



UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI INFORMATICA

Refined Ventricular Activity Cancellation in Electrograms During Atrial Fibrillation by Combining Average Beat Subtraction and Interpolation

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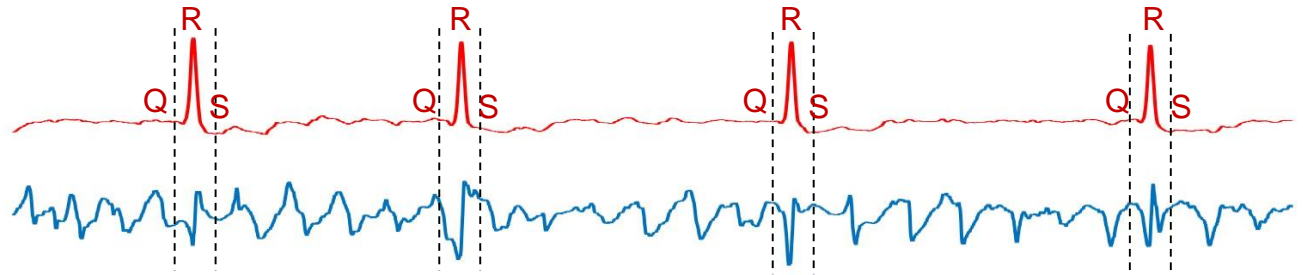
Introduction

- Atrial fibrillation (AF) is the most common arrhythmia encountered in clinical practice
- Catheter based ablation has become a preferred method to treat AF
- During ablation routines for the treatment of AF, atrial electrograms (EGM) are measured on the atrial myocardium

Problems

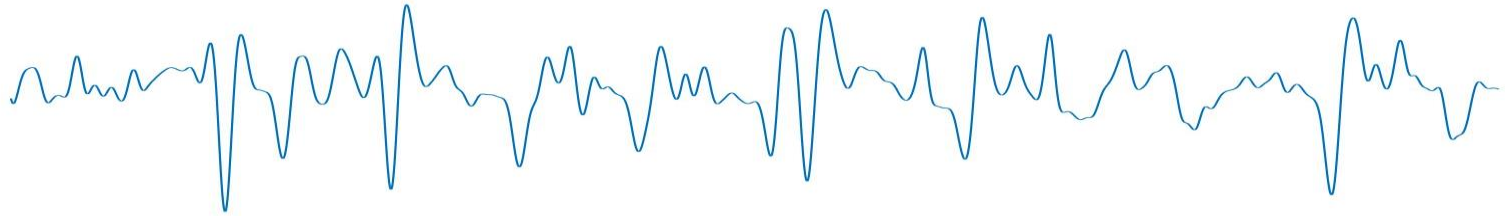
Surface ECG

Atrial EGM

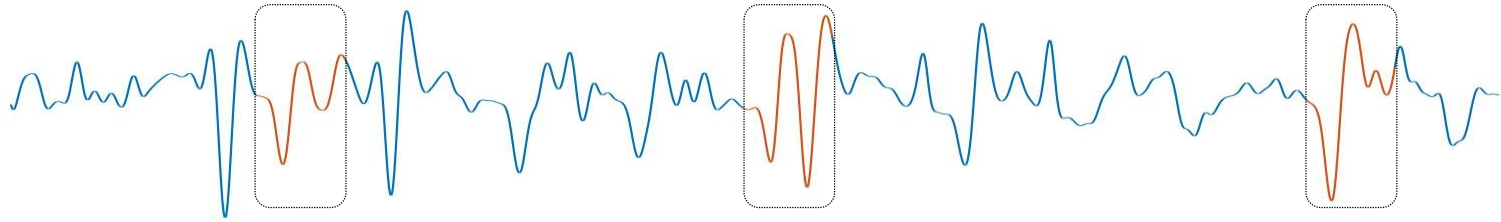


- Far-field ventricular activity distorts the morphology of the pure atrial activity, complicate its analysis and affect its final interpretation
- Many algorithms have been developed in the last decades to reduce this interference
- All methodologies present pros and cons

