Milestone2 Report

Tianshu Chen   Zeyu Zhai   Haojing Yu

Purpose: In milestone2, we perform feature extraction from FHR data (Fetal Heart Rate) which is sampled by medical machine to record heart rate (bpm) beats per minute. The feature we extraction includes:

1. FHR Baseline
2. Baseline Variability
3. Acceleration
4. Deceleration

We tried to include another feature --- Uterine contraction, but the definition in data-level (wave patterns) is not clear.

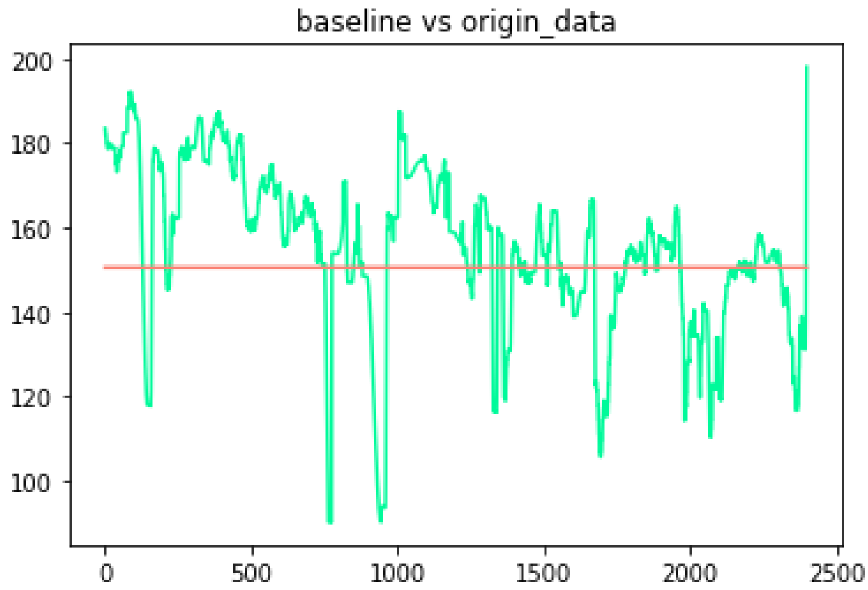
FHR Baseline

From "*The 2008 National Institute of Child Health and Human Development Workshop Report on Electronic Fetal Monitoring*", we find the definition as follows: The baseline FHR is determined by approximating the mean rounded to increments of 5 beats per minute (bpm) during a 10minute window, excluding accelerations and decelerations and periods of marked FHR variability (25 bpm).

Inspiration

The strategy we use to find baseline is to iteratively reduce peaks and valleys until we have about 2 minutes data-length. In terms of sample size, that will be 480 samples, as 1 minute stand for 240 sample. After deleting peaks and valleys, we can simply calculate the mean of the remain.

Result as follow:



Baseline value = 150.57931210526314, which is a normal baseline.

Baseline Variability

Baseline FHR variability is determined in a 10-minute window, excluding accelerations and decelerations. Baseline FHR variability is defined as fluctuations in the baseline FHR that are irregular in amplitude and frequency.

We can simply find baseline variability from the “remain”. For each peaks and valleys left, we find the range of it, for example, the onset of an acceleration to peak.

After that, we classify the 4 different baseline variability:

1. Absent FHR Variability
2. Minimal FHR Variability
3. Moderate FHR Variability
4. Marked FHR Variability

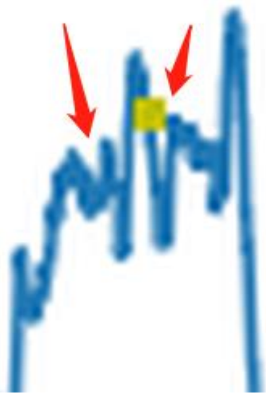
Regarding their characteristics, the amplitude ranges, we construct result as follow:

Variability Type	Number of Variability
moderate variability	887
marked variability	300
minimal variability	606
absent variability	0

Acceleration & Deceleration

The way we find acceleration and deceleration is a little bit “tricky”. Since the waveform is not consecutive growing, that means no part of the waveform can satisfy the requirement: an increase from the onset of acceleration to the peak in 30 seconds. 30 seconds stand for 120 samples.

For example, in the following picture, even the accelerating peak has small part that goes down for a while, which cause in-consecutive.

