



THE UNIVERSITY
of ADELAIDE

Sonia Kleinig (a1740773)

Hien Long Nguyen (a1798520)

Supervised by Derek Abbott and Mohsen Dorraki

CAN WE TEACH A MACHINE TO BE A CARDIOLOGIST?

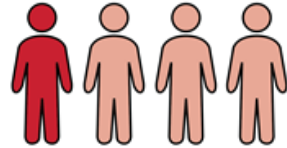
PROJECT NUMBER: UG13434

adelaide.edu.au

Outline

- **Introduction**
 - **The Big Picture**
- **Technical Information**
 - **What is an ECG?**
 - **Machine Learning Techniques**
- **Current Progress**
 - **MATLAB Classification**
 - **Future Direction**
 - **Risk Assessment**
- **Conclusion**

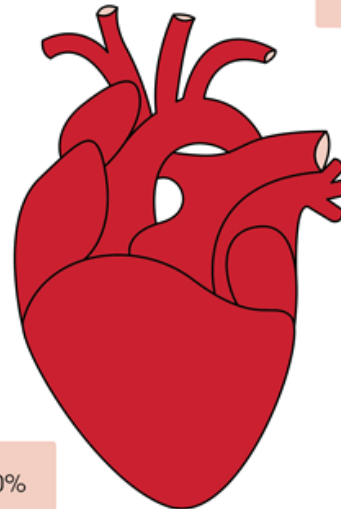
The Big Picture



Causes **1 in 4 deaths**¹

Costs the Australian economy \$5 billion each year, more than any other disease³.

Kills **118** people every day or **one person every 12 mins**¹



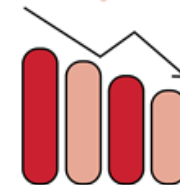
Over the last 10 years, deaths have been declining thanks to research into risk factors, medications and interventions¹



