

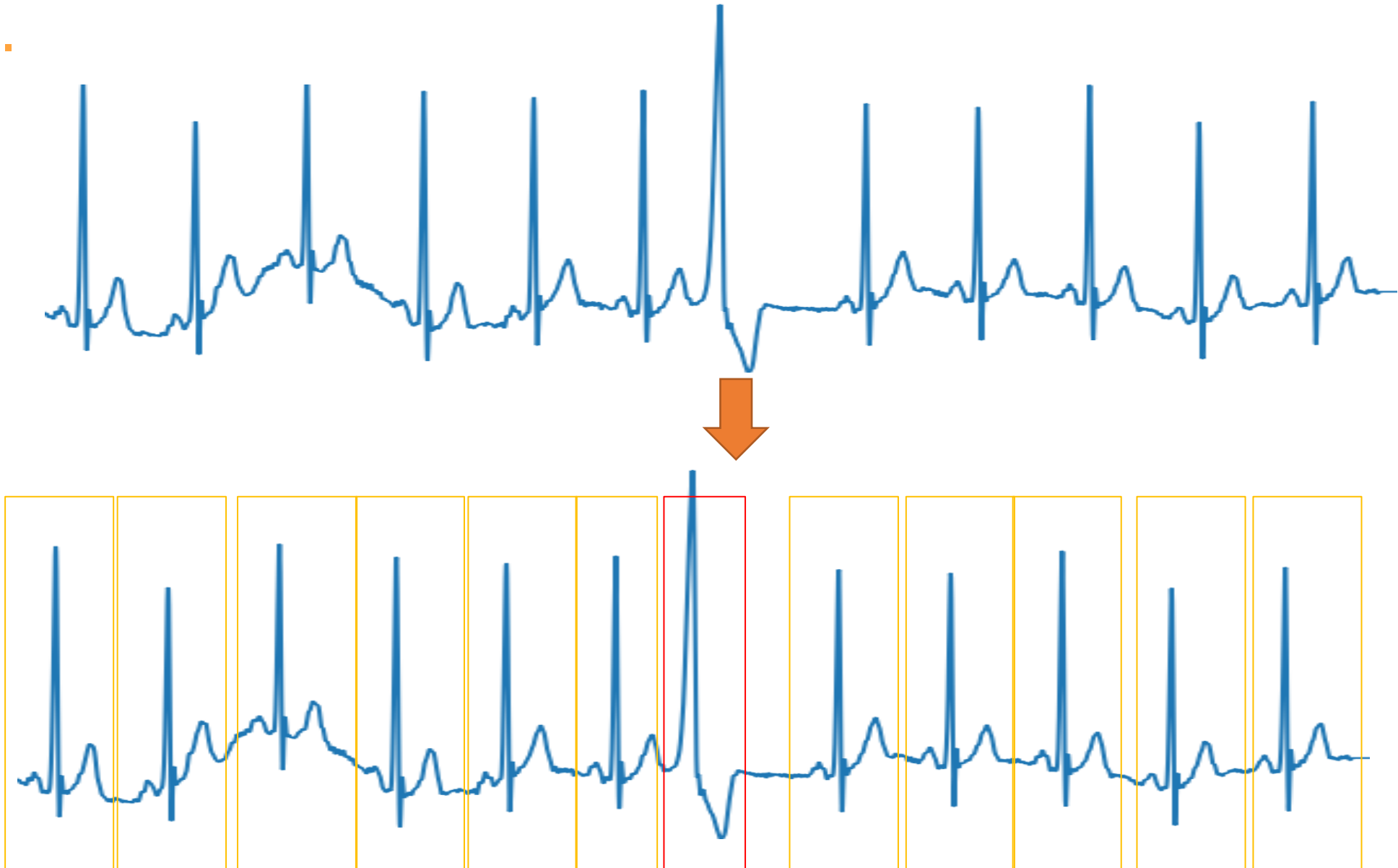
# Simultaneous ECG Heartbeat Segmentation and Classification with Feature Fusion and Long Term Context Dependencies

