Project Design Phase-I
Solution Architecture

Date	19 September 2022
Team ID	PNT2022TMID23446
Project Name	Visualizing and Predicting Heart Diseases with an Interactive Dash Board
Maximum Marks	4 Marks

Team ID: PNT2022TMID23446

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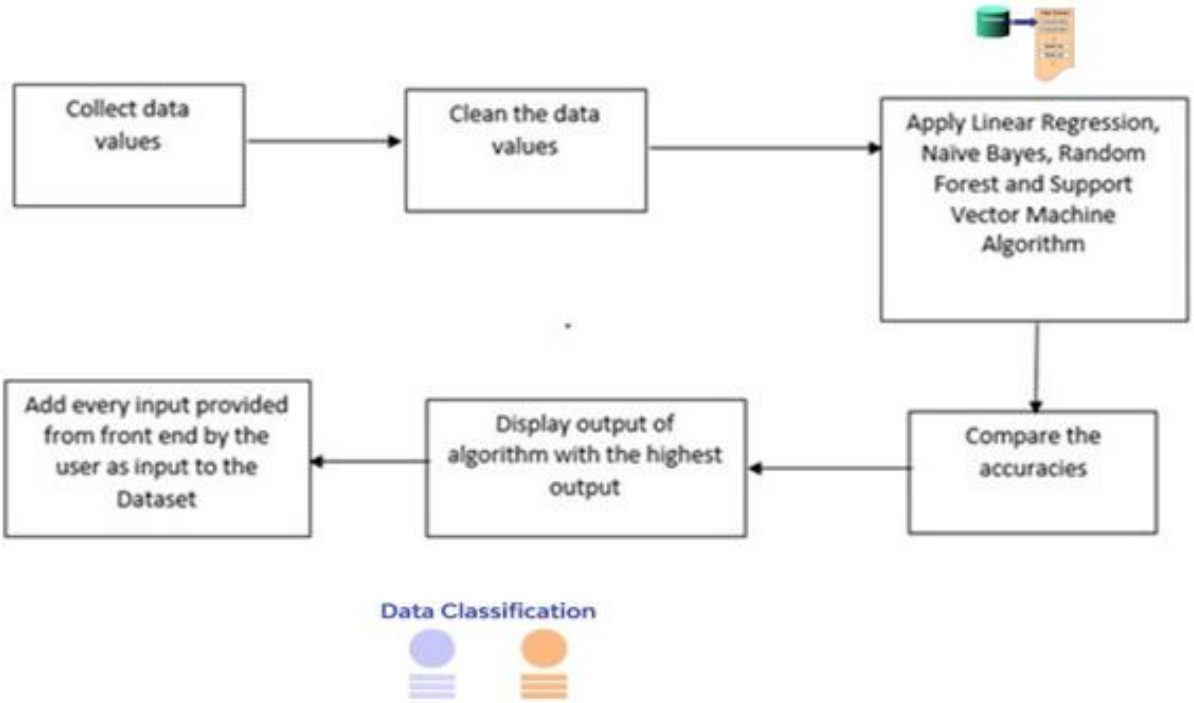
Solution Architecture:

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

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

Solution Architecture Diagram:



- Cardiovascular diseases are the most common cause of death worldwide over the last few decades in the developed as well as underdeveloped and developing countries.
- Early detection of cardiac diseases and continuous supervision of clinicians can reduce the mortality rate.
- However, accurate detection of heart diseases in all cases and consultation of a patient for 24 hours by a doctor is not available since it requires more sapience, time and expertise.
- In this study, a tentative design of a cloud-based heart disease prediction system had been proposed to detect impending heart disease using Machine learning techniques.
- For the accurate detection of the heart disease, an efficient machine learning technique should be used which had been derived from a distinctive analysis among several machine learning algorithms in a Java Based Open Access Data Mining Platform, WEKA.

Data mining turns the large collection of raw healthcare data into information that can help to make informed decisions and predictions. There are 13 columns in the dataset, which are described below.

No.	Attribute	Description
1	Age	Age in years
2	Sex	Male = 1, female = 0
3	Cp	Chest pain type (typical angina = 1, atypical angina = 2, non-anginal pain = 3, asymptomatic = 4)
4	Trestbps	Resting blood sugar (in mm Hg in case of admission to hospital)
5	Chol	Serum cholesterol in mg/dl
6	Fbs	Fasting blood sugar > 120 mg/dl (true = 1, false = 0)
7	Restecg	Resting electrocardiographic results (normal = 0, having ST-T wave abnormality = 1, left ventricular hypertrophy = 2)
8	Thalach	Maximum heart rate
9	Exang	Exercise-induced angina
10	Old peak	ST depression induced by exercise comparative to rest
11	Slope	Slope of the peak exercise ST segment (upsloping = 1, flat = 2, down sloping = 3)
12	Ca	Number of major vessels which are colored by fluoroscopy
13	Thal	Normal = 0, fixed defect = 2, reversible defect = 3

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. **CP**: 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. **Trestbps**: 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. **Chol**: 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. **Fbs**: 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. **Rest 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. **Thalach**: 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. **Exang :** 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. **Old Peak** : 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 multi- vessel 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.

5.1. Performance Analysis of Machine Learning Algorithms

There are various kinds of algorithms are available, which can be applied to the dataset. More than 10 algorithms are applied to the dataset, among those only 5 important algorithms are analyzed and discussed which showed an accuracy level of more than 80%. The algorithms are applied to the data set by using 10-fold Cross-Validation on WEKA version 3.8.2 for measuring the performance of the machine learning algorithms. The following measures are calculated for performance analysis:

$$\text{Precision} = \frac{tp}{tp+fp} \tag{1}$$

$$\text{Recall} = \frac{tp}{tp+fn} \tag{2}$$

$$F_{\text{score}} = \frac{2\times\text{precision}\times\text{recall}}{\text{precision}+\text{recall}} \tag{3}$$

$$\text{Accuracy} = \frac{tp+tn}{n} \tag{4}$$

$$\text{Sensitivity} = \frac{tp}{tp+fn} \tag{5}$$

$$\text{Specificity} = \frac{tn}{tn+fp} \tag{6}$$

Here,

n = Total number of instances, tp = true positive, tn = true negative,

fp = false positive, fn = false negative.

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 . 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 database for this type of patient monitoring application. If the proposed application can be integrated and developed successfully, it will be available in the Android play store consequently. 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 . Alongside heart disease, this system can also be used for any disease patient monitoring purposes.