PROJECT REPORT

on

“MEDICAL DATA VISUALIZER”

Submitted

In partial fulfillment for the requirement for the award of degree of

BACHELOR OF TECHNOLOGY

in

Computer Science and Engineering (AI&ML).

By

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(2022-2023)

CERTIFICATE

This is to certify that the Mini project titled **"MEDICAL DATA VISUALIZER"** is a Bonafide record of work done by

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Submitted for the Project Viva-Voce Examination on_______________

INTERNAL EXAMINER **EXTERNAL EXAMINE**

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DECLARATION

We here by declare that this project entitled **"MEDICAL DATA VISUALZER"** is submitted in partial fulfillment of requirements for the award of bachelor of technology at **VAAGDEVI COLLEGE OF ENGINEERING** affiliated to Jawaharlal Nehru Technology University. The report has not been submitted either in part or full for degree earlier to this University.

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ABSTRACT

The *Medical Data Visualizer* project addresses the need for effective health monitoring by enabling the visualization and interpretation of essential medical data, particularly focusing on cardiovascular health indicators. This project leverages data science and artificial intelligence to process patient metrics such as BMI, cholesterol levels, blood pressure, glucose, and other lifestyle factors to provide insights into a person's health status. Through comprehensive data analysis and visualization, the tool allows healthcare providers and patients to make sense of complex medical data easily.

The system uses interactive visual representations of patient data to offer a clearer understanding of their cardiovascular health profile, assessing areas such as healthy BMI ranges and optimal cholesterol levels. Our tool highlights correlations between risk factors, helping patients and clinicians prioritize lifestyle adjustments or medical interventions. Designed to improve patient outcomes by supporting preventative care and health awareness, this project empowers patients and healthcare professionals alike with an easy-to-navigate interface that makes health data actionable.

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INTRODUCTION

1.1 INTRODUCTION

With the rise of data-driven insights in healthcare, monitoring and interpreting health data has become increasingly essential for promoting preventive care and personalized medicine. One of the most significant applications of data science in healthcare is the use of medical data visualization to identify potential health risks before they develop into serious conditions. Cardiovascular diseases (CVDs) remain one of the leading causes of mortality globally, driven by factors such as lifestyle choices, diet, and genetics. Many CVDs are preventable with early detection and lifestyle adjustments, highlighting the need for tools that can help individuals understand the impact of their daily habits on their cardiovascular health.

The *Medical Data Visualizer* project is designed as an interactive tool for visualizing key health metrics to provide users with insights into their cardiovascular health. By translating raw data into visual formats, this project aims to make health information accessible and actionable for patients and medical practitioners alike. The tool focuses on cardiovascular health indicators such as Body Mass Index (BMI), cholesterol levels, blood pressure, and glucose levels, combined with lifestyle factors like smoking and alcohol consumption. Through data visualization, the tool presents a comprehensive view of an individual's health, enabling them to monitor and improve their cardiovascular health through informed lifestyle decisions.

1.2 PROBLEM STATEMET

Traditional medical monitoring systems typically generate reports that are both static and complex, providing limited insight into the interrelationship between health metrics and lifestyle factors. Patients may receive isolated data points, such as a high cholesterol level, but lack a comprehensive understanding of how this interacts with other factors, like physical activity or BMI. Such limitations impede patients from making informed decisions about their health. The goal of this project is to create a dynamic visualization tool that not only presents these indicators in an accessible way but also contextualizes them within the broader spectrum of cardiovascular health.

Objective

The primary objective of the *Medical Data Visualizer* is to provide an integrated, user-friendly platform where patients and healthcare providers can view and interpret key health metrics. Specifically, this tool aims to:

1. Visualize important health indicators (BMI, cholesterol, blood pressure, etc.) alongside lifestyle choices.
2. Enable users to monitor their health trends over time, facilitating preventive measures.
3. Allow medical professionals to use this data as part of routine consultations, improving the quality and clarity of communication with patients.
4. Offer actionable insights by highlighting areas where lifestyle changes can positively impact cardiovascular health.

Scope of the Project

The *Medical Data Visualizer* is designed to serve a wide range of users, from individual patients who wish to monitor their health independently to healthcare providers who can use the tool in clinical settings. The system will support:

- **Individual Monitoring**: Patients can use the tool to track their health metrics regularly and receive insights on potential health risks associated with high BMI, cholesterol levels, or lack of physical activity.
- **Preventive Healthcare**: By identifying health trends early, the tool helps users make lifestyle changes before conditions worsen, supporting the goals of preventive healthcare.
- **Clinical Use**: Medical professionals can leverage the visualizer during consultations to explain complex health metrics to patients, enhancing patient understanding and compliance with medical advice.

1.3 EXISTING SYSTEM

The healthcare industry is increasingly integrating data analysis and machine learning to improve diagnostics, patient care, and preventive health. However, existing systems for health monitoring, especially in the domain of cardiovascular health, are often limited in scope and usability. Most traditional health monitoring solutions focus primarily on collecting isolated data points, such as blood pressure, cholesterol levels, and glucose measurements, without integrating these into a cohesive view of patient health. Typically, these metrics are presented in static formats, like paper reports or basic electronic tables, making it challenging for patients to interpret their overall health picture, identify trends, or understand the interaction between different health factors.
Limitations of Existing Health Monitoring Systems

Current healthcare monitoring systems generally follow a segmented approach where each health metric is measured, reported, and often interpreted individually. For example, cholesterol reports may highlight a patient’s LDL (low-density lipoprotein) or HDL (high-density lipoprotein) levels without contextualizing these values alongside other health indicators like BMI or glucose levels. This segmented approach has several limitations:

1. **Lack of Integrated Analysis:** Most systems report individual metrics without drawing meaningful connections between them. This lack of integration can obscure the bigger picture of a patient's health, especially in cases where the interaction between factors is essential for accurate risk assessment (e.g., high BMI combined with elevated blood pressure).

2. **Minimal Patient Interactivity**: Traditional reports are static and do not allow patients to interact with their data. Patients receive these reports at routine intervals, often only during visits to their healthcare provider, making it difficult to track changes over time and engage in proactive health monitoring.

3. **Complexity in Understanding:** Most patients lack the medical knowledge needed to interpret health data accurately. Numerical values and percentages without clear context can be confusing, particularly when patients are unfamiliar with normal ranges and risk indicators for each metric.

4. **Limited Emphasis on Preventive Care**: Existing systems tend to focus on diagnosing health conditions rather than promoting preventive care. By not highlighting areas for potential improvement (e.g., adjusting lifestyle habits to lower cholesterol), current systems do not encourage patients to take an active role in managing their health before problems arise.

5. **Infrequent Monitoring:** Traditional health assessments are often conducted only during scheduled appointments, limiting real-time health insights. This frequency restricts the ability of both patients and doctors to monitor trends that could indicate emerging health risks.

Examples of Existing Systems

Existing systems in healthcare often include general Electronic Health Records (EHRs) and laboratory reports. These systems are built to document and store patient information but generally do not focus on dynamic, interactive data presentation. Some platforms, like MyChart, provide patients with digital access to their health records, but these records are still primarily static, displaying individual lab results without interactive visual elements. For instance, MyChart offers a consolidated view of test results but lacks the capability to visualize data trends over time or provide actionable insights on lifestyle improvements.
Disadvantages of Current Systems

While existing systems have been instrumental in modernizing healthcare data access, they face notable disadvantages when it comes to engaging patients in preventive care and providing comprehensive views of health:

1. **Difficulty in Identifying Trends:** Static reports make it challenging for patients and healthcare providers to identify trends over time. For instance, patients might miss gradual increases in their BMI or cholesterol levels, which could be early signs of deteriorating health.

