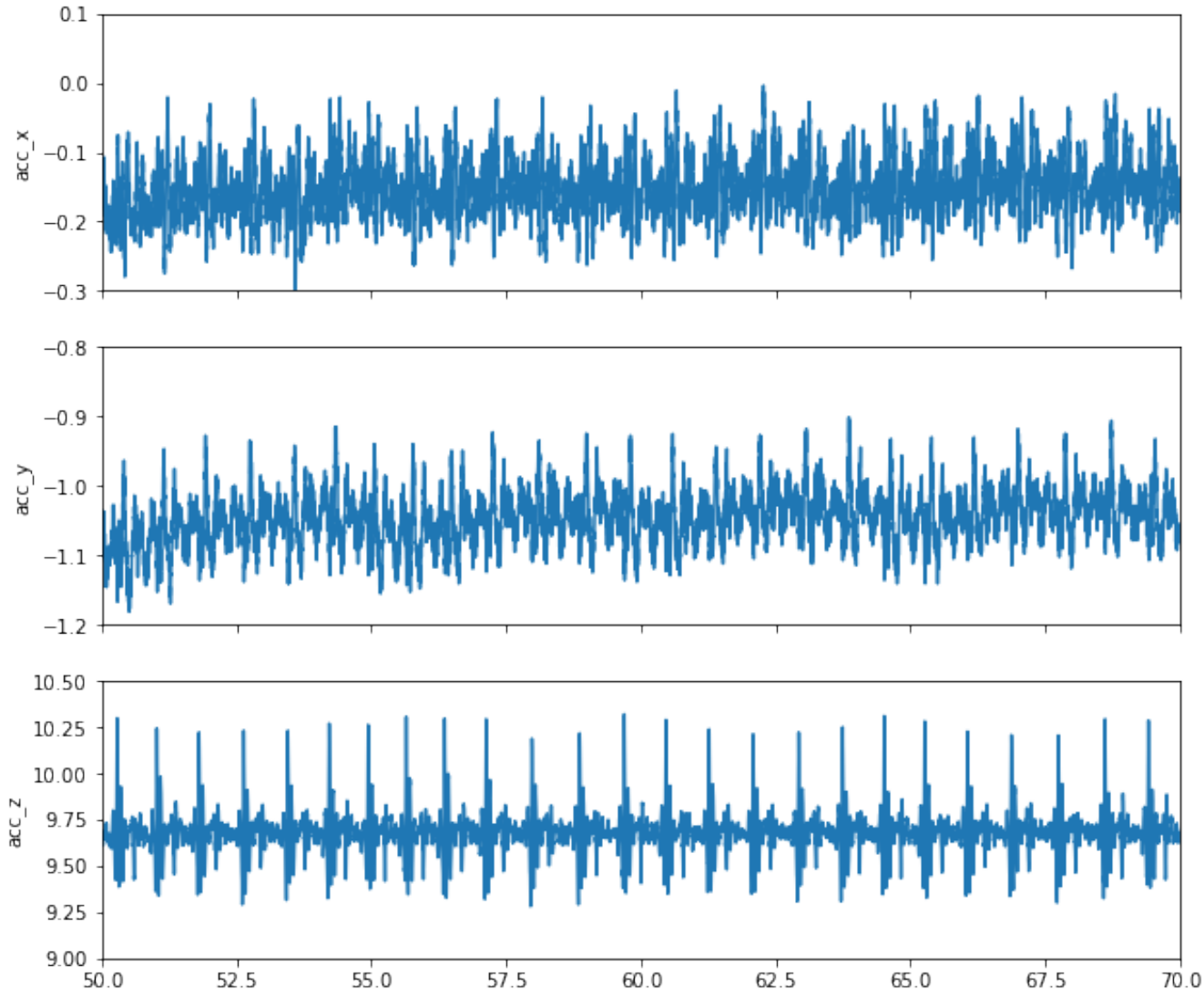
Load data from CSV file

	Time (s)	Acceleration x (m/s^2)	Acceleration y (m/s^2)	Acceleration z (m/s^2)	Absolute acceleration (m/s^2)
0	0.020513	0.005384	-2.492723	9.374481	9.700237
1	0.022916	0.031705	-2.456831	9.391231	9.707329
2	0.025319	0.038883	-2.442474	9.386445	9.699100
3	0.027722	0.072383	-2.425724	9.424730	9.732159
4	0.030124	0.072383	-2.418545	9.429516	9.735007
...	...	...	...	...	...
247944	595.760053	0.450449	-3.449852	9.680762	10.286960
