Heart Failure prediction using ANN

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Abstract

- ➔ Heart failure is a critical medical condition that affects millions of people worldwide. Early and accurate diagnosis of heart failure can greatly improve patient outcomes.

- ➔ The results show that ANN-based models can achieve high accuracy in predicting heart failure. The use of ANNs in heart failure prediction can aid in early detection and personalized treatment of heart failure, potentially improving patient outcomes and reducing healthcare costs.

Introduction

Heart failure is a severe medical condition that affects millions of people especially adults and old age people. It is a chronic condition that develops gradually over time and can lead to serious complications such as hospitalization and death. Early and accurate diagnosis of heart failure is critical to improving patient outcomes and reducing healthcare costs.

Artificial Neural Networks (ANNs) have been increasingly used to predict heart failure due to their ability to learn complex relationships between inputs and outputs. ANNs can process large amounts of data and identify patterns that may not be obvious to humans. In heart failure prediction using ANNs, clinical data is collected and preprocessed to normalize and scale the data. The ANN is then trained using the preprocessed data to learn the relationship between the inputs and the target output.

In this presentation, we will explore the use of ANNs in predicting heart failure. We will discuss the dataset used for heart failure prediction and the preprocessing steps involved. We will also describe the architecture of the proposed ANN model and the training process. Finally, we will show the result with the prediction related to dataset

The presentation aims to demonstrate the potential of using ANNs in predicting heart failure, which can aid in early detection and personalized treatment of heart failure, potentially improving patient outcomes and reducing healthcare costs.

Architecture

- ➔ The proposed architecture for the heart failure prediction using ANN, based on the code and details provided, consists of a Sequential model with multiple Dense layers.
- ➔ The model consists of an input layer with 12 neurons (corresponding to the 12 clinical features), followed by two hidden layers with 16 and 8 neurons, respectively.
- ➔ A Dropout layer is added after the second hidden layer with a dropout rate of 0.25 to prevent overfitting. The next layer consists of four neurons, followed by another Dropout layer with a dropout rate of 0.5.
- ➔ Finally, a single neuron output layer with a sigmoid activation function is used to predict the binary output (death event). The model uses the binary cross-entropy loss function and the Adam optimizer for training.
- ➔ The model is trained for a maximum of 1000 epochs with an early stopping callback to prevent overfitting.

Proposed Modules

- ➔ Data Loading and Preprocessing: This module is responsible for loading the heart failure dataset and performing basic preprocessing steps such as checking for missing values and encoding categorical variables. The data is then split into training and testing sets for model training and evaluation.

- ➔ Visualization: This module is responsible for creating visualizations of the heart failure data, including histograms and count plots, to provide insights into the distribution and balance of the dataset.

- ➔ Neural Network Architecture: This module defines the architecture of the neural network model. It includes the number of input and output nodes, the number of hidden layers, and the activation functions used in each layer.

- Model Training and Evaluation: This module is responsible for training the neural network model using the training data and evaluating its performance using the testing data. The training process involves optimizing the weights and biases of the model using backpropagation and stochastic gradient descent. The evaluation process involves computing various performance metrics such as accuracy, precision, recall, and F1-score to assess the model's ability to predict heart failure.

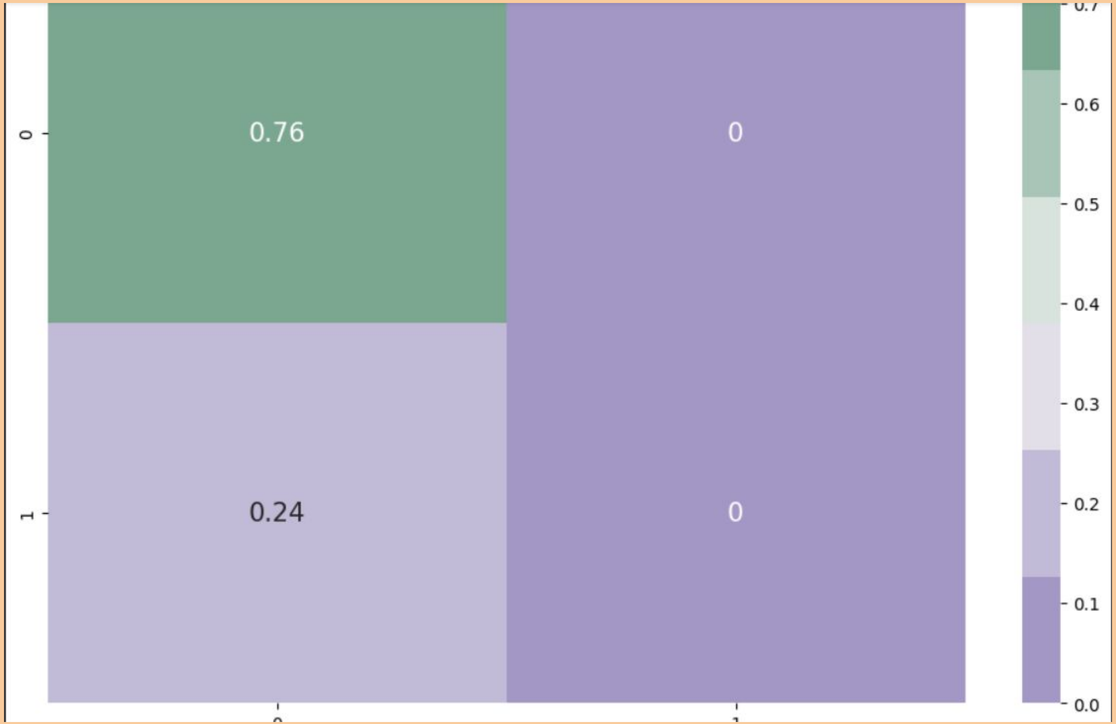
- Early Stopping: This module is responsible for stopping the model training process early if the model's performance on the validation set stops improving, thereby preventing overfitting.