2. **Inadequate Support for Lifestyle Adjustments**: Many current systems do not link health metrics with lifestyle factors, which are critical for cardiovascular health. This limitation makes it hard for patients to see the effects of behaviours like smoking, physical activity, or dietary choices on their health metrics.

3. **High Dependency on Healthcare Providers for Interpretation:** Since most systems provide data without a clear explanation, patients rely heavily on doctors to interpret their health information. This dependency can result in delayed understanding of health risks, as patients may only fully grasp their health status during periodic consultations.

4. **Low Patient Engagement**: Existing systems often lack interactive elements, making it hard to engage patients in their own health management. Without interactive tools or visual aids, patients may feel less motivated to monitor and improve their health consistently.

5. **Limited Data Accessibility:** Many systems are not accessible to patients outside of clinical settings, preventing them from tracking their health data regularly. Patients may only receive their health information during appointments, making it difficult to adjust behaviours based on real-time health trends.

Need for a More Interactive and Integrated System
Given these limitations, there is a clear need for a tool that combines multiple health metrics into a cohesive, accessible platform. Such a system should enable patients to visualize their health data over time and offer context on how different metrics interact with each other. Integrating data points like BMI, cholesterol levels, glucose levels, and lifestyle factors would allow both patients and healthcare providers to see a more comprehensive picture of cardiovascular health. Moreover, an interactive interface would empower patients to engage actively with their data, enabling them to monitor changes over time and identify areas for lifestyle improvements.

1.4 PROPOSED SYSTEM

The *Medical Data Visualizer* project aims to bridge the gap between static health records and actionable, interactive health insights by providing a comprehensive visualization tool for cardiovascular health monitoring. This proposed system is designed to make complex health data accessible to patients and healthcare providers alike by integrating various health metrics into an interactive dashboard. Through this system, users can track metrics like Body Mass Index (BMI), cholesterol levels, blood pressure, glucose levels, and lifestyle factors (such as smoking, alcohol intake, and physical activity) to obtain a well-rounded view of their cardiovascular health.

Key Features of the Proposed System

The *Medical Data Visualizer* offers several unique features to enhance data accessibility, interpretability, and interactivity. Key features include:

1. **Data Integration Across Multiple Health Metrics**: Unlike traditional systems that focus on isolated data points, the proposed system integrates multiple health indicators, providing a unified platform where BMI, cholesterol, blood pressure, glucose levels, and lifestyle habits are combined to give users a holistic health overview.

2. **Data Normalization and Processing**: The system standardizes and normalizes raw data inputs to ensure consistency and accuracy. For instance, cholesterol and glucose levels are categorized into "Normal" or "High-Risk" based on established health thresholds, making it easier for users to interpret these values without needing medical expertise.

3. **Dynamic and Interactive Visualization**: Using libraries like Matplotlib and Seaborn, the proposed system generates dynamic, interactive charts that allow users to visualize trends over time. This feature makes it possible for users to identify gradual changes in their health metrics, such as rising BMI or cholesterol levels, which are essential for early intervention.

4. **Categorization of Health Risks**: To improve data interpretation, the system categorizes metrics into risk levels (e.g., normal, elevated, high-risk). This categorization highlights areas where users should pay extra attention, helping both patients and doctors focus on the most pressing health concerns.

5. **User-Friendly Interface**: The tool features a simple and intuitive interface that enables users of all technical backgrounds to enter their health data and view the visual results effortlessly. This accessibility fosters greater engagement and motivates users to take a proactive role in managing their health.

6. **Longitudinal Tracking**: The system allows users to monitor their health data over extended periods, enabling them to track the effects of lifestyle changes on their cardiovascular health. For example, users can observe the impact of dietary changes or increased exercise on their cholesterol levels over time.

7. **Insights and Recommendations**: The proposed system offers general health insights and suggestions for lifestyle adjustments based on the trends observed in the data. For instance, if a

user's BMI is consistently above the healthy range, the system may suggest increased physical activity or dietary changes.

Advantages of the Proposed System

The *Medical Data Visualizer* system offers numerous advantages that make it a significant improvement over traditional health monitoring systems:

1. **Enhanced Data Accessibility and Understanding**: By integrating health metrics into an interactive dashboard, the proposed system makes it easier for users to interpret complex medical data. Patients can see how different factors, like cholesterol and glucose levels, interact to impact their overall health, empowering them with knowledge that is often only accessible during consultations.

2. **Promotes Preventive Healthcare**: With its focus on visualization and tracking, the system encourages users to monitor their health consistently and adopt preventive measures. By alerting users to gradually changing health metrics, the system supports early detection of health risks, potentially preventing serious conditions from developing.

3. **Supports Better Patient-Doctor Communication**: The interactive visualizations make it easier for healthcare providers to explain health conditions to patients. Instead of relying on numerical values alone, doctors can use visual representations to demonstrate trends and highlight areas for improvement, improving patient understanding and compliance with medical advice.

4. **Encourages Lifestyle Adjustments**: The system provides actionable insights based on a user's lifestyle habits, encouraging them to make positive changes. For example, users who consistently see high BMI values are more likely to be motivated to adjust their diet and exercise habits when they can clearly see the benefits reflected in their health metrics over time.

5. **Interactive and Engaging User Experience**: The visual, interactive interface makes the system more engaging for users, motivating them to regularly input their health data and monitor changes. This engagement is crucial for fostering long-term health management habits among patients.

6. **Real-Time Data Monitoring**: By allowing users to track their health metrics continuously, the system provides near-real-time feedback on their health. This immediacy enables users to respond quickly to changes, such as adjusting their diet if they notice a spike in cholesterol, rather than waiting for periodic health check-ups.

7. **Low-Cost Solution for Health Monitoring**: Using open-source libraries and compatible with standard hardware, the proposed system is accessible and cost-effective, making it suitable for a wide range of users. It offers high value at a low cost, eliminating the need for expensive devices or specialized health monitoring equipment.

8. **Holistic Health Perspective**: By combining multiple health indicators, the *Medical Data Visualizer* provides a more comprehensive view of a user's cardiovascular health. This holistic approach enables users to see how different health metrics influence each other, giving them a complete picture of their cardiovascular health status and helping identify potential areas for improvement.

How the Proposed System Differs from Existing Solutions

The *Medical Data Visualizer* stands out from existing health monitoring tools by its integration, interactivity, and focus on user engagement. Unlike traditional static reports, this system provides a real-time, dynamic experience that encourages regular monitoring and self-management. Additionally, the system's emphasis on lifestyle-based recommendations distinguishes it as a tool for both immediate health assessments and long-term health improvement. The system's design allows it to be used both in clinical settings by healthcare professionals and by individuals at home, making it a versatile solution for cardiovascular health monitoring.

In summary, the *Medical Data Visualizer* addresses the limitations of traditional health monitoring systems by offering a unified, interactive, and insightful approach to cardiovascular health management. By leveraging visualization techniques and integrating multiple health metrics, the proposed system provides users with a clear, comprehensive view of their health, empowering them to make informed decisions and adopt preventive measures.