247945	595.762455	0.519841	-3.394817	9.611370	10.206540
247946	595.764858	0.550947	-3.366103	9.601799	10.189639
247947	595.767261	0.601197	-3.311068	9.589835	10.163147
247948	595.769664	0.634696	-3.287140	9.594621	10.161933

247949 rows × 5 columns

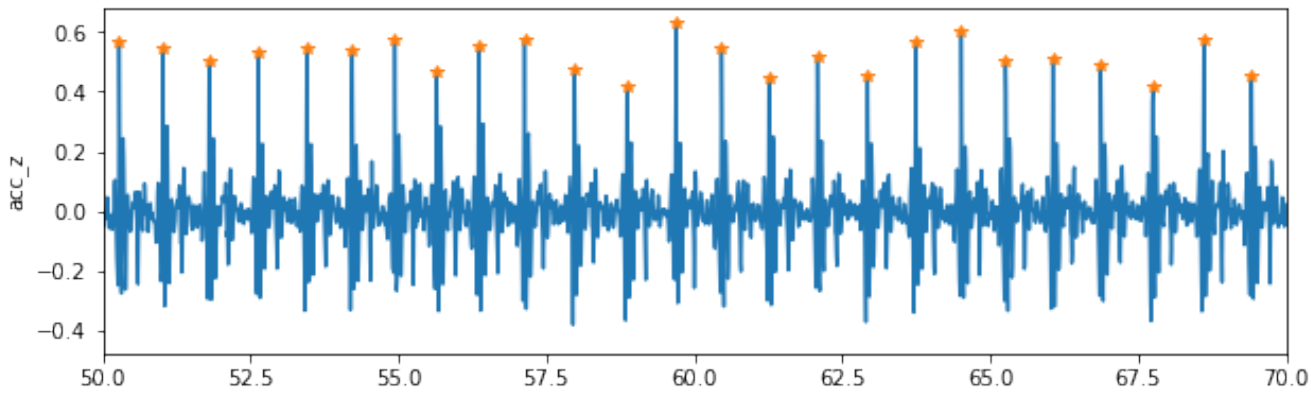
Downsample the signals to 100 Hz by using interpolation



R peak detections

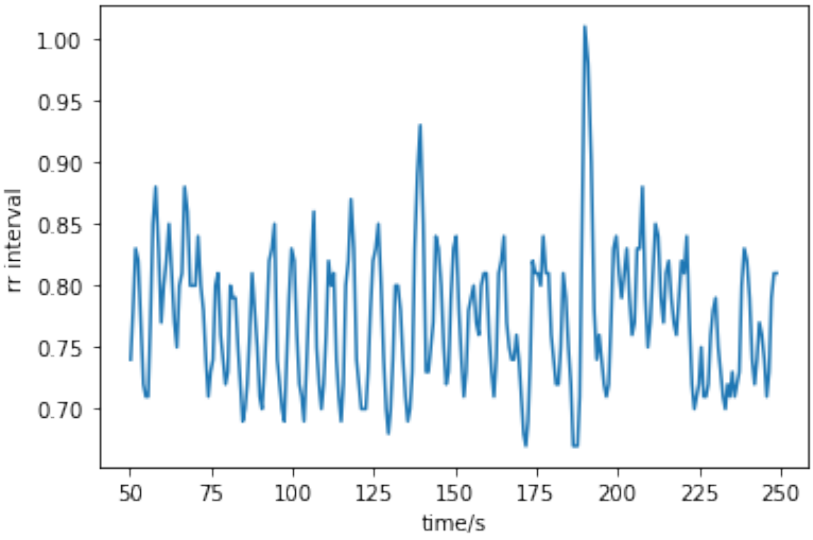
Although in all of the three signals, we can find peaks, the z-direction has the clearest peaks.

