Detection of Myocardial Infarction in Coronary Artery Disease Patients based on Phonocardiogram Signal Using Ensemble Learning

Gilang Muhammad Rizky (Presenter)
Satria Mandala, S.T., M.Sc., Ph.D
dr. Miftah Pramudyo, Sp JP (K)

Introduction

- Myocardial Infarction (MI) or heart attack is one of the most deadly diseases in the world.
- Phonocardiogram (PCG) is one type of signal commonly used for detecting cardiovascular diseases.
- Usually, the process of detecting MI requires various laboratory tests that can be quite time-consuming, while patients need quick and accurate treatment.
- Research related to MI detection is still rare.

Introduction (contd.)

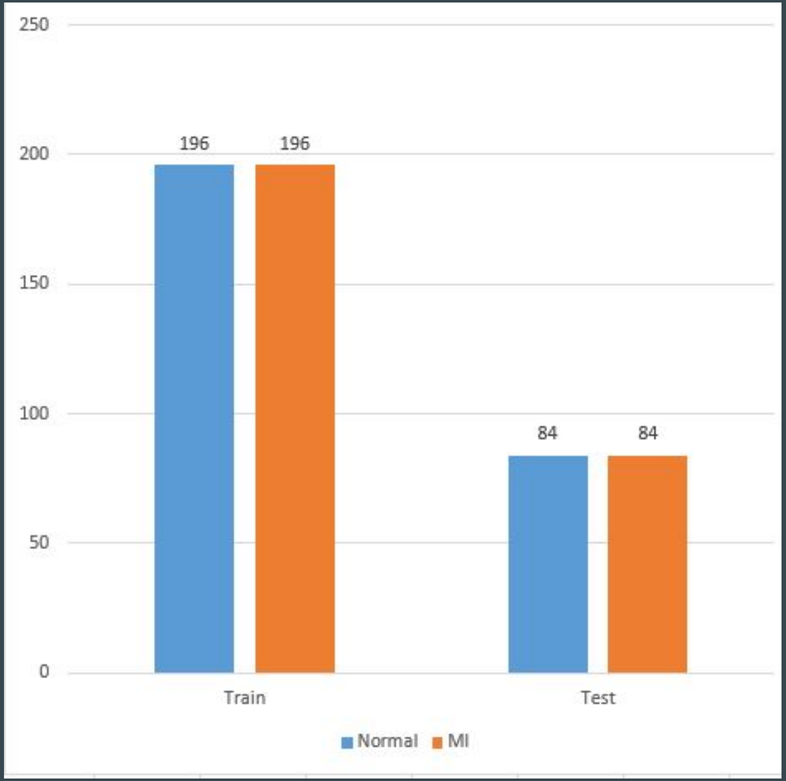
The purpose of this research:

- Design an ensemble learning model to detect MI from CAD patient by using balanced data Based on PCG Signal
- To determine which method (among the proposed methods) has the best performance

Research Method

a. Dataset

The dataset was obtained from recordings of the heart using a digital stethoscope (based on the Phonocardiogram signal) with a duration of 30 seconds, conducted at Hasan Sadikin Hospital in Bandung. The total number of data used was 560, with 280 labeled as normal and 280 labeled as MI. Then, a data split process was carried out with a 70:30 ratio.



Research Method (contd.)

b. Preprocessing

The preprocessing was done using the noisereduce library obtained from the Python Package Index (PyPI).

c. Feature Extraction

Feature extraction was performed using three methods: Mel-Frequency Cepstral Coefficient (MFCC), Energy Entropy, and Discrete Wavelet Transform (DWT).

Research Method (contd.)

Classification

Ensemble Learning Method	Base Estimator
Bagging	Decision Tree
Boosting	Decision Tree
Stacking	Decision Tree dan SVM

Research Method (contd.)

e. Model Evaluation

	Actual	
Predict	**Positive**	**Negative**
Positive	TP	FP
Negative	FN	TN

$$specificity = \frac{TN}{TN + FP}$$

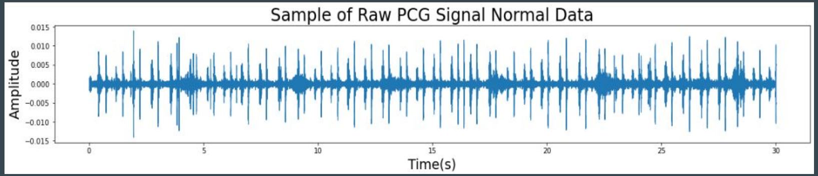
$$sensitivity = \frac{TP}{TP + FN}$$

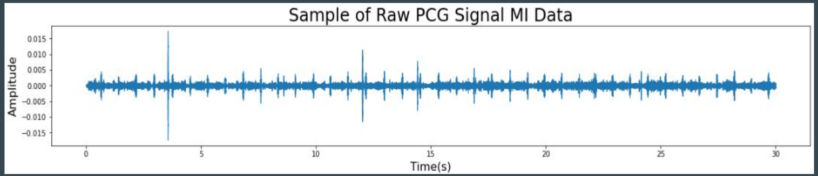
$$accuracy = \frac{TP + TN}{TP + FP + FN + TN}$$

