Respiratory Rate Determination by Non-Invasive Means

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1 Introduction

1.1 Background

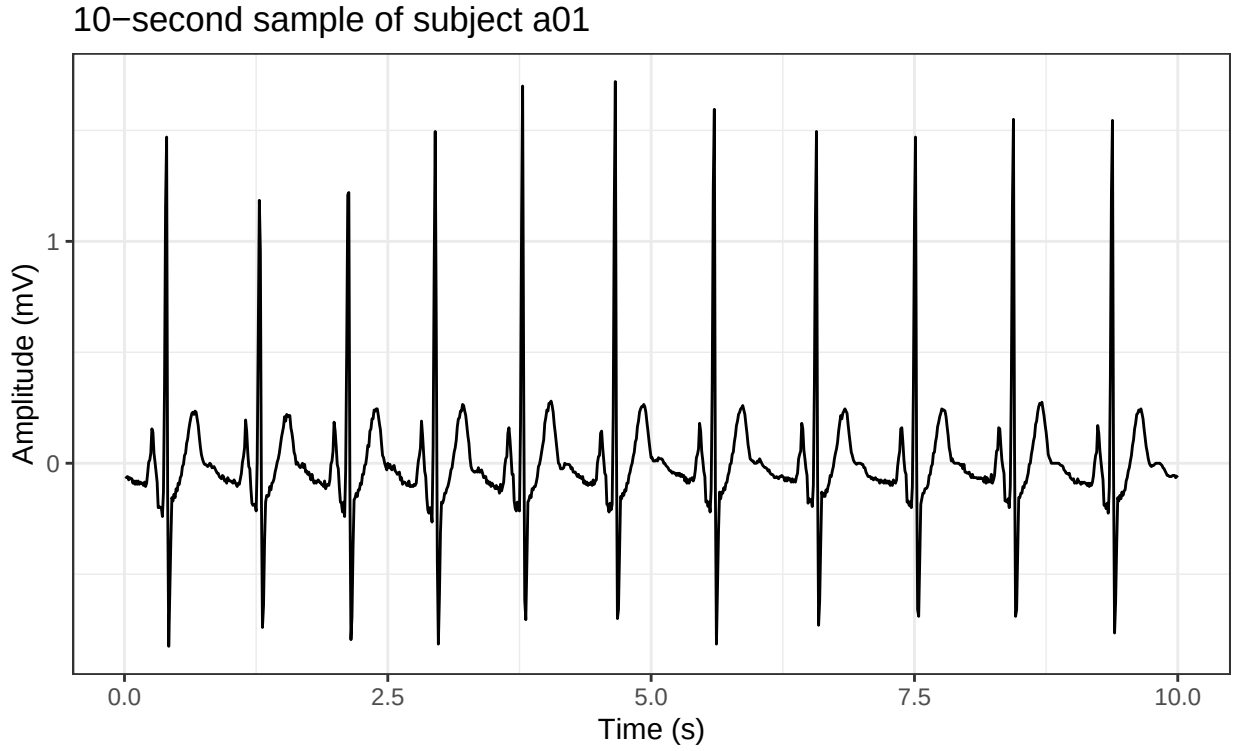
(Penzel et al., 2000).