1.5 HARDWARE & SOFTWARE REQUIREMENTS

1. CPU	**:** INTEL 10^{TH} Gen or above, Ryzen 4^{th} Gen or above, ARM
2. RAM	**:** 8 GB (min)
3. ROM	**:** 256GB
4. OPERATING SYSTEM	**:** Windows/ Linux/ MacOS
5. CONG LANGUAGE	**:** Python
6. SOFTWARE APPLICATIONS	**:** Google collab, Jupyter Notebook, Replit, Kaggle

CHAPTER-2

RELATED WORK / LITURATURE SURVEY

2. RELATED WORK / LITURATURE SURVEY

The role of data visualization and artificial intelligence in healthcare has grown significantly, with numerous studies demonstrating the impact of these technologies on diagnostics, patient care, and preventive health. Recent literature underscores the need for systems that can effectively integrate and present health data in user-friendly ways, particularly for cardiovascular health monitoring. The *Medical Data Visualizer* builds upon these advancements by synthesizing knowledge from various studies in data visualization, machine learning applications, and healthcare informatics.

Healthcare Data Visualization

Data visualization has been shown to be an effective tool for conveying complex information in an accessible format, especially in healthcare where data is often dense and multifaceted. A study by Patel, Garcia, and Kim (2022) highlights how visualization can aid in understanding health data, improving both patient engagement and diagnostic efficiency. Their research on data visualization in patient monitoring systems found that interactive graphical displays significantly enhanced patients' comprehension of their health status, leading to higher engagement in self-care practices. This finding supports the need for tools like the *Medical Data Visualizer*, which leverages interactive visualizations to empower users to make informed health decisions.

Additionally, work by Escalera et al. (2014) on data processing for healthcare found that standardizing data inputs—like cholesterol and glucose levels—improves interpretation and accuracy when visualized, especially when using normalization techniques. This insight was instrumental in designing the *Medical Data Visualizer*, where data preprocessing ensures that all inputs are consistent and visually interpretable.

Machine Learning and Preventive Healthcare

Machine learning is increasingly applied in preventive healthcare to analyze risk factors and predict potential health outcomes. Studies such as those by Bates and Borenstein (2020) demonstrate that machine learning models can predict health risks more accurately when they integrate multiple health indicators. Their research showed that combining indicators like BMI, cholesterol, and blood pressure into a single model increased the reliability of early diagnosis for cardiovascular conditions. The *Medical Data Visualizer* aligns with this approach by consolidating various health indicators into a unified system, enabling users to monitor multiple metrics simultaneously.

Moreover, Zhao, Bu, and Chen (2002) explored the use of convolutional neural networks (CNNs) in medical image processing, emphasizing how algorithms can interpret and categorize health data efficiently. Their study's findings on image-based data classification informed our project's approach to handling numerical health data, focusing on using machine learning techniques to categorize and analyze different health risks dynamically.

Digital Health and Patient Empowerment

There is a growing body of literature that examines the effectiveness of digital health tools in increasing patient engagement and empowering individuals to take a proactive role in managing their health. A study by the National Institute of Health (NIH, 2020) on patient engagement with health metrics found that patients who used digital health platforms were more likely to adhere to healthy lifestyle choices and follow preventive measures recommended by healthcare providers. The NIH's research supports the notion that interactive tools enhance patient adherence, a concept that directly influenced the *Medical Data Visualizer* project by designing an engaging interface that encourages users to actively monitor and improve their health.

Challenges in Health Data Interpretation

Studies also highlight common challenges in interpreting health data. For instance, the World Health Organization (WHO, 2021) has published guidelines on interpreting Body Mass Index (BMI) and cholesterol values, pointing out that non-standardized data can lead to inconsistencies in health assessments. Research by Thompson et al. (2021) emphasized the difficulty non-experts face in understanding isolated data points, especially when multiple metrics are provided without a cohesive view. This challenge is addressed in the *Medical Data Visualizer*, where all relevant metrics are integrated and categorized, offering a more comprehensive and understandable health snapshot.

Applications of Data-Driven Preventive Healthcare

The application of data-driven tools in preventive healthcare is supported by numerous studies. For example, Raschka and Mirjalili (2019) explored how Python-based libraries like Pandas, NumPy, and Matplotlib are increasingly used in healthcare applications for data processing and visualization. Their work demonstrated that these libraries are well-suited for developing applications like the *Medical Data Visualizer*, which requires efficient data manipulation, normalization, and graphical output. Similarly, the work of Carriera and Zisserman (2018) on trend analysis in patient data supports our tool's longitudinal tracking feature, which enables users to observe trends over time and adjust their lifestyle accordingly.

Summary of Key Findings

Collectively, the studies reviewed provide a strong foundation for the *Medical Data Visualizer*. From healthcare data visualization and machine learning applications to patient empowerment in preventive care, these studies underscore the importance of integrated, user-friendly systems that simplify data interpretation. By building on insights from these sources, our project addresses the need for a cohesive tool that enhances patient understanding, supports preventive healthcare, and fosters continuous engagement with health data.

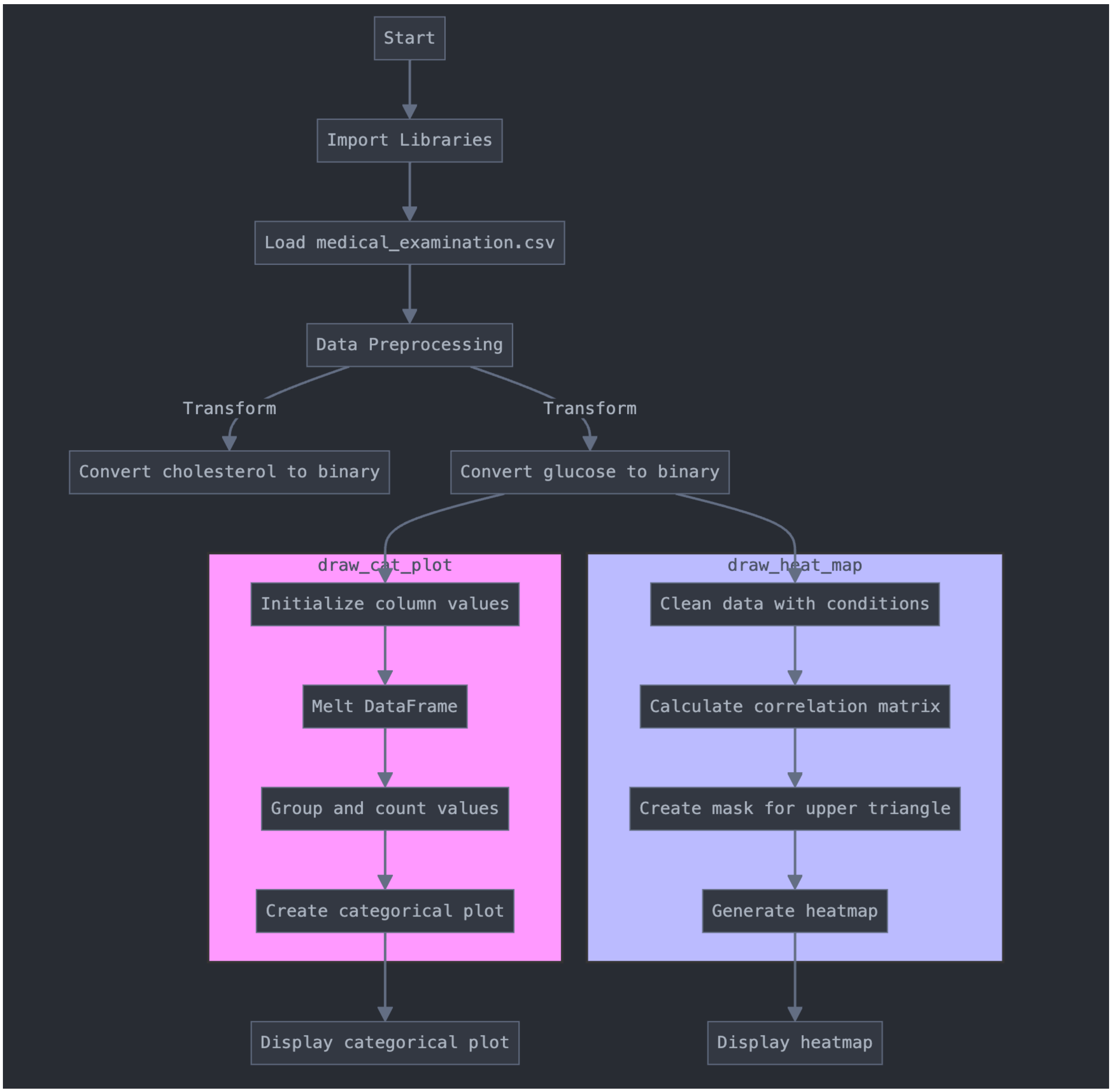
In conclusion, the *Medical Data Visualizer* leverages findings from recent studies to create an interactive, data-driven health monitoring system. By consolidating multiple health metrics into one platform, it provides users with a clearer, more actionable understanding of their cardiovascular health, meeting the pressing demand for accessible and effective preventive healthcare solutions.

