

A Data-Driven Framework for Pediatric Cardiac Arrhythmia Detection

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Pediatric Postoperative Arrhythmia can be Fatal



Arrhythmia Rate $\frac{1}{6}$

Pediatric Postoperative Monitoring

Children Heart ICU

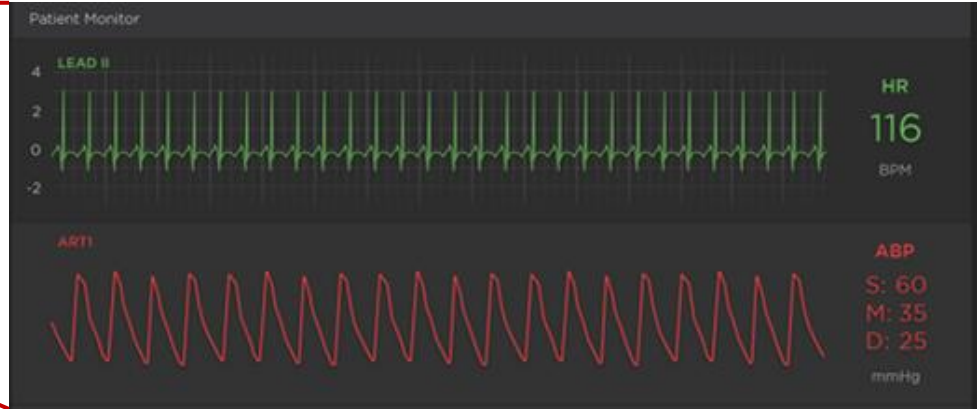


Pediatric Postoperative Monitoring

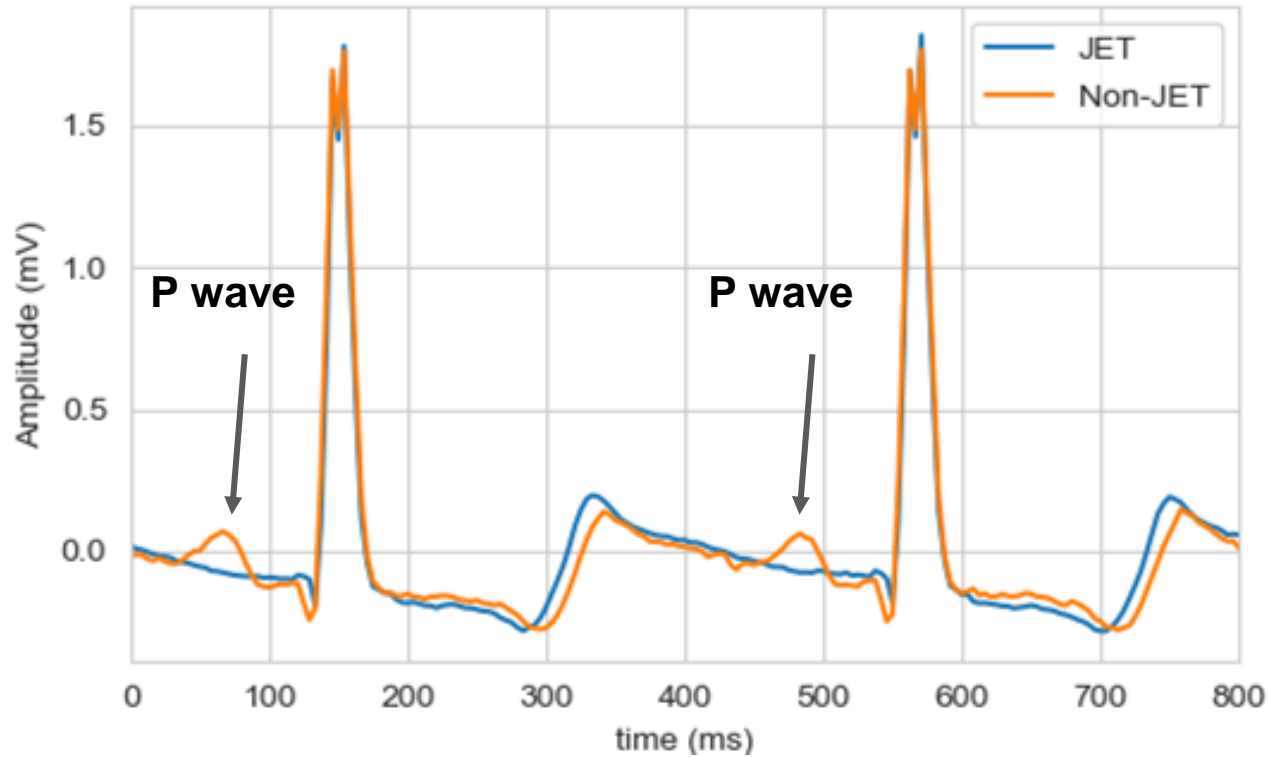
Children Heart ICU



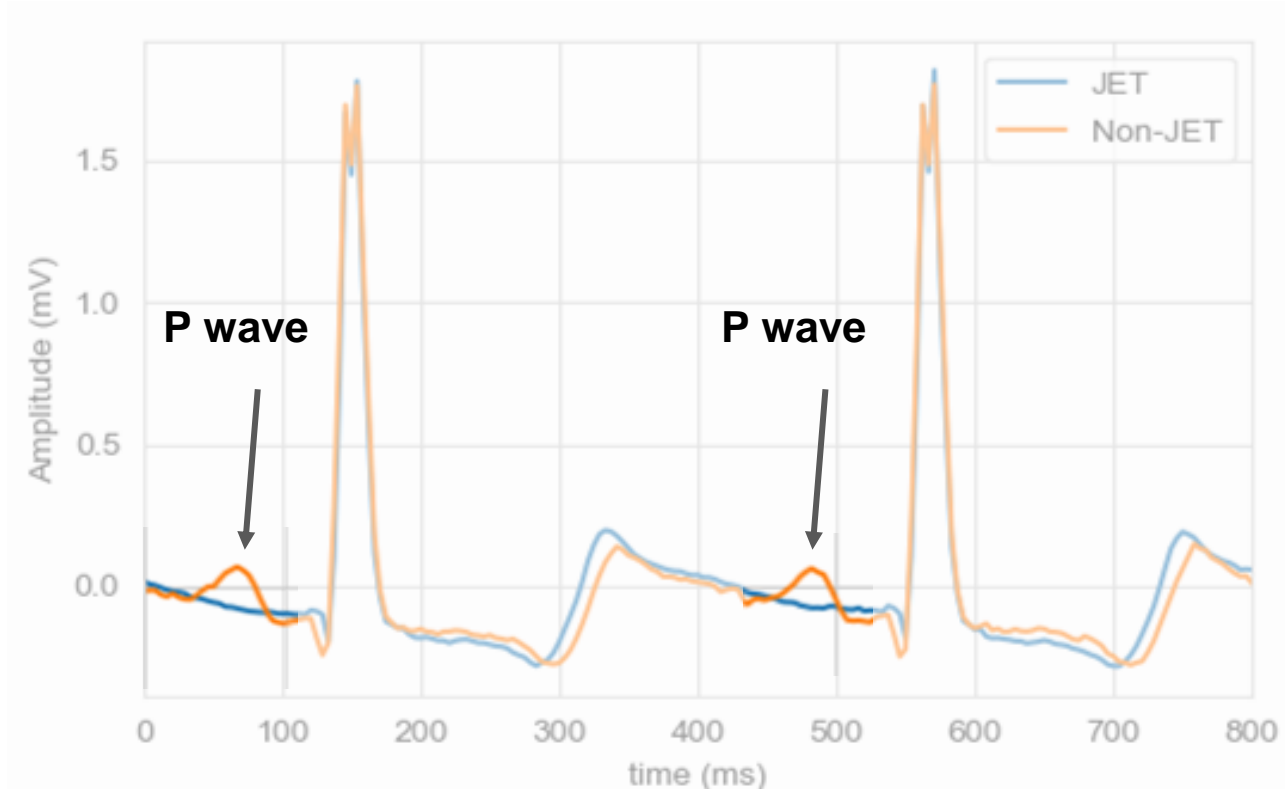
Waveforms Monitoring
Electrocardiogram (ECG) and Blood Pressures