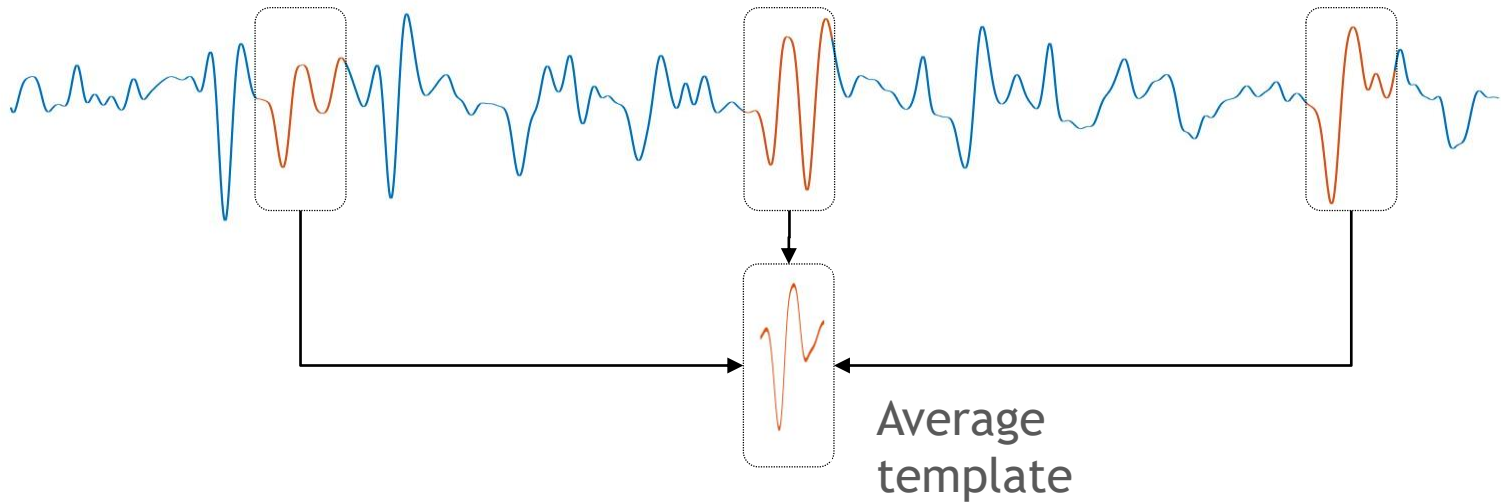
Average Beat Subtraction



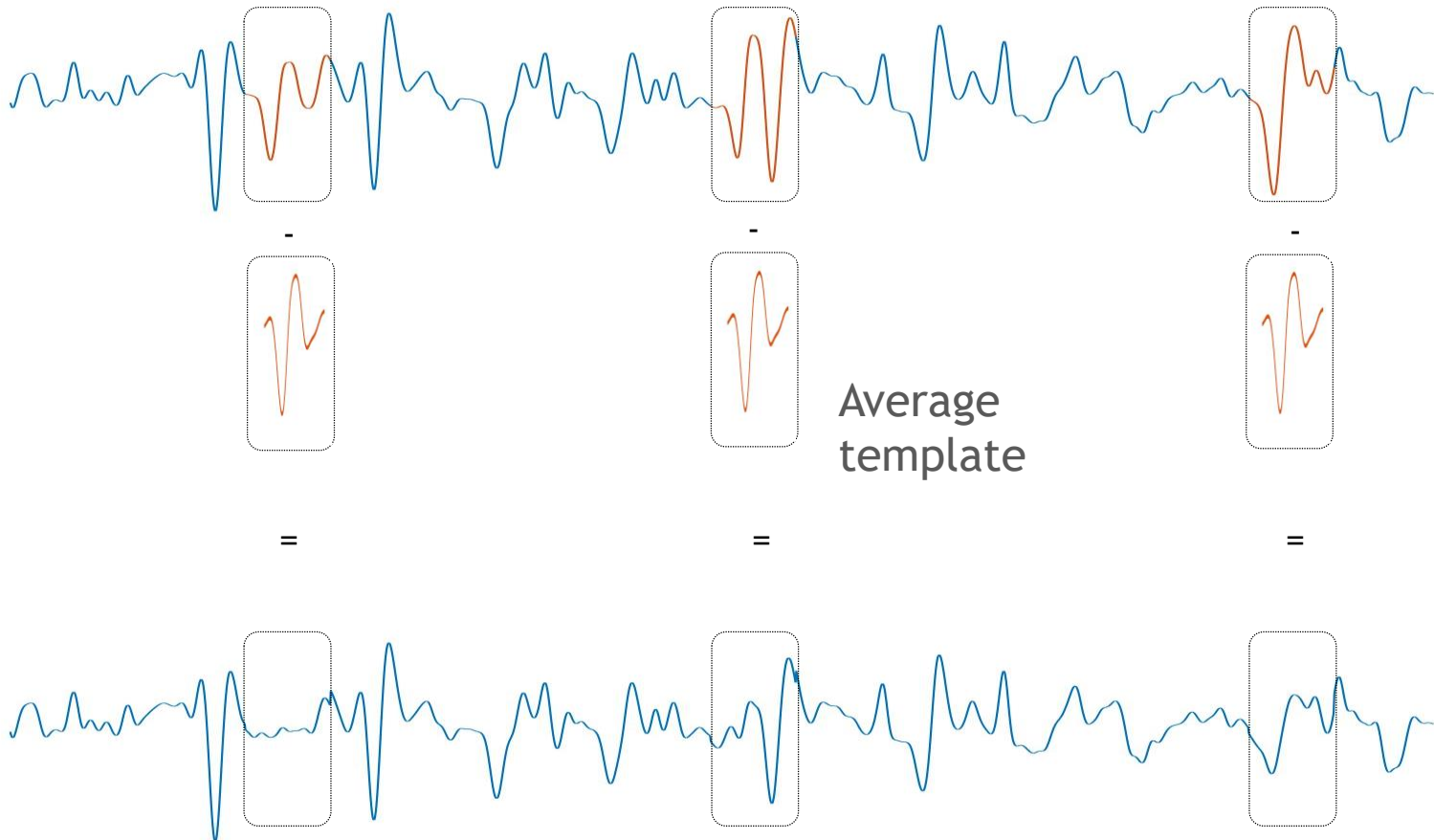
Average Beat Subtraction



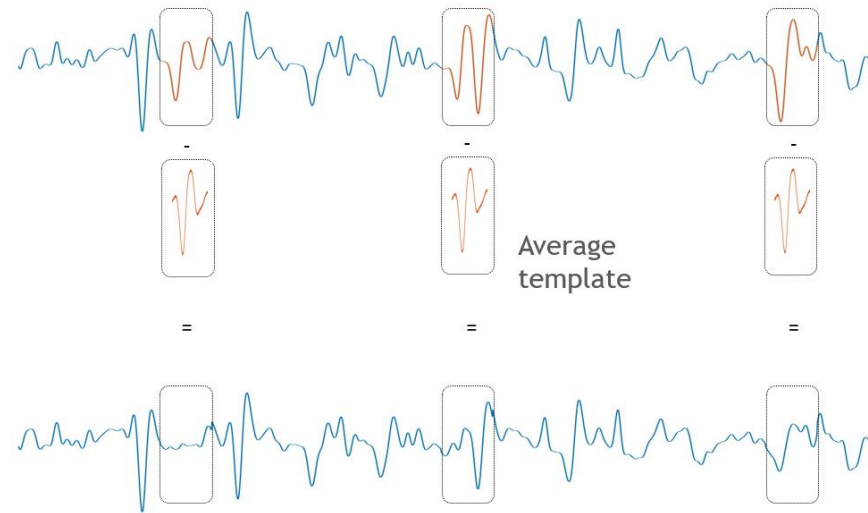
Average Beat Subtraction



Average Beat Subtraction

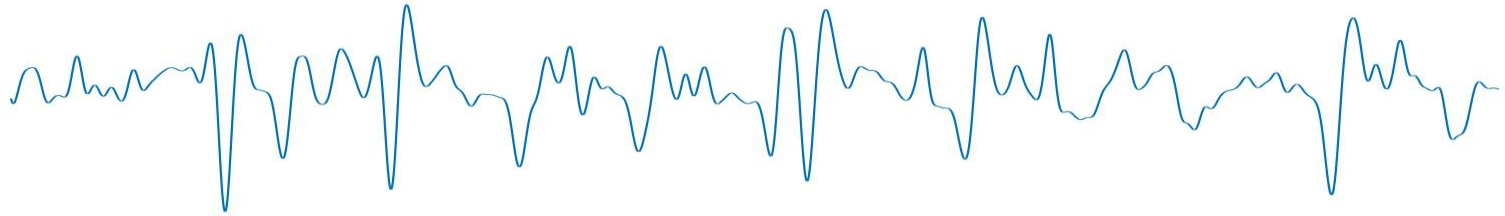


Average Beat Subtraction

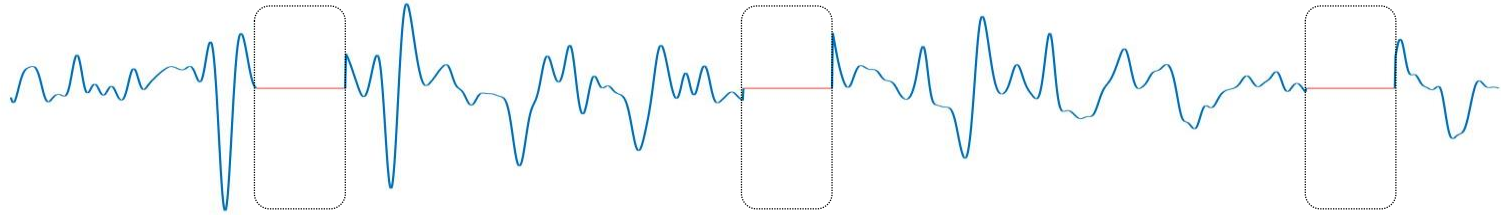


- Simple to implement
- Can be very effective in uncomplicated cases
- Might leave high power residue
- Discontinuity at the borders of the ventricular segment