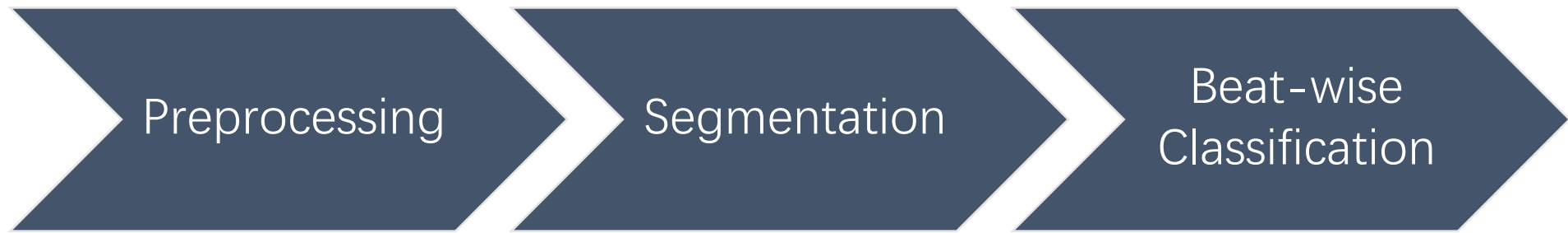
Xi Qiu, Fudan University

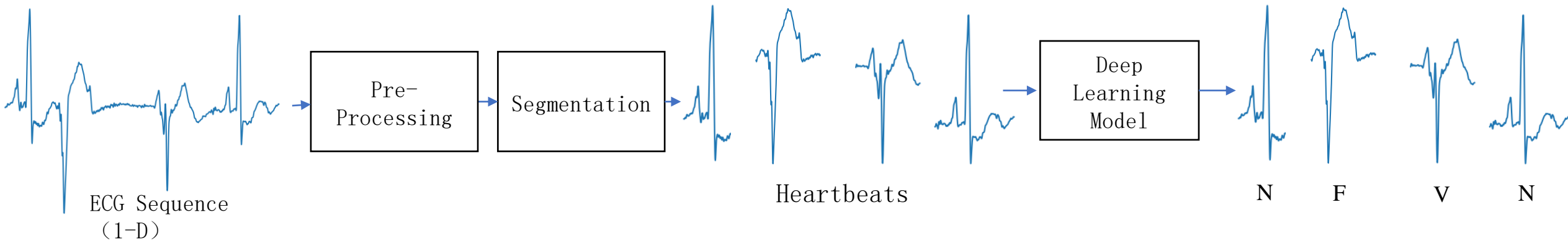
Shen Liang, Fudan University

Yanchun Zhang, Victoria University









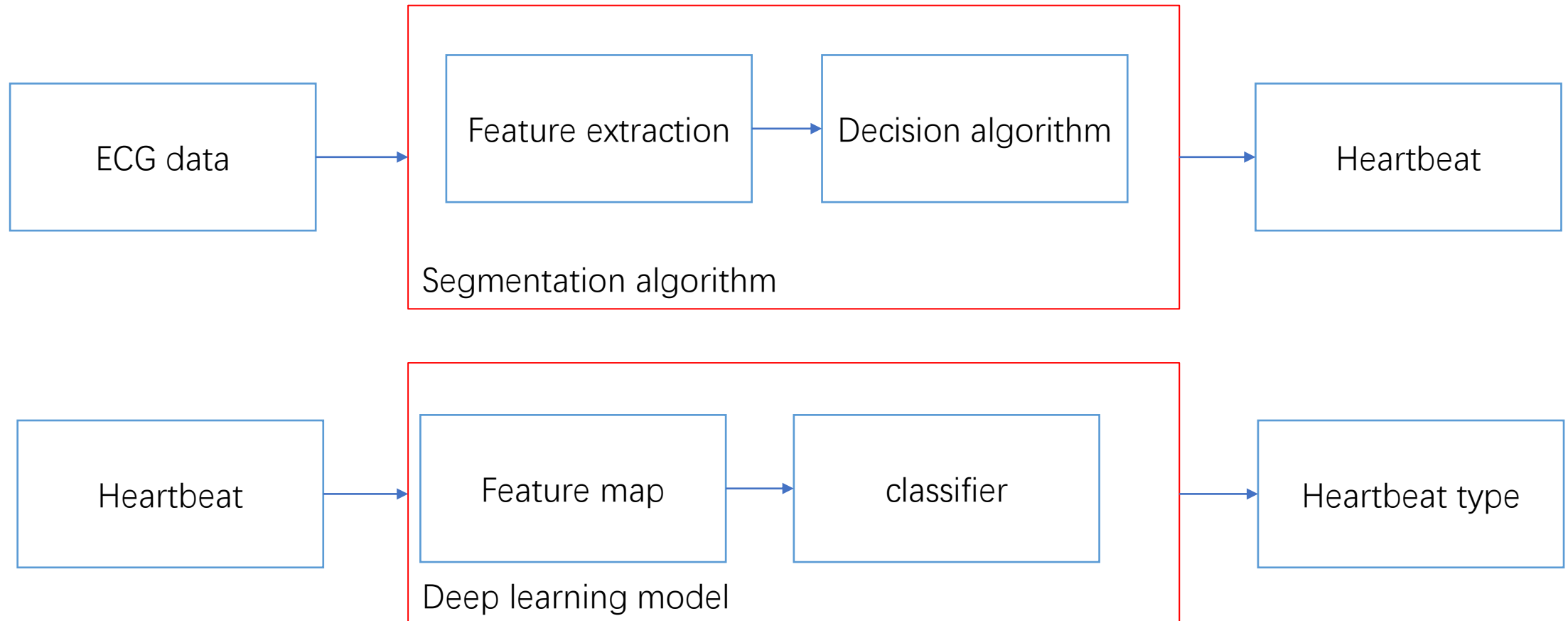
Process of the deep learning based methods



## Motivation

improvement:

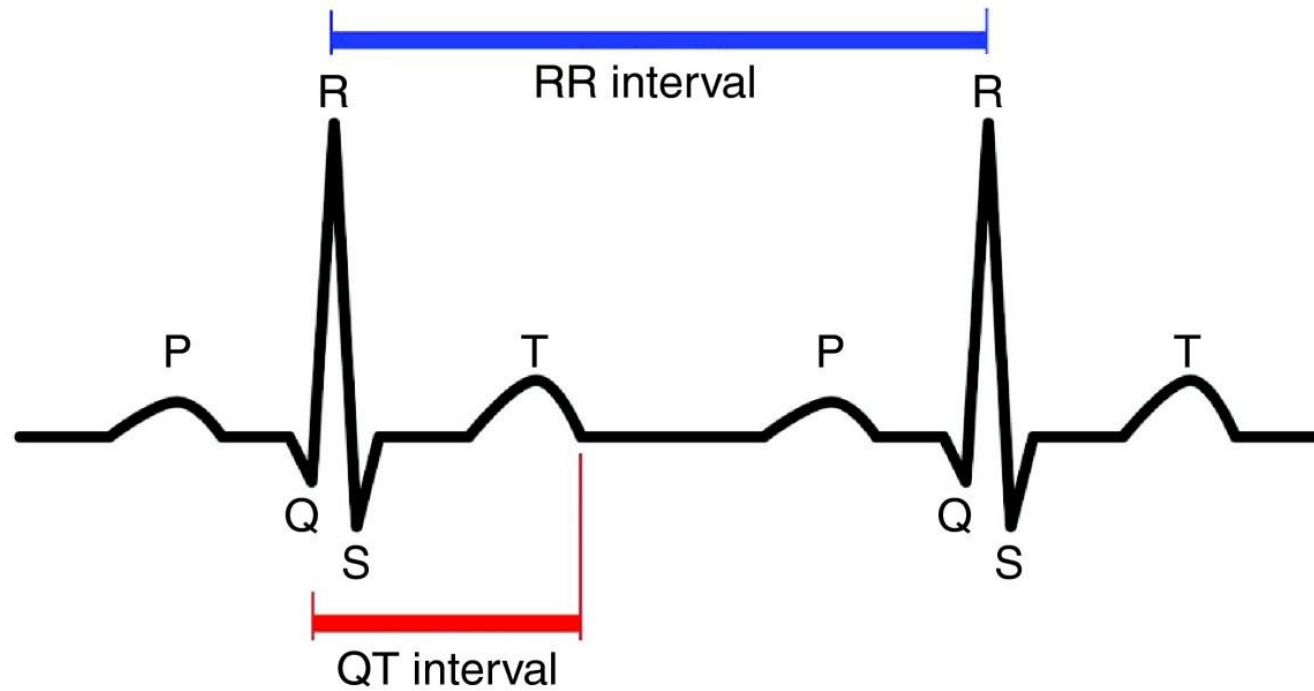
- Reuse/share feature



## Motivation

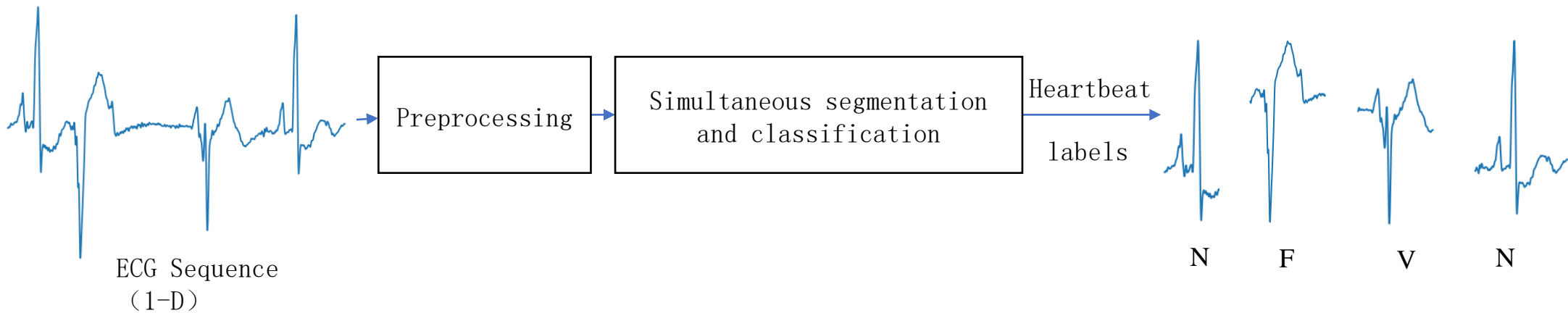
improvement:

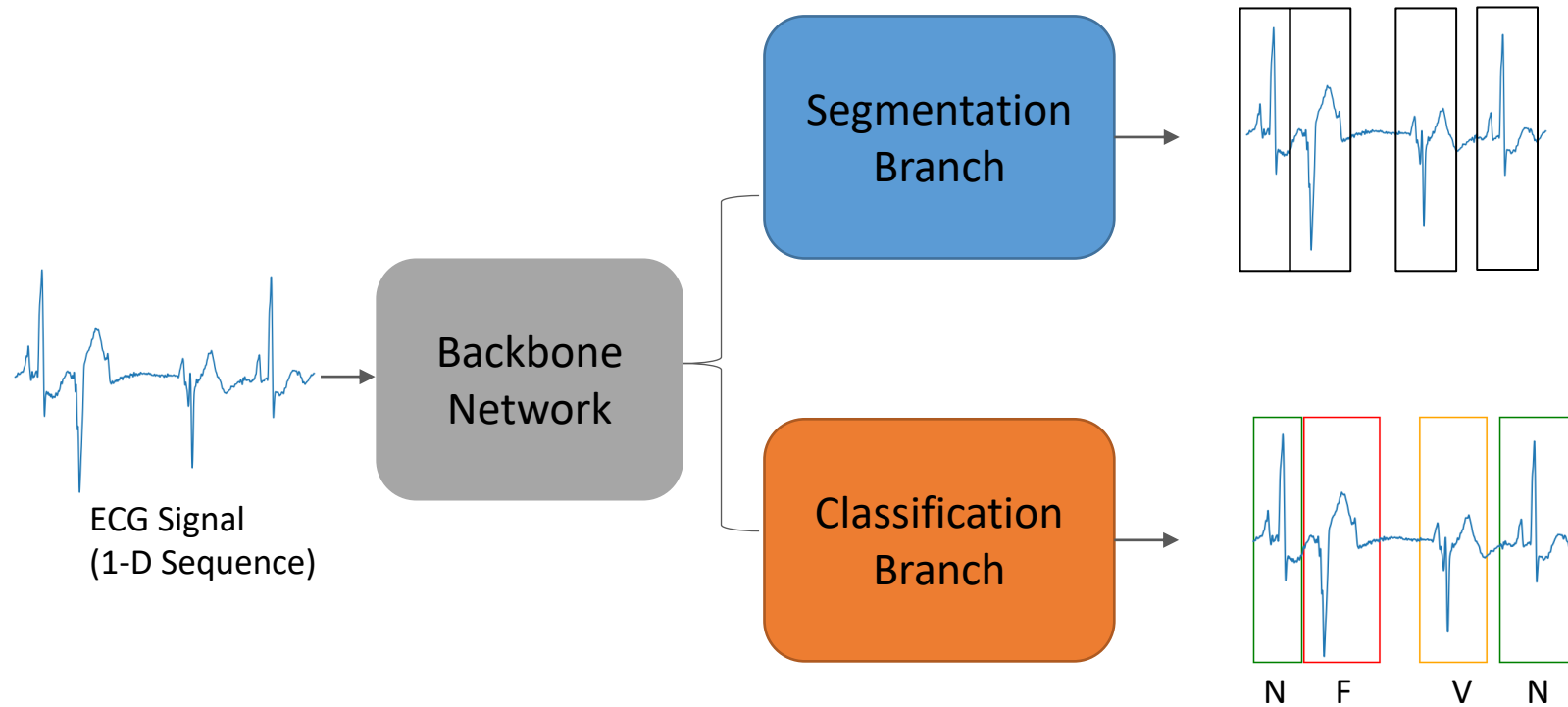
- Heartbeat context information



Our goal:

- Integrate segmentation and classification task
- Capture heartbeat context information

