A COMPREHENSIVE MEASURE OF WELL-BEING : THE HUMAN DEVELOPMENT INDEX

AN INDUSTRY ORIENTED MINI REPORT

Submitted to

JAWAHARLAL NEHRU TECNOLOGICAL UNIVERSITY, HYDERABAD

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

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In

COMPUTER SCIENCE AND ENGINEERING(CSE)

Submitted By

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CERTIFICATE OF COMPLETION
INDUSTRY ORIENTED MINI PROJECT

This is to certify that the UG Project Phase-1 entitled "A COMPREHENSIVE MEASURE OF WELL-BEING: THE HUMAN DEVELOPMENT INDEX USING MACHINE LEARNING" is being submitted by DEEKSHITH PATTIPAKA(22UK15A0515),SATHWIKA PAKALA(21UK1A05F0),SYED IRSHADAHMED(21UK1A05D4),UDAYKRISHNA YALAMANCHILI(21UK1A05E6) in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science & Engineering to Jawaharlal Nehru Technological University Hyderabad during the academic year 2023- 2024.

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(Professor)

External

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ABSTRACT

The Human Development Index (HDI) is a composite statistic used to rank countries based on human development levels, traditionally measured through life expectancy, education, and per capita income indicators. Despite its widespread use, the HDI has limitations in capturing the complexity and nuances of human well-being. This project aims to enhance the HDI by leveraging machine learning techniques to provide a more comprehensive and accurate measure of human development.

In this study, we develop a predictive model using machine learning algorithms to estimate the HDI based on a broader set of features. The model incorporates additional variables such as mean years of schooling, gross national income per capita, and other relevant socio-economic indicators. By analyzing data from various countries, the model identifies patterns and relationships that traditional methods may overlook.

We implemented a Flask web application to make the predictive model accessible and user-friendly. The application allows users to input relevant data, including life expectancy, education levels, income, and country-specific information. The model then processes this data and provides an HDI prediction, categorizing it into low, medium, high, or very high HDI.

The results demonstrate that the machine learning-enhanced HDI offers a more nuanced understanding of human development, capturing variations that the traditional HDI might miss. This approach not only improves the accuracy of HDI predictions but also provides policymakers and researchers with deeper insights into the factors influencing human well-being.

Overall, this project highlights the potential of machine learning in redefining traditional metrics and advancing our understanding of global development. By providing a more detailed and dynamic measure of HDI, we aim to support more effective policy-making and contribute to the broader discourse on human development.

TABLE OF CONTENTS:-

1.INTRODUCTION

1.1.OVERVIEW

The project titled "A Comprehensive Measure Of Well-Bein Human Development Index Using Machine Learning" aims to improve the accuracy and comprehensiveness of the Human Development Index (HDI) by employing machine learning techniques and incorporating additional socio-economic indicators. The HDI, a widely used metric for evaluating countries' development levels, traditionally relies on life expectancy, education, and income. However, it has limitations in fully capturing the complexities of human well-being. This project seeks to address these limitations by leveraging machine learning to provide a more nuanced measure of HDI. The methodology involves collecting data from international databases, including variables such as life expectancy, mean years of schooling, GNI per capita, and other socio-economic indicators. Machine learning models are trained to predict HDI using this data, with efforts made to evaluate and optimize the models for accurate predictions. A user-friendly web application is developed using Flask to allow users to input data and receive HDI predictions, displaying the predicted HDI and categorizing it into low, medium, high, or very high HDI. The expected outcome is a more accurate and comprehensive HDI measure, accessible through the web application, providing deeper insights into human development and aiding policymakers in making informed decisions. Ultimately, this project enhances the traditional HDI, offering a better understanding of global development and supporting more effective policy-making to improve human well-being.

1.2.PURPOSE

The purpose of the "Enhancing the Human Development Index Using Machine Learning" project is to advance the traditional Human Development Index (HDI) by integrating machine learning techniques and additional socio-economic indicators. The project aims to address the limitations of the traditional HDI, which relies on basic metrics like life expectancy, education, and income, but fails to capture the full complexity of human well-being. By employing machine learning, the project seeks to provide a more accurate, nuanced, and comprehensive measure of human development. This enhanced HDI will offer deeper insights into the factors affecting human well-being, support more informed decision-making by policymakers, and contribute to a better understanding of global development dynamics. Ultimately, the project aims to improve the assessment of human development, leading to more effective policies and strategies that can enhance the quality of life across different countries and communities.

2.LITERATURE SURVEY

2.1 EXISTING PROBLEM

- **Income Inequality**:

Distribution Issues: The HDI uses average income levels and does not account for income inequality within a country. High income inequality can lead to a skewed understanding of a country's development.

- **Education and Health Metrics**:

  Quality Over Quantity: The HDI uses quantitative measures (years of schooling and life expectancy) without considering the quality of education and healthcare services.

- **Neglect of Non-Income Indicators**:

  Holistic Well-being: The HDI's emphasis on income as a significant component can overshadow other crucial non-income indicators of well-being, such as mental health, happiness, and social inclusion.

2.2 PROPOSED SOLLUTION

Our innovative proposed solution aim to create a more comprehensive, accurate, and actionable measure of human development.

1. **Address Income Inequality**:

- **Gini Coefficient or Palma Ratio**: Supplement GNI per capita with measures of income inequality to provide a more nuanced view of economic well-being.
- **Distribution-Adjusted Income**: Use income metrics adjusted for distribution to better reflect the economic reality of different population segments.

2. **Enhance Education and Health Metrics**:

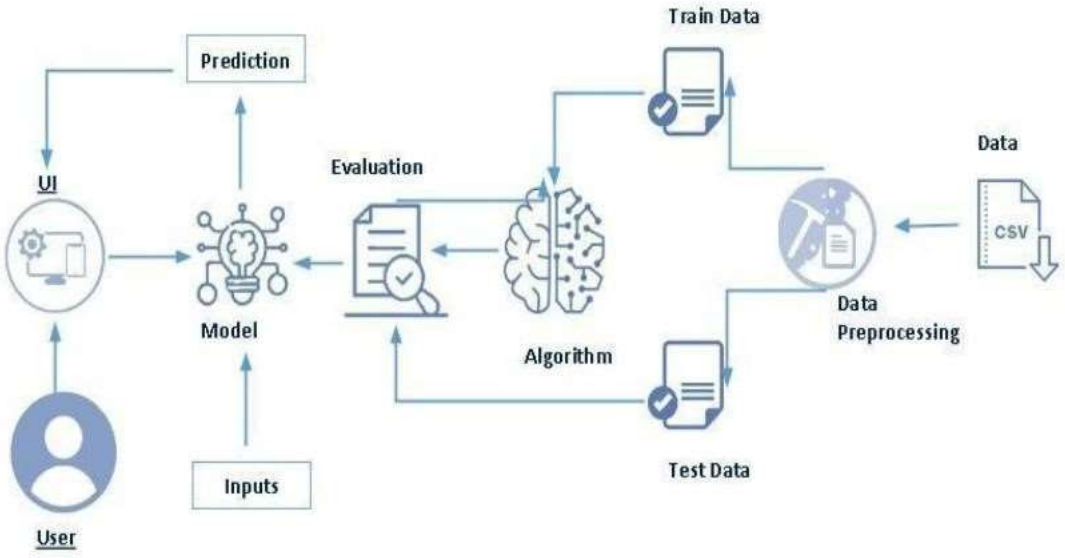
- **Quality of Education**: Include indicators like literacy rates, quality of education, student-teacher ratios, and learning outcomes.
- **Health Quality**: Consider healthcare accessibility, quality of healthcare services, and health outcomes beyond life expectancy, such as disease prevalence and mental health.

3. **Incorporate Cultural and Societal Factors**:

- **Cultural Sensitivity**: Include indicators that reflect cultural values and societal priorities, ensuring that the HDI is relevant to different cultural contexts.
- **Subjective Well-Being**: Integrate measures of happiness, life satisfaction, and subjective well-being to capture a holistic view of human development.
- By implementing these solutions, the HDI can be transformed into a more comprehensive, accurate, and actionable tool for measuring and promoting human development worldwide.

