

Universitatea POLITEHNICA Timișoara
Facultatea de Automatică și Calculatoare

ECG(EKG) Interpreter

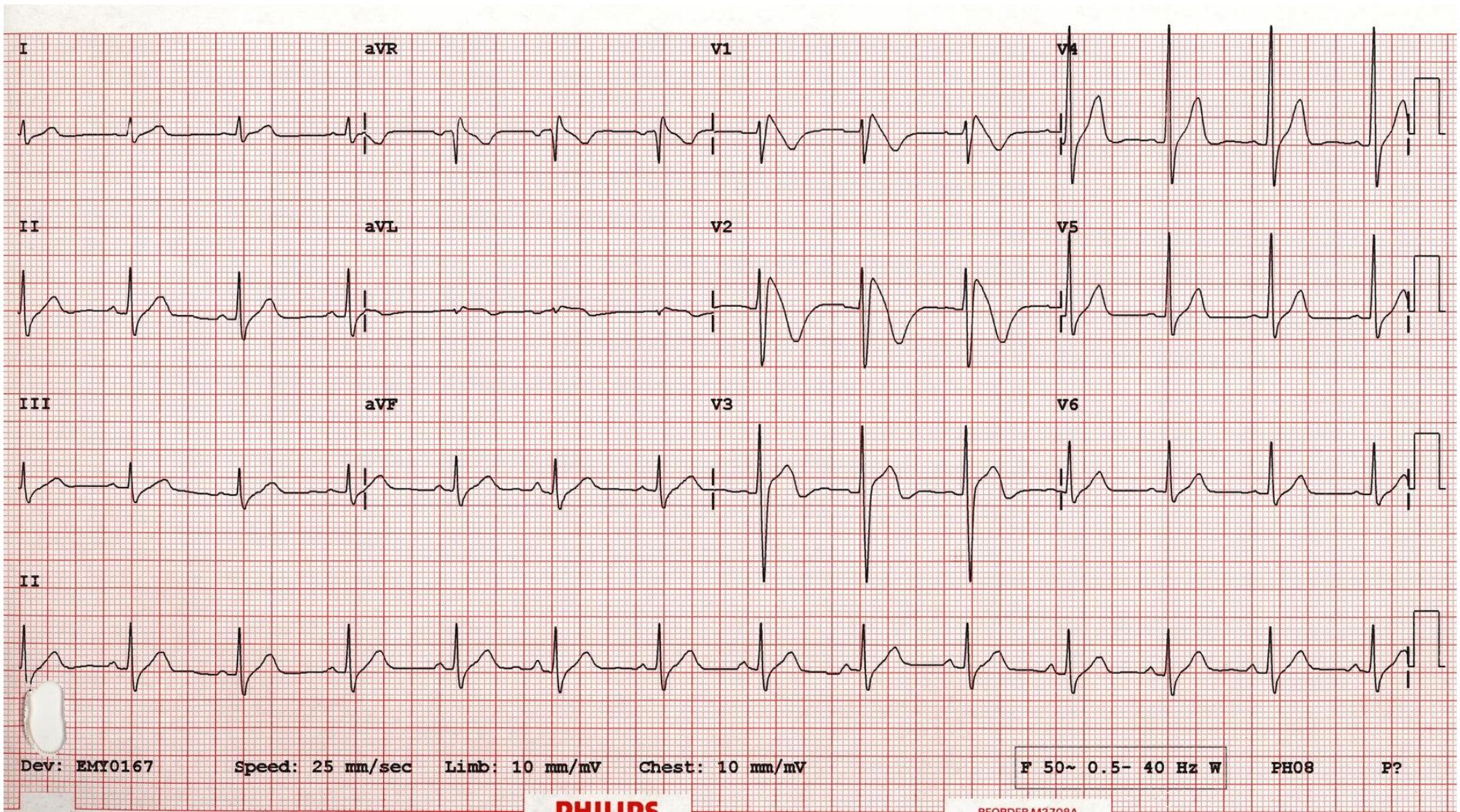
Ingineria Calculatoarelor – Proiect 2017

<https://github.com/MarioSavu/ECGsInterpreter>

Darie-Mario SAVU

What's an ECG?

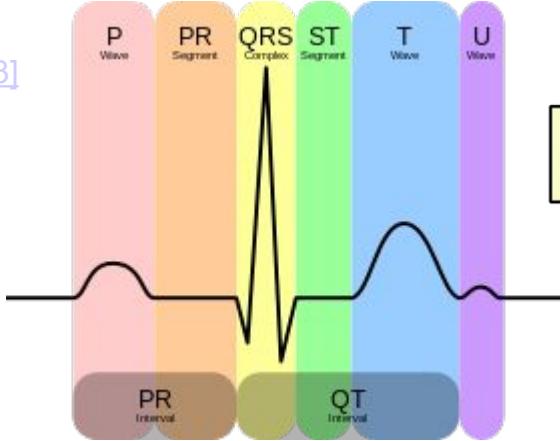
- From a **medical** point of view: an electrocardiogram is a test that checks for problems with the electrical activity of your heart.^[1]
- From **my** point of view: it's a set of signals that can be processed after acquisition by any programmable device



