Continuation/Research Progression Projects Form (7)

Required for projects that are a continuation/progression in the same field of study as a previous project. This form must be accompanied by the previous year's abstract and Research Plan/Project Summary.

Student's Name(s) Aditya Kendre

To be completed by Student Researcher: List all components of the current project that make it new and different from previous research. The information must be on the form; use an additional form for previous year and earlier projects.

Components	Current Research Project	Previous Research Project: Year: 19-20
1. Title	Generative Adversarial Networks for PCG Arrhythmia Detection	ECG-Based Abnormal Heartbeat Classification: A Deep Learning Approach for Arrhythmia Detection
2. Change in goal/ purpose/objective	To create a lightweight, precise, and accurate model for predicting heart arrhythmias in Phonocardiograms using a Generative Adversarial Network capable of exceeding Cardiologists' accuracy.	To create a model capable of surpassing the accuracy of Cardiologists in identifying heart arrhythmias in Electrocardiograms.
3. Changes in methodology	A Generative Adversarial Networks comprises of two models: a generator model and a classifier model (which contains a Convolutional Neural Network). The generator creates artificial PCG data to deceive the classifier into predicting the data is a real PCG signal while simultaneously being fed true PCG data from a dataset.	A Convolutional Neural Network extracts latent features from an electrocardiogram database following a fully-connected Linear layer that predicts whether an arrhythmia is present within the electrocardiogram, based upon the features extracted by the CNN.
4. Variable studied	Manipulated variables include: Learning Rate, Batch size, Number of Epochs, Hidden Layers, Hidden Units, Activations Functions, and level of Data Augmentation. Responding variables include: Loss, Accuracy, Recall, Precision, F-Beta Score, F1 Score, and ROC and AUC.	Manipulated variables include: Number of layers, Hidden Units, and the level of Data Augmentation. Responding variables include: Loss and Accuracy.
5. Additional changes	Conversion between ECG and PCG signals using an Autoencoder.	ECG signal with a one-dimensional CNN.

Attached are:

☑ Abstract and Research Plan/Project Summary, Year 19-20

I hereby certify that the above information is correct and that the current year Abstract & Certification and project display board properly reflect work done only in the current year.

Aditya Kendre	aditya	10/30/20
Student's Printed Name(s)	Signature	Date of Signature (mm/dd/yy)

OFFICIAL ABSTRACT and CERTIFICATION

A Deep Learning Approach for Arrhythmia Detection

Aditya Kendre
Cumberland Valley High School, Mechanicsburg PA, Adams County

Early detection of cardiac arrhythmia has the potential to prevent the millions of moralities that the disease causes globally. However, there are few automated systems to identify arrhythmia. A significant impediment in achieving successful methods include the lack of a large training dataset. Despite this difficulty, processes like data augmentation allow for anincreased amount and diversity of data. Here, the electrocardiogram (ECG) datasets were obtained from the PhysioNet database. The dataset was used to train a Convolutional Neural Network (CNN) on classifying cardiac arrhythmia. Experimental results illustrate advantages such as better responsiveness and higher accuracy of deep learning-based models when compared to the traditional analysis on ECGs.

Category
Pick one only — mark an "X" in box at right

- Animal Sciences
- Behavioral & Social Sciences
- Biochemistry
- Biomedical & Health Sciences
- Biomedical Engineering
- Cellular & Molecular Biology
- Chemistry
- Computational Biology & Bioinformatics ■
- Earth & Environmental Sciences
- Embedded Systems
- Energy: Sustainable Materials and Design
- Engineering Mechanics
- Environmental Engineering
- Materials Science
- Mathematics
- Microbiology
- Physics & Astronomy
- Plant Sciences
- Robotics & Intelligent Machines
- Systems Software
- Translational Medical Sciences

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check ALL that apply):

   ☐ human participants ☐ potentially hazardous biological agents

   ☐ vertebrate animals ☐ microorganisms ☐ rDNA ☐ tissue

2. I/we worked or used equipment in a regulated research institution or industrial setting: ☐ Yes ■ No

3. This project is a continuation of previous research. ☐ Yes ■ No

4. My display board includes non-published photographs/visual depictions of humans (other than myself): ☐ Yes ■ No

5. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only ■ Yes ☐ No

6. I/we hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work. ■ Yes ☐ No

This stamp or embossed seal attests that this project is in compliance with all federal and state laws and regulations and that all appropriate reviews and approvals have been obtained including the final clearance by the Scientific Review Committee.

ECG-Based Abnormal Heartbeat Classification: A Deep Learning Approach for Arrhythmia Detection

Aditya Kendre

Cumberland Valley High School

Rationale

Electrocardiograms (ECG) have created a profound impact in the field of cardiology, specify in recognizing of heart arrhythmias. Non-invasive arrhythmia analysis is based on 10 electrodes that reflect the electrical activity on ECGs. An estimated three million cases of arrhythmia occur in the United States yearly (Mayo Clinic). Diagnosing this disease early is the key to one's wellness, yet 18% of cardiologists misinterpreted ECGs containing atrial fibrillation (Anh et al, 2006). With the recent advancements in technology, Machine Learning algorithms such as Deep Neural Networks (DNNs), allow a computer to learn features and identify patterns within a given dataset. On the basic level, DNNs receive input data, and through a series of weights and biases, outputs a confidence value in all possible labels of the dataset, similar to a human's neural network. Furtherance in the accuracy of abnormal heartbeat classification will allow cardiologists to accurately, and efficiently recognizing arrhythmia before becoming prevalent in one's wellbeing.

Research

Research Question: This research project will examine whether a classifier will be able to accurately identify abnormal heartbeat in ECGs.

Hypothesis: If an image classifier received a supervised dataset of heart arrhythmia of ECGs, then the image classifier will allow an accurate identification of arrhythmia.

Expectation: The image classifier should reach an accuracy of above 82%.

Procedure:

1. Gather a dataset of annotated ECGs
2. Determine type of classifier used to learn dataset features
3. Analyze results using Gradient Decent and Mean Loss function

Risks and Safety:

This research project involves no risks or safety concerns.

References

Alfaras, Miquel, Soriano, & Silvia. (2019, July 3). A Fast Machine Learning Model for ECG-Based Heartbeat Classification and Arrhythmia Detection. Retrieved October 30, 2019, from https://www.frontiersin.org/articles/10.3389/fphy.2019.00103/full.

Mayo Clinic. (2019, April 2). Heart arrhythmia. Retrieved October 30, 2019, from https://www.mayoclinic.org/diseases-conditions/heart-arrhythmia/symptoms-causes/syc-20350668?utm_source=Google&utm_medium=abstract&utm_content=Cardiac-arrhythmia&utm_campaign=Knowledge-panel.

Srinivasan, N. T., & Schilling, R. J. (2018, June). Sudden Cardiac Death and Arrhythmias. Retrieved October 30, 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6020177/.