3.THEORITICAL ANALYSIS

3.1. BLOCK DIAGRAM



3.2. SOFTWARE DESIGNING

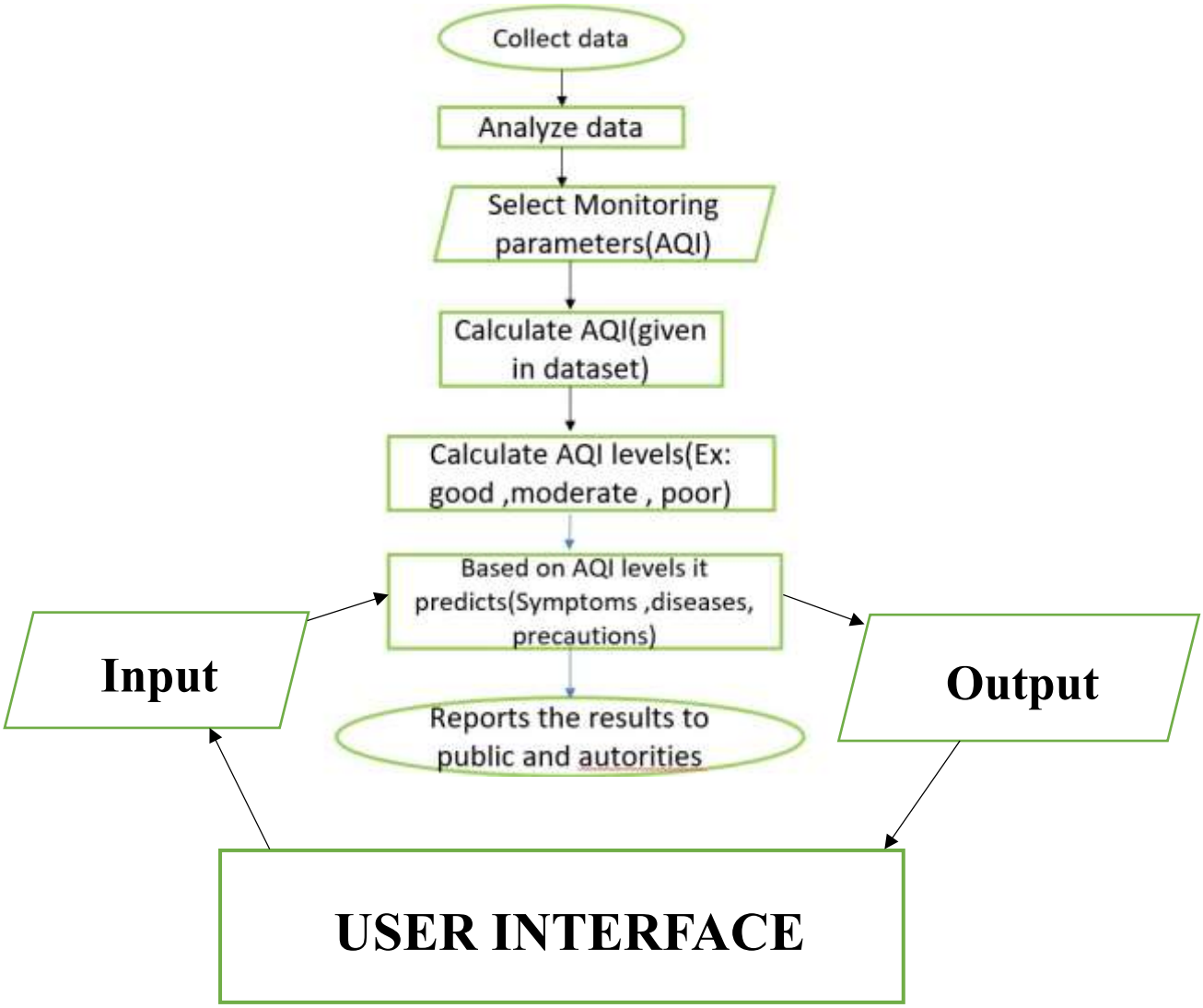
The following is the Software required to complete this project:

- **Google Colab**: Google Colab will serve as the development and execution environment for your predictive modeling, data preprocessing, and model training tasks. It provides a cloud-based Jupyter Notebook environment with access to Python libraries and hardware acceleration.

- **Dataset (CSV File)**: The dataset in CSV format is essential for training and testing your predictive model. It should include historical air quality data, weather information, pollutant levels, and other relevant features.

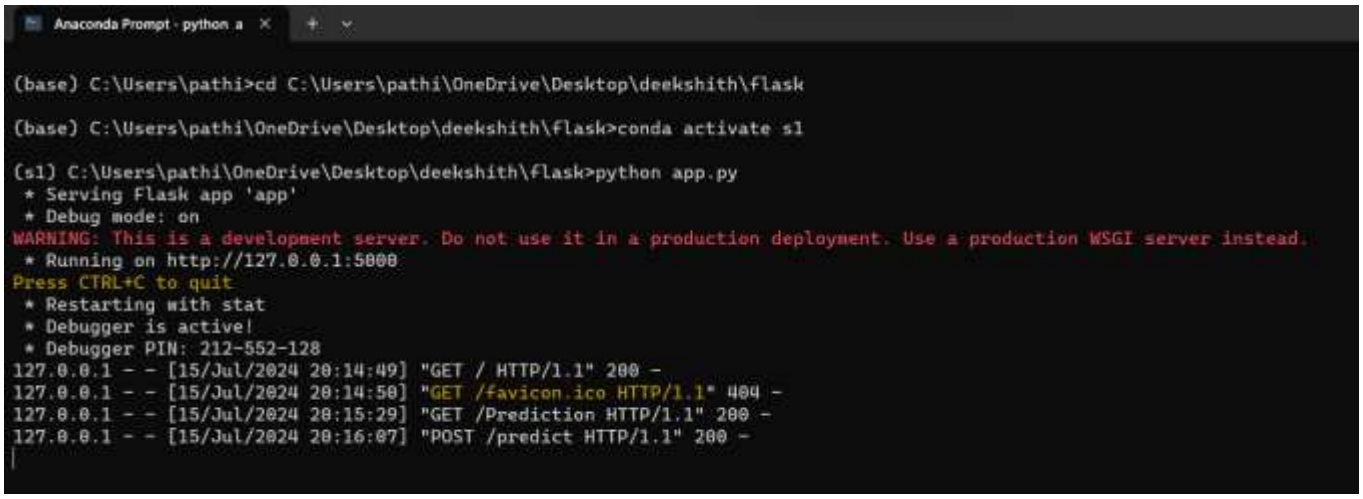
- **Data Preprocessing Tools**: Python libraries like NumPy, Pandas, and Scikit-learn will be used to preprocess the dataset. This includes handling missing data, feature scaling, and data cleaning.
- **Feature Selection/Drop**: Feature selection or dropping unnecessary features from the dataset can be done using Scikit-learn or custom Python code to enhance the model's efficiency.
- **Model Training Tools**: Machine learning libraries such as Scikit-learn, TensorFlow, will be used to develop, train, and fine-tune the predictive model. Regression or classification models can be considered, depending on the nature of the HDI prediction task.
- **Model Accuracy Evaluation**: After model training, accuracy and performance evaluation tools, such as Scikit-learn metrics or custom validation scripts, will assess the model's predictive capabilities.
- **UI Based on Flask Environment**: Flask, a Python web framework, will be used to develop the user interface (UI) for the system. The Flask application will provide a user-friendly platform for users to input location data or view HDI predictions, health information, and recommended precautions.
- Google Colab will be the central hub for model development and training, while Flask will facilitate user interaction and data presentation. The dataset, along with data preprocessing, will ensure the quality of the training data, and feature selection will optimize the model. Finally, model accuracy evaluation will confirm the system's predictive capabilities, allowing users to rely on the HDI predictions.