Kills around **40% more males** than females¹

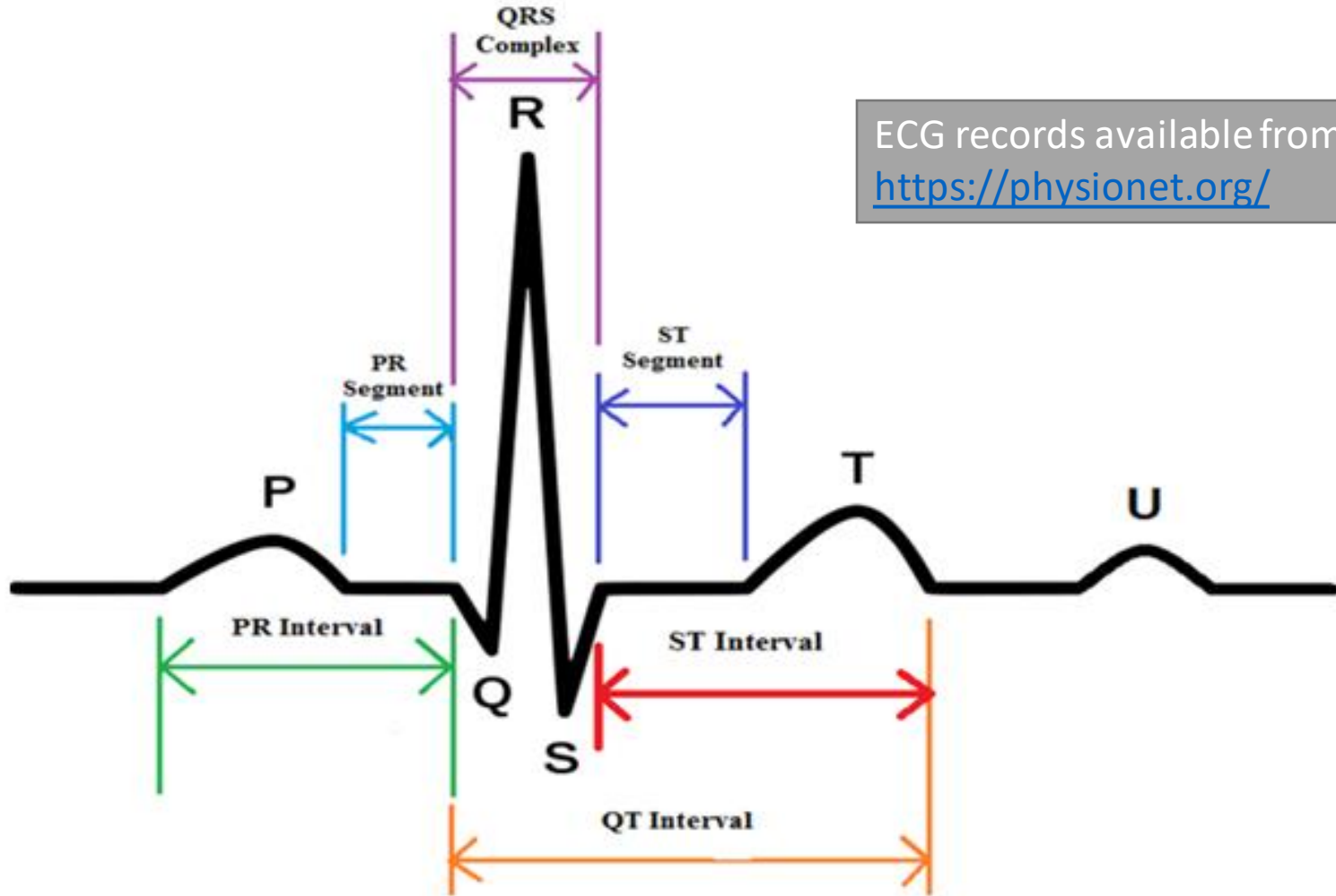


Aboriginal and Torres Strait Islanders die from CVD at a higher rate than non-Indigenous Australians².



Source:
<https://www.heartfoundation.org.au/activities-finding-or-opinion/key-stats-cardiovascular-disease>

What is an ECG?

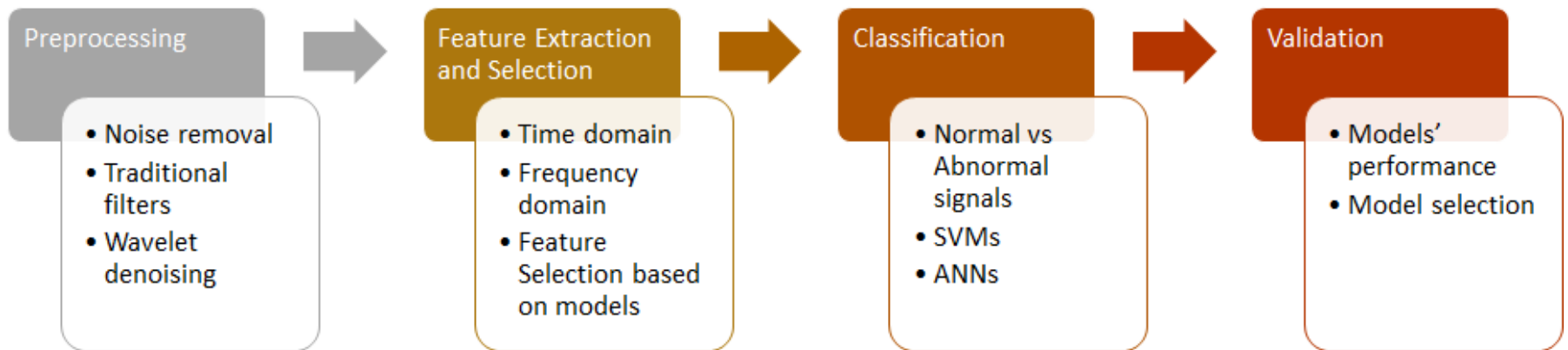


ECG records available from:
<https://physionet.org/>

https://www.researchgate.net/figure/Schematic-representation-of-normal-ECG-waveform_fig3_287200946

