**VISUALIZING AND PREDICTING**

**HEART DISEASES WITH AN**

**INTERACTIVE DASHBOARD**

**NALAIYA THIRAN PROJECT BASED LEARNING**

**on**

**PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP**

**A PROJECT REPORT**

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**Abstract**

Healthcare industries generate enormous amount of data, so called big data that accommodates hidden knowledge or pattern for decision making. The huge volume of data is used to make decision which is more accurate than intuition. Exploratory Data Analysis (EDA) detects mistakes, finds appropriate data, checks assumptions and determines the correlation among the explanatory variables. In the context, EDA is considered as analysing data that excludes inferences and statistical modelling. Analytics is an essential technique for any profession as it forecast the future and hidden pattern. Data analytics is considered as a cost effective technology in the recent past and it plays an essential role in healthcare which includes new research findings, emergency situations and outbreaks of disease. The use of analytics in healthcare improves care by facilitating preventive care and EDA is a vital step while analysing data. In this paper, the risk factors that causes heart disease is considered and predicted using K-means algorithm and the analysis is carried out using a publicly available data for heart disease.

**CHAPTER 1**

**INTRODUCTION**

Heart disease defines a range of conditions that affect the human heart. The name "heart disease" is often used commonly with the name"cardiovascular disease". Heart disease is a term that allow to a many medical circumstances related to the heart. These medical circumstances characterize the irregular health condition that directly affects the heart and all its parts. Heart disease generally allows to some conditions that involve narrowed or blocked blood vessels which can lead to a heart attack, stroke or chest pain. Other heart conditions, such as those that affect your heart's muscles, valves or rhythm, are also considered forms of heart disease.There are various types of cardiovascular disease. The most similar types are heart failure (HF) and Coronary Artery Disease (CAD). The main root cause of heart failure (HF) occurs due to the blockade or narrowing down of coronary arteries. Coronary arteries also supply blood to the heart. Data mining is a non-trivial extraction of implicit, previously unknown potential useful information called as knowledge from the medical data using complex algorithms. Big data (BD) can be referred as huge record of information set. Big Data and Data Mining are two various things. The tasks carried out by these two methods are similar focusing on collecting the huge amount of data, handling it and preparing a report on the data by taking out the information which is knowledgeable. Data Mining is an activity of observing the patterns in the data which is relevant and with particular information by using Big Data. The useful patterns with hidden patterns, unknown correlations are analytically handled for making knowledgeable decisions through this Big Data analytics process.

**CHAPTER 2**

**OBJECTIVE**

1. To analysis the dataset and predict the presence or absence of heart diseases.
2. Gain a broad understanding of plotting different visualizations to predict the heart disease.
3. Able to create meaningful Visualizations and Dashboard.

**Project Objectives:**

1. Age: displays the age of the individual.
2. Sex: displays the gender of the individual using the following format :
   1. = male

0 = female

1. Chest-pain type: displays the type of chest-pain experienced by the individual using the following format :
   1. = typical angina 2 = atypical angina 3 = non — anginal pain

4 = asymptotic

1. Resting Blood Pressure: displays the resting blood pressure value of an individual in mmHg (unit)
2. Serum Cholestrol: displays the serum cholesterol in mg/dl (unit)
3. Fasting Blood Sugar: compares the fasting blood sugar value of an individual with 120mg/dl.

If fasting blood sugar > 120mg/dl then : 1 (true) else : 0 (false)

1. Resting ECG : displays resting electrocardiographic results
   1. = normal
   2. = having ST-T wave abnormality
   3. = left ventricular hyperthrophy
2. Max heart rate achieved : displays the max heart rate achieved by an individual.
3. Exercise induced angina :
   1. = yes

0 = no

1. ST depression induced by exercise relative to rest: displays the value which is an integer or float.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 11. Peak | exercise |  | ST | segment : |
| 1 |  | = |  | upsloping |

* 1. = flat
  2. = downsloping

1. Number of major vessels (0–3) colored by flourosopy : displays the value as integer or float.
2. Thal : displays the thalassemia :

3 = normal

* 1. = fixed defect
  2. = reversible defect

1. Diagnosis of heart disease : Displays whether the individual is suffering from heart disease or not :

0 = absence

1, 2, 3, 4 = present.

Data Analysis

Let us look at the people’s age who are suffering from the disease or not. Here, target = 1 implies that the person is suffering from heart disease and target = 0 implies the person is not suffering.

We see that most people who are suffering are of the age of 58, followed by 57.

Majorly, people belonging to the age group 50+ are suffering from the disease.

Next, let us look at the distribution of age and gender for each target class.

We see that for females who are suffering from the disease are older than males.

Data Pre-Processing

The dataset contains 14 columns and 303 rows.

Let us check the null values

null values in each column of the data

We see that there are only 6 cells with null values with 4 belonging to attribute ca and 2 to thal.

As the null values are very less we can either drop them or impute them. I have imputed the mean in place of the null values however one can also delete these rows entirely.

Now let us divide the data in the test and train set.

In this project, I have divided the data into an 80: 20 ratio. That is, the training size is 80% and the testing size is 20% of the whole data.

**DATA VISUALIZATION**

Average Age For Different Types Of Chest Pain In Existing Heart Diseases

What could cause chest pain?

Although chest pain can sometimes be a symptom of a heart problem, there are many other possible causes. While some of these are serious conditions, most are not harmful.

Chest pain is the second biggest cause of emergency room (ER) visits in the United States, leading to over 8 millionTrusted Source ER visits every year. Worldwide, chest pain affects 20–40% of the general population.

Various heart problems can cause pain in the chest.

1. Heart attack

Chest pain is one of the fiveTrusted Source main symptoms of a heart attack. The others are:

1. pain in the jaw, neck or back
2. light headedness or weakness
3. pain in the arms or shoulders
4. shortness of breath

Females particularly may also experience sudden tiredness, nausea, or vomiting.

If someone thinks they are having a heart attack, they should seek emergency medical help. The quicker a person can get to ER, the quicker treatment can begin.

Getting prompt treatment increases a person’s chances of survival and potentially reduces the severity of the damage to the heart.

How do you recognize the signs of a heart attack?

2. Myocarditis

Myocarditis is when the heart becomes inflamed, resulting in symptoms that are similar to a heart attack, such as:

1. chest pain
2. shortness of breath
3. fast or irregular heartbeat

Myocarditis usually results from a viral infection, according to the Centers for Disease Control and Prevention (CDC)Trusted Source.

What is an inflamed heart?

3. Angina

Angina feels like a squeezing pain or pressure on the chest.

It occursTrusted Source when not enough blood is getting to the heart. A person may also feel pain in the:

1. shoulder
2. back
3. neck
4. arms
5. jaw

Angina can feel like indigestion.

It is a symptom of coronary artery disease.

4. Aortic aneurism and dissection

Aortic dissection is a tear or separation of the inner layers of the aorta, the main artery that leads from the heart. This can lead to a buildup of blood in the artery.

An aortic aneurysm refers to an enlargement in the aorta.

Both conditionsTrusted Source can cause the aorta to rupture or burst.

Aortic dissection and a severe aortic aneurysm are emergencies and require immediate medical help.

A stable aortic aneurysm may not need emergency treatment.

5. Coronary artery dissection

Coronary artery dissection is when tearing occurs in the coronary artery wall. If the innermost layer tears, blood can seep through and build up, causing a bulge. It can lead to a heart attack.

Sudden intense pain that appears to “tear” across the chest, neck, back, or abdomen can be a symptom of coronary artery dissection.

This is a rare but serious condition. The American Heart Association (AHA)Trusted Source notes that experts do not know exactly why it happens, but it can affect people without the usual risk factors for heart disease.

6. Pericarditis

Pericarditis is inflammation of the sac around the heart.

It can resultTrusted Source in:

1. severe chest pain behind the breast bone
2. a buildup of fluid around the heart
3. cardiac tamponade, when fluid presses on the heart
4. obstructive shock, when the heart cannot fillTrusted Source with blood effectively.

Pain may be worse when a person breathes in or is lying down but improves when they sit up or lean forward.

It usually results from a viral infection, but there are many other possible causes.

7. Mitral valve prolapse

A mitral valve prolapse is when a valve in the heart is unable to close fully. In mild cases, this condition may have no obvious symptoms.

If symptoms occur, they includeTrusted Source:

1. rapid heartbeat
2. chest discomfort
3. fatigue

Average Age For Different Chest Pain Types

Different Kinds of Chest Pain and What Causes It:

Having a sudden chest pain is terrifying to most people. If you ask many people what they associate with the words chest pain, chances are their thoughts will jump directly to heart attacks. While chest pain can be caused by a heart attack, there are also other possibilities, many unrelated to your heart altogether.

Don't Ignore It!

Chest pain is not something to ignore, and you should always seek out the advice of a physician to rule out any cardiac or life-threatening causes for the pain. Problems in your lungs, muscles, ribs, gastrointestinal tract, or nerves can also cause chest pain. Some of these are life threatening, and some are simply uncomfortable but benign. The different causes of chest pain present with different symptoms.

Types of Pain:

Your pain can be sharp, dull, burning, stabbing, tight, or aching depending on the cause. When speaking to your physician, it is imperative that you try to describe your pain to help them diagnose the cause. Let’s explore some different types of chest pain and the part of the body involved. We will discuss the symptoms, causes, treatment and prevention for each category. As always, this is meant to serve as a guide, and is not a substitute for seeking professional medical advice.

Heart

Coronary Artery Diseases (CAD)

Coronary artery disease is caused by damaged or diseased blood vessels that supply the heart with blood and oxygen. Deposits of cholesterol, or plaque in your arteries, is usually the main cause of coronary artery disease. When the artery becomes either mostly or completely blocked by plaque or cholesterol, it deprives the heart muscle of oxygen, this results in a heart attack.