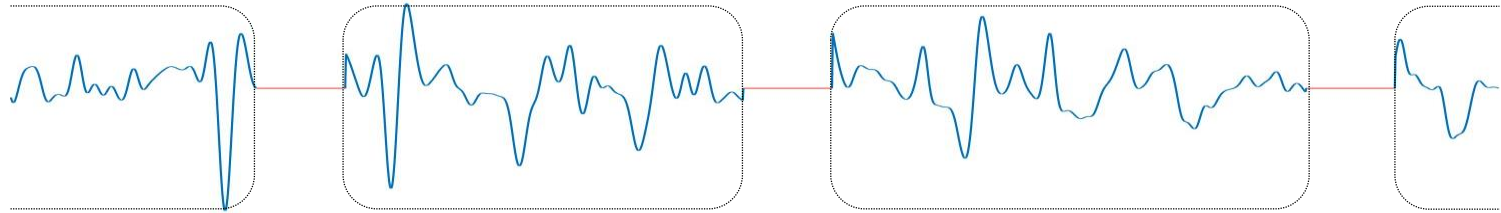
Interpolation



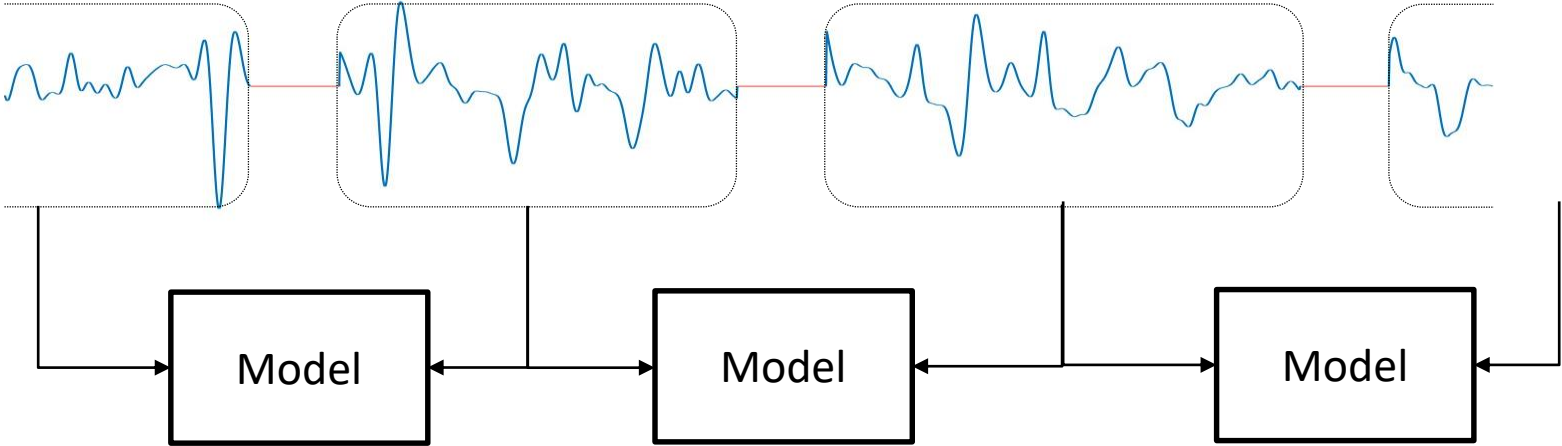
Interpolation



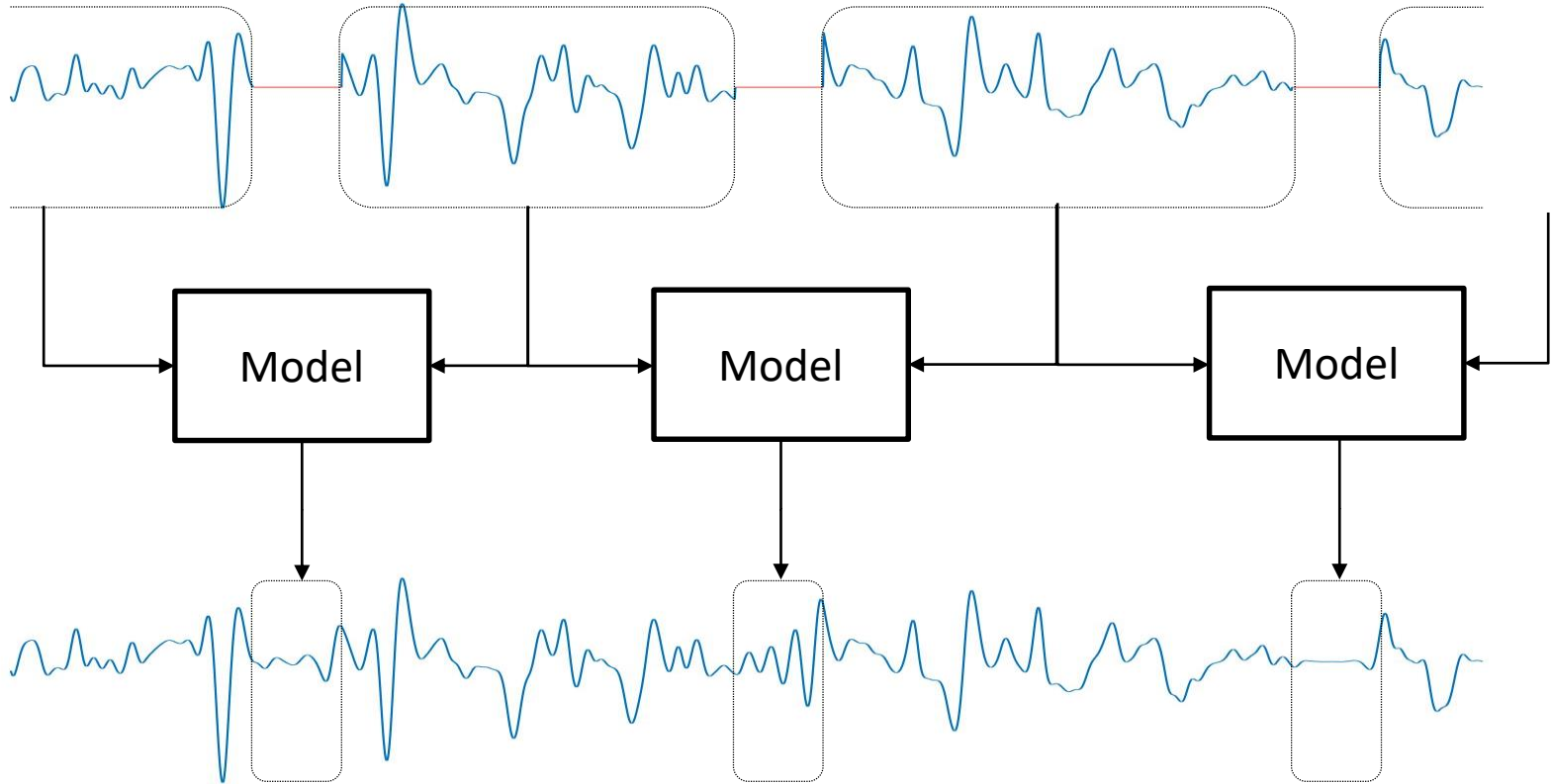
Interpolation



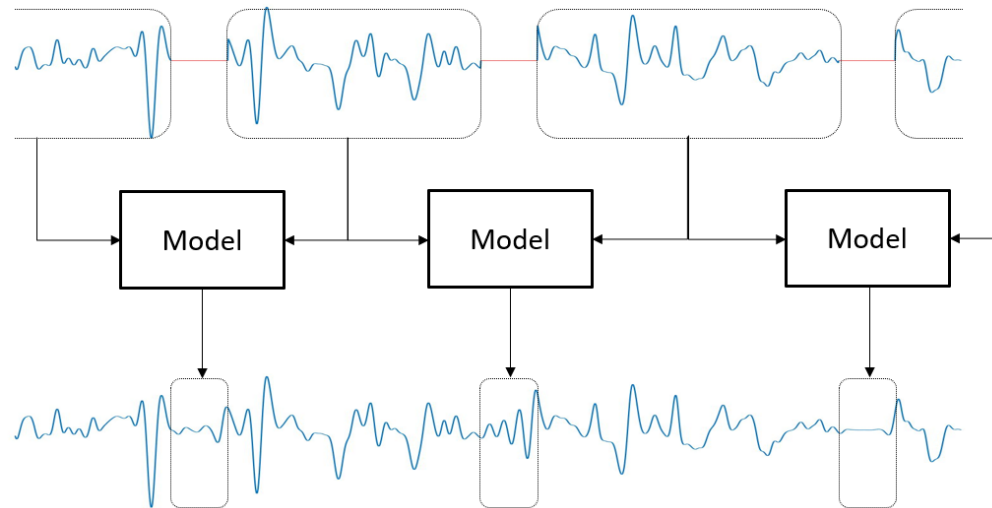
Interpolation



Interpolation

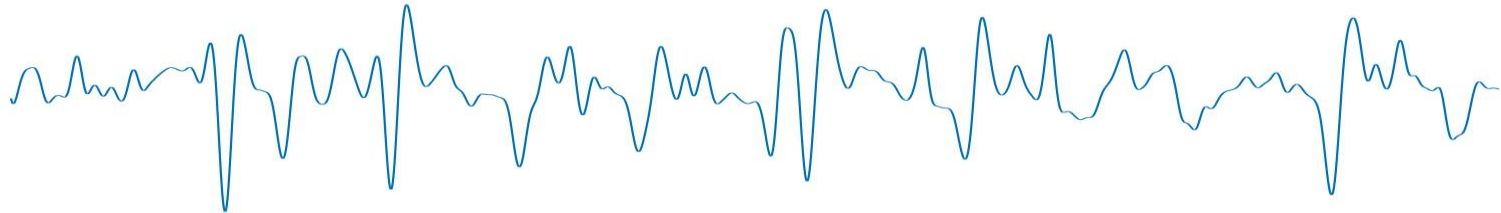


Interpolation

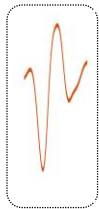
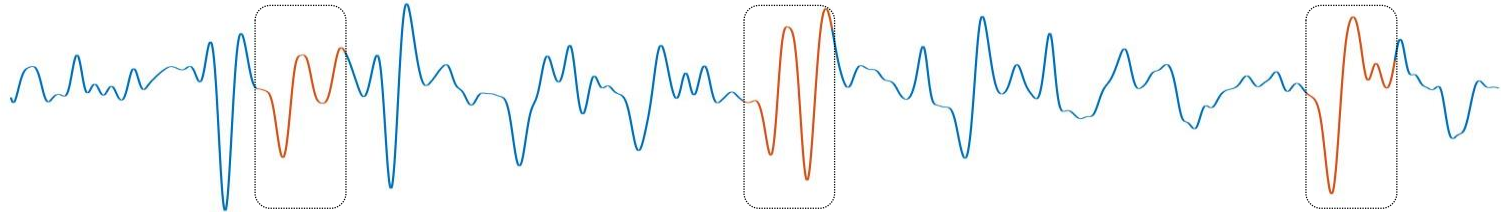