5.FLOWCHART

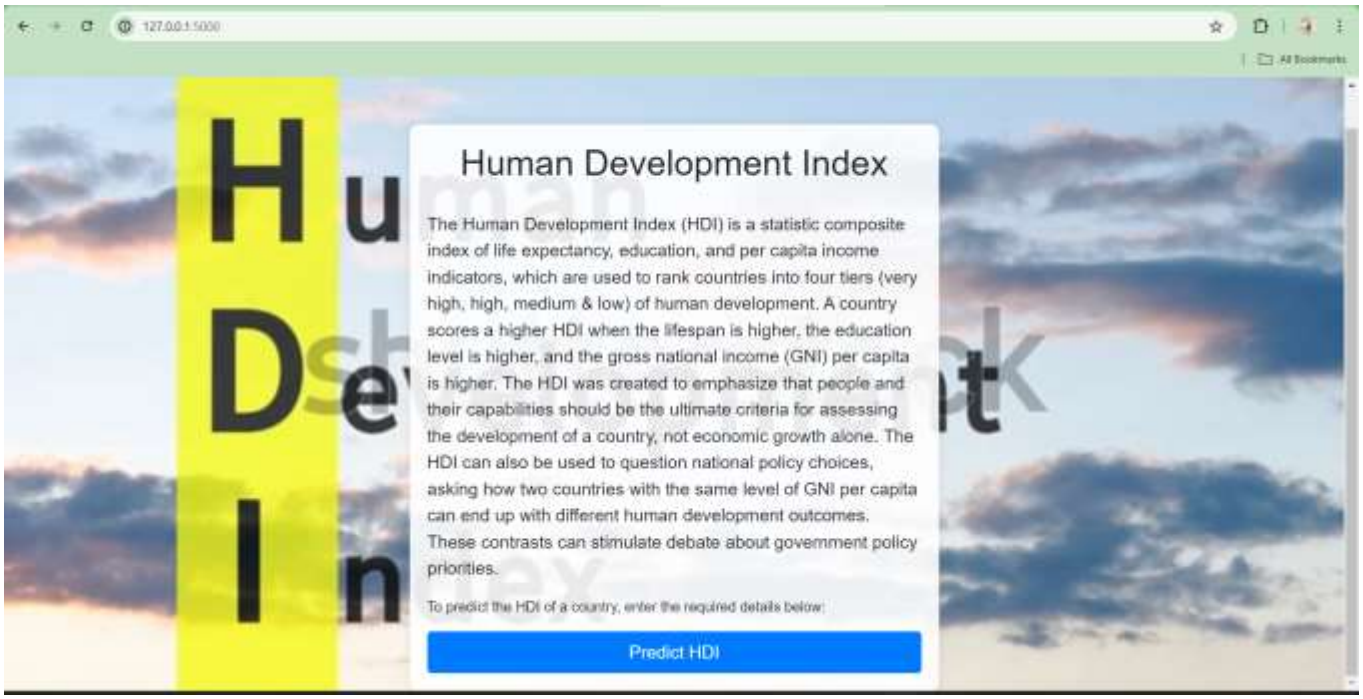

Collect data
Analyze data
Select Monitoring parameters(AQI)
Calculate AQI(given in dataset)
Calculate AQI levels(Ex: good ,moderate , poor)
Based on AQI levels it predicts(Symptoms ,diseases, precautions)
Reports the results to public and autorities
Input
Output
USER INTERFACE

5.RESULT

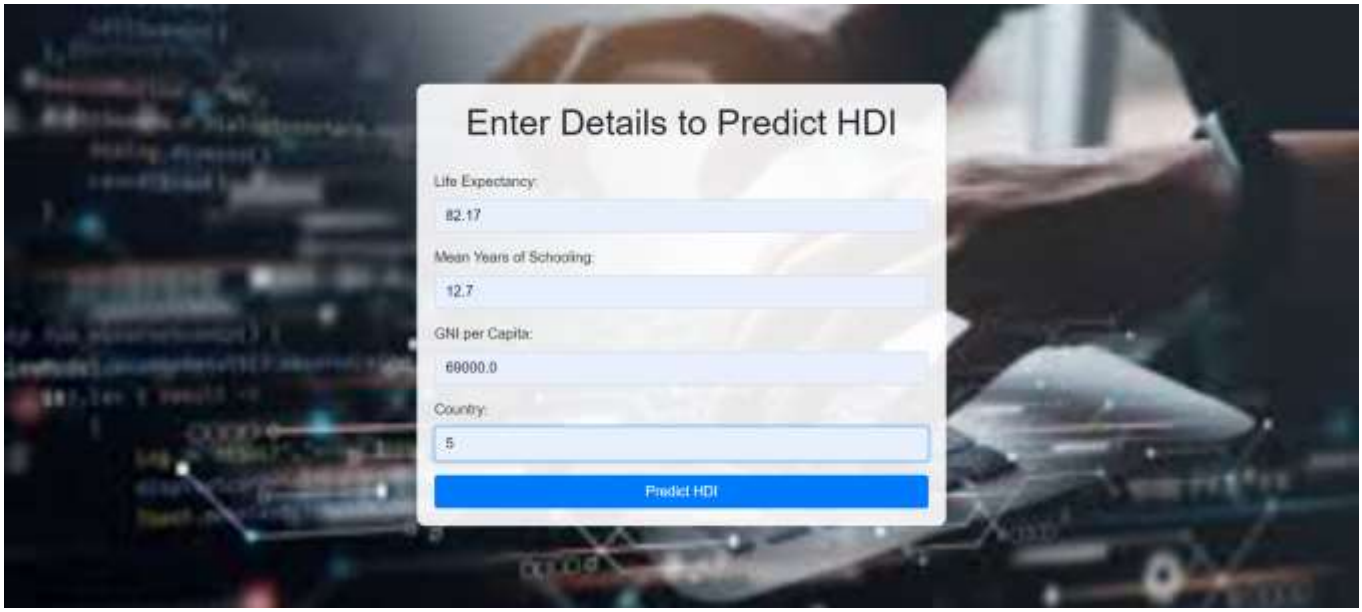
Executing app.py :



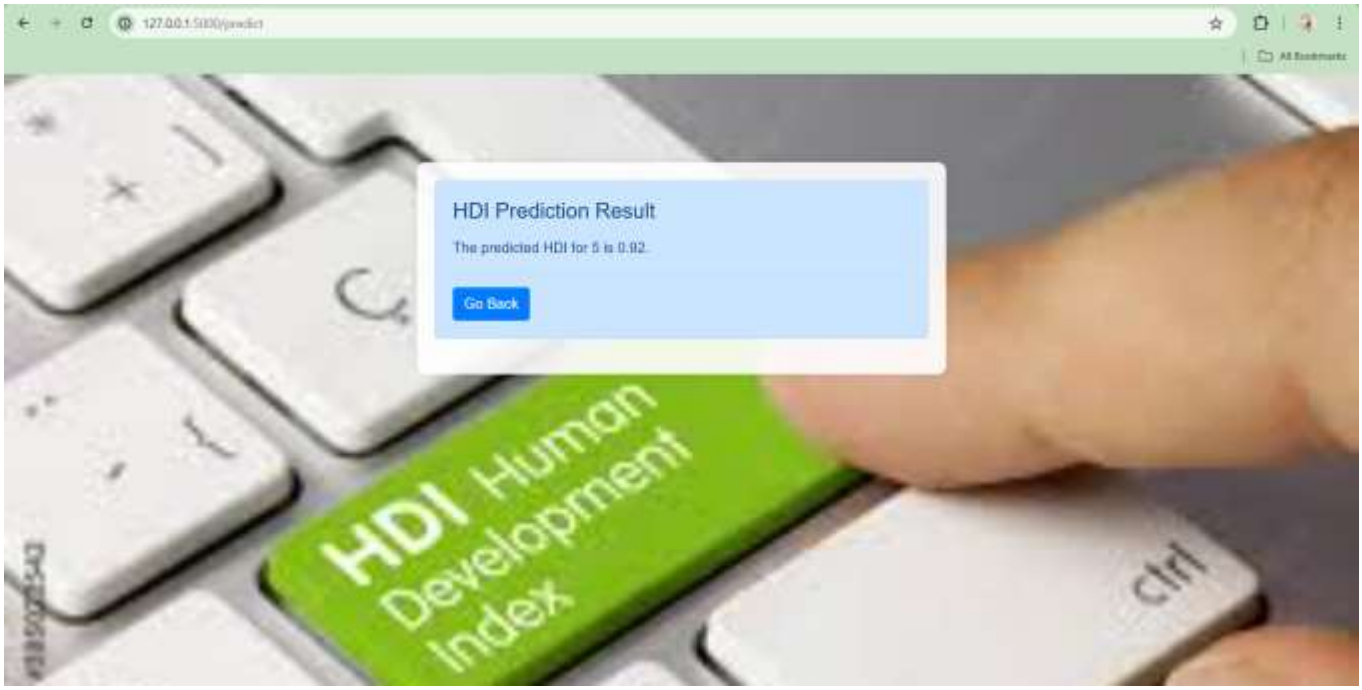
HOME PAGE



INDEX PAGE



PREDICTED PAGE



7.ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

1. HDI measures three factors, rather than just income, giving a more rounded view of living standards than GDP.
2. Health, education and income are pivotal to good living standards
3. The data used is easy--to--obtain and reliable
4. Gives an idea about future living standards (i.e. education and life expectancy are indicators of the future situation)
5. The HDI is given as one number between 0 and 1, which allows for easy comparison between different countries.

