**Flab or Fab**

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# Project Title and Team Members:

## Project Title: Flab or Fab?

## Team Members

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**GitHub Project Repository Link:**

<https://github.com/nehabaddam/SDV-Project.git>

# Goal and Objectives

## Abstract

AI is rapidly integrating into various aspects of our world, contributing to its improvement. We hope to create a web application "Flab or Fab" which can serve as a preventative measure by providing users with insights into their health and lifestyle habits based on user input such as age, weight, height, and other lifestyle habits. In addition, the tool will have the option to redirect users to a page that visually demonstrates how these factors can contribute to obesity and help improve health literacy and encourage users to adopt healthy habits.

## Motivation

Given the rising incidence of diseases associated with obesity resulting from sedentary lifestyles and unhealthy habits, it is crucial to address this issue by providing people with AI-based tools to assess their health from the comfort of their homes without the need for hospital visits.

Furthermore, "Flab or Fab" can assist consumers in better grasping the complicated connection between lifestyle choices and health outcomes by illustrating the components that contribute to obesity. Individuals may be able to make beneficial changes in their lives as a result, lowering

their risk of acquiring obesity-related health issues. Finally, "Flab or Fab" demonstrates AI's potential to change healthcare by providing individualized and accessible solutions for better health outcomes.

## Significance

Obesity is a chronic disease with several causes that leads to excessive body fat accumulation. And obesity is linked to several serious life-threatening diseases like diabetes, hypertension, osteoarthritis, knee pain, hip issues, depression, mental health, and cancer which reduce the life expectancy in humans.[5]

Worldwide, obesity has nearly tripled in the last 50 years. The United States and Mexico have large numbers of teens and middle-aged people who are obese and thus leading to serious life-threatening diseases. Japan has taken decisive steps to ensure that the obesity level is at the lowest levels and thus Japan has successfully achieved the highest life expectancy of 84.3 years.[4]

Obesity can be easily controlled by educating the public and creating awareness about the advantages of maintaining a healthy weight by adopting healthy food habits, and daily importance of exercise and regular mindful eating, and adopting other methods like Meditation to reduce Stress rather than resorting to eating high-calorie junk food.

Though Obesity is a huge problem, there are no web applications that predict obesity levels and types. Many BMI calculators just calculate the Body Mass Index by taking in the height and weight of the user. For example, the Centre for Disease Control has developed an Adult BMI calculator, that does not predict obesity type.[2] Another such example is National Heath, Lung, and Blood Institutes Calculate Your Body Mass Index. [1]

So, with the help of Fab or Fab, they can determine their obesity score and can take important steps in reducing their obesity and maintaining a healthy weight and thus protecting themselves from serious life-threatening diseases and thus increasing their life expectancy.

## Objectives

The primary aim of "Flab or Fab" is to gather information from users about the factors that contribute to obesity through a series of basic questions. This information is then used to calculate the user's risk of developing heart disease. Even if an individual is currently in good health, taking the assessment provided by "Flab or Fab" can help them determine their obesity score and make positive changes to their lifestyle to maintain or improve their health.

### Workflow Diagram

Ongoing research in the medical field has aimed to pinpoint the risk factors associated with obesity. Some factors that have been identified include genetics, overeating, a sedentary lifestyle, an unhealthy diet, medical conditions, medications, sleep deprivation, and stress. Despite progress in understanding these factors, there is still room for improvement in accurately predicting the risk of obesity and informing individuals about their health. [3] The "Flab or Fab" web application utilizes previous and current research data on these factors to predict the type of obesity using AI algorithms and present the risk information to users in an easily understandable visual format.

Diagram

Description automatically generated

## **Features**

The primary goal of "Flab or Fab" is to accurately predict an individual's obesity score. This is achieved by training the model using existing data and validating and testing it with the latest data available. Multiple models are tested to determine the one that produces the highest level of accuracy, which is then used to predict the risk factor for obesity. Once the model is trained, the website can be hosted to allow users to input their information dynamically, and the obesity score will be produced as output. Additionally, the tool will use visualization techniques to demonstrate how various factors contribute to obesity.

We are focusing on using the following classification models:

* Random Forest
* Logistic Regression
* Decision Tree

**Input:**

We are hoping to consider below inputs:

1. Gender (Female, Male)
2. Age (numeric)
3. Height (numeric)
4. Weight (numeric)
5. family\_history\_with\_overweight (Yes/No)
6. FAVC: Whether the individual consume high-calorie food frequently (Yes/No)
7. FCVC: Frequency of consumption of vegetables by the individual weekly (numeric).
8. NCP: Number of main meals consumed by the individual per day(numeric).
9. CAEC: Consumption of food between main meals (Yes/No).
10. SMOKE: Whether the individual smokes tobacco (Yes/No).
11. CH2O: Water consumption of the individual in liters per day (numeric)
12. SCC: Whether the individual monitors their calorie intake (Yes/No)
13. FAF: Physical activity level of the individual (numeric).
14. TUE: Time spent by the individual on sedentary activities per day in hours(numeric).
15. CALC: Consumption of alcohol by the individual (Yes/No).
16. MTRANS: Mode of transportation used by the individual. (Automobile, Motorbike, Bike, Public\_Transportation, Walking)
17. NObeyesdad: Type of Obesity
18. (Insufficient\_Weight, Normal\_Weight, Overweight\_Level\_I, Overweight\_Level\_II, Obesity\_T ype\_I, Obesity\_Type\_II, Obesity\_Type\_III)

**Output:**

A calculated obesity type and visual representation of how inputs contribute to obesity.

# Project Increment-I

## Domain

Data science or Data Analysis are often regarded as the domains for data visualization. To aid in ease of decision-making and understanding, data visualization aims to display complicated data in a visual and understandable style. Charts, graphs, maps, and other visual tools are used in data visualization to portray data in a form that is simple to understand and analyze. We use different marks and channels and different symbols and shapes and colors and legends and zooming and panning to make the visualizations dynamic and interactive. A variety of sectors, including business, economics, medicine, and social sciences might benefit from data visualization.

## Data Abstraction

Data abstraction deals with the steps and methods that can be taken to simplify the process of understanding the data and extracting meaningful insights from the data and classifying the information in the data in tables or charts so that they can be easily understood by the end user.