- Frequency content of the residue similar to nearby atrial activity
- Residual power in range of nearby atrial activity
- Continuity at borders
- Might fail due to models poorly fitted
- Possibly flat signal around peak of ventricular activity

Refined Average Beat Subtraction



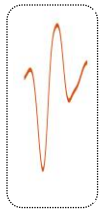
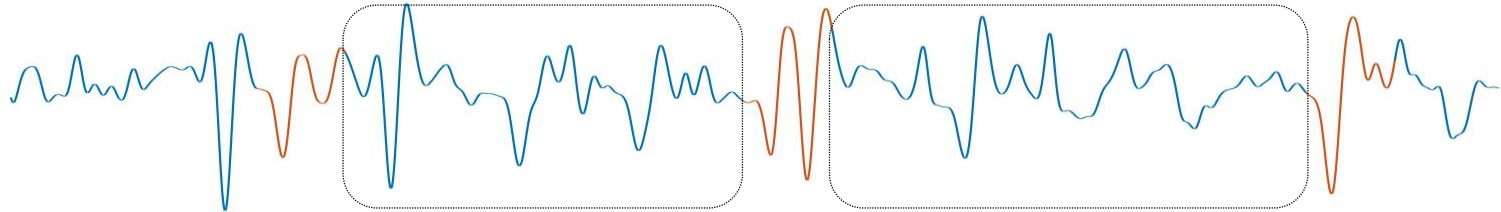
Refined Average Beat Subtraction



