Final presentation

Detection of Ischemic ST segment Deviation Episode in the ECG

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BS (CIS) 8th semester

Roll # 14

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Detection of Ischemic ST segment Deviation Episode in the ECG

Presentation Outlines:

- Ischemic ECG Signal
- Database
- QRS detection
- Base line removal
- Isoelectric level calculation & removal
- Feature extraction
- Data Normalization
- Feature reduction using PCA
- Results Analysis

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Reflection of Ischemia in ECG:

- ST segment deviation
  i. Elevation
  ii. Depression
- T wave Inversion

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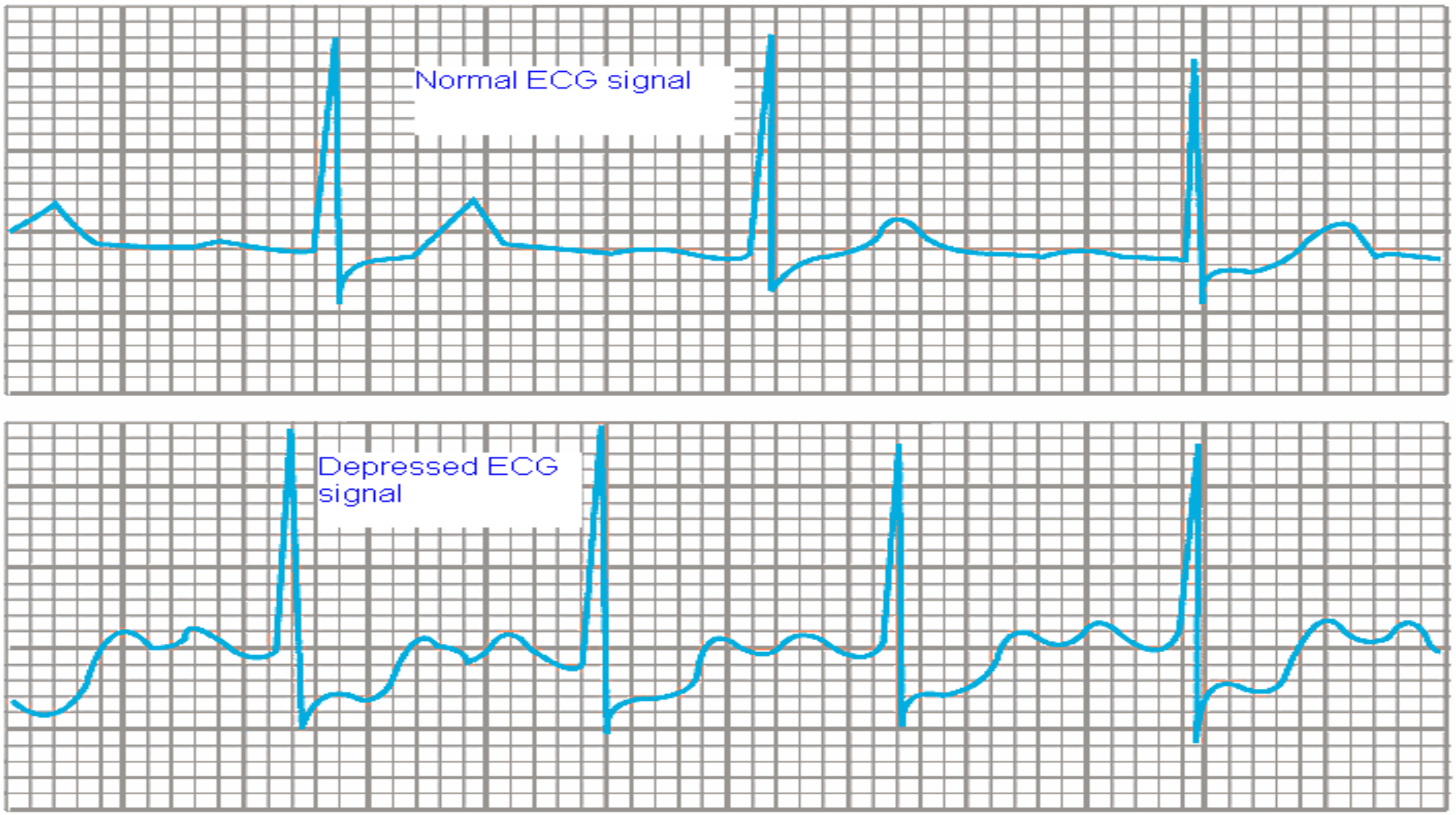
Ischemic ECG signal



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Database:

• **EDC-ESTT database**

The European ST-T Database is intended to be used for evaluation of algorithms for analysis of ST and T-wave changes. Each record is two hours in duration and contains two signals, each sampled at 250 samples per second.

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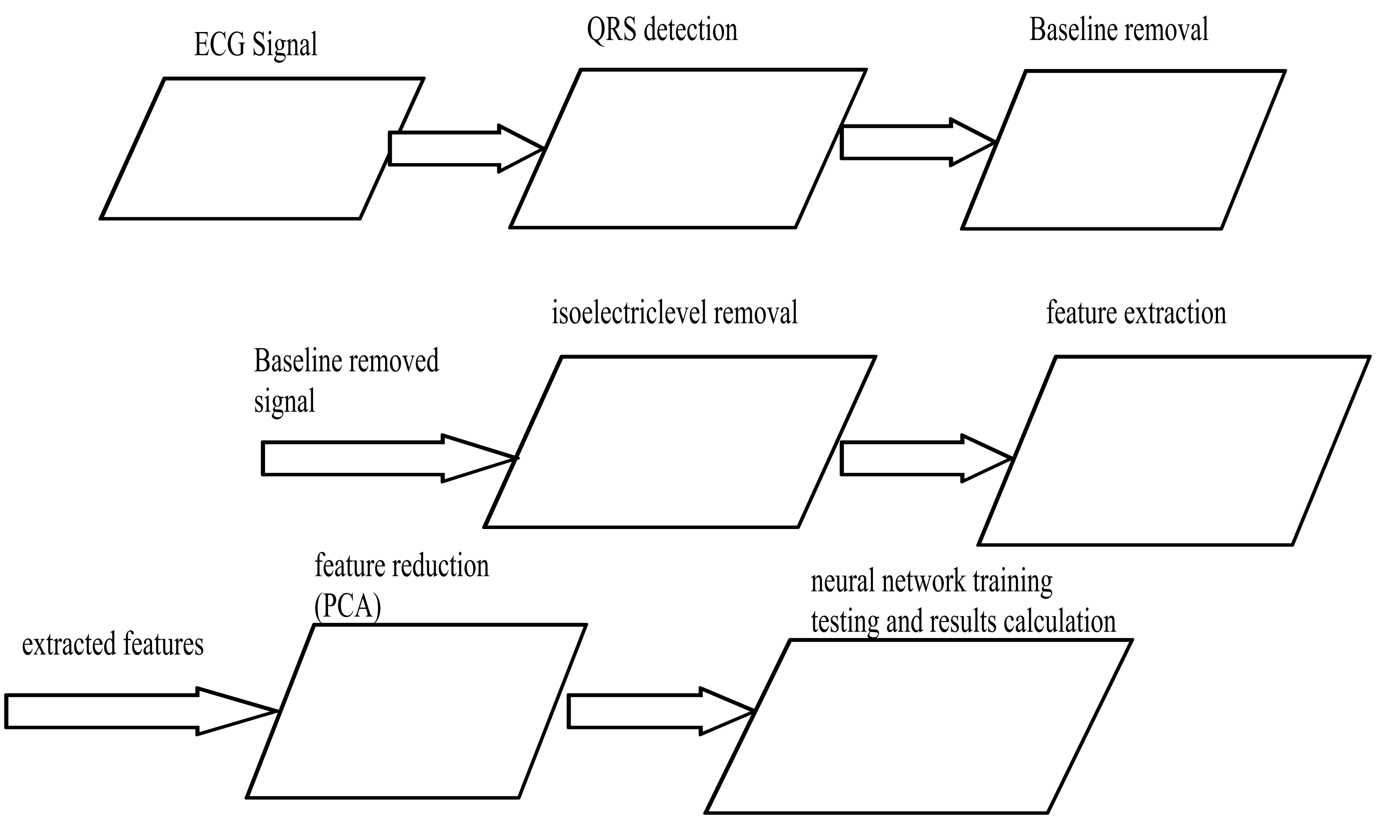
System Architecture



