Report on ECG hearbeat classification

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1 Introduction

The heart is a muscular organ responsible for pumping blood throughout the body, providing oxygen and nutrients to various tissues and organs. It is a crucial component of the circulatory system, which plays a vital role in maintaining overall health and homeostasis.

The heartbeat, or cardiac cycle, refers to the rhythmic contraction and relaxation of the heart muscle, resulting in the pumping of blood. This rhythmic action is essential for maintaining a consistent flow of blood to meet the body's metabolic demands. The heartbeat is typically measured in beats per minute (bpm) and can vary depending on factors such as age, fitness level, and health status. In clinical diagnosis, the measurement and analysis of the heartbeat provide valuable information about a person's cardiovascular health.

And with the ever-increasing pace of AI or more specifically Machine Learning, people have been able to enhance diagnosis, improve treatment and streamline healthcare. And if we take a closer look into heartbeat classification, ML algorithms have been employed to classify heartbeats into different categories, making foundation for solution of various problems.

2 Background

The data is about ECG heartbeat which composes of two hearbeat signals derived from two famous datasets in heartbeat classification, the MIT-BIH Arrhythmia Dataset and the PTB Diagnostic ECG Database. The signals correspond to electrocardiogram (ECG) shapes of heartbeats for the normal case and the cases affected by different arrhythmias and myocardial infarction. These signals are preprocessed and segmented, with each segment corresponding to a heartbeat.

In this day, Convolutional Neural Network is one of the most popular Deep Learning model which is primarily used in Computer Vision domain to extract

features from visual data such as images or videos. However, many reasearchs have shown that CNN also work well on 1D data or in this case, the classification of ECG heartbeat.

3 Method

Type	# Channels	Kernel Size	Stride	Padding
Convolution	32	3	1	1
Max Pool		2	2	0
Convolution	64	3	1	1
Max Pool		2	2	0
FC layers				

I use a convolutional neural network with two convolution layers followed with a max pool layer and a ReLU activation function. After extracting features, I use fully connected layers to classify the signal.

4 Evaluation

4.1 Dataset

In this practical section, I will only focus on the first data which is the MITBIH data. This data contains the total of 109446 samples which are then divided into 87554 and 21892 sample for training and test set, respectively. There are in total 5 classes: N, S, V, F, and Q. All the samples in the data have already been cropped, downsampled and padded with zeros if necessary so that each of them has a fixed dimension of 188, with the latest column being the class.

First, we need to visualize some aspects regarding the data.

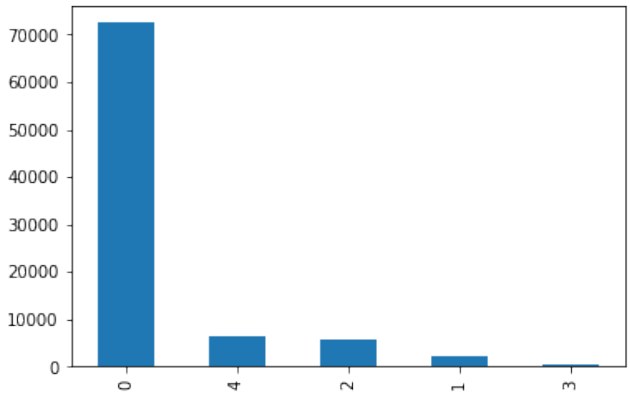

Figure 1: Data distribution before over-sampling

The figure 1 below show that the data is highly imbalanced so we need to make steps to balance out the data. I have done this by over-sampling the data using SMOTE technique which increase the sample from all the minor class to be equal to the majority one.

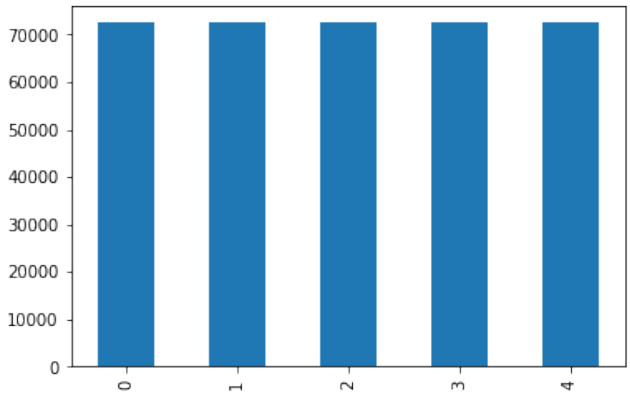

Figure 2: Data distribution after over-sampling

4.2 Result

The model achieve a 98 %-symbol accuracy which is very high for 5-class classification problem. This show how powerful CNN model is to 1D data since it enables the ability of learning neighbor relationship between features in the data.

5 Discussion

The extremely high accuracy might not be that great since there's might be some problems in training like overfit, imbalanced data or it might simply due to errors in code and I need to conduct further investigation on this.