[2]

ECG example

[3]

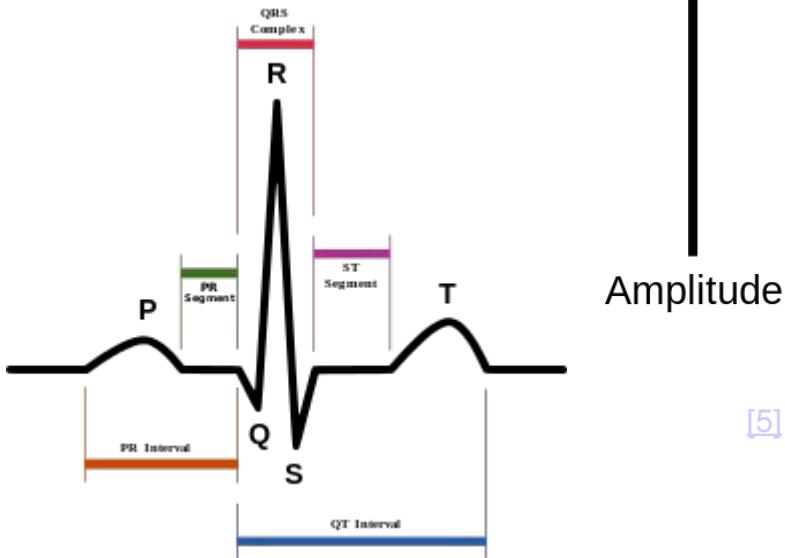


1 mV (10 mm high)
reference pulse

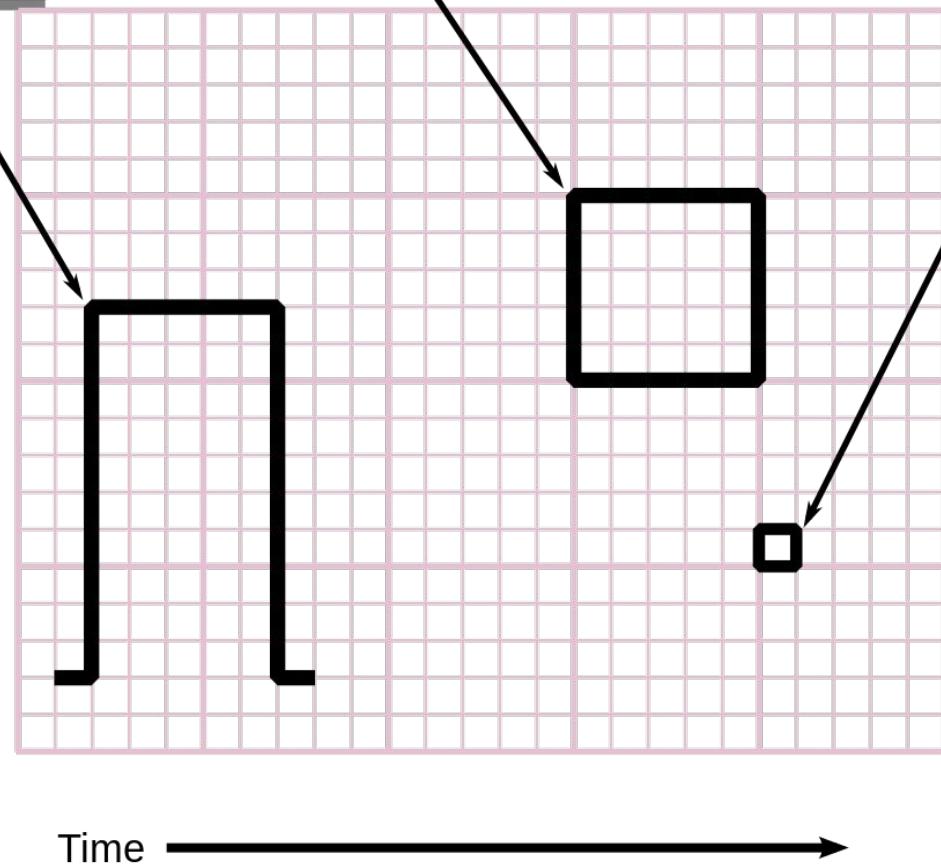
One large $5\text{ mm} \times 5\text{ mm}$ box
represents 0.2 seconds (200 ms)
time and 0.5 mV amplitude.

One small $1\text{ mm} \times 1\text{ mm}$ block
represents 40 ms time and
0.1 mV amplitude.

[4]



[5]



Signal characteristics and waveforms

How do you interpret these signals?

There's a finite list of checks that a medical professional has to observe:

1. Rhythm
2. Rate
3. Axis
4. P Wave
5. P-R Interval
6. QRS Complex
7. Q Wave
8. R Wave
9. S Wave
10. ST Segment Changes
11. T Wave

[11 Steps to Read an ECG, Dr J Anthonypillai](#)

Why ECGs?