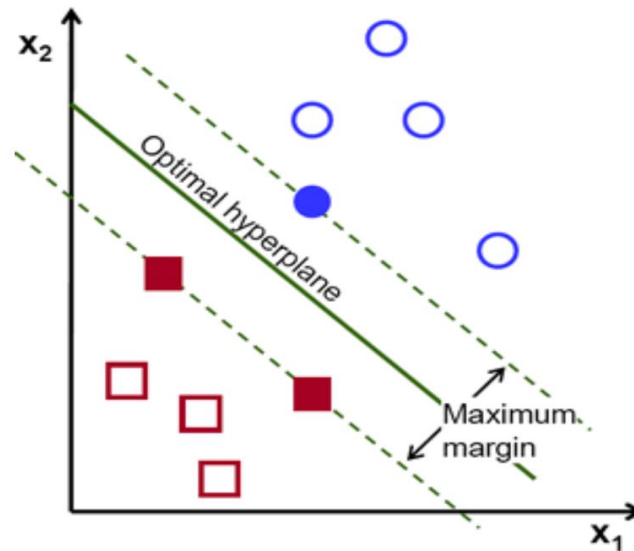
Steps to Analyse ECG

- **Use ML algorithms to classify signals**
- **Compare between ML techniques**



Support Vector Machine

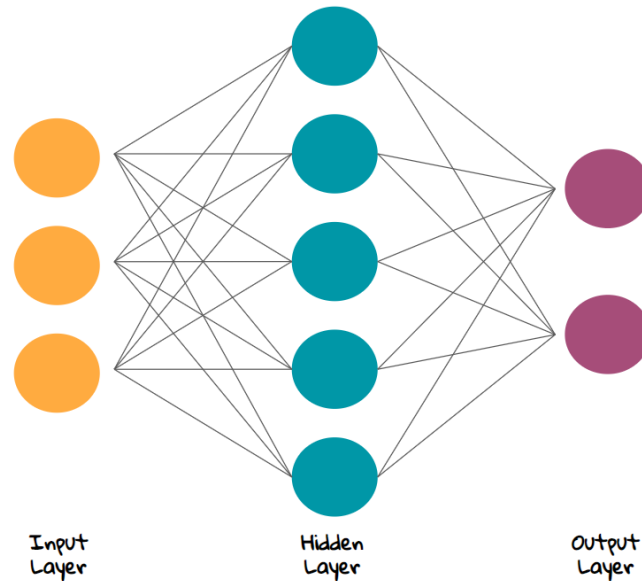
- **Supervised Learning technique**
- **Class separation based on extracted features**



<https://towardsdatascience.com/support-vector-machine-introduction-to-machine-learning-algorithms-934a444fca47>

Artificial Neural Networks

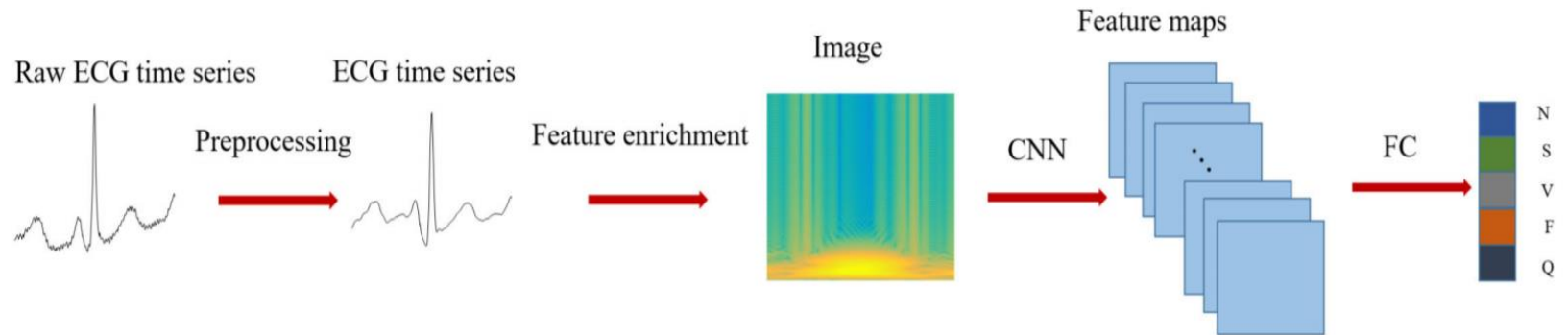
- **Human brain simulation**
- **Efficient tool for pattern recognition**



<https://towardsdatascience.com/the-most-intuitive-and-easiest-guide-for-artificial-neural-network-6a3f2bc0eacb>

Convolutional Neural Networks (CNNs)