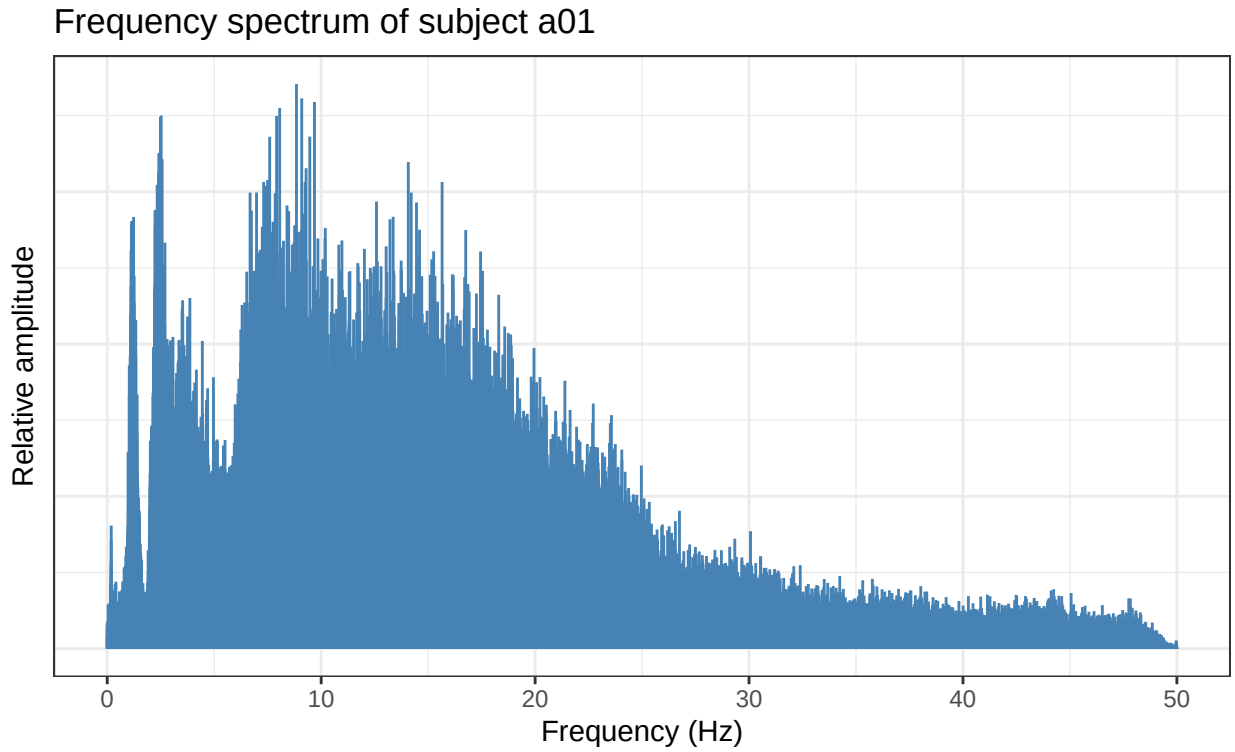
2 The data

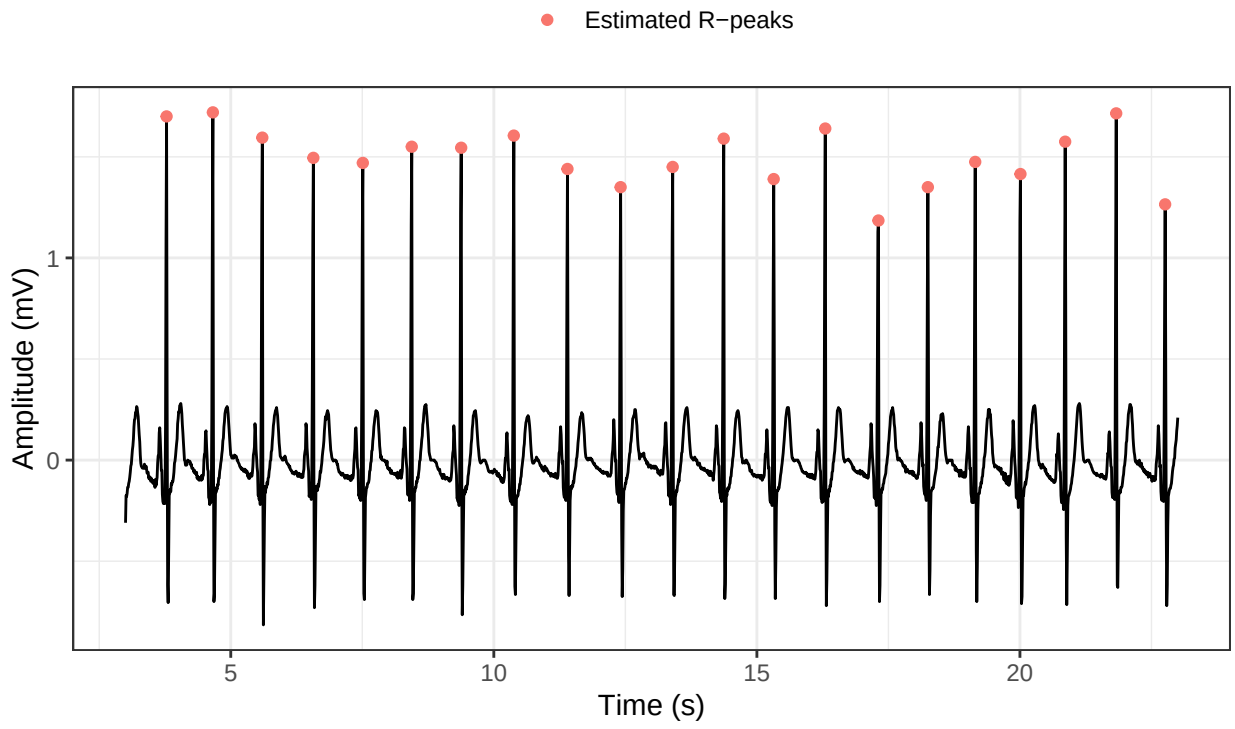