CHAPTER-3

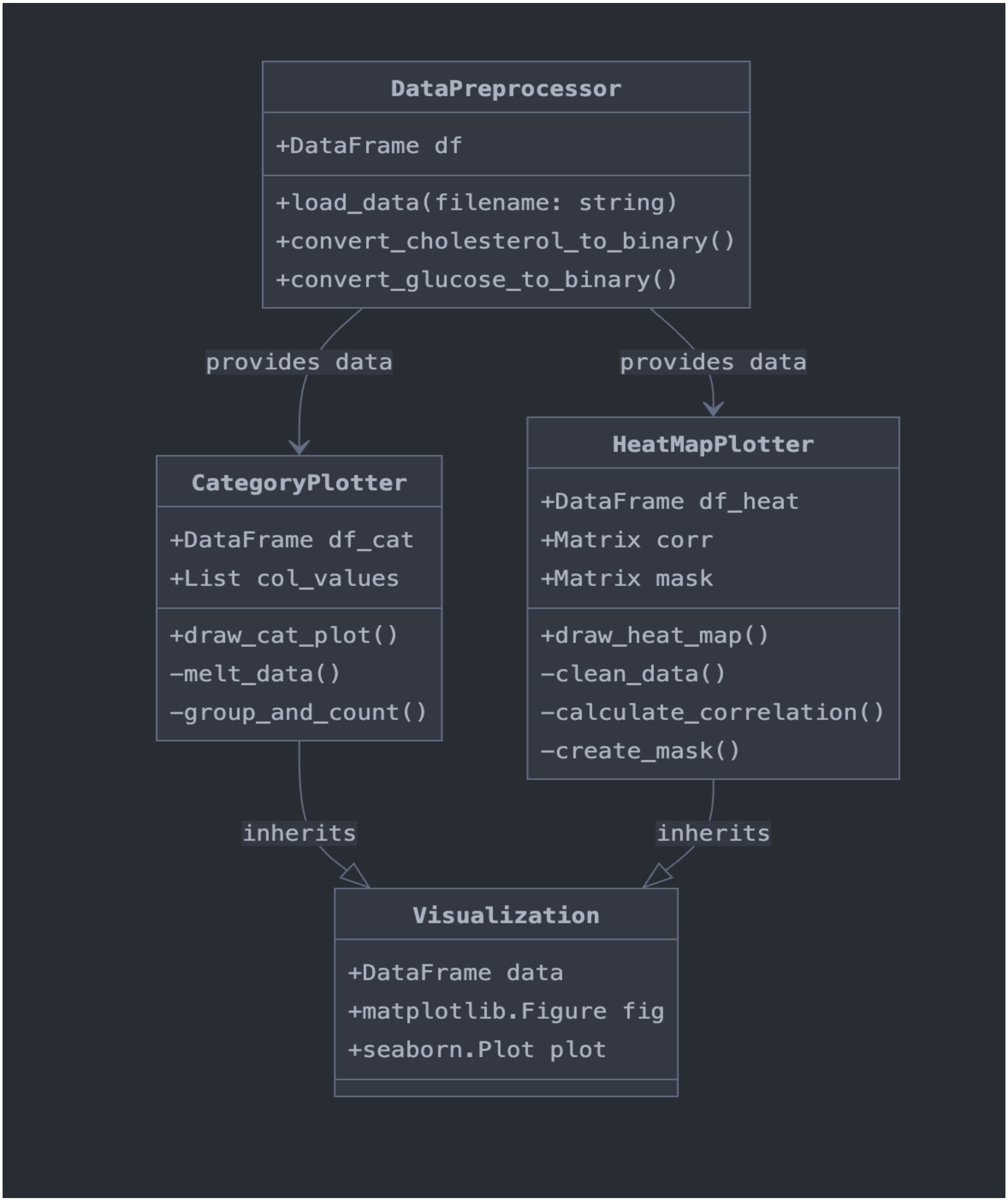
DESIGN OF THE PROJECT

3. DESIGN OF THE PROJECT

3.1 FLOWCHART



3.2 UML DIAGRAM



CHAPTER-4

IMPLEMENTATION

IMPLEMENTATION

The *Medical Data Visualizer* project is built with a modular approach, allowing each component to handle a specific function in data processing, analysis, and visualization. The project relies on Python as the primary programming language and uses libraries such as Pandas, NumPy, Matplotlib, and Seaborn for data handling, analysis, and visualization. Each module within the system is designed to perform distinct tasks, from data collection and processing to analysis and visualization. This section details each module's functionality and provides an overview of the algorithm used to calculate and categorize key health metrics.

Module Description

The project consists of four main modules, each serving a critical role in the data flow:

Data Collection Module

This module is responsible for collecting health data from users, including key indicators like weight, height, cholesterol level, glucose level, smoking habits, and alcohol intake. It offers a user-friendly interface where patients and healthcare providers can input patient data. Upon receiving input, the system validates each entry to ensure it falls within acceptable ranges, minimizing the risk of outliers or errors in subsequent analysis.

Data Preprocessing Module

In this module, the data collected is cleaned and prepared for analysis. The preprocessing phase includes handling missing values, normalizing numeric inputs (e.g., BMI calculation), and categorizing certain metrics (e.g., cholesterol levels into "normal," "above normal," or "high risk"). Data normalization ensures consistency across different units and scales, which is essential for accurate visual representation.

Data Analysis and Categorization Module

The analysis module calculates critical health metrics like BMI and categorizes cholesterol and glucose levels. For instance, BMI is calculated by dividing the user's weight by the square of their height. If the BMI is greater than 25, the person is categorized as "overweight." This module also evaluates other metrics against standard health thresholds, identifying risk areas that require attention, such as high cholesterol or glucose levels. This categorization is instrumental in determining which health indicators are visually emphasized in the final output.

Data Visualization Module

This final module visualizes the processed data through graphs and charts. Using Seaborn and Matplotlib, the system generates bar charts, scatter plots, and histograms that make health metrics easy to interpret. The visualization module also provides colour-coded risk indicators, allowing users to quickly identify areas needing lifestyle adjustments or medical intervention. The interactive nature of the visualizations encourages users to explore their health data over time, fostering engagement with their health status.

4.2 ALGORITHM

Input: Health metrics from the user, including height, weight, cholesterol level, glucose level, smoking habits, and alcohol intake.

Output: Calculated health metrics (e.g., BMI) and categorized risk levels, displayed as interactive visualizations.