Average
template

t

Refined Average Beat Subtraction



Average
template

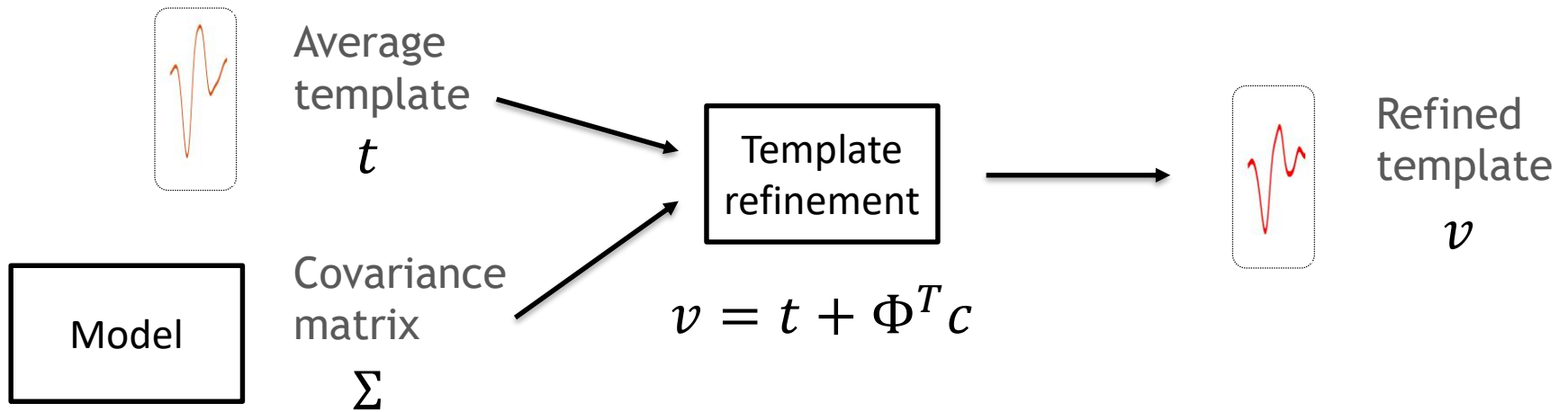
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Model