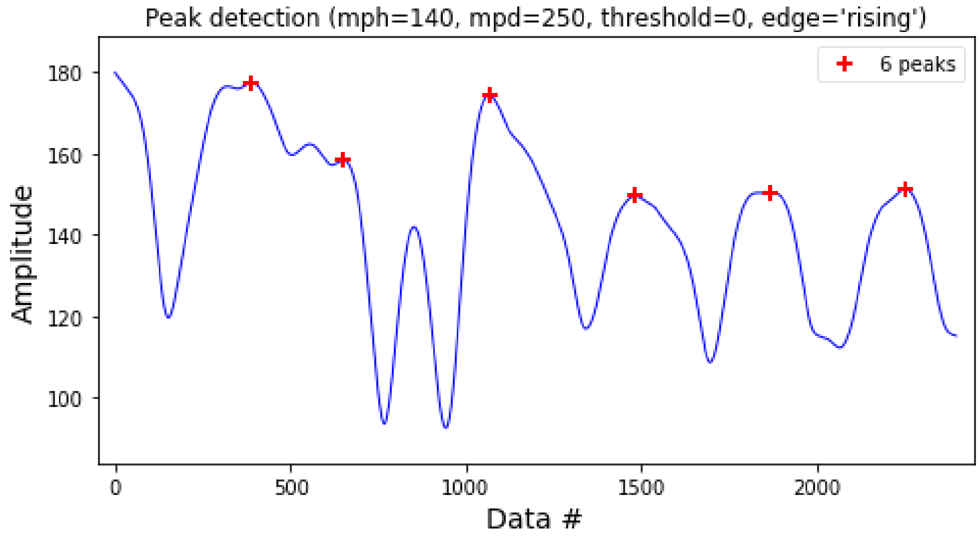


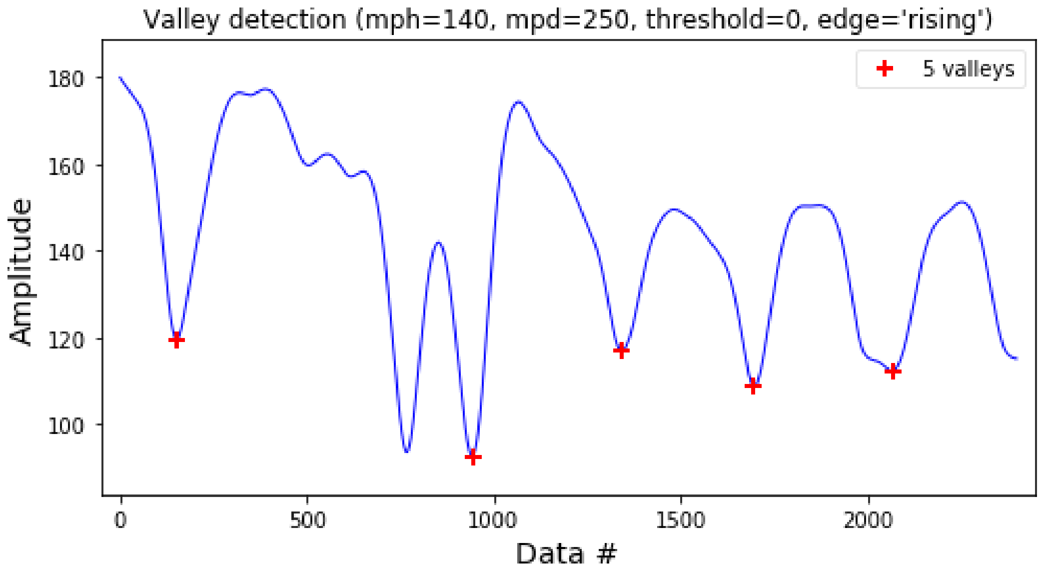
The way we solve this is to use a smoothing filter to filter out these edges to make an approximate version of the original waveform. The method we use is called “" *Asymmetric Least Squares Smoothing*" by P. Eilers and H. Boelens in 2005”.

Smoothing Method: Asymmetric Least Squares

We use the Asymmetric least squares (ALS) approach, in which the squared error loss function is given different weights depending on whether the residual is positive or negative. The kernel method based on locally linear fit is adopted, which also provides an estimator of the derivative of the regression function. Under the assumption that the observations are strictly stationary and ρ-mixing the asymptotic normality for the estimators of conditional expectiles is established by using the convexity lemma.

After smoothing, we can have a smooth and consecutive waveform:





In this way, we can find the acceleration and deceleration. We find the range of acceleration and deceleration and label it in the original waveform.

Way to find ranges:

For the acceleration and deceleration, we start from the peak/

valley and going backward (left indexing) and record the first item that give a negative difference.

Figure on the left show the range of peaks, from the red arrow to the peak point. Figure on the right show the range of the valleys, from the red arrow to the valley point.

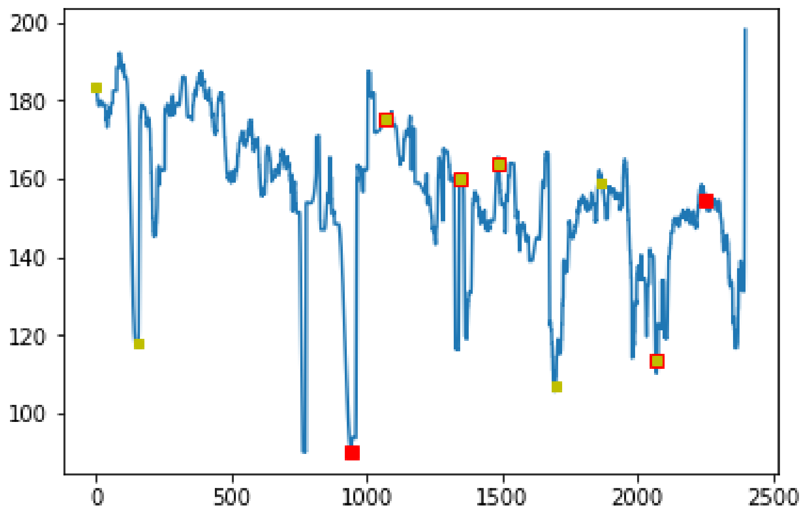
Results shows:

Acceleration ranges:

[943, 1067, 1343, 1483, 2067, 2253]

Deceleration ranges:

[0, 152, 1067, 1343, 1483, 1697, 1868, 2067]



The yellow dots-pairs represent deceleration range, each two represent the starting position and the ending position. The red dots-pairs represent acceleration ranges in the same way.

None of them is a “Prolong” acceleration/deceleration.