### Dataset

For this project, we are using 5 datasets to create dynamic and interactive data visualization to understand obesity in different countries around the world.

The 5 datasets that are to be used are in CSV format and they are named obesity, obesity\_data, world, obesity\_country, and world\_population.

### **Types** and Attributes

The five datasets that have been used in the project namely obesity, obesity\_data, world, obesity\_country, and world\_population are further explained in detail below along with different types, col, umns, and attributes in each dataset.

The first dataset being used is obesity as shown below.

Table

Description automatically generated

As shown above, the obesity dataset consists of 17 columns and 2112 rows of data.

The data consist of both quantitative and categorical data. The different columns that are used in the dataset are Gender, Height, Weight, family\_history, FAVC, FCVC NCP, Smoke, CH2O, SCC, FAF, TUE, CALC, MTRANS, NObeyesdad. So the Gender column is categorical having either male or female, family\_history, FAVC, Smoke, SCC.

Are also categorical with only 2 outputs either yes or no, the remaining columns are quantitative. The two columns CAEC and CALC are also categorical with 3 values Always, Never, and Sometimes.

The second dataset that we are using is shown below which is obesity\_data.

Application, table

Description automatically generated

This dataset consists of 17 columns and 2112 rows of data. The different columns that are used in the dataset are Gender, Height, Weight, family\_history, FAVC, FCVC NCP, Smoke, CH2O, SCC, FAF, TUE, CALC, MTRANS, NObeyesdad.The columns Gender, family\_history, FAVC, Smoke, and SCC have values of either 0 or 1 and the remaining columns have quantitative values. This data set consists of numerical values so it's easy to make graphs and charts with it. The details in the obesity\_data dataset are about the different genders their weight, height and family history, hereditary habits like smoking, and their food eating patterns ncp, favc, fcvc like if they eat high-calorie foods if they eat vegetables and the physical activity done by each person and the mode of transportation taken by each individual. The third dataset being used for the Project is Obesity\_country.

Graphical user interface, application, Word

Description automatically generated

The above dataset obesity\_country consists of 24571 rows and 5 columns. The columns are Country, year, obesity percentage, and sex. The sex column is categorical and shows whether the person is male, female, or both sexes. The year column details the year in which the details were recorded. Then in obesity percentages we have the obesity percentages of different countries recorded in different years which are quantitative values.

The below screenshot shows the details of the World dataset.

Table

Description automatically generated

The above dataset World consists of 250 rows and 11 columns. The different columns are country name, alpha-2, alpha-3, country-cc, iso\_3166, region, sub-region, intermediate, region-code, sub-region, intermediate -region code. The data set consists of both categorical and numerical data. The dataset has information about different country names and their codes and the region and subregions the different countries belong to.

The below screenshot gives the details about the world\_population dataset.

A picture containing background pattern

Description automatically generated

The above dataset world\_population consists of 12596 rows and 3 columns. The three columns are country, year, and count. This dataset has numerical and categorical data types. The country column is categorical showing the names of different countries. The year and Count columns are numerical, and they show the different values of the population for different countries in different years.

## Task Abstraction

## Implementation Using Tools

The different tools that are used for the project are :

1. Flask
2. Python libraries math, numpy, pandas, joblib.
3. Gridsearchcv
4. Sklearn for Random Forest
5. Plotly, plotly.express, plotly.graphobjs
6. Matplotlib for geographical dataset

### Flask Architecture

1. **User:** The user opens the webpage and enters his/her details based on the questions asked. Once the user enters all his details and clicks on the continue button, the model predicts the output and displays it on the webpage.
2. **Flask Application:** The flask application consists of 3 main parts.
3. **Web Pages:** The home page and result page are hosted by Flask.
4. **Data:** The existing data is collected to train the model
5. **Model:** The model is trained using the Data, random forest classifier is used. It is compiled and executed using the flask run command and we use it later for predictions.

Diagram

Description automatically generated

#### Flask

Flask is a microframework for developers that enables them to quickly and easily build and grow web projects.

Python is used to create the Flask web application framework. It was created by Armin Ronacher, who served as the team leader of Poocco, an international group of Python aficionados. The Werkzeg WSGI toolkit and the Jinja2 template engine serve as the foundation for Flask. They're both Pocco projects.

#### WSGI

For the creation of Python web applications, the Web Server Gateway Interface (WSGI) has been the de facto standard. The WSGI specification describes a standard interface for web servers and online applications.

A WSGI toolkit called Werkzeug implements requests, response objects, and utility operations. On top of it can now be created a web frame. Werkzeg serves as one of the foundations of the Flask framework.

#### Jinja2

A well-liked Python template engine is jinja2. A web template system renders a dynamic web page by fusing a template with a particular data source.

#### Benefits of Flask

##### Scalable

Size matters, and because Flask is a microframework, you can use it to expand a tech project like a web app extremely quickly. It's the perfect option if you want to create an app that starts small but has the potential to grow quickly and in areas you haven't fully figured out. It can operate without interruption even as it scales up and higher because of its ease of usage and lack of dependencies.

##### Flexible:

One of Flask's main benefits and its fundamental feature. The Zen of Python states that simplicity is preferable to complexity since it is more easily rearranged and moved around.

##### Simple to navigate:

Like Django, being able to travel with ease is essential for enabling web developers to focus on just coding swiftly without becoming slowed down. Web developers can save time and effort using the microframework since it is fundamentally simple to understand, and it also gives them more control over their code and the possibilities.

##### Lightweight:

When we refer to the design of a tool or framework when we use this term, we mean that there aren't many elements that need to be put together and taken apart, and it doesn't require a lot of extensions to work. Web designers have some degree of control over this layout.

Additionally, Flask enables modular programming, which allows for the division of its functionality into several swappable modules. Each module serves as a standalone construction block that can carry out a specific functionality. Together, this indicates that all of the structure's component elements are adaptable, movable, and tested on their own.[10]

### Python libraries: Pandas, NumPy, Math, Joblib.

#### Pandas

Pandas is an open-source library designed primarily for working quickly and logically with relational or labeled data. It offers a range of data structures and procedures for working with time series and numerical data. The NumPy library serves as the foundation for this library. Pandas is quick and offers its users exceptional performance & productivity.