The chest pain you feel with CAD compares to someone sitting on your chest. Your chest feels tight and like it’s under pressure. The pain may wax and wane, and may be exacerbated by exercise. Due to the blockages in your arteries, you may feel short of breath as your heart can’t receive and pump enough oxygen to keep your lungs working properly. Along with the shortness of breath, you may also feel extremely fatigued and tired. If you suspect a heart attack or have a family history of heart disease, call 911 or get to your doctor as soon as possible if you suffer any of the above symptoms.

The best way to prevent CAD is to eat a healthy diet and exercise regularly, and absolutely DO NOT SMOKE tobacco products. Knowing your family health history is also critical because some families are genetically prone to heart disease. If you have a family member that had a heart attack, high cholesterol, or other heart problems at a young age you may also be pre-disposed to those conditions.

Talk to your doctor about your risks and ask if there are any tests or blood work that you need to ensure you do not have CAD.

If CAD is caught in the early stages your doctor will prescribe medications to lower your cholesterol. They will also start you on an exercise program. This will lower your cholesterol and blood pressure if that also happens to be an issue.

**BP Variation With Respect To Age**

Blood pressure variability has been considered a physiological marker of autonomic nervous system control, with short- and long-term fluctuations from intricate interactions among behavioral, environmental, neural central or reflex influences, along with other potential contributing factors.

Current indexes of blood pressure variability raise methodological issues related to their poor reproducibility, their interdependence, and their association with the level of blood pressure. Besides methodological problems, the progn ostic significance of blood pressure variability remains controversial. Some studies reported association of end-organ damage (Parati et al., 1987a; Tatasciore et al., 2007; Matsui et al., 2011), cardiovascular events (Kikuya et al., 2000; Rothwell et al., 2010a,b; Rothwell, 2010; Webb et al., 2010; Johansson et al., 2012; Shimbo et al., 2012), or mortality (Muntner et al., 2011) with blood pressure variability, whereas others failed to find any association or found variability to be inferior to the level of blood pressure (Pierdomenico et al., 2006; Hansen et al., 2010; Schutte et al., 2012). This review addressed to what extent blood pressure.

Increased BP variability causes target organ damage, e.g., endothelial dysfunction, vascular and cardiac hypertrophy, disease and cerebral . and different BP variabilities, both occurring in ASCOT, are obviously difficult to dissociate, even with complex statistical adjustments, a lower BP variability may be an additional property of CCBs contributing to their established effectiveness in preventing CV outcomes. Analyses of individual data from trials comparing CCBs with placebo and other agents are desirable.

Central command continuously modulates the baroreflex- and chemoreflexmediated cardiovascular and autonomic functions.33,34 This modulation is important for BP variability during sleep and daytime activities. Several cortical and subcortical brain sites have direct neural projections to the autonomic centers located in the brainstem and modulate their functions.

**Dashboard Showing Different Types Of Visuals**

Normal Blood Pressure

People with a blood pressure range of 90 to 120 systolic and 60 to 80 diastolic have normal blood pressure, says Dr. Wong. A systolic reading below 90 signifies low blood pressure.

Elevated Blood Pressure

A blood pressure reading of 120 to 129 systolic and less than 80 diastolic signifies elevated blood pressure and, thus, a higher probability of developing hypertension.

“As blood pressure elevates, there is increased workload on the heart and arteries,” says Dr. Desai. “This results in [the] thickening of the heart muscle (hypertrophy), which can lead to heart failure. It also results in [the] micro-tearing of the artery wall, leading to cholesterol deposition (atherosclerosis). This leads to [the] narrowing of the vessel and further elevation of blood pressure.”

Hypertension Stage I

Hypertension Stage I is defined by a systolic reading of 130 to 139 and a diastolic reading of 80 to 89.

Dr. Wong says while doctors initially treat this stage of hypertension by suggesting a healthier lifestyle—eating more vegetables and whole grains, using less salt, increasing physical activity and controlling stress—medications may be needed if blood pressure falls in this range on multiple readings over a period of time in people with other cardiovascular risk factors.

Dr. Wong adds that, per 2017 ACC/AHA guidelines, adults with Hypertension Stage I should consider medication after three to six months of nonpharmacologic therapy. There’s also a risk of atherosclerosis—thickening or hardening of the arteries caused by a buildup of plaque in the inner lining of an artery—if it isn’t treated. Risk factors for atherosclerosis may include high cholesterol and triglyceride levels, high blood pressure, smoking, diabetes, obesity, physical activity and eating saturated fats.

1. Age: Age of subject
2. Sex: Gender of subject:
   1. = female 1 = male
3. Chest-pain type: Type of chest-pain experienced by the individual:

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | = | typical | angina |
| 2 | = | atypical | angina |
| 3 | = | non-angina | pain |

4 = asymptomatic angina

1. Resting Blood Pressure: Resting blood pressure in mm Hg
2. Serum Cholesterol: Serum cholesterol in mg/dl
3. Fasting Blood Sugar: Fasting blood sugar level relative to 120 mg/dl: 0 = fasting blood sugar <= 120 mg/dl

1 = fasting blood sugar > 120 mg/dl

1. Resting ECG: Resting electrocardiographic results
   1. = normal
   2. = ST-T wave abnormality
   3. = left ventricle hyperthrophy
2. Max Heart Rate Achieved: Max heart rate of subject

|  |  |  |
| --- | --- | --- |
| 9. Exercise  0 = no 1 = yes | Induced | Angina: |

1. ST Depression Induced by Exercise Relative to Rest: ST Depression of subject
2. Peak Exercise ST Segment:
   1. = Up-sloaping
   2. = Flat
   3. = Down-sloaping
3. Number of Major Vessels (0-3) Visible on Flouroscopy: Number of visible vessels under flouro
4. Thal: Form of thalassemia: 3

3 = normal

* 1. = fixed defect
  2. = reversible defect.

Effect Of Existing Heart Disease On Average Of Exercise Angina

Angina (pronounced ANN-juh-nuh or ann-JIE-nuh) is pain in the chest that comes on with exercise, stress, or other things that make the heart work harder. It is an extremely common symptom of which is caused by cholesterol-clogged coronary arteries. This is the network of arteries that nourish the heart muscle.

Symptoms

Angina tends to appear during physical activity, emotional stress, or exposure to cold temperatures, or after big meals. Symptoms of angina include:

1. pressure, aching, or burning in the middle of the chest
2. pressure, aching, or burning in the neck, jaw, and shoulders (usually the left shoulder) and even down the arm
3. a sense of anxiety or uneasiness

The pain of angina usually isn't sharp. Instead, it is more a sense of pressure or squeezing. Sometimes it is just an uncomfortable sensation, not really a pain. Angina is not affected by the position of your body or by taking a deep breath, while other causes of chest pain, such as pleurisy or pericarditis, often are.

Diagnosing angina

Your doctor can suspect a diagnosis of angina based on your description of your symptoms, when they appear and your risk factors for coronary artery disease.

Your doctor will likely first do an electrocardiogram (ECG) to help determine what additional testing is needed to confirm the diagnosis.

Treatment for angina

Treatment for angina depends on how severe it is, whether it has recently become more severe (even if it is still mild), how much it interferes with your life, and your expectations and goals. Lifestyle changes are sometimes enough to make angina go away, though most people need one or more medications to ease or prevent angina. Some people need a procedure to open or bypass blocked coronary arteries.

Lifestyle changes for angina

Some of the following may help ease angina:

Reduce risk factors. Stopping smoking, losing weight if needed, and lowering high blood pressure, high cholesterol, and high blood sugar can help control angina.

Adjust your daily activities. If certain kinds of activity regularly cause angina, try performing the activity more slowly. Your heart is under more stress in the mornings and after meals, so try reducing physical activity at those times.

Reduce stress and anger. If anger and stress regularly bring on your angina, a stress-reduction program or meditation can help.

Exercise. Even though exercise can bring on angina, a supervised program of exercise can safely strengthen the heart and eventually reduce angina. Start slowly, and gradually build up your level of exercise during optimal times of the day. Your physician can tell you what you can and cannot do.

Heart-healthy eating. Adopting a Mediterranean or other heart-healthy eating strategy can help fight the cholesterol-filled plaque that is responsible for angina.

Medications for angina

Medication also plays an important role in treatment. Several types of medication are to ease or prevent angina. These include:

1. nitrates
2. beta blockers
3. calcium-channel blockers
4. aspirin
5. statins
6. ACE inhibitors
7. ranolazine

Nitrates cause the coronary arteries to widen, increasing blood flow through the coronary arteries. They come in several forms. One kind (nitroglycerin) is a pill that you place under your tongue when you first feel pain or discomfort. It should relieve angina within 5 minutes. Longacting nitrates, taken every day by pill or patch, help prevent angina attacks.

Beta blockers slow the heart rate so the heart doesn't have to work so hard. They reduce the risk of abnormal heart rhythms and lower blood pressure.

**Maximum Heart Rate In Existing Heart Disease By Exercise Angina**

Talk to your doctor. Before starting any type of exercise program when you have chronic angina, talk to you doctor. They will be able to give you the clearance to exercise and also give you safety tips.

1. Before starting to exercise, ask your doctor if regular physical activity is safe and appropriate for you. Although exercise can help improve angina in many patients, this isn't true for everyone.
2. Ask you doctor what types of exercise are best for you. Are you allowed to do cardiovascular exercise? Should those exercises be low intensity or can you do more moderate or high intensity exercises?
3. Ask you doctor about what signs and symptoms are dangerous. For example, if you experience chest pain while walking on the treadmill, what should your plan of action be?