DISADVANTAGES:

1. HDI gives no indication equality. Income and access to educational and health services might be high amongst a small group of people but low amongst others.
2. Years of schooling is unreliable if students are repeating years due to lack of progress. Also, going to school is worthless is the education is of a poor quality.
3. The calculation excludes outliers from the data, which is unfair because countries should be rewarded with higher HDIs for good performance in one particular field.
4. Adult literacy places too much emphasis on reading and writing-- in this modern age computer literacy is arguably more important.

8.APPLICATIONS

1. **Policy Making**: Governments use the HDI to identify areas that needed improvement in health, education and income to enhance overall human development.
2. **Research and Analysis**: Researchers and academics use the HDI to study trends in human development over time and across different regions, providing valuable insights for policy recommendations.
3. **Global Ranking**: The HDI is used to rank countries based on their development levels, allowing for comparision and highlighting disparities that need attention.
4. **Sustainable Development Goals**: The HDI is used to track progress towards achieving the United Nation's sustainable development goals, which aim to improve the quality of life for people around the world.

9.CONCLUSION

- In conclusion, the Human Development Index (HDI) serves as a pivotal tool in the global landscape of development measurement, offering a multifaceted view of human well-being that transcends mere economic metrics. By incorporating health, education, and income indicators, the HDI provides a comprehensive snapshot of development that is easy to understand and widely accepted. It guides policymakers, informs international comparisons, and raises public awareness about the crucial dimensions of human development.

- while the HDI is an invaluable tool for assessing and promoting human development, ongoing efforts to expand and improve its methodology are essential. These improvements will ensure that the HDI continues to serve as a reliable and comprehensive measure, driving policies and actions that enhance the quality of life and well-being for people worldwide.

10.FUTURE SCOPE

Future Scope of the A COMPREHENSIVE MEASURE OF WELL-BEING: A HUMAN DEVELOPMENT INDEX are:

1. **Environmental Sustainability**: Integrate indicators related to environmental health and sustainability, such as carbon emissions, air and water quality, and resource use.
2. **Multidimensional Poverty Index (MPI)**: Complement the HDI with MPI to capture the broader spectrum of poverty and inequality..
3. **Income Distribution Metrics:** Incorporate measures like the Gini coefficient or Palma ratio to reflect income inequality.

4. **Alignment with SDGs**: Ensure the HDI is aligned with the United Nations Sustainable Development Goals, providing a comprehensive framework for measuring progress toward these goals.

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12.APPENDIX

Model building :

1)Dataset
2)Google Colab and VS code Application Building

- HTML file (home.html, indexnew.html, resultsnew.html, error.html)
- Models in pickle format

SOURCE CODE:

Home.html :

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>HDI Predictor</title>
    <link
href="https://stackpath.bootstrapcdn.com/bootstrap/4.5.2/css/bootstrap.min.css"
rel="stylesheet">
    <style>
        body {
            font-family: Arial, sans-serif;
            background-image: url('https://www.shutterstock.com/image-
illustration/acronym-hdi-human-development-index-600w-339214301.jpg'); /* Replace with
your background image URL */
            background-size: cover;
            background-position: center;
            background-repeat: no-repeat;
            background-attachment: fixed;
        }

        .container {
            max-width: 600px;
```

```
            margin-top: 100px;
            background-color: rgba(255, 255, 255, 0.9);
            padding: 20px;
            border-radius: 10px;
            box-shadow: 0px 0px 10px rgba(0, 0, 0, 0.1);
        }

        h1 {
            text-align: center;
            margin-bottom: 30px;
        }

        .btn-primary {
            background-color: #007bff;
            border-color: #007bff;
        }

        .btn-primary:hover {
            background-color: #0069d9;
            border-color: #0062cc;
        }
    </style>
</head>
<body>
    <div class="container">
        <h1 class="text-center">Human Development Index</h1>
        <p class="lead">The Human Development Index (HDI) is a statistic composite
index of life expectancy, education, and per capita income indicators, which are used
to rank countries into four tiers (very high, high, medium & low) of human development.
A country scores a higher HDI when the lifespan is higher, the education level is
higher, and the gross national income (GNI) per capita is higher. The HDI was created
to emphasize that people and their capabilities should be the ultimate criteria for
assessing the development of a country, not economic growth alone. The HDI can also be
used to question national policy choices, asking how two countries with the same level
of GNI per capita can end up with different human development outcomes. These contrasts
can stimulate debate about government policy priorities.</p>
        <p>To predict the HDI of a country, enter the required details below:</p>
        <a href="/Prediction" class="btn btn-primary btn-lg btn-block">Predict HDI</a>
    </div>

    <script src="https://code.jquery.com/jquery-3.5.1.slim.min.js"></script>
    <script
src="https://cdn.jsdelivr.net/npm/@popperjs/core@2.9.2/dist/umd/popper.min.js"></script
>
```

```
    <script
src="https://stackpath.bootstrapcdn.com/bootstrap/4.5.2/js/bootstrap.min.js"></script>
</body>
</html>
```

Indexnew.html :

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Predict HDI</title>
    <link
href="https://stackpath.bootstrapcdn.com/bootstrap/4.5.2/css/bootstrap.min.css"
rel="stylesheet">
    <style>
        body {
            font-family: Arial, sans-serif;
            background-image: url('https://encrypted-
tbn0.gstatic.com/images?q=tbn:ANd9GcQovEiSw8rQFuFN29swsVJwnqY7ijwtzFenRw&s'); /*
Replace with your background image URL */
            background-size: cover;
            background-position: center;
            background-repeat: no-repeat;
            background-attachment: fixed;
        }

        .container {
            max-width: 600px;
            margin-top: 100px;
            background-color: rgba(255, 255, 255, 0.9);
            padding: 20px;
            border-radius: 10px;
            box-shadow: 0px 0px 10px rgba(0, 0, 0, 0.1);
        }

        h1 {
            text-align: center;
            margin-bottom: 30px;
        }

        .btn-primary {
```

```
            background-color: #007bff;
            border-color: #007bff;
        }

        .btn-primary:hover {
            background-color: #0069d9;
            border-color: #0062cc;
        }
    </style>
</head>
<body>
    <div class="container">
        <h1 class="text-center">Enter Details to Predict HDI</h1>
        <form action="/predict" method="post">
            <div class="form-group">
                <label for="lifeExpectancy">Life Expectancy:</label>
                <input type="text" class="form-control" id="lifeExpectancy"
name="lifeExpectancy" required>
            </div>
            <div class="form-group">
                <label for="meanYearsOfSchooling">Mean Years of Schooling:</label>
                <input type="text" class="form-control" id="meanYearsOfSchooling"
name="meanYearsOfSchooling" required>
            </div>
            <div class="form-group">
                <label for="gniPerCapita">GNI per Capita:</label>
                <input type="text" class="form-control" id="gniPerCapita"
name="gniPerCapita" required>
            </div>
            <div class="form-group">
                <label for="Country">Country:</label>
                <input type="text" class="form-control" id="Country" name="Country"
required>
            </div>
            <button type="submit" class="btn btn-primary btn-block">Predict
HDI</button>
        </form>
    </div>

    <script src="https://code.jquery.com/jquery-3.5.1.slim.min.js"></script>
    <script
src="https://cdn.jsdelivr.net/npm/@popperjs/core@2.9.2/dist/umd/popper.min.js"></script
>
    <script
src="https://stackpath.bootstrapcdn.com/bootstrap/4.5.2/js/bootstrap.min.js"></script>
```

```
</body>
</html>
```

