Assignment 2

Hans Harder, s3754766

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Overview Each time the heart contracts, it will send out an electric signal which can be measured. The ECG measures the voltage between two given extremities (e.g. LL_LA measures the difference from left leg to left arm).

- LL = Left Leg
- LA = Left Arm
- RA = Right Arm

Task 4. See Figure 1. The following procedure was used to find the heartbeats:

1. Initialize an empty list l of indices.
2. Find global minimum $\min_g$.
3. Select area a with width ± 150 around $\text{index}(\min_g)$ and find maximum $\max_l$ in this area.
4. The area contains a valid heartbeats if

$$5 < \text{index}(\max_l) - \text{index}(\min_g) < 20 \tag{1}$$

5. If parts of the heartbeat are missing on the left side: select the first value of the sample and copy it to the beginning until the target width of 300 is reached.
6. If parts of the heartbeat are missing on the right side: select the last value of the sample and copy it to the end until the target width of 300 is reached.

7. Remove a from the column.

8. Add index($\min_g$) to l.

9. Repeat from 2. until no area is left.

Do this procedure for LL_RA and LL_LA and union the results (it could be that we find heartbeats in LL_RA which we don't find in LL_LA and vice versa). Take the resulting list of indices and extract the respective samples from ECG_LL_RA_24BIT_CAL, ECG_LL_LA_24BIT_CAL and ECG_LA_RA_24BIT_CAL.

Task 5. The method used above does not require any interpolation, as each sample already has the same length.

Task 6. See Figure 3, 2 for plotted densities of samples 50, 100, 150 and 200.

- LL_RA shows more evenly distributed density values in comparison to LL_LA. This implies a more wide range of values, resulting in more "jittery" heartbeat samples.
- LL_LA shows more peaks in its density plot, implying a more consistent heartbeat (e.g. T and P intervals almost equal).
- in LL_LA the QRS-complex can also be seen in form of a small bump after the main density peak (e.g. the green line at 5.25).
- LA_RA has the highest peaks (e.g. black and yellow at 2.5), which shows that most of the samples tend to stay around the same value.

Task 7. See Figure 7, 5, 6 for standardized heartbeats.

Task 8. See Figure 9, 8 and 10 for the plotted densities of 5 selected samples from the standardized heartbeats.

- LL_RA has lower density peaks, which speaks for more distributed values over the interval from -2 to 1.

- LA_RA as well as LL_LA have very high density peaks, which shows that the heartbeat is more even. However, LL_LA also shows smaller density peaks on the right side of the main peak for almost each sample which is the QRS-complex.

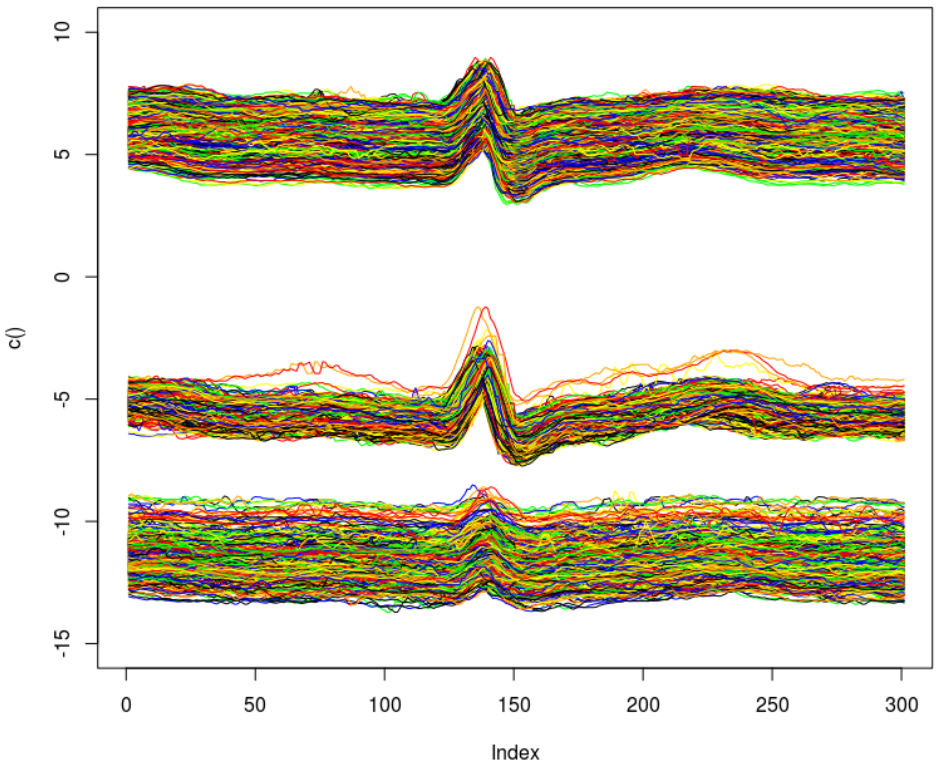

Figure 1: Heartbeats. Shows the heartbeats extracted from columns ECG_LL_RA_24BIT_CAL, ECG_LL_LA_24BIT_CAL and ECG_LA_RA_24BIT_CAL respectively. Samples $\in [3, 10]$ are from LL_RA, samples $\in [-8, 0]$ from LL_LA and the remainder from LA_RA.

