

# Statement of Works

## Heart Condition Monitoring

### Background Information

The focus of SenSights is to remotely communicate with clinics the biometric of **seniors**. The ability to alert of abnormal biometrics of seniors reduces the time for applying a treatment and increases the security of seniors.

SenSights can enhance the health monitoring system by classifying in more depth the heart conditions of the patients. The classification can lower the delivery time of treatment and the accuracy of the correct treatment.

The early warnings of the heart conditions can decrease the aggravation of coronary heart disease and other heart complications caused by prolonged untreated heart conditions. [1]

The explanation of the heart conditions are below.

1. Atrial Fibrillation is an irregular heartbeat – a subset of arrhythmia. It is when the upper chambers of the heart (the atria) beat irregularly. It can lead to blood clots, heart failure and other heart complications. More than 2.7 million Americans have AF. [2]
2. Atrioventricular Block (AV) block represents a delay or disturbance in the transmission of an impulse from the atria to the ventricles. This can be due to an anatomical or functional impairment in the heart's conduction system. This disruption in normal electrical activity can be transient or permanent, and then further characterized as delayed, intermittent, or absent. [3]
3. Sinus bradycardia is a type of slow heartbeat. A special group of cells begin the signal to start your heartbeat. These cells are in the sinoatrial (SA) node. Normally, the SA node fires the signal at about 60 to 100 times per minute at rest. In sinus bradycardia, the node fires less than 60 times per minute. This can cause other organs to become oxygen-deprived which can lead fainting and dizziness. [4]
4. Sinus tachycardia is an increase in your heart rate. When the increase in the heart rate is due not to exercise, stress, caffeine it is called inappropriate sinus tachycardia (IST) which can lead to shortness of breath, chest pains, dizziness or fainting, headaches, anxiety, and trouble exercising. [5]

## Minimum Viable Product (MVP)

1. Implement an algorithm that classifies five heart conditions with the use of biometrics. The five heart conditions are Normal, Atrial Fibrillation, Atrioventricular Block, Sinus Bradycardia and Sinus Tachycardia. It should be used as an early warning sign and not a diagnosis test, since the remote devices are single-lead sensors and not 12-lead sensors used in clinics.

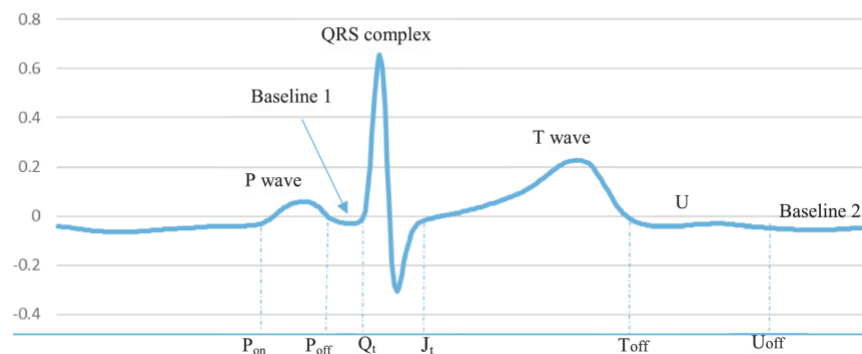
## Proposed Method

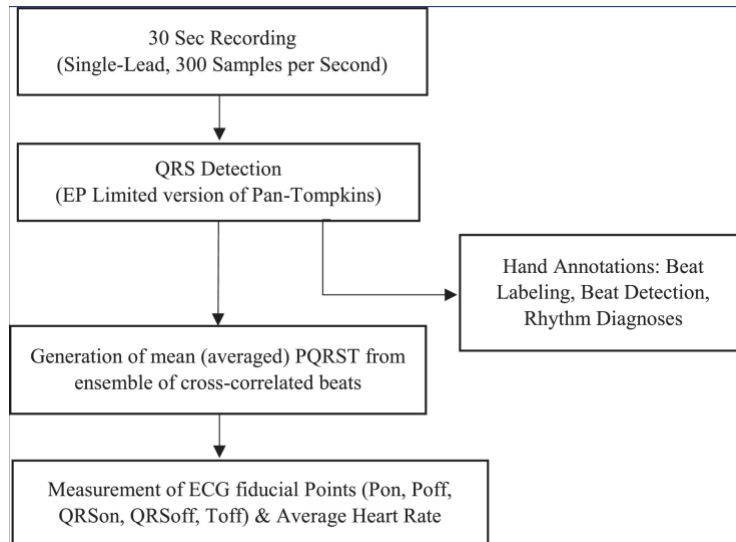
The proposed method below are based on the research paper 'Sensor analytics for interpretation of EKG Signals' [6]

