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End-of-Studies Project Dissertation

presentedby

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Theme

AI : in the detection of heart risk for Telehealth

Proposedby :Bougheria Nadia&Bouachria Mohamed

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THANKS

In This humble Thesis I would like to thank God for all the blessing that he descended upon us on earth giving me the strength and will to finish my studies in all glory with the help one the best supports on earth also known as my mother and I would like to thank my teachers

Mr. Bouachria M. and Mrs.Bougherira.N that helped me realize a portion of my dream in serving and saving humanity and I would like to thank my friends specially Doctor Azouaoui I. who contributed in all medicine and health information in this thesis

And I am thankful by all the moral support of my family members and they have been nothing but supportive of me

ملخص:

أدى تقاطع تقنية العالمية وأجهزة الحوسبة المصغرة عالية القدرة إلى ثورة في تقديم الرعاية الصحية وولادة الطب عن بعد والصحة المتنقلة. إن التطورات السريعة في أجهزة التصوير المحمولة باليد مع الأجهزة الأخرى مثل تطبيقات الهواتف الذكية والأجهزة القابلة للارتداء تخطو خطوات كبيرة في مجال تصوير القلب والأوعية الدموية بشكل لم يسبق له مثيل. على الرغم من أن هذه التقنيات تقدم وعدًا مشرقًا في تصوير القلب والأوعية الدموية ، إلا أنها بعيدة كل البعد عن الوضوح. يشمل تدفق البيانات الهائل من التطبيب عن بعد تصوير القلب والأوعية الدموية الذي يحل محل القدرات الحالية لنظام الرعاية الصحية الحالي والبرامج الإحصائية. الذكاء الاصطناعي مع التعلم الآلي هو الطريقة الوحيدة والوحيدة للتنقل عبر هذه المتاهة المعقدة لتدفق البيانات من خلال أساليب مختلفة. تعمل تقنيات التعلم العميق على توسيع دورها من خلال التعرف على الصور والقياسات الآلية. يوفر الذكاء الاصطناعي فرصة غير محدودة لتحليل البيانات بدقة. بينما نمضي قدمًا ، أصبحت مستقبل الصحة المحمولة والتطبيب عن بُعد والذكاء الاصطناعي متشابكة بشكل متزايد لإحداث الطب الدقيق

كلمات المفاتيح:الذكاء الاصطناعي؛ التعلم الالي؛ التطبيب عن بعد

Résumé :L'intersection de la technologie mondiale et des dispositifs informatiques miniaturisés à haute capacité a conduit à une révolution dans la prestation des soins de santé et à la naissance de la télémédecine et de la santé mobile. Les progrès rapides des appareils d'imagerie portables avec d'autres appareils tels que les applications pour smartphones et les appareils portables font de grands progrès dans le domaine de l'imagerie cardiovasculaire comme jamais auparavant. Bien que ces technologies offrent une belle promesse en imagerie cardiovasculaire, c'est loin d'être simple. L'afflux massif de données provenant de la télémédecine, notamment l'imagerie cardiovasculaire, remplace les capacités existantes du système de santé et des logiciels statistiques actuels. Avec est le seul et unique moyen de naviguer dans ce labyrinthe complexe d'afflux de données à travers diverses approches. Les techniques d'apprentissage en profondeur élargissent encore leur rôle par la reconnaissance d'images et les mesures automatisées. L'intelligence artificielle offre des possibilités illimitées d'analyser rigoureusement les données. À mesure que nous avançons, les futurs de la santé mobile, de la et de l'intelligence artificielle s'entremêlent de plus en plus pour donner naissance à la médecine de précision.

Mots clés :L'intelligence artificielle ; l'apprentissage automatique ; télémédecine

Abstract: The intersection of global technology and miniaturized high-capability computing devices has led to a revolution in the delivery of healthcare and the birth of telemedicine and mobile health . Rapid advances in handheld imaging devices with other devices such as smartphone apps and wearable devices are making great strides in the field of cardiovascular imaging like never before. Although these technologies offer a bright promise in cardiovascular imaging, it is far from straightforward. The massive data influx from telemedicine are including cardiovascular imaging supersedes the existing capabilities of current healthcare system and statistical software. Artificial intelligence with machine learning is the one and only way to navigate through this complex maze of the data influx through various approaches [1]. Deep learning techniques are further expanding their role by image recognition and automated measurements. Artificial intelligence provides limitless opportunity to rigorously analyze data. As we move forward, the futures of mHealth, telemedicine and artificial intelligence are increasingly becoming intertwined to give rise to precision of medicine.

Keywords :Artificial intelligence, mobile health, machine learning

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GENERAL INTRODUCTION

Artificial intelligence is a field of computer science that makes a computer system that can mimic human intelligence. It is comprised of two words “Artificial” and “intelligence”, which means “a human-made thinking power.”

In order to understand Artificial Intelligence, we must first pose the question: **what is intelligence?**

From an objective point of view, general human behavior in aspects of survival is considered intelligent. Although the same can be said about similar behavior found in animals, the human counterpart is more complex.

Psychologists don’t treat every human behavior as an intelligent act, but more of a combination of multiple criteria present in each individual, and it differentiate from one to another. To define intelligence in a human, we must first have an understanding of the following concepts: learning, reasoning, problem solving, perception and language (or other forms of communication). The same can be applied in order to understand Artificial Intelligence, which has to undergo the same conditional testing to become truly self-reliant. One of the biggest contributions of A.I. comes most apparent in “learning”, which leverages data to improve performance and accuracy on some of the set tasks which can be further explored in “Machine learning”. And it is a subset within Artificial intelligence that is more focused on self-learning by using data that we input which can be usually past event, studies, statistics, imagery, audios, ext… all that in order to predict future desired events.

Machine learning was used in the past decade in various fields we mention some such as : agriculture, traffic, real estate, health care

And the idea is simple is to take a large amount of data and use different algorithms to study, analyze, calculate every important information we have within the dataset in order to have either classification,(example: customer retention). or regression, (example: airline companies). as an outcome, and this is known as supervised learning

In this thesis we shall discuss variant algorithms of Machine Learning which they were used in the health care field and more specifically in the cardiovascular issues in order to determine if a person has a risky heart abnormality by using dataset from “Kaggle” that has over 900 people with data that includes ECG information and more.

The dataset was treated by various Machine learning algorithms. Thus, we mention: Decision Tree, Random Forest, Neural network.

which helps with classification with each individual by splitting the data set into “training set” with 818 individuals & “testing set” with 101 individuals with the showing of the presence of heart risk and its percentage.

This study of health care through dataset with Machine Learning can even help with the prediction of someone’s health in the future upcoming researches.

CHAPTER I: INTRODUCTION OF MACHINE LEARNING

CHAPITRE 1 Brief history of machine learning:

Arthur Samuel introduced machine learning method to the world back in 1956 through the very popular game "checkers"

On February 24th, 1956, Arthur Samuel's Checkers program, which was developed for play on the **IBM701**, was demonstrated to the public on television. In 1962, self-proclaimed checkers master Robert Nealy played the game on an **IBM7094** computer. The computer won. Other games resulted in losses for the Samuel Checkers program, but it is still considered a milestone for artificial intelligence, and offered the public in the early 1960s an example of the capabilities of the Artificial intelligence.[1]

1.1Definition of machine learning:

Machine learning is a major part of Artificial intelligence which focuses on data and algorithms and it resembles the way humans learn and it gradually improve in its accuracy.

Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions, uncovering key insights within data mining projects. These insights subsequently drive decision making within applications, ideally the modern world and what it contains is considered a huge set of data. As big data continues to expand and grow, the modern man demand for data scientists will increase, requiring them to assist in the identification of the most relevant information that will help the society evolves through its various techniques.

The basic concept of machine learning in data science involves using statistical learning and optimization methods that let computers analyze datasets and identify patterns and its techniques leverage data mining to identify historic trends and inform future models.

1.2machine learning algorithms:

The purpose of machine learning is to use machine learning algorithms to analyze data. By leveraging machine learning, a developer can improve the efficiency of a task involving large quantities of data without the need for manual human input for the most of the time.

Around the world, strong machine learning algorithms can be used to improve the productivity of professionals working in data science, computer science, and many other fields.

There are a number of machine learning algorithms that are commonly used by modern technology companies. Each of these machine learning algorithms can have numerous applications in a variety of educational and business settings.

To learn about many different machine learning algorithms, as well as how they are applicable to the broader field of machine learning we represent the algorithms used in Machine Learning process:

1.2.1 LINEAR REGRESSION

Linear regression is an algorithm used to analyze the relationship between independent input variables and at least one target variable. This kind of regression is used to predict continuous outcomes, variables that can take any numerical outcome.

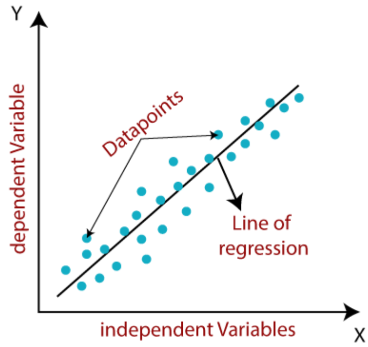


Figure 1: linear regression graph

For example, given data on the neighborhood and property, can a model predict the sale value of a home? Linear relationships occur when the data relationship being observed tends to follow a straight line overall, and as such, this model can be used to observe whether a data point is increasing, decreasing, or remaining the same relative to some independent variable, such as time elapsed or position.