##### Advantages

* For altering and analyzing data, it is quick and effective.
* It is possible to load data from different file objects.
* Simple handling of missing data in both floating point and non-floating point data (expressed as NaN)
* Size mutability: columns in DataFrame and higher-dimensional objects can be added and removed.
* joining and merging of data sets.
* Flexible data set reshaping and pivoting
* Time-series functionality is included.
* Effective group by functionality for splitting, applying, and combining data sets.

#### Numpy

The Python package NumPy is used to manipulate arrays. Additionally, it has matrices, Fourier transform, and functions for working in the area of linear algebra. Numerical Python is referred to as NumPy. The equivalent of arrays in Python are lists, although they take a long time to execute. The goal of NumPy is to offer array objects that are up to 50 times faster than conventional Python lists. The NumPy array object is referred to as an array, and it has several supporting methods that make using an ND array relatively simple. In data research, where speed and resources are crucial, arrays are employed a lot. In contrast to lists, NumPy arrays are stored in a single continuous location in memory, making it very easy for programs to access and manipulate them. In computer science, this characteristic is known as the locality of reference.

This is the primary factor that makes NumPy faster than lists. Additionally, it is enhanced to function with modern CPU architectures.

#### Math

Math module for Python. You can use a built-in module in Python to do mathematical operations. There are several techniques and constants in the math module.

#### Joblib

To train a machine learning model with a large-size dataset, we also need a decent amount of time. Machine learning models need huge datasets to achieve high accuracy. As a result, we use the joblib library to avoid training the model again. Instead, we train the model only once, save it using the joblib library, and then reuse it.

#### Library Joblib

This article will examine how to save and load machine learning models using Python's joblib library. The use of Google Colab is made for this project.

Python's Joblib package enables the simultaneous execution of computationally demanding jobs. It offers a collection of tools for carrying out parallel operations on massive data sets.

#### Matplotlib

A well-liked Python data visualization library is Matplotlib. Users can make a wide range of graphs using this software, including line plots, scatter plots, bar plots, histograms, and more. For these plots, Matplotlib offers a variety of customization choices, including control over colors, typefaces, labels, and legends.

Matplotlib is a crucial tool for producing plots of publication quality and is widely used in the scientific and data analytic sectors. It can be used in a range of settings, including desktop GUIs, online applications, and Jupyter notebooks.

Matplotlib has several important features, including:

* Wide variety of plot types and styles are supported.
* Colors, fonts, labels, and legends that can be changed.
* ability to divide a figure into many figures and create subplots.
* Including NumPy, Pandas, and other scientific computing libraries in the integration assistance with interactive charting tools like zooming and panning
* Access to extensibility via a potent object-oriented API
* With the help of Python's package management, pip, Matplotlib can be installed for free and without restriction.

#### Plotly

Plotly is a data visualization package for Python, R, and other programming languages that enables the creation of interactive, web-based plots. Users can design numerous interactive graphs with Plotly, including line plots, scatter plots, bar plots, histograms, 3D surface plots, and more.

The ability to produce interactive plots that can be integrated into websites, notebooks, and other applications is one of Plotly's primary advantages. There are many other ways to personalize these plots, including changing the colors, labels, and annotations.

Through its web-based platform, Plotly Online, Plotly offers assistance for data exploration and analysis in addition to its web-based plotting features. Users of this platform can upload data, make graphs, and publish their work online.

Plotly has several important features, including:

* Wide variety of interactive plot kinds and styles are supported.
* Colors, fonts, labels, and annotations that can be changed.
* Python, R, and other programming languages integration.
* the capability to develop interactive graphs for dashboards and web apps.
* assistance with data analysis and exploration with Plotly Online.
* Adaptability via a potent API[11]

##### Plotly.express

On top of Plotly, Plotly Express is a high-level data visualization library. For constructing a range of interactive graphs, including line plots, scatter plots, bar plots, histograms, and more, it offers a clear and basic syntax.

Its simplicity and ease of usage are two of Plotly Express's standout qualities. It offers a variety of methods for building various plot kinds, each with practical default values that are easily customizable.

Additionally, Plotly Express supports a broad variety of data formats, such as CSV files, Pandas data frames, and more. Additionally, it interacts with Plotly Online, Plotly's web-based platform, making it simple for users to share their work with others.

Plotly Express has several important features, such as:

* syntax for generating at a high level
* a high-level syntax for building different interactive plots
* simple and simple customization possibilities
* large range of data formats supported
* Extensibility via a potent API Integration with Plotly Online for sharing and collaboration[11]

##### Plotly.graph\_objs

Plotly's plotly.graph\_objs sub-module offers a low-level interface for creating and modifying specific plot components including traces, layouts, and annotations. Users that need more precise control over the appearance and behavior of their plots should utilize it.

Users can construct a variety of interactive graphs Plotly.graph\_objs, including line plots, scatter plots, bar plots, heatmaps, and more. Numerous customization choices, including different colors, markers, and line types, are available for each trace.

Plotly.graph\_objs has a Layout class in addition to traces for altering a plot's general design, including axis labels, titles, and annotations. The Annotations class allows users to add unique annotations to their plots.

Plotly.graph\_objs has a number of important features, including:

* Low-level interface for building and altering specific plot components
* controlling a plot's appearance and actions with great detail
* Wide variety of interactive plot kinds and styles are supported.
* Colors, fonts, labels, and annotations that can be changed
* Extensibility via a potent API Integration with Plotly Online for sharing and collaboration

#### GridSearchCV

The scikit-learn library's GridSearchCV function is used to do hyperparameter tuning on machine learning models. It is applied to find the ideal set of hyperparameters for a particular machine-learning method.

Hyperparameters are variables that are chosen in advance of the learning process and are not discovered through data analysis. The regularization parameter, the number of hidden layers in a neural network, and the learning rate are a few examples of hyperparameters. The values of a machine learning model's hyperparameters may have a significant impact on how well it performs.