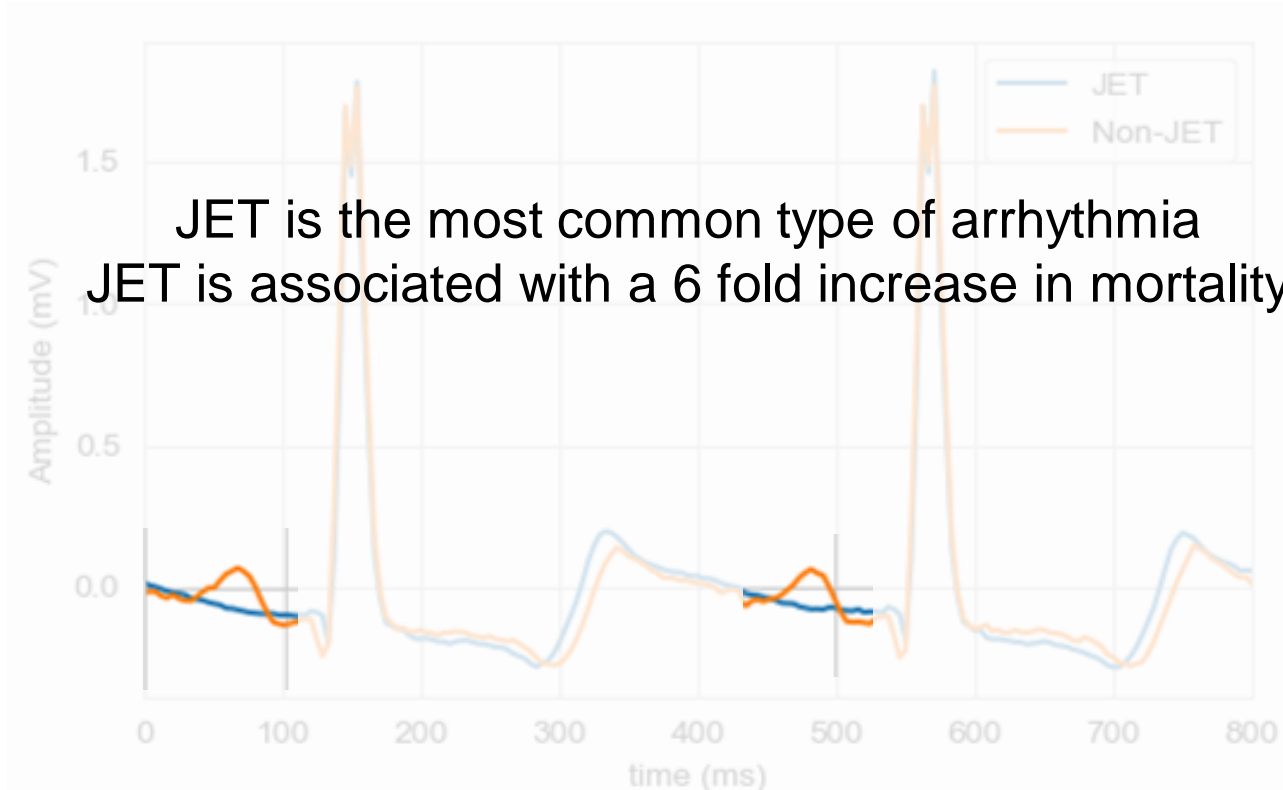
Junctional Ectopic Tachycardia (JET) Arrhythmia



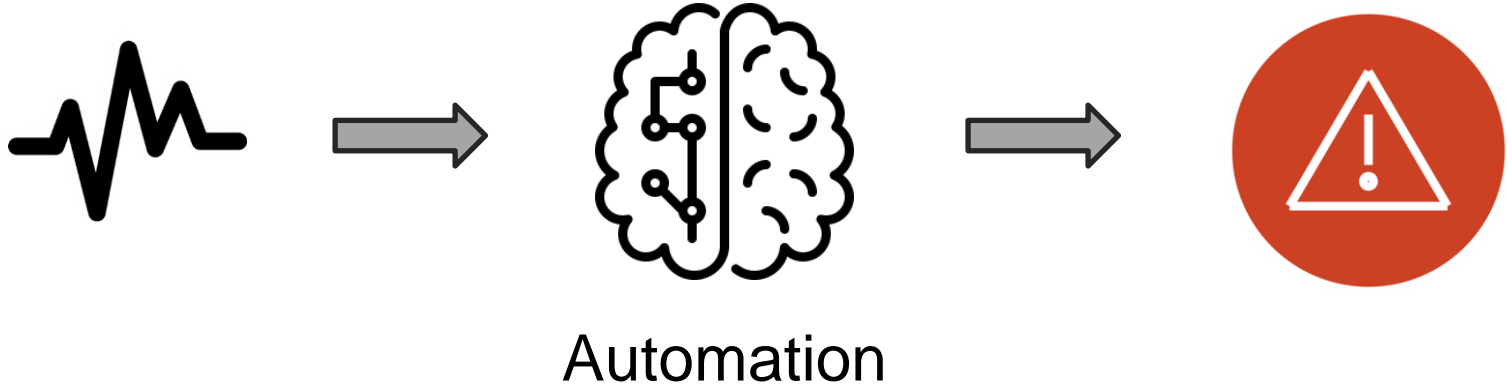
Junctional Ectopic Tachycardia (JET) Arrhythmia



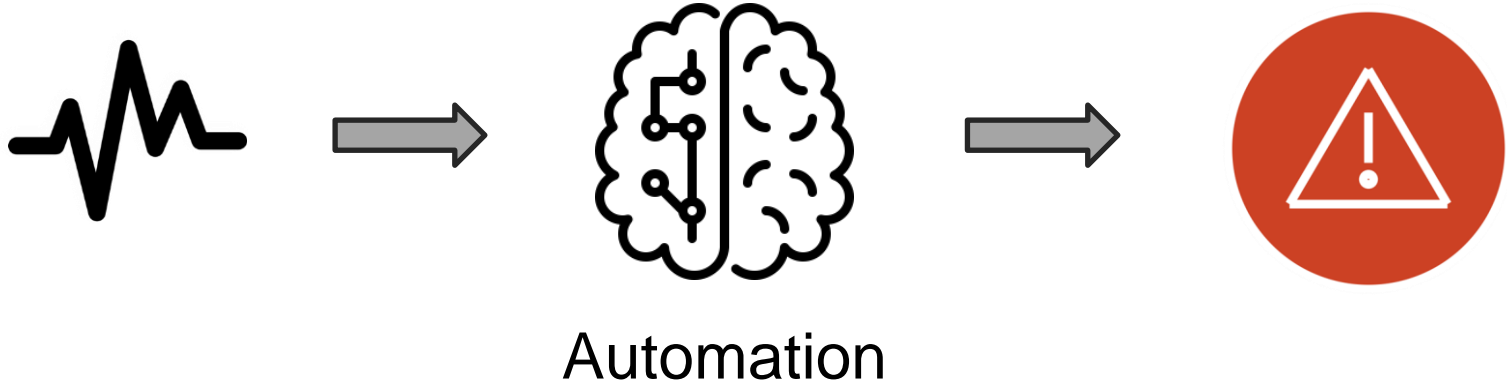
Junctional Ectopic Tachycardia (JET) Arrhythmia



