Peak detection using U-Net under low Peak to Noise Ratio environments

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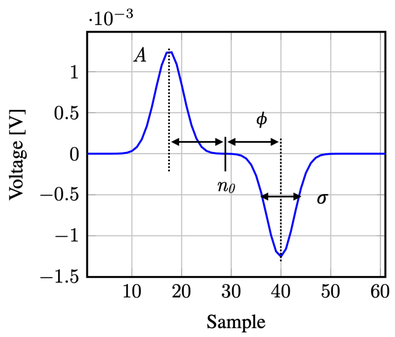
Introduction

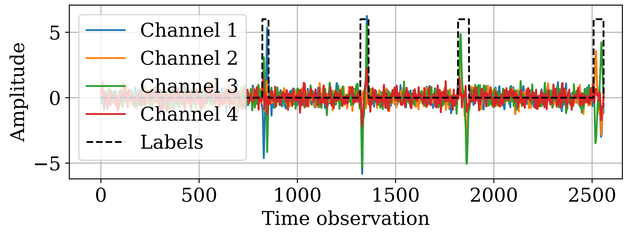
SBT Instruments has developed a new approach to bacteria measurement. The signals sensored by the device are four time-series channels.

The events in each channel look as follows:



Dataset

A synthetic data generator was designed to be as close as posible to reality. Multiple 30 seconds measurements with different PNR were generated.



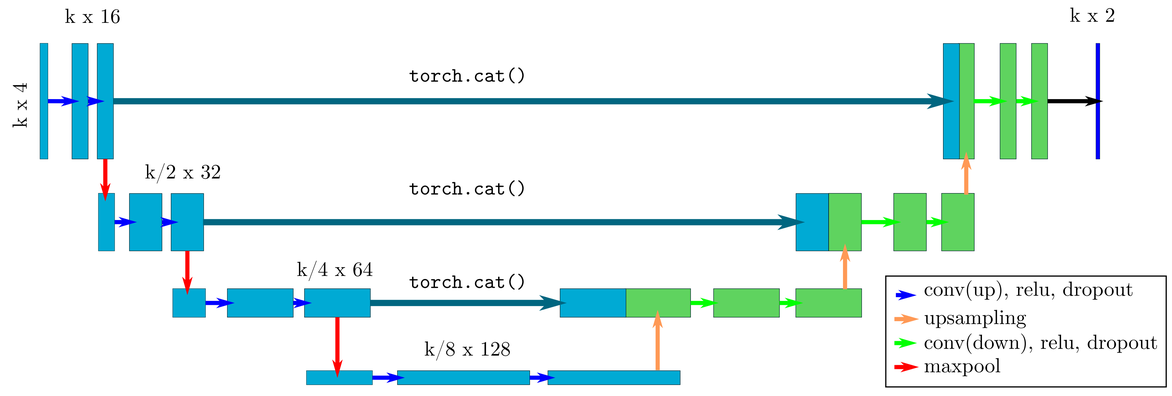
Pre-processing

Data imbalance becomes an issue when training.. Thus, a few methods were introduced:

- Splitting the sequence into chunks
- Disregard the majority of peakless chunks
- Apply some weighting on the loss function

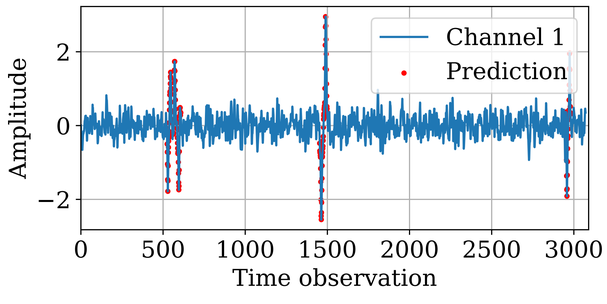
Model

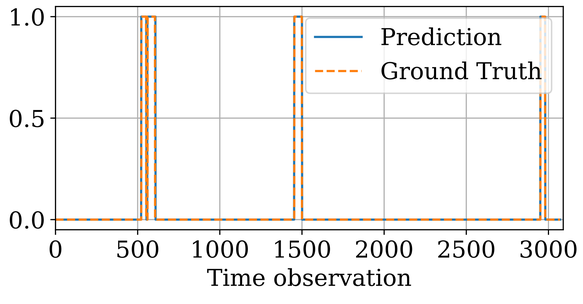
A model used for image segmentation [1] was transformed to a 1D problem [2]. The arquitecture is shown in the following figure, where k is the length of the chunk:



Results - Qualitative

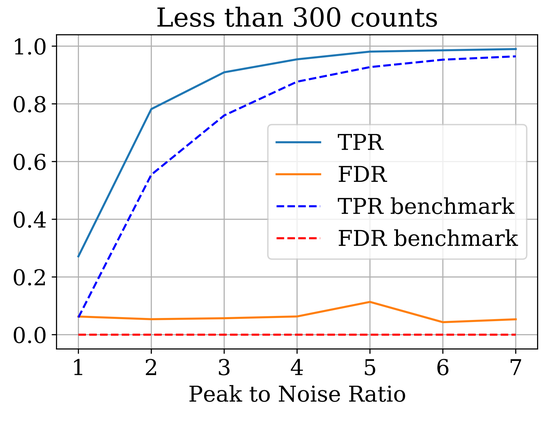
A measurement extracted from the testing bench is shown (PNR = 5). It can be seen that for this level of PNR the method has no problems on detecting the peaks.

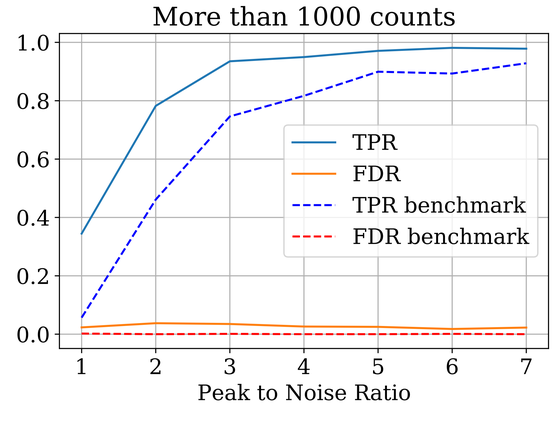




Results - Quantitative

A testing bench was designed to compare the proposed peak detector method to the current method. The following figure shows the overcome of the U-Net under noisy conditions:





References

[1] Olaf Ronneberger and Philipp Fischer and Thomas Brox. U-Net: Convolutional Networks for Biomedical Image. arXiv:1505.04597, 2015.
[2] Daniel Stoller, Sebastian Ewert and Simon Dixon. Wave-U-Net: A Multi-Scale Neural Network for End-to-End Audio Source Separation. arXiv:1806.03185, 2018.