Resultsnew.html :

```
<!DOCTYPE html>

<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>HDI Prediction Result</title>
    <link
href="https://stackpath.bootstrapcdn.com/bootstrap/4.5.2/css/bootstrap.min.css"
rel="stylesheet">
    <style>
        body {
            font-family: Arial, sans-serif;
            background-image: url('https://encrypted-
tbn0.gstatic.com/images?q=tbn:ANd9GcQBMIjFsUmh0OrHkc46bnMI4SjdiGzioej5bQ&s'); /*
Replace with your background image URL */
            background-size: cover;
            background-position: center;
            background-repeat: no-repeat;
            background-attachment: fixed;
        }

        .container {
            max-width: 600px;
            margin-top: 100px;
            background-color: rgba(255, 255, 255, 0.9);
            padding: 20px;
            border-radius: 10px;
            box-shadow: 0px 0px 10px rgba(0, 0, 0, 0.1);
        }

        .alert {
            background-color: #cce5ff;
            color: #004085;
            border-color: #b8daff;
            margin-bottom: 20px;
            padding: 20px;
            border-radius: 5px;
        }
```

```
        h4 {
            margin-bottom: 15px;
        }

        .btn-primary {
            background-color: #007bff;
            border-color: #007bff;
        }

        .btn-primary:hover {
            background-color: #0069d9;
            border-color: #0062cc;
        }
    </style>
</head>
<body>
    <div class="container">
        <div class="alert alert-info" role="alert">
            <h4 class="alert-heading">HDI Prediction Result</h4>
            <p>{{ prediction_text }}</p>
            <hr>
            <a href="/home" class="btn btn-primary">Go Back</a>
        </div>
    </div>

    <script src="https://code.jquery.com/jquery-3.5.1.slim.min.js"></script>
    <script
src="https://cdn.jsdelivr.net/npm/@popperjs/core@2.9.2/dist/umd/popper.min.js"></script
>
    <script
src="https://stackpath.bootstrapcdn.com/bootstrap/4.5.2/js/bootstrap.min.js"></script>
</body>
</html>
```

Error.html :

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Error</title>
    <style>
```

```
        body, html {
            height: 100%;
            margin: 0;
            font-family: Arial, sans-serif;
            text-align: center;
            background-image: url('background-image.jpg'); /* Replace with your
background image */
            background-position: center;
            background-repeat: no-repeat;
            background-size: cover;
            display: flex;
            justify-content: center;
            align-items: center;
            color: white;
        }
        .container {
            background-color: rgba(0, 0, 0, 0.7); /* Dark overlay */
            padding: 40px;
            border-radius: 10px;
            width: 50%;
        }
        h1 {
            font-size: 2.5em;
            color: red;
            margin-bottom: 20px;
        }
        p {
            font-size: 1.2em;
            color: yellowgreen;
        }
    </style>
</head>
<body>
    <div class="container">
        <h1>Error</h1>
        <p>{{ error_text }}</p> <!-- Dynamic error message -->
    </div>
</body>
</html>
```

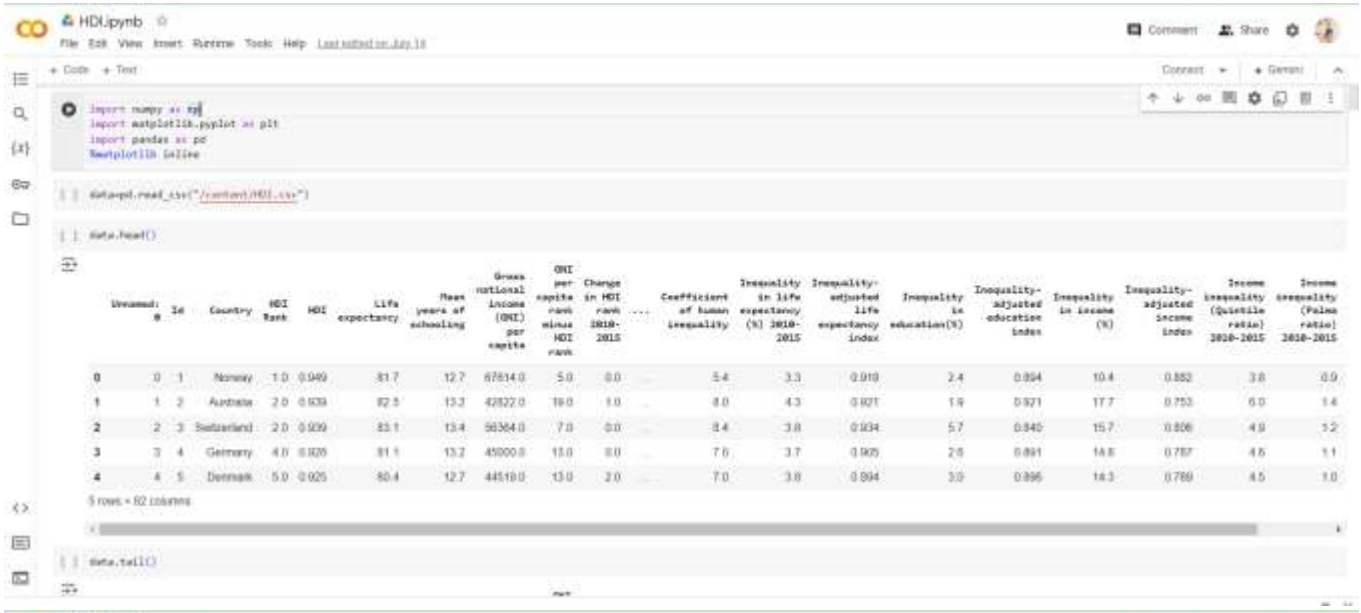
App.py :

```
from flask import Flask, render_template, request, redirect, url_for
```

```
import pickle

app = Flask(__name__)

# Load the model
with open('HDI.pkl', 'rb') as f:
    model = pickle.load(f)

@app.route('/')
@app.route('/home')
def home():
    return render_template('home.html')

@app.route('/Prediction')
def prediction():
    return render_template('indexnew.html')

@app.route('/predict', methods=['POST'])
def predict():
    try:
        # Retrieve form data
        life_expectancy = float(request.form['lifeExpectancy'])
        mean_years_of_schooling = float(request.form['meanYearsOfSchooling'])
        gni_per_capita = float(request.form['gniPerCapita'])
        country = request.form['Country']

        # Assuming the model requires these inputs in a specific order
        features = [life_expectancy, mean_years_of_schooling, gni_per_capita,country]

        # Make prediction
        prediction = model.predict([features])[0]
        prediction_text = f'The predicted HDI for {country} is {prediction:.2f}.'

        return render_template('resultsnew.html', prediction_text=prediction_text)
    except Exception as e:
        error_text = str(e)
        return render_template('error.html', error_text=error_text)

if __name__ == '__main__':
    app.run(debug=True)
```

CODE SNIPPETS

MODEL BUILDING :



```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
%matplotlib inline
```

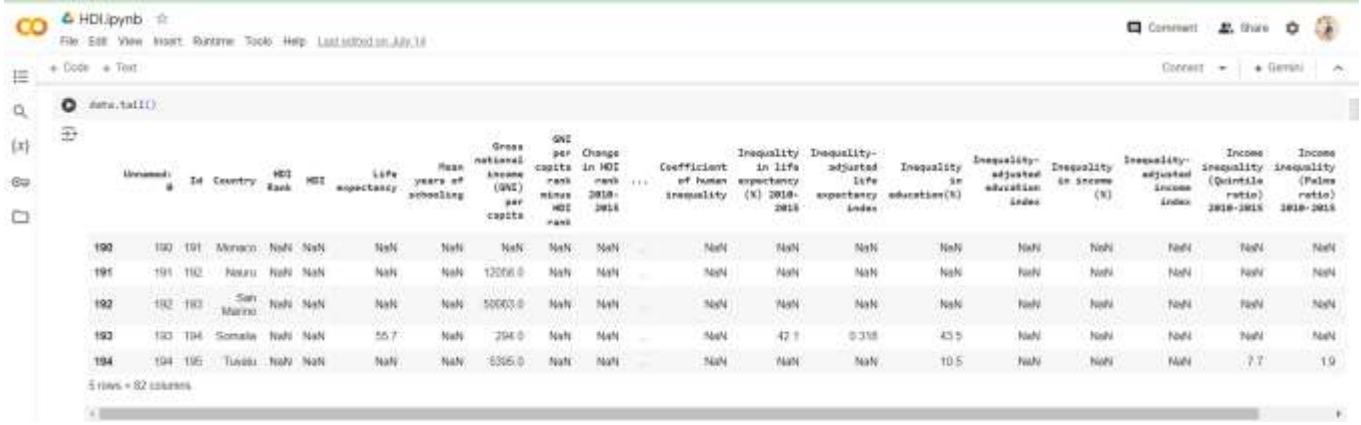
```
data=pd.read_csv("/content/HDI.csv")
```