Base line Removal

- Baseline wandering can result from the motion of electrodes, perspiration or respiration.
- It causes problems in analyzing ECG signals.
- Two techniques used for baseline removal
- Spline interpolation
- Median filtering

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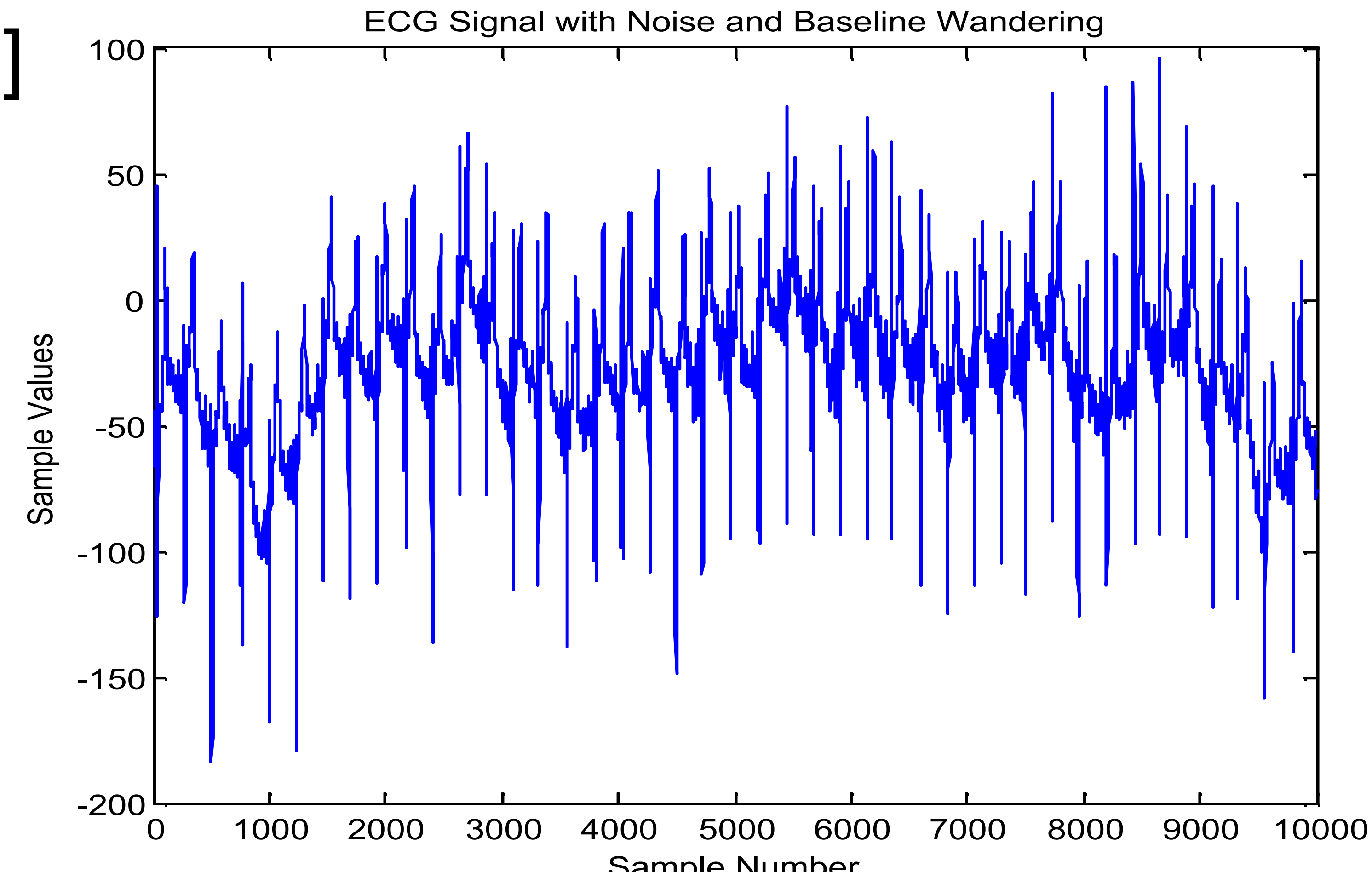
[4]



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Median filtering

- In this procedure we first compute the median of the signal values and subtract this median value from the signal
- Fifth polynomial is fitted to this shifted waveform using least squares method to obtain a baseline estimate

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Median filtering

- Subtract the baseline from the original ECG to get the Baseline removed signal

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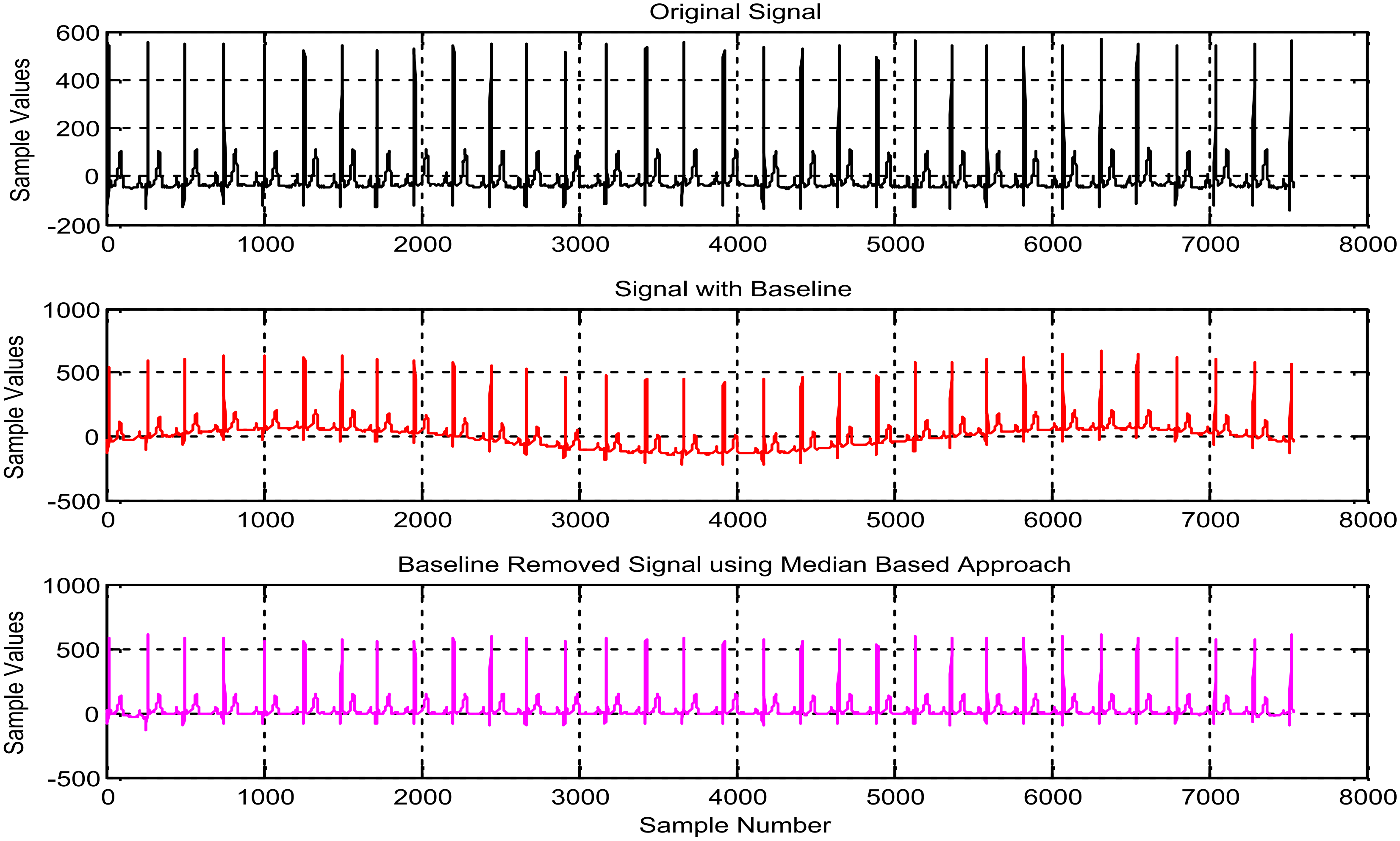

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Using Spline interpolation

- Mean of the Signal is subtracted from it,
- First order polynomial is fitted on the mean subtracted signal, to find the baseline estimates.
- This baseline estimates are subtracted from the Signal to obtain it's Baseline removed form.