Machine learning models can be employed to analyze data in order to observe and map linear regressions. Independent variables and target variables can be input into a linear regression machine learning model, and the model will then map the coefficients of the best fit line to the data. In other words, the linear regression models attempt to map a straight line, or a linear relationship, through the dataset.

1.2.2 LOGISTIC REGRESSION

Logistic regression is a supervised learning algorithm that is used for classification problems. Instead of continuous output like in linear regression, a logistic model predicts the probability of a binary event occurring.

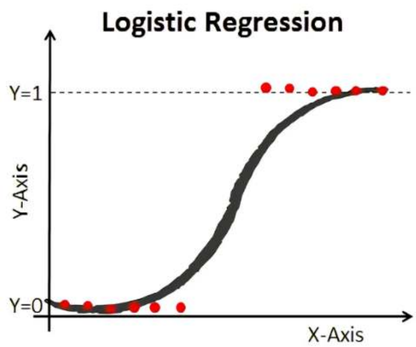


Figure 2: logistic regression graph

For example, given an email, can a model predict whether the contents are spam or not?

Machine learning algorithms can use logistic regression models to determine categorical outcomes. When given a dataset, the logistic regression model can check any weights and biases and then use the given dependent categorical target variables to understand how to correctly categorize that dataset.

1.2.3 NEURAL NETWORKS

Neural networks are artificial intelligence algorithms that attempt to replicate the way the human brain processes information to understand and intelligently classify data.

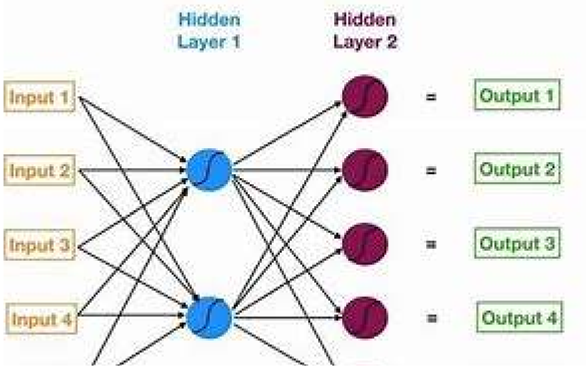


Figure 3:neural network

These neural network learning algorithms are used to recognize patterns in data and speech, translate languages, make financial predictions, and much more through thousands, or sometimes millions, of interconnected processing nodes. Data is “fed-forward” through layers that process and assign weights, before being sent to the next layer of nodes, and so on.

Crucially, neural network algorithms are designed to quickly learn from input training data in order to improve the proficiency and efficiency of the network’s algorithms. As such, neural networks serve as key examples of the power and potential of machine learning models.

1.2.4 DECISION TREES

Decision trees are data structures with nodes that are used to test against some input data.

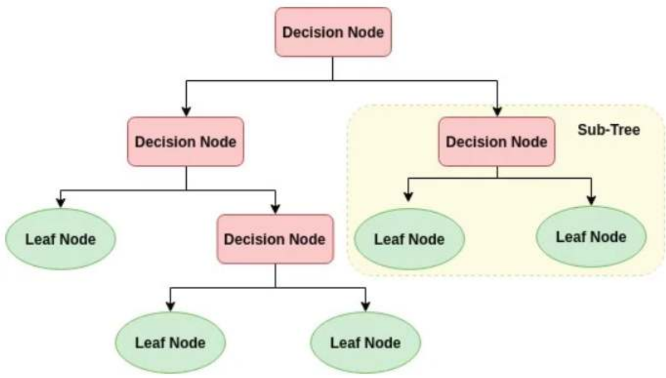


Figure 4: Decision tree

The input data is tested against the leaf nodes down the tree to attempt to produce the correct, desired output. They are easy to visually understand due to their tree-like structure and can be designed to categorize data based on some categorization schema.

Decision trees are one method of supervised learning, a field in machine learning that refers to how the predictive machine learning model is devised via the training of a learning algorithm.

1.2.5 RANDOM FOREST

Random forest models are capable of classifying data using a variety of decision tree models all at once.

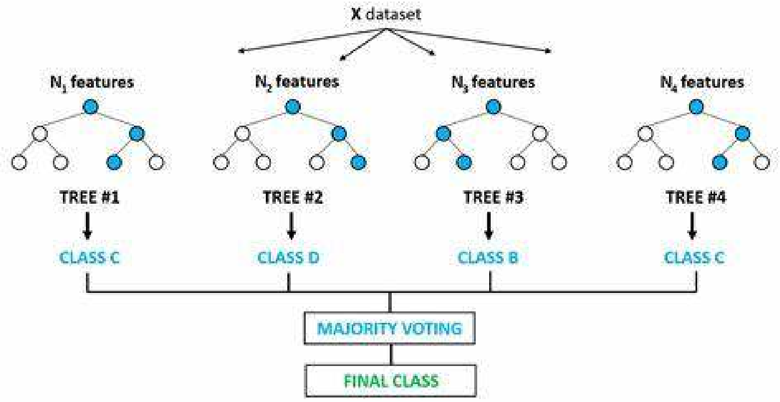


Figure 5: Random Forest

Like decision trees, random forests can be used to determine the classification of categorical variables or the regression of continuous variables. These random forest models generate a number of decision trees as specified by the user, forming what is known as an ensemble. Each tree then makes its own prediction based on some input data, and the random forest machine learning algorithm then makes a prediction by combining the predictions of each decision tree in the ensemble.

1.3Importance of machine learning

Overall, one must ask why is machine learning is so important and who is using it in the modern society?

Well, there are two major reason we use machine learning:

- **Scale of data:** Companies are faced with massive volumes and varieties of data that need to be processed. Processing power is more efficient and readily available. Models that can be programmed to process data on their own, determine conclusions, and identify patterns are invaluable.

- **Unexpected findings:** Since a machine learning algorithm update autonomously, analytical accuracy improves with each run as it teaches itself from the datasets it analyzes. This iterative nature of learning is unique and valuable because it occurs without human intervention in other words, machine learning algorithms can uncover hidden insights, predicts future events without being specifically programmed to do so.

And when it comes to where machine learning algorithms and techniques are used, we may include these important fields:

- Marketing and sales
- Financial services
- Brick-and-mortar retail
- Health care
- Transportation
- Oil and gas
- Government

Amazon, Facebook, Netflix, and, of course, Google have all been using machine learning algorithms to drive searches, recommendations, targeted advertising, and more for well over a decade.

1.4Contribution of machine learning in health care:

The increasingly growing number of applications of machine learning in healthcare allows us to foretaste at a future where data, analysis, and innovation work hand-in-hand to help countless patients without them ever realizing it.

Soon, it will be quite common to find Machine Learning based applications embedded with real-time patient data available from different healthcare systems in multiple countries, thereby increasing the efficacy of new treatment options which were unavailable before. Healthcare covers detailed processes of the diagnosis, treatment and prevention of disease.

The medical industry in most countries is evolving at a rapid pace. The healthcare industry with rich data as they generate massive amounts of data, including electronic medical records, administrative reports and other findings.

Health informatics are becoming a very research-intensive field and the largest consumer of public funds. With the occurrence of computers and new algorithms, health care has seen an increase in computer tools and could no longer ignore these emerging tools. This resulted in uniting of healthcare and computing to form health informatics. This is expected to create more efficiency and effectiveness in the health care system, while at the same time, improve the quality of healthcare and lower cost. Machine learning and Deep Learning algorithms will enhance prediction accuracy of any healthcare problem to an upper limit as compared to existing researches.

1.4.1 CLASSIFICATION:

Classification is technique to classify data into a desired and individual number of classes where we can assign labels to each class. Healthcare Diagnosis, Speech recognition, Handwriting recognition, Biometric identification, Document classification, etc. are the applications of Machine Learning Classification. There are two categories of classifiers Binary classifiers and multi-Class classifiers. The classification as two distinct classes or with two possible outcomes called as Binary classifiers. Classification with more than two distinct classes called as multi-Class classifiers Following are the various classification algorithms used in healthcare:

- K-Nearest Neighbor (K-NN)
- Decision Tree (DT)
- Support Vector Machine (SVM)
- Neural Network (NN)
- Bayesian Methods

Breast cancer is one of the dangerous diseases in women. Potter et al. has performed experiment on the breast cancer data set using Weka tool and then analyze the performance of different classifier using 10-fold cross validation method. Data mining can contribute with important benefits to the blood bank sector. J48 algorithm and WEKA (decision tree) tool have been used for the complete research work. Classification rules performed well in the classification of blood donors, whose accuracy rate reached 89.9%. [3]

1.4.2 REGRESSION:

Regression analysis is a set of statistical methods used to determine, examine or estimate the relationship between two or more variables. There are many types of regression analysis, however, their core function, is to examine the influence of one or more independent variables on a dependent variable. Regression is also used in predicting and forecasting where its use has substantial overlap with the field of machine learning.