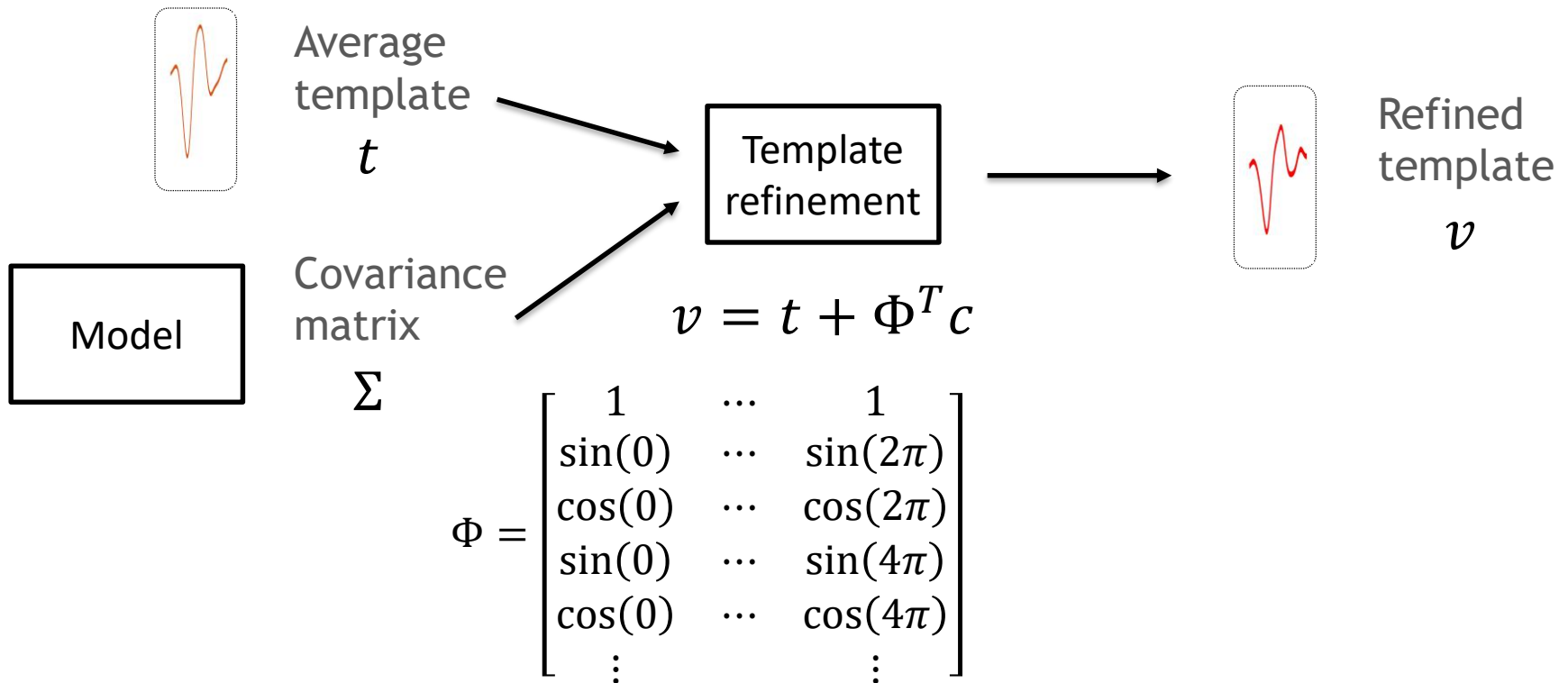
Covariance
matrix

Σ

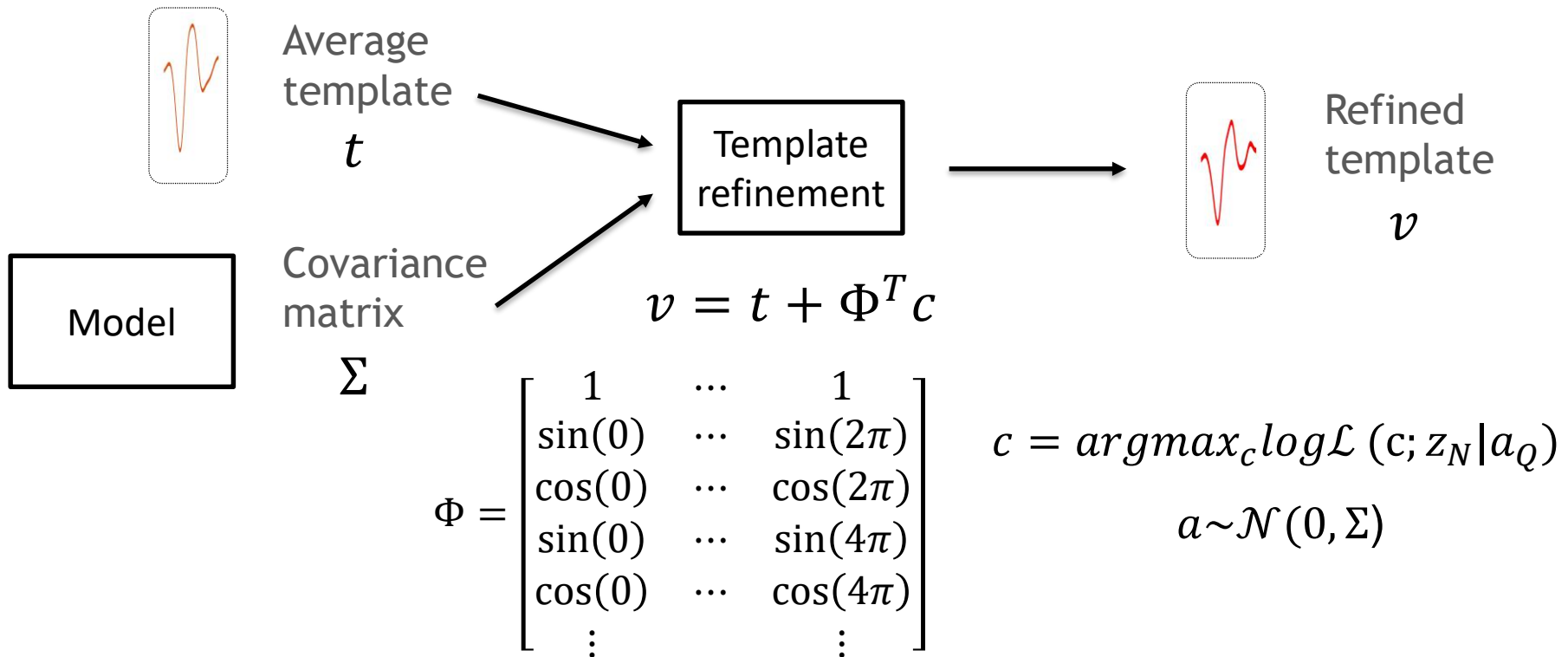
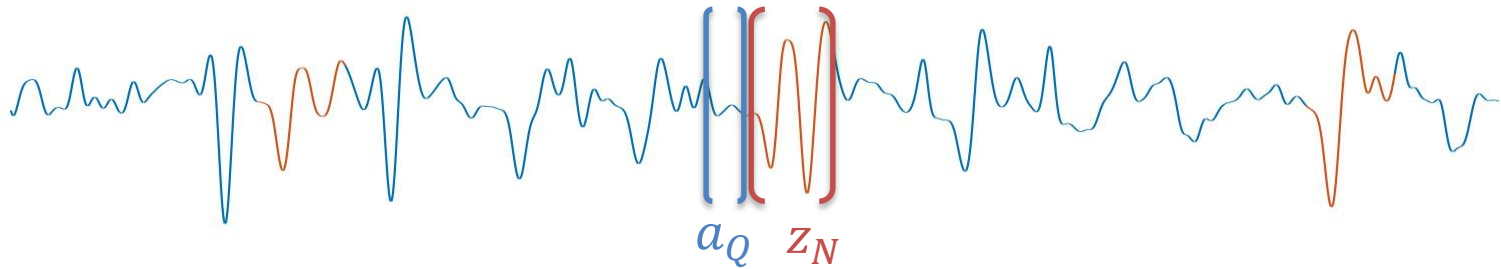
Refined Average Beat Subtraction