Step 1: Data Collection and Validation

1. **Input Collection**: Accept user inputs for key health indicators:
   - Height (in meters)
   - Weight (in kilograms)
   - Cholesterol level (1 for normal, 2 for above normal, 3 for high risk)
   - Glucose level (1 for normal, 2 for above normal, 3 for high risk)
   - Smoking status (binary: 0 for non-smoker, 1 for smoker)
   - Alcohol intake (binary: 0 for non-drinker, 1 for regular drinker)

2. **Validation**: Check if the inputs are within realistic ranges:
   - Height should be within 1.0 to 2.5 meters.
   - Weight should be between 30 kg and 200 kg.
   - Ensure systolic blood pressure (ap_hi) is greater than diastolic pressure (ap_lo), if provided.

Step 2: Data Preprocessing

3. **Normalization**: Convert categorical data for cholesterol and glucose levels:
   - Map cholesterol levels: 1 to "Normal," 2 to "Above Normal," 3 to "High Risk."
   - Map glucose levels similarly.

4. **Outlier Removal**: Filter out unrealistic values for height and weight:
   - Retain data only if height and weight fall within the 2.5th to 97.5th percentile range.

Step 3: BMI Calculation

5. **Calculate BMI**:
   - Use the formula: BMI=Weight (kg)Height (m)2\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}BMI=Height (m)2Weight (kg)
   - Classify BMI based on the calculated value:
     - BMI > 25: Categorize as "Overweight."
     - BMI ≤ 25: Categorize as "Normal."

Step 4: Risk Categorization

6. **Cholesterol and Glucose Risk Levels**:
   - Categorize cholesterol levels as:

        - "Normal" (Level 1)
        - "Above Normal" (Level 2)
        - "High Risk" (Level 3)
    - Similarly, categorize glucose levels based on the provided levels.

7. **Aggregate Risk Levels**:
    - Combine BMI, cholesterol, and glucose risk levels into a single profile that highlights high-risk areas.

Step 5: Data Visualization

8. **Generate Graphs**:
    - Use Seaborn and Matplotlib to create bar charts, scatter plots, and histograms to visualize:
        - BMI levels across different heights.
        - Cholesterol and glucose levels categorized by risk.
    - Colour-code visual elements to indicate risk (e.g., red for high risk, green for normal).

9. **Display Interactive Visualizations**:
    - Display graphs that allow users to explore each metric individually and in combination.
    - Include tooltips or labels on graphs to clarify metric values and risk levels.

Step 6: Provide Insights and Recommendations

10. **Insights**: Based on risk categorization, suggest areas for improvement:
    - If BMI is high, recommend dietary and exercise adjustments.
    - For high cholesterol, suggest reducing saturated fats and regular monitoring.
11. **Output**: Present final visualizations with categorized metrics and provide a summary of recommendations.

4.3 SOURCE CODE:

Load Relevant Libraries

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
```

Load Dataframe and Inspect

```
 df = pd. read_csv ( 'medical_examination.csv')
df. head ()
```

Add Overweight column where 1 = overweight (BMI > 25), 0 = not overweight

```
df ['overweight'] = np where(df ['weight']/np square(df|'height']/100) > 25, 1, 0)
df. head ( )
```

Normalize data by making 0 good and 1 bad. Change the values of cholesterol and gluc to 0 if 1 and 1 if greater than 1

```
df['cholesterol'] = np.where(df['cholesterol'] >1, 1, 0)
df['gluc'] = np.where(df['gluc']>1,1,0)
df.head()
```

Draw Categorical Plot by creating a dataframe by unpivoting the main dataframe using the values from cholesterol, gluc, smoke, alco, active and overweight. Also, group and reformat the data to split it by 'cardio' and show the counts of each feature. Visualize by categorizing the data by cardio and the respective values of the variables.

```
def draw_cat_plot():
   col_values = ['cholesterol','gluc','smoke','alco','active','overweight']

   df_cat = pd.melt(df, id_vars = 'cardio', value_vars = col_values)
   df_cat =
pd.DataFrame(df_cat.groupby(['cardio','variable','value'])['value'].count()).rename(columns={'value':'total'
}).reset_index()
```

```
    sns.catplot(data = df_cat, x = 'variable',y = 'total', hue = 'value', col = 'cardio', kind = 'bar')

draw_cat_plot()
```

Clean the data by removing incorrect values which are: Systolic Pressure lower than Diastolic, height and weight less than 2.5 percentile and more than 97.5th percentile.

```
def draw_heat_map():

    #Clean the data
    df_heat = df[(df['ap_lo'] <= df['ap_hi']) &
    (df['height'] >= df['height'].quantile(0.025)) &
    (df['height'] <= df['height'].quantile(0.975)) &
    (df['weight'] >= df['weight'].quantile(0.025)) &
    (df['weight'] <= df['weight'].quantile(0.975))]

    #Calculate the correlation matrix and generate a mask for upper triangle
    corr = df_heat.corr()
    mask = np.zeros_like(corr, dtype=np.bool)
    mask[np.triu_indices_from(mask)] = True

    fig, ax = plt.subplots(figsize=(12,6))

    ax = sns.heatmap(corr, mask = mask, vmax=0.5, vmin=0.5, annot=True, fmt = '.1f', center = 0)