Arrhythmia Detection Algorithms

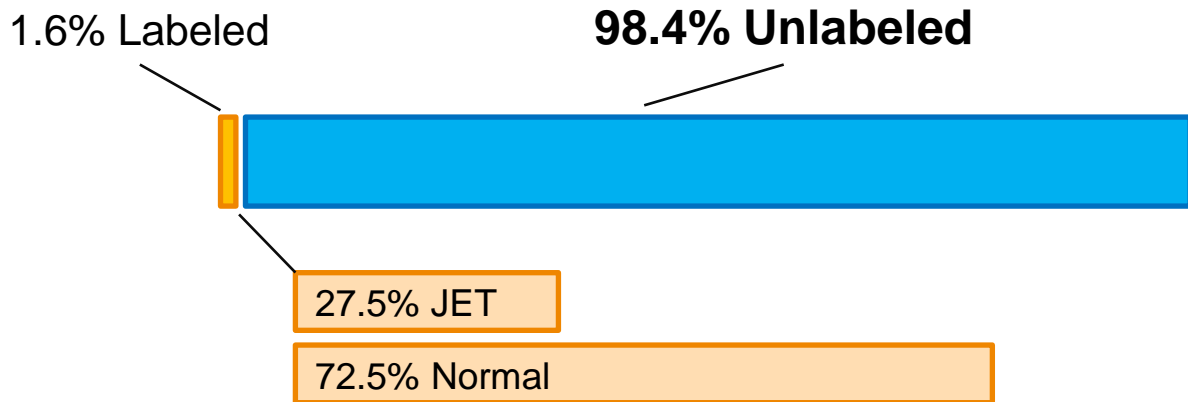


JET Detection Algorithms are needed



The Dataset

9 Patient
~1190 Hours
Data



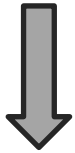
Traditional Visualization