Track your heart rate during exercise. Tracking your heart rate may be a beneficial practice when you're exercising with angina. It can give you an idea of how hard your heart is working.

1. Purchase a heart rate monitor for yourself. You can choose to get a wrist band or watch monitor, however it's best to purchase a chest strap monitor. These are the most accurate.
2. When you first start an exercise program after being diagnosed with angina, it's typically recommended to do low intensity exercises that keep your heart rate at about 50% of your maximum heart rate.
3. To find your maximum heart rate, subtract your age from 220. For example, if you're 60 years old, your maximum heart rate would be 160 beats per minute.
4. Using your heart rate tracker, keep you heart rate right at 50% during your exercise routine. In this example, you'd aim for your heart rate to be around 80 beats per minute.
5. If cleared by your doctor, you can slowly build up your aerobic endurance and increase to 60 or 70% of your maximum heart rate. However, don't aim to reach your max heart rate during exercise.
6. People with angina can adapt to exercise in a way that allows them to improve their exercise performance. Sometimes, you can take nitroglycerin to improve your exercise performance, but also, sometimes the exercise by itself helps you adapt.

Consider starting with a cardiac rehab program. If you have been just diagnosed with angina, your doctor may suggest attending a regular cardiac rehab program. These are great medically supervised programs that can help you get back into regular exercise.

1. A cardiac rehab program is provided on an outpatient basis to those who have suffered from a cardiac event or have chronic cardiac conditions. They are designed to help improve fitness levels while reducing symptoms and side effects.

Start with short bouts of low intensity exercises. Many people that have angina, are at lower fitness levels. This may especially be true if you've been required to take several weeks or months off from your exercise routine when you were initially diagnosed.

1. If you are trying to recover and rebuild your cardiac strength and endurance, it's recommended to start with short bouts of lower intensity exercises.
2. Restarting with higher intensity exercises, or trying to go for a longer period of time could cause symptoms to reoccur or for your condition to get worse.
3. Aim to start with just 15-20 minutes of low intensity activity each day. If this feels too easy, increase the time to 25-30 minutes the next day, but do not increase the intensity.

Choose exercises that are low in intensity like walking, water walking, cycling or using the elliptical.

1. As your endurance gets better and your fitness improves, you can very slowly increase first the length of your exercises and then the intensity as well.
2. These exercises can increase your heart rate, but you are in full control of how high your heart rate increases during your exercise routine.

**Serum Cholesterol Levels Vs Age**

Serum cholesterol level was studied in normal subjects in Kasakake Village. The serum cholesterol levels increased significantly with age, from the third to the fifth decade in males and from the third to the seventh decade in females. Thereafter, the levels were maintained in males while declined in females. The mean peak values (+/- SD) were 178 +/- 31 mg/100 ml in males and 207 +/- 37 mg/100 ml in females. The presumptive values of the zero-year-old obtained from the regression lines calculated from the plot of serum cholesterol values against age were 129 mg/100 ml and 112 mg/100 ml in males and females respectively. Throughout the age-range examined in females, the serum cholesterol level was well correlated with the relative body weight determined with modified Broca's method. A similar, but less obvious correlation was demonstrated in males. However, there was not comparable change in the relative body weight against the trend of the serum cholesterol level in both sexes. In the babies normally delivered with full term, the mean cholesterol level (+/- SD) in the umbilical cord blood serum was 65 +/- 13 mg/100 ml and it increased to 150 +/- 46 mg/100 ml during one to three months after birth which was very close to the presumptive values obtained from the regression lines in the adults. There also was significant correlation between the cholesterol value and the body weight. It is concluded that in normal people, age and relative body weight are major and independent determinants of serum cholesterol level from the start of their life.

Cholesterol in adults

Sex and gender exist on spectrums. This article will use the terms “men,” “women,” or both to refer to sex assigned at birth.

Your total cholesterol level is the overall amount of cholesterol found in your blood. It consists of:

1. low-density lipoproteins (LDLs)
2. high-density lipoproteins (HDLs)
3. triglycerides

LDL is also called “bad” cholesterol because it blocks your blood vessels and increases your risk for heart disease. HDL is considered “good” cholesterol because it helps protect you from heart disease. The higher your HDL, the better.

Total cholesterol also includes a triglyceride count. These are another type of fat that can build up in the body and are considered the “building blocks” of cholesterol.

High levels of triglycerides and low levels of HDL raise your risk for heart disease.

The American Heart AssociationTrusted Source recommends that all adults have their cholesterol checked every 4 to 6 years, starting at age 20, which is when cholesterol levels can start to rise.

As we age, cholesterol levels tend to climb. Men are generally at a higher risk than women for higher cholesterol. However, a woman’s risk goes up after she enters menopause.

For those with high cholesterol and other cardiac risk factors, such as diabetes, more frequent testing is recommended.

Cholesterol in children

Children who are physically active, eat a nutrient-dense diet, are not overweight, and do not have a family history of high cholesterol are at a lower risk for having high cholesterol.

Current guidelinesTrusted Source recommend that all children have their cholesterol checked between ages 9 and 11 years, and then again between ages 17 and 21 years.

Children with more risk factors, such as having diabetes, obesity, or a family history of high cholesterol, should be checked between ages 2 and 8 years, and again between ages 12 and 16 years.

**CHAPTER 3**

**IDEATION PHASE**

**3.1 Literature Survey**

PAPER 1

Armin Yazdani, Kasturi Dewi Varathan, Yin Kia Chiam,Asad Waqar Malik ,Wan Azman Wan Ahmad ,BMC Medical Informatics and Decision Making volume 21, Article number: 194 (2021) This paper is motivated by the gap in the literature, thus proposes an algorithm that measures the strength of the significant features that contribute to heart disease prediction. The study is aimed at predicting heart disease based on the scores of significant features using Weighted Associative Rule Mining.

PAPER 2

Harshit Jindal, Sarthak Agrawal, Rishabh Khera, Rachna Jain and Preeti NagraPublished under licence by IOP Publishing Ltd IOP Conference Series: Materials Science and Engineering, Volume 1022, 1st International Conference on Computational Research and Data Analytics (ICCRDA 2020) 24th October 2020, Rajpura, India Citation Harshit Jindal et al 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1022 012072 . We prepared a heart disease prediction system to predict whether the patient is likely to be diagnosed with a heart disease or not using the medical history of the patient. The strength of the proposed model was quiet satisfying and was able to predict evidence of having a heart disease in a particular individual by using KNN and Logistic Regression which showed a good accuracy in comparison to the previously used classifier such as naive bayes etc.

PAPER 3

Rohit Bharti,Aditya Khamparia,Mohammad Shabaz,Gaurav Dhiman,Sagar Pande and Parneet Singh Volume 2021 | Article ID 8387680 | https://doi.org/10.1155/2021/8387680 They can use different machine learning and deep learning models to diagnose the disease and classify or predict the results. A complete genomic data analysis can easily be done using machine learning models. Models can be trained for knowledge pandemic predictions and also medical records can be transformed and analyzed more deeply for better predictions.

PAPER 4

Proceedings of the International Conference on Innovative Computing & Communication (ICICC) 2021 Rati Goel Inderprastha Engineering College Date Written: July 12, 2021 This paper can predict this disease by using various attributes in the data set. They have collected a data set consists of 13 elements and 383 individual value to analyze the patients performance. The main aim of the paper is to get a better accuracy to detect the heart disease using ML algorithm.

**3.2 Empathy Map**

**3.2 Ideation**

**3.2 Problem Statement**

**Ideation Phase Define the Problem Statements**

|  |  |
| --- | --- |
| **Who does the problem affect?** | The majority of people who die of coronary heart disease are 65 or older. While heart attacks can strike people of  both sexes in old age,  women are at greater risk of dying  (within a few weeks). |

|  |  |
| --- | --- |
| **What are the boundaries of theproblem?** | Several health conditions, your lifestyle, and your age and family history can increase your risk for heart disease. |
| **What is the issue?** | In real time life of human, if the person is affected by heart  disease, then it produces the side effect problems Chest pain, chest tightness, chest  pressure and chest discomfort (angina), Shortness of breath, Pain in the neck, jaw, throat, upper belly area or back. |

|  |  |
| --- | --- |
| **When does the issue occur?** | Heart disease - and the conditions that lead to it - can  happen at any age. High rates of obesity and high blood pressure among younger people (ages  35–64) are putting them at risk for heart disease earlier in life. |

|  |  |
| --- | --- |
| **Where is the issue coming?** | CAD happens when coronary arteries struggle to supply the heart with enough blood, oxygen and nutrients. Cholesterol deposits, or plaques, are almost  always to blame. These buildups narrow your arteries, decreasing blood flow to your heart. This can cause chest pain, shortness of breath or even a heart attack. |
| **Why is it important that we fix the problem?** | Predict if the patient suffers from heart disease. The health professional enters the input values from the patient's health report. The data is fed into model which predicts the probability of having heart disease. |

|  |  |
| --- | --- |
| **Which solution can be used to address this issue?** | A machine learning powered web application model with the strong building of algorithm that helps to  identify and predicts the disease with the identification of symptoms. It processes the  breathing signals using a neural network that infers whether the person has Heart disease, and if they are identified then it  assesses the severity of their disease in accordance with the  Movement Disorder Society Unified Heart Disease using ML algorithms. |

|  |  |
| --- | --- |
| **What methodology used to solvethe issue?** | Supervised and Un-supervised machine learning, Data mining, Computer vision with OpenCV, Python web application interface - Flask, Jupyter Notebook, IBM Cloud. |