- I think I can make an application that does the same interpretation as a human would (possibly even more precise)
- EKGs are still manually interpreted, and there are nurses and sometimes even doctors who struggle with or misinterpret ECGs, there must be a better way of doing this
- I've never done signal processing, and ECGs are a nice way to start learning:
 - They are very well documented
 - They do not require real time processing
 - The signals are relatively easy to distinguish
 - This was done before.. so there's a lot of documentation on how to implement an ECG interpreter if I hit a roadblock

Software development tools

- [Qt framework](#) as an IDE and cross-platform C++ SDK solution to quickly develop an application.
- [QCustomPlot](#) widget for plotting and data visualization

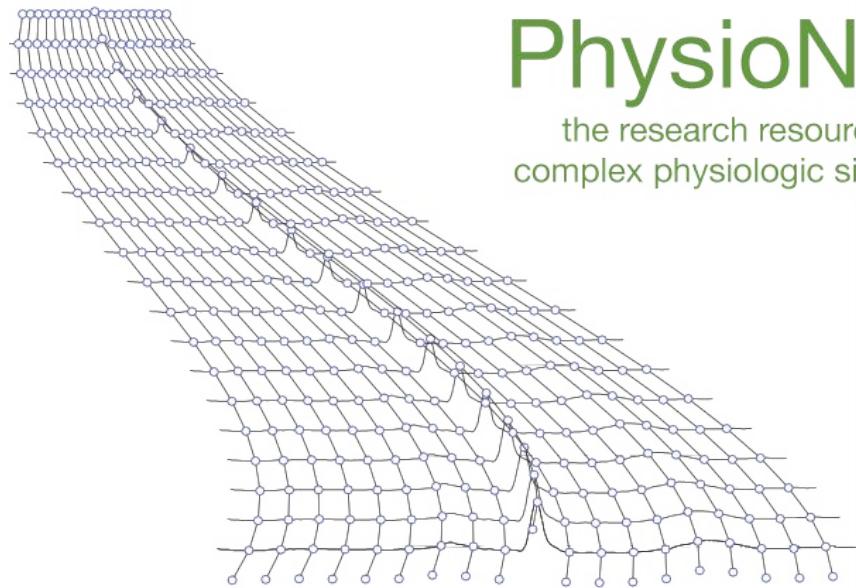


QCustomPlot

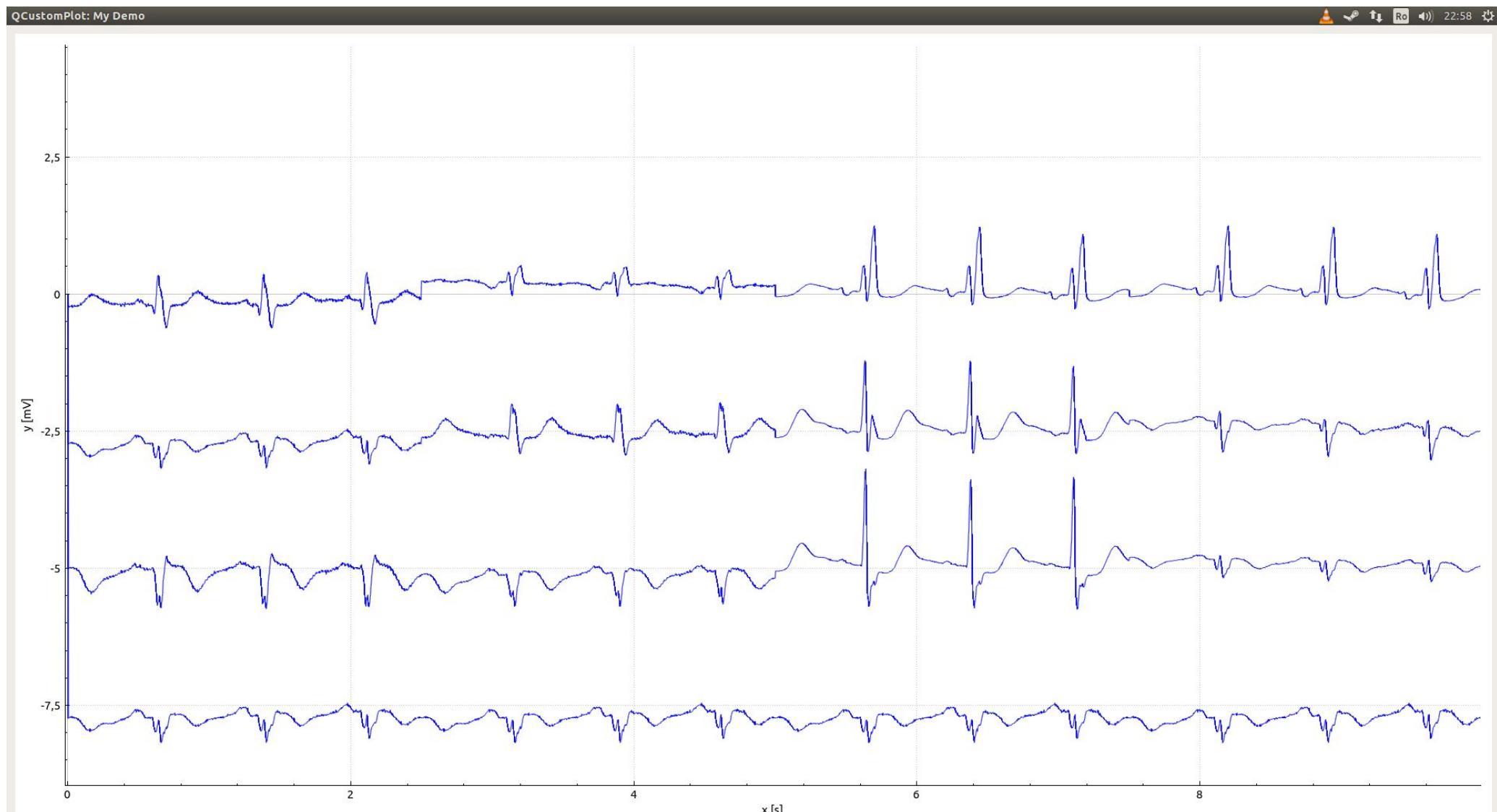
Input data: PhysioBank Databases

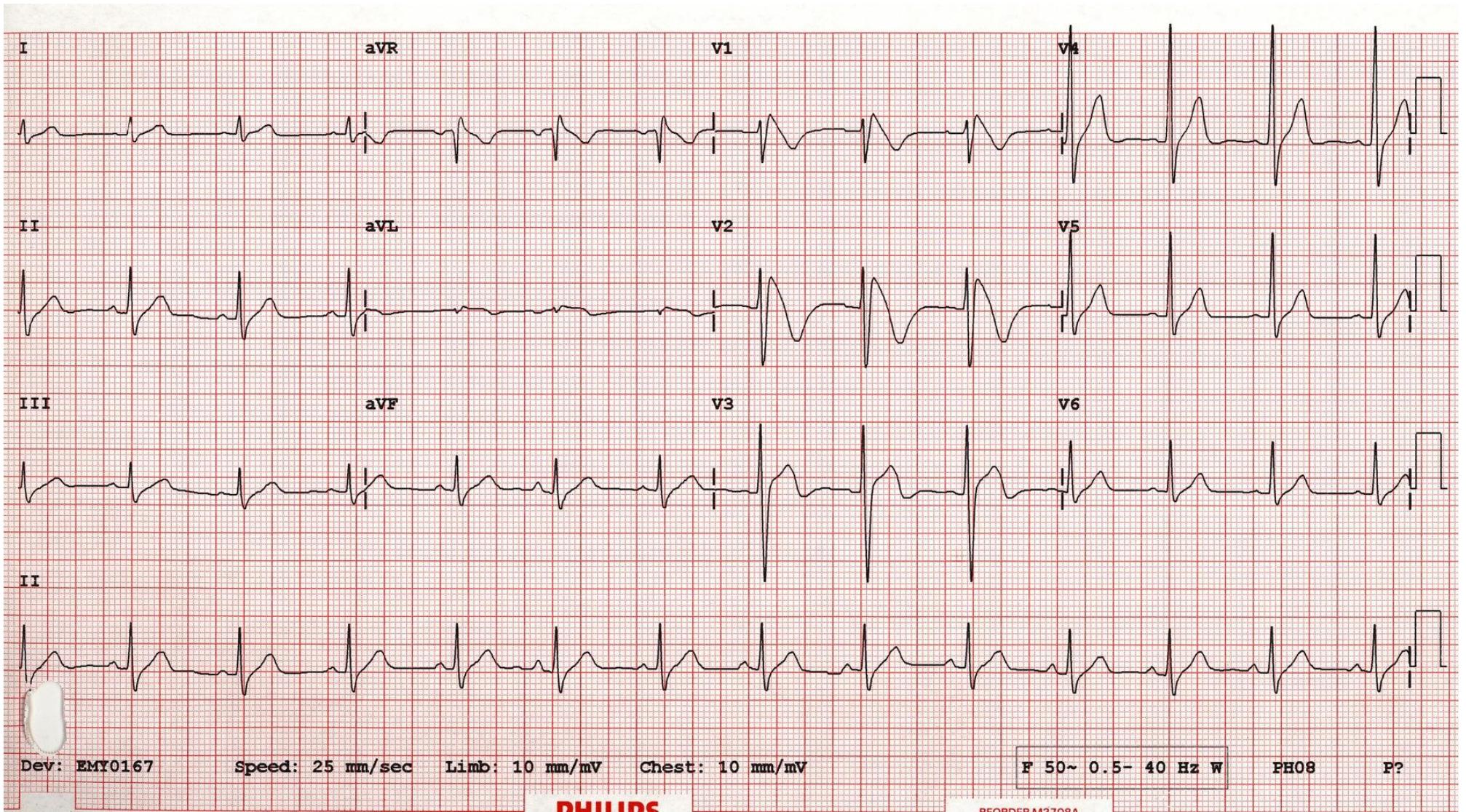
[PhysioNet](#) offers free web access to large collections of recorded physiologic signals (PhysioBank) and related open-source software.