Advanced Visualization



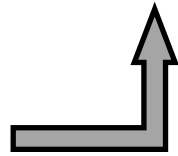
Periodic ECG data



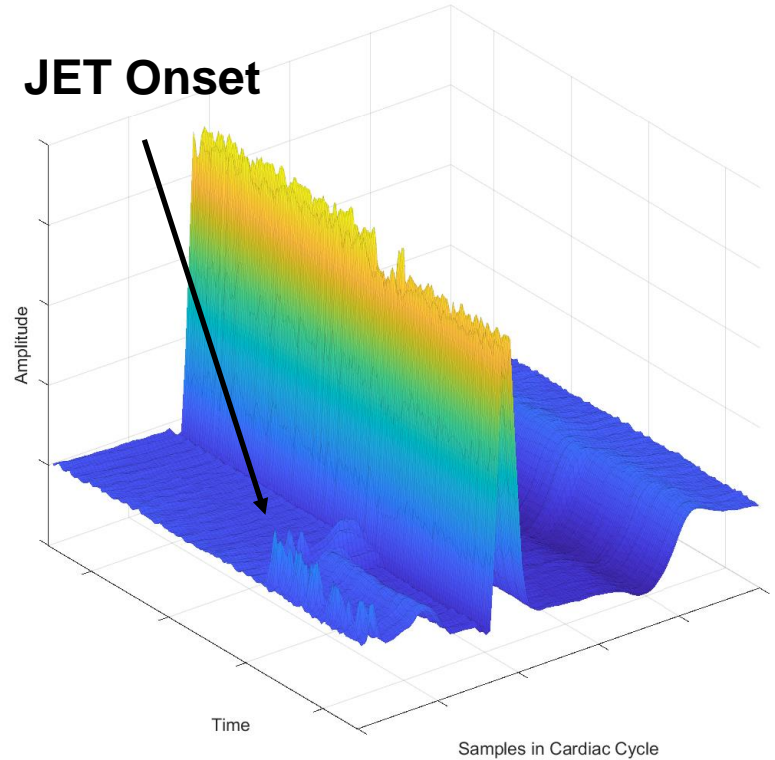
Segmented ECG data



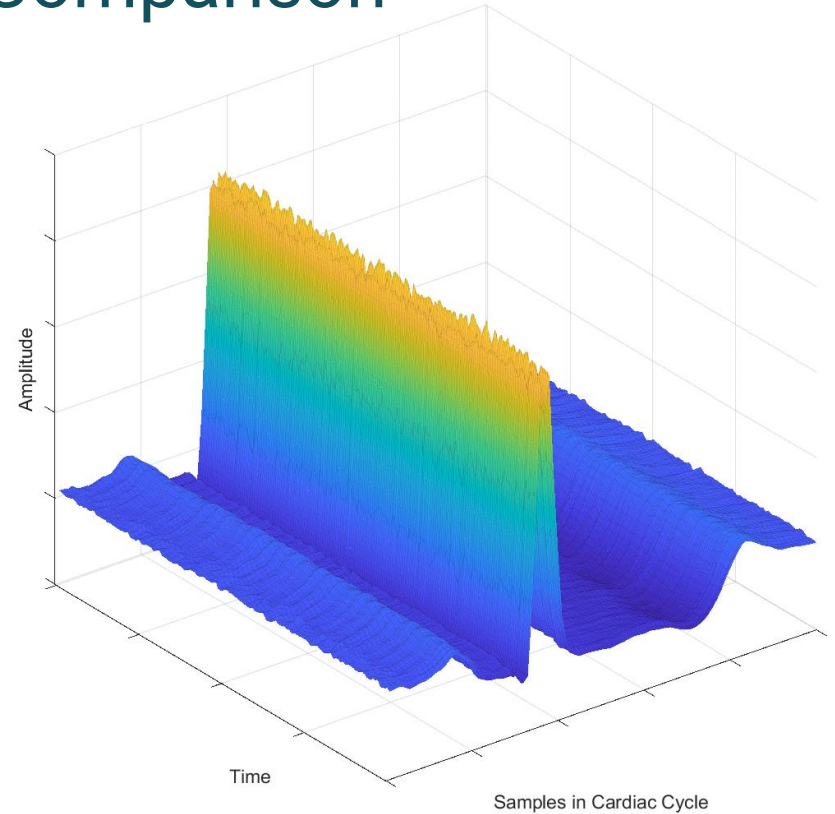
Stacks of ECG