Using scipy.signal.find_peaks to get the peaks. For more information about this function, please visit: https://docs.scipy.org/doc/scipy/reference/generated/scipy.signal.find_peaks.html



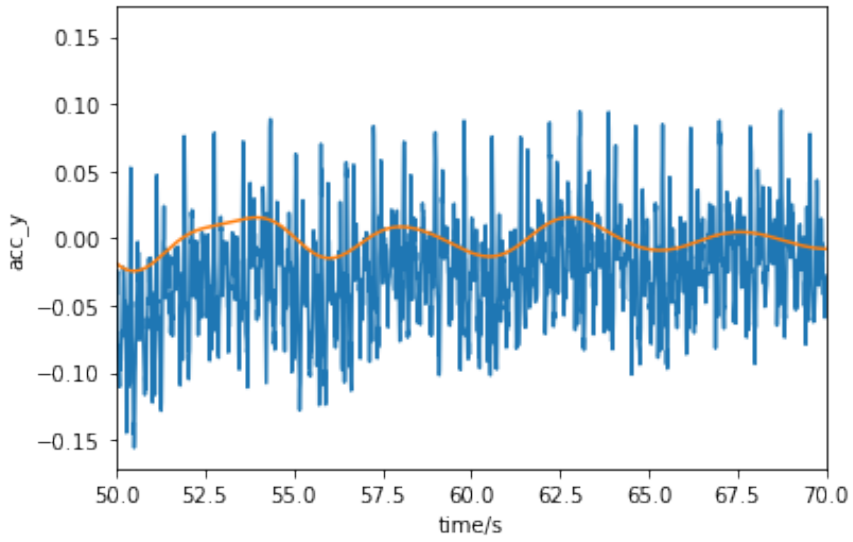
RR interval