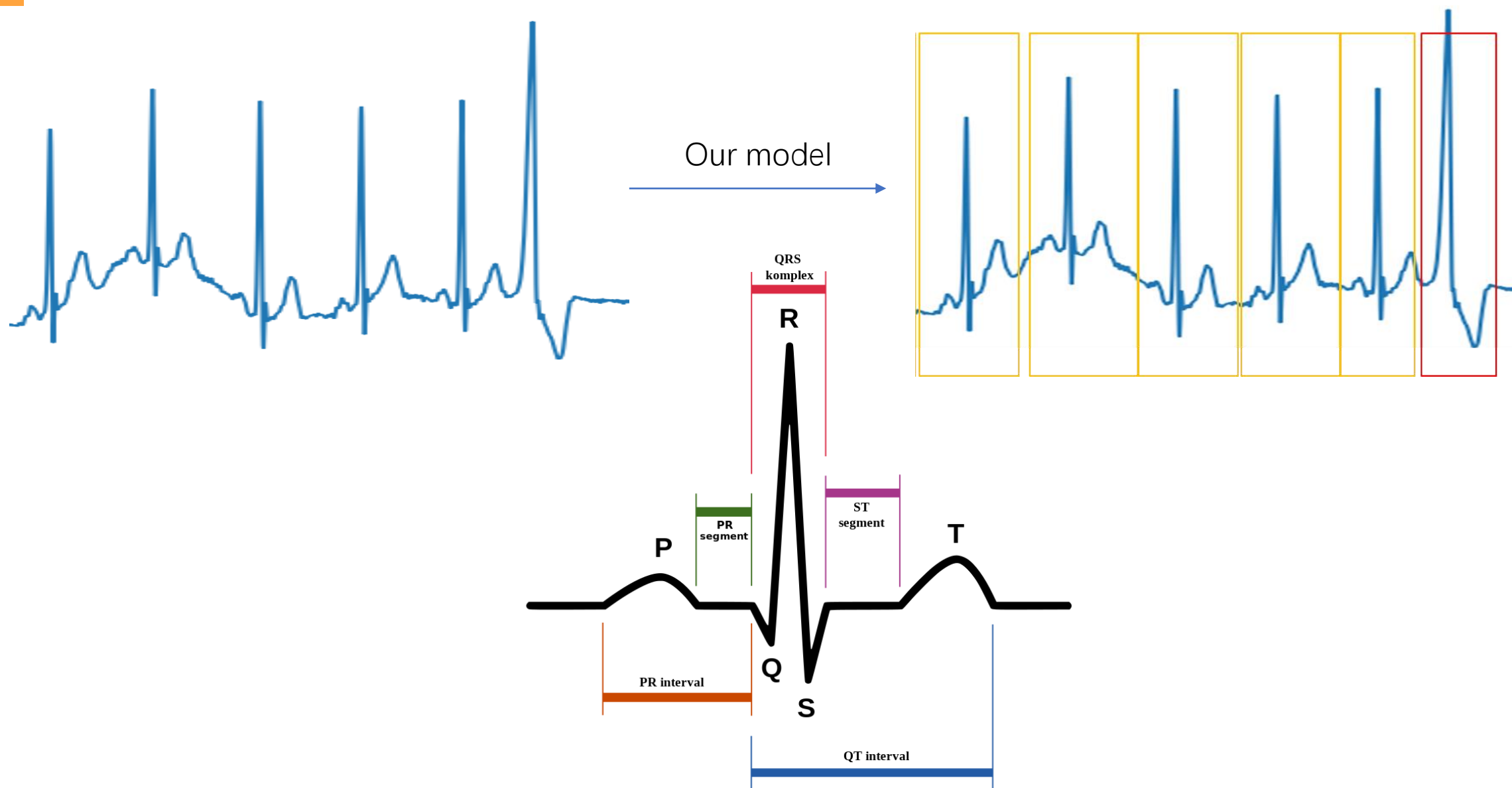


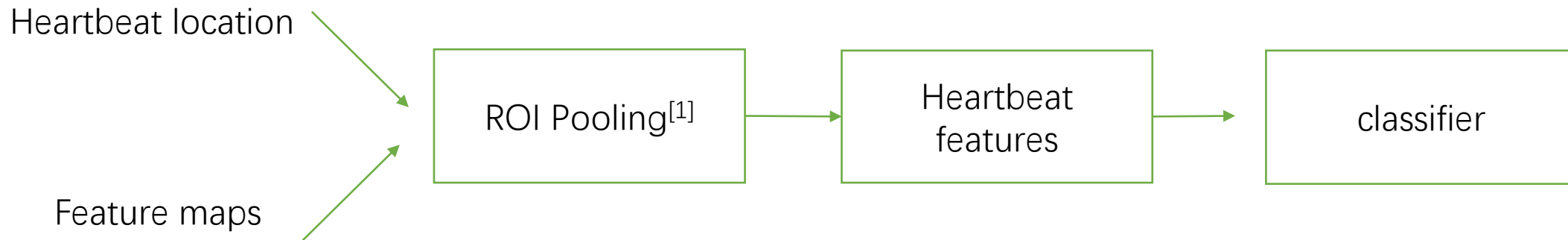


Ren, Shaoqing, et al. "Faster r-cnn: Towards real-time object detection with region proposal networks." *Advances in neural information processing systems*. 2015.