In an extensive search over a given hyperparameter space, GridSearchCV trains and evaluates a model for each set of hyperparameters. It estimates each model's performance using cross-validation and chooses the set of hyperparameters that result in the best performance.

GridSearchCV has a number of important features, including:

* For machine learning models, automatic hyperparameter tuning
* thorough investigation of a certain hyperparameter space
* estimation of model performance by cross-validation
* choosing the ideal collection of hyperparameters for the model and data at hand

The Scikit-Learn library includes GridSearchCV, which may be imported by executing the command from sklearn.model\_selection import GridSearchCV. It is an effective method for enhancing machine learning model performance and lowering the danger of overfitting.

#### Sklearn

A well-liked open-source machine-learning library for Python is called Scikit-learn (often referred to as sklearn). It offers several tools for implementing and using machine learning algorithms and is built on top of NumPy, SciPy, and matplotlib.

Several algorithms for supervised and unsupervised learning tasks are included in Scikit-learn, such as:

* Regression techniques include logistic and linear regression.
* Classification techniques include decision trees, support vector machines, and k-nearest neighbors.
* Hierarchical clustering, k-means clustering, etc.
* Dimensional reduction techniques include PCA, etc.
* Scikit-learn additionally contains tools for data preprocessing, model selection, and evaluation in addition to these techniques. For instance, it offers functions for scaling and normalizing data, dividing data into training and testing sets, and choosing the ideal collection of hyperparameters for a particular model.
* Scikit-learn's salient characteristics include:
* Implementing machine learning algorithms using a straightforward and reliable API
* extensive instructions and documentation
* Numerous tasks and algorithms are supported.
* Matplotlib, SciPy, and NumPy integration
* Using optimized C code, many algorithms are implemented efficiently.
* A large user community and ongoing development

#### Random Forest Classifier

A well-liked supervised learning approach for classification tasks is the Random Forest Classifier. It uses the ensemble learning technique to merge various decision trees into a potent model that can easily generalize to new data.

A random subset of the training data and a random subset of the features are used to construct each decision tree in a Random Forest Classifier. This increases the diversity of the trees and lessens overfitting. The forecasts of all the trees are combined to get the model's final prediction.

The Random Forest Classifier's major characteristics include:

* The capacity to handle both continuous and categorical data
* Robustness to missing data and noise
* High performance and accuracy across a variety of datasets
* Automatic selection of key characteristics
* Overfitting resistance thanks to the ensemble approach
* capacity for working with high-dimensional and huge datasets

The RandomForestClassifier class in scikit-learn can be used to build a Random Forest Classifier model. The class offers a wide range of hyperparameters, such as the number of trees, the depth of each tree, and the number of features utilized at each split, that can be modified to enhance the performance of the model.

### Use of different tools in the Project:

* We wrote the code of the project in Visual Studio Code. We created Python files named app.py, model.py, and obesity.py.
* Firstly, we created the flask environment. Then we wrote the different HTML codes in the template folder. In the template folder, we have index.html, analyze.html, charts.html, and obesity.html.
* The index.html contains the code for the opening page of the web application.
* In index.html under the head> tag we give the title as Obesity Type Predictor. Then in the style tag, we give the style for the webpage.
* Then in the .header and .footer> tag we give the details of dimension and color and different positionings. Then we give the input commands for entering inputs and then we create a button > tag to give the details of the buttons that the user clicks and then in the output box we give the details for displaying the output.
* Then in the body>tag we give the names of all the different input features like age, weight, gender, family history, smoking, transportation, etc.
* Then in charts.html we give the same style.css for the background of the page and then in body>tag we give the text-align commands and the titles for different charts and the colors and the submit button etc.
* In the chart.html page we link the image to the source page.
* Then in the analyze.html page we use the same styles.css as in index.html and then in body>tag we give the different button types as obesity factors, highest obese countries, lowest obese countries, continental obesity indicator, gender-specific obesity, etc,
* Then in obesity.html we use the same styles.css and then in the class>tag we give all the different feature names that are used to predict obesity.
* The app.py file contains the code for the website that is created that predicts obesity.
* For creating the obesity prediction model, we used the sklearn library. Firstly we cleaned the data frame, by doing data preprocessing, then we scaled the data frame, then we chose the columns needed, and then normalized the data frame.
* Then we created a split and created a testing and training dataset. Then using a random forest classifier and grid search we created a machine learning model that is trained to predict obesity.
* In the model.py we write the Python code for creating the globe visualization showing different countries using matplotlib and Plotly.express.We gave the details of different countries to be drawn on the globe and linked the values of obesity percentages of different countries.
* Then in obesity.py we write the code for creating different plots and graphs using Plotly. express. Using Plotly. express we write the code to create different bar charts for obesity, height, gender, and weight, and for different features fcvc, favc, NCP, smoking and water consumption, and violin graph and scatter plot for alcohol consumption and other features.

### Project Run Instructions

To run the Flask application follow the below instructions:

1. Extract the project zip folder.
2. from the file directory of the project open the terminal.
3. Run the below commands.
4. py -m venv env (to set up the Python environment)
5. Set-ExecutionPolicy Unrestricted -Scope Process
6. .\env\Scripts\activate (to activate the environment)
7. iv. flask run (to run flask application)
8. We can run the application by clicking on the local host path that is displayed on the terminal.

## Preliminary Results for Analysis

### Visualization Graphs

Initially we launch the webpage of our web application “Flab or Fab”. The webpage is designed with the main page which is an obesity type predictor. The below screenshot shows the main page of the web app created for obesity-type prediction.

#### Main Page

**Graphical user interface, application, Teams

Description automatically generated**

**A picture containing application

Description automatically generated**

**Screenshot: Main page of the web application Flab or Fab**

The main page involves a questionnaire consisting of drop-down fields and text fields which can enable users to manually select a choice of input based on several factors like age, weight, and other day-to-day habits. The Obesity type predictor will give the response on the likelihood of a user becoming overweight.

##### Main Page Components

* Title of the page.
* Input drop-down fields and text fields (expected input from the user).
* Predict obesity type button.
* Analyse Button

##### Title of the main page

We have given the title of the initial page as an obesity type predictor where we have varied fields which need to be filled by the user who wants to check his/her obesity type.