[PhysioBank](#) contains over 90,000 recordings, or over 4 terabytes of digitized physiologic signals and time series, organized in over 80 databases.



Step 1: Loading the data

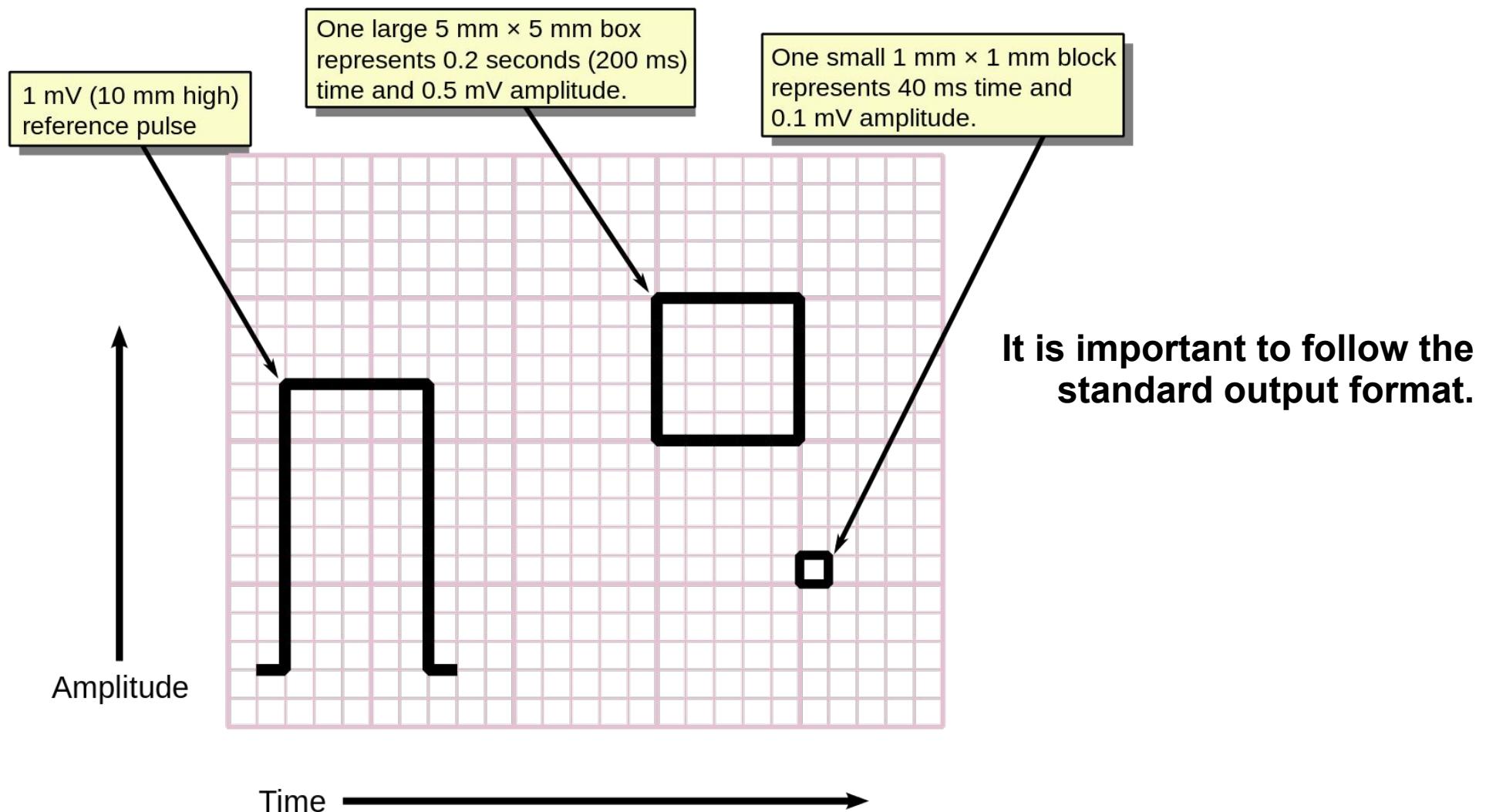




[2]