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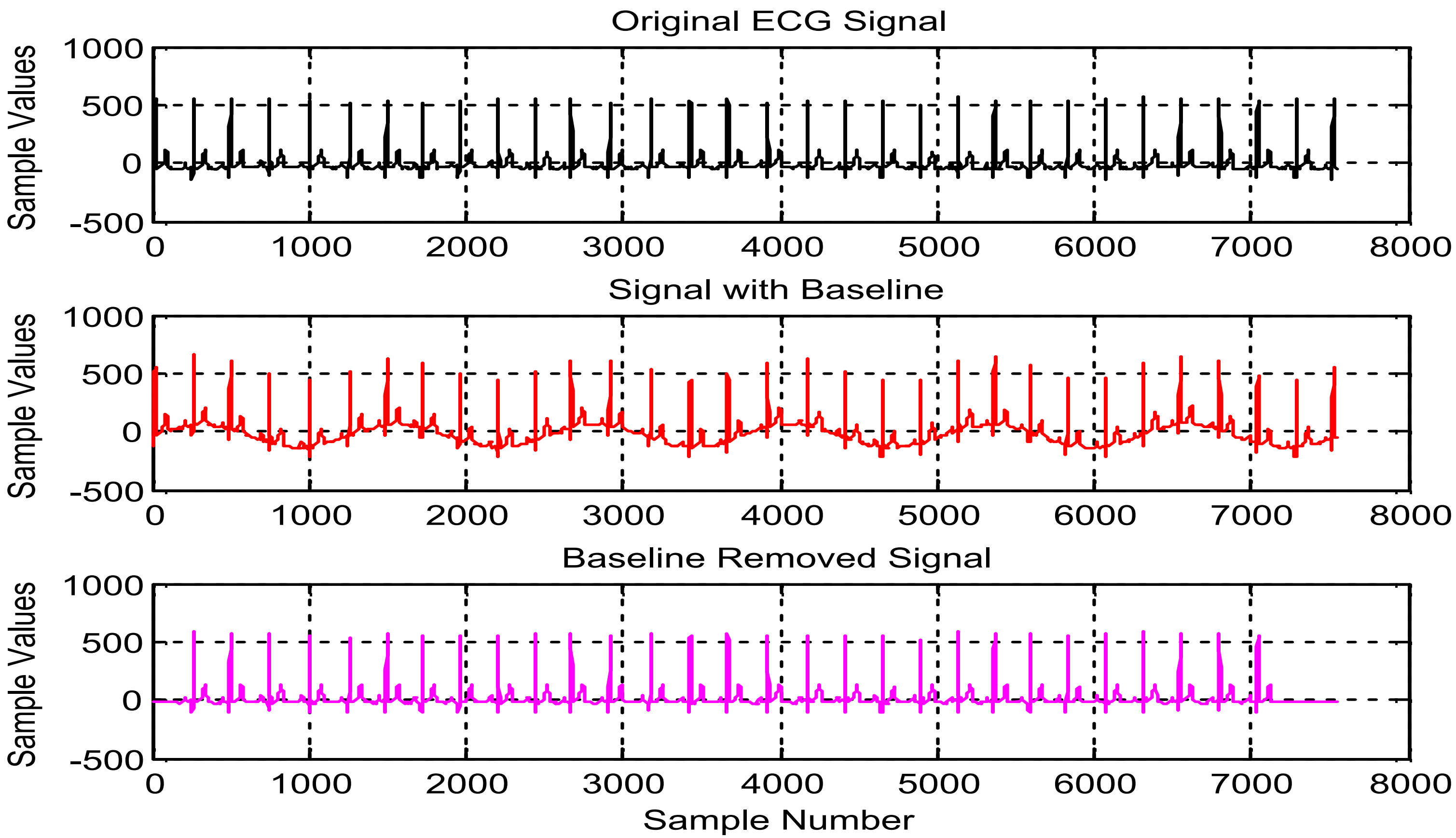
Using Spline interpolation [4]



Comparison of the two techniques

- Use of the median filtering based approach can remove only slowly varying baseline drift.
- First order polynomial is able to cope up with fast baseline variations
- Therefore for ST segment variations Spline fitting is better to use. (according to literature)

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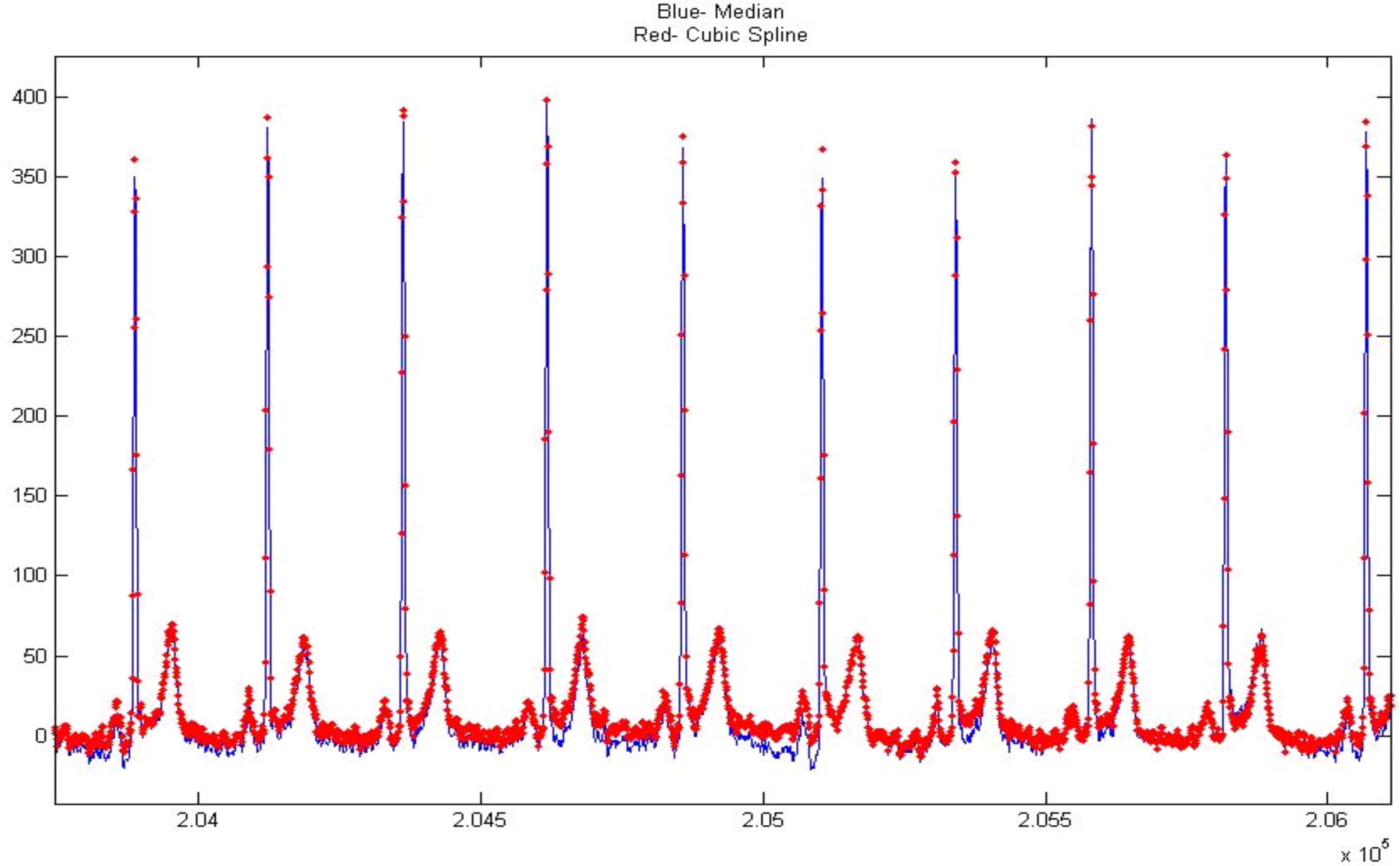