**CHAPTER 4**

**Project Design Phase-I**

**4.1 Proposed\_Solution**

**Proposed Solution Template:**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Parameter** | **Description** |
| 1. | Problem Statement (Problem to be solved) | Heart disease refers to several types of abnormalities in heart conditions. The leading cause of death is heart disease. It is infeasible for a common man to frequently undergo tests for ECG and so on. Hence, there needs a replacement for this, which must be handy and reliable. |
| 2. | Idea / Solution description | The idea behind the proposed solution is to propose an interactive dashboard for visualizing and predicting heart diseases in which user can view his/her medical report analysis and the predicted final result. The dashboard will be generated using IBM Cognos. The heart disease will be predicted using Naïve Bayes Algorithm. |
| 3. | Novelty / Uniqueness | The novelty behind the proposed system is to provide suggestions to the user based on his/her medical analysis. It will provide the preventive measures to take care of the user himself. |
| 4. | Social Impact / Customer Satisfaction | The system helps the user as well as the doctor to make better decisions to predict heart disease. It is useful in predicting the disease in an earlier stage and makes the user alert about his current condition periodically. |

|  |  |  |
| --- | --- | --- |
| 5. | Business Model (Revenue Model) | This interactive dashboard for heart disease prediction can be deployed in Health care centres and Hospitals, so that it makes the analysis in a fast manner. |

|  |  |  |
| --- | --- | --- |
| 6. | Scalability of the Solution | The proposed solution will work efficiently in both smaller and larger datasets in a similar manner. In future, it can be changed to predict some other diseases with more accuracy. |

**4.2 Problem – Solution Fit**

**Problem – Solution Fit Template:**

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer’s problem. It helps entrepreneurs, marketers and corporate innovators identify behavioural patterns and recognize what would work and why

**Purpose:**

1. Solve complex problems in a way that fits the state of your customers.
2. Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behaviour.
3. Sharpen your communication and marketing strategy with the right triggers and messaging.
4. Increase touch-points with your company by finding the right problem-behaviour fit and building trust by solving frequent annoyances, or urgent or costly problems.

**Understand the existing situation in order to improve it for your target group.**

**4.3 Solution Architecture**

Heart disease describes a range of conditions that affect your heart. Diseases under the heart disease umbrella include blood vessel diseases, such as coronary artery disease, heart rhythm problems (arrhythmias) and heart defects you’re born with (congenital heart defects), among others.

The term “heart disease” is often used interchangeably with the term “cardiovascular disease”. Cardiovascular disease generally refers to conditions that involve narrowed or blocked blood vessels that can lead to a heart attack, chest pain (angina) or stroke. Other heart conditions, such as those that affect your heart’s muscle, valves or rhythm, also are considered forms of heart disease.

Heart disease is one of the biggest causes of morbidity and mortality among the population of the world. Prediction of cardiovascular disease is regarded as one of the most important subjects in the section of clinical data analysis. The amount of data in the healthcare industry is huge. Data mining turns the large collection of raw healthcare data into information that can help to make informed decisions and predictions.

The dataset consists of 303 individuals data. There are 14 columns in the dataset, which are described below.

1. Age: displays the age of the individual.
2. Sex: displays the gender of the individual using the following format :
   1. = male

0 = female

1. Chest-pain type: displays the type of chest-pain experienced by the individual using the following format :
   1. = typical angina 2 = atypical angina 3 = non — anginal pain

4 = asymptotic

1. Resting Blood Pressure: displays the resting blood pressure value of an individual in mmHg (unit)
2. Serum Cholestrol: displays the serum cholesterol in mg/dl (unit)
3. Fasting Blood Sugar: compares the fasting blood sugar value of an individual with 120mg/dl.

If fasting blood sugar > 120mg/dl then : 1 (true)

else : 0 (false)

1. Resting ECG : displays resting electrocardiographic results
   1. = normal
   2. = having ST-T wave abnormality
   3. = left ventricular hyperthrophy
2. Max heart rate achieved : displays the max heart rate achieved by an individual.
3. Exercise induced angina :
   1. = yes

0 = no

1. ST depression induced by exercise relative to rest: displays the value which is an integer or float.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 11. Peak | exercise |  | ST | segment : |
| 1 |  | = |  | upsloping |
| 2 |  | = |  | flat |

3 = downsloping

12. Number of major vessels (0–3) colored by flourosopy : displays the value as integer or float.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 13. Thal : | displays | the |  | thalassemia | : |
| 3 |  | = |  |  | normal |
| 6 | = |  | fixed |  | defect |

7 = reversible defect

14. Diagnosis of heart disease : Displays whether the individual is suffering from heart disease or not

:

0 = absence

1, 2, 3, 4 = present.

In the actual dataset, we had 76 features but for our study, we chose only the above 14 because :

1. Age: Age is the most important risk factor in developing cardiovascular or heart diseases, with approximately a tripling of risk with each decade of life. Coronary fatty streaks can begin to form in adolescence. It is estimated that 82 percent of people who die of coronary heart disease are 65 and older. Simultaneously, the risk of stroke doubles every decade after age 55.
2. Sex: Men are at greater risk of heart disease than pre-menopausal women. Once past menopause, it has been argued that a woman’s risk is similar to a man’s although more recent data from the WHO and UN disputes this. If a female has diabetes, she is more likely to develop heart disease than a male with diabetes.
3. Angina (Chest Pain): Angina is chest pain or discomfort caused when your heart muscle doesn’t get enough oxygen-rich blood. It may feel like pressure or squeezing in your chest. The discomfort also can occur in your shoulders, arms, neck, jaw, or back. Angina pain may even feel like indigestion.
4. Resting Blood Pressure: Over time, high blood pressure can damage arteries that feed your heart. High blood pressure that occurs with other conditions, such as obesity, high cholesterol or diabetes, increases your risk even more.
5. Serum Cholesterol: A high level of low-density lipoprotein (LDL) cholesterol (the “bad” cholesterol) is most likely to narrow arteries. A high level of triglycerides, a type of blood fat related to your diet, also ups your risk of a heart attack. However, a high level of high-density lipoprotein (HDL) cholesterol (the “good” cholesterol) lowers your risk of a heart attack.
6. Fasting Blood Sugar: Not producing enough of a hormone secreted by your pancreas (insulin) or not responding to insulin properly causes your body’s blood sugar levels to rise, increasing your risk of a heart attack.
7. Resting ECG: For people at low risk of cardiovascular disease, the USPSTF concludes with moderate certainty that the potential harms of screening with resting or exercise ECG equal or exceed the potential benefits. For people at intermediate to high risk, current evidence is insufficient to assess the balance of benefits and harms of screening.
8. Max heart rate achieved: The increase in cardiovascular risk, associated with the acceleration of heart rate, was comparable to the increase in risk observed with high blood pressure. It has been shown that an increase in heart rate by 10 beats per minute was associated with an increase in the risk of cardiac death by at least 20%, and this increase in the risk is similar to the one observed with an increase in systolic blood pressure by 10 mm Hg.
9. Exercise induced angina: The pain or discomfort associated with angina usually feels tight, gripping or squeezing, and can vary from mild to severe. Angina is usually felt in the center of your chest but may spread to either or both of your shoulders, or your back, neck, jaw or arm. It can even be felt in your hands. o Types of Angina a. Stable Angina / Angina Pectoris b. Unstable Angina c. Variant (Prinzmetal) Angina d. Microvascular Angina.
10. Peak exercise ST segment: A treadmill ECG stress test is considered abnormal when there is a horizontal or down-sloping ST-segment depression ≥ 1 mm at 60–80 ms after the J point. Exercise ECGs with up-sloping ST-segment depressions are typically reported as an ‘equivocal’ test. In general, the occurrence of horizontal or down-sloping ST-segment depression at a lower workload (calculated in METs) or heart rate indicates a worse prognosis and higher likelihood of multivessel disease. The duration of ST-segment depression is also important, as prolonged recovery after peak stress is consistent with a positive treadmill ECG stress test. Another finding that is highly indicative of significant CAD is the occurrence of ST-segment elevation > 1 mm (often suggesting transmural ischemia); these patients are frequently referred urgently for coronary angiography.

The Approach

The code for this article can be found here.

The code is implemented in Python and different classification models are applied.

In this article I will be using the following classification models for classification :

1. SVM
2. Naive Bayes
3. Logistic Regression
4. Decision Tree
5. Random Forest
6. LightGBM · XGboost

Data Analysis

Let us look at the people’s age who are suffering from the disease or not.

Here, target = 1 implies that the person is suffering from heart disease and target = 0 implies the person is not suffering.

We see that most people who are suffering are of the age of 58, followed by 57.

Majorly, people belonging to the age group 50+ are suffering from the disease.

Next, let us look at the distribution of age and gender for each target class.

We see that for females who are suffering from the disease are older than males.

The Data

The dataset used in this article is the Cleveland Heart Disease dataset taken from the UCI repository.

Advantages

1. User can search for doctor’s help at any point of time.
2. User can talk about their Heart Disease and get instant diagnosis.
3. Doctors get more clients online.
4. Very useful in case of emergency.

Disadvantages

1. Accuracy Issues: A computerized system alone does not ensure accuracy, and the warehouse data is only as good as the data entry that created it.
2. The system is not fully automated, it needs data from user for full diagnosis

The Heart Disease prediction will have the following key takeaways:

* 1. Data insight: As mentioned here we will be working with the heart disease detection dataset and we will be putting out interesting inferences from the data to derive some meaningful results.
  2. EDA: Exploratory data analysis is the key step for getting meaningful results.
  3. Feature engineering: After getting the insights from the data we have to alter the features so that they can move forward for the model building phase.
  4. Model building: In this phase, we will be building our Machine learning model for heart disease detection.

Feature information of the cleveland dataset.