And comparing to the example

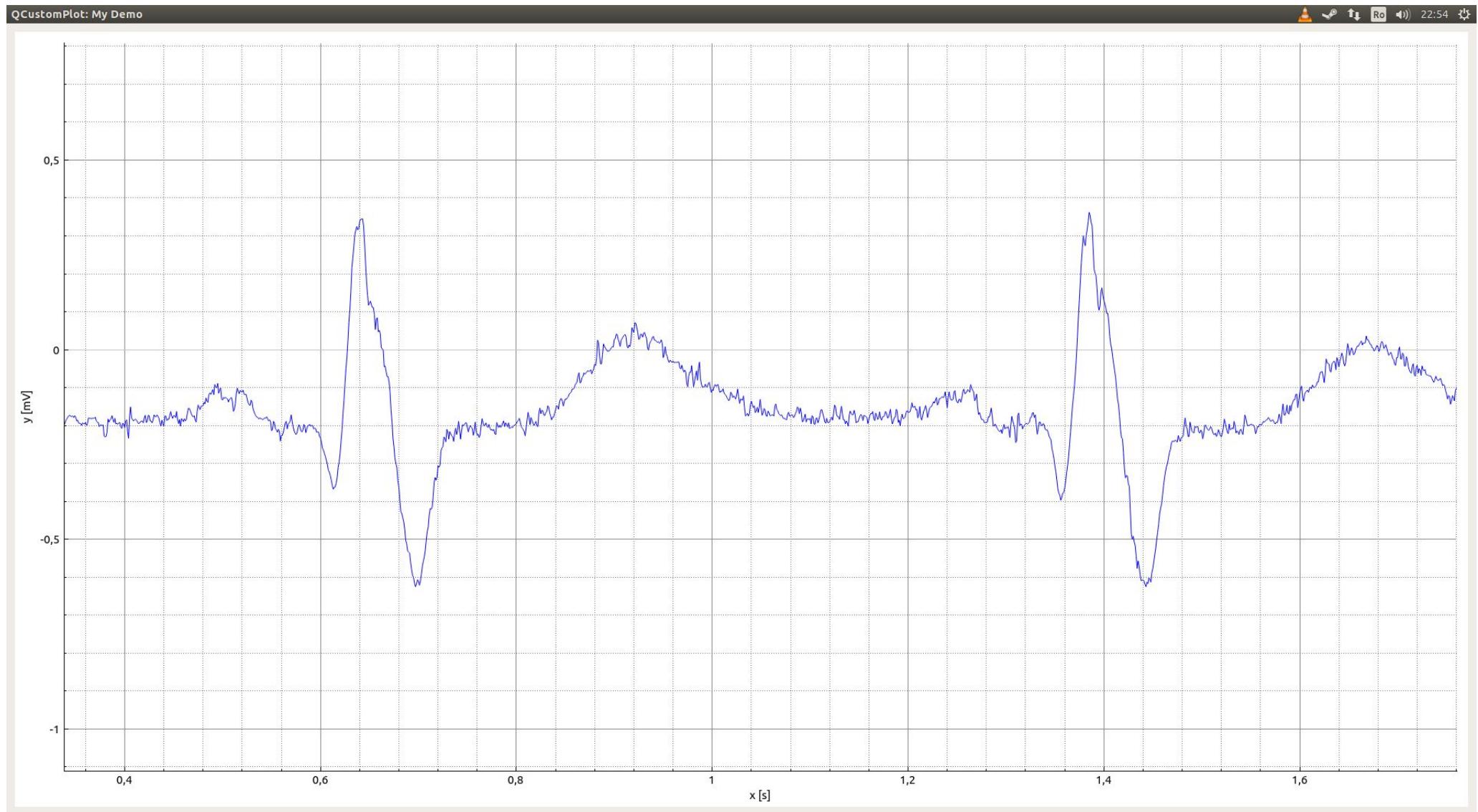
Problem #1: data visualization



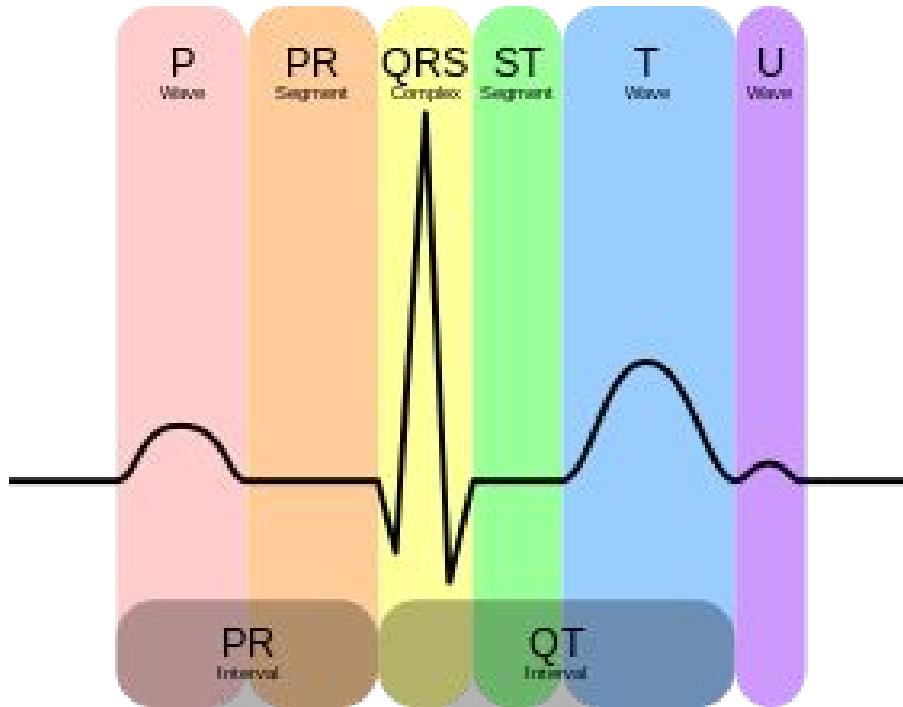
After some work and changes to QCP



Step 2: Zooming in



And comparing to the example



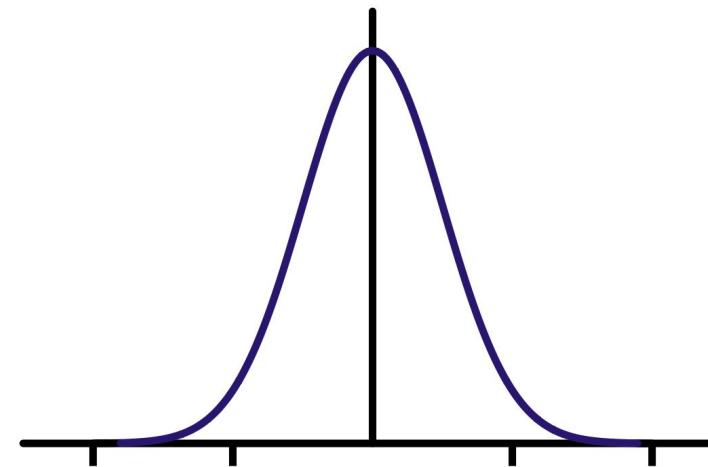