RR interval is the time interval between R peaks

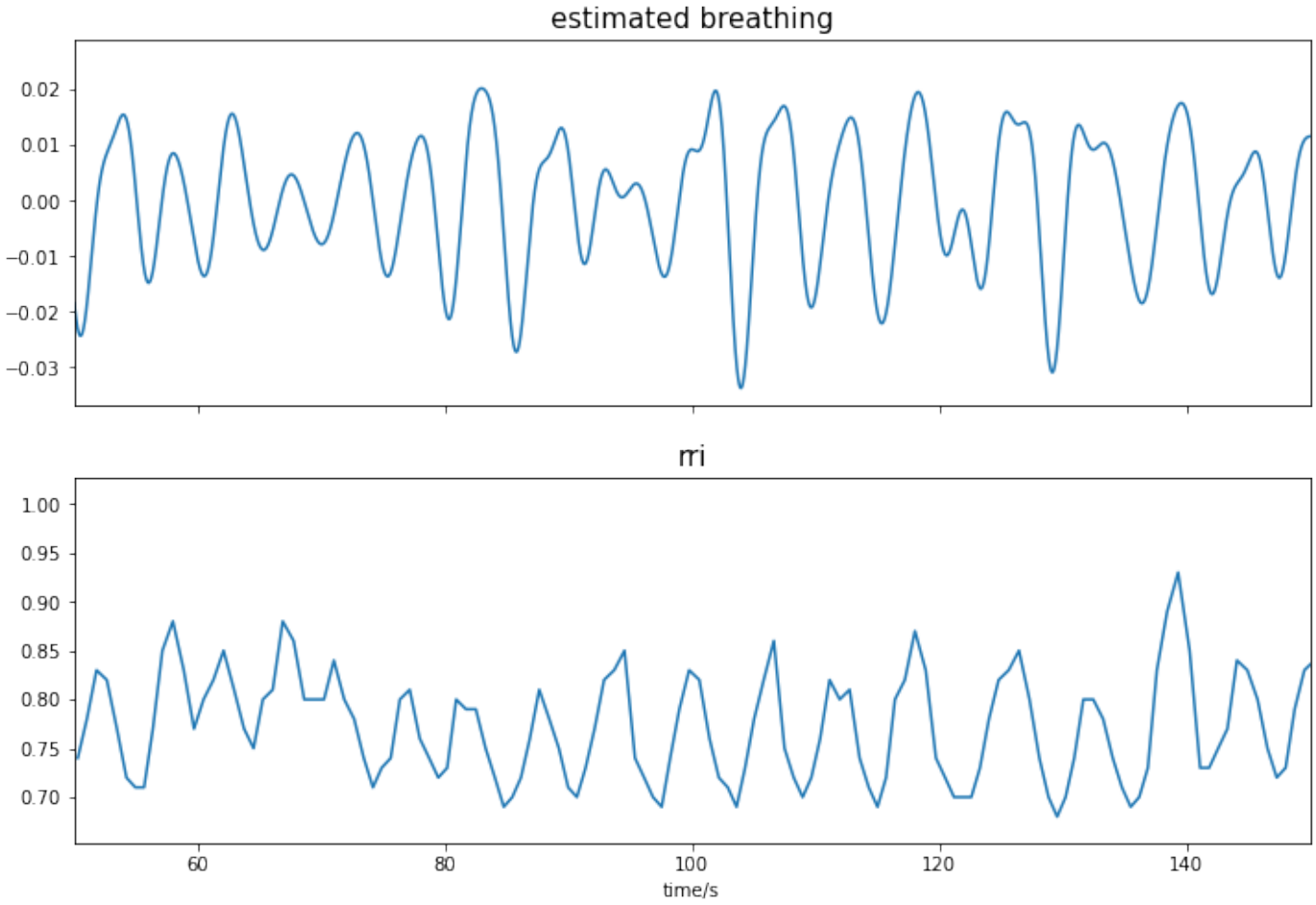


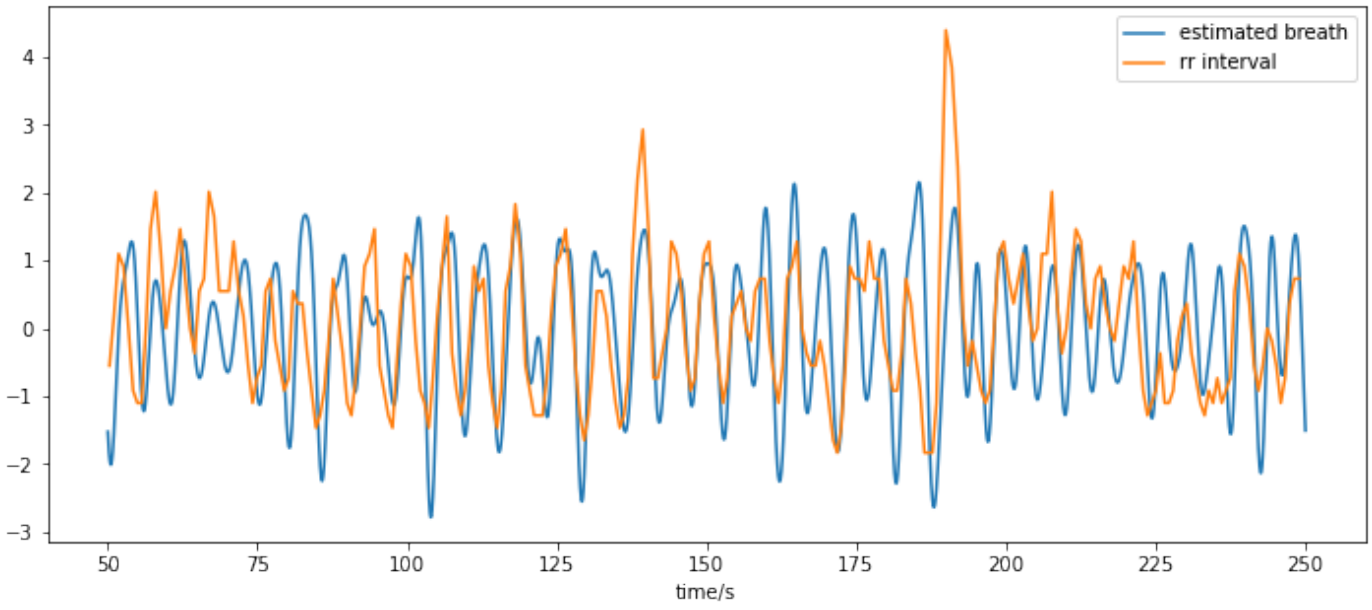
Estimate breathing signal

The fluctuation in acceleration y is meanly caused by breathing. So using a bandpass filter, we can get the breathing signal.