S.No Attribute Description Range of

Name Values

1. Age Age of the person in years 29 to 79
2. Sex Gender of the person [1: Male, 0: 0, 1

Female]

1. Cp Chest pain type [1-Typical Type 1 1, 2, 3, 4

Angina

2- Atypical Type Angina

3-Non-angina pain

4-Asymptomatic)

1. Trestbps Resting Blood Pressure in mm Hg 94 to 200
2. Chol Serum cholesterol in mg/dl 126 to 564
3. Fbs Fasting Blood Sugar in mg/dl 0, 1
4. Restecg Resting Electrocardiographic Results 0, 1, 2
5. Thalach Maximum Heart Rate Achieved 71 to 202
6. Exang Exercise Induced Angina 0, 1
7. OldPeak ST depression induced by exercise 1 to 3

relative to rest

1. Slope Slope of the Peak Exercise ST segment 1, 2, 3
2. Ca Number of major vessels colored by 0 to 3

fluoroscopy

1. Thal 3 – Normal, 6 – Fixed Defect, 7 – 3, 6, 7

Reversible Defect

1. Num Class Attribute 0 or 1

Patients from age 29 to 79 have been selected in this dataset. Male patients are denoted by a gender value 1 and female patients are denoted by gender value 0. Four types of chest pain can be considered as indicative of heart disease. Type 1 angina is caused by reduced blood flow to the heart muscles because of narrowed coronary arteries. Type 1 Angina is a chest pain that occurs during mental or emotional stress. Non-angina chest pain may be caused due to various reasons and may not often be due to actual heart disease. The fourth type, Asymptomatic, may not be a symptom of heart disease. The next attribute trestbps is the reading of the resting blood pressure. Chol is the cholesterol level. Fbs is the fasting blood sugar level; the value is assigned as 1 if the fasting blood sugar is below 120 mg/dl and 0 if it is above. Restecg is the resting electrocardiographic result, thalach is the maximum heart rate, exang is the exercise induced angina which is recorded as 1 if there is pain and 0 if there is no pain, oldpeak is the ST depression induced by exercise, slope is the slope of the peak exercise ST segment, ca is the number of major vessels colored by fluoroscopy, thal is the duration of the exercise test in minutes, and num is the class attribute. The class attribute has a value of 0 for normal and 1 for patients diagnosed with heart disease.

**CHAPTER 5**

**PROJECT DESIGN PHASE 2**

**5.1 Customer Journey Map** - Visualizing and Predicting Heart Diseases with an Interactive Dash Board

Project Design Phase II Customer Journey Map

Customer Journey Map:

The customer journey map is a visual representation of the steps a customer takes to complete a specific action, such as signing up for a product trial or subscribing to a newsletter.The more steps involved to complete the specific action, the more detailed the customer journey map will be.

**5.2 Solution Requirements**

**Solution Architecture:**

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

1. Find the best tech solution to solve existing business problems.
2. Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
3. Define features, development phases, and solution requirements.
4. Provide specifications according to which the solution is defined, managed, and delivered.

**Example - Solution Architecture Diagram:**

**Solution Requirements (Functional & Non-functional)**

**Functional Requirements:**

Following are the functional requirements of the proposed solution.

|  |  |  |
| --- | --- | --- |
| **FR No.** | **Functional Requirement (Epic)** | **Sub Requirement (Story / Sub-Task)** |
| FR-1 | User Registration | Enables user to make registration for the application through Gmail |
| FR-2 | User Confirmation | Once after registration, the user will get confirmation via Email |
| FR-3 | Visualizing Data | User can visualize the trends on the heart disease through Dashboard created using IBM Cognos  Analytics |
| FR-4 | Generating Report | User can view his/her health report and can make decisions accordingly |

**Non-functional Requirements:**

Following are the non-functional requirements of the proposed solution.

|  |  |  |
| --- | --- | --- |
| **NFR No.** | **Non-Functional Requirement** | **Description** |
| NFR-1 | **Usability** | The application will have a simple and user- friendly graphical interface. Users will be able to understand and use all the features of the application easily. Any action has to be performed with just a few clicks |
| NFR-2 | **Security** | For security of the application the technique known as database replication should be used so that all the important data should be kept safe. In case of crash, the system should be able to backup and recover the data |
| NFR-3 | **Reliability** | The application has to be consistent in every scenario and has to work without failure in any environment. |
| NFR-4 | **Performance** | Performance of the application depends on the response time and the speed of the data submission. The response time of the application is direct and faster, which depends on the efficiency of the implemented algorithm. |
| NFR-5 | **Availability** | The application has to be available 24 x 7 for users without any interruption |
| NFR-6 | **Scalability** | The application can withstand the increase in the number of users and has to be able to develop higher versions. |

**5.3 Data Flow Diagrams:**  
  
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

**Data Flow Diagram for Heart Disease Prediction Dashboard:**

**Flow:**

1) User creates an account in the application.  
 2) User enters the medical records in the dashboard.  
 3) User can view the visualizations of trends in the form of graphs and charts for his/her medical records with the trained dataset. 4) User can view the accuracy of probability of occurrence of heart disease in the dashboard.

**User Stories:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **User Type** | **Functional Requirement (Epic)** | **User Story Number** | **User Story / Task** | **Acceptance criteria** | **Priority** | **Release** |
| Customer (Web user) | Registration | USN-1 | As a user, I can register for the application by entering my email, password, and confirming my password. | I can access my account / Dashboard | High | Sprint-1 |
|  |  | USN-2 | As a user, I will receive confirmation email once I have registered for the application | I can receive confirmation email & click confirm | High | Sprint-1 |
|  | Login | USN-3 | As a user, I can log into the application by entering email & password | I can access my account / Dashboard whenlogged in | High | Sprint-1 |
| Customer (Web user) | Dashboard | USN-4 | User can view his/her complete medical analysis and accuracy of disease  prediction | I can view my medical analysis in the  dashboard | High | Sprint-2 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | USN-5 | User can view the accuracy of occurrence of heart disease | I can view the accuracy of heart disease in the dashboard | High | Sprint-2 |
| Customer Care Executive | Helpdesk | USN-6 | As a customer care executive, he/she can view the customer queries. | I can post my queries in the dashboard | Medium | Sprint-3 |
|  |  | USN-7 | As a customer care executive, he/she can answer the customer queries. | I can get support from helpdesk | High | Sprint-3 |
| Administrato r | User Profile | USN-8 | As an admin, he/she can update the health details of users. | I can view my updated health details. | High | Sprint-4 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **User Type** | **Functional Requirement (Epic)** | **User Story Number** | **User Story / Task** | **Acceptance criteria** | **Priority** | **Release** |
|  |  | USN-9 | As an admin, he/she can add or delete users. | I can access my account / Dashboard whenlogged in | High | Sprint-4 |
|  |  | USN-10 | As an admin, he/she can manage the user details. | I can view the organized data of myself. | High | Sprint-4 |

**5.4 Technical Architecture**

Table-1 : Components & Technologies:

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | Component | Description | Technology |
| 1. | User Interface | How user interacts with application e.g. Web UI, Mobile App, etc. | HTML, CSS, Python etc. |
| 2. | Application Logic-1 | Logic for a process in the application | Python |
| 3. | Application Logic-2 | Logic for a process in the application | IBM Cognos Analytics |
| 4. | Application Logic-3 | Logic for a process in the application | IBM Watson Assistant |
| 5. | Database | Data Type, Configurations etc. | MySQL, etc. |
| 6. | Cloud Database | Database Service on Cloud | IBM DB2, IBM Pak etc. |
| 7. | File Storage | File storage requirements | Use Professional Records Storage, IBM Block Storage or Other Storage Services. |
| 8. | External API | Purpose of External API used in the application | IBM SPSS, etc. |
| 9. | Infrastructure (Server / Cloud) | Application Deployment on Local System /  Cloud  Local Server Configuration:  Cloud Server Configuration : | Personal Server, IBM Cloud Server etc. |

Table-2: Application Characteristics:

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | Characteristics | Description | Technology |
| 1. | Open-Source Frameworks | Open-source frameworks used | Technology of Opensource framework – Django or Flask in Python. |
| 2. | Security Implementations | Security / access controls implemented, use of firewalls etc. | e.g. Privacy - Encryptions, IBM Security Manager etc. |
| 3. | Scalable Architecture | Scalability of architecture (3 – tier, Microservices) | Technology used - IaaS, PaaS, SaaS (IBM Cloud). |
| 4. | Availability | Availability of application | Technology used - The Availability of getting used to this software or  product  design is through by accessing IBM  cognos Analytics and IBM cloud. |
| 5. | Performance | Performance of the application | Technology used - The performance  should be fast relaying. This prediction  system should be made available in cloud to ensure better  accessibility and setting a milestone in providing good quality affordable healthcare. |

References :

https://www.ibm.com/products/cognos-analytics https://cloud.ibm.com/catalog/services/watson-assistant https://www.ibm.com/in-en/cloud-paks https://www.ibm.com/cloud

**CHAPTER 6**

**PROJECT PLANNING PHASE**

**6.1 Prepare Milestone and Activity List**

What is a project milestone:

A milestone is a marker in a project that signifies a change or stage in development. Milestones are powerful components in project management because they show key events and map forward movement in your project plan.

Milestones act as signposts through the course of your project, helping ensure you stay on track. Without project milestone tracking, you’re just monitoring tasks and not necessarily following the right path in your project.

What’s the difference between tasks and milestones:

You’re not building a rocket here—you’re building a project plan, and the components aren’t that complex. That said, distinguishing between tasks and milestones can be difficult on larger projects, or if the project you’re managing just isn’t within the realm of your expertise (yet).

If you’ve ever been confused about what is (or isn't) a milestone in your gantt chart, ask yourself these questions:

1. Is this a task or a deliverable?
2. Will this impact the final deadline?
3. Is this an important moment in the project that will indicate forward progress?
4. Does this need to be reviewed by stakeholders?
5. Is this an event that impacts the project?