- The signal is obviously noisy but it looks somewhat similar in shape

Solution: Gaussian Filter/Blur



Used in ISP/DSP for reducing noise.

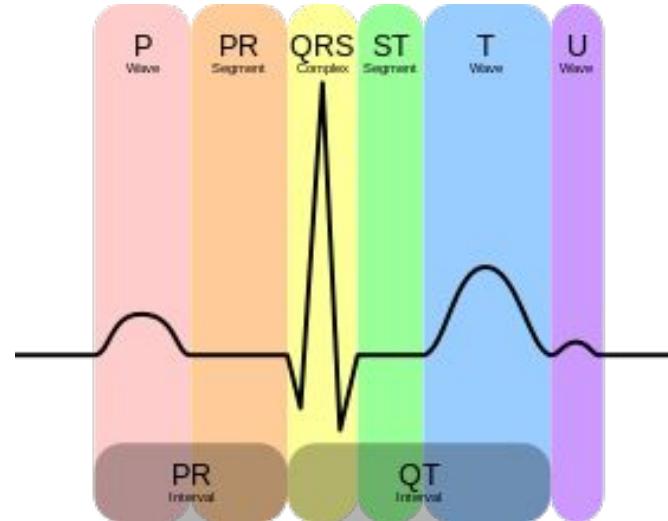
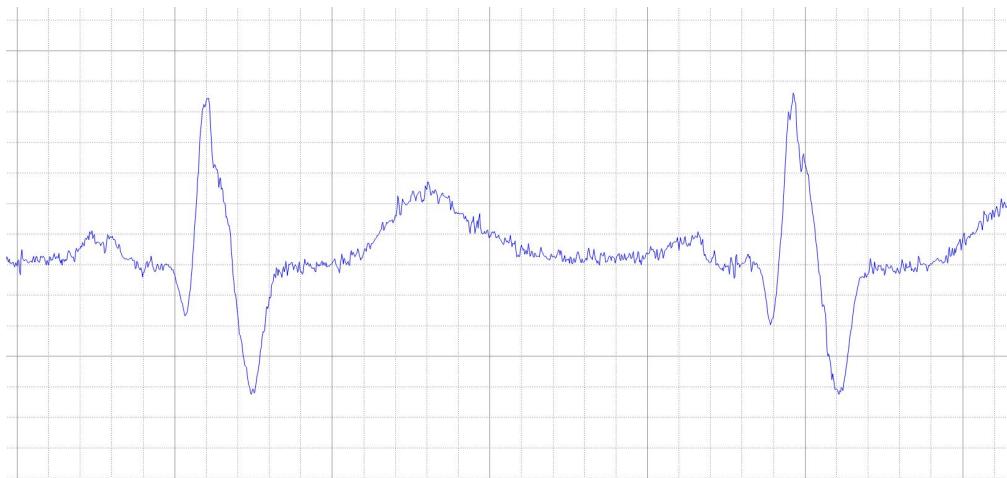
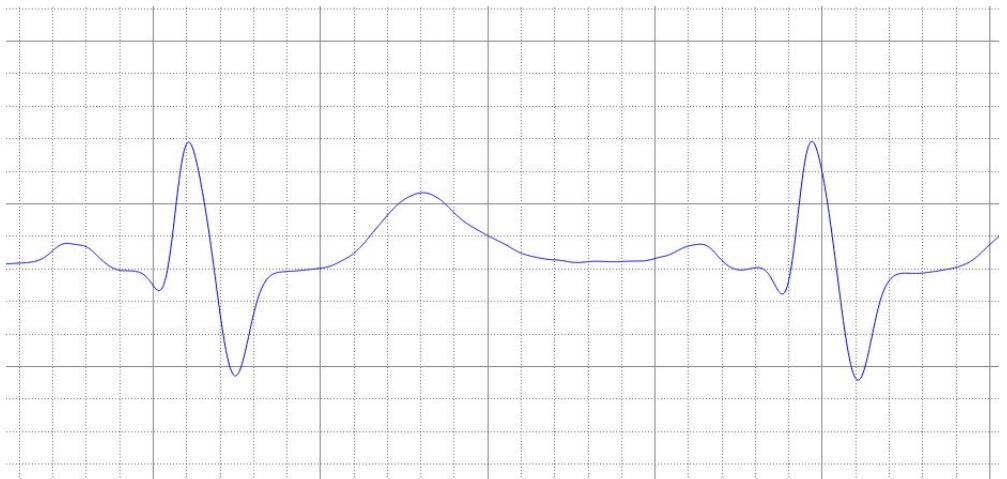
It's the result of a convolution with the Gaussian function.