There are numerous forms of regression. However, the two most commonly used are those mentioned before: "linear regression & logistic regression". These are the first algorithms that people learn in data science. Regression itself made a huge contribution in the health care department by Regression analysis may be used to predict Length of Stay in the hospital, predict healthcare costs of individuals based on some variables, Prediction of total surgical procedure time to enable efficient use of operating theatres however it has its own limitation in results because this assumption may not always hold good and may lead to misleading results.

Conclusion:

In this chapter we took an understanding of major role of Artificial Intelligence that happened to be Machine Learning which is a method with various algorithms that responsible for the learning faze and it can gradually get smarter depending on how many data it receives for an outcome of high accuracy results.

CHAPTER II: CLASSIFICATION OF THE HEART'S CONDITION

CHAPITRE 2 What is the heart?

The heart is a mechanical muscle with 4 main chambers: "right atrial & left atrial" and "left ventricular & right ventricular" with the role of supplying blood to all the tissues of the body with O2 and its exchange's it with CO2 through electrical impulses that happens because of SA node (Sinoatrial node)

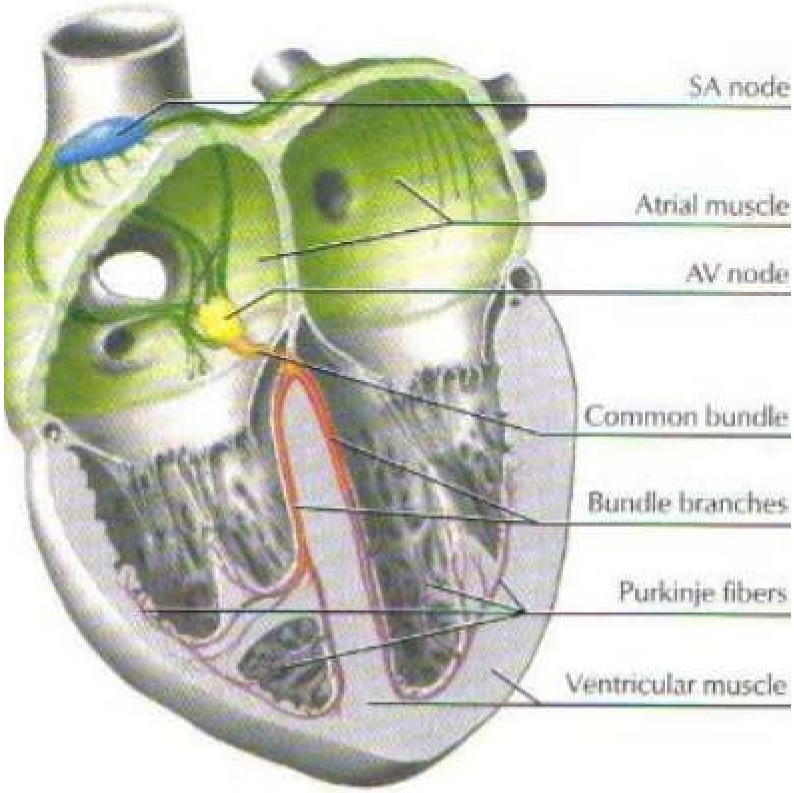


Figure 6:longitudinal section of the heart

as we observe the figure the SA node is responsible of the heart beat by spontaneously generating action potential in its own cells

This small mass of specialized cells lies in the wall of the right atrium. The sinoatrial cells generate these regular impulses because they are electrically unstable. This instability leads them to discharge (depolarize) regularly, usually between 60 and 80 times a minute.

This depolarization followed by recovery (repolarization), but almost immediately their instability leads them to discharge again, setting the heart rate. Because the SA node discharges faster than any other part of the heart, it normally sets the heart rate and is called the pacemaker of the heart. Firing of the SA node triggers atrial contraction

the potential action spreads through the entire heart and that allows the contraction of the heart muscle for it to complete its job.

There for the Electrocardiograph (ECG) shows the graph that represents the heart's impulses, thus we conclude normality and abnormality of the patient

2.1Heart failure:

Heart failure is a global epidemic that affects more than 38 million patients worldwide. The prevalence of Heart Failure is increasing in the world, affecting million adults. Although the incidence of new Heart Failure in the world has plateaued, the global incidence continues to rise. Heart Failure can be due to multiple different etiologies, with incidence rates varying based on age, race, sex, location, comorbidities, and socioeconomic status. In addition to Heart Failure with a reduced ejection fraction, Heart Failure with a preserved ejection fraction is contributing to the increasing prevalence of Heart Failure. Heart Failure hospitalizations and healthcare use are also increasing. Morbidity and mortality remain high. Heart Failure will continue to burden the healthcare system until more effective prevention and treatment measures are developed. Older adults have a higher rate, at nearly 10 cases per 1000 people after age 65 years. The lifetime risk of Heart Failure is 20% for people older than 40 years, and is higher among those with hypertension or obesity etc.

2.1.1COMMON HEARTPATHOLOGY:

- coronary heart disease: a disease of the blood vessels supplying the heart muscle
- rheumatic heart disease: damage to the heart muscle and heart valves from rheumatic fever, caused by streptococcal bacteria;
- congenital heart disease: birth defects that affect the normal development and functioning of the heart caused by malformations of the heart structure from birth;
- deep vein thrombosis and pulmonary embolism: blood clots in the leg veins, which can dislodge and move to the heart and lungs.

And most of these common heart pathologies can be detected through ECG and show normal and abnormal events that occurs in the patient in order to prevent mortality events and give the best medical service.

2.1.2 MACHINE LEARNING ON HEALTH CARE:

Throughout the modern history of innovation solutions were presented to humanity through computer science and Artificial intelligence there for we shall represent some of initiations that contributed in the benefit of health care industry

Diagnose breast cancer from histopathological images using Neural Designer:

This example aims to assess whether a lump in a breast could be malignant (cancerous) or benign (non-cancerous). For that, we use digitized histopathological images of fine-needle aspiration (FNA) biopsy using machine learning.

Dr. William H. Walberg, from the University of Wisconsin Hospitals, Madison, obtained this breast cancer database.The variable to be predicted can have two values (malignant or benignant tumor). Therefore, this is a binary classification project using artificial intelligence and machine learning.[4]

Early detection of lung carcinoma:

The main goal of this study is to build a model which provides a lung cancer risk assessment and risk management decision support tool to facilitate prevention and screening discussions between people and their doctors It will take approximately 2 minutes to complete a questionnaire with different cancer risk factors and pathologies This is a classification project since the variable to be predicted is binary (cancer or not).[5]

Model obesity levels using machine learning:

The variable to be predicted is continuous (Insufficient Weight, Normal Weight, Overweight Level I, Overweight Level II, Obesity Type I, Obesity Type II and Obesity Type III). Therefore, this is an approximation projectthe basic goal is to model the obesity levels as a function of the input variables and advise the patient on how to improve the obesity level.[6]

Diagnose liver diseases from different types of analysis using machine learning:

The variable to be predicted is categorical (no disease, suspect disease, hepatitis c, fibrosis, cirrhosis). Therefore, this is a classification project.

The goal is to model the probability if the patient has not any disease or suffers from hepatitis, fibrosis, or cirrhosis, conditioned on different tests such as blood analysis or urine tests.[7]

Diagnose dermatological diseases using machine learning:

this exampleintends to identify the dermatologic disease that the patient is suffering.based on clinical and histopathologic data.

The diagnosis of erythemato-squamous diseases (ESDs) is important in dermatology because they are pretty common and share clinical features with very few differences. This characteristic makes an accurate diagnosis a challenging problem as they have overlapping signs and symptoms. The diseases in this group include psoriasis, seborrheic dermatitis, lichen planus, pityriasis rosea, among others. The development of a predictive tool can assist the physician in diagnosing the patient more effectively and quickly.The variable we will predict is categorical, the type of ESDs (psoriasis, seborrheic dermatitis, etc.). Thus, this is a classification project. [8]

It was aimed to model class membership probabilities conditioned on the input variables using artificial intelligence and machine learning.

2.2Creation of a machine learning model-1-:

One way of detecting the heart disease is to determine the presence of abnormalities in PQRST interval on ECG signals. Therefore, it is expected to be used as a preliminary diagnosis of heart health and to prevent or decrease the mortality rate due to heart attack.

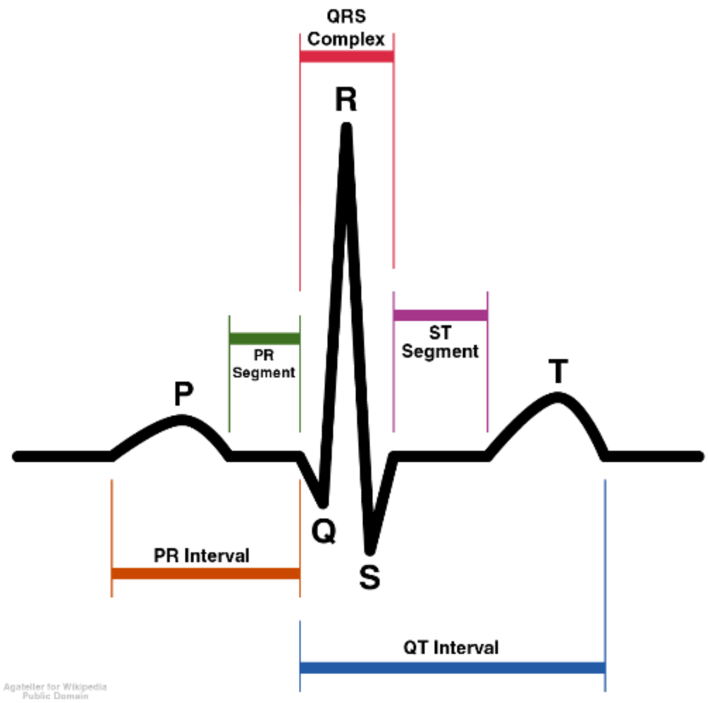


Figure ":Ideal ECG

One complete heartbeat in the ECG (P-wave, QRS complex, T-wave).