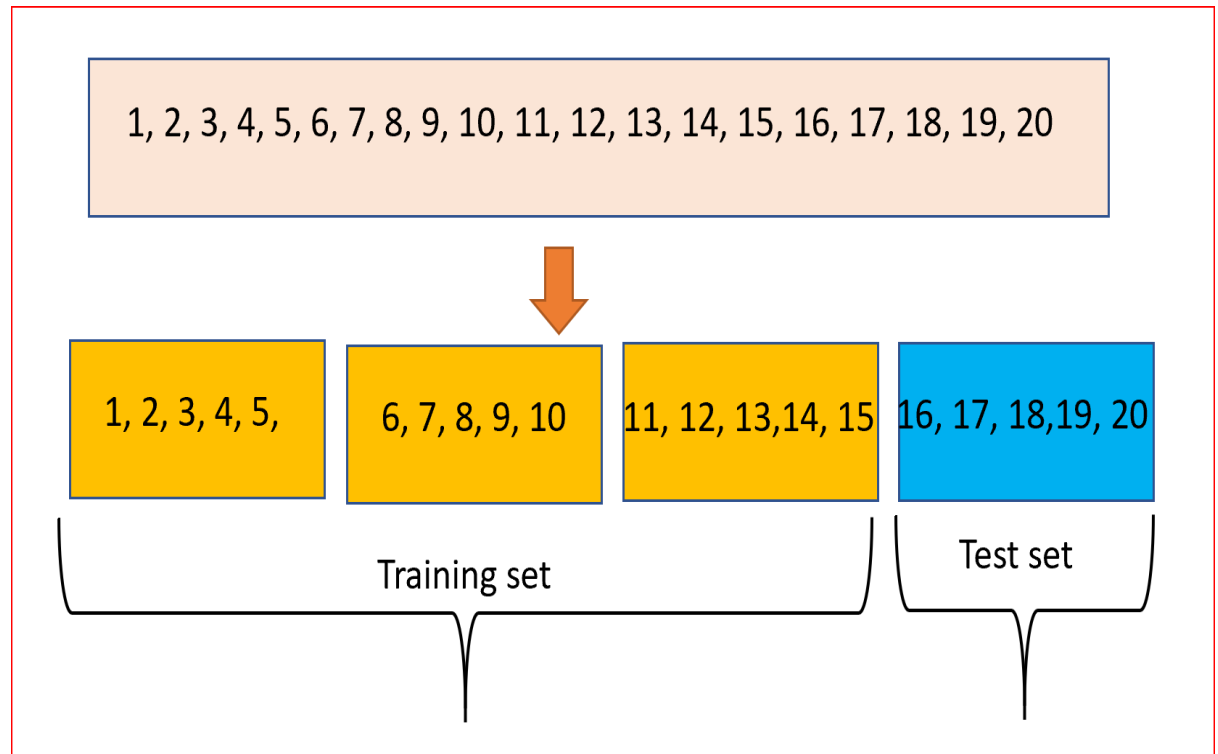
- **Accuracy in 2D data recognition**
- **Transfer ECGs to time-frequency images**



"Feature Enrichment Based Convolutional Neural Network for Heartbeat Classification From Electrocardiogram" [Online]DOI:[10.1109/ACCESS.2019.2948857](https://doi.org/10.1109/ACCESS.2019.2948857)