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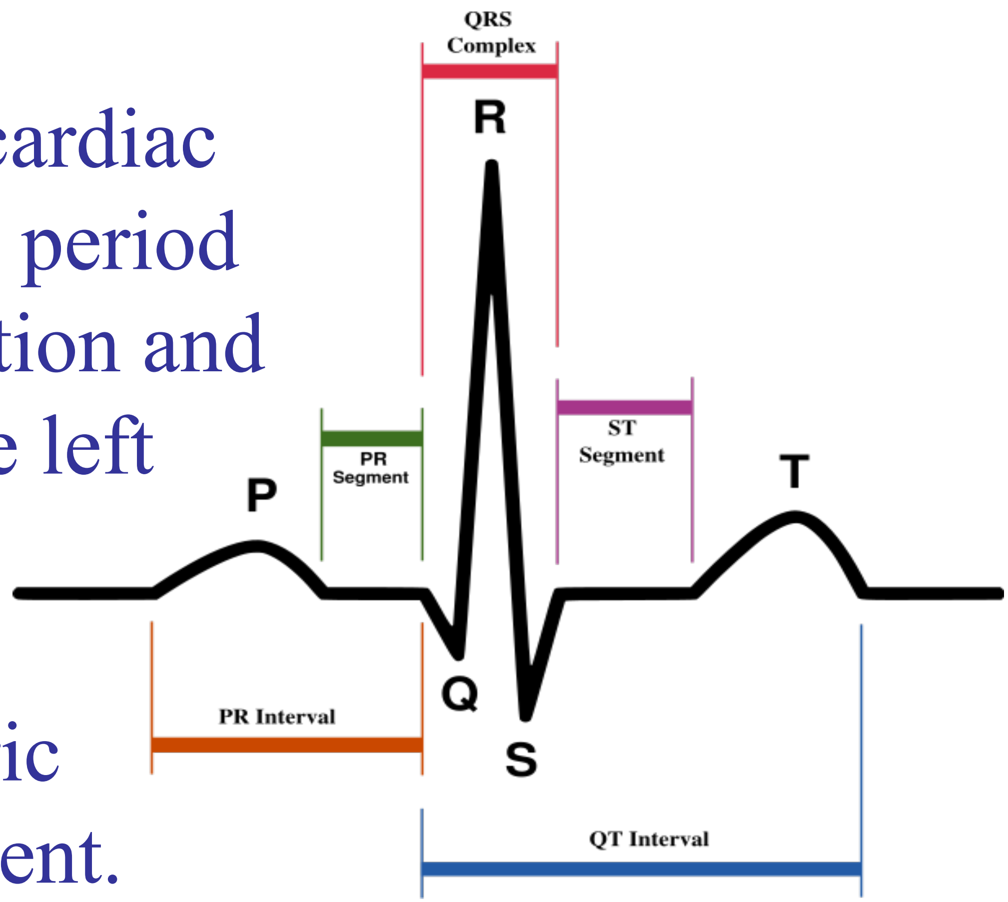
ST segment of the cardiac cycle represents the period between depolarization and repolarization of the left ventricle.

In normal state, ST segment is isoelectric relative to PR segment.



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ST segment deviation episode requires

- ST segment
- Isoelectric level
- ST deviation=ST segment - isoelectriclevel

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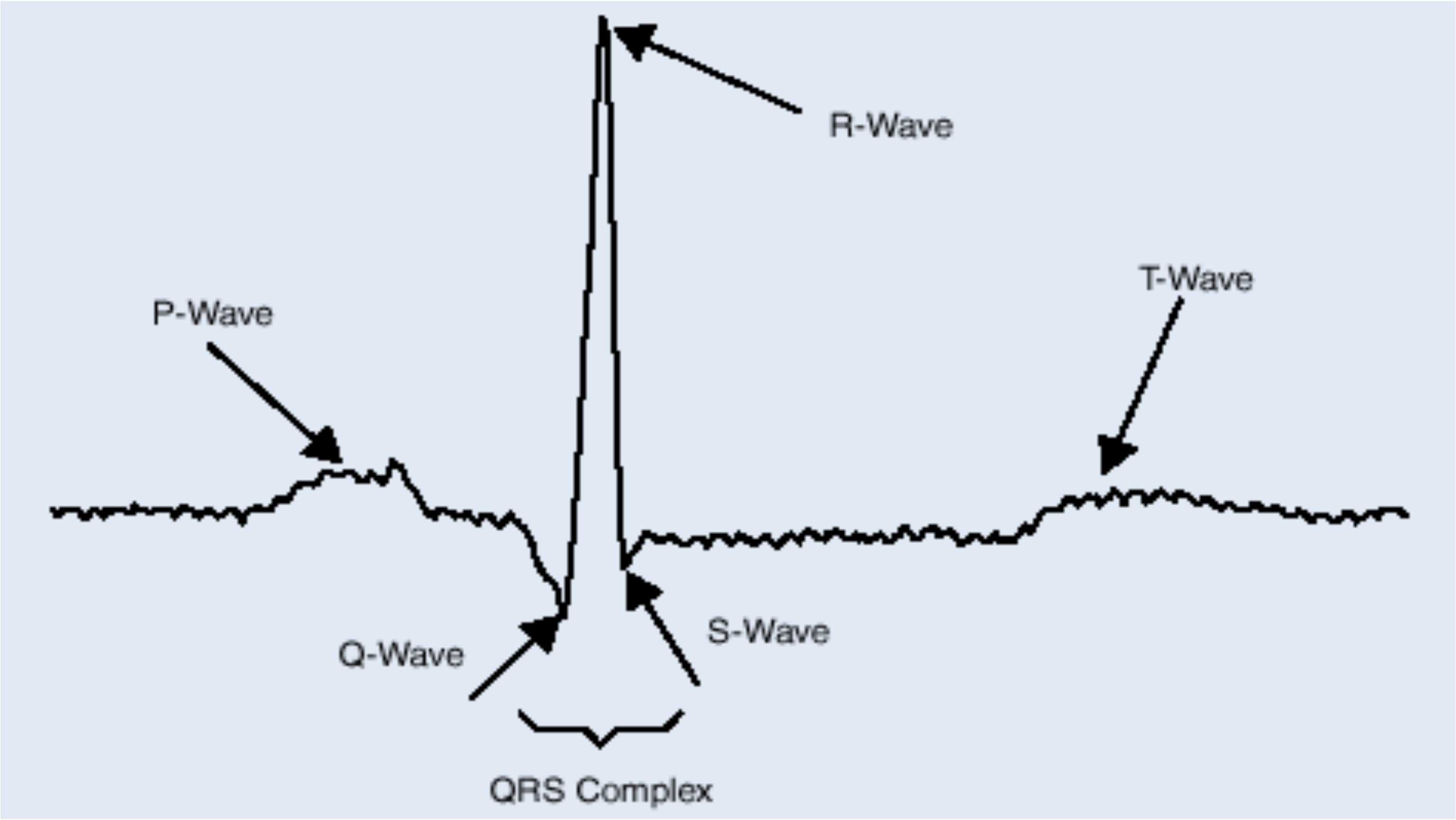
QRS detection



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QRS detection

In order to proceed with ST deviation:

•QRS onset

•QRS offset

•QRS fudicial point.