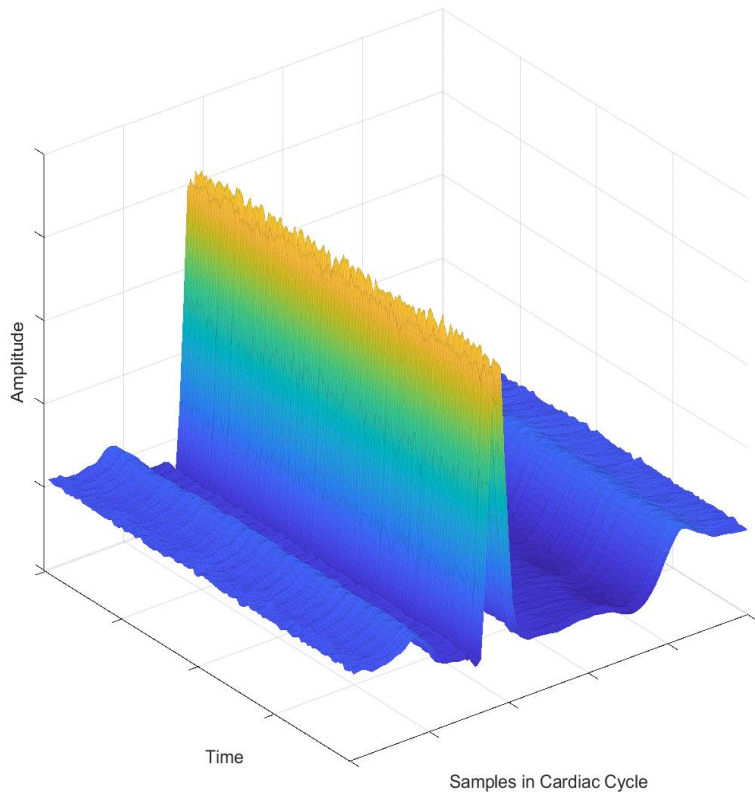
JET Onset



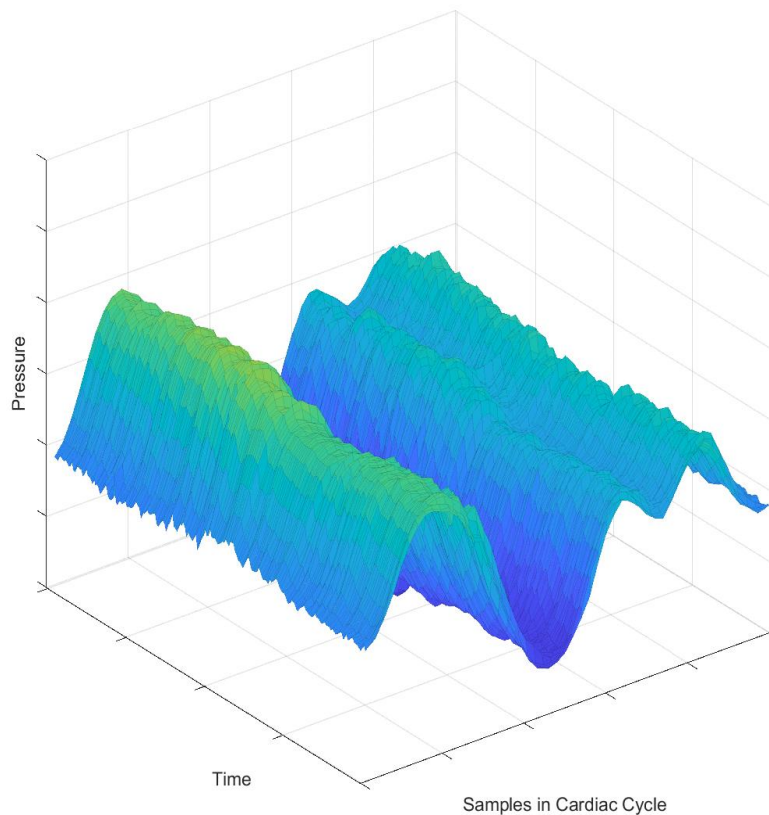
Visualization Comparison



Advanced Visualization with Pressure

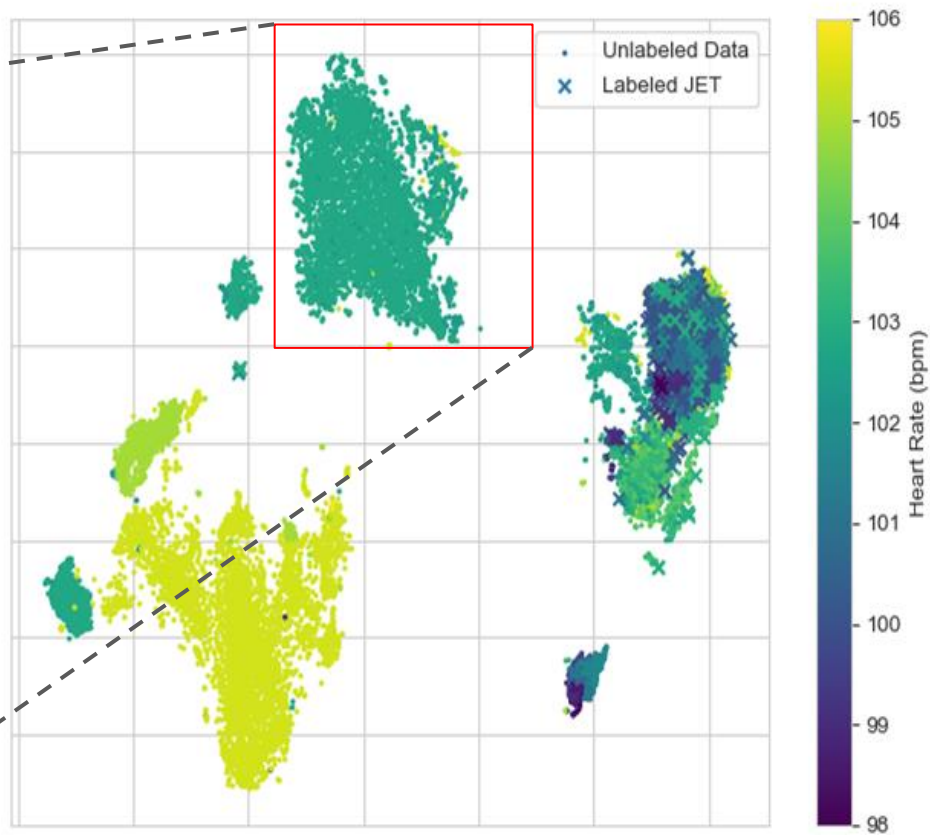
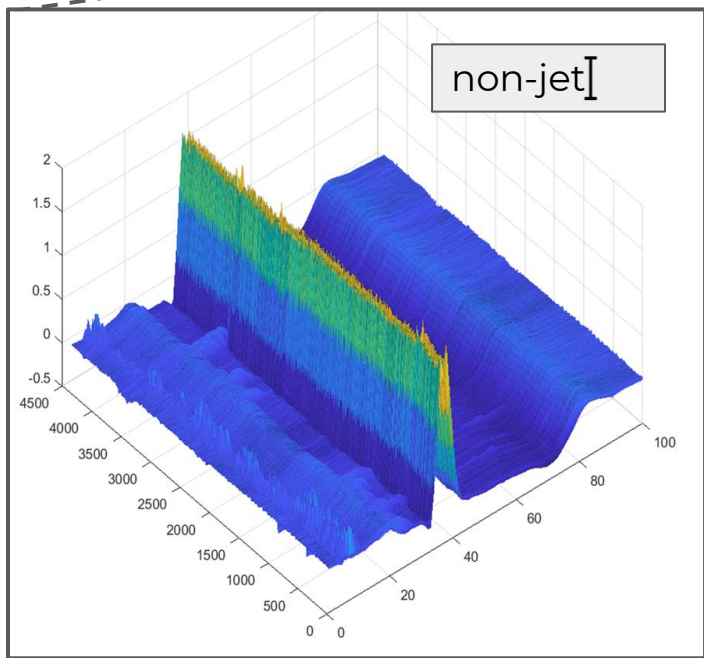