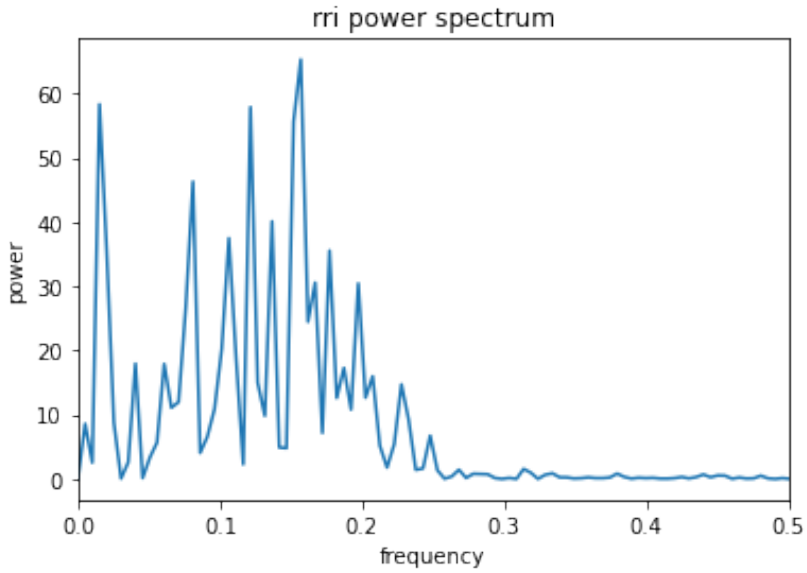


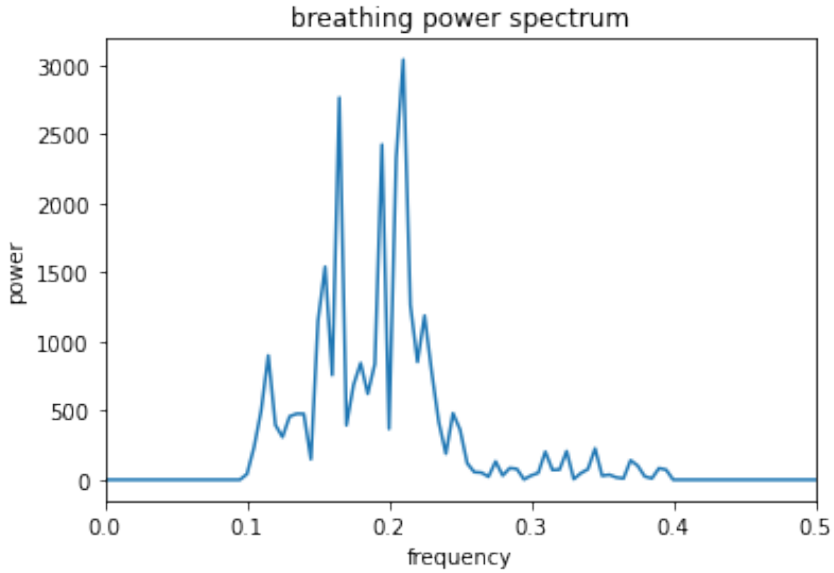
Comparing the estimated breathing with RR interval, we can see that the heart rate variability is in synchrony with respiration.