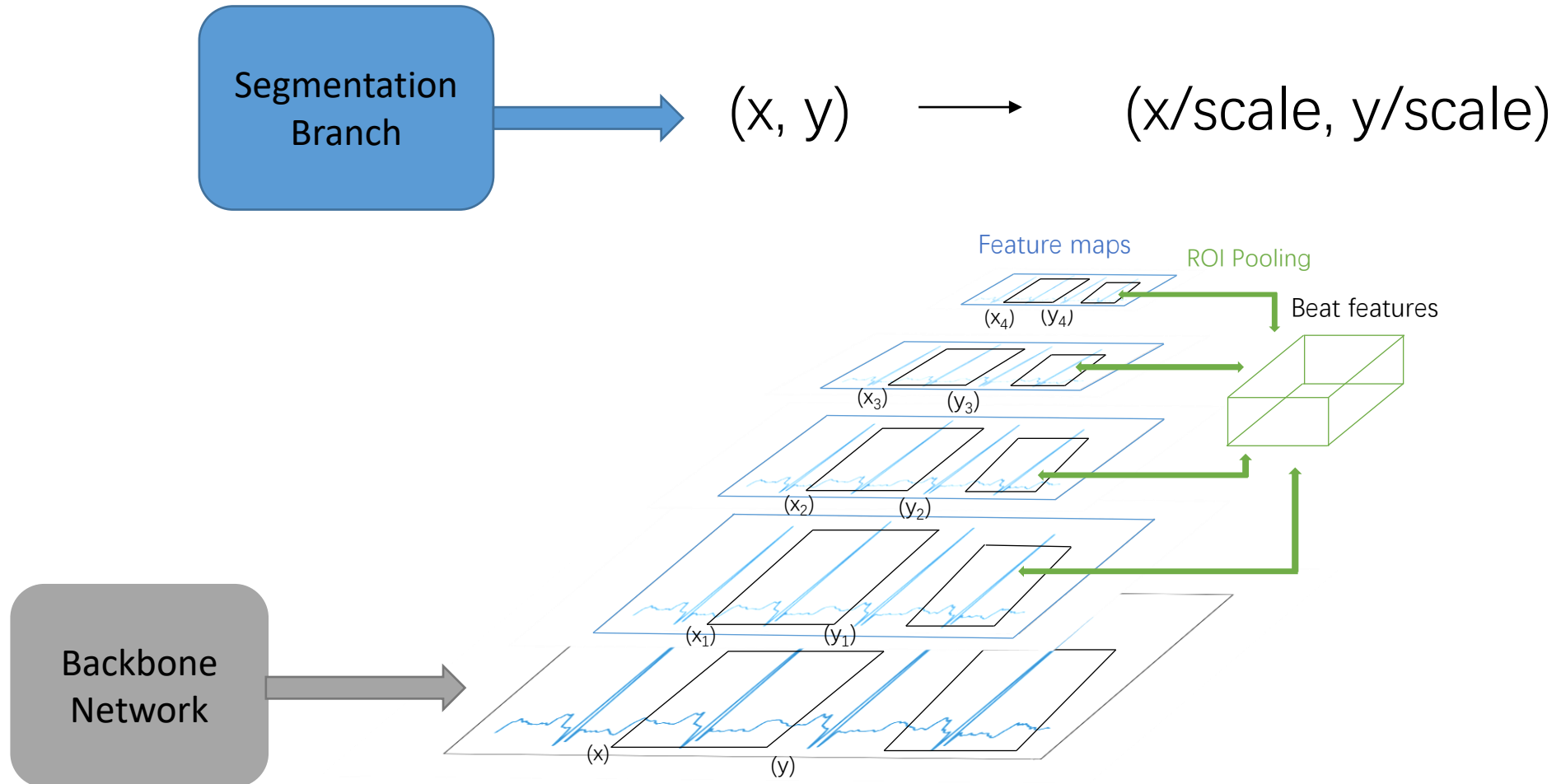


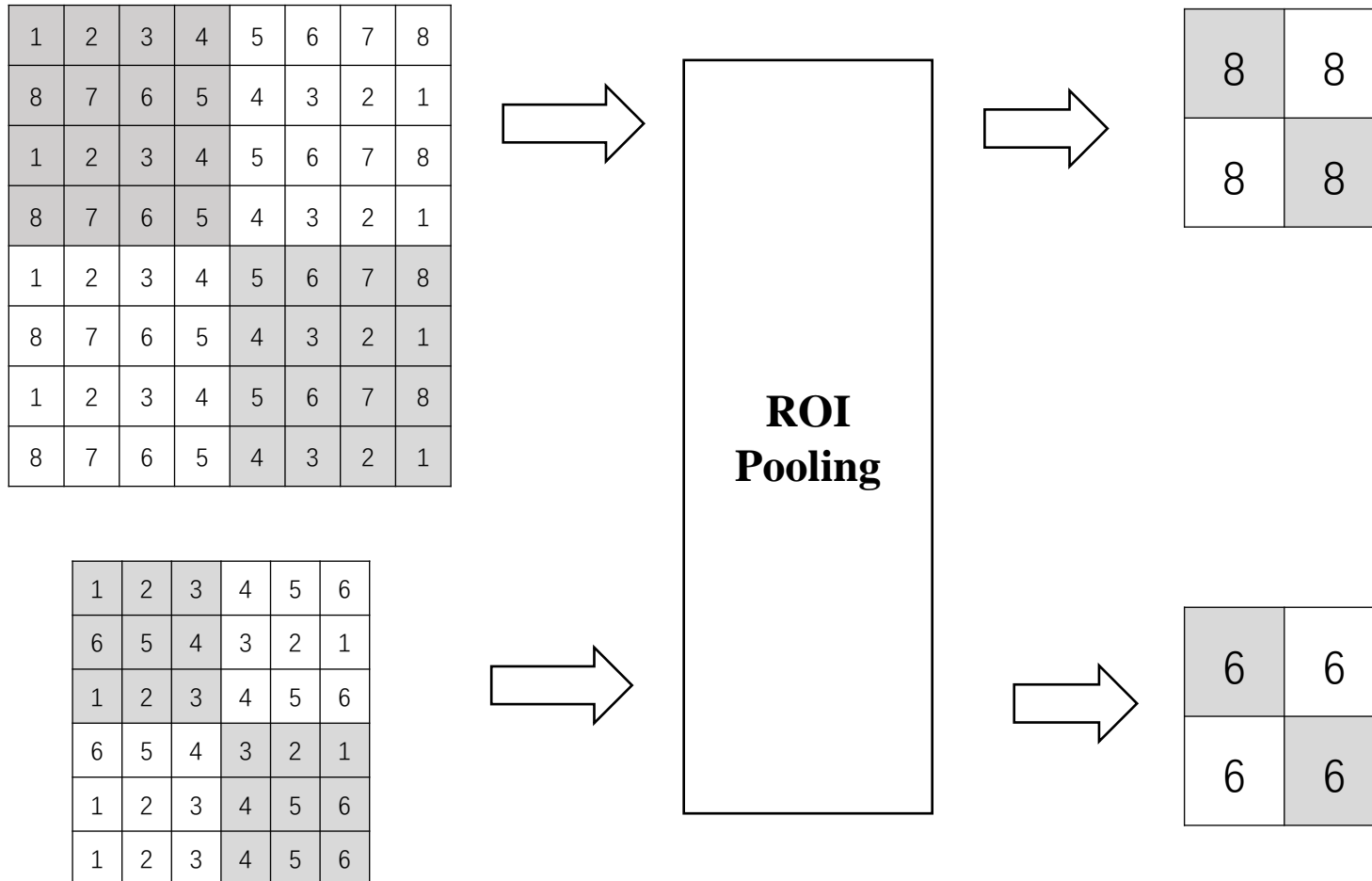


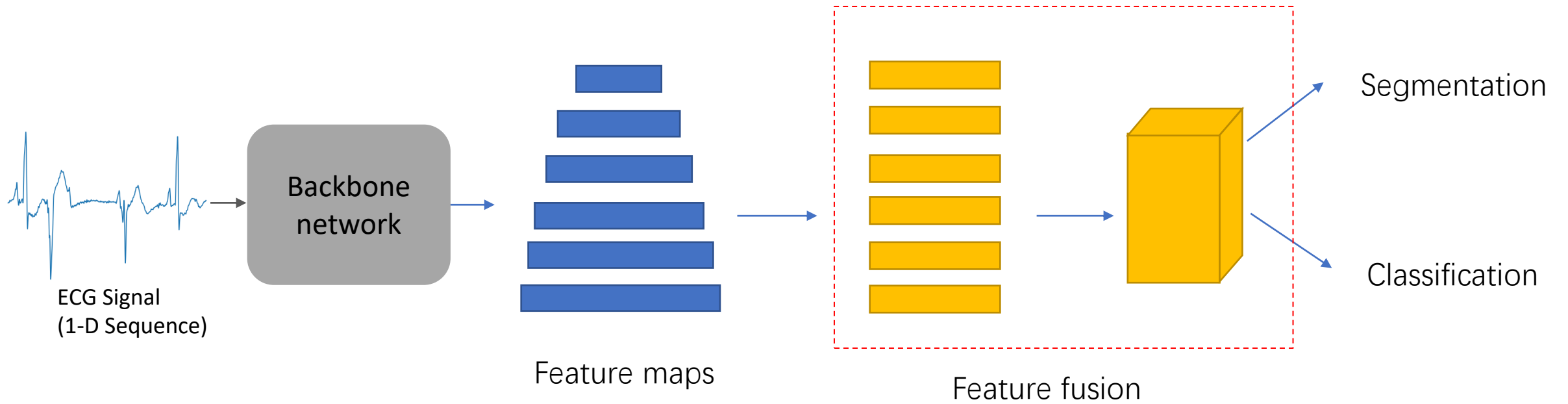


[1]Ren, Shaoqing, et al. "Faster r-cnn: Towards real-time object detection with region proposal networks." *Advances in neural information processing systems*. 2015.