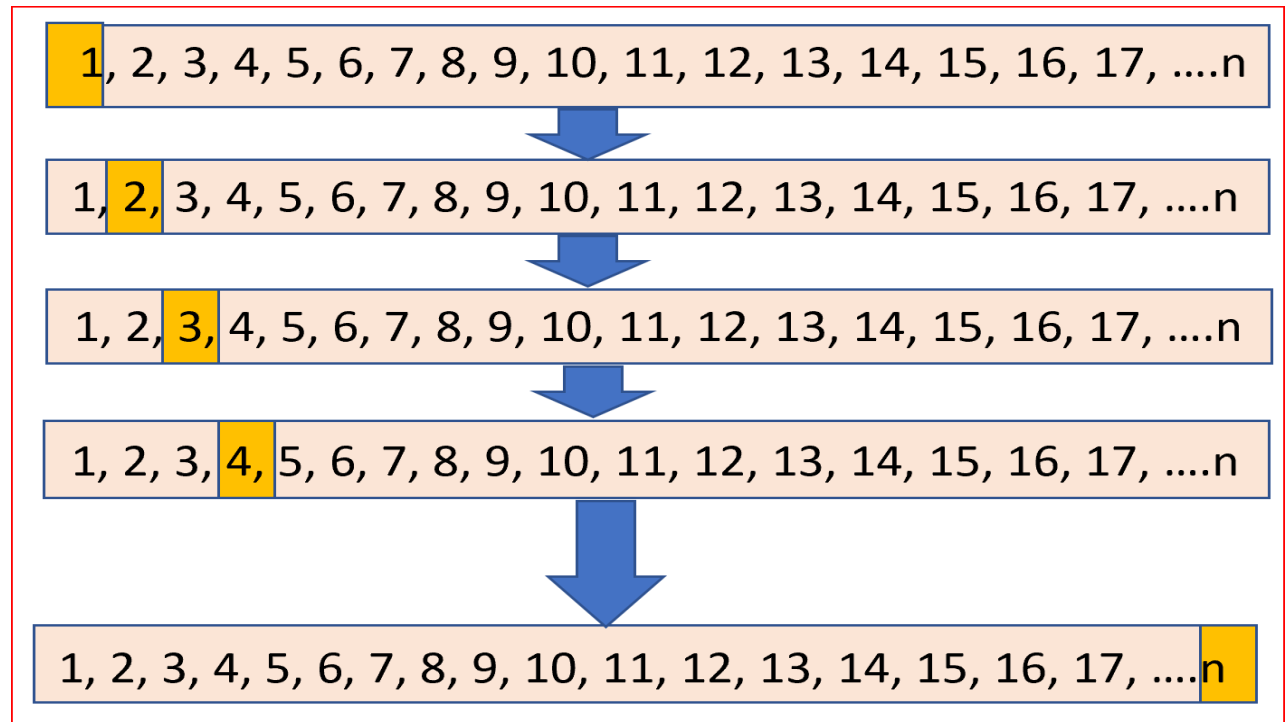
Validation

- **Estimate classifier's performance**



Source:
<https://medium.datadriveninvestor.com/k-fold-and-other-cross