##### User input fields in the Obesity Predictor

1. **Drop-down**

Below are the types of input fields designed on the main page which involve drop-down fields. The drop-down will enable the user to easily select their answers from the different options listed in the drop-down menu.

For instance, there is a gender field, with a male or female option and a yes/no dropdown option for the "family history of obesity" field. Similarly, dropdown menus are available for the other fields such as frequency of consuming high caloric food/consumption of food between means which has drop-down options such as I do not drink, I drink. There are other fields such as smoking habits, calorie monitoring, and consumption of alcohol which have yes or no as drop-down options, and another field which is a mode of transportation that involves choices of public or private.

1. **Text fields**

Text fields on a web page are the input fields where users can enter text, such as age, height, weight, frequency of consuming vegetables, number of main meals, daily water intake (in liters), physical activity frequency, and time spent using technology devices.

1. **Predict obesity Button**

After filling in all the required fields and then when we click on the predict obesity button, the webpage gives the response on the type of obesity. In the backend we have a prediction model that takes in the user input and based on the values and model created it will decide the output and prints the response on the screen.

##### User test case: Overweight

Graphical user interface, application

Description automatically generated

**Screenshot: The response of the predictor for the user test case.**

##### User test case: Insufficient Weight

We can see in the screenshot that a user has answered all the questions required and the obesity predictor gives a response that the Male user is Overweight based on the factors.

Graphical user interface, application

Description automatically generated

**Screenshot: The response of the predictor for the user test case**

We can see in the screenshot that a user has answered all the questions required but the weight is insufficient and the obesity predictor gives a response that the weight is insufficient.

#### Analyze Page

There is also an analyze button at the right corner of the main page. When we click the button, it will further navigate to another dynamic web page that gives more in detail information about the factors that are responsible for obesity type.

##### Analyze

**Graphical user interface, application, Teams

Description automatically generated**

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**Screenshot: The response of the predictor for the user test case**

The analysis page shows a globe-level indicator and a world map with various countries shown in various color intensities. It is a useful approach to show the obesity level and year of obesity. The values of the vertical and horizontal parameters are used to gauge the degree of obesity in various nations which will decide the color shade of each nation.

The globe is shown as an interactive graphic design with each nation labeled and colored by the severity of its obesity problem based on the selected year. For instance, nations with greater rates of obesity can be highlighted in dark blue, whereas nations with lower rates might be highlighted in lighter shades of the globe.

The user can change the year and also rotate the globe by moving the cursor over the globe which is an interactive aspect as shown in the screenshot above.

##### Navigation buttons

We have a few other buttons to navigate to different pages which show different visualization graphs for different factors of the dataset.

Here we have 5 buttons for the user to navigate and check the effect of factors in detail that determine the type of obesity.

1. Obesity Factors
2. High-obesity Countries
3. Lowest obesity Countries
4. Continental obesity Indicator
5. Gender-specific obesity indicators.

##### Back button

There is also a back button for the user to navigate to the main page. As seen in the above screenshot, the back button is green in color.

##### User test case

Graphical user interface, text, application

Description automatically generated

**Screenshot: Tool tip showing the particular country’s obesity details.**

As seen in the above screenshot as the user selects a particular year, he can hover over the country and check in detail information about obesity in the tooltip. The details involve factors such as country name, selected year, country, and obesity intensity.

Here we can see the example of Niger which is located in Africa, the selected year is 2016, the country is Niger, and the obesity intensity is 5.5.

Graphical user interface

Description automatically generated

**Screenshot: User clicking on the obesity factors button**

As seen in the above screenshot, the user clicks on the obesity factors button. To acknowledge the user about the button, click the color of the button is changed to darker color on the click action. This will provide good visibility for the user.

#### Obesity Factors Section:

On clicking the obesity factors button, we can see various visualization options as shown in the screenshot below.

##### Different factors that affect obesity levels:

On the left side of the page, we can see various factors based on which the obesity level varies as shown in the above screenshot.

These are the same factors that we asked about in the main page fields. This will let the user know the relevance of each field and the user can independently check each field’s significance in deciding the obesity level across the globe. The user would be able to check the visualization and effect for all the fields globally.

##### Selection of obesity type factor:

**Graphical user interface, application, Teams

Description automatically generated Screenshot: Obesity factors section**

In this section, we can see a graph which shows the bar graph plotted for the obesity type and the count of people. As we can see in the screenshot, type-1 obesity has the highest count of 350. While the lowest count in the dataset involves people with insufficient weight. There are other types for which the count is checked such as obesity type 2 and 3, overweight type 1 to 3, and normal weight count.

##### Selection of age factor:

**Graphical user interface, application

Description automatically generated**

The bar graph shows the age group that falls into each obesity category with age groups on the x-axis and the count of individuals in each obesity category on the y-axis. The bars for each age group will indicate the number of people in that age group who fall into each category of obesity.

As we can see in the bar graph the obese type-1 people fall between the age group 20- 25, the maximum of people has obesity type-2 and they fall in the age group greater than 25 while the minimum count of people with overweight type 2 is age 20.

##### Selection of height factor:

The bar graph shows Counts of people in each obese group are shown on the y-axis of the bar graph with height categories on the x-axis. The bars for each height category would represent the number of people in each obesity category for that height category.

As seen in the above screenshot there is not much height difference among people in various obesity levels. The average height of people with obesity type 2 is greater than 1.6 whereas, for normal weight, height is 1.65.

Here each obesity type is represented by different colors for visualization.

##### Selection of weight factor:

Graphical user interface, chart, bar chart

Description automatically generated

Given the weight, we can group the weights into weight ranges and count the people falling into each category. The bar graph shows that the maximum number of people who have a weight 50-80 are obesity type-1, while the least people who weigh above 130 falls into obesity type-

##### Selection of Family history with an overweight factor:

Chart, bar chart

Description automatically generated

The bar graph consists of family history with an overweight factor which is yes or no depicted in different colors, orange color for yes, and blue representing no. We can see in the bar graph that the maximum number of people who come in the obesity type-1 category and their response to the question of having a family history of being overweight is yes while for insufficient weight 270 people responded both yes and no.