ECG



Pressure

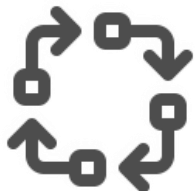
Visualize & Annotate



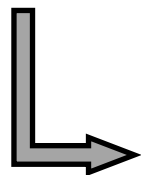
Modeling



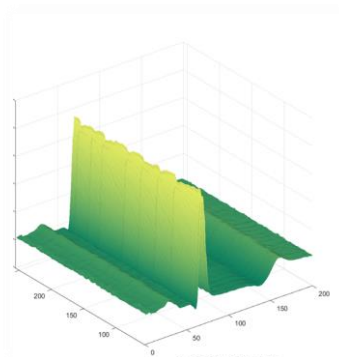
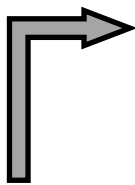
Segmented ECG



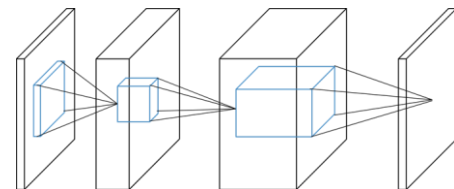
Pre-processing



Gradient Boosting



Stacks of ECG



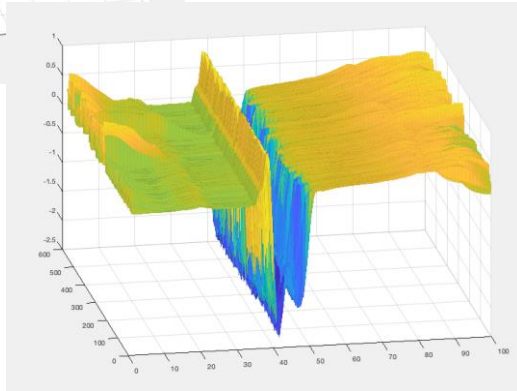
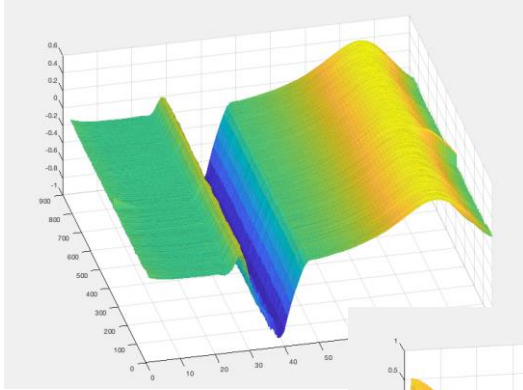
CNN

Supervised Learning Results

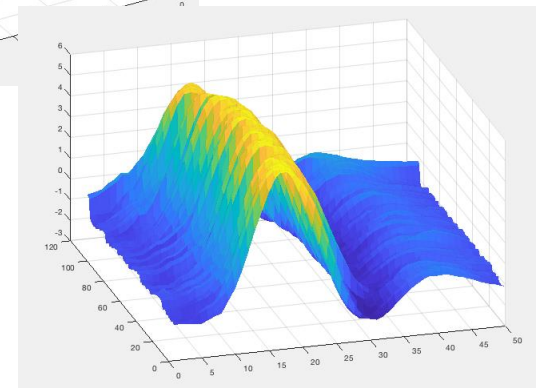
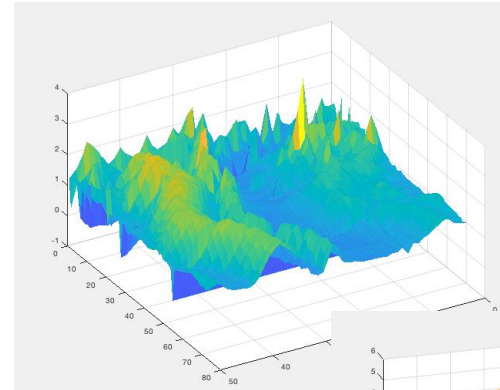
Models perform well when no patient is held out