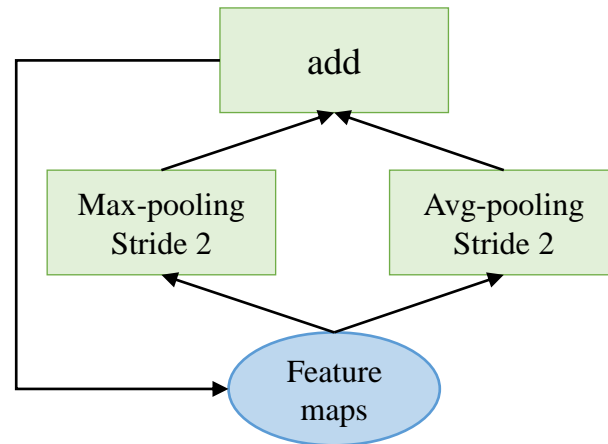


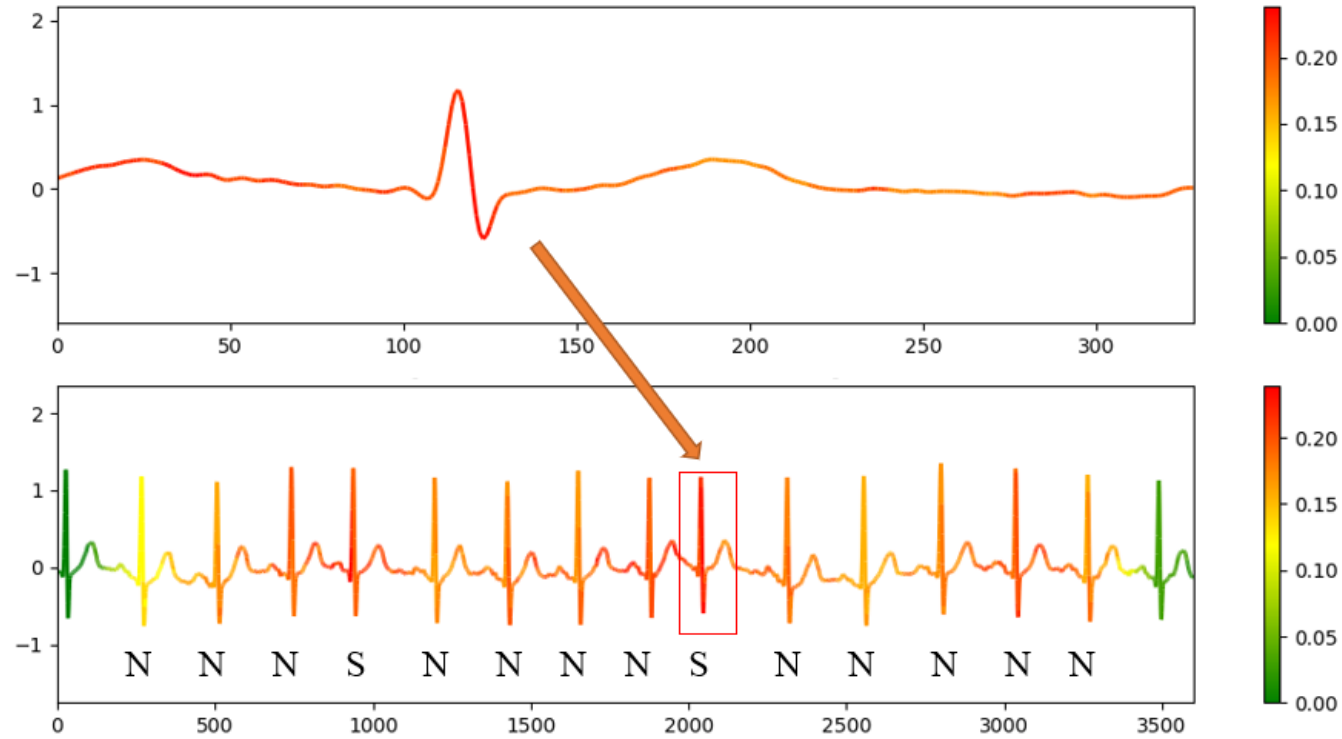






$$x = \begin{cases} x & \text{if } \text{len}(x) = L; \\ \text{Max-Pool}(x) + \text{Avg-Pool}(x) & \text{else.} \end{cases}$$