##### Selection of frequency of consuming high caloric food factor:

Chart, bar chart

Description automatically generated

It is used to depict the density and distribution of a continuous variable. Here we plot the frequency of high-caloric food vs obesity on the violin graph. The x-axis consists of the obesity level and the y-axis consists of the frequency of high-caloric food. As seen in the above screenshot the kernel density estimates the data for both the attributes, frequency of consuming high-calorie foods within each obesity level group that has a corresponding violin plot for every obesity level category on the x-axis.

##### Selection of several main meals factor:

Chart, scatter chart

Description automatically generated

##### Selection of consumption of food between meals factor:

Chart, bar chart

Description automatically generated

The above screenshot consists of a scatter plot that shows the relation between the number of meals and the weight of the person, and also the data points representing obesity level. The weight is plotted on the x-axis and the number of meals is plotted on the y-axis. To represent each obesity level corresponding to the data points, every category is assigned a color as shown on the left-side legend. This enables the user to visually identify the trends in the dataset. As seen, the people consuming 3 meals in a day are most weighted and fall in the category of obesity type-1. While the least consuming meals are weight between 80-100 and fall in overweight type-2.

##### Selection of smoking habit factor:

Chart, line chart

Description automatically generatedThe line graph shows the smoking habit of people with the corresponding obesity level they belong to. As seen, the greatest number of people are non-smokers. While people who smoke fall in the category of obesity level-1 and level-2.

##### Selection of Daily water intake factor:

Graphical user interface

Description automatically generated

The stacked bar graph shows the average water intake by females and males. As seen, the average intake of water is slightly higher for males than females. A person of normal weight consumes 2-3 liters of water whereas people belonging to the overweight type-2 category consume more than 12 liters of water. We can identify the water intake comparison between both females and males in different obesity categories.

##### Selection of Calories monitoring factor:

Chart, bar chart

Description automatically generated

##### Selection of Physical activity frequency factor:

Chart, bar chart, treemap chart

Description automatically generated

The horizontal scatter plot is used to display the physical activity frequency on the x-axis and obesity level on the y-axis concerning the male and female categories.

We can observe that the male has more physical activity than the female. Obesity type-2 consists of 99% males, and they have a physical activity frequency of 290 while obesity type 3 consists of females, and they have physical activity frequency of 230.

##### Selection of time spent using technology devices factor:

Graphical user interface, chart, application, bar chart

Description automatically generated with medium confidence

We can observe the meantime using technology devices vs obesity levels in males and females. As seen for obesity type-1 and type-3, males spend more time using devices than females. Whereas obesity type-2, overweight level-1, and level-2 involve more percentage of females using the devices. For normal weight, the average time is 0.6 hrs. The highest time spent is 1 hour by men who fall in obesity 3. The female who falls into obesity type-2 also spends 1hr on average on devices. We can see that the use of devices affects human weight.

##### Selection of calories intake factor:

Graphical user interface, bar chart

Description automatically generated

The bar graph shows the people’s calorie intake in terms of their answers as no, sometimes, frequently, or always belonging to different obesity level categories. As seen, obesity type-1 has the highest calorie intake who’s the answer to the calorie intake is always. Whereas the orange color associated with the answer was no, belonging to normal weight, obesity type-1, overweight level-1, and level-2.

##### Selection of Mode of transportation factor:

Graphical user interface, application, bar chart

Description automatically generated

The bar graph shows the mode of transportation automobile, bike, motorbike, public transportation, and walking. We can observe that the mode of transportation has significant effects on obesity, as people belonging to normal weight are walking whereas people who fall in the other obesity levels use public transport.

#### Highest Obesity Countries

The second button on analyze page is the highest obesity countries.

Graphical user interface

Description automatically generated

Chart, bar chart

Description automatically generated

In this, we analyze the average obesity rate for different countries. The x-axis of the graph will show the names of the countries being compared, while the y-axis will show the average obesity rates for each country. Here we use different colors to interpret different countries to help the user easily understand. The bar graph can also be used to compare the average obesity of different countries and to identify any trends in the data. We can observe that Kuwait has the highest average obesity whereas Bahrain has the lowest average obesity.

#### Lowest Obesity Countries

Graphical user interface, application

Description automatically generated

Chart, bar chart

Description automatically generated

#### Continent-wise obesity prevalence

Graphical user interface

Description automatically generated

Chart, line chart

Description automatically generated

A line graph shows the continent-wise obesity prevalence over the years, we have added color coding to distinguish between the continents. The x-axis of the graph will show the years being compared and the y-axis shows the obesity prevalence for each continent. To make it simpler to identify the continents, each continent might be represented on the graph by a distinct colored line. The height of the line depicts the annual prevalence of obesity in that continent. We can see that the lowest obesity. We can see that Africa has the lowest obesity prevalence over the years while America has the highest. We can conclude that most Americans are prone to obesity.

#### World Obesity by Gender

We can use a global map to display the gender-specific obesity rates in various countries. The user can choose the year they want to view by using a global indicator on the map. Each country's level of obesity can be determined by the hue of the globe.

To make it simpler to identify each country, a distinct color shade is used to represent each one on the map. The obesity rate in that country increases with the color's intensity. For instance, a country with a high percentage of obesity will have a darker shade, whereas a country with a low prevalence of obesity will have a lighter shade of color.

Graphical user interface, application

Description automatically generated

Graphical user interface, text, application

Description automatically generated

Diagram

Description automatically generated

We have also added a tooltip that shows the details information when we hover over a country. As seen in the screenshot above it shows the details about

Graphical user interface

Description automatically generated with low confidence

##### Male

We can particularly select gender. Here when we click on male, the globe map shows the intensity of obesity in men across different countries. As seen here countries like India has the lowest obesity rate and

Graphical user interface, Teams

Description automatically generated

Graphical user interface, text, application

Description automatically generated

Graphical user interface, application, Word

Description automatically generated

The tooltip gives information about India. Here we can see that the

##### Female

Diagram

Description automatically generated

Graphical user interface, text, application, timeline

Description automatically generated

Graphical user interface, text, application

Description automatically generated

## Story Telling

### Who, what, where?

One of the biggest health issues in the world today is obesity, which no longer just affects wealthy nations but affects people of all income levels. Every year, 4.7 million premature deaths are caused by obesity. Obesity, which is characterized by having a high body mass index, increases the chance of developing several of the world's major killers, such as heart disease, stroke, diabetes, and different types of cancer. None of these health effects are specifically caused by obesity, although it can raise the likelihood that they will manifest.[6]