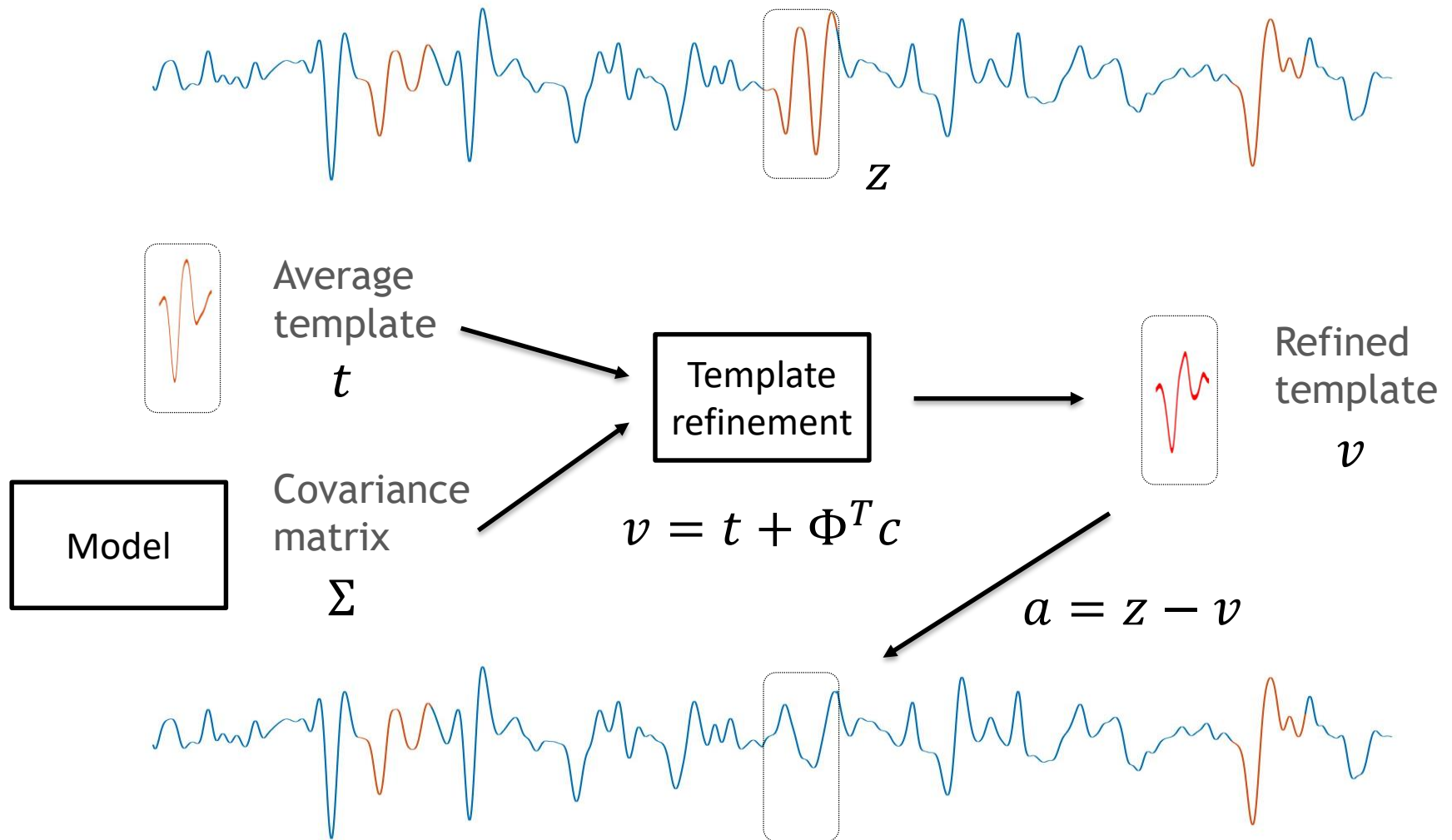
Refined Average Beat Subtraction



Refined Average Beat Subtraction

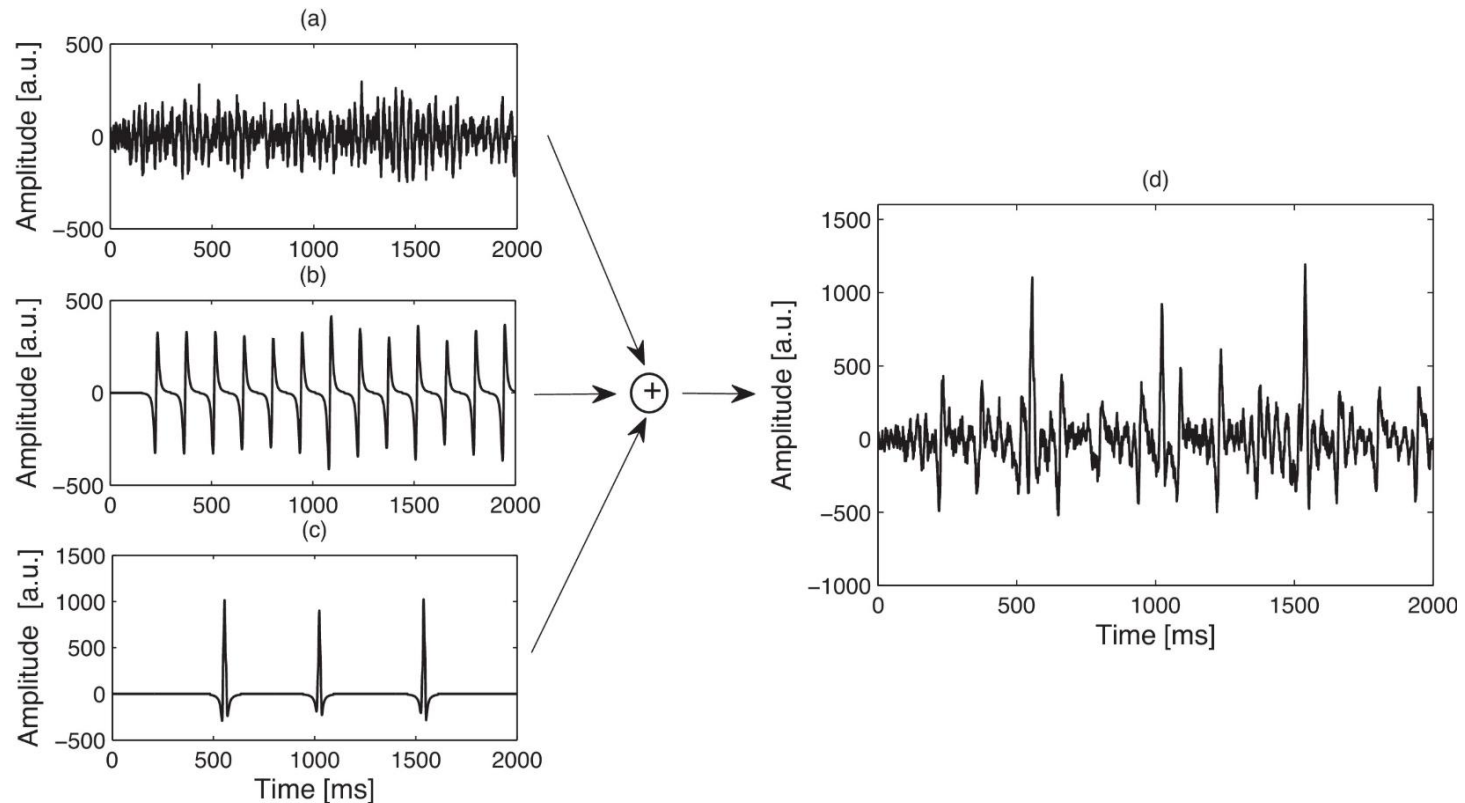


Refined Average Beat Subtraction



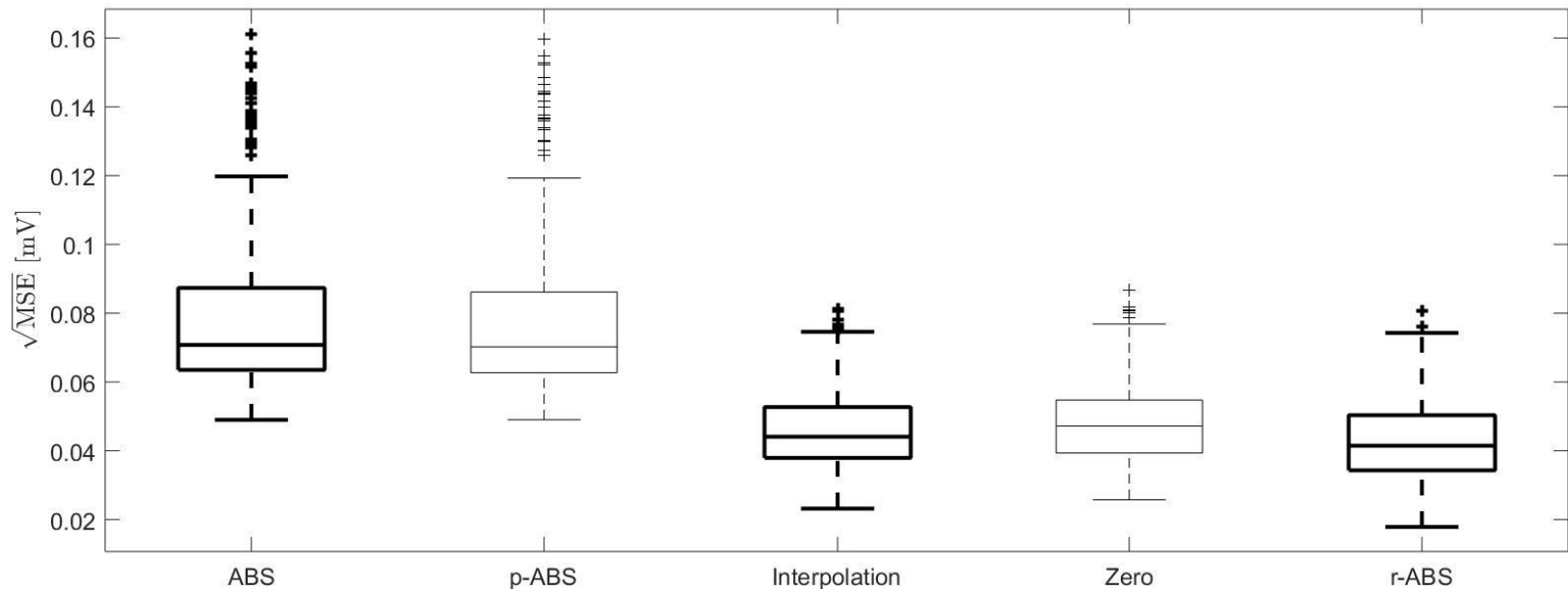
Experiments and Results

- 10 synthetic signals, one minute long, with HR of 120bpm, 1kHz sampling frequency