-validation-techniques-6c03a2563f1e>

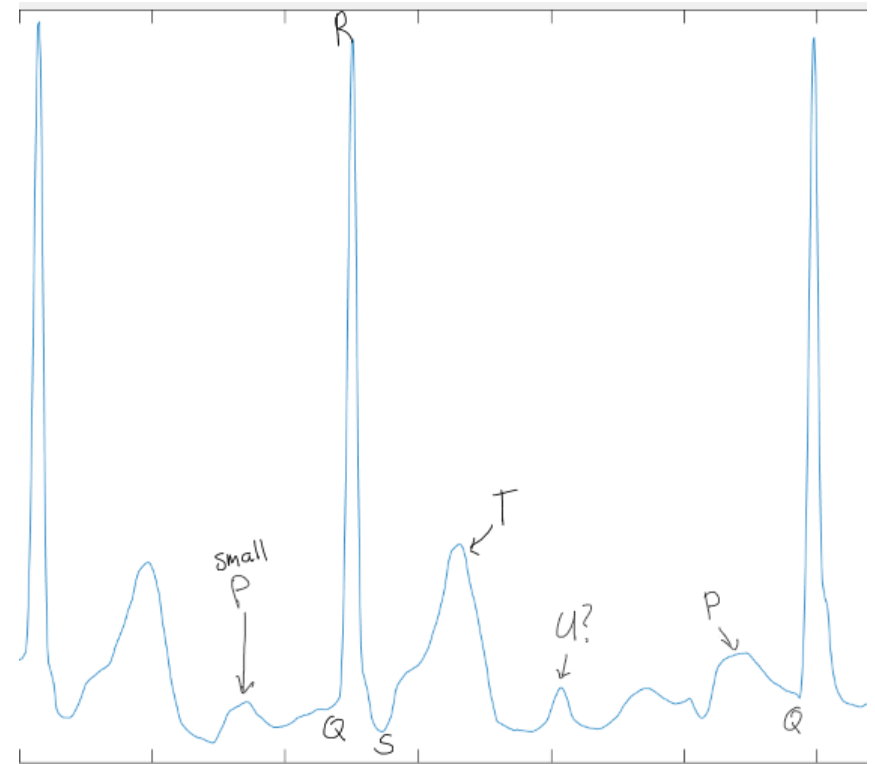
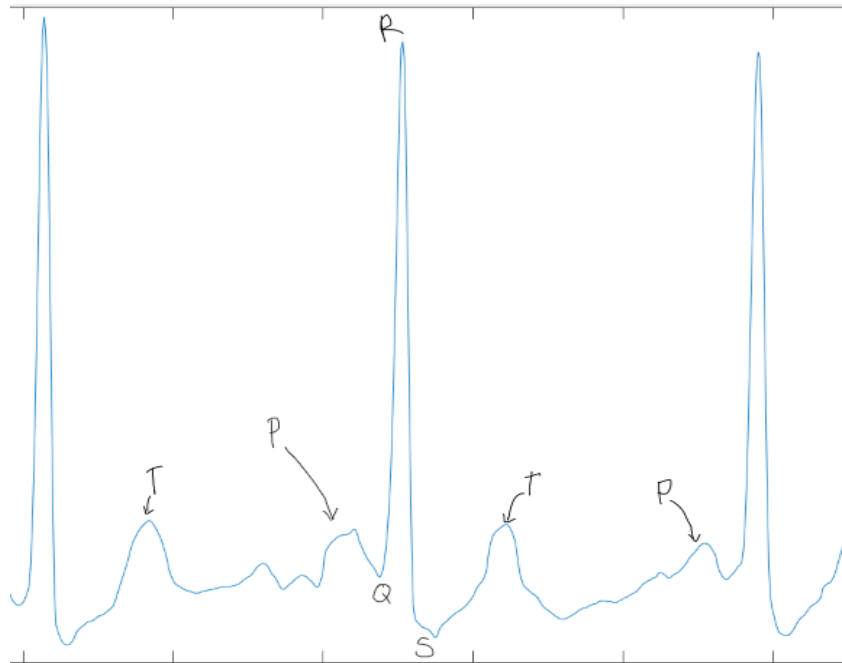
Leave One Out Cross Validation - LOOCV