-Heart failure is a common event caused by Cardio Vascular diseases and this dataset contains 11 features that can be used to predict a possible heart disease. People with cardiovascular disease or who are at high cardiovascular risk (due to the presence of one or more risk factors such as hypertension, diabetes, hyperlipidemia or already established disease) need early detection and management where in a machine learning model can be of great help.

after getting the dataset that contains information that allows us to make classification with the output of 2 results: "healthy" & "sick".

The information that we have from this dataset goes as following:

1. Age: age of the patient [years]
2. Sex: sex of the patient [M: Male, F: Female]
3. Chest Pain Type: chest pain type:

   TA: Typical Angina: A condition marked by severe pain in the chest, often also spreading to the shoulders, arms, and neck, caused by an inadequate blood supply to the heart. [1]

   ATA: Atypical Angina: The term “atypical” is used to describe a form of anginal chest pain that does not fit the typical presentation.

   NAP: Non-Anginal: A chest pain is very likely nonanginal if its duration is over 30 minutes or less than 5 seconds, it increases with inspiration, can be brought on with one movement of the trunk or arm, can be brought on by local fingers pressure, or bending forward, or it can be relieved immediately on lying down.[2]

   ASY: Asymptomatic:is defined as a transient alteration in myocardial perfusion in the absence of chest pain or the usual anginal equivalents.
4. Resting BP: resting blood pressure [mm Hg]
5. Cholesterol: serum cholesterol [mm/dl]
6. Fasting BS: fasting blood sugar:

   1: if Fasting BS > 120 mg/dl

   0: otherwise]
7. Resting ECG: resting electrocardiogram results

   Normal: Normal

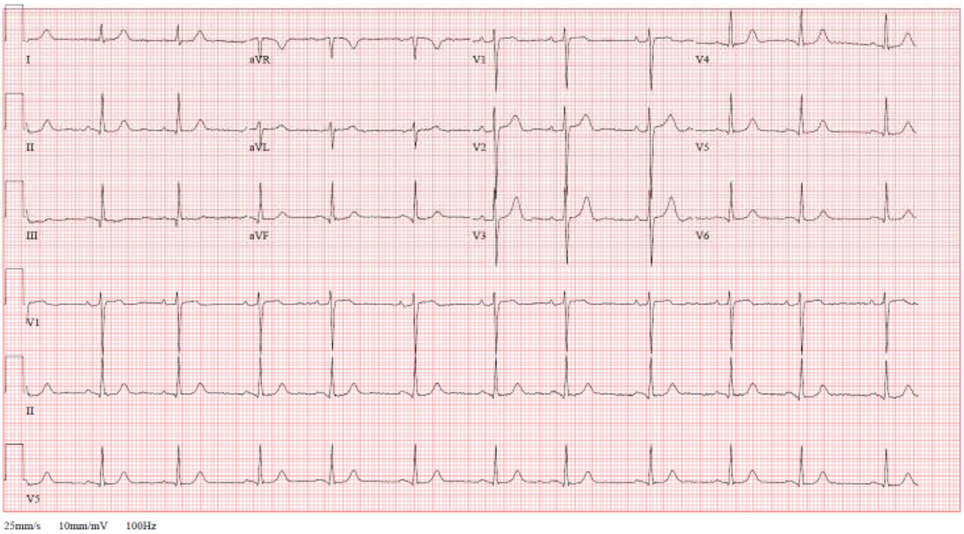


Figure 7: normal ECG

ST: having ST-T wave abnormality (T wave inversions and/or ST elevation or depression of > 0.05 mV)

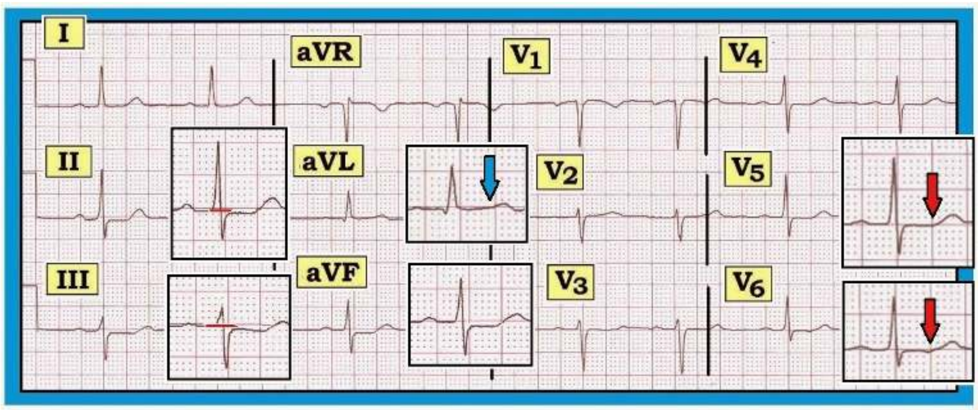


Figure 8: ECG with ST wave abnormality

LVH: showing probable or definite left ventricular hypertrophy by Estes' criteria]

Figure 9: ECG with QRS complex abnormality

8. Max HR: maximum heart rate achieved [Numeric value between 60 and 202] and its usually calculated by dividing 220 from current age – example: 220-24 = 196 BPM

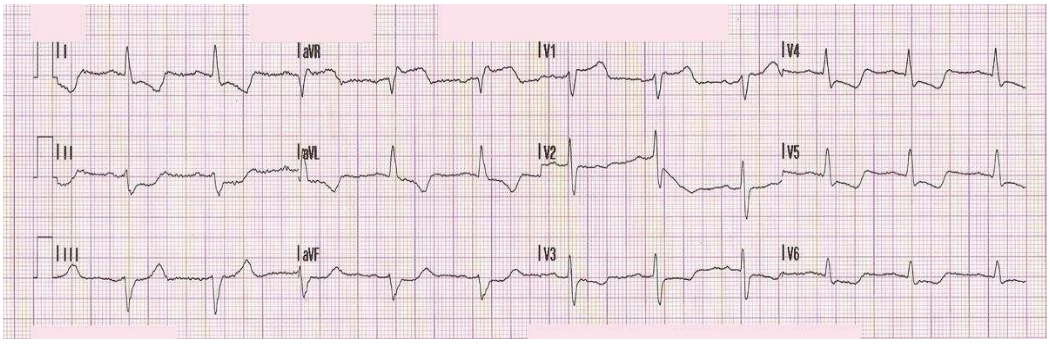
9. Exercise Angina: exercise-induced angina

   "Angina, or heart pain and discomfort, occurs when your heart isn't getting an adequate supply of oxygen-rich blood. It can feel like a pain, pressure or tightness in your chest, arms, shoulders or jaw. Angina is a symptom of an underlying heart condition that's triggered when you physically exert yourself to a point where your body can not supply enough oxygen-rich blood to your heart quick enough.

The exercise-induced angina is by encouraging your body to use a network of tiny blood vessels that supply your heart. Exercise can also reduce the risk of the angina getting worse, and of a heart attack or stroke”.

[Y: Yes, N: No]

10.Old peak: old peak = ST [Numeric value measured in depression]

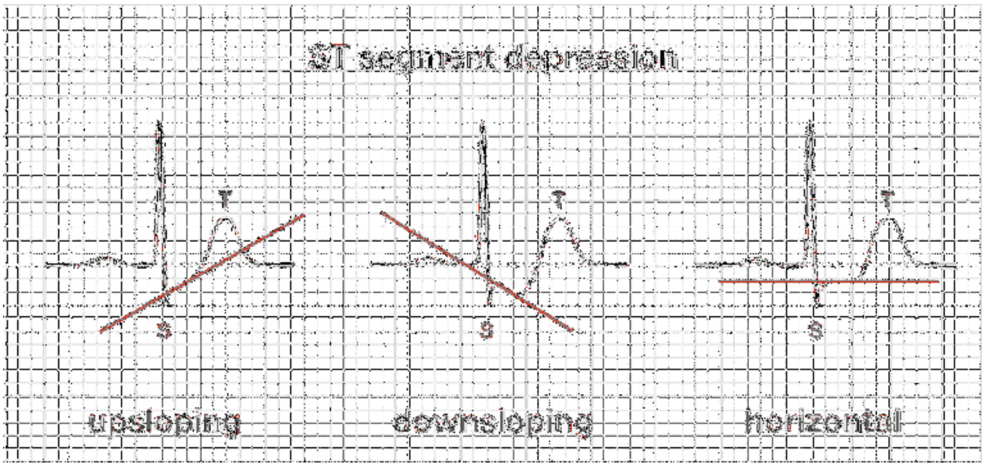


10. ST_Slope: the slope of the peak exercise ST segment [Up: upsloping

Figure 10: a small ST measured depression

Flat: flat or horizontal

Down: down sloping]