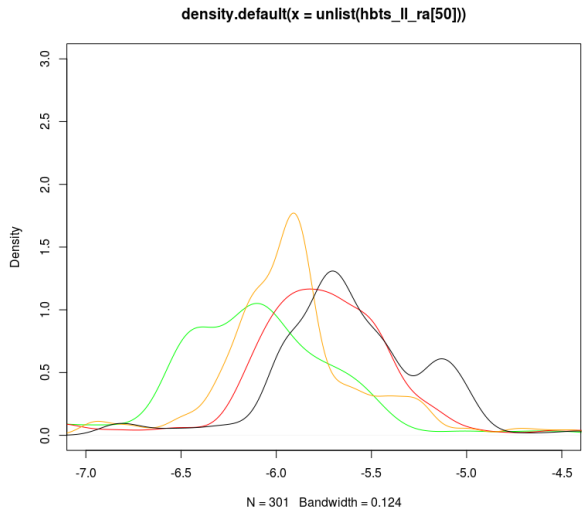

Figure 2: Density of heartbeats from column ECG_LL_RA_24BIT_CAL. Sample No. 50 is green; 100 is red; 150 is orange; 200 is black.

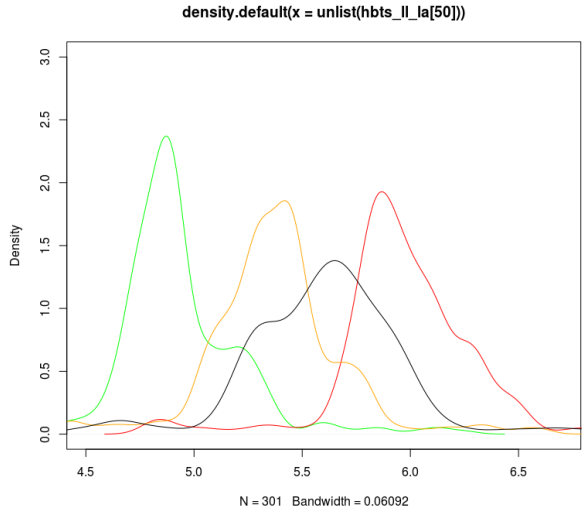

Figure 3: Density of heartbeats from column ECG_LL_LA_24BIT_CAL. Sample No. 50 is green; 100 is red; 150 is orange; 200 is black.

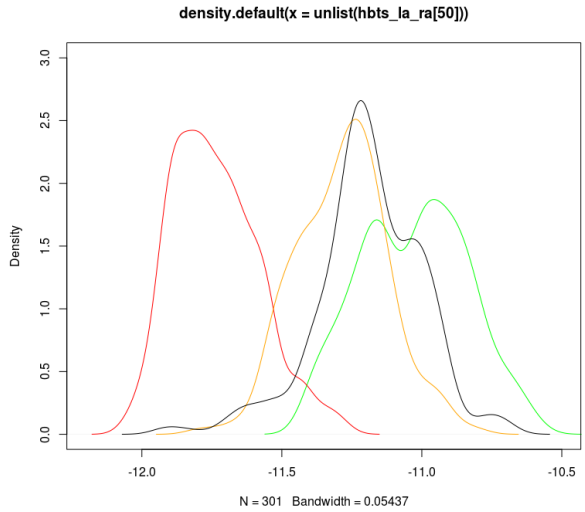

Figure 4: Density of heartbeats from column ECG_LA_RA_24BIT_CAL. Sample No. 50 is green; 100 is red; 150 is orange; 200 is black.

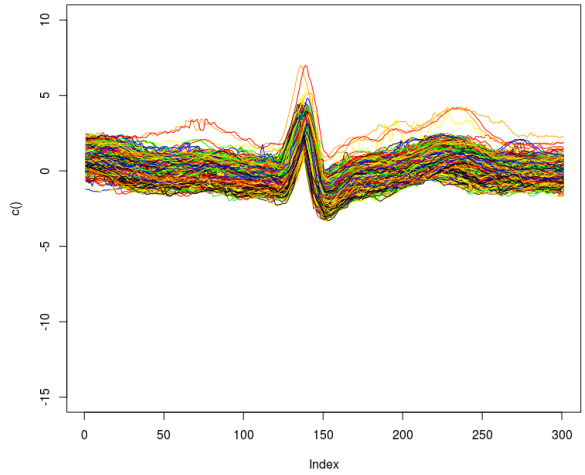

Figure 5: Standardized Heartbeats from column ECG_LL_RA_24BIT_CAL.