•DWT (discrete wavelet transform) based QRS detector .

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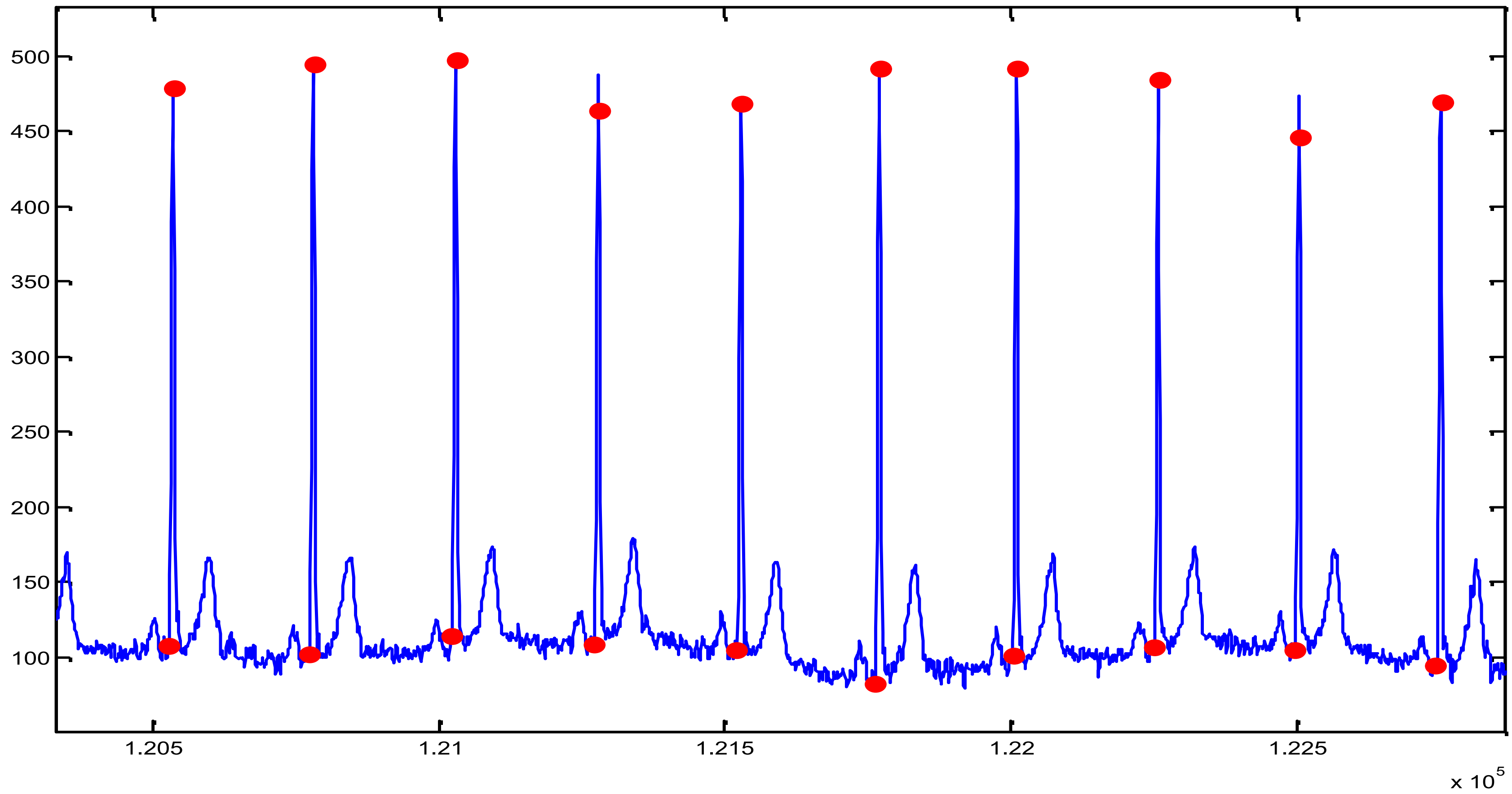
EDC Database Subject #e0103 QRS points



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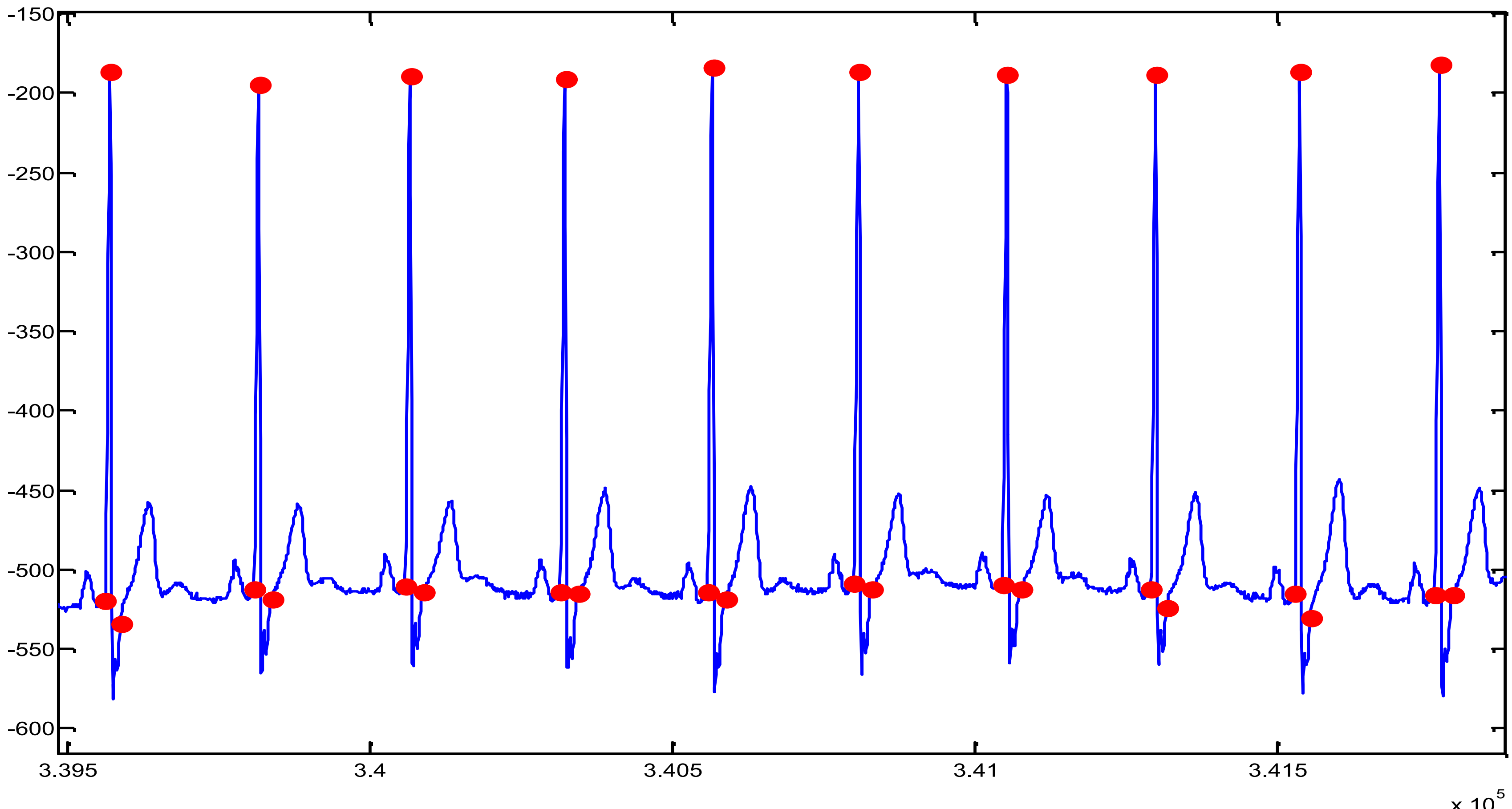
EDC Database Subject #e0509 QRS points



Isoelectric level:

- Flattest region on the signal
- Value equal or very close to zero.
- Region starts 80ms before the QRS on
- Ends at QRS on.