Heat map of an abnormal heartbeat



# Training

- Train the segmentation branch
- Train the classification branch

$$\textit{Smooth L1}(x) = \begin{cases} 0.5x^2 & |x| \leq 1 \\ |x| - 0.5 & \textit{otherwise} \end{cases} \quad (2)$$

$$\textit{Focal Loss}(p_t) = -\alpha_t(1 - p_t)^\gamma \log(p_t) \quad (3)$$

Lin, Tsung-Yi, et al. "Focal loss for dense object detection." *Proceedings of the IEEE international conference on computer vision*. 2017.





- Heartbeat segmentation task
- MIT-BIH arrhythmia database<sup>[2,3]</sup>

**Table 2.** Heartbeat segmentation performance

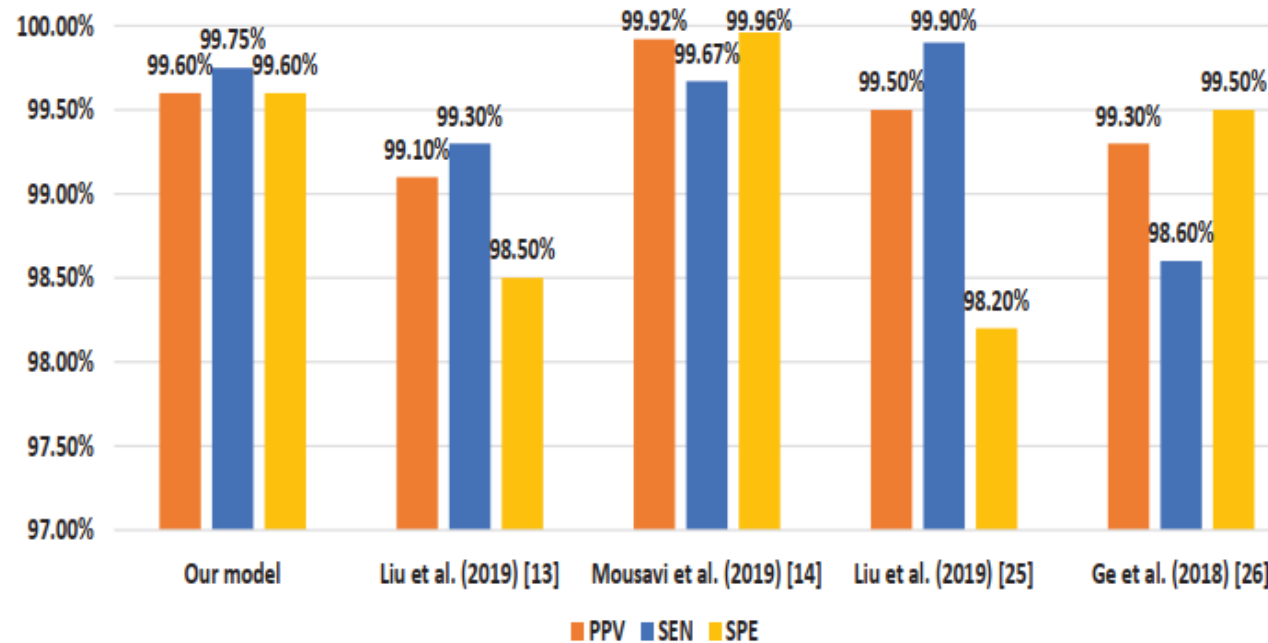
| Method            | PPV (%) | SEN (%) | ACC (%) |
|-------------------|---------|---------|---------|
| Our model         | 99.63   | 99.89   | 99.52   |
| Pan-Tompkins [23] | 99.56   | 99.76   | 99.32   |
| Wavedet [24]      | 99.86   | 99.80   | 99.66   |

[2] Moody GB, Mark RG. The impact of the MIT-BIH Arrhythmia Database. IEEE Eng in Med and Biol 20(3):45-50 (May-June 2001). (PMID: 11446209)

[3] Goldberger AL, Amaral LAN, Glass L, Hausdorff JM, Ivanov PCh, Mark RG, Mietus JE, Moody GB, Peng C-K, Stanley HE. PhysioBank, PhysioToolkit, and PhysioNet: Components of a New Research Resource for Complex Physiologic Signals (2003). Circulation. 101(23):e215-e220.



- Heartbeat classification task
- MIT-BIH arrhythmia database AAMI 5 classes(N,S,V,F,Q)



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[14] Mousavi, S., Afghah, F.: Inter- and intra-patient ECG heartbeat classification for arrhythmia detection: a sequence to sequence deep learning approach. In: ICASSP 2019-2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). pp. 1308–1312. IEEE (2019)

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- Simultaneously conduct heartbeat segmentation and classification.
- Capture heartbeat context information
  
- Future work
  - Multi-lead ECG data analysis



Thank you