The Global Burden of Disease report states that in 2017, 4.7 million premature deaths were attributed to obesity To put this into perspective, nearly four times as many people perished in traffic accidents, and nearly five times as many people died of HIV/AIDS in 2017. Obesity caused 8% of deaths worldwide in 2017; this is an increase from 4.5% in 1990. Around the world, this percentage varies greatly.[6]

More than 15% of deaths in numerous middle-income nations in 2017 were related to obesity, especially in Eastern Europe, Central Asia, North Africa, and Latin America. This is probably because we have a high prevalence of obesity but inferior general health and healthcare systems in comparison to high-income nations with comparable high levels of obesity.[7]

This percentage ranges between 8 and 10% in the majority of high-income nations. The percentage of many middle-income countries is roughly half of this. In contrast to other wealthy nations, only about 5% of premature deaths in Japan and South Korea are related to obesity. Less than 5% of fatalities in low-income nations, particularly in Sub-Saharan Africa, are caused by obesity.[6]

Both for men and women, the WHO Americas area continues to have the highest obesity rates. However, the numbers in Africa are likely to quadruple by 2030, from 8 million males (2010) to 27 million men (2030), and from 26 million women (2010) to 74 million women, whilst the Americas are predicted to see a 1.5 fold increase between 2010 and 2030. (2030).[7]

Almost 75 percent of all overweight children worldwide reside in Asia and Africa. About two-thirds of children under five who were overweight or obese in 2019 lived in Asia, and the number of overweight children under five in Africa has increased by almost 24% since 2000.[7]

A survey from the Global Obesity Federation predicts that by 2035, more than 4 billion people, or 51% of the global population aged 5 and older, would be overweight or obese. In contrast, 38% of the world's population, or 2.6 billion individuals, were overweight or obese in 2020. By 2035, 24 percent of the world's population, or over 2 billion people, are predicted to be obese, up from 14 percent in 2020. The rate of obesity is forecast to double in boys, from 10 to 20 percent, and more than double in girls, from 8 to 18 percent, among children and adolescents aged 5 to 19, representing the sharpest increase.[8]

This indicates not only a reduction in the quality of life for those who are obese but also higher direct medical costs and indirect costs from lost productivity as a result of associated illnesses. These expenses are thought to total EUR1.8 trillion annually or 2.8% of world GDP. If the obesity trend is not reversed, health systems will not only have to deal with increased expenditures associated with aging societies but also with a significant additional financial burden.[9]

### What, When, How, and Why?

An imbalance between calories ingested and calories burned is the primary cause of obesity. When we consume more calories than we burn, our bodies produce surplus energy, which they then store as fat. Although there are several potential causes for this imbalance in energy intake and output, including hereditary abnormalities, living in a setting that promotes excessive consumption of foods high in calories, prolonged inactivity, and low levels of physical activity is the most common one.[7]

One of the main causes of the present obesity epidemic is the expanding availability of ultra-processed meals, which have high quantities of sugars, salt, saturated fats, and refined carbs. Consumption of foods high in fat and free sugars has increased over the past few decades as worldwide diets have altered. Due to the more sedentary character of many occupations, evolving transit options, and escalating urbanization, there has also been an increase in physical inactivity. A lack of supportive policies in areas including health, agriculture, transportation, urban planning, environment, food processing, distribution, marketing, and education contributes to these shifts in dietary and physical activity patterns in many societies.[7]

There are many techniques to measure and identify it, but the Body Mass Index (BMI), which uses a person's height and weight to determine whether their weight is healthy, is the most popular one. A person's BMI is calculated by dividing their weight in kilograms by the square of their height in meters. A BMI of over 25 in adults is regarded as overweight, and one of over 30 as obese.[7]

This indicates that there are two possible causes for the rise in obesity rates in recent decades: either an increase in calorie intake, i.e., eating more; or a decrease in energy expenditure due to decreased levels of daily activity. Both factors are probably contributing to the growth in obesity. Interventions that address both energy intake and expenditure will probably be required to combat obesity.[6]

To prevent overweight and obesity, supportive environments and communities are crucial in influencing people's decisions. They do this by deciding to eat healthier foods and engage in regular physical activity the simplest one (the choice that is most accessible, available, and affordable).

On a personal level, people can Reduce the amount of energy they consume from total fats and sugars; increase their consumption of fruit and vegetables; add legumes, whole grains, and nuts; and get regular exercise.

At the societal level, it is crucial to encourage people to heed the advice by persistently implementing population-based, evidence-based policies that make regular physical activity and healthier eating options readily available, affordable, and easily accessible to everyone, especially the poorest people. One illustration of such a measure is a levy on beverages with added sugar. The food industry can significantly contribute to the promotion of healthy diets by lowering the fat, sugar, and salt content of processed foods, ensuring that all consumers have access to affordable, healthy options, restricting the marketing of foods high in sugar, salt, and fat, especially those marketed to children and teenagers, and promoting regular consumption of healthy foods.[6]

### Data

Five datasets are being used in this project. The five datasets are obesity, obesity\_data, world, obesity\_country, and world\_population.

For the World dataset the lists are the result of merging data from two sources, the Wikipedia [ISO 3166-1 article](http://en.wikipedia.org/wiki/ISO_3166-1#Officially_assigned_code_elements) for alpha and numeric country codes, and the [UN Statistics](https://unstats.un.org/unsd/methodology/m49/overview) site for countries' regional, and sub-regional codes. In addition to countries, it includes dependent territories. The [International Organization for Standardization (ISO)](https://www.iso.org/iso-3166-country-codes.html) site provides partial data (capitalized and sometimes stripped of non-Latin ornamentation) but sells the complete data set as a Microsoft Access 2003 database. Other sites give you the numeric and character codes, but there appeared to be no sites that included the associated UN-maintained regional codes in their data sets. The data was scraped from the above two websites which are all publicly available already to produce some ready-to-use complete data sets.

