2. Intro

Atrial fibrillation (AF) is one of the most common types of arrhythmias, which are irregular heart rhythms [1]. AF occurs when the upper chambers of the heart (atria) beat out of rhythm and as a result, blood is not pumped efficiently to the rest of the body, causing an unusually fast heart rate, quivering, or thumping sensations in the heart [2]. Often episodes of AF are asymptomatic [3]. AF is the most common sustained cardiac arrhythmia and as of 2020, 33 million people are affected by this disease worldwide [4]. AF patients are at moderate-to-high risk of stroke and the disease is a common factor of heart failure [5]. As such, establishing an effective monitoring system for early AF detection along with an effective approach to treating AF is essential [5].

AF is often transient or paroxysmal in nature, and the correct diagnosis of AF can be challenging in patients with paroxysmal AF [6]. The main characteristic of AF disorder is the irregular rhythm of the heartbeat or more specifically when a varying period is observed in Electrocardiogram (ECG) signal between R–R peaks [7]. The disease is hard to diagnose, since patients suffering from AF may not have symptoms at early onset, and there is spontaneous termination of arrhythmia. Thus using machine learning to detect AF can be very beneficial.

Heart disease prediction using machine learning has become common in the last few decades. There are numerous studies using deep learning techniques to detect heart arrhythmias in general and AF in particular. Machine learning algorithms have the potential to improve patient outcomes particularly where diagnoses are made from large volumes or complex patterns of data such as in AF.

We based our project on a study that aims to detect Atrial Fibrillation using long short-term memory network (LSTM) with RR interval signals [8]. The goal of this study is to reduce workload of the clinicians and enable a robust diagnosis support system for AF. Their proposed Computer-Aided Diagnoses (CAD) system can be used for long-term monitoring of the human heart. The system achieved 98.5% accuracy with 10-fold cross-validation (2- subjects) and 99.77% accuracy with blindfold validation (3 subjects).

תרומה של כל מאמר??

לפרט על החסרונות שאנחנו נתייחס אליהם (רוני – מה זה אומר?)

\*\* צריך להבין מה להכניס כאן ומה להכניס בmethod כי יש הגדרות חופפות באתר הקורס

3. Methods

This section introduces the approach used by the paper we rely on and our modifications and improvements.

3.1 Original Approach

The model implemented in the study [8] is based on Recurrent Neural Network (RNN). To identify RR intervals as AF it is necessary to examine each RR interval in relation to other intervals over time. So, in order to classify AF it is crucial to be able to put an RR interval in its context. RNNs allow the network to retain and utilize state information, meaning information on what has happened in previous time steps. The RNNs have a "memory" that captures information about all elements of the same input sequence.

LSTMs are an improvement on standard RNNs since they incorporate a gating mechanism and are able to deal with the [vanishing gradient problem](https://en.wikipedia.org/wiki/Vanishing_gradient_problem) that can be encountered when training traditional RNNs. An LSTM has the ability to control which information is remembered and which is forgotten. The model from the study [8] used a Bidirectional LSTM, which utilizes past and future data from the input sequence. This enables the network to make a more accurate prediction because it is given a wider context.

**# TODO** add architecture diagram

3.2 Modifications and Improvements

3.3 Methods used

3.4 Data used

The experiments conducted by the study [8] and by us were based on data from the MIT-BIH Atrial Fibrillation Database [9][10]. The database includes 23 long-term ECG recordings of human subjects with atrial fibrillation (mostly paroxysmal). The individual recordings are each 10 hours in duration and contain two ECG signals each sampled at 250 samples per second. The R peaks are labeled and the RR intervals were extracted according to these labels.

**Acronyms**

AF Atrial Fibrillation

CAD Computer-Aided Diagnosis

ECG Electrocardiogram

LSTM Long Short-Term Memory

RNN Recurrent Neural Network

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Ka H. C. Li1,2,3†, [Mei Dong](https://loop.frontiersin.org/people/537180/overview)4†, [Mengqi Gong](http://www.frontiersin.org/people/u/528268)5, George Bazoukis6, Ishan Lakhani2,3, Yan Y. Ting2,3, [Sunny H. Wong](http://www.frontiersin.org/people/u/468199)2,3, Guangping Li7, William K. K. Wu8, Vassilios S. Vassiliou8, Martin C. S. Wong10, [Konstantinos Letsas](http://www.frontiersin.org/people/u/19580)5, [Yimei Du](http://www.frontiersin.org/people/u/292862)11, [Victoria Laxton](http://www.frontiersin.org/people/u/377563)12, Bryan P. Yan1, Yat S. Chan1, [Yunlong Xia](http://www.frontiersin.org/people/u/501745)12, [Tong Liu](http://www.frontiersin.org/people/u/282803)2\*, [Gary Tse](http://www.frontiersin.org/people/u/335924)2,3\* and International Health Informatics Study (IHIS) Network

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