2.1 Data source

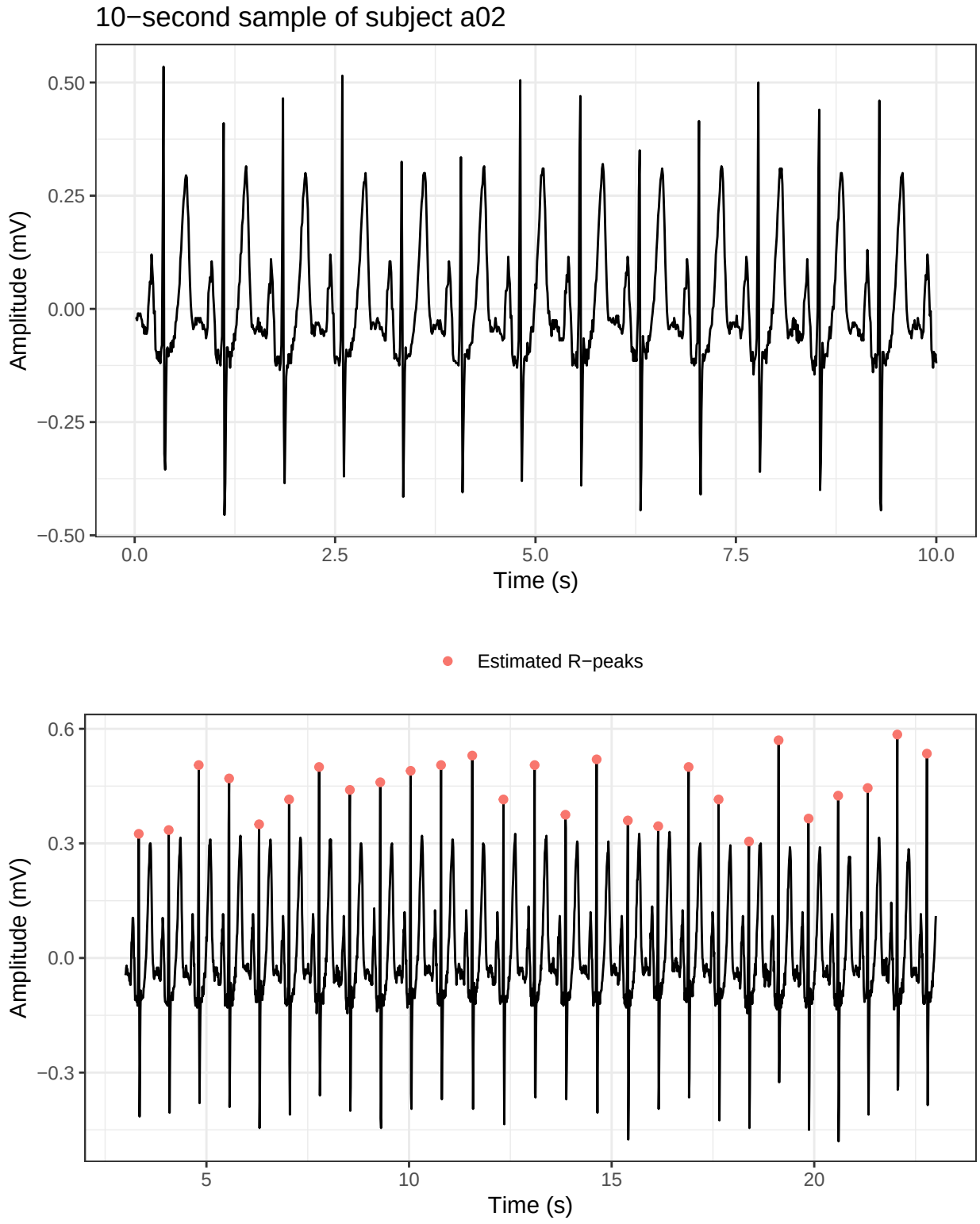
(Goldberger et al., 2000).