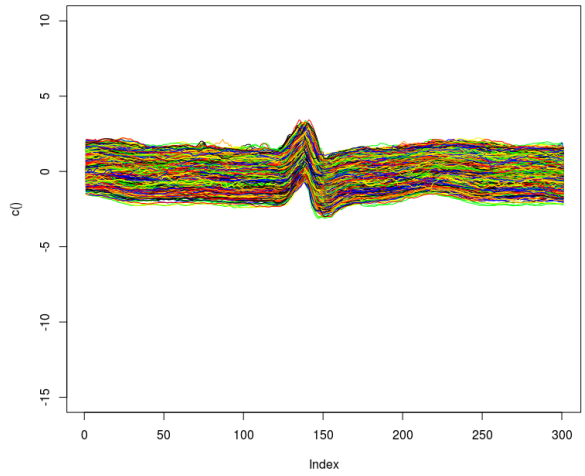

Figure 6: Standardized Heartbeats from column ECG_LL_LA_24BIT_CAL.

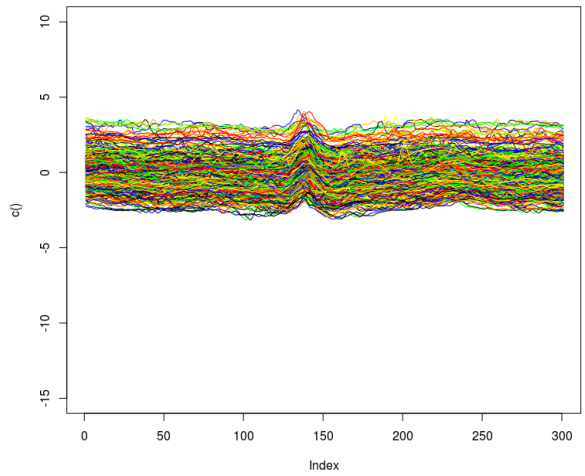

Figure 7: Standardized Heartbeats from column ECG_LA_RA_24BIT_CAL.

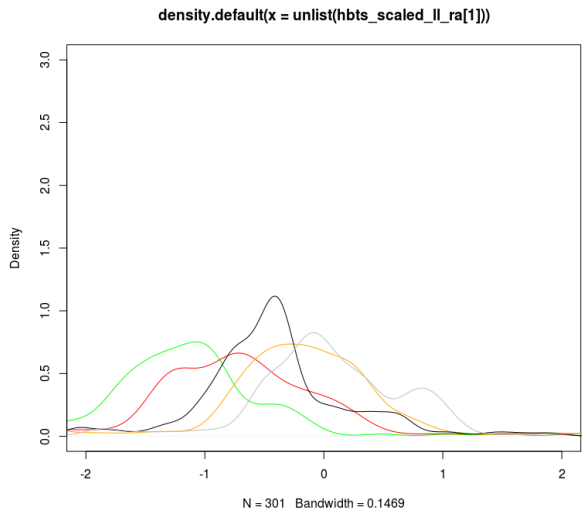

Figure 8: Density of standardized samples (indices: 1 - green, 50 - red, 100 - orange, 150 - black, 200 - grey) from column ECG_LL_RA_24BIT_CAL.

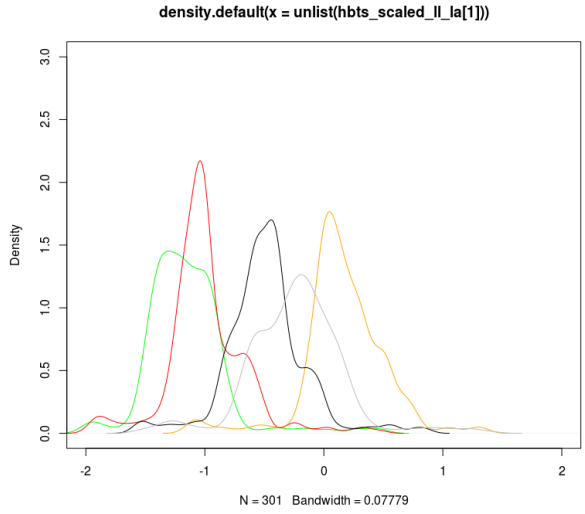

Figure 9: Density of standardized samples (indices: 1 - green, 50 - red, 100 - orange, 150 - black, 200 - grey) from column ECG_LL_LA_24BIT_CAL.

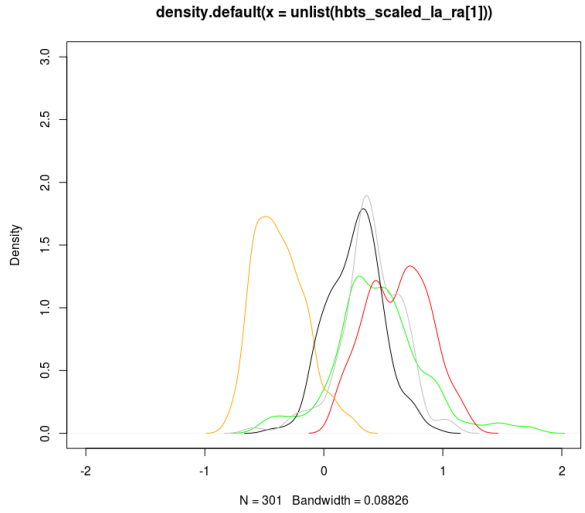

Figure 10: Density of standardized samples (indices: 1 - green, 50 - red, 100 - orange, 150 - black, 200 - grey) from column ECG_LA_RA_24BIT_CAL.