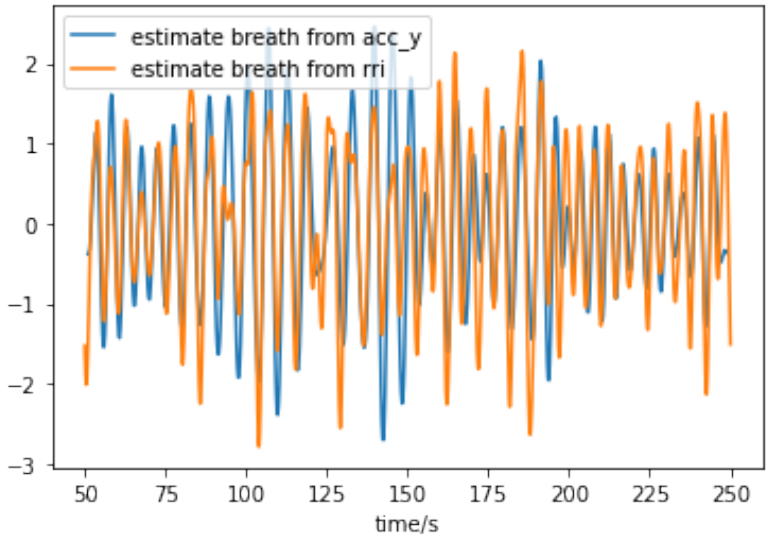
Resample both signals to 4 Hz and plot the power spectrum



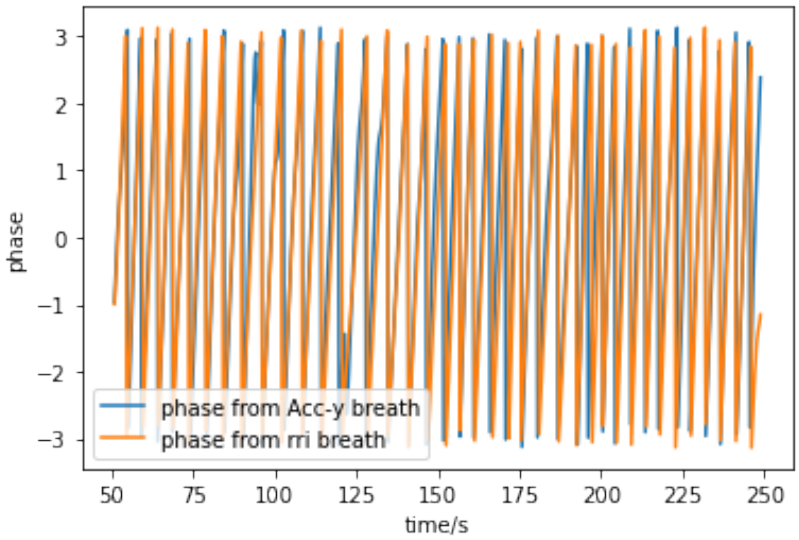


Estimate breathe from RR interval

`Respiratory sinus arrhythmia (RSA)` is heart rate variability in synchrony with respiration, by which the R-R interval on an ECG is shortened during inspiration and prolonged during expiration. So apply a suitable `band pass filter` on the RR interval, you could also get an estimated breathing signal.



Phases of these two breathing signal



Get phase synchronization index

```
phase synchronization index is: 0.8338912553519401
```