Source:
<https://medium.datadriveninvestor.com/k-fold-and-other-cross-validation-techniques-6c03a2563f1e>

Current Progress

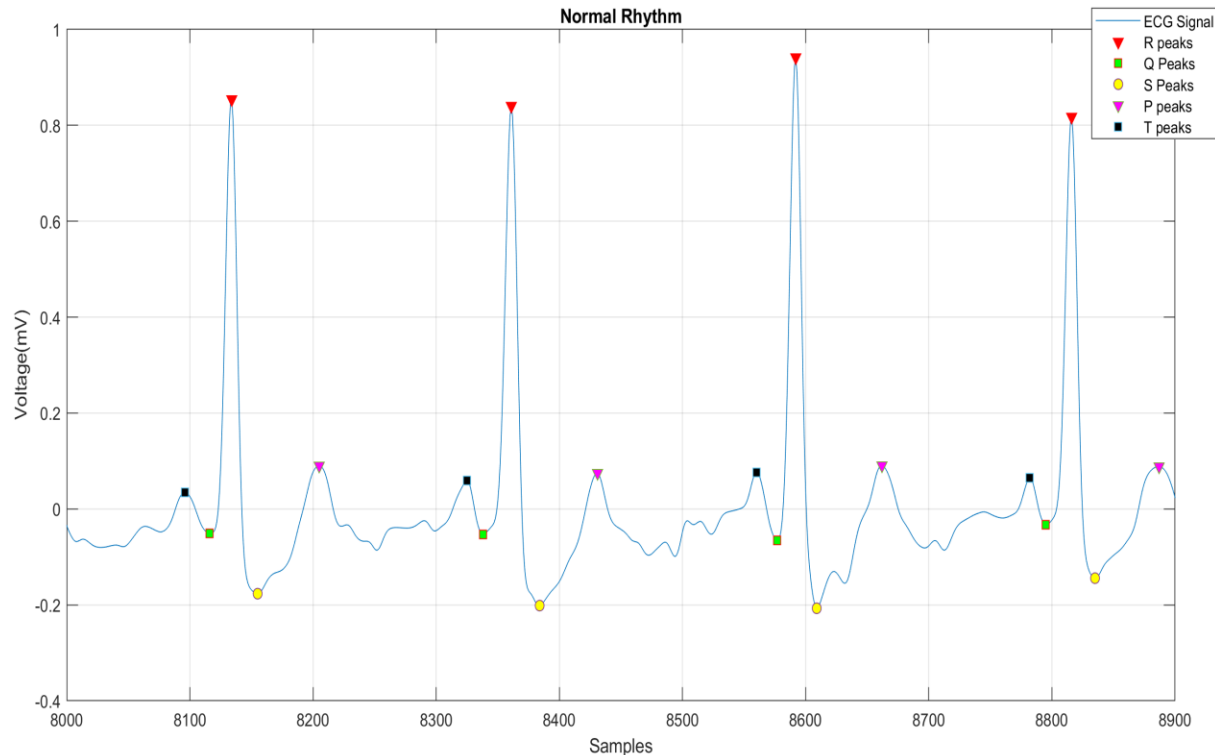
Manually Classifying ECGs



Normal (above), and atrial fibrillation (right)

Data from: <https://physionet.org/content/challenge-2017/1.0.0/>

Feature Identification - Healthy



- Identical waveforms
- Regular inter-beat intervals

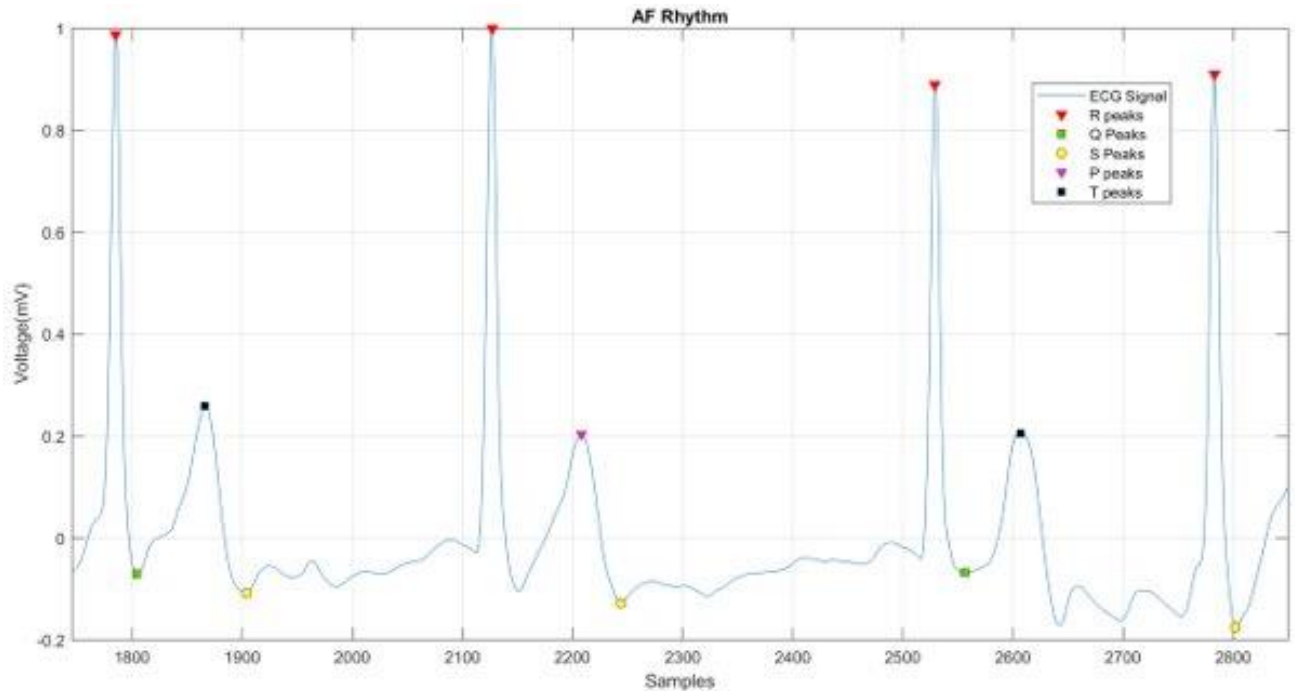
Data from: <https://physionet.org/content/challenge-2017/1.0.0/>

Algorithm: PQRSTdetection

<https://au.mathworks.com/matlabcentral/fileexchange/66098-ecg-p-qrs-t-wave-detecting-matlab-code>