12.HeartDisease: output class [1: heart disease, 0: Normal] [2]

Figure 11: type of ST slopes

2.2.1 APPLICATION TYPE:

The input variable will help us do a classification of the last 101 patients of our data set and the output shall be

[1]: presence of a potential heart pathology

[0]: absence of potential heart pathology

After getting the data set and using python as the programming language we run the testing on all the data we have through these steps

First splitting the data into "training set" with 817 patients out of 918

```
dta = pd.read_csv("C:\\Users\\Med\\Desktop\\train.csv")
Y = dta.pop("HeartDisease")
dta
```

	Age	Sex	ChestPainType	RestingBP	Cholesterol	FastingBS	RestingECG	MaxHR	ExerciseAngina	Oldpeak	ST_Slope
0	40	M	ATA	140	289	0	Normal	172	N	0.0	Up
1	49	F	NAP	160	180	0	Normal	156	N	1.0	Flat
2	37	M	ATA	130	283	0	ST	98	N	0.0	Up
3	48	F	ASY	138	214	0	Normal	108	Y	1.5	Flat
4	54	M	NAP	150	195	0	Normal	122	N	0.0	Up
...	...	...	...	...	...	...	...	...	...	...	...
812	54	F	NAP	110	214	0	Normal	158	N	1.6	Flat
813	69	F	TA	140	239	0	Normal	151	N	1.8	Up
814	77	M	ASY	125	304	0	LVH	162	Y	0.0	Up
815	68	M	NAP	118	277	0	Normal	151	N	1.0	Up
816	58	M	ASY	125	300	0	LVH	171	N	0.0	Up

817 rows × 11 columns

total patients of our dataset and we read :

Figure 12:training set

The main idea of the training set was to put the dataset in binary input there for we binarized it :

```python
from sklearn.preprocessing import LabelBinarizer
binarizer = LabelBinarizer()
X_train = pd.get_dummies(dta)
X_train
```

	Age	RestingBP	Cholesterol	FastingBS	MaxHR	Oldpeak	Sex_F	Sex_M	ChestPainType_ASY	ChestPainType_ATA	ChestPainType_NAP	ChestPainType_
0	40	140	289	0	172	0.0	0	1	0	1	0	
1	49	160	180	0	156	1.0	1	0	0	0	1	
2	37	130	283	0	98	0.0	0	1	0	1	0	
3	48	138	214	0	108	1.5	1	0	1	0	0	
4	54	150	195	0	122	0.0	0	1	0	0	1	
...	...	...	...	...	...	...	...	...	...	...	...	
812	54	110	214	0	158	1.6	1	0	0	0	1	
813	69	140	239	0	151	1.8	1	0	0	0	0	
814	77	125	304	0	162	0.0	0	1	1	0	0	
815	68	118	277	0	151	1.0	0	1	0	0	1	
816	58	125	300	0	171	0.0	0	1	1	0	0	

817 rows × 20 columns

Figure 13:binarized training set

We began with decision tree with depth of 5

```
from sklearn.tree import DecisionTreeClassifier
dtree = DecisionTreeClassifier(random_state=0, max_depth=5)
```

```
dtree.fit(X_train,Y)
```

```
DecisionTreeClassifier(max_depth=5, random_state=0)
```

Figure 15: decision tree import

```
plt.figure(figsize=(25,10))

plot_tree(dtree)
plt.show()
```

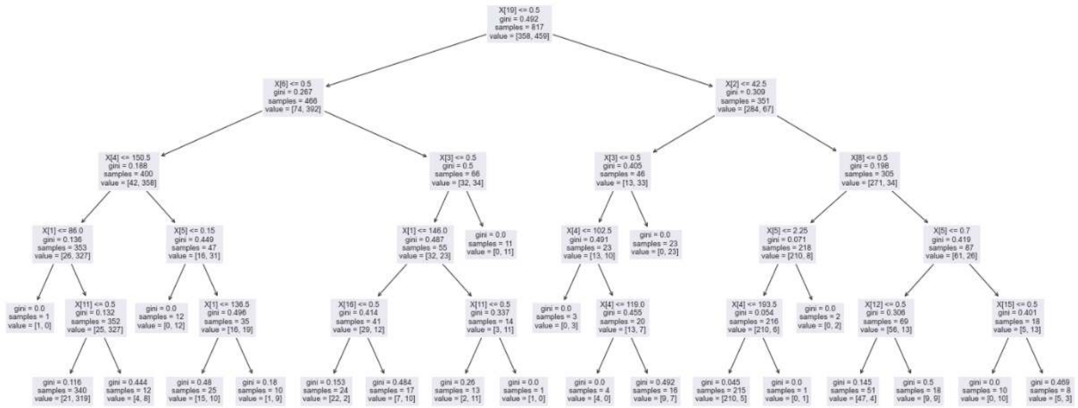


Figure 14:decision tree through python

We show the figure of our decision tree to see all the calculations and roots and leaves that helps determine the classification of the patient

```
from sklearn.tree import DecisionTreeClassifier
dtree = DecisionTreeClassifier(random_state=0, max_depth=5)
```

```
dtree.fit(X_train,Y)
```

```
DecisionTreeClassifier(max_depth=5, random_state=0)
```

```
XX=[60,125,258,0,141,2.8,0,1,1,0,0,0,1,0,0,0,1,0,1,0]
Classification=dtree.predict([XX])
```

```
Classification
```

```
array([1], dtype=int64)
```

Figure 16:classification

As we see here the decision tree came up with classification result as [1] which is the potential heart pathology case and this is the example of decision tree and how it works otherwise it shall display [0]

There for we shall begin the testing and observe how can Machine learning help us with classification and even prevent mortality cases through the data we give it.

The test went as follow:

We read the 101 data left of the patients:

```
dta_test = pd.read_csv("C:\\Users\\Med\\Desktop\\last100cases.csv")
Y_test = dta_test.pop("HeartDisease")
dta_test
```

```
X_test
```

	Age	RestingBP	Cholesterol	FastingBS	MaxHR	Oldpeak	Sex_F	Sex_M	ChestPainType_ASY	ChestPainType_ATA	ChestPainType_NAP	ChestPainType_T
0	60	125	258	0	141	2.8	0	1	1	0	0	
1	51	140	299	0	173	1.6	0	1	1	0	0	
2	55	160	289	0	145	0.8	0	1	1	0	0	
3	52	152	298	1	178	1.2	0	1	0	0	0	
4	60	102	318	0	160	0.0	1	0	0	0	1	
...	...	...	...	...	...	...	...	...	...	...	...	
96	45	110	264	0	132	1.2	0	1	0	0	0	
97	68	144	193	1	141	3.4	0	1	1	0	0	
98	57	130	131	0	115	1.2	0	1	1	0	0	
99	57	130	236	0	174	0.0	1	0	0	1	0	
100	38	138	175	0	173	0.0	0	1	0	0	1	

101 rows × 20 columns

ope
Flat
Up
Flat
Flat
Up
...
Flat
Flat
Flat
Flat
Up

100 38 M NAP 138 175 0 Normal 173 N 0.0 Up

101 rows × 11 columns

Figure 18:binarized testing set

Figure 17:testing set

We binarize it:

The we executed 3 main algorithms on this data set which are

I. RANDOM FOREST1:

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.datasets import make_classification

clf = RandomForestClassifier(n_estimators=100,max_depth=6, random_state=0)
clf.fit(X_test, Y_test)
RandomForestClassifier(...)
```

Figure 19:random forest import

With output result as follow:

```
#rf
rf=clf.predict(X_test)
print(rf)
```

```
[1 1 1 0 0 0 1 0 1 0 0 1 0 0 0 0 0 0 1 1 0 1 0 0 1 1 0 0 1 1 0 1 0 1 0 1 0
 0 1 0 0 1 0 1 1 0 1 1 1 0 1 0 0 0 0 1 1 0 0 1 1 0 1 0 0 0 0 1 0 0 1 1 1 0
 0 0 1 0 1 0 1 0 1 1 1 0 0 0 1 0 1 1 1 0 1 1 1 1 1 1 0]
```

Figure 20:random forest result

We can even demonstrate the probability of each patient by:

```python
#rf
rf=clf.predict_proba(X_test)
print(rf)
```

```
[[0.00071429 0.99928571]
 [0.14       0.86      ]
 [0.03888889 0.96111111]
 [0.88349071 0.11650929]
 [0.82978847 0.17021153]
 [0.78588889 0.21411111]
 [0.19392857 0.80607143]
 [0.845      0.155     ]
 [0.36899603 0.63100397]
 [0.73935897 0.26064103]
 [0.91275913 0.08724087]
 [0.02071429 0.97928571]
 [0.9534846  0.0465154 ]
 [0.92792539 0.07207461]
 [0.9328139  0.0671861 ]
 [0.86988889 0.13011111]
 [0.81857779 0.18142221]
 [0.97399875 0.02600125]
 [0.02071429 0.97928571]
 [0.05462918 0.94537082]
 [0.88975621 0.11024379]
 [0.0325     0.9675    ]
 [0.88423596 0.11576404]
 [0.84320604 0.15679396]
 [0.4363927  0.5636073 ]
 [0.04       0.96      ]
 [0.86370279 0.13629721]
 [0.86116276 0.13883724]
 [0.02       0.98      ]
 [0.17246795 0.82753205]
 [0.79301273 0.20698727]
 [0.11388889 0.88611111]
```

Figure 21:random forest probability

II. DECISION TREE1:

```
#decision tree
Tree=dtree.predict(X_test)
print(Tree)
```

```
[1 1 1 1 0 0 1 0 1 0 0 1 1 0 0 0 1 0 1 1 0 1 0 1 0 1 0 1 1 1 0 0 1 1 0 1 0
 0 1 0 0 0 0 1 0 0 1 1 1 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 1 0 0 1
 0 0 0 0 1 0 1 0 0 1 1 1 0 1 1 0 1 1 1 0 1 1 1 1 1 0 0]
```

Figure 22:decision tree result

We can even demonstrate the probability of each patient by:

```
#decision tree
Tree=dtree.predict_proba(X_test)
print(Tree)
```

```
[[0.06176471 0.93823529]
 [0.         1.        ]
 [0.06176471 0.93823529]
 [0.1        0.9       ]
 [0.97674419 0.02325581]
 [0.6        0.4       ]
 [0.06176471 0.93823529]
 [0.6        0.4       ]
 [0.1        0.9       ]
 [0.6        0.4       ]
 [0.91666667 0.08333333]
 [0.06176471 0.93823529]
 [0.         1.        ]
 [0.97674419 0.02325581]
 [0.97674419 0.02325581]
 [0.97674419 0.02325581]
 [0.06176471 0.93823529]
 [0.97674419 0.02325581]
 [0.06176471 0.93823529]
 [0.06176471 0.93823529]
 [0.97674419 0.02325581]
 [0.         1.        ]
 [0.625      0.375     ]
 [0.06176471 0.93823529]
 [0.91666667 0.08333333]
 [0.         1.        ]
 [0.97674419 0.02325581]
 [0.         1.        ]
 [0.41176471 0.58823529]
 [0.06176471 0.93823529]
 [0.5        0.5       ]
 [0.92156863 0.07843137]
```

Figure 23:decision tree probability

III. NEURAL NETWORK1:

For the neural network we used MLP (Multi-Layer Perceptron)

```
from sklearn.neural_network import MLPClassifier
from sklearn.datasets import make_classification
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(X_train, Y, stratify=Y,random_state=1)
```

And the result went as follow:

Figure 24:multi-layer perceptron import

```
#MLP
NN=clf_mlp.predict(X_test)
print(NN)
```

```
[1 0 1 0 0 1 1 0 0 0 0 1 0 0 0 0 0 0 1 1 1 1 0 0 1 1 0 0 1 0 0 0 1 1 0 1 0
 0 1 0 1 1 0 0 0 0 1 1 1 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 1 0 0 0
 1 0 0 0 1 0 1 0 0 1 1 0 0 0 1 0 0 1 0 0 1 1 0 1 1 0 0]
```

Figure 25:Neural Network

We can even demonstrate the probability of each patient by:

```
#MLP
NN=clf_mlp.predict_proba(X_test)
print(NN)
```

```
[[0.18146058 0.81853942]
 [0.7712103  0.2287897 ]
 [0.22058385 0.77941615]
 [0.706574   0.293426  ]
 [0.78488419 0.21511581]
 [0.44329264 0.55670736]
 [0.19495797 0.80504203]
 [0.91709507 0.08290493]
 [0.50211679 0.49788321]
 [0.55995404 0.44004596]
 [0.91261631 0.08738369]
 [0.19004831 0.80995169]
 [0.95596468 0.04403532]
 [0.92591812 0.07408188]
 [0.84567739 0.15432261]
 [0.7507292  0.2492708 ]
 [0.56410777 0.43589223]
 [0.96725983 0.03274017]
 [0.27362103 0.72637897]
 [0.11218893 0.88781107]
 [0.44424568 0.55575432]
 [0.15187552 0.84812448]
 [0.80029393 0.19970607]
 [0.82144172 0.17855828]
 [0.13309213 0.86690787]
 [0.16483652 0.83516348]
 [0.64450078 0.35549922]
 [0.59380001 0.40619999]
 [0.20800228 0.79199772]
 [0.71757832 0.28242168]
 [0.89043433 0.10956567]
 [0.82827168 0.17172832]
```

Figure 26:Neural network probability

2.3Confusion matrix1:

In the addition of the out coming results we shall use the confusion matrix which a matrix that has 4 important values depending on the original dataset results of “heart disease” to determine if our classification were true or false :

True negative: the output of absence potential heart pathology that it true.

True Positive: the output of presence of potential heart pathology that is true.

False Negative: the output of absence of potential heart pathology that is false.

False positive: the output of presence of potential heart pathology that is false.

We used the last digit of our data set “heart disease” to compare the original classification and ours:

```
Z = final.pop('HeartDisease')
```

```
Z
```

```
0      1
1      1
2      1
3      0
4      0
      ..
96     1
97     1
98     1
99     1
100    0
Name: HeartDisease, Length: 101, dtype: int64
```

Figure 27:"heart disease" import

```
#Random_forest_Results
list_TP=[]
list_TN=[]
list_FN=[]
list_FP=[]
for i in range (0,101):
    if Z [i]==1 and Z[i]==rf[i]:
        list_TP.append(i)
    elif Z[i]==0 and Z[i]==rf[i]:
        list_TN.append(i)
    elif Z[i]==1 and rf[i]==0:
        list_FN.append(i)
    else:
        list_FP.append(i)
```

Figure 30:comparing random forest and "heart disease"

```
ion_Tree_results
P=[]
N=[]
N=[]
P=[]
in range (0,101):
 Z [i]==1 and Z[i]==Tree[i]:
  list_TP.append(i)
if Z[i]==0 and Z[i]==Tree[i]:
  list_TN.append(i)
if Z[i]==1 and Tree[i]==0:
  list_FN.append(i)
se:
  list_FP.append(i)
```

Figure 29:comparing decision tree and "heart disease"

```
#MLP_results
list_TP=[]
list_TN=[]
list_FN=[]
list_FP=[]
for i in range (0,101):
    if Z [i]==1 and Z[i]==NN[i]:
        list_TP.append(i)
    elif Z[i]==0 and Z[i]==NN[i]:
        list_TN.append(i)
    elif Z[i]==1 and NN[i]==0:
        list_FN.append(i)
    else:
        list_FP.append(i)
```

Figure 28:comparing neural network and "heart disease"

	Random forest1	**Decision tree1**	**Neural network1**
True negative	49	41	46
True positive	52	36	31
False negative	00	13	18
False positive	00	11	6
Accuracy	100%	76.23%	76.23%
Sensitivity	100%	73.46%	63.26%
Specificity	100%	78.84%	88.46%

Table 1: results of model 1

Accuracy: $\frac{true\ positive+true\ negative}{true\ postive+true\ negative+false\ postive+false\ negative}$×100=xx%

Accuracy helps us conclude how the classification was correct or false

Sensitivity:$\frac{true\ positive}{true\ positive+false\ negative}$×100:xx%

And sensitivity means of all the people with a positive output(either it's true or false)what proportion of those are True Positive or have the presence of potential heart pathology

Specificity:$\frac{true\ negative}{true\ negative+false\ positive}$ ×100:xx%

And Specificity means all the people with negative output (either it's true or false) what proportion of those are True negative or have the absence of potential heart pathology

Conclusion:

Cardiovascular disease is the leading cause of mortality in the world it leads to a spectrum of complications that can complicate patient management. The emergence of artificial intelligence has garnered significant interest in many industries, and the field of cardiovascular imaging is no exception. Machine learning especially is showing significant promise in various diagnostic imaging modalities. As conventional statistics are reaching their apex in computational capabilities, this will have a positive impact on diagnosis and prognosis for cardiovascular pathology classification

2.4 Creation of a machine learning model-2-:

[1]mobile application there for the patient can put every accessible data they have on themselves such as age, sex, blood pressure, sugar level, pain type etc. as it is impossible to get ECG information in our daily life.

And the algorithm shall work as follow

```
dta = pd.read_csv("C:\\Users\\Med\\Desktop\\train2.csv")
Y = dta.pop("HeartDisease")
dta
```

	Age	Sex	ChestPainType	RestingBP	MaxHR	ExerciseAngina
0	40	M	ATA	140	172	N
1	49	F	NAP	160	156	N
2	37	M	ATA	130	98	N
3	48	F	ASY	138	108	Y
4	54	M	NAP	150	122	N
...	...	...	...	...	...	...
812	54	F	NAP	110	158	N
813	69	F	TA	140	151	N
814	77	M	ASY	125	162	Y
815	68	M	NAP	118	151	N
816	58	M	ASY	125	171	N

817 rows × 6 columns

Figure 31:training set 2

We binarize it:

```
from sklearn.preprocessing import LabelBinarizer
binarizer = LabelBinarizer()
X_train = pd.get_dummies(dta)
X_train
```

	Age	RestingBP	MaxHR	Sex_F	Sex_M	ChestPainType_ASY	ChestPainType_ATA	ChestPainType_NAP	ChestPainType_TA	ExerciseAngina_N	Ex
0	40	140	172	0	1	0	1	0	0	1	
1	49	160	156	1	0	0	0	1	0	1	
2	37	130	98	0	1	0	1	0	0	1	
3	48	138	108	1	0	1	0	0	0	0	
4	54	150	122	0	1	0	0	1	0	1	
...	...	...	...	...	...	...	...	...	...	...	
812	54	110	158	1	0	0	0	1	0	1	
813	69	140	151	1	0	0	0	0	1	1	
814	77	125	162	0	1	1	0	0	0	0	
815	68	118	151	0	1	0	0	1	0	1	
816	58	125	171	0	1	1	0	0	0	1	

Figure 32:binarized training set2

We apply the following algorithms to our training set :

```
mor_test = pd.read_csv("C:\\Users\\Med\\Desktop\\last100casesapp.csv")
rom_test = mor_test.pop("HeartDisease")
mor_test
```

	Age	Sex	ChestPainType	RestingBP	MaxHR	ExerciseAngina
0	60	M	ASY	125	141	Y
1	51	M	ASY	140	173	Y
2	55	M	ASY	160	145	Y
3	52	M	TA	152	178	N
4	60	F	NAP	102	160	N
...	...	...	...	...	...	...
96	45	M	TA	110	132	N
97	68	M	ASY	144	141	N
98	57	M	ASY	130	115	Y
99	57	F	ATA	130	174	N
100	38	M	NAP	138	173	N

101 rows × 6 columns

Figure 33:testing set 2

We binarize it:

```
X_test
```

	Age	RestingBP	MaxHR	Sex_F	Sex_M	ChestPainType_ASY	ChestPainType_ATA	ChestPainType_NAP	ChestPainType_TA	ExerciseAngina_N	ExerciseAng
0	60	125	141	0	1	1	0	0	0	0	
1	51	140	173	0	1	1	0	0	0	0	
2	55	160	145	0	1	1	0	0	0	0	
3	52	152	178	0	1	0	0	0	1	1	
4	60	102	160	1	0	0	0	1	0	1	
...	...	...	...	...	...	...	...	...	...	...	
96	45	110	132	0	1	0	0	0	1	1	
97	68	144	141	0	1	1	0	0	0	1	
98	57	130	115	0	1	1	0	0	0	0	
99	57	130	174	1	0	0	1	0	0	1	
100	38	138	173	0	1	0	0	1	0	1	

101 rows × 11 columns

Figure 34:binarized testing set 2

After that we apply the algorithms as follows:

2.4.1 DECISION TREE2:

```
from sklearn.tree import DecisionTreeClassifier
dtree = DecisionTreeClassifier(random_state=0, max_depth=5)
```

```
dtree.fit(X_train,Y)
```

```
DecisionTreeClassifier(max_depth=5, random_state=0)
```

Figure 35:decision tree import

With the result

```
#decision tree
Tree=dtree.predict(X_test)
print(Tree)
```

```
[1 0 1 1 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 1 0 1 0 0 0 0 0 1 1 0 1 1 0 0 0 1 0
 0 1 0 0 0 0 1 1 0 0 1 1 0 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 1 1 0 0
 0 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 1 1 1 0 1 1 1 1 1 0 0]
```

Figure 36:out-put result of classification

and probability

```
#decision tree
Tree=dtree.predict_proba(X_test)
print(Tree)
```

```
[[0.07024793 0.92975207]
 [1.         0.        ]
 [0.07024793 0.92975207]
 [0.4        0.6       ]
 [0.88888889 0.11111111]
 [1.         0.        ]
 [0.11111111 0.88888889]
 [0.91282051 0.08717949]
 [0.58333333 0.41666667]
 [0.91282051 0.08717949]
 [0.91282051 0.08717949]
 [0.07024793 0.92975207]
 [0.91282051 0.08717949]
 [0.91282051 0.08717949]
 [0.88888889 0.11111111]
 [1.         0.        ]
 [0.91282051 0.08717949]
 [0.91282051 0.08717949]
 [0.07024793 0.92975207]
 [0.1884058  0.8115942 ]
 [0.58333333 0.41666667]
 [0.07024793 0.92975207]
 [0.51428571 0.48571429]
 [0.91282051 0.08717949]
 [0.88888889 0.11111111]
 [0.8        0.2       ]
 [0.5        0.5       ]
 [0.4        0.6       ]
 [0.29411765 0.70588235]
 [0.76       0.24      ]
 [0.24324324 0.75675676]
 [0.07024793 0.92975207]
```

Figure 37:decision tree probability

2.4.2 RANDOM FOREST2:

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.datasets import make_classification

clf = RandomForestClassifier(n_estimators=100,max_depth=6, random_state=0)
clf.fit(X_train, Y)
#RandomForestClassifier(...)
```

```
RandomForestClassifier(max_depth=6, random_state=0)
```

Figure 38:random forest import

with the result:

```
#rf
rf=clf.predict(X_test)
print(rf)
```

```
[1 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 1 1 0 1 0 0 0 1 0 0 1 1 1 1 0 1 0 1 0
 0 1 0 0 0 0 1 1 0 0 1 1 0 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 1 1 0 0
 0 0 0 0 1 0 1 0 1 1 1 0 0 0 0 0 1 1 1 0 1 1 0 1 1 0 0]
```

Figure 39:random forest results

And probability:

```
#rf
rf=clf.predict_proba(X_test)
print(rf)
```

```
[[0.09618045 0.90381955]
 [0.51689414 0.48310586]
 [0.08902741 0.91097259]
 [0.60600343 0.39399657]
 [0.78740406 0.21259594]
 [0.58180405 0.41819595]
 [0.17698581 0.82301419]
 [0.88757181 0.11242819]
 [0.58423105 0.41576895]
 [0.73992418 0.26007582]
 [0.95438947 0.04561053]
 [0.09090582 0.90909418]
 [0.80225318 0.19774682]
 [0.98508148 0.01491852]
 [0.87011652 0.12988348]
 [0.64830093 0.35169907]
 [0.70553142 0.29446858]
 [0.93996993 0.06003007]
 [0.09324911 0.90675089]
 [0.32190357 0.67809643]
 [0.61104307 0.38895693]
 [0.07279894 0.92720106]
 [0.75256144 0.24743856]
 [0.93365183 0.06634817]
 [0.8721003  0.1278997 ]
 [0.45658012 0.54341988]
 [0.77593719 0.22406281]
 [0.63232706 0.36767294]
 [0.19164715 0.80835285]
 [0.48885735 0.51114265]
 [0.48253154 0.51746846]
```

Figure 40:random forest probability

2.4.3 NEURAL NETWORK2:

```
from sklearn.neural_network import MLPClassifier
from sklearn.datasets import make_classification
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(X_train, Y, stratify=Y,random_state=1)
```

Figure 41:multi-layer perceptron import

With the result:

```
#MLP
NN=clf_mlp.predict(X_test)
print(NN)
```

```
[1 1 1 0 0 0 1 0 1 0 0 1 0 0 0 0 0 0 1 1 0 1 0 1 1 1 0 0 1 1 0 1 0 1 0 1 1
 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 1 0 1 1 0 1 0 1 0 0 0 1 0 0 1 1 1 0 1 1 0 1
 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 1 1 0 0 1 1 0 1 1 0 0]
```

Figure 42:neural network results

And probability:

```
#MLP
NN=clf_mlp.predict_proba(X_test)
print(NN)
```

```
[[0.41956481 0.58043519]
 [0.43728047 0.56271953]
 [0.13226391 0.86773609]
 [0.5674017  0.4325983 ]
 [0.9105661  0.0894339 ]
 [0.72027426 0.27972574]
 [0.40676543 0.59323457]
 [0.73263827 0.26736173]
 [0.29139631 0.70860369]
 [0.73314222 0.26685778]
 [0.79546072 0.20453928]
 [0.30225952 0.69774048]
 [0.82390714 0.17609286]
 [0.81529885 0.18470115]
 [0.84010086 0.15989914]
 [0.74385379 0.25614621]
 [0.67310527 0.32689473]
 [0.80946001 0.19053999]
 [0.41555018 0.58444982]
 [0.41449351 0.58550649]
 [0.59151362 0.40848638]
 [0.32502555 0.67497445]
 [0.69171646 0.30828354]
 [0.37578121 0.62421879]
 [0.27246906 0.72753094]
 [0.30391466 0.69608534]
 [0.63428857 0.36571143]
 [0.88320186 0.11679814]
 [0.37819691 0.62180309]
 [0.49216008 0.50783992]
 [0.84804024 0.15195976]
```

Figure 43:neural network probabilities

2.5Confusion matrix 2:

	Random forest2	**Decision tree2**	**Neural Network2**
True negative	49	48	43
True positive	36	32	34
False negative	13	17	15
False positive	3	4	9
Accuracy	84.15%	79.20%	76.23%
Sensitivity	73.46%	65.30%	69.38%
Specificity	94.23%	92.30%	82.69%

Table 2: results for model 2

Conclusion:

Random forest algorithm is the best out-coming results between the other algorithms used in our machine learning model for it in the first model giving an accuracy of 100% and in the model2 it showed an accuracy of 84.15%.