Filtered output

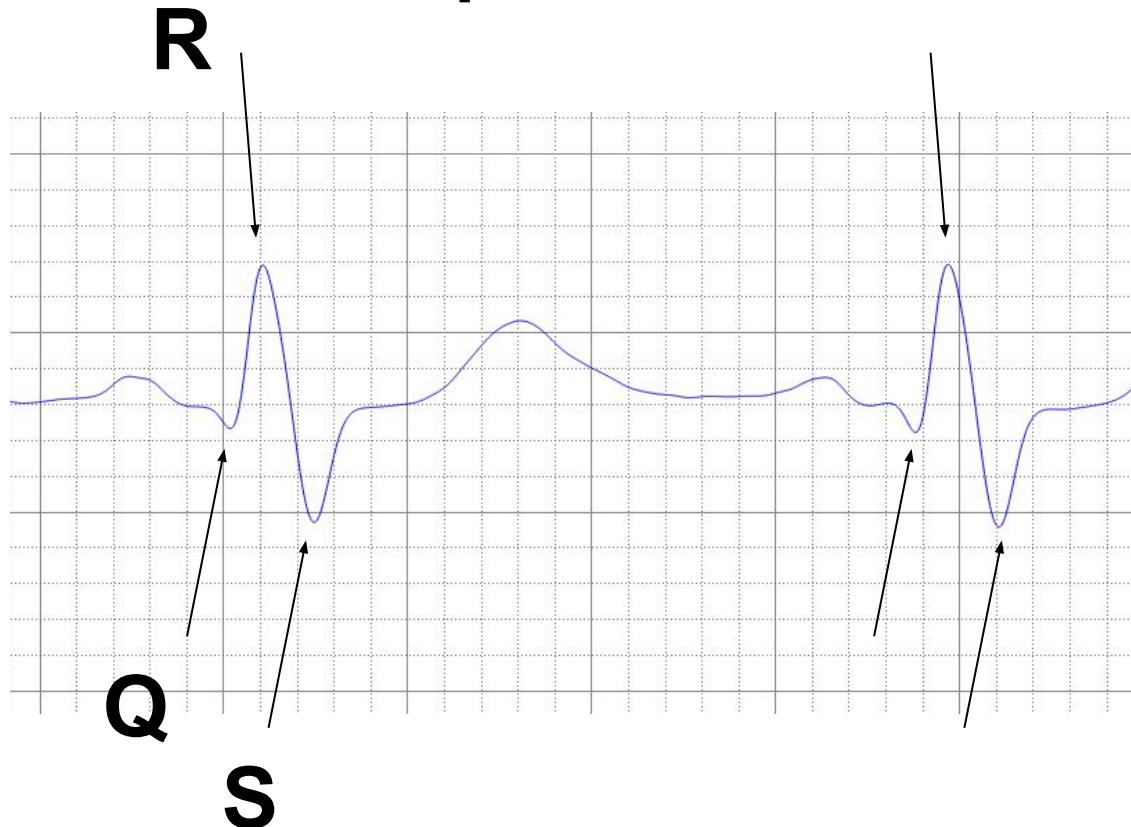


Signal comparison



- Clean signal
- Happens to look almost identical to the textbook example

Step 3: QRS Complex detection



Number of S (min) points 3

Point 0 xVal 0.698 yVal -0.528547
Point 1 xVal 1.443 yVal -0.541673
Point 2 xVal 2.171 yVal -0.470862

Number of R (max) points 3

Point 0 xVal 0.642 yVal 0.189636
Point 1 xVal 1.387 yVal 0.191412
Point 2 xVal 2.114 yVal 0.244239

Number of Q points 3

Point 0 xVal 0.607 yVal -0.266627
Point 1 xVal 1.352 yVal -0.277276
Point 2 xVal 2.08 yVal -0.192702

Heart beat interval average (R wave) 0.736

Heart rate (R wave) 81.5217 BPM

Heart beat interval average (S wave) 0.7365

Heart rate (S wave) 81.4664 BPM

Heart beat interval average (Q wave) 0.7365

Heart rate (Q wave) 81.4664 BPM

Step 4+?

- Repeat procedure to find P and T waves
- Graphically mark the P QRS T peaks or intervals
- Add some if-else/switch's to output medical results based on previously processed data
- Done!
 - Well not really, I stopped at step 3
 - There was nothing left to learn and I've lost interest

Thank you!

+

Q&A