    return fig


draw_heat_map()
```

4.4 DATASET

Data description

The rows in the dataset represent patients and the columns represent information like body measurements, results from various blood tests, and lifestyle choices. You will use the dataset to explore the relationship between cardiac disease, body measurements, blood markers, and lifestyle choices.

File name: medical_examination.csv

Feature	Variable Type	Variable	Value Type
Age	Objective Feature	age	int (days)
Height	Objective Feature	height	int (cm)
Weight	Objective Feature	weight	float (kg)
Gender	Objective Feature	gender	categorical code
Systolic blood pressure	Examination Feature	ap_hi	int
Diastolic blood pressure	Examination Feature	ap_lo	int
Cholesterol	Examination Feature	cholesterol	1: normal, 2: above normal, 3: well above normal
Glucose	Examination Feature	gluc	1: normal, 2: above normal, 3: well above normal
Smoking	Subjective Feature	smoke	binary
Alcohol intake	Subjective Feature	alco	binary
Physical activity	Subjective Feature	active	binary
Presence or absence of cardiovascular disease	Target Variable	cardio	binary

Dataset Link: https://github.com/CR017/Medical_Data_Visualizer/blob/main/medical_examination.csv

CHAPTER-5
APPLICATIONS

APPLICATIONS

Patient Monitoring in Clinical Settings

In hospitals and clinics, the *Medical Data Visualizer* can support healthcare providers in monitoring patient health indicators more efficiently. Doctors and nurses can input patient data, such as cholesterol levels, BMI, glucose, and blood pressure, and instantly receive a visualized, integrated overview of the patient’s cardiovascular health. By displaying this information in an easily interpretable format, healthcare providers can quickly identify areas of concern and determine if further tests or immediate interventions are necessary.

This system can also serve as a visual aid during patient consultations, where doctors can show patients their health metrics in a clear, comprehensible way. For example, a doctor could use visualizations to explain how lifestyle factors, such as diet and exercise, directly impact BMI or cholesterol levels. This visual representation not only aids in patient understanding but also encourages patient engagement with their own health data, making it easier to communicate complex medical concepts.

Preventive Healthcare and Early Risk Detection

Preventive healthcare is crucial in reducing the incidence of chronic conditions, especially cardiovascular diseases, which are often driven by lifestyle factors. The *Medical Data Visualizer* helps users detect risk factors early by tracking and visualizing health metrics over time. By identifying trends—such as a gradual increase in BMI or cholesterol levels—the tool enables users to take proactive measures before conditions escalate. Patients can monitor their data regularly, detecting shifts in health indicators that might signify potential risks, even before symptoms become apparent.

This approach aligns well with preventive healthcare goals by enabling patients to make lifestyle adjustments based on real-time data feedback. For example, if a user notices their cholesterol levels trending upwards, they may be motivated to reduce saturated fat intake or increase their physical activity. Such preventive actions can significantly reduce the likelihood of developing severe health conditions, contributing to long-term wellness.

Personalized Health Management for Individuals

For individuals looking to take control of their health independently, the *Medical Data Visualizer* offers a user-friendly platform for tracking essential health metrics over time. Users can enter their data periodically—such as weekly or monthly—allowing them to see trends in their cardiovascular health. This tool is particularly valuable for people managing chronic conditions like hypertension, diabetes, or obesity, where continuous monitoring of health indicators is crucial.

Through personalized tracking, individuals can make informed choices about diet, exercise, and lifestyle habits that align with their health goals. The tool’s visual feedback enables users to understand the direct impact of these choices on their health metrics, motivating them to sustain healthy behaviors. For instance, if an individual reduces their alcohol intake, they might observe improvements in their glucose levels and BMI, reinforcing the value of their efforts.

Educational Use for Medical and Health Training

The *Medical Data Visualizer* has applications in medical and health education, where it can serve as an instructional tool to teach students about cardiovascular health metrics, their significance, and the interpretation of health data. Medical students, nursing students, and even dietetics or physical therapy students can benefit from this hands-on experience with data-driven healthcare tools. By exploring hypothetical patient data through the visualizer, students can learn to identify health risks, understand the interplay between different health metrics, and gain practical experience in preventive healthcare practices.

Additionally, the visual nature of the tool makes it an effective educational aid, as students can see the impact of specific health behaviors (like diet and exercise) on cardiovascular indicators. This hands-on learning approach fosters a deeper understanding of health metrics and encourages critical thinking about patient health management strategies.

Research Tool for Data Analysis in Public Health Studies

The *Medical Data Visualizer* can also serve as a research tool for public health analysts and data scientists studying the prevalence of cardiovascular risk factors within populations. By aggregating and analyzing data across different groups, researchers can identify patterns and correlations between lifestyle choices (like smoking or alcohol consumption) and cardiovascular health indicators (such as cholesterol and BMI). This type of analysis can be instrumental in shaping public health policies, informing community health programs, and targeting high-risk populations with preventive interventions.

Researchers could also use the tool to analyze longitudinal data and examine how changes in specific health behaviors impact health metrics over time. For instance, they might study how a population's average BMI or cholesterol levels shift after the implementation of a public health campaign promoting physical activity. The visualized data can provide powerful evidence of campaign effectiveness, supporting efforts to improve community health outcomes.

CHAPTER-6
SYSTEM TESTING

SYSTEM TESTING

System testing is a critical phase in the development of the *Medical Data Visualizer* project, ensuring that the software meets functional requirements and performs reliably under varied conditions. This stage involves multiple levels of testing, from individual module verification to integrated system testing. Each type of testing is designed to validate specific aspects of the system, including data accuracy, usability, performance, and compatibility. Comprehensive testing ensures that the *Medical Data Visualizer* operates effectively, providing accurate and actionable insights for users.

Unit Testing

Unit testing focuses on verifying that each individual module within the *Medical Data Visualizer* functions correctly. In this project, unit testing was conducted on the following core modules:

1. **Data Collection Module**: Ensures that user input is correctly accepted, validated, and stored. Tests verify that inputs, such as height and weight, fall within realistic ranges and reject invalid values (e.g., negative heights or weights above a reasonable threshold).

2. **Data Preprocessing Module**: Tests in this module check that data is correctly normalized and cleaned. For instance, the system verifies that values for height and weight are filtered to remove outliers, ensuring consistency in the visualizations.

3. **Data Analysis Module**: This module calculates BMI and categorizes cholesterol and glucose levels. Unit tests validate the accuracy of calculations, such as the BMI formula, and ensure that values are categorized correctly (e.g., “Normal” vs. “High Risk” for cholesterol levels).

4. **Data Visualization Module**: Tests ensure that graphs and charts display the correct data, with appropriate labels, colours, and scales. For example, unit tests verify that high-risk values are highlighted in red, while normal values are in green.

Each unit test was executed independently to identify and address bugs at an early stage, ensuring that each module performs as expected before integration.

Integration Testing

Integration testing examines the interactions between different modules to ensure seamless data flow within the system. In the *Medical Data Visualizer*, this phase involved testing the interactions between:

1. **Data Collection and Preprocessing**: Ensures that user input is correctly transferred to the preprocessing module without errors, such as missing or incorrectly formatted data.

2. **Preprocessing and Analysis**: Tests verify that cleaned data flows seamlessly into the analysis module. For example, BMI calculations should only occur after data has been validated and normalized.

3. **Analysis and Visualization**: This step ensures that calculated metrics (e.g., BMI, cholesterol levels) are accurately passed to the visualization module, and displayed with correct risk categorizations.

Integration testing helps confirm that each module communicates effectively, allowing the system to operate as a cohesive unit.

System Testing

System testing evaluates the *Medical Data Visualizer* as a complete system, testing all functionalities from data entry to visualization output. The main objectives of system testing include verifying that:

1. **All Features Function Correctly**: Users can successfully input their health metrics, view accurate analysis, and access visualizations that reflect the entered data.

2. **Data Accuracy**: The system accurately calculates BMI, cholesterol risk levels, and glucose categories, displaying these metrics in an easy-to-understand format.

3. **Risk Highlighting**: System testing confirms that the visualizations correctly colour-code risk levels (e.g., red for high risk, green for normal), making it easy for users to interpret their health data.

System testing scenarios included entering a variety of valid and invalid data sets, ensuring the system provides expected results and meaningful feedback for errors.

User Acceptance Testing (UAT)

User Acceptance Testing (UAT) is conducted with end-users—such as healthcare providers, individual users, or students—to ensure the system meets user needs and expectations. This testing phase focuses on usability and functionality from a user's perspective. Key aspects tested during UAT include:

1. **Usability**: Ensures the interface is user-friendly, intuitive, and accessible for individuals with varying levels of technical expertise. Users are able to navigate the system smoothly, entering and viewing health data without difficulty.

2. **Interpretability of Visualizations**: UAT verifies that users can easily interpret the visualized health metrics and understand risk indicators. For example, users are asked if they can distinguish between normal and high-risk cholesterol levels based on the colour-coded visualizations.

3. **Feedback Mechanisms**: Tests verify that the system provides clear feedback for errors, such as invalid input entries, and offers suggestions for corrective action.

During UAT, testers provided feedback on any areas of confusion or difficulty, allowing developers to make interface adjustments based on real user experiences.

Performance Testing

Performance testing assesses the system's response time, reliability, and behavior under different load conditions. In the *Medical Data Visualizer*, performance tests were conducted to ensure the system remains efficient and responsive, even with high data volumes or multiple users.

1. **Load Testing**: Simulates scenarios where multiple users input data simultaneously to ensure the system maintains quick response times and does not lag.

2. **Stress Testing**: Examines system behavior under extreme conditions, such as entering unusually large data sets or repeatedly generating complex visualizations, to test system stability and identify performance limits.

3. **Response Time Testing**: Measures the time taken for the system to display visualizations after data entry. A maximum acceptable response time (e.g., under 2 seconds) was established to maintain smooth user experience.

Performance testing ensures the *Medical Data Visualizer* is both robust and responsive, delivering results promptly even during high demand.

Security Testing

Given the sensitivity of health data, security testing was conducted to ensure data protection and privacy within the system. Security tests included:

1. **Data Privacy Checks**: Ensures that user data is stored securely and cannot be accessed by unauthorized users. Tests validate data encryption and restricted access to sensitive information.

2. **Input Validation for Security**: Tests ensure that inputs are sanitized to prevent injection attacks or data breaches. For instance, inputs are restricted to expected formats, preventing any malicious scripts from being entered.

3. **Session Management**: Validates secure session handling, ensuring user sessions are properly managed and automatically timed out after periods of inactivity.

Regression Testing

Each time the system was updated or modified, regression testing was conducted to ensure that changes did not introduce new bugs or affect existing functionalities. Regression tests checked that:

1. **Core Features Remain Functional**: Major updates, such as modifications to the visualization module, did not impact other areas, like data collection or analysis.

2. **User Interface Consistency**: Any updates to the user interface did not disrupt user navigation or change the position of essential features.

CHAPTER-7
SYSTEM STUDY

SYSTEM STUDY

The *System Study* phase evaluates the *Medical Data Visualizer* project's feasibility, effectiveness, and potential impact before full implementation. This phase ensures that the project aligns with technical, economic, and social requirements, validating that it is feasible to develop, sustainable for users, and beneficial to the community. The study examines the system's goals, the problem it aims to solve, and how effectively it meets user needs while being practical for development and deployment.

Feasibility Study

The feasibility study assesses whether the project is viable and provides value across three main aspects: technical, economic, and social feasibility.

1. **Technical Feasibility**

    - **Platform and Tools**: The *Medical Data Visualizer* relies on widely available, reliable technologies. The project is developed primarily using Python, a well-established programming language known for data science applications. Libraries like Pandas, NumPy, Matplotlib, and Seaborn provide robust tools for data manipulation and visualization, making them ideal for this project. The project's reliance on open-source libraries ensures that the technical resources needed are accessible and cost-effective.
    - **Compatibility**: The system is designed to operate on multiple platforms, including Windows, MacOS, and Linux, and can run on standard computers with moderate processing power. This flexibility ensures that both users and healthcare facilities can access the tool without requiring advanced hardware.
    - **Scalability**: Given its modular structure, the system can be expanded with additional features (e.g., integration with medical devices, predictive health analysis) without major restructuring. The architecture supports scalability, allowing future enhancements to be added, making the tool more powerful and versatile over time.

The technical feasibility assessment confirms that the system is practical to develop and maintain using available resources and technology.

2. **Economic Feasibility**
    - **Cost of Development**: By using open-source libraries and tools, the development costs are minimized. Python and its libraries (Pandas, NumPy, Matplotlib, and Seaborn) do not require licensing fees, which significantly reduces the initial investment. This approach allows for affordable development while still delivering a highly functional product.
    - **Deployment Costs**: The system's lightweight architecture means that it can be deployed in healthcare settings without expensive infrastructure. The only costs involved would be for computer hardware, which is already widely available in most clinics, hospitals, and homes.
    - **User Affordability**: The system is intended to be cost-effective for users, with minimal hardware requirements, meaning it can be accessible to a broad user base, including individuals who may not have access to high-end technology.
    - **Maintenance Costs**: Since the system is built on stable, open-source software, the cost of maintenance and updates is low. Maintenance efforts can focus primarily on security updates and occasional feature improvements, making the system economically sustainable in the long term.

Economic feasibility confirms that the system is affordable to develop, deploy, and maintain, ensuring that it provides value without imposing high costs on users or healthcare providers.

3. **Social Feasibility**
    - **User Acceptance**: The *Medical Data Visualizer* targets both healthcare providers and individual users who are interested in managing their cardiovascular health. The system's intuitive design, easy-to-understand visualizations, and actionable insights increase its acceptance among users with varying levels of technical expertise.
    - **Educational Value**: The system provides an educational function by presenting complex health data in an accessible way. It helps users understand how lifestyle factors affect health metrics, encouraging them to adopt healthier habits. For medical students, doctors, and health coaches, the system can serve as a teaching tool for interpreting health data.
    - **Preventive Healthcare Support**: The tool's focus on preventive care—by tracking BMI, cholesterol, and glucose levels, and encouraging users to address health risks early—aligns with public health goals of reducing cardiovascular disease through preventive measures. This social impact adds significant value, as it empowers users to take charge of their health and reduce reliance on reactive healthcare services.

CHAPTER-6

RESULT

OUTPUT SCREEN

Load Relevant Libraries

In [9]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
```