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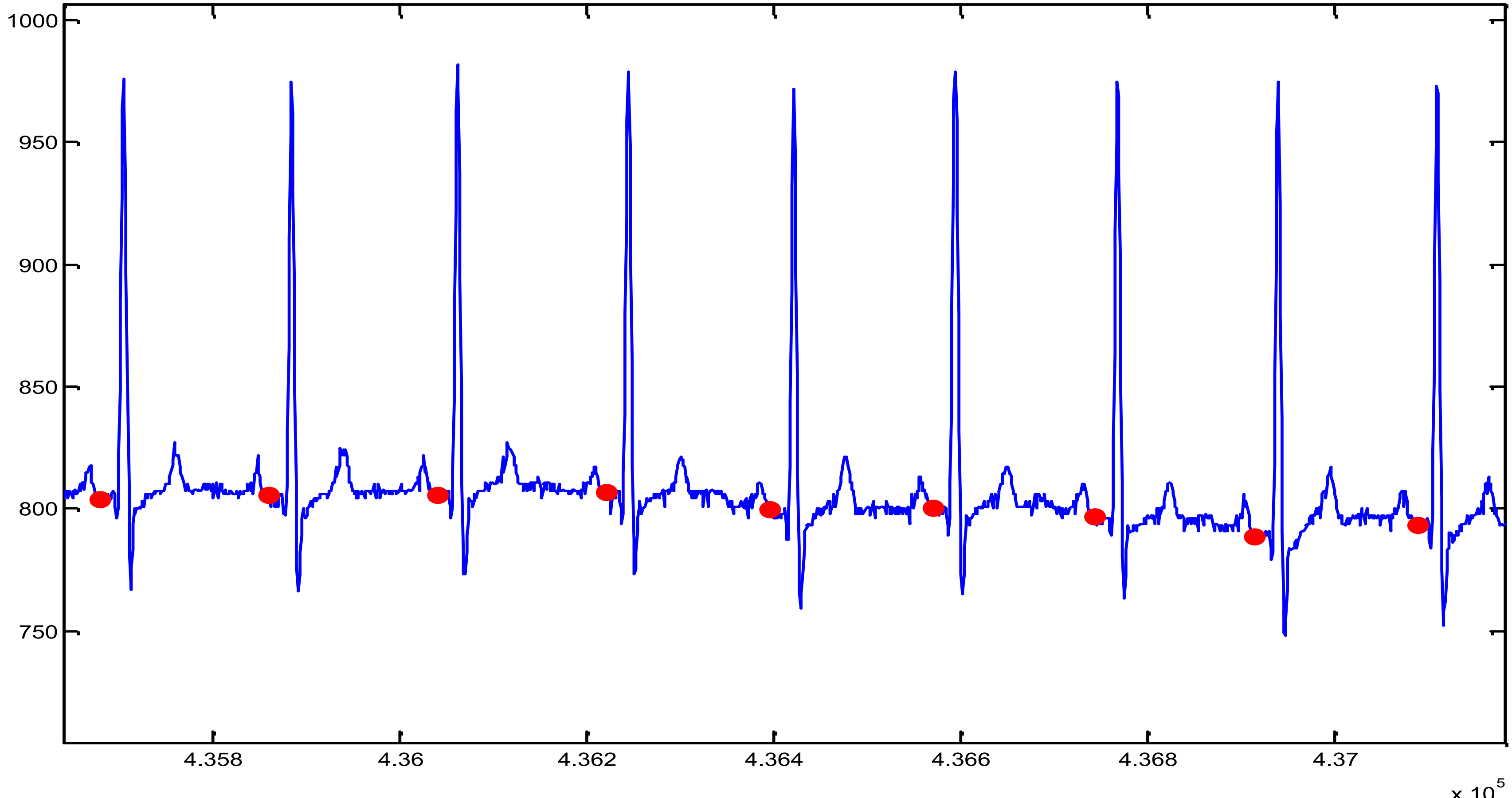
EDC Database Subject #e0515 Isoelectric level



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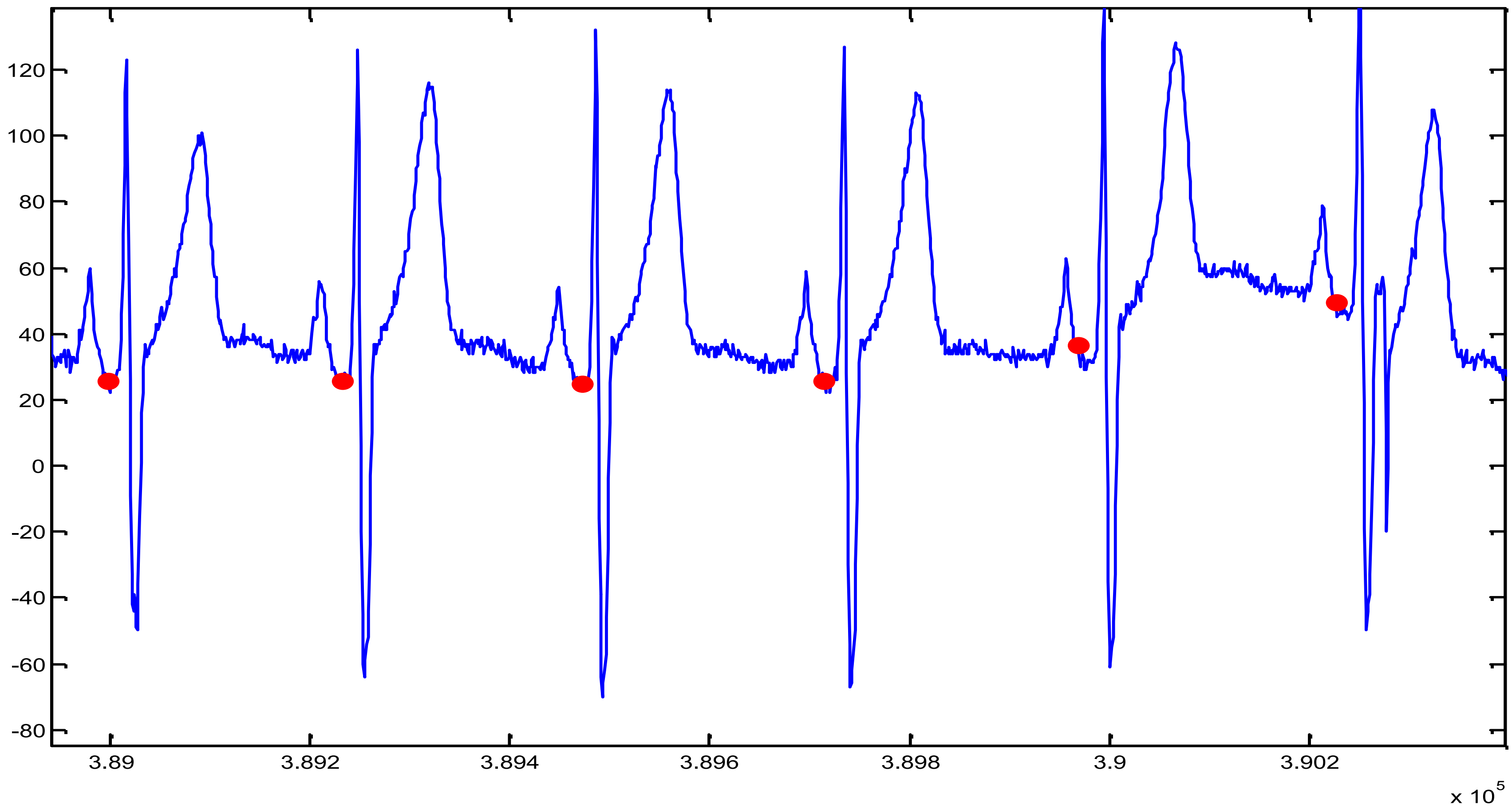
EDC Database Subject #e1301 Isoelectric level



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Feature extraction:

- ST region refers as ROI (region of interest)
- ROI (26 samples after the qrs_off)
- Subtraction Isoelectric level from ROI
- ST deviation

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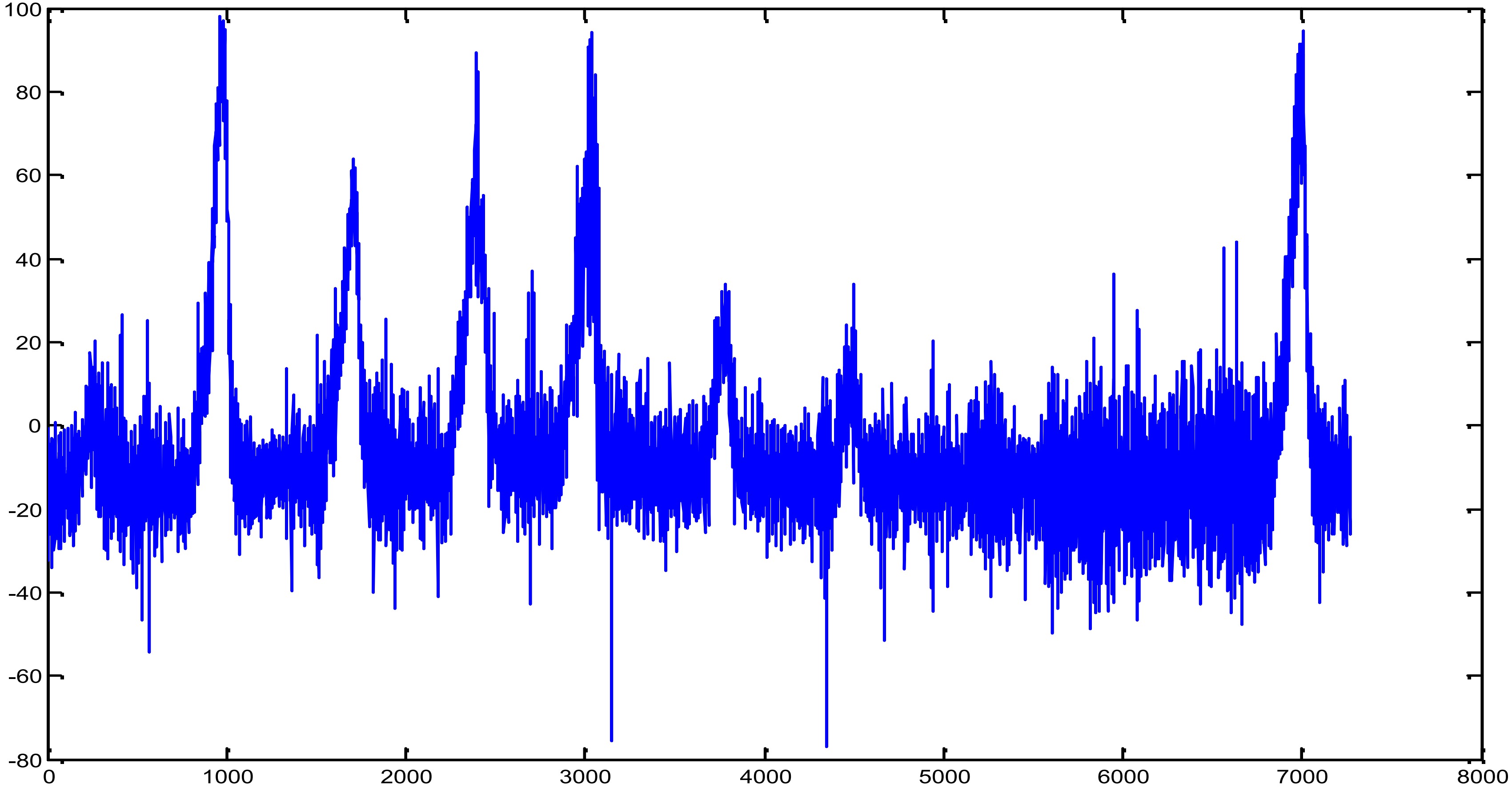
ST deviation:e103_MLIII



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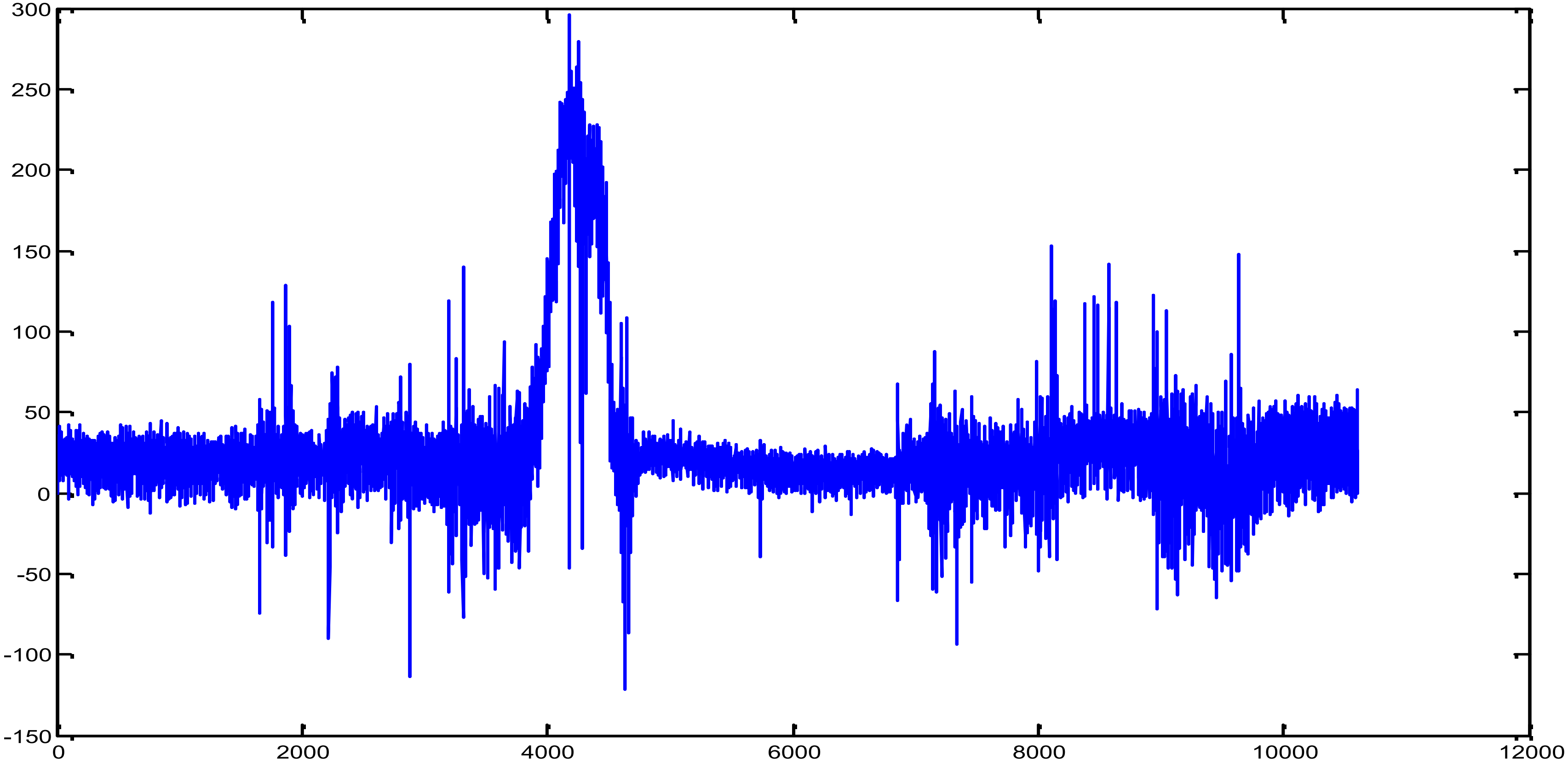
ST deviation:e121_MLIII



Data Normalization:

- Equal weightage of all the features
- Mean of the data (u)
- Standard deviation of the data (Std)
- Normalized data=(x - u)/ Std

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Feature Space:

- Size of the features is 26 X no. of beats of each subject
- Which is more time consuming when it comes to classify or train a neural network for it.