```
data.head()
```

	Unnamed: 0	Id	Country	HDI Rank	HDI	Life expectancy	Mean years of schooling	Gross national income (GNI) per capita	GNI per capita rank minus HDI rank	Change in HDI rank 2010-2015	...	Coefficient of human inequality	Inequality in life expectancy (%) 2010-2015	Inequality-adjusted life expectancy index	Inequality in education(%)	Inequality-adjusted education index	Inequality in income (%)	Inequality-adjusted income index	Income inequality (Quintile ratio) 2010-2015	Income inequality (Palma ratio) 2010-2015
0	0	1	Norway	1.0	0.949	81.7	12.7	67614.0	5.0	0.0	...	5.4	3.3	0.919	2.4	0.894	10.4	0.883	3.8	0.9
1	1	2	Australia	2.0	0.939	82.5	13.2	42822.0	19.0	1.0	...	8.0	4.3	0.901	1.9	0.921	17.7	0.753	6.0	1.4
2	2	3	Switzerland	2.0	0.939	83.1	13.4	56364.0	7.0	0.0	...	8.4	3.8	0.934	5.7	0.840	15.7	0.806	4.9	1.2
3	3	4	Germany	4.0	0.926	81.1	13.2	45000.0	13.0	0.0	...	7.6	3.7	0.905	2.6	0.891	14.6	0.787	4.6	1.1
4	4	5	Denmark	5.0	0.925	80.4	12.7	44519.0	13.0	2.0	...	7.0	3.8	0.894	3.0	0.896	14.3	0.789	4.5	1.0

5 rows × 82 columns

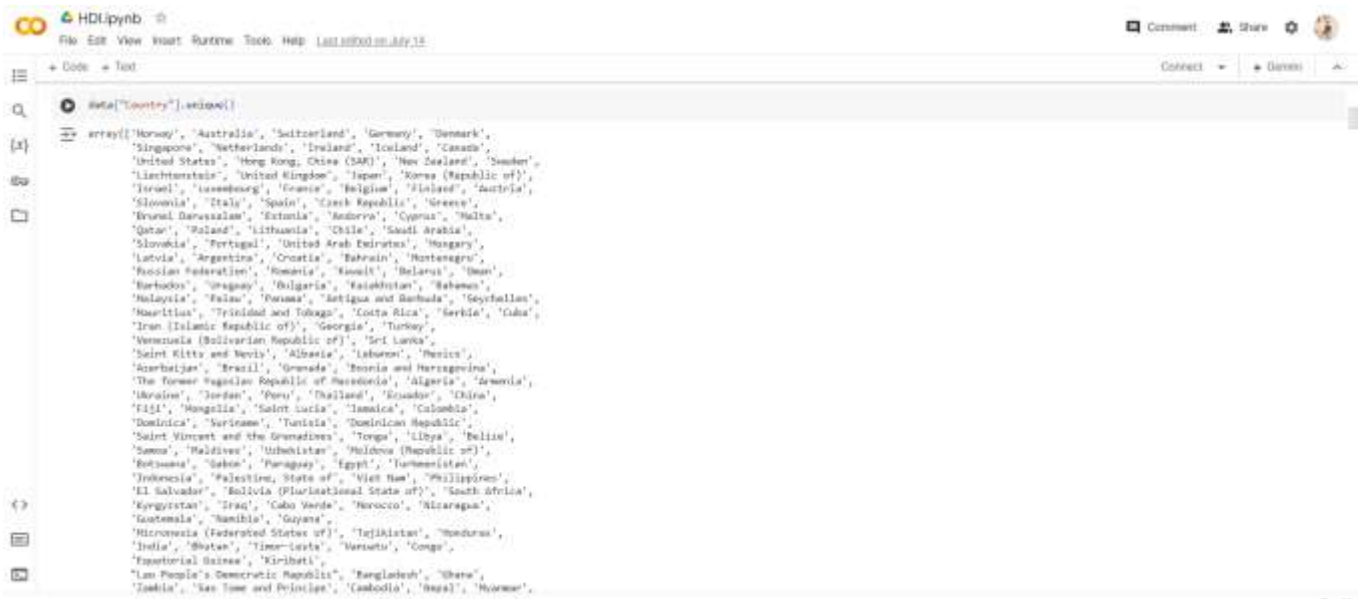
```
data.tail()
```