Machine learning is the next future step for health care industry for it to continually and gradually learn automatically from all the input data that has been giving, thus it will save us time and we can always access future dataset and manipulate it for future medical projects

CHAPTER III: TELEHEALTH

CHAPITRE 3

What is telehealth ?:

Telehealth is a practice of medicine where health-related services, care, and information are provided via telecommunication technologies and unlike telemedicine which serves with a very limited spectrum such as providing clinical services only.

3.1 The usage of telehealth:

Telehealth let the health provider (doctor, nurse, etc.…) offer their services without personal presences for medical care .

It is possible through any electronical device wither it's a smart tablet computer with various options it can be done on a call either voice call of video call, exchanging information by using secure messaging, email, secure messaging, and secure file exchange or remote monitoring which allows the health provider to observe and care for the patient by an organized observation done with specifically for the patient, health monitoring devices include continuous glucose monitors that remind diabetes patients to take their insulin, while allowing their physician to monitor the disease, digital blood pressure monitors that enable patients to remotely send physicians their blood pressure and blood oxygen levels.

the health care provider may also ask the patient to send information that will help improve their health:

- the weight, blood pressure, blood sugar, or vital information
- Images of a wound, or eye or skin condition
- A diary or document of your symptoms
- Medical records that may be filed with another provider, such as X-rays

Health care providers can send the patient information to manage their health at home:

- Notifications or reminders to do rehabilitation exercises or take medication
- New suggestions for improving diet, mobility, or stress management
- Detailed instructions on how to continue your care at home
- Encouragement to stick with your treatment plan

3.2Benefit usage of Telehealth:

Throughout the past decade we observe an enormous evolution in health care and in telecommunication technologies better phones better coverage but systems and better faster reach then ever and that can benefit the Telehealth domain giving the last circumstances that happen with corona virus there for there is benefit with Telehealth

Limited physical contact reduces everyone’s exposure to COVID-19

Virtual visits ensure you get health care wherever you are located – at home, at work or even in your car

Virtual visits cut down on travel, time off from work, and the need for child care

Virtual health care tools can shorten the wait for an appointment

increased access to specialists who are located far away from your hometown

3.3The potential of using Telehealth :

We know that the web development is the process of building web sites and applications and it relies a lot on coding and programming skills more than anything to power its functionality that relies on various layers known as front-end and back-end. Front-end it refers to everything that the user experience directly things like layouts, fonts, colors, menus.so it's also known as the client side and some of the front-end languages can be "CSS & HTML". and the back-end is where the user doesn't see or interact with its responsible for storing and organizing data and ensuring everything on the front end is running smoothly.

In all the communication between health care provider and the patient through what ever platform they use that has to be an application to treat all the information if we use a certain plat form to aide this commination an infrastructure must be built which with hold patient category services such as in-putting al the personal health data that is related to the person.

And health provider services such as their location their contact information their availability

In order to have smooth functioning application we can use these frame works and programs to do so, thus we shall use: **Django** as back-end framework Django is a high-level Python web framework that encourages rapid development and clean, pragmatic design. Built by experienced developers, it takes care of much of the hassle of web development,Companies like Facebook are shifting their backend from PHP to Django and even Instagram uses Django as its back-end framework. Making it the most popular back-end frame work there is to date.

Following it with another popular front-end framework we have **React** is an open-source JavaScript library used for front-end development, and for general website/app creation we need the 4 most important part database back-end REST API and front-end

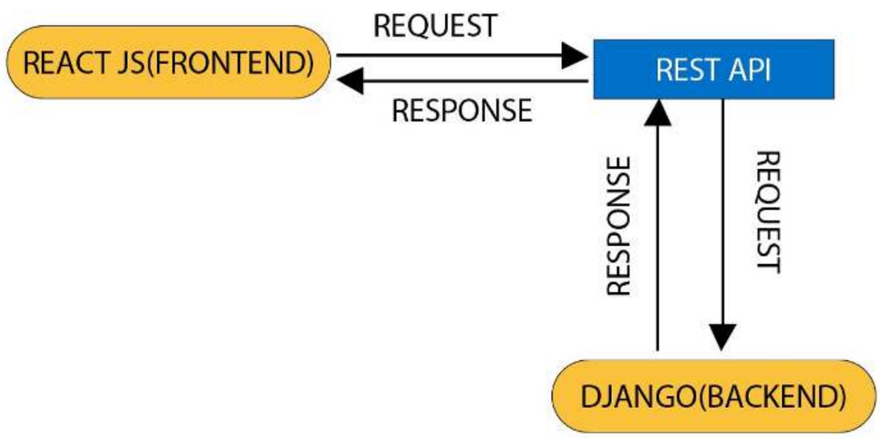


Figure 44:communication between ends

The goal of the application is to give the user quick diagnosis and display local navigation system to determine presence or absence of potential heart disease and local cardiologists that shall give the best outcome service as possible.

In previous chapter we used python to determine a machine learning model that helped give classification of heart condition of 101 patient all at once and for future references it can also be used on individuals that needs it using “Random Forest” as it showed the best out coming results there is with 100% accuracy in the first model that can be used in ambulance hospitals and clinics for it needs ECG information

And the model 2 with 84.15% accuracy and it can be used on mobile phones for it needs general accessible information by people such as age, sex, blood pressure, fasting sugar level, maximum heart rate, type of pain.

The client shall put all the personal information while the mobile app does its work and helping out the community and doctors for better future healthier generations.

Conclusion:

Telehealth is not a perfect fit for everyone or every medical condition. Make sure you discuss any disadvantages or risks with your health care provider.Telehealth has signification potential to address a variety of healthcare problems especially in underserved areas. Has significant potential to address a range of healthcare problems and it has the need for higher speed and higher capacity telecommunications Government, professional groups in healthcare, and telecommunications industry need to work together for rising of higher better community.

GENERAL CONCLUSION

The burgeoning of telemedicine and AI are expanding the boundaries of echocardiography and cardiology. AI and telemedicine are establishing new bridges between patient and physician and helping underserved population to overcome previous barriers with their health care providers. AI is the truss support for these bridges. AI is the primary means and will be interconnected with the growth of these novel healthcare technologies for years to come. As telemedicine create big data even in resource-limited areas where the number of experts is not sufficient and big data from these technologies are getting more and more complex, AI will assist cardiologists to provide more focused and personalized decision for the patients.

REFERENCES

[1] N. K. ,. P. P. S. Karthik Seetharam, «Application of mobile health, telemedicine and artificial intelligence to echocardiography,» 1 june 2019. [En ligne]. Available: https://pubmed.ncbi.nlm.nih.gov/30844756/#affiliation-1.

[2] «The IBM 700 Series,» [En ligne]. Available: https://www.ibm.com/ibm/history/ibm100/us/en/icons/ibm700series/impacts/.

[3] I. Journal, 12 december 2019. [En ligne]. Available: https://www.academia.edu/41566431/IRJET_Machine_Learning_Classification_Algorithms_for_Predictive_Analysis_in_Healthcare.

[4] «Diagnose breast cancer from histopathological images using Artificial Intelligence,» [En ligne]. Available: https://www.neuraldesigner.com/learning/examples/breast-cancer-diagnosis.

[5] «Early detection of lung carcinoma using artificial intelligence,» [En ligne]. Available: https://www.neuraldesigner.com/learning/examples/lung-cancer.

[6] «Model obesity levels using machine learning,» [En ligne]. Available: https://www.neuraldesigner.com/learning/examples/obesity-level.

[7] «Diagnose liver diseases from different types of analysis using machine learning,» [En ligne]. Available: https://www.neuraldesigner.com/learning/examples/diagnose-hcv.

]

[8] «Diagnose dermatological diseases using neural networks,» [En ligne]. Available: https://www.neuraldesigner.com/learning/examples/examples-dermatology.

[9] michael, 22 september 2022. [En ligne]. Available: https://empoweryourlifestyles.com/what-is-typical-angina/#Angina_Definition.

[10] S. U. o. N. Y. B. 1. Department of Internal Medicine. [En ligne]. Available: https://pubmed.ncbi.nlm.nih.gov/2255129/#affiliation-1.

[11] FEDESORIANO, «kaggle,» 10 september 2021. [En ligne]. Available: https://www.kaggle.com/datasets/fedesoriano/heart-failure-prediction?resource=download.

[12] M. W. V. U. West Virginia University Heart and Vascular Institute, «Application of mobile health, telemedicine and artificial intelligence to echocardiography,» 20 febuary 2019. [En ligne]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6432977/#:~:text=The%20massive%20data%20influx%20from%20telemedicine%20and%20mHealth,maze%20of%20the%20data%20influx%20through%20various%20approaches..

[13] N. K. ,. P. P. S. Karthik Seetharam, 1 june 2019. [En ligne]. Available: https://pubmed.ncbi.nlm.nih.gov/30844756/#affiliation-1.