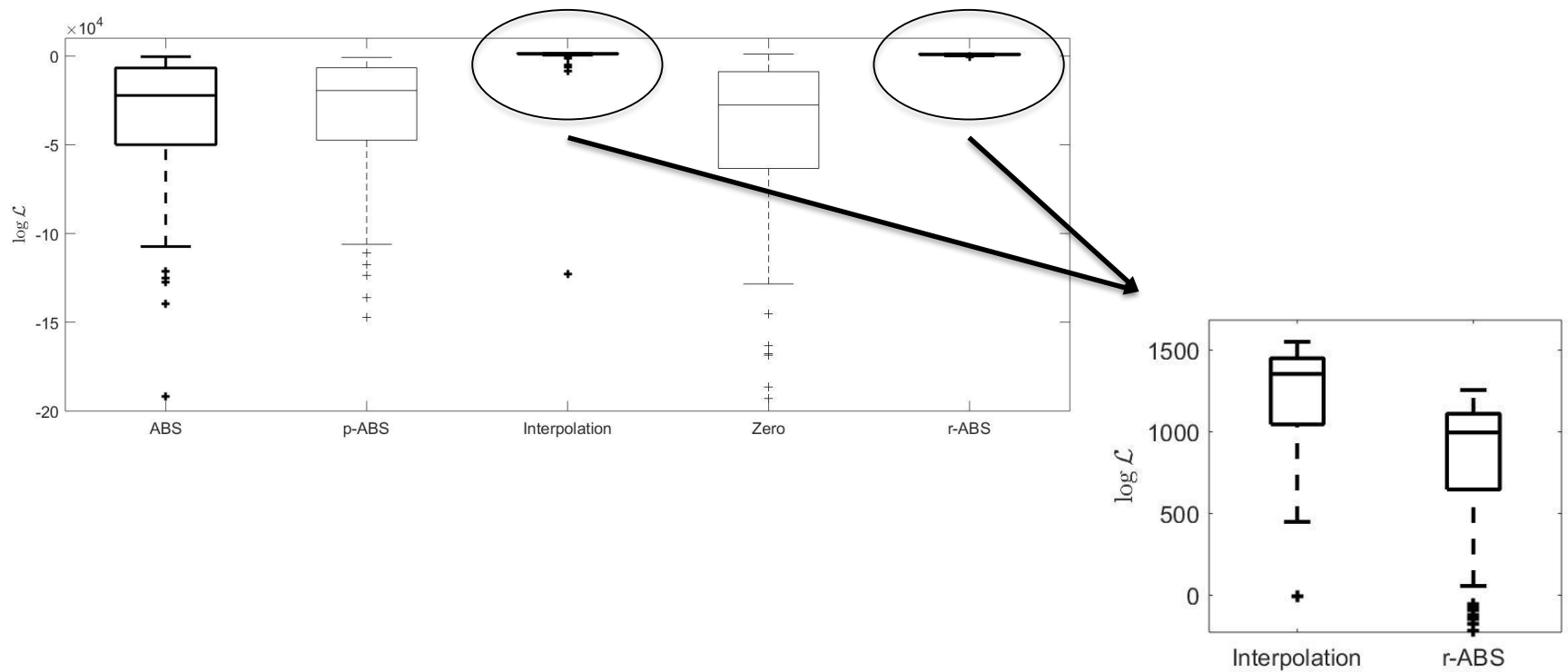
Experiments and Results

- 5 methods compared
- Performance measured using root MSE

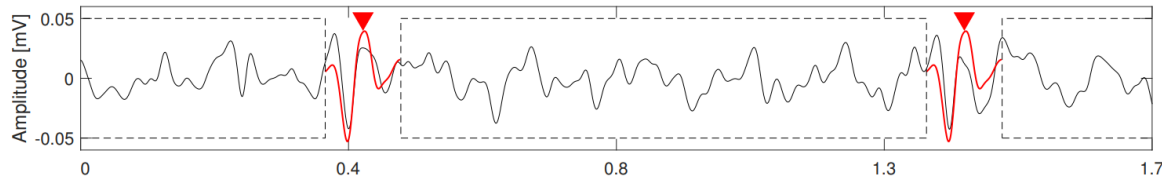


Experiments and Results

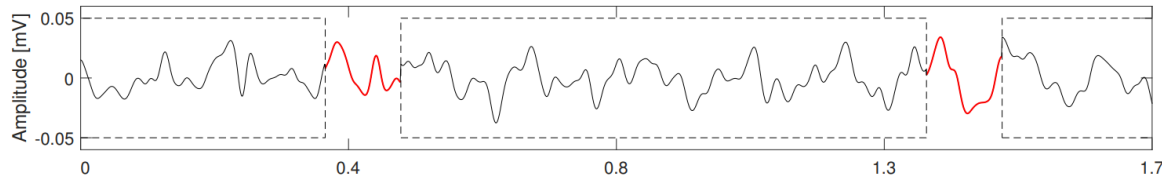
- The real signal taken from the PhysioNet Intracardiac Atrial Fibrillation Database
- Performance measured using log likelihood



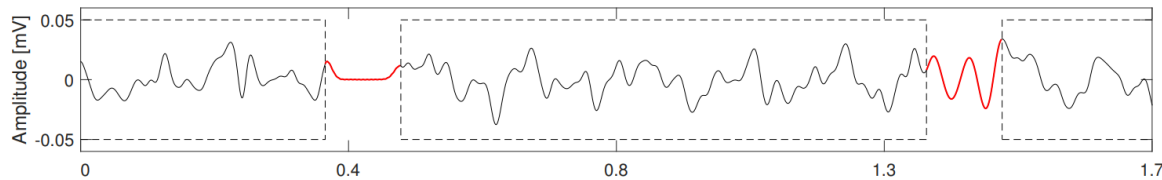
Experiments and Results



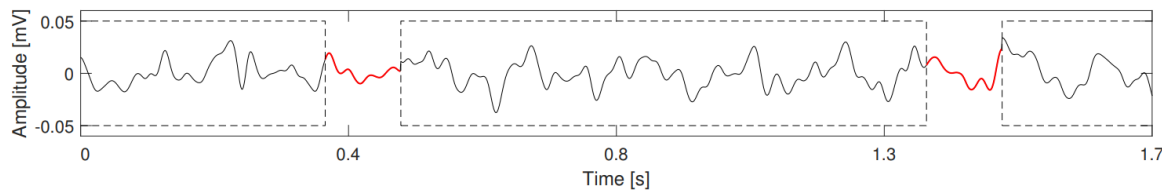
Original AEG



ABS



Interpolation



r-ABS

Conclusions

- The methodology combines two common techniques, ABS and interpolation, in an unified framework
- It was able to refine and improve ventricular activity estimate to match the stochastic process properties
- Algorithm still shares some of the limitations with ABS and interpolation

Thank you for your attention

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