Result and Discussion

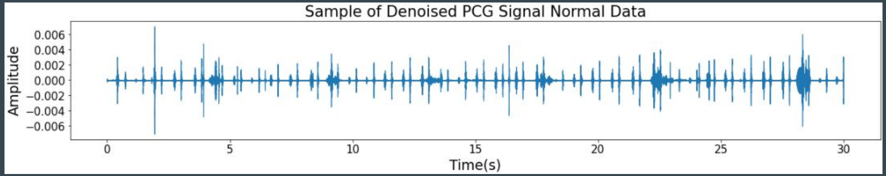
a. Preprocessing

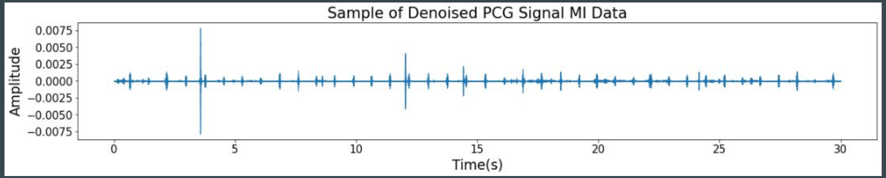
Before Preprocessing





After Preprocessing





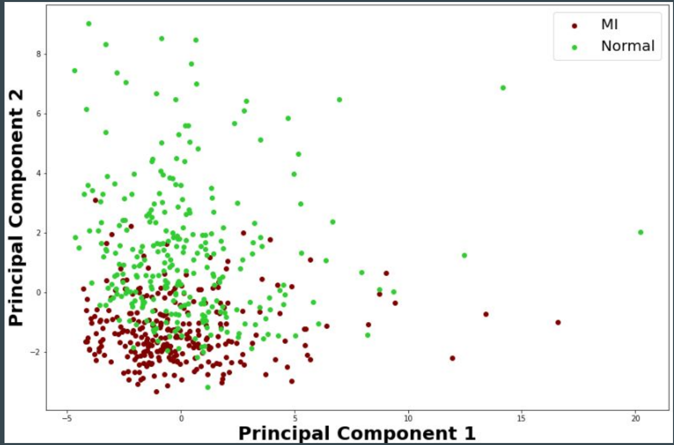
Research Method (contd.)

b. Feature Extraction

Extracted Feature

Extracted Feature
MFCC Means', 'MFCC std', 'MFCC max', 'MFCC min', 'Median_mfcc', 'Variance_mfcc', 'Skewness_mfcc', 'Q1_mfcc', 'Q3_mfcc', 'Interquartile Range (IQR)_mfcc', MinMax_mfcc', 'Kurtosis_mfcc', 'Wavelet Means', 'Wavelet std', 'Wavelet max', 'Wavelet min' , Median_wavelet', 'Variance_wavelet', 'Skewness_wavelet', 'Q1_wavelet', 'Q3_wavelet', 'IQR_wavelet', 'MinMax_wavelet', 'Kurtosis_wavelet' 'Energy Entrophy'

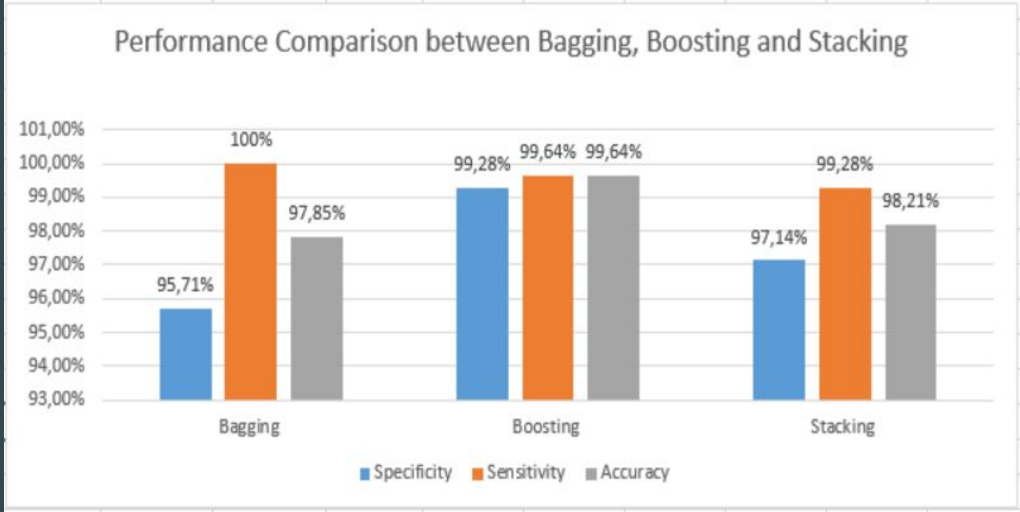
Data Distribution (Using PCA)



Research Method (contd.)

c. Classification

Model	Specificity	Sensitivity	Accuracy
Bagging	95.71%	100%	97.85%
Boosting	99.28%	99.64%	99.64%
Stacking	97.14%	99.28%	98.21%



Research Method (contd.)

d. Comparison of Proposed Method with Other Works

Author	Signal Type	Method	Number of Data	Sensitivity	Accuracy
Han and Shi (2019)	ECG	SVM	448	99.56%	99.81%
Hammad et al. (2022)	ECG	CNN	549	81.11%	89.72%
Zarrabi et al. (2017)	ECG, PCG, Clinical Feature	KNN	-	98%	99%
Khan et al. (2020)	PCG	Ensemble Subspace KNN	645	89%	94.9%
Penelitian ini	PCG	Bagging	560	100%	97.85%
		Boosting		99.64%	99.64%
		Stacking		99.28%	98.21%

Conclusion

- Developed models to detect Myocardial Infarction or heart attacks based on the Phonocardiogram signal using ensemble learning.
- Boosting has the best performance with a specificity value of 99.28%, a sensitivity value of 99.64%, and an accuracy value of 99.64%.

Suggestion for Future Research

- Using different method such as Deep Learning or different ensemble method such as XGBoost or Gradient Boost
- Conducting multiclass MI research

THANK YOU