Feature Identification - Abnormal

- Strange waveforms
- Irregular inter-beat intervals



Data from: <https://physionet.org/content/challenge-2017/1.0.0/>

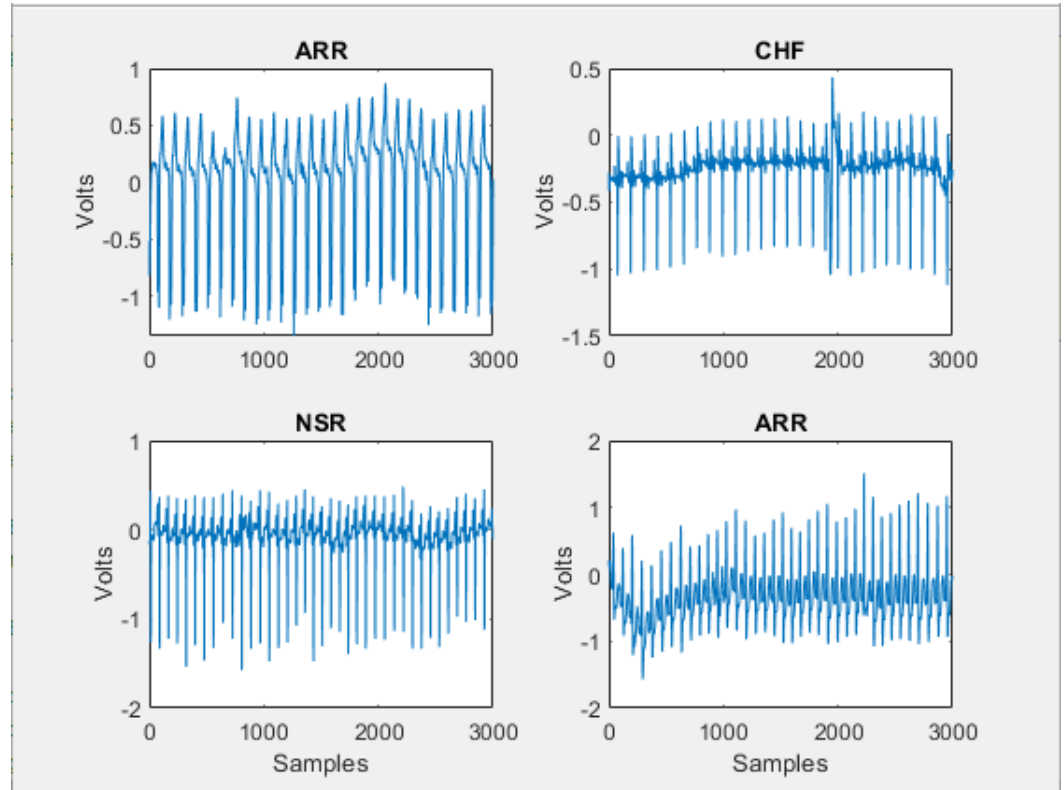
Algorithm: PQRSTdetection

<https://au.mathworks.com/matlabcentral/fileexchange/66098-ecg-p-qrs-t-wave-detecting-matlab-code>

MATLAB SVM Classifier Example

```
testAccuracy =  
97.9592
```

	Precision	Recall	F1_Score
ARR	100	100	100
CHF	100	88.889	94.118
NSR	91.667	100	95.652



Algorithm from: <https://au.mathworks.com/help/wavelet/ug/ecg-classification-using-wavelet-features.html>

Future Direction

- **Continue developing ML algorithm**
 - **Improve feature identification accuracy, reduce errors**
 - **Better pre-processing**
- **Heart disease identification**
 - **Based on features extracted from ECG**
- **End goal: develop ML algorithm to identify ECG features**
 - **And classify signals as normal/abnormal**

Risk Assessment

- **COVID-19 is an ever-present risk**
 - **Able to work from home**
 - Appropriate computer set-up
 - Ergonomic practices followed
 - Software available for free, or through the University
 - **Meetings conducted via Zoom**
 - This is our current practice
 - Convenient, easy to continue
 - **No lab work is required**
 - So no access to campus is needed

Conclusion

- **Heart disease → prevalent issue**
- **ML techniques used to classify ECG waveforms as normal/abnormal**
 - **SVM, ANN, etc.**
- **Improves diagnosis time and precision**
 - **Saves lives**