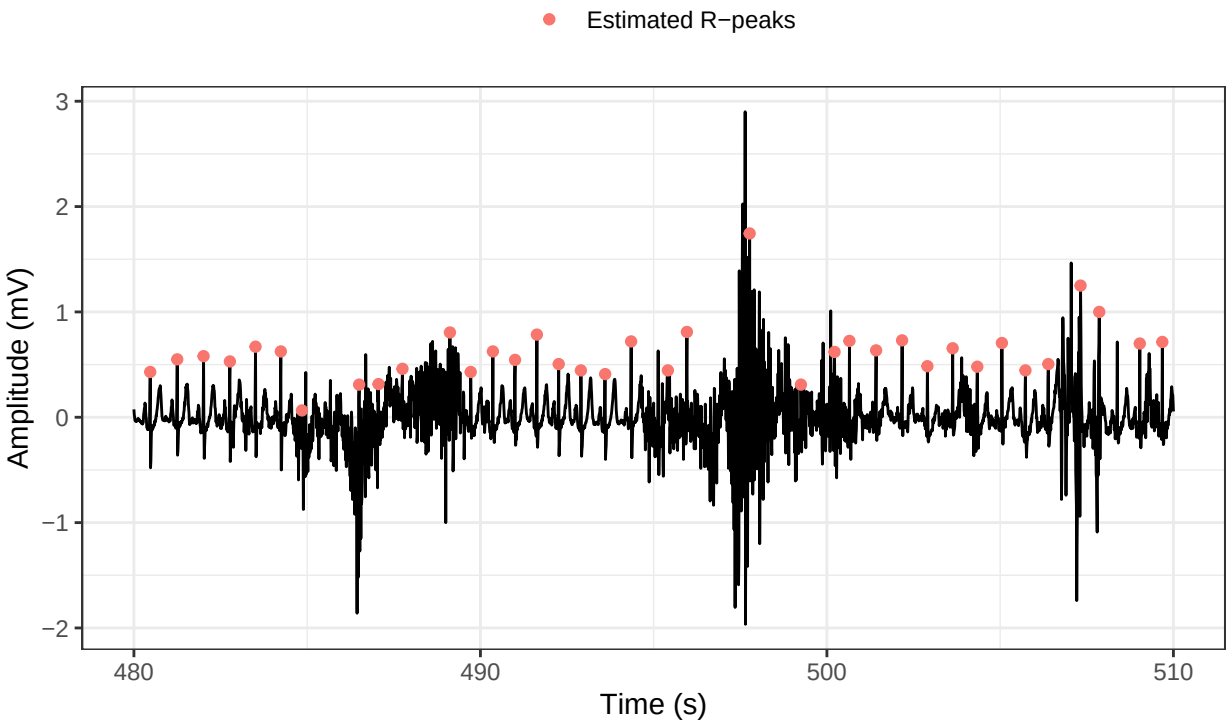
2.2 Sample plot

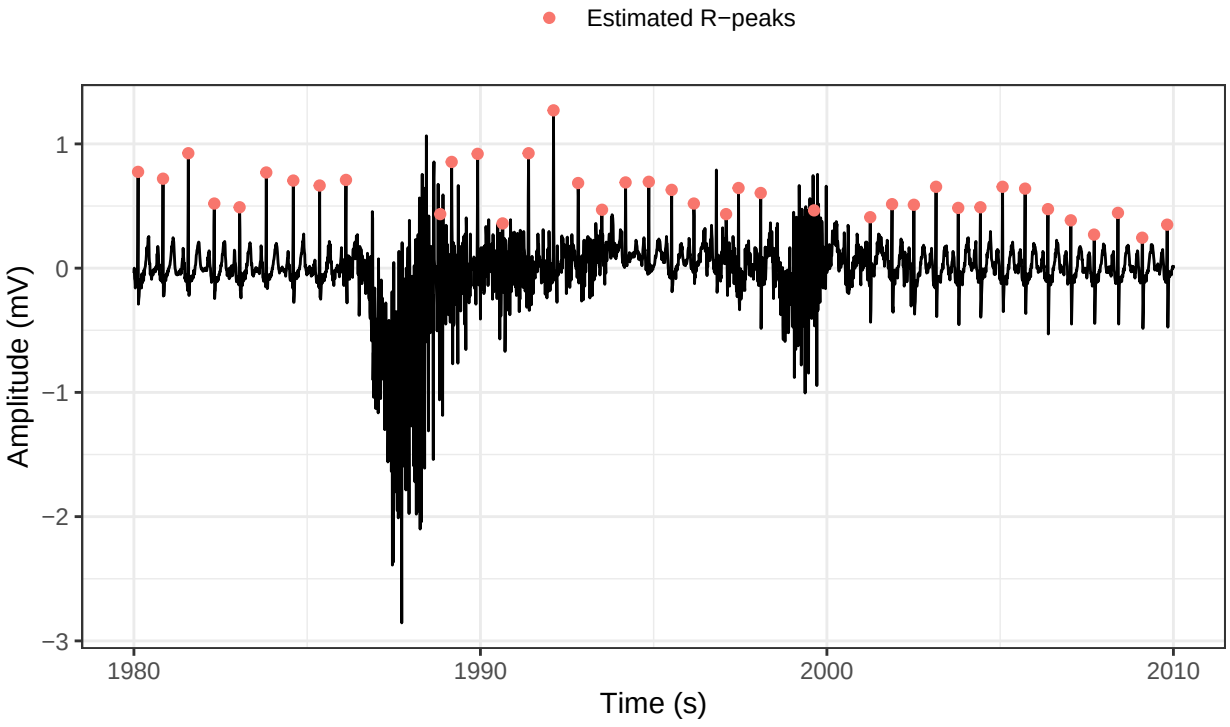


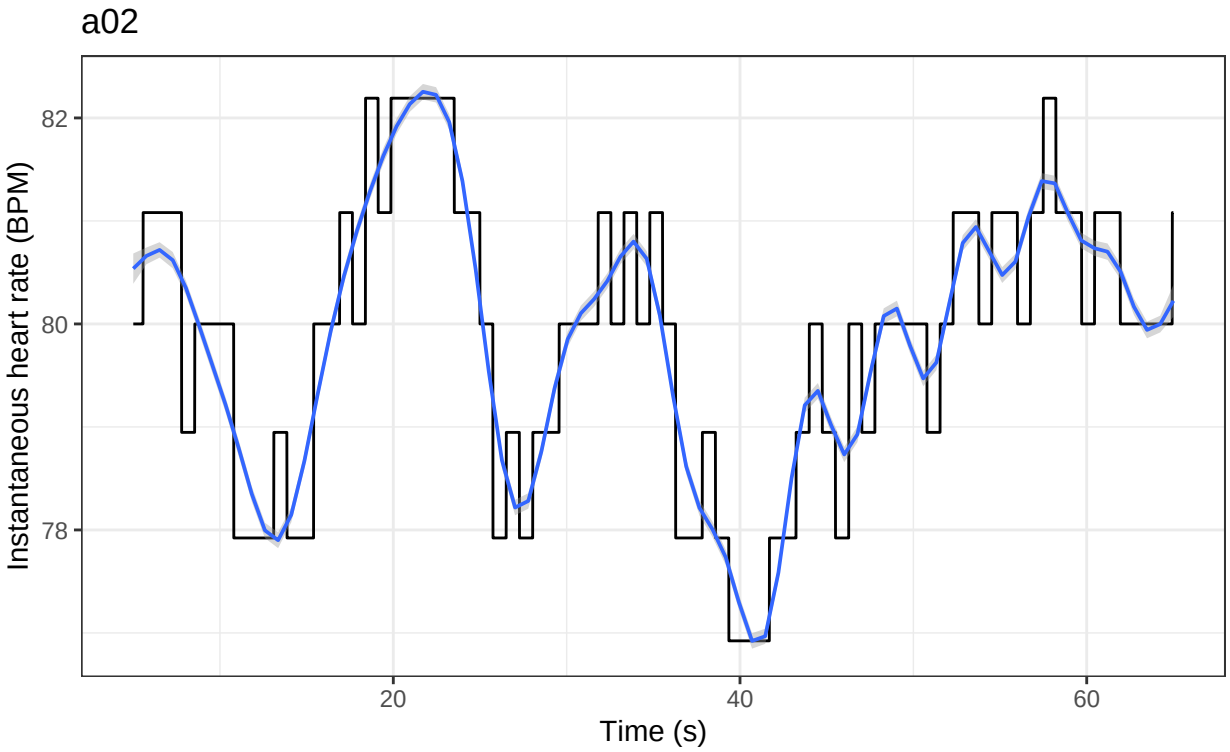

Frequency spectrum of subject a01
Relative amplitude
0
10
20
30
40
50
Frequency (Hz)