Load Dataframe and Inspect

In [10]:
```
df = pd.read_csv('medical_examination.csv')
df.head()
```

Out[10]:

	id	age	gender	height	weight	ap_hi	ap_lo	cholesterol	gluc	smoke	alco	active	cardio
0	0	18393	2	168	62.0	110	80	1	1	0	0	1	0
1	1	20228	1	156	85.0	140	90	3	1	0	0	1	1
2	2	18857	1	165	64.0	130	70	3	1	0	0	0	1
3	3	17623	2	169	82.0	150	100	1	1	0	0	1	1
4	4	17474	1	156	56.0	100	60	1	1	0	0	0	0

Add Overweight colummn where 1 = overweight (BMI > 25), 0 = not overweight

In [11]:
```
df['overweight'] = np.where(df['weight']/np.square(df['height']/100) > 25, 1, 0)
df.head()
```

Out[11]:

	id	age	gender	height	weight	ap_hi	ap_lo	cholesterol	gluc	smoke	alco	active	cardio	overweight
0	0	18393	2	168	62.0	110	80	1	1	0	0	1	0	0
1	1	20228	1	156	85.0	140	90	3	1	0	0	1	1	1
2	2	18857	1	165	64.0	130	70	3	1	0	0	0	1	0
3	3	17623	2	169	82.0	150	100	1	1	0	0	1	1	1
4	4	17474	1	156	56.0	100	60	1	1	0	0	0	0	0

Normalize data by making 0 good and 1 bad. Change the values of cholesterol and gluc to 0 if 1 and 1 if greater than 1.

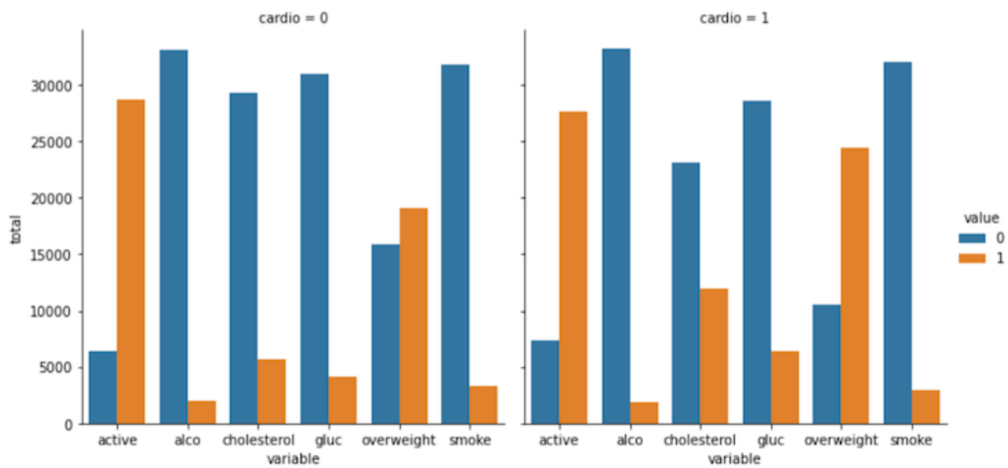
In [12]:
```
df['cholesterol'] = np.where(df['cholesterol'] >1, 1, 0)
df['gluc'] = np.where(df['gluc']>1,1,0)
df.head()
```

Out[12]:

	id	age	gender	height	weight	ap_hi	ap_lo	cholesterol	gluc	smoke	alco	active	cardio	overweight
0	0	18393	2	168	62.0	110	80	0	0	0	0	1	0	0
1	1	20228	1	156	85.0	140	90	1	0	0	0	1	1	1
2	2	18857	1	165	64.0	130	70	1	0	0	0	0	1	0
3	3	17623	2	169	82.0	150	100	0	0	0	0	1	1	1
4	4	17474	1	156	56.0	100	60	0	0	0	0	0	0	0

Draw Categorical Plot by creating a dataframe by unpivoting the main dataframe using the values from cholesterol, gluc, smoke, alco, active and overweight. Also, group and reformat the data to split it by 'cardio' and show the counts of each feature. Visualize by categorizing the data by cardio and the respective values of the variables.