Essentially, you want to set the most important events of your project as milestones so they can be easily seen and mapped by the project team. Milestones are given additional significance over tasks in a plan so the project manager can track the tasks while the team and stakeholders focus on forward progress.

Here’s how to tell the difference between milestones vs tasks when looking at your plan in TeamGantt:

1. A milestone is represented by a gold, diamond-shaped icon or symbol on your gantt chart with a single-day duration.
2. Tasks show up as horizontal bars on the gantt chart. They can be assigned different task colors, as well as multi-day durations.

What Is a Milestone Schedule:

A milestone schedule, or milestone chart, is simply a timeline that uses milestones to divide a project schedule into major phases. Due to its simplicity, it’s used when project managers or sponsors need to share an overview of the project schedule with stakeholders or team members without going over every detail.

How to Decide What’s a Project Milestone:

As discussed above, project milestones measure progress by breaking the project into phases. A milestone is a marker that separates the end of one phase from the start of another.

According to the project management institute (PMI), there are typically five phases in project management: initiation, planning, execution, monitoring & controlling and closure. But when exactly do you add the milestones?

The simple answer is when you’ve completed everything related to that project phase. For example, completing the project charter is usually the last step in the initiation phase of a project. This would be when you place your milestone to indicate you’re moving from initiation to planning.

However, the exact point at which you want to set your milestones might vary depending on your project, your organization and other factors. It’s always best to seek help from experts in the industry and in your company or project team. A little guidance upfront can save a lot of headaches later on.

Milestones are more a period in time than the specific completion of tasks or project deliverables, so the question arises, can you have milestones that don’t relate to project phases? The short answer is yes. You can set any sort of milestones you want in a project. Traditionally, they break projects into phases, but you can choose to create a milestone to indicate a big task, important event, deliverable or more.

Project Milestones Examples

What could be better to explain how to use milestones in project management than some examples? Let’s look at some common project milestones examples for each phase of the project life cycle.

1. Project approval
2. Start and end of project phases
3. Getting your project charter approved
4. Securing financing, equipment or resources
5. Assembling a project team
6. Getting your project plan approved
7. Project kick-off meeting
8. Completing critical tasks
9. Producing key project deliverables
10. Reaching project goals and objectives
11. Project completion

**6.2 Sprint Delivery Plan**

Product Backlog, Sprint Schedule, and Estimation

Use the below template to create product backlog and sprint schedule

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sprint | Functional  Requirement  (Epic) | User Story  Number | User Story / Task | Story Points | Priority | Team Members |
| Sprint-1 | Registration | USN-1 | As a user, I can register for the application by entering my email, password, and confirming my password. | 2 | High | 1 |
| Sprint-1 |  | USN-2 | As a user, I will receive confirmation email once I have registered for the application | 1 | High | 2 |
| Sprint-2 |  | USN-3 | As a user, I can register for the application through Facebook | 2 | Low | 4 |
| Sprint-1 |  | USN-4 | As a user, I can register for the application through Gmail | 2 | Medium | 3 |
| Sprint-1 | Login | USN-5 | As a user, I can log into the application by entering email & password | 1 | High | 2 |
| Sprint-2 | Dashboard | USN-6 | Profile - view & update your profile | 2 | High | 5 |
| Sprint-1 |  | USN-7 | Change Password - user can change the password | 1 | High | 2 |
| Sprint-1 |  | USN-8 | Home - Analyze your Heart | 2 | High | 5 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sprint | Functional  Requirement  (Epic) | User Story  Number | User Story / Task | Story Points | Priority | Team Members |
| Sprint-3 |  | USN-9 | The user will have to fill in the below 13 fields for the system to predict a disease  -Age in Year -Gender  -Chest Pain Type  -Fasting Blood Sugar  -Resting Electrographic  Results(Restecg)  -Exercise Induced Angina(Exang) -The slope of the peak exercise ST segment  -CA – Number of major vessels colored by fluoroscopy  -Thal  -Trest Blood Pressure  -Serum Cholesterol -Maximum heart  rate achieved(Thalach) -ST depression induced by exercise(Oldpeak) | 2 | High | 5 |
|  |  | USN-10 | View Doctors - view doctor detail by searching by names or filter by specialty | 1 | Medium | 4 |
| Sprint-3 | System Requirment | USN-11 | I. Hardware Requirement  i. Laptop or PC  · I5 processor system or higher | 2 | High | 2 |
| Sprint | Functional  Requirement  (Epic) | User Story  Number | User Story / Task | Story Points | Priority | Team Members |
|  |  |  | · 4 GB RAM or higher · 128 GB ROM or higher ii. Android Phone (12.0 and above) |  |  |  |
| Sprint-3 |  | USN-12 | II. Software Requirement  iii. Laptop or PC   1. Windows 10 or higher 2. Android Studio | 2 | Medium | 2 |
| Sprint-4 | Dashboard | USN-13 | Query | 1 | High | 1 |
|  |  | USN-14 | Toll Free | 1 | High | 1 |
|  |  | USN-15 | Ratings | 2 | Medium | 2 |
|  |  | USN-16 | Verification | 2 | High | 2 |
|  |  | USN-17 | Validation | 1 | High | 2 |
|  |  | USN-18 | Feedback – send feedback to the  Admin | 2 | Medium | 3 |

Project Tracker, Velocity

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sprint | Total Story Points | Duration | Sprint Start Date | Sprint End Date (Planned) | Story Points  Completed (as on  Planned End  Date) | Sprint Release Date  (Actual) |  |
| Sprint-1 | 20 | 6 Days | 24 Oct 2022 | 29 Oct 2022 | 20 | 29 Oct 2022 |
| Sprint-2 | 20 | 6 Days | 31 Oct 2022 | 05 Nov 2022 | 18 | 06 Nov 2022 |
| Sprint-3 | 20 | 6 Days | 07 Nov 2022 | 12 Nov 2022 | 20 | 11 Nov 2022 |
| Sprint-4 | 20 | 6 Days | 14 Nov 2022 | 19 Nov 2022 | 19 | 19 Nov 2022 |
|  |  |  |  |  |  |  | |

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let’s calculate the team’s average velocity (AV) per iteration unit (story points per day)

Reference:

https://ieeexplore.ieee.org/document/9619208/

**CHAPTER 7**

**PROJECT DEVELOPMENT PHASE**

**Project Development - Delivery of Sprint - 1**

Create heart.html

<html lang="en">

<head>

<title>Heart Disease Prediction</title>

</head>

<body background="heart.jpg">

<h1 style="font-size: 3rem; color: #96b0e3; text-align:right ">Heart Diseases Prediction</h1>

</body>

</html>

ML

Stlye.css

\*{

margin: 0;

padding: 0;

font-family: sans-serif;

}

body{

background: linear-gradient(rgba(0,0,0,0.4)50%,rgba(0,0,0,0.4)50%), url(ML.jpg);

background-position: center;

background-size: cover;

height: 100vh;

}

.form{

width: 250px;

height: 330px;

color: #fff;

background: linear-gradient(to top, rgba(0,0,0,0.8)50%,rgba(0,0,0,0.8)50%);

position: absolute;

top: 50%;

left: 50%;

transform: translate(-50%,-50%);

padding: 40px 25px;

border-radius: 10px;

}

.form h1{

width: 220px;

text-align: center;

padding-left: 11px;

font-size: 35px;

color: #66ff00;

margin-bottom: 20px;

}

.form p{

padding-bottom: -15px;

}

.form input{

width: 100%;

height: 35px;

padding-top: 5px;

margin-bottom: 30px;

background: transparent;

border-bottom: 1px solid #fff;

border-top: none;

border-left: none;

border-right: none;

color: #fff;

outline: none;

font-size: 15px;

letter-spacing: 1px;

}

.form input[type="submit"]

{

width: 60%;

margin-left: 50px;

border: none;

height: 40px;

color: #000;

background: #fff;

font-size: 16px;

font-weight: bold;

border-radius: 15px;

}

.form input[type="submit"]:hover{

cursor: pointer;

background: #66ff00;

color: #fff;

font-weight: bold;

}

heart.jpg

login.html

<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="UTF-8">

<meta http-equiv="X-UA-Compatible" content="IE=edge">

<meta name="viewport" content="width=device-width, initial-scale=1.0">

<title>LOGIN PASSWORD VALIDATION | PRAROZ TUTORIAL</title>

<link rel="stylesheet" href="style.css">

<script src="valid.js"></script>

</head>

<body>

<div class="form">

<h1>LOGIN HERE</h1>

<p>Username :</p>

<input type="text" name="" placeholder="Name Here">

<p>Password :</p>

<input type="password" name="" placeholder="Password Here" id="pass">

<input type="checkbox" onclick="myfunction()">

<input type="submit" name="" value="LOGIN" onclick="validate()">

</div>

<div>

<p id="length"></p>

</div>

valid.js

function myfunction(){

var x =document.getElementById("pass");

if(x.type === "password"){

x.type = "text";

}

else{

x.type = "password";

}

}

function validate(){

var password = document.getElementById("pass");

var length = document.getElementById("length");

if(password.value.length >= 8){

alert("Login Succesfull");

window.location.replace("heart1.html");

return false;

}

else{

alert("Login Failed");

}

}

function lpage(){

window.location.replace("Landingpage.html")

}

**Project Flow**

IBM Cloud:

IBM offers three hardware platforms for cloud computing. These platforms offer built-in support for virtualization. IBM also offers a virtualization application infrastructure, Web sphere, which supports programming models and open standards for virtualization.