```
data.tail()
```

	Unnamed: 0	Id	Country	HDI Rank	HDI	Life expectancy	Mean years of schooling	Gross national income (GNI) per capita	GNI per capita rank minus HDI rank	Change in HDI rank 2010-2016	...	Coefficient of human inequality	Inequality in life expectancy (%) 2010-2016	Inequality-adjusted life expectancy index	Inequality in education(%)	Inequality-adjusted education index	Inequality in income (%)	Inequality-adjusted income index	Income inequality (Quintile ratio) 2010-2016	Income inequality (Palma ratio) 2010-2016
190	190	191	Monaco	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
191	191	192	Nauru	NaN	NaN	NaN	NaN	12056.0	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
192	192	193	San Marino	NaN	NaN	NaN	NaN	50003.0	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
193	193	194	Somalia	NaN	NaN	55.7	NaN	294.0	NaN	NaN	...	NaN	42.1	0.318	43.5	NaN	NaN	NaN	NaN	NaN
194	194	195	Tuvalu	NaN	NaN	NaN	NaN	6395.0	NaN	NaN	...	NaN	NaN	NaN	10.5	NaN	NaN	NaN	7.7	1.9

5 rows × 82 columns


HDI.ipynb
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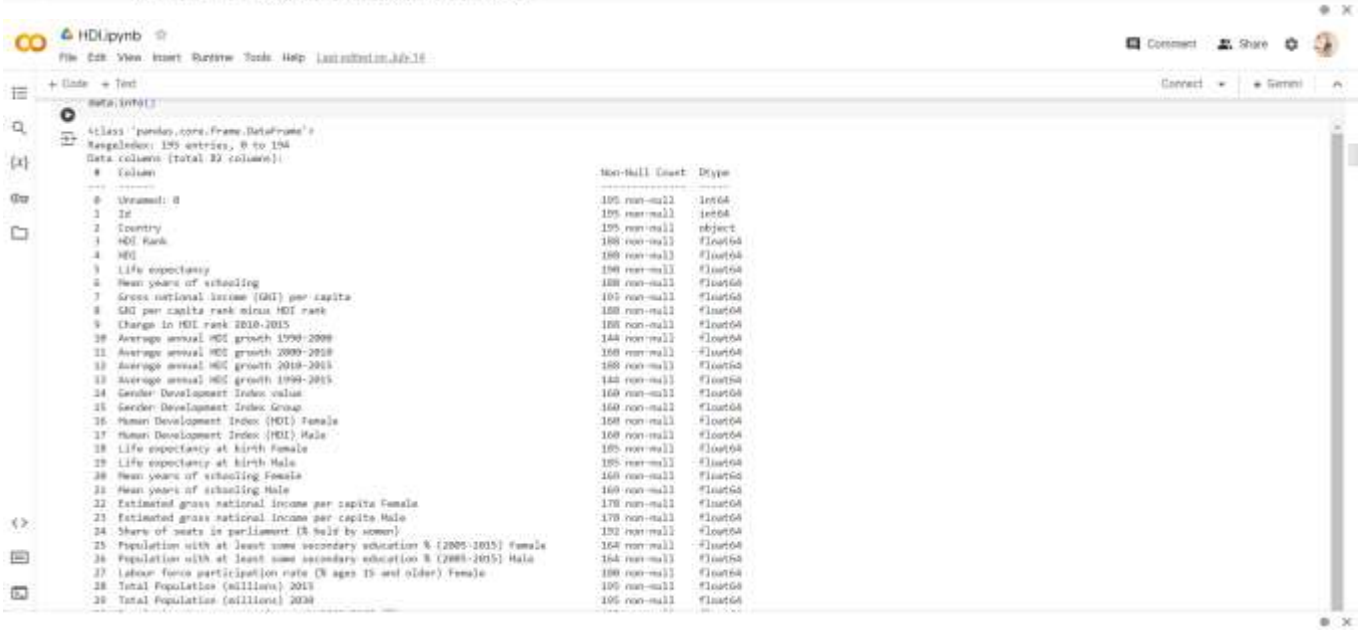
data["Country"].unique()
array(['Norway', 'Australia', 'Switzerland', 'Germany', 'Denmark',
'Singapore', 'Netherlands', 'Ireland', 'Iceland', 'Canada',
'United States', 'Hong Kong, China (SAR)', 'New Zealand', 'Sweden',
'Liechtenstein', 'United Kingdom', 'Japan', 'Korea (Republic of)',
'Israel', 'Luxembourg', 'France', 'Belgium', 'Finland', 'Austria',
'Slovenia', 'Italy', 'Spain', 'Czech Republic', 'Greece',
'Brunei Darussalam', 'Estonia', 'Andorra', 'Cyprus', 'Malta',
'Qatar', 'Poland', 'Lithuania', 'Chile', 'Saudi Arabia',
'Slovakia', 'Portugal', 'United Arab Emirates', 'Hungary',
'Latvia', 'Argentina', 'Croatia', 'Bahrain', 'Montenegro',
'Russian Federation', 'Romania', 'Kuwait', 'Belarus', 'Oman',
'Barbados', 'Uruguay', 'Bulgaria', 'Kazakhstan', 'Bahamas',
'Malaysia', 'Palau', 'Panama', 'Antigua and Barbuda', 'Seychelles',
'Mauritius', 'Trinidad and Tobago', 'Costa Rica', 'Serbia', 'Cuba',
'Iran (Islamic Republic of)', 'Georgia', 'Turkey',
'Venezuela (Bolivarian Republic of)', 'Sri Lanka',
'Saint Kitts and Nevis', 'Albania', 'Lebanon', 'Mexico',
'Azerbaijan', 'Brazil', 'Grenada', 'Bosnia and Herzegovina',
'The former Yugoslav Republic of Macedonia', 'Algeria', 'Armenia',
'Ukraine', 'Jordan', 'Peru', 'Thailand', 'Ecuador', 'China',
'Fiji', 'Mongolia', 'Saint Lucia', 'Jamaica', 'Colombia',
'Dominica', 'Suriname', 'Tunisia', 'Dominican Republic',
'Saint Vincent and the Grenadines', 'Tonga', 'Libya', 'Belize',
'Samoa', 'Maldives', 'Uzbekistan', 'Moldova (Republic of)',
'Botswana', 'Gabon', 'Paraguay', 'Egypt', 'Turkmenistan',
'Indonesia', 'Palestine, State of', 'Viet Nam', 'Philippines',
'El Salvador', 'Bolivia (Plurinational State of)', 'South Africa',
'Kyrgyzstan', 'Iraq', 'Cabo Verde', 'Morocco', 'Nicaragua',
'Guatemala', 'Namibia', 'Guyana',
'Micronesia (Federated States of)', 'Tajikistan', 'Honduras',
'India', 'Bhutan', 'Timor-Leste', 'Vanuatu', 'Congo',
'Equatorial Guinea', 'Kiribati',
"Lao People's Democratic Republic", 'Bangladesh', 'Ghana',
'Zambia', 'Sao Tome and Principe', 'Cambodia', 'Nepal', 'Myanmar',


HDI.ipynb
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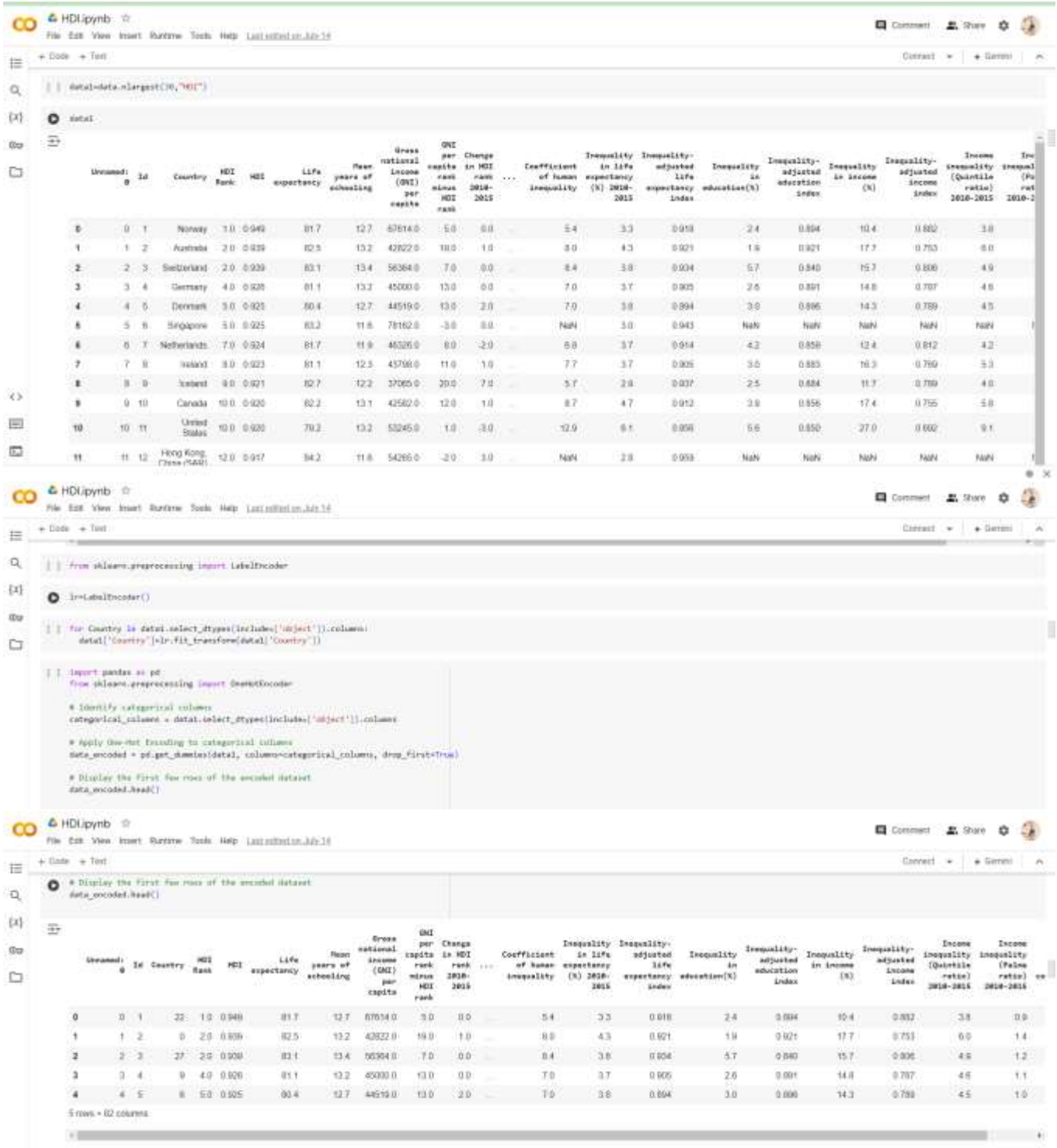
data.info()
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 195 entries, 0 to 194
Data columns (total 32 columns):
Column Non-Null Count Dtype
0 Unnamed: 0 195 non-null int64
1 Id 195 non-null int64
2 Country 195 non-null object
3 HDI Rank 188 non-null float64
4 HDI 189 non-null float64
5 Life expectancy 190 non-null float64
6 Mean years of schooling 188 non-null float64
7 Gross national income (GNI) per capita 185 non-null float64
8 GNI per capita rank minus HDI rank 188 non-null float64
9 Change in HDI rank 2010-2015 188 non-null float64
10 Average annual HDI growth 1990-2000 144 non-null float64
11 Average annual HDI growth 2000-2010 160 non-null float64
12 Average annual HDI growth 2010-2015 188 non-null float64
13 Average annual HDI growth 1990-2015 142 non-null float64
14 Gender Development Index value 160 non-null float64
15 Gender Development Index Group 160 non-null float64
16 Human Development Index (HDI) Female 160 non-null float64
17 Human Development Index (HDI) Male 160 non-null float64
18 Life expectancy at birth Female 185 non-null float64
19 Life expectancy at birth Male 185 non-null float64
20 Mean years of schooling Female 160 non-null float64
21 Mean years of schooling Male 160 non-null float64
22 Estimated gross national income per capita Female 178 non-null float64
23 Estimated gross national income per capita Male 178 non-null float64
24 Share of seats in parliament (% held by women) 192 non-null float64
25 Population with at least some secondary education % (2005-2015) Female 164 non-null float64
26 Population with at least some secondary education % (2005-2015) Male 164 non-null float64
27 Labour force participation rate (% ages 15 and older) Female 180 non-null float64
28 Total Population (millions) 2015 195 non-null float64
29 Total Population (millions) 2030 195 non-null float64



HDI.ipynb