In [13]:
```
def draw_cat_plot():
    col_values = ['cholesterol','gluc','smoke','alco','active','overweight']

    df_cat = pd.melt(df, id_vars = 'cardio', value_vars = col_values)
    df_cat = pd.DataFrame(df_cat.groupby(['cardio','variable','value'])['value'].count()).rename(columns={'value'

    sns.catplot(data = df_cat, x = 'variable',y = 'total', hue = 'value', col = 'cardio', kind = 'bar')

draw_cat_plot()
```



Clean the data by removing incorrect values which are: Systolic Pressure lower than Diastolic, height and weight less than 2.5 percentile and more than 97.5th percentile.

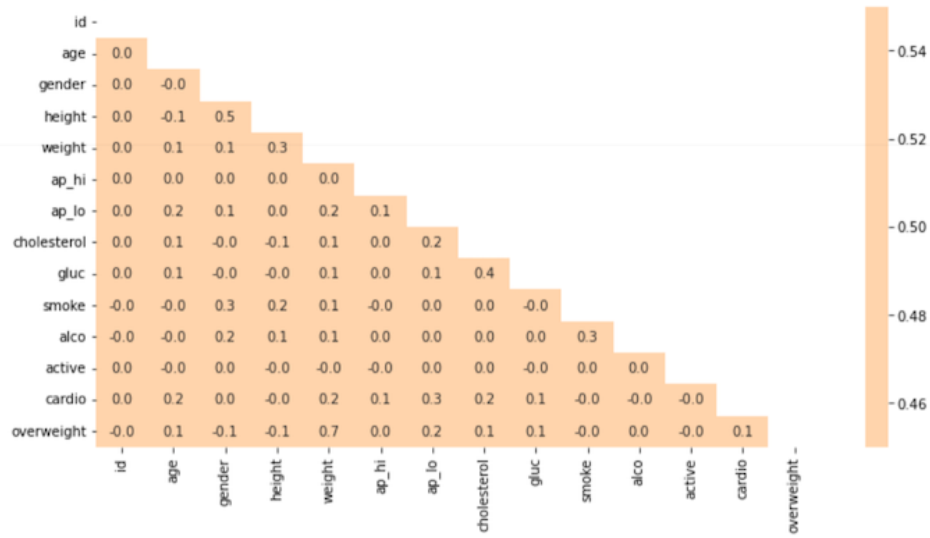
In [26]:
```
def draw_heat_map():

    #Clean the data
    df_heat = df[(df['ap_lo'] <= df['ap_hi']) &
    (df['height'] >= df['height'].quantile(0.025)) &
    (df['height'] <= df['height'].quantile(0.975)) &
    (df['weight'] >= df['weight'].quantile(0.025)) &
    (df['weight'] <= df['weight'].quantile(0.975))]

    #Calculate the correlation matrix and generate a mask for upper triangle
    corr = df_heat.corr()
    mask = np.zeros_like(corr, dtype=np.bool)
    mask[np.triu_indices_from(mask)] = True

    fig, ax = plt.subplots(figsize=(12,6))

    ax = sns.heatmap(corr, mask = mask, vmax=0.5, vmin=0.5, annot=True, fmt = '.1f', center = 0)

    return fig
```

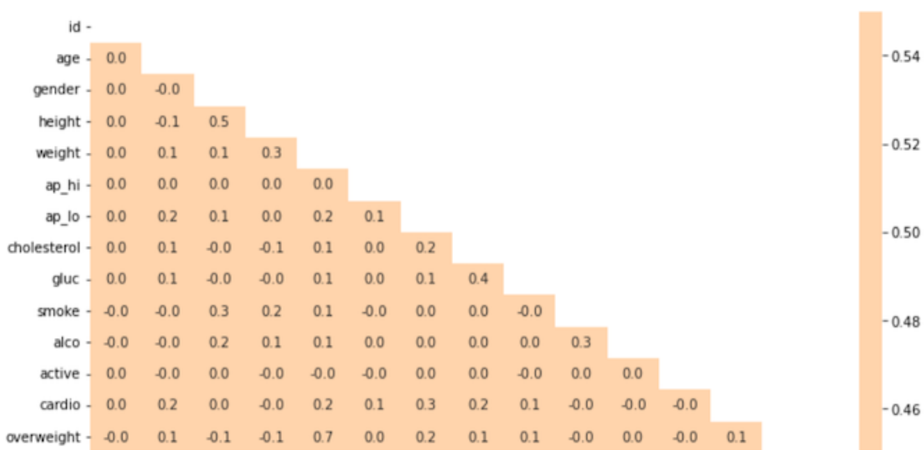
In [27]:

```
draw_heat_map()
```

```
/var/folders/pg/g6tg_cg936vg7skkz0z1140w0000gn/T/ipykernel_7066/98482108.py:12: DeprecationWarning: `np.bool` is a deprecated alias for the builtin `bool`. To silence this warning, use `bool` by itself. Doing this will not modify any behavior and is safe. If you specifically wanted the numpy scalar type, use `np.bool_` here.
Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/devdocs/release/1.20.0-notes.html#deprecations
  mask = np.zeros_like(corr, dtype=np.bool)
```

Out[27]:





CHAPTER-7

CONCLOSUIN & FUTURESCOPE

7.1 CONCLUSION

The Medical Data Visualizer project addresses a critical need in healthcare by providing accessible, interactive tools for monitoring cardiovascular health data. By transforming complex health metrics into intuitive visual formats, the project empowers users to manage their health proactively and engage in preventive care. Its versatility extends from individual tracking to educational and research applications.

7.2 FUTURESCOPE

Future improvements could include:

- **Integration with Wearable Devices**: Real-time data from smartwatches and fitness trackers could enhance monitoring.
- **Machine Learning for Predictive Analysis**: Incorporating predictive models could alert users to potential health risks.
- **Expanded Data Inputs**: Supporting additional health indicators would provide a comprehensive health overview.
- **Mobile Application Development**: A mobile app could increase accessibility and user engagement.
- **Advanced Population Health Analytics**: Aggregate data analysis could yield valuable insights for public health research.

The Medical Data Visualizer is a valuable tool for enhancing health literacy, encouraging preventive care, and engaging users with their health metrics. By focusing on cardiovascular health, it addresses a crucial public health area and showcases the potential of data-driven tools to improve quality of life. As digital health technologies evolve, the Medical Data Visualizer exemplifies a promising approach to making personal health data actionable, supporting preventive healthcare initiatives today and in the future.

CHAPTER-8
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