### Data

An electrocardiogram (EKG or ECG) is a tool used by physicians to assess and analyze the electrical activity of the human heart in a waveform. The waveform has several components that determine the stage of a heartbeat or cardiac cycle, and they are seen below. The electrocardiogram data collected is through Apple watches, and other devices. The electrocardiogram data collected on the referred research paper is through the equipment called Kardia and it is produced by AliveCor ([www.alivecor.com/](http://www.alivecor.com/)). The process of the data collection and data labelling is below.

The data set used in the paper is not publicly available. Similar data sets exist but not to the quality of the one created in the paper. A lot of other research is based on the MIT-BIH Arrhythmia Database or the UCSF database.





## Model

The 3 different models were trained to solve the classification problem. The three models were, decision tree, Label Powerset, and a neural network with one hidden layer, three hidden neurons and one output neuron for each label. The four input variables are QT interval, PR interval, P wave interval and average heart rate.

## Results

The overall multi-label validation accuracy of the decision tree was 91.1%, label powerset classifier was 91.0% and multilayer perceptron neural network classifier was 89.9%.

## Team

	Team Member 1	Team Member 2	Team Member 3	Team Member 4
Seniority (Junior/Senior)	Senior	Senior	Senior	Senior
Technical (Y/N)	Yes	Yes	Yes	Yes
Coding Experience (None/Some/Lots)	Lots	Lots	Some	Some
AI Experience (None/Some/Lots)	Lots	Some	None	None

## Funding

Further meetings with Sensights will confirm this.

## Timeline (tentative)

### October 2021

- Team will research the methods for analyzing EKG data
- Team technical training on relevant data preprocessing
- Begin data collection
- Begin the cleaning and preprocessing data

### November 2021

- Continue cleaning and preprocessing data
- Begin training preliminary classification models
- Define evaluation tests on classification models

### December 2021

- Exams and winter break
- Finish data preprocessing

### January 2021

- Train preliminary classification models
- Test classification models
- Evaluate results

### February 2021

- Model tuning
- Iteration on the architecture of the classification model
- Evaluate result and compare results

### March 2021

- Deliver MVP to LocateMotion
- Showcase project at CUCAI

## Potential Scope Changes

Further communication between QMIND and Sensights will clarify the accessible to datasets, and scope limitations.

In the case the scope is too small, students are welcome to increase the complexity of the model by increasing the number of hidden layers or by using a SVM. Another architecture would be a RNN. All these are available in keras.

## Onboarding

- Explain the EKG data, and a technique for reading the values, youtube is a great resource.
- Train the students in preprocessing data.
- Train students on logistic regression, K-Means Clustering, and deep learning – concept of hidden layers stacked with a classification layer at the end.

## Sources

- [1] F. Liang and Y. Wang, "Coronary heart disease and atrial fibrillation: a vicious cycle," *Am. J. Physiol.-Heart Circ. Physiol.*, vol. 320, no. 1, pp. H1–H12, Jan. 2021, doi: 10.1152/ajpheart.00702.2020.
- [2] "What is Atrial Fibrillation (AFib or AF)?," *www.heart.org*. <https://www.heart.org/en/health-topics/atrial-fibrillation/what-is-atrial-fibrillation-afib-or-af> (accessed Jul. 21, 2021).
- [3] A. H. Kashou, A. Goyal, T. Nguyen, and L. Chhabra, "Atrioventricular Block," in *StatPearls*, Treasure Island (FL): StatPearls Publishing, 2021. Accessed: Jul. 21, 2021. [Online]. Available: <http://www.ncbi.nlm.nih.gov/books/NBK459147/>
- [4] "Articles," *Cedars-Sinai*. <https://www.cedars-sinai.org/health-library/articles.html> (accessed Jul. 21, 2021).
- [5] "Sinus Tachycardia: Normal vs. Inappropriate, Causes, Treatment," *Healthline*, Jan. 02, 2018. <https://www.healthline.com/health/sinus-tachycardia> (accessed Jul. 21, 2021).
- [6] P. Kalgotra, R. Sharda, B. Hammer, and D. E. Albert, "Sensor analytics for interpretation of EKG signals," *Expert Syst. Appl.*, vol. 123, pp. 377–385, Jun. 2019, doi: 10.1016/j.eswa.2018.12.056.