```
data1=data.nlargest(30,"HDI")
```

```
data1
```

	Unnamed: 0	Id	Country	HDI Rank	HDI	Life expectancy	Mean years of schooling	Gross national Income (GNI) per capita	GNI per capita rank minus HDI rank	Change in HDI rank 2010-2015	...	Coefficient of human inequality	Inequality in life expectancy (%) 2010-2015	Inequality-adjusted life expectancy index	Inequality in education(%)	Inequality-adjusted education index	Inequality in income (%)	Inequality-adjusted income index	Income inequality (Quintile ratio) 2010-2015	Income inequal (Pa rat 2010-2
0	0	1	Norway	1.0	0.949	81.7	12.7	67614.0	5.0	0.0	...	5.4	3.3	0.918	2.4	0.894	10.4	0.852	3.8	
1	1	2	Australia	2.0	0.939	82.5	13.2	42822.0	19.0	1.0	...	8.0	4.3	0.921	1.9	0.921	17.7	0.753	6.0	
2	2	3	Switzerland	2.0	0.939	83.1	13.4	56384.0	7.0	0.0	...	8.4	3.8	0.934	5.7	0.840	15.7	0.806	4.9	
3	3	4	Germany	4.0	0.926	81.1	13.2	45000.0	13.0	0.0	...	7.0	3.7	0.905	2.6	0.891	14.8	0.707	4.6	
4	4	5	Denmark	5.0	0.925	80.4	12.7	44519.0	13.0	2.0	...	7.0	3.8	0.894	3.0	0.886	14.3	0.789	4.5	
5	5	6	Singapore	5.0	0.925	83.2	11.6	78162.0	-3.0	0.0	...	NaN	3.0	0.943	NaN	NaN	NaN	NaN	NaN	
6	6	7	Netherlands	7.0	0.924	81.7	11.9	46326.0	8.0	-2.0	...	6.8	3.7	0.914	4.2	0.858	12.4	0.812	4.2	
7	7	8	Ireland	8.0	0.923	81.1	12.3	43798.0	11.0	1.0	...	7.7	3.7	0.905	3.0	0.883	16.3	0.769	5.3	
8	8	9	Iceland	9.0	0.921	82.7	12.2	37065.0	20.0	7.0	...	5.7	2.9	0.937	2.5	0.884	11.7	0.789	4.0	
9	9	10	Canada	10.0	0.920	82.2	13.1	42582.0	12.0	1.0	...	8.7	4.7	0.912	3.9	0.856	17.4	0.755	5.8	
10	10	11	United States	10.0	0.920	79.3	13.2	53245.0	1.0	-3.0	...	12.9	6.1	0.858	0.6	0.850	27.0	0.662	9.1	
11	11	12	Hong Kong (China (SAR))	12.0	0.917	84.2	11.6	54266.0	-2.0	3.0	...	NaN	2.8	0.959	NaN	NaN	NaN	NaN	NaN	

HDI.ipynb

```
from sklearn.preprocessing import LabelEncoder
```

```
lr=LabelEncoder()
```

```
for Country in data1.select_dtypes(includes=['object']).columns:
    data1['Country']=lr.fit_transform(data1['Country'])
```

```
import pandas as pd
from sklearn.preprocessing import OneHotEncoder

# Identify categorical columns
categorical_columns = data1.select_dtypes(includes=['object']).columns

# Apply One-Hot Encoding to categorical columns
data_encoded = pd.get_dummies(data1, columns=categorical_columns, drop_first=True)

# Display the first few rows of the encoded dataset
data_encoded.head()
```


HDI.ipynb

```
# Display the first few rows of the encoded dataset
data_encoded.head()
```

	Unnamed: 0	Id	Country	HDI Rank	HDI	Life expectancy	Mean years of schooling	Gross national Income (GNI) per capita	GNI per capita rank minus HDI rank	Change in HDI rank 2010-2015	...	Coefficient of human inequality	Inequality in life expectancy (%) 2010-2015	Inequality-adjusted life expectancy index	Inequality in education(%)	Inequality-adjusted education index	Inequality in income (%)	Inequality-adjusted income index	Income inequality (Quintile ratio) 2010-2015	Income inequality (Palma ratio) 2010-2015	co
0	0	1	22	1.0	0.949	81.7	12.7	67614.0	9.0	0.0	...	5.4	3.3	0.918	2.4	0.894	10.4	0.852	3.8	0.9	
1	1	2	0	2.0	0.939	82.5	13.2	42822.0	19.0	1.0	...	8.0	4.3	0.921	1.9	0.921	17.7	0.753	6.0	1.4	
2	2	3	27	2.0	0.939	83.1	13.4	56384.0	7.0	0.0	...	8.4	3.8	0.934	5.7	0.840	15.7	0.806	4.9	1.2	
3	3	4	9	4.0	0.926	81.1	13.2	45000.0	13.0	0.0	...	7.0	3.7	0.905	2.6	0.891	14.8	0.707	4.6	1.1	
4	4	5	8	5.0	0.925	80.4	12.7	44519.0	13.0	2.0	...	7.0	3.8	0.894	3.0	0.886	14.3	0.789	4.5	1.0	

5 rows × 82 columns

HDI.ipynb

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```
data_filled = data_encoded.fillna(data_encoded.mean())
```

```
data_filled.fillna(data_filled.mean(),inplace=True)
data_filled
```

	Unnamed: 0	Id	Country	HDI Rank	HDI	Life expectancy	Mean years of schooling	Gross national income (GNI) per capita	GNI per capita rank minus HDI rank	Change in HDI rank 2010-2015	...	Coefficient of human inequality	Inequality in life expectancy (%) 2010-2015	Inequality-adjusted life expectancy index	Inequality in education(%)	Inequality-adjusted education index	Inequality in income (%)	Inequality-adjusted income index	Income inequality (Quintile ratio) 2010-2015	Income inequality (Palma ratio) 2010-2015
0	0	1	22	1.0	0.949	81.7	12.7	67614.0	5.0	0.0	...	5.400	3.300000	0.918000	2.400	0.80400	10.400	0.88200	3.600000	0.900000
1	1	2	9	2.0	0.939	82.5	13.2	42602.0	19.0	1.0	...	8.000	4.300000	0.921000	1.900	0.92100	17.700	0.75300	6.000000	1.400000
2	2	3	27	2.0	0.939	83.1	13.4	56364.0	7.0	0.0	...	8.400	3.800000	0.934000	5.700	0.84000	15.700	0.80800	4.000000	1.200000
3	3	4	8	4.0	0.916	83.1	13.2	45000.0	13.0	0.0	...	7.000	3.700000	0.905000	2.600	0.89100	14.000	0.78700	4.600000	1.100000
4	4	5	6	5.0	0.915	80.4	12.7	44619.0	13.0	2.0	...	7.000	3.800000	0.894000	3.000	0.88600	14.300	0.78800	4.500000	1.000000
5	5	6	23	5.0	0.915	83.2	11.6	78162.0	-3.0	0.0	...	8.688	3.000000	0.943000	6.124	0.81848	16.184	0.76008	5.445833	1.245833
6	6	7	20	7.0	0.924	81.7	11.9	46326.0	8.0	-2.0	...	6.800	3.700000	0.914000	4.200	0.85900	12.400	0.81200	4.200000	1.000000
7	7	8	13	8.0	0.923	81.1	12.3	43798.0	11.0	1.0	...	7.700	3.700000	0.905000	3.000	0.88300	16.300	0.76900	5.300000	1.300000
8	8	9	12	9.0	0.921	82.7	12.2	37095.0	20.0	7.0	...	5.700	2.900000	0.937000	2.500	0.88400	11.700	0.78900	4.000000	1.000000
9	9	10	4	10.0	0.920	82.2	13.1	42582.0	12.0	1.0	...	8.700	4.700000	0.912000	3.900	0.85800	17.400	0.75500	5.800000	1.300000
10	10	11	29	10.0	0.920	79.2	13.2	53245.0	1.0	-3.0	...	12.900	6.100000	0.850000	5.600	0.85000	27.000	0.66200	9.100000	2.000000
11	11	12	11	12.0	0.917	84.2	11.6	54265.0	-2.0	3.0	...	8.688	2.000000	0.959000	6.124	0.81848	16.184	0.76008	5.445833	1.245833

HDI.ipynb

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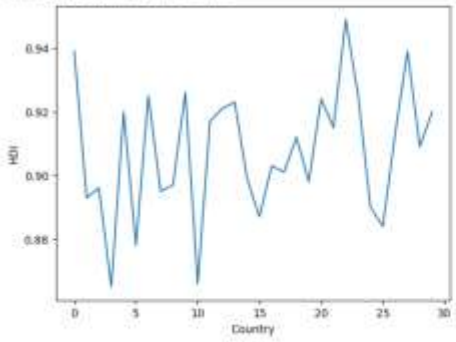