70-30 Sample-wise Split	Gradient Boosting	CNN
Sensitivity	99.88%	96.37%
Specificity	98.90%	99.75%
AUROC	99.87%	98.06%

Waveform Pattern Variances among Patients



ECG



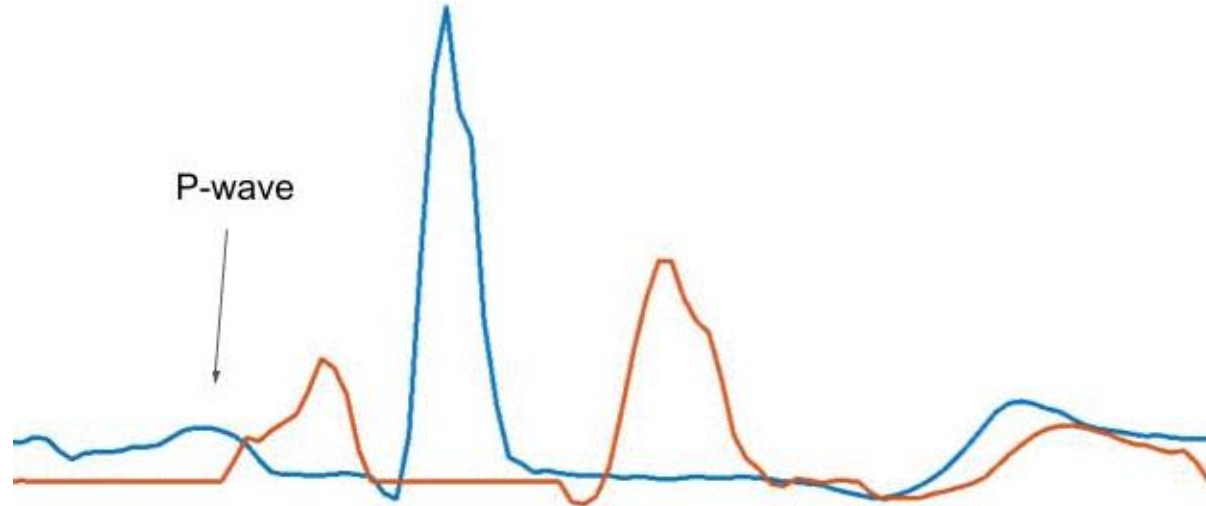
Pressure

Semi-supervised Modeling

Morphological Parameterization (MorPa)



Segmented
ECG cycle

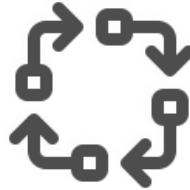


Semi-supervised Modeling

Morphological Parameterization (MorPa)

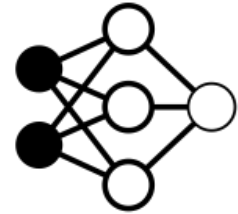


ECG cycle



MorPa
Unsupervised

9 Features



Neural
Network
Supervised

Semi-Supervised MorPa Results

Leave one out Cross-Validation on 4 Patients

Train on 1
Test on 3

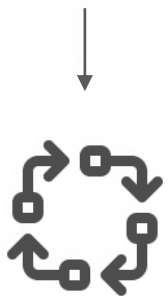
87.5%
AUROC

LOO-CV	MorPa
Sensitivity	87.07%
Specificity	87.12%
AUROC	90.71%

Data Driven JET Detection

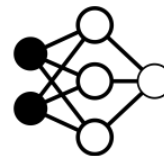
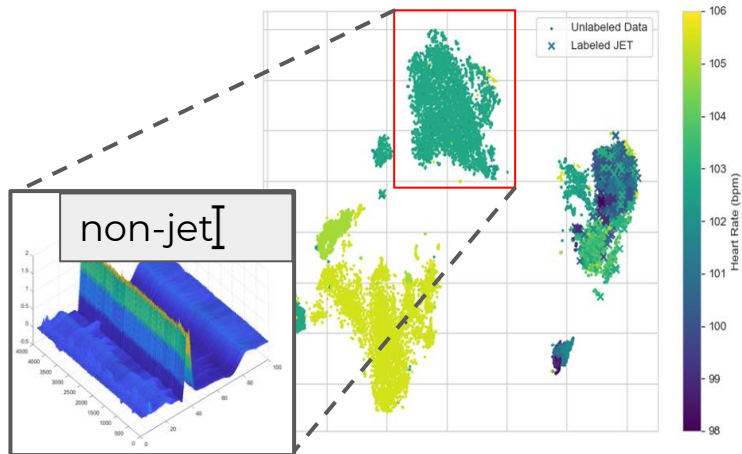
Human in the loop


~1190 Hrs of Data



MorPa
Embeddings

Selective
Annotation



Marginal
Samples

Exponentially
Reduce
Annotations
Required

Thank You !

- Souptik Barua
- Parag Jain
- Meng Li
- Raajen Patel
- Craig Rusin
- Xincheng Tan
- Genevera Allen