The management layer of the IBM cloud framework includes IBM Tivoli middleware. Management tools provide capabilities to regulate images with automated provisioning and de-provisioning, monitor operations and meter usage while tracking costs and allocating billing. The last layer of the framework provides integrated workload tools. Workloads (in the context of cloud computing) are services or instances of code that can be executed to meet specific business needs. IBM also offers tools for cloud based collaboration, development and testing, application development, analytics, business-to-business integration, and security.

The IBM SmartCloud brand includes three primary services: the infrastructure, software, and platform services, each of which is offered through public, private and hybrid cloud delivery models. IBM places these offerings under three umbrellas: the SmartCloud Foundation, SmartCloud Services and SmartCloud Solutions.

The SmartCloud Foundation consists of the infrastructure, hardware, provisioning, management, integration and security that serve as the underpinnings of a private or hybrid cloud. Built using those foundational components, PaaS, IaaS and backup services make up SmartCloud Services. Running on this cloud platform and infrastructure, SmartCloud Solutions consist of a number of collaboration, analytics and marketing SaaS applications.

IBM also builds cloud environments for clients that are not necessarily on the SmartCloud Platform. For example, features of the SmartCloud platform—such as Tivoli management software or IBM Systems Director virtualization—can be integrated separately as part of a nonIBM cloud platform. The SmartCloud platform consists solely of IBM hardware, software, services and practices.

IBM SmartCloud Enterprise and SmartCloud Enterprise+ are designed to compete with products like those of Rackspace and Amazon Web Services. Erich Clementi, vice president of Global Technology Services at IBM, said in 2012 that the goal with SmartCloud Enterprise and SmartCloud Enterprise+ was to provide an Amazon EC2-like experience primarily for test and development purposes and to provide a more robust experience for production workloads.

In 2011, IBM SmartCloud integrated Hadoop-based InfoSphere

BigInsights for big data, Green Hat for software testing and Nirvanix for cloud storage. In 2012, the then new CEO Virginia Rometty said the company planned to spend $20 billion on acquisitions by 2015.

1. Private cloud, owned and operated by the customer
2. Private cloud, owned by the customer, but operated by IBM (or another provider)
3. Private cloud, owned and operated by IBM (or another provider)
4. Virtual private cloud services (based on multi-tenanted support for individual enterprises)
5. Public cloud services (based on the provision of functions to individuals)

The majority of cloud users choose a hybrid cloud model, with some workloads being served by internal systems, some from commercial cloud providers and some from public cloud service providers.

On August 25, 2011, IBM announced the release of a new hybrid cloud model orchestrated by IBM WebSphere Cast Iron integration of on- and off-premises resources. Enterprises can use Cast Iron integration to link their public cloud appliances— hosted on environments like Amazon EC2, Google Apps, Salesforce.com, Oracle CRM, SugarCRM and a number of others—to their existing systems or in-house, private cloud environments. Cast Iron Integration aims to reduce the time and effort needed for customized coding, in favor of simple workload provisioning through Tivoli Management Framework.

The IBM public cloud offering, SmartCloud Enterprise, was launched on April 7, 2011. SCE is hosted IaaS with service level agreements (SLA)s, and can be offered in a private, public or hybrid model. The environment is hosted on IBM servers (System p or System x), with a standard set of software images to choose from.

IBM participates in several cloud standards initiatives within various standards development organizations involved in cloud service models IaaS, PaaS and SaaS, all of which work toward improvements in cloud interoperability and security.

IBM is a member of The Open Group, a council that works for the development of open, vendor-neutral IT standards and certifications. Other members of the group include HP, Oracle, SAP and numerous others.[27] IBM contributed the Cloud Computing Reference Architecture in February 2011 to The Open Group as the basis of an industry-wide cloud architecture. IBM's CCRA is based on real-world input from many cloud implementations across IBM. It is intended to be used as a blueprint/guide for architecting cloud implementations, driven by functional and non-functional requirements of the respective cloud implementation. HP and Microsoft have also published Cloud Computing Reference Architectures.

Within the IaaS space, IBM is a member of the Cloud Management Work Group (CMWG) within the Distributed Management Task

Force (DMTF), which released a draft version of their IaaS APIs, called the Cloud Infrastructure Management Interface (CIMI), on September 14, 2011. The CIMI APIs define a logical model for the management of resources within the Infrastructure as a Service domain. With these APIs, clients can create, manage and connect machines, volumes and networks.

IBM Cloud Account

Create and login to IBM Account.

Link: https://cloud.ibm.com/registration

IBM Cognos Analytics:

IBM Cognos Business Intelligence is a web-based integrated business intelligence suite by IBM. It provides a toolset for reporting, analytics, scorecarding, and monitoring of events and metrics. The software consists of several components designed to meet the different information requirements in a company. IBM Cognos has components such as IBM Cognos Framework Manager, IBM Cognos Cube Designer, IBM Cognos Transformer.

Cognos Connection

Cognos Connection is the Web portal for IBM Cognos BI. It is the starting point for access to all functions provided with the suite. Using this portal, content can be searched in the form of reports, scorecards, and agents, it can be managed, structured, and displayed. In addition, the portal is used for multiple functions, for example to schedule and distribute reports, for creating tasks, administering the server, and the access permissions to content available to different users. You can also create shortcuts, URLs, and pages.

Query Studio

Query Studio allows simple queries and self-service reports to answer basic business questions. The report layout can be customized and data can be filtered and sorted. Formatting and creation of diagrams is also supported.[1]

Report Studio

The Report Studio is used to create management reports. It offers two different modes: The professional authoring mode enables users to access the full range of Report Studio functionality. In this mode, users can create any type of report, including charts, maps, lists, and repeat functions. In professional authoring mode all types of Data (relational or multidimensional) can be used, but dynamic data can not be displayed.[1]

The express authoring mode has a more simple user interface, designed for non-technical users. It enables them to create traditional financial or management reports in a more focused user interface. In contrast to the professional authoring mode, the express authoring mode allows the use of dynamic data.

Analysis Studio

Users can create analyses of large data sources and search for background information about an event or action. Multidimensional analysis allows identifying trends and understanding of anomalies or deviations, which are not obvious in other types of reports. Drag-and-drop features, elements and key performance indicators can be included in the analysis, rows and columns can be switched, OLAP-functionalities[2][3] like drill-up and drill-down can be used to get a deeper understanding about the sources of the information used in the analysis.

Event Studio

The Event Studio is a notification tool that informs about events within the enterprise in real time. Therefore, agents can be created to detect the occurrence of business events or exceptional circumstances, based on the change of specified event- or data conditions. A notification may be served by sending an e-mail, its publication in the portal, or by triggering reports. This can be used to handle failure with notification. It is very robust in nature.

Workspace

IBM Cognos Workspace (formerly introduced in version 10.1 as IBM Cognos Business Insight and renamed in version 10.2.0) is a web-based interface that allows business users to use existing IBM Cognos content (report objects) to build interactive workspaces for insight and collaboration.

**Working with Dataset**

Exploration Of Chorestrol By Age And Gender :

Cholesterol is a waxy, fat-like substance that plays many roles in the body, including synthesizing hormones and vitamin D. It also assists in the transporting of lipids. Cholesterol is found in the foods you eat, but it is also made by the liver.

Cholesterol circulating in the blood is carried by special particles called lipoproteins. The two major cholesterol-carrying lipoproteins are lowdensity lipoprotein (LDL) and high-density lipoprotein (HDL):

1. LDL cholesterol (LDL-C) is often referred to as "bad" cholesterol because too much of it can build up in your arteries and form plaques, which increases the risk of heart disease.

1. HDL cholesterol (HDL-C) is often referred to as "good" cholesterol as it carries cholesterol to the liver to be broken down and excreted.

LDL Cholesterol Range by Age and Assigned Sex

Age/Sex Classification LDL

|  |  |  |
| --- | --- | --- |
| Males 19 and younger | Normal | Less than 110mg/dL |
|  | Borderline | 110-129mg/dL |
|  | High | Greater than or equal to 130mg/dL |
| Males 20 and older | Normal | Less than 100 mg/dL |
|  | Borderline | 130-159 mg/dL |
|  | High | 160-189mg/dL |
| Females 19 and younger | Normal | Less than 110mg/dL |
|  | Borderline | 110-129mg/dL |
|  | High | Greater than or equal to  130mg/dL |
| Females 20 and older | Normal | Less than 100 mg/dL |
|  | Borderline | 130-159 mg/dL |
|  | High | 160-189mg/dL |

HDL Cholesterol Range by Age and Assigned Sex

Age/Sex Classification HDL

Males 19 and younger Optimal More than 45 mg/dL

|  |  |  |
| --- | --- | --- |
| Males 20 and older | Optimal | More than 40 mg/dL |
| Females 19 and younger | Optimal | More than 45 mg/dL |
| Females 20 and older | Optimal | More than 50 mg/dL |

Exploration of Data :

Exploration of Data relationships among the values is presented along with plotting of Average Age for different Chest Pain Types. For visualizing it, we will require the following data:

1. Sex
2. Age
3. Chest Pain Type

From the bar graph, we can observe that among disease patients, male are higher than female.

Chest pain distribution according to target variable :

Chest pain (cp) or angina is a type of discomfort caused when heart muscle doesn’t receive enough oxygen rich blood, which triggered discomfort in arms, shoulders, neck, etc.

However, looking at the bar graph above, its raised a question of higher number of healthy subject having typical\_angina. Or in other word, most of the healthy subject having chest pain, which is also discussed here.

Chest pain can be subjective due to stress, physical activities and many more and varies between gender. Women and elderly patients usually have atypical symptoms with a history of disease. This article provide analysis comparing typical anginal vs nontypical angina patients in a clinical trial.

Exploration Of Max Heart Rate During The Chest Pain:

Average Max Heart Beat Achieved during Chest Pain:

Here we are plotting the average Max Heartbeats recorded for a person based on Gender and Chest Pain Type.