The World dataset consists of

* name - Country name in English
* alpha-2 - ISO code formed of 2 letters.
* alpha-2 - ISO code formed of 3 letters (use this in your plotly maps ;) )
* country code - unique
* region - the continent of provenience
* sub-region - subcontinent
* intermediate region
* codes for region/ subregion/ intermediate region

The World dataset was taken from lukes on GitHub: <https://github.com/lukes/ISO-3166-Countries-with-Regional-Codes/blob/master/all/all.csv>.

Obesity and Obesity\_data recorded the Obesity among adults dataset by WHO, from the year 1975 to the year 2016. The dataset is obtained from <https://apps.who.int/gho/data/node.main.A900A?lang=en>.

The columns for the obesity dataset:

* Gender (Female, Male)
* Age (numeric)
* Height (numeric)
* Weight (numeric)
* family\_history\_with\_overweight (Yes/No)
* FAVC: Whether the individual consume high-calorie food frequently (Yes/No)
* FCVC: Frequency of consumption of vegetables by the individual weekly (numeric).
* NCP: Number of main meals consumed by the individual per day(numeric).
* CAEC: Consumption of food between main meals (Yes/No).
* SMOKE: Whether the individual smokes tobacco (Yes/No).
* CH2O: Water consumption of the individual in liters per day (numeric)
* SCC: Whether the individual monitors their calorie intake (Yes/No)
* FAF: Physical activity level of the individual (numeric).
* TUE: Time spent by the individual on sedentary activities per day in hours(numeric).
* CALC: Consumption of alcohol by the individual (Yes/No).
* MTRANS: Mode of transportation used by the individual. (Automobile, Motorbike, Bike, Public\_Transportation, Walking)
* NObeyesdad: Type of Obesity
* (Insufficient\_Weight, Normal\_Weight, Overweight\_Level\_I, Overweight\_Level\_II, Obesity\_T ype\_I, Obesity\_Type\_II, Obesity\_Type\_III)

Prevalence of obesity among adults, BMI &gt;= 30 (age-standardized estimate) (%)

The World\_Population dataset contains population data of different countries/regions from 1960 to 2018 and the dataset has been downloaded from

<https://data.worldbank.org/indicator/SP.POP.TOTL>

There is condensed and region-wise data in the population dataset.

Mainly adults both male and female were sampled in the above dataset and the period during which the data was collected was between 1960 to 2018. The dataset is around 4 years old.

In the obesity dataset eating habits, smoking habits, calorie intake, physical activity, sedentary activities, and alcohol consumption were recorded among adults. Based on it the obesity prediction was generated.

In the World dataset and world population dataset the data was collected from 250 countries all over the world and for each country population was recorded for different years. Obesity is a global phenomenon, so it is geographical coverage is the whole world. This is a longitudinal dataset. This dataset has GIS.

The obesity dataset mainly focuses on adults. Obesity happens due to unhealthy eating and lifestyle choices by humans.

### Users.

The targeted users are the adult population who is at high risk of obesity due to the unhealthy choices made by them and it is important to make them aware and conscious and help them in making better life choices for better health and long life.

The application is deployed on the web, so anyone with access to the internet can access the obesity prediction model Flab or Fab which will predict obesity.

Firstly, the website app helps to give individual obesity prediction, and secondly we have around 16 visualizations that show global obesity patterns the visualizations make it easy to analyze the different causes of obesity and the most dominant causes, so the user can understand better and then the user can make required changes in the lifestyle to reduce obesity and improve the health and staying fit and fabulous.

The visualizations are useful to the user using the web application because the user becomes more aware and conscious about the different causes of obesity and the user also becomes serious about obesity while seeing different visualizations showing the harmful effects and reduced life expectancy caused by obesity and with the web app the user can have a personal monitoring system to check the obesity every few months and thus maintain good health.

If all adults in the community start using this web app, the community as a whole will be better aware of the dangers of obesity, and thus community as a whole can implement healthy lifestyle habits and thus can reverse the adverse side effects of obesity and thus resulting in better quality life and a higher life expectancy for the community and reduce the health expenditure budget.

## Project Management

### Implementation status report

#### Work completed:

**Description:**

**Responsibility (Task, Person)**:

* 1. Neha Goud Baddam: Worked on model generation and model metrics calculation. Also worked on documentation.
  2. Panduga Raja Tejasvi Prasad: Worked on data gathering and data cleaning.
  3. Yasmeen Haleem: Worked on outlier detection and removal.
  4. Siddarth Kundaram: Worked on outlier detection and removal.

**Contributions (members/percentage)**:

1. Neha Goud Baddam: 25%
2. Panduga Raja Tejasvi Prasad: 25%
3. Yasmeen Haleem: 25%
4. Siddarth Kundaram: 25%

#### Work to be completed:

**Description:**

**Responsibility (Task, Person)**:

1. Neha Goud Baddam: Designing a web application using a flask that will take user inputs (all 14 attributes) and generate risk factors as output.
2. Reshmi Chowdary Divi: Testing the web application.
3. Purandhara Maharshi Chidurala: Documentation and hosting of the website.

**Issues/Concerns**: There are no specific issues as of now, the issues could arise in Increment-2, while testing the web application. Also, the accuracy of the model is low, we may try to increase the accuracy to some extent. And also add many other aspects to existing visualizations.

# References

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2. [National Heart, Lung, and Blood Institute: Calculate your Body Mass Index:](https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmicalc.htm) This site takes in Height and weight and visualizes the BMI chart for easy understanding.
3. [Obesity prediction using Machine Learning:](https://pubmed.ncbi.nlm.nih.gov/29426065/) This summary of machine learning algorithms provides a unique overview of the state of data analysis applied specifically to obesity.
4. [An Analysis of Indonesian Basic Health Research 2018:](https://www.frontiersin.org/articles/10.3389/fnut.2021.669155/full) This article suggests multiple machine-learning techniques that predict obesity levels.
5. We are using an existing dataset for this project: [UCI Obesity Level Dataset](https://archive-beta.ics.uci.edu/dataset/544/estimation+of+obesity+levels+based+on+eating+habits+and+physical+condition)
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