One copy will be attached to your application. One copy will be displayed with your project. Other copies will be for judges to take away.

**SYNOPSYS CHAMPIONSHIP PROJECT ABSTRACT**

*The Abstract is a required part of your project. Bring 10 -15 copies to Project Check-In.*

Your abstract should be written after you finish your research and experimentation and should include:

* Your project title and the full name of every team member (all centered)
* The purpose of your project
* Your hypothesis or evaluation criteria
* A brief statement about the procedures and equipment you used
* Your results (analysis of data)
* Your conclusions

Type or print neatly using 10- or 12- point black font, single spaced. Your abstract should be 500 words or less and fit within the frame.

Project Number: 102-H30-A1

Convolutional Neural Network classification of Mel-Spectrograms to diagnose Heart Arrhythmias

Sreehari Ram Mohan

**Motivation:**

Qualified physicians recognize less than 40% of heart sounds heard through cardiac auscultation (the act of listening to heart sounds with a stethoscope). The elusiveness of detecting Heart Arrhythmias is a major reason why heart-related diseases are a leading cause of death in the United States, taking over 610,000 lives annually (1 in 4 deaths). The goal of this project was to create a low-cost, effective early-warning system for patients to use for diagnosis of fatal heart conditions.

**Problem Statement:**

Heart Arrhythmias occur when the heart's electrical system malfunctions and causes the heart to beat improperly. My goal was to create a low-cost portable device which can be used to detect heart arrhythmias in patients. The device must be accurate (>85% validated accuracy and <5% false negative rate), and also be portable (fits in the hand), low-cost (< $75), and quick to diagnose ( < 1 minute per diagnosis).

**Approach:**

The first step of the project was gathering the data, 3240 waveform audio files were obtained from the Physionet 2016 Cardiology Challenge. In the data preparation phase, Mel Frequency Cepstral Coefficients (which essentially display the different frequencies present in the sounds) were used to extract high order features from the sound and Mel-Frequency Spectrograms were then saved to get a visual representation of the sound. In order to choose a model, I benchmarked the accuracy of Convolutional Neural Networks, Logistic Regression, KNNs, SVMs, Naive Bayes, Decision Trees, Random Forests, and Google's Inception v3. The Neural Network Model was ultimately chosen due to its high accuracy and low prediction time. In the Training phase, the model was trained on nearly 3,240 sound clips for 100 epochs and achieved a validated accuracy score of 88.8% and a false negative rate of only 3.7%. In the Evaluation phase, a Raspberry Pi 3, stethoscope head, and condenser microphone were used to capture heartbeat sounds and return a prediction. While hyperparameter tuning, a class weights dictionary was utilized to counteract the highly imbalanced dataset (since there were 3.872 times more arrhythmias than normal heartbeats in my dataset). In the Prediction stage of the project, I created a GUI Python program using Tkinter (a Python user interface library) to allow the patient to use the model on the custom hardware device.

**Results:**

After 100 epochs (1 epoch is 1 complete presentation of the data to the model), the validated accuracy was 88.8%, and the model had a false negative rate of less than 3.7%. Furthermore, I can conclude, from a 1-tailed hypothesis test for difference in accuracy, that my model’s accuracy is significantly better than the diagnosing capability of medical workers using handheld diagnosis devices (p = 0.001349 & 99.99% confidence level).

**Conclusion:**

In the future, I would like to increase the reliability of the Heart Rate Peak Detection Algorithm, so that the software can more accurately tell a patient what their resting heart rate is. Furthermore, I want to move the software to smartphones so patients can diagnose themselves anywhere on the go.