The R-R Interval

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Cardiac output is typically recorded in the form of ECG which contains several clearly identifiable peaks, see Fig. 1. In particular, the R peaks are dominant sharp peaks in the waveform. Most analysis is performed on a time series derived from the ECG – the RR interval (RRI) – which is the time difference between consecutive R peaks.

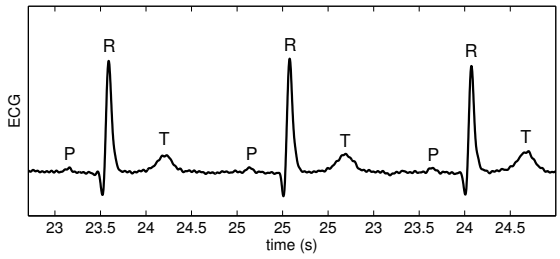

Figure 1: ECG waveform. Observe that R peaks – dominant sharp peaks in ECG waveform – can be clearly distinguished.

To generate the RRI from ECG (see Fig. 2), the following steps must be performed:

- Bandpass filter the ECG (see Fig. 3). Suggested range 5 - 20 Hz.
- Calculate the time instants at which R peaks – dominant sharp peaks in ECG waveform – occur.
- Calculate the time difference between successive R peaks (see Fig. 4).
- Plot time differences between successive R peaks as a function of time (see Fig. 5).
- Interpolate at regular sample intervals to obtain the RR interval (RRI) time series (see Fig. 6). It is recommended to sample at intervals no larger than 0.25 s (sampling frequency no less than 4 Hz). Cubic spline interpolation is the preferred method of interpolation.

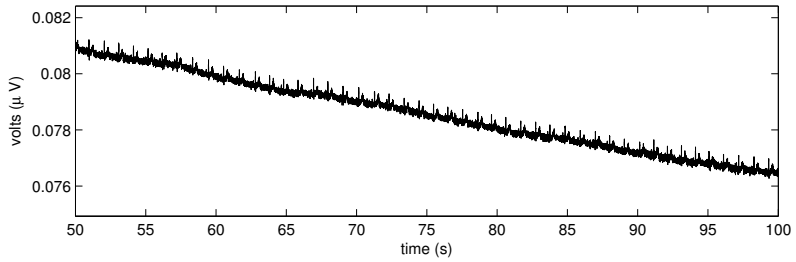

Figure 2: Raw ECG time series with noise and trend (time segment shown: 50 - 100 s).

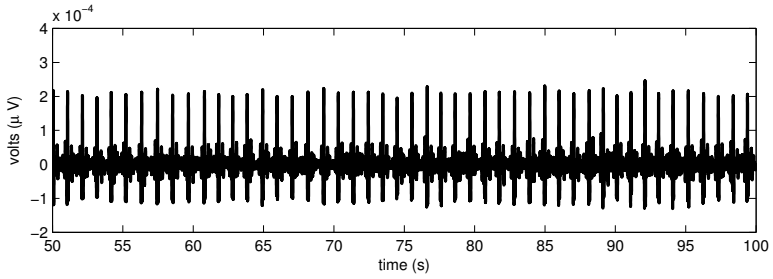

Figure 3: Bandpass filter the ECG time series (time segment shown: 50 - 100 s). In the above, the time series is filtered within the range 5 to 20 Hz.

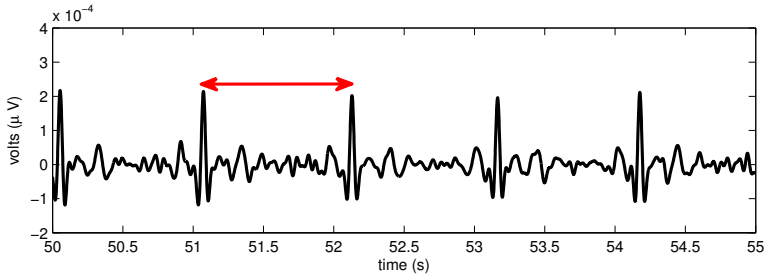

Figure 4: Calculate the difference between successive R peaks (time segment shown: 50 - 55 s).

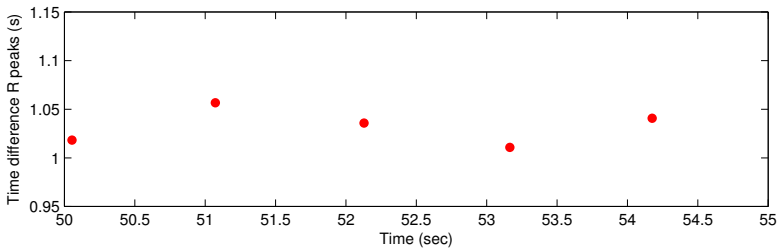

Figure 5: Plot the time differences between successive R peaks as function of time (time segment shown: 50 - 55 s).

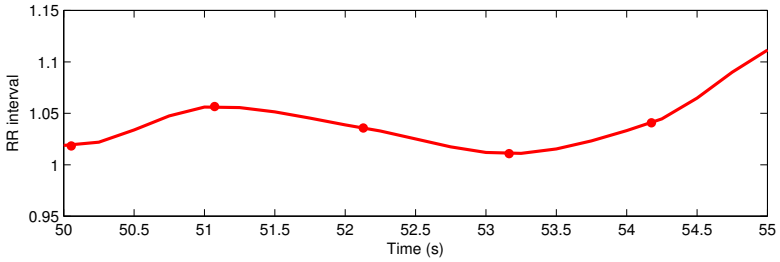

Figure 6: Interpolate at regular sample intervals to obtain the RR interval (RRI) time series (time segment shown: 50 - 55 s).

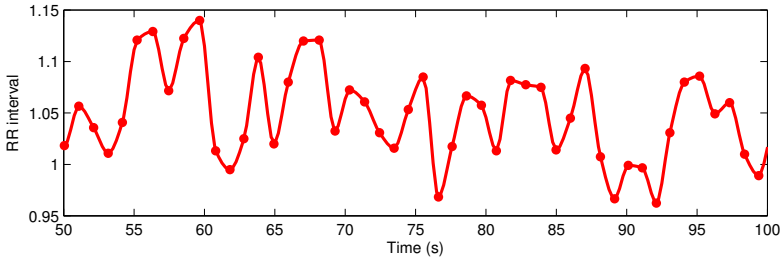

Figure 7: The RRI time series (time segment shown: 50 - 100 s).