Chapter 1

Introduction

1.1 Background

Cardiovascular diseases (CVDs) are one of the leading causes of global morbidity and mortality (Vaduganathan et al. 2022). Among prognostic indicators for cardiac dysfunction, left ventricular ejection fraction (LVEF) is considered the main indicator for diagnosing heart failure (HF) (Breathett et al., 2016). Current clinical workflows rely on several modalities, including transthoracic echocardiography (TTE), cardiac magnetic resonance imaging (CMR), and computed tomography (CT), to measure LVEF (Scatteia et al., 2021). However, each of these modalities poses different forms of accessibility issues, making them non-universally applicable due to high costs, specialized equipment requirements, and limited availability in low-resource settings.

The electrocardiogram (ECG) is potentially viable for identifying subtle electrophysiological signatures linked to LVEF. Recent explorations deep learning architectures that involve both convolutional neural networks (CNNs) and recurrent neural networks (RNNs), such as 1D CNN-GRU and 1D CNN-LSTM, have demonstrated remarkable success in time series analysis, including decoding complex ECG signatures. Several studies have demonstrated the capability of machine learning models in detecting atrial fibrillation (Attia et al., 2019) and silent left ventricular dysfunction (Raghunath et al., 2020) with accuracy surpassing human-level performance. However, the application of these techniques to predict continuous variables like LVEF remains underexplored. This study aims to address this gap by proposing a novel ML-driven framework to predict LVEF directly from ECG signal data.

1.2 Objective

The main objective of this study is to develop a machine learning framework capable of predicting left ventricular ejection fraction (LVEF) from electrocardiogram (ECG) data. To accomplish this objective, extraction of electrophysiological features that correlate with LVEF is carried out with deep learning approaches that involve both convolutional neural networks and recurrent neural networks (1D CNN-GRU and 1D CNN-LSTM). The performance of these approaches will be evaluated to determine their effectiveness for this goal.

1.3 Hypothesis

- H0 : Deep learning models built of CNNs and RNN can't learn electrophysiological features from ECG signals to predict left ventricular ejection fraction (LVEF)
- H1: Deep learning models built of CNNs and RNN can learn electrophysiological features from ECG signals to predict left ventricular ejection fraction (LVEF)