PCA(Principal component analysis):

PCA is used for Dimensionality Reduction.

Why Dimensionality Reduction ?

- Reduces time complexity: Less computation
- Reduces space complexity: Less parameters
- Saves the cost of observing the feature

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PCA(Principal component analysis):

Here we chose some k<n features ignoring the remaining features. n is total number of Features.

Our objective here is to chose the best feature set that contributes the most in classification out of the given Data set.

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PCA(Principal component analysis):

Procedure:

1. Project the data as 1-dimensional Data sets
2. Subtract mean of the data from each data set
3. Combine the mean centered data sets (mean centered matrix)
4. Multiply the mean centered matrix by it’s transpose (Covariance matrix)

PCA(Principal component analysis):

Procedure:

5. This covariance matrix has up to P eigenvectors associated with non-zero eigenvalues.
6. Assuming P<N. The eigenvectors are sorted high to low.
7. The eigenvector associated with the largest eigenvalue is the eigenvector that finds the greatest variance in the data.

PCA(Principal component analysis):

Procedure:

8. Smallest eigenvalue is associated with the eigenvector that finds the least variance in the data.
9. According to a threshold Variance, reduce the dimensions by discarding the eigenvectors with variance less than that threshold.

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Training of MLIII Data

- Total beats: 184246
- Used for Training NN: 52493
- Used for Cross-validation: 20123
- Used for Testing: 110595

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Training Results

Lead	Total Beats	Training Beats	Cross-Validation Beats	Cross-Validation Error
MLIII	73651	52493	20123	0.068%

Accuracy Parameters

TP (True Positives)

Target and predicted value both are positives.

FN (False Negative)

Target value is +ive and predicted one –ive.

FP (False Positive)

Target value is –ive and predicted one +ive.

TN (True Negative)

Target and predicted both are –ive.

Accuracy Parameters

Sensitivity

TP/(TP+FN)*100

Specificity

TN/(TN+FP)*100

MLIII Data

Lead	Total beats	Normal	Ischemic
MLIII	184246	174830	9416
Training	73651	68939	4712
Testing	110595	105891	4704

MLIII Testing Results

Lead	No.0f Beats	Sensitivity	Specificity	Threshold
MLIII	110595	21%	99%	0
MLIII	110595	4%	99%	0.7
MLIII	110595	76%	72%	-0.7

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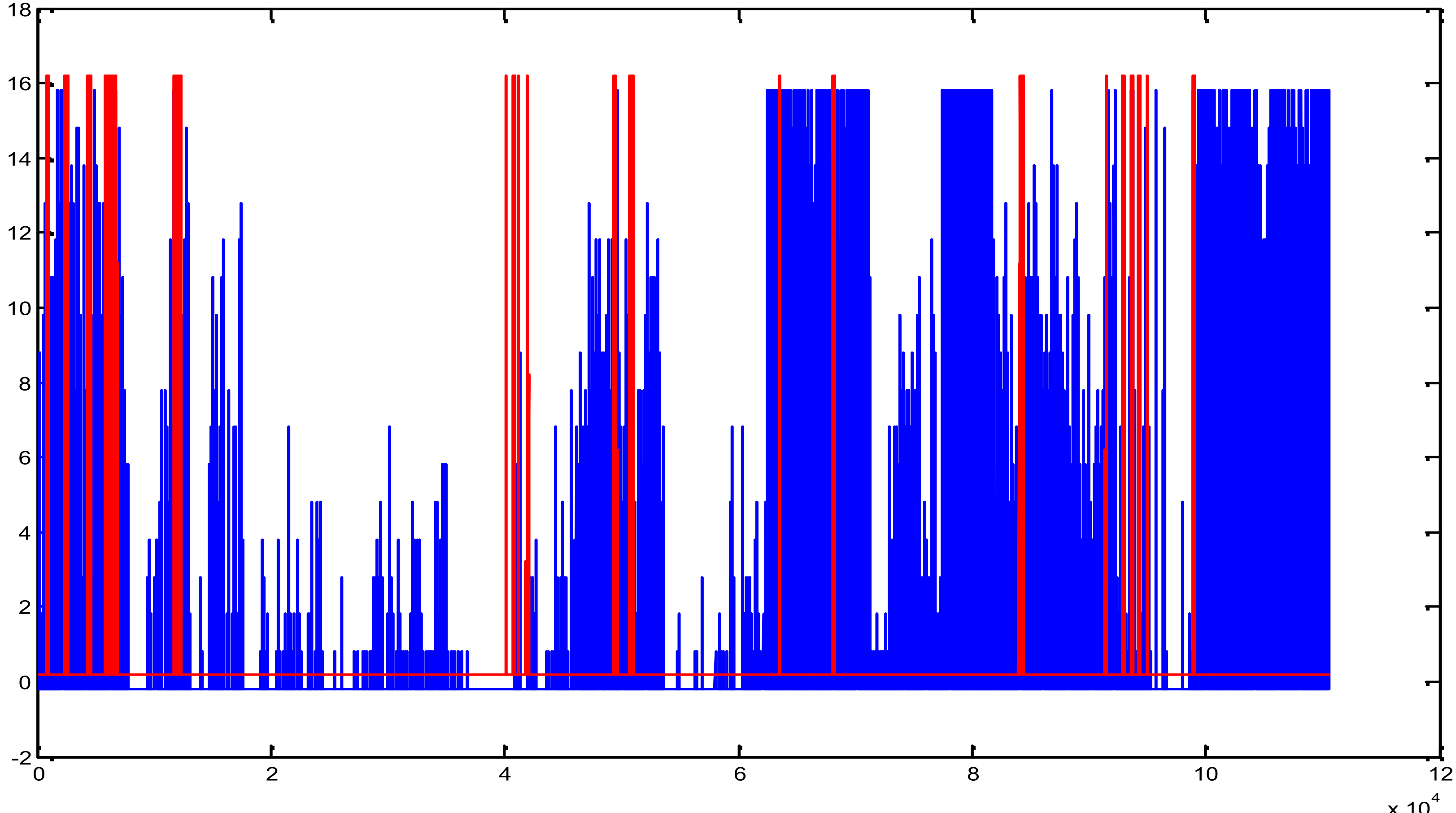
MLIII Results



MLI Data Results

Lead	Sensitivity	specificity	Threshold
MLI	42%	35%	-0.78

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V1 Data Results

Lead	Sensitivity	specificity	Threshold
V1	58%	51%	-0.69

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V2 Data Results

Lead	Sensitivity	specificity	Threshold
V2	54%	46%	-0.73

V3 Data Results

Lead	Sensitivity	specificity	Threshold
V3	75%	58%	-0.82

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Analysis:

Where is the problem?

- QRS detection
- Baseline removal
- ST segment and Isoelectric level detection
- Data Labels

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Analysis:

QRS detection

- no problem with QRS detector
- Detects QRS on, off and fuducial points efficiently

Baseline removal

- Used world wide for the variation of ST segment so nothing is wrong with this one.

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Analysis:

ST segment and Isoelectric level detection

•If QRS detector has no problem than ST segment and Isoelectric levels has absolutely no problem

Data Labels

•No problem with Data labels because I match them with online physionet Database viewer.

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Summary:

- Ischemic Signal
- QRS Detection and Base line removal
- Detection and removal of Isoelectric level
- Feature extraction and reduction (PCA)
- Results & Analysis

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[6] Papaloukas, C., et al. *A robust knowledge-based technique for ischemia detection in noisy ECGs*. in *Knowledge-Based Intelligent Engineering Systems and Allied Technologies, 2000. Proceedings. Fourth International Conference on*. 2000.

[7] Meyer, C.R. and H.N. Keiser, *Electrocardiogram baseline noise estimation and removal using cubic splines and state-space computation techniques.* Comput. Biomed. Res. , 1977. **10**: p. 459- 470.

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THANKS…..