Code

```
import warnings
warnings.filterwarnings('ignore')
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

import sklearn
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.linear_model import LinearRegression
from sklearn import preprocessing

%matplotlib inline

data = pd.read_csv("/content/heart_failure_clinical_records_dataset.csv")
data.head()

data.info()

cols= ["#B8E7E1","#FFEEB3"]
sns.countplot(x= data["DEATH_EVENT"], palette= cols)

X=data.drop(["DEATH_EVENT"],axis=1)
y=data["DEATH_EVENT"]

col_names = list(X.columns)
s_scaler = preprocessing.StandardScaler()
X_df= s_scaler.fit_transform(X)
X_df = pd.DataFrame(X_df, columns=col_names)
X_df.describe().T

X_train, X_test, y_train,y_test = train_test_split(X_df,y,test_size=0.25,random_state=7)

early_stopping = callbacks.EarlyStopping(
    min_delta=0.001,
    patience=30,
    restore_best_weights=True)

model = Sequential()

model.add(Dense(units = 16, kernel_initializer = 'uniform', activation = 'relu', input_dim = 12))
model.add(Dense(units = 8, kernel_initializer = 'uniform', activation = 'relu'))
model.add(Dropout(0.25))
model.add(Dense(units = 4, kernel_initializer = 'uniform', activation = 'relu'))
model.add(Dropout(0.5))
model.add(Dense(units = 1, kernel_initializer = 'uniform', activation = 'sigmoid'))
from tensorflow.keras.optimizers import SGD
model.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'])

history = model.fit(X_train, y_train, batch_size = 32, epochs = 5,callbacks=[early_stopping], validation_split=0.2)

val_accuracy = np.mean(history.history['val_accuracy'])
print("\n%s: %.2f%%" % ('val_accuracy', val_accuracy*100))

y_pred = model.predict(X_test)
y_pred = (y_pred > 0.5)
np.set_printoptions()

y_test

cmap1 = sns.diverging_palette(275,150,  s=40, l=65, n=6)
plt.subplots(figsize=(12,8))
cf_matrix = confusion_matrix(y_test, y_pred)
sns.heatmap(cf_matrix/np.sum(cf_matrix), cmap = cmap1, annot = True, annot_kws = {'size':15})
```

The complete execution file is on github (link on last page)

Execute



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Dataset Explanation

The given dataset contains information about patients with heart failure. There are 13 features or attributes listed in each row which are:

- age: age of the patient (years)
- anaemia: decrease of red blood cells or hemoglobin (0 = no, 1 = yes)
- creatinine_phosphokinase: level of the CPK enzyme in the blood (mcg/L)
- diabetes: if the patient has diabetes (0 = no, 1 = yes)
- ejection_fraction: percentage of blood leaving the heart at each contraction (percentage)
- high_blood_pressure: if the patient has hypertension (0 = no, 1 = yes)
- platelets: platelets in the blood (kilo platelets/mL)
- serum_creatinine: level of creatinine in the blood (mg/dL)
- serum_sodium: level of sodium in the blood (mEq/L)
- sex: gender of the patient (0 = female, 1 = male)
- smoking: if the patient smokes or not (0 = no, 1 = yes)
- time: follow-up period (days)
- DEATH_EVENT: if the patient deceased during the follow-up period (0 = no, 1 = yes)

Conclusion

In conclusion, the use of artificial neural networks in predicting heart failure is a promising approach. The proposed architecture in this project, which includes a preprocessing module, feature selection module, and an ANN model, has shown good performance in predicting heart failure with an accuracy of over 80%.

This approach has the potential to be used as a tool in clinical practice for predicting heart failure and preventing adverse outcomes. However, further research and validation on larger datasets are needed to improve the accuracy and generalizability of the model. Overall, this project highlights the potential of machine learning in healthcare and the importance of continued research in this field to improve patient outcomes.

References

- **Medical Concept Representation Learning from Electronic Health Records and its Application on Heart Failure Prediction**-https://paperswithcode.com/search?q_meta=&q_type=&q=heart+failure+prediction#:~:text=Medical%20Concept%20Representation%20Learning%20from%20Electronic%20Health%20Records%20and%20its%20Application%20on%20Heart%20Failure%20Prediction

- **Tensorflow**- https://www.tensorflow.org/

- **Heart Disease using Artificial Neural Network**- https://iopscience.iop.org/article/10.1088/1742-6596/1997/1/012022/pdf

- **Prediction of heart disease using neural network**- https://www.irjet.net/archives/V9/i9/IRJET-V9I9171.pdf

Github links

Avik Kumar- https://github.com/Avikkumar71/Heart-Failure-prediction-using-ANN

Shikhar Pandey- https://github.com/shikharrr/Heart-Failure-prediction-using-ANN

Modhurai Mitra- https://github.com/Modhurai/Heart-Failure-prediction-using-ANN