Estimated R−peaks
Amplitude (mV)
1
0
5
10
15
20
Time (s)

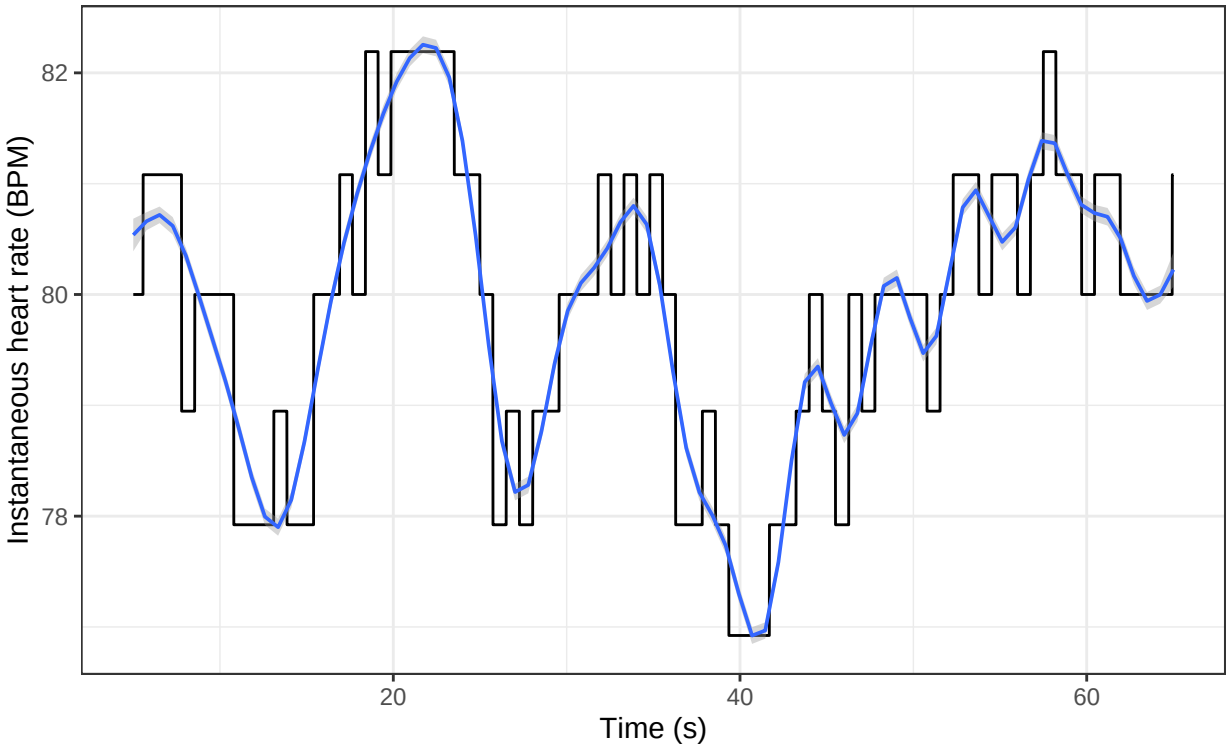

10−second sample of subject a02
0.50
0.25
0.00
−0.25
−0.50
Amplitude (mV)
0.0
2.5
5.0
7.5
10.0
Time (s)
Estimated R−peaks
0.6
0.3
0.0
−0.3
Amplitude (mV)
5
10
15
20
Time (s)