For moderate-intensity physical activity, your target heart rate should

be between 64% and 76%1,2 of your maximum heart rate. You can estimate your maximum heart rate based on your age. To estimate your maximum age-related heart rate, subtract your age from 220. For example, for a 50-year-old person, the estimated maximum age-related heart rate would be calculated as 220 – 50 years = 170 beats per minute (bpm). The 64% and 76% levels would be:

1. 64% level: 170 x 0.64 = 109 bpm, and
2. 76% level: 170 x 0.76 = 129 bpm

This shows that moderate-intensity physical activity for a 50-year-old person will require that the heart rate remains between 109 and 129 bpm during physical activity.

For vigorous-intensity physical activity, your target heart rate should

be between 77% and 93%1,2 of your maximum heart rate. To figure out this range, follow the same formula used above, except change “64 and 76%” to “77 and 93%”. For example, for a 35-year-old person, the estimated maximum age-related heart rate would be calculated as 220 – 35 years = 185 beats per minute (bpm). The 77% and 93% levels would be:

1. 77% level: 185 x 0.77 = 142 bpm, and
2. 93% level: 185 x 0.93 = 172 bpm

This shows that vigorous-intensity physical activity for a 35-year-old person will require that the heart rate remains between 142 and 172 bpm during physical activity.

Exploration Of BP By Age:

Blood Pressure vation by Age

Here we need to consider the age as a dimension, because we want to plot the BP values against it. Changing the age from a measure to dimension will allow us to plot all values from BP present in the dataset corresponding to their age.

Blood pressure readings are composed of two numbers—for example, 120/80 mm Hg. Both numbers are an important part of your blood pressure reading.

The top number (systolic pressure) measures the pressure in your arteries when your heart beats. The bottom number (diastolic pressure) measures the pressure in your arteries between each heart beat.

The standard unit of measure, mm Hg, stands for "millimeters of mercury." Mercury pressure gauges have been replaced with electronic pressure gauges, but the abbreviation is still used.

Blood Pressure by Age

Men Women

|  |  |  |
| --- | --- | --- |
| 18-39 years | 119/70 mm Hg | 110/68 mm Hg |
| 40-59 years | 124/77 mm Hg | 122/74 mm Hg |
| 60+ years | 133/69 mm Hg | 139/68 mm Hg |
|  |  |  |

Blood Pressure by Race/Ethnicity

White 122/71 mm Hg

|  |  |
| --- | --- |
| Black | 127/73 mm Hg |
| Mexican American | 123/70 mm Hg |

Exploration Of BPvsChestPainType And Gender :

Average BP during the Chest Pain

We are going to plot average BP recorded for Male and Female based on Gender during the Chest pain recorded.

Background: Gender has been proposed as a potentially important predictor of bereavement outcomes. The majority of research in the field has explored this issue by examining gender differences in global grief severity. Findings have been mixed. In this study, we explore potential gender differences in grief using network analysis. This approach examines how individual symptoms relate to and reinforce each other, and so offers potential to shed light on novel aspects of grief expression across genders.

Method: Graphical lasso networks were constructed using self-report data from 839 spousally bereaved older participants (584 female, 255 male) collected at 2- and 11- months post-bereavement. Edge strength, node strength and global network strength were compared to identify similarities and differences between gender networks across time.

Results: At both time points, the strongest connection for both genders was from yearning to pangs of grief. Yearning, pangs of grief, acceptance, bitterness and shock were prominent nodes at time 1. Numbness and meaninglessness emerged as prominent nodes at time 2. Males and females differed in the relative importance of shock at time 1, and the female network had greater overall strength than the male network at time 2.

Conclusions: This study identified many similarities and few differences in the relationships between prolonged grief symptoms for males and females. Findings suggest that future studies should examine alternate sources of variation in grief outcomes. Limitations are discussed.

Loading the Dataset :

According to our project:-

1. Navigate to a package or data module in Team content or My content.

1. From the package or data module context menu , tap Create data set.
2. Drag the data items from the source pane to the data set editor pane. The items appear as columnar data in a similar fashion to a list report.

1. For relational data or data modules, select the Summarize detailed values, suppressing duplicates check box.

If you are not sure if this check box should be selected, clear the check box to see how the data is aggregated in the edit window. Condensed data that is set into fewer rows usually leads to better performing reports and dashboards. A reason for not aggregating the data in your data set is that you lose some details in the process, and the data from one system might not match the data from another system. This is especially true for calculations, such as an average.

1. To add filters to the columns or individual items of the data set, tap the item and then tap . You can add a customized filter or use one of the preset options.

1. For data with prompts, tap Reprompt to choose values or enter different values.

1. If your data set is very large, you can tap the Page views icon and toggle between the two settings:
   1. Tap Page design to avoid delays in data retrieval. o Tap Page preview when you want to see the refreshed data.

1. After you are done adding columns, tap the save icon .
   1. To save the data set for the first time or to save changes to the data set, from the drop-down list tap Save. This option saves the metadata, but does not load the data. Depending on the data set, loading data may take some time. o To save an updated data set to a new data set, from the drop-down list tap Save as. This option saves the metadata, but does not load the data. Depending on the data set, loading data may take some time. o To save the data set and load the data, from the drop-down list tap Save and load data. In addition to saving new or changed metadata, this option loads data. This data is immediately available when you use it in the creation of a dashboard or story.

1. In the Save as window, choose where to save the data set. In the Save as box, type a name, and then tap Save.

1. Optional: To create a data set while building a dashboard, perform the following steps:
   1. Create a new dashboard, choose a template, and tap OK.
   2. Tap to add some data.
   3. Navigate to a package by tapping Team content, and then tap Open.
   4. The Create data set window appears. You can create a new data set and after you save it, you can continue to build your dashboard.

If you need to modify the data set, you can also do that from within the dashboard by expanding the data sources.

Understanding the Dataset:

This database contains of 14 fields. The "goal" field refers to the presence of heart disease in the patient. It is integer valued from 0 (no presence) to 4.

The data dictionary is as follows :

SnoField Name

1. Age
2. Sex
3. Chest pain type
4. BP
5. Cholesterol
6. FBS over 120
7. EKG results
8. Max HR
9. Exercise angina
10. ST depression 11 Slope of ST Number of
11. vessels fluro
12. Thallium
13. Heart Disease

Reference :

The data can be downloaded from the following:

https://www.kaggle.com/datasets/rishidamarla/heart-diseaseprediction

**CHAPTER 8**

**CONCLUSION**

it is clear that SVM, Random Forest and Simple Logistic models

Arduino Uno with the necessary sensors.

Real-time sensor data on a serial monitor in Arduino-based system.

showed higher accuracy rates of more than 95 percent which make them considerable models for biomedical applications of disease detection and prediction. Moreover, to determine the best performing model for the considered databases in this study, other analysis criteria are considered. The accuracy, sensitivity, specificity, precision, and F-score of SVM is higher than both Random Forest and Simple Logistic models. Besides, the miss rate of SVM is lowest. The number of features also affects the performance of the model classification and prediction capabilities. The unpublished results of this work indicated that when features numbers were reduced, the model performance measures were also reduced with SVM still showing the best performance. The same analysis was performed in Python platform where SVM also showed the best performance among the models with Radial Basis Kernel Function. Therefore, it is decisive that Support Vector Machine is the most efficient algorithm to be implemented on the heart disease prediction system as found in our study when the 13 features were considered. In the previous research works [[2](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#ref2)] - [[14](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#ref14)] [[17](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#ref17)] [[18](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#ref18)] [[19](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#ref19)] concerning comparison among various machine learning algorithms, it was found that no algorithm attained an accuracy level of more than 90 percent in heart disease prediction using the same number and types features as used in this study. Moreover, in this study, two datasets consisting of the same number and type of attributes were merged. Therefore, the chosen model will be more robust than that of presented in other studies. [Table 3](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#t3) explains the relationship among the temperature, humidity, heart rate and different decisions of action pertaining to risk level and human comfort that can be applied to the designed Continuous Patient Monitoring system. This design validates the possibility of an integrated Cardiac patient monitoring system which can be used by the patient at home environment and enables the patient with an online centralized monitoring system where the doctors/nurses can provide real-time suggestions.

In future works, Photoplethysmography (PPG) based blood pressure sensor module or electronic sphygmomanometer can also be connected to the Arduino which will be capable of transmitting real-time data to the server. This sensor is not added to the designed patient monitoring system due to the unavailability of a clinically recognized system at this moment, although huge research is going on the development of PPG based blood pressure monitor [[20](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#ref20)] . Though a model of the cloud-based heart disease detection application is represented here, the future works will be focused on the

development of a dedicated server and data

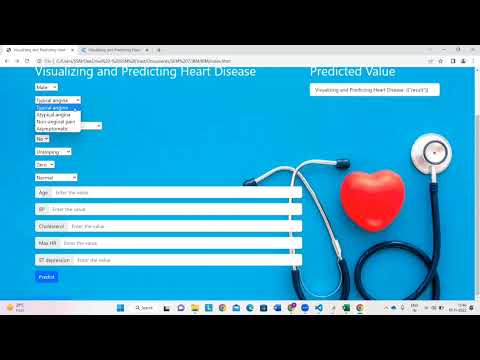
Thus, any patient or doctor from any region of the globe will be capable of installing this application and use this application for heart disease prediction as reported in [[21](https://www.scirp.org/journal/paperinformation.aspx?paperid=88650#ref21)] . Alongside heart disease, this system can also be used for any disease patient monitoring purposes.

**CHAPTER 9**

**REFERENCES**

|  |  |
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git hub : https://github.com/IBM-EPBL/IBM-Project-37439-1660309228

youtube video : 

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