i \leq n} (amp(r_i) - amp(s_i) - amp(q_i))$$

1.11 Heart Rate

$$HR_S = \frac{60}{RR_S/SR}$$