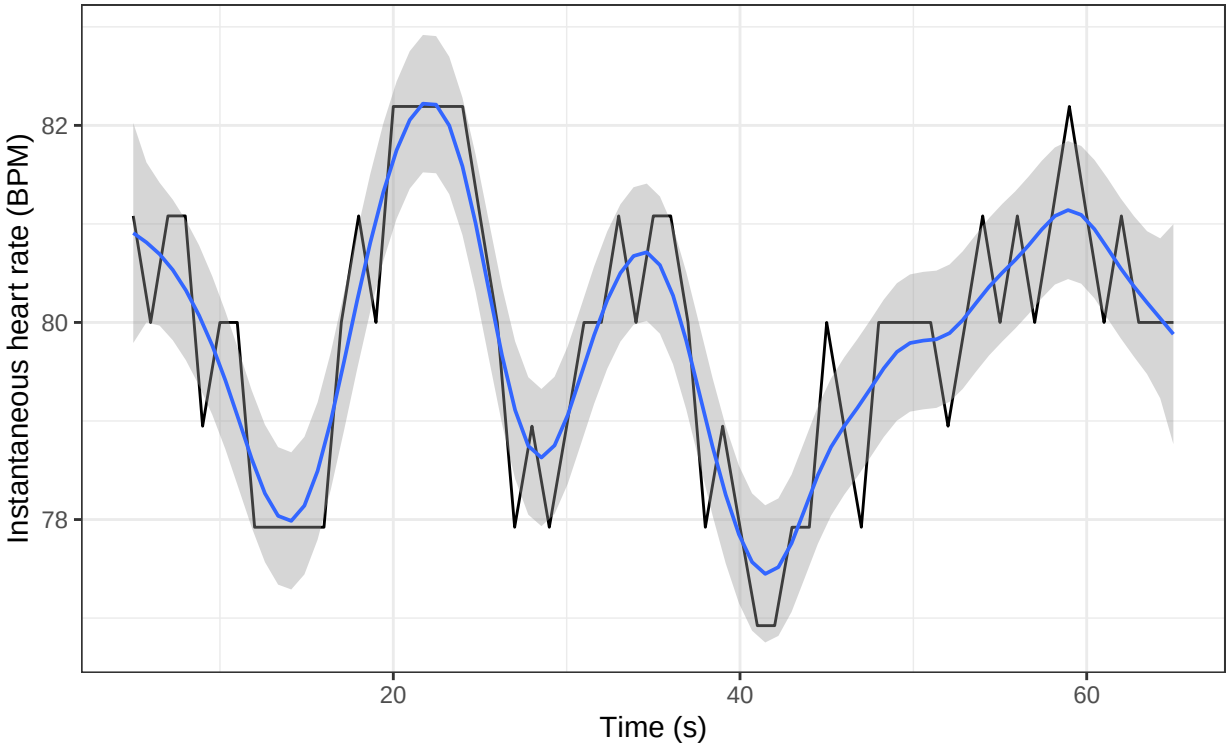

Estimated R−peaks
Amplitude (mV)
3
2
1
0
−1
−2
480
490
500
510
Time (s)

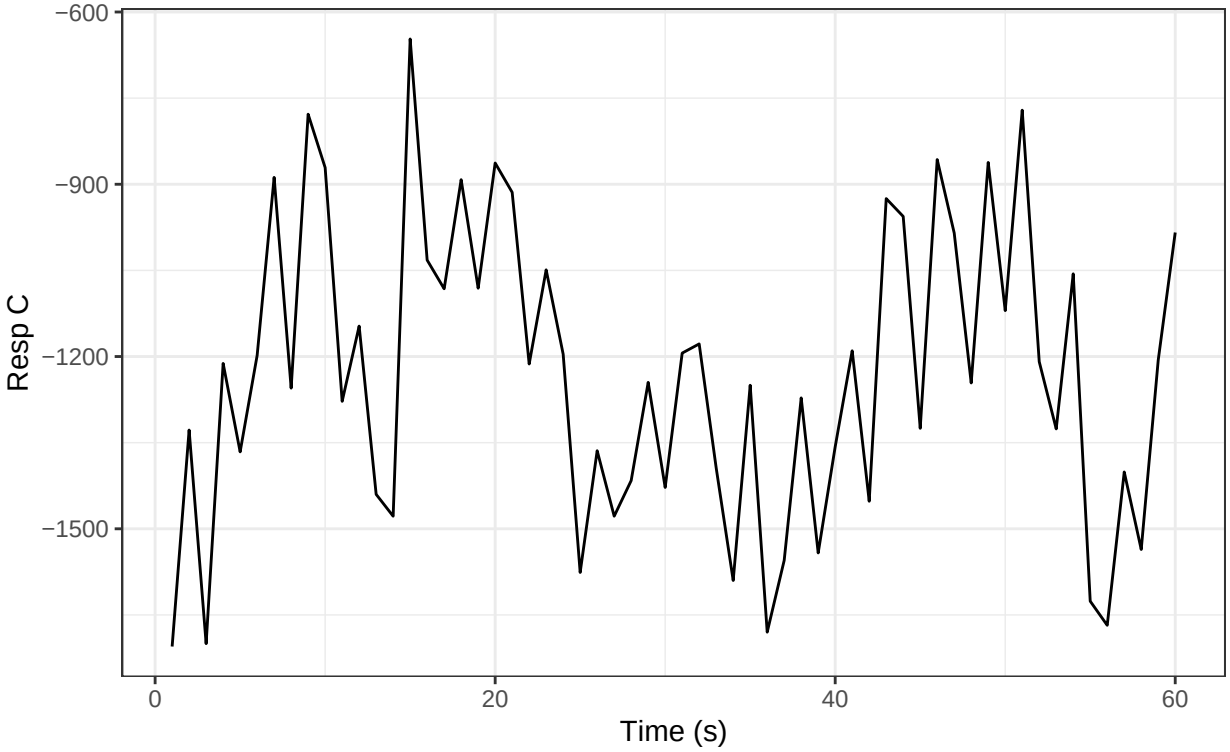

Estimated R−peaks
Amplitude (mV)
1
0
−1
−2
−3
1980
1990
2000
2010
Time (s)

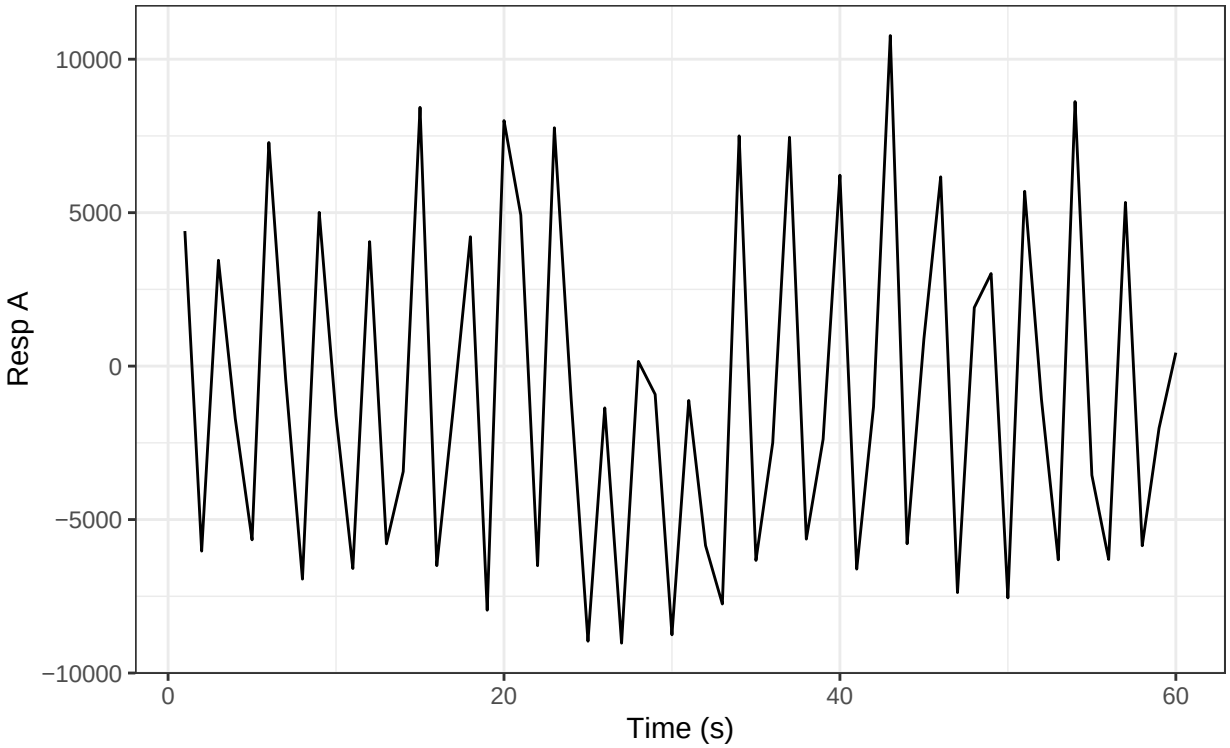

a02
Instantaneous heart rate (BPM)
82
80
78
20
40
60
Time (s)

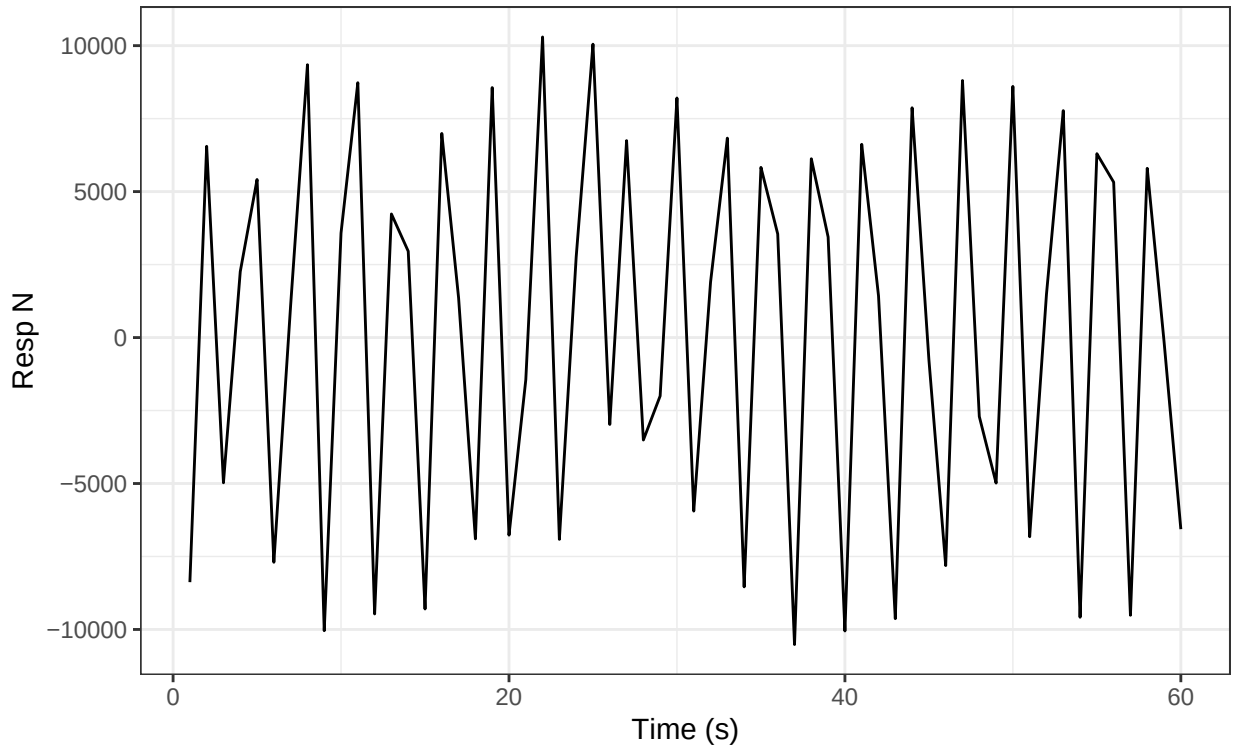
2.3 Respiratory analysis (Subject a02)



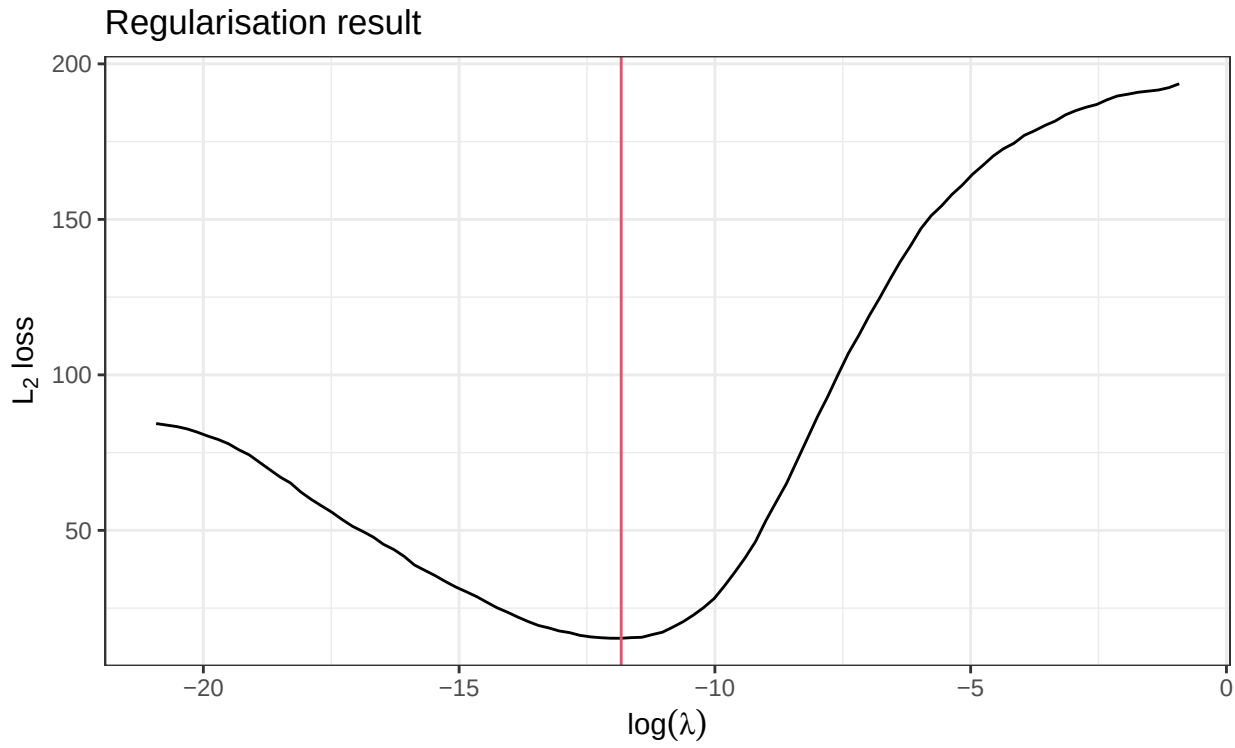



−600
−900
−1200
−1500
Resp C
0
20
40
60
Time (s)


10000
5000
0
−5000
−10000
Resp A
0
20
40
60
Time (s)




```
#> opt_lambda
#> 7.2698e-06
```




```
#>
#> Call:
```

```
#> lm(formula = breath_chest ~ 0 + breath_ecg, data = resp_df)
#>
#> Residuals:
#>      Min       1Q   Median       3Q      Max
#> -10.2234  -2.2273  -0.1918   2.2924  11.7450
#>
#> Coefficients:
#>            Estimate Std. Error t value Pr(>|t|)
#> breath_ecg 0.984194   0.008906   110.5   <2e-16 ***
#> ---
#> Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
#>
#> Residual standard error: 3.904 on 529 degrees of freedom
#> Multiple R-squared:  0.9585, Adjusted R-squared:  0.9584
#> F-statistic: 1.221e+04 on 1 and 529 DF,  p-value: < 2.2e-16

#> Wald Chi-squared test

#>    p-value
#> 0.07592432

#>                2.5 %   97.5 %
#> breath_ecg 0.9666988 1.001689

#> # A tibble: 530 x 2
#>    breath_chest breath_ecg
#>           <dbl>      <dbl>
#>  1         19.5       18.5
#>  2         18         18.5
#>  3         18.5       19.5
#>  4         23.5       19.5
#>  5         21.5       18.5
#>  6         16.5       16
#>  7         24.5       15.5
#>  8         22.5       15.5
#>  9         18         14
#> 10         18.5       19.5
#> # i 520 more rows

#>   breath_chest     breath_ecg
#>  Min.   : 6.00   Min.   :11.50
#>  1st Qu.:16.50   1st Qu.:18.00
#>  Median :18.50   Median :19.00
#>  Mean   :18.83   Mean   :18.95
#>  3rd Qu.:20.50   3rd Qu.:20.00
#>  Max.   :29.00   Max.   :24.50
```

References

Goldberger, A. L., Amaral, L. A., Glass, L., Hausdorff, J. M., Ivanov, P. C., Mark, R. G., Mietus, J. E., Moody, G. B., Peng, C.-K., & Stanley, H. E. (2000). Physiobank, physiotoolkit, and physionet. *Circulation*, *101*(23), e215–e220.

Penzel, T., Moody, G. B., Mark, R. G., Goldberger, A. L., & Peter, J. H. (2000). The apnea-ecg database. *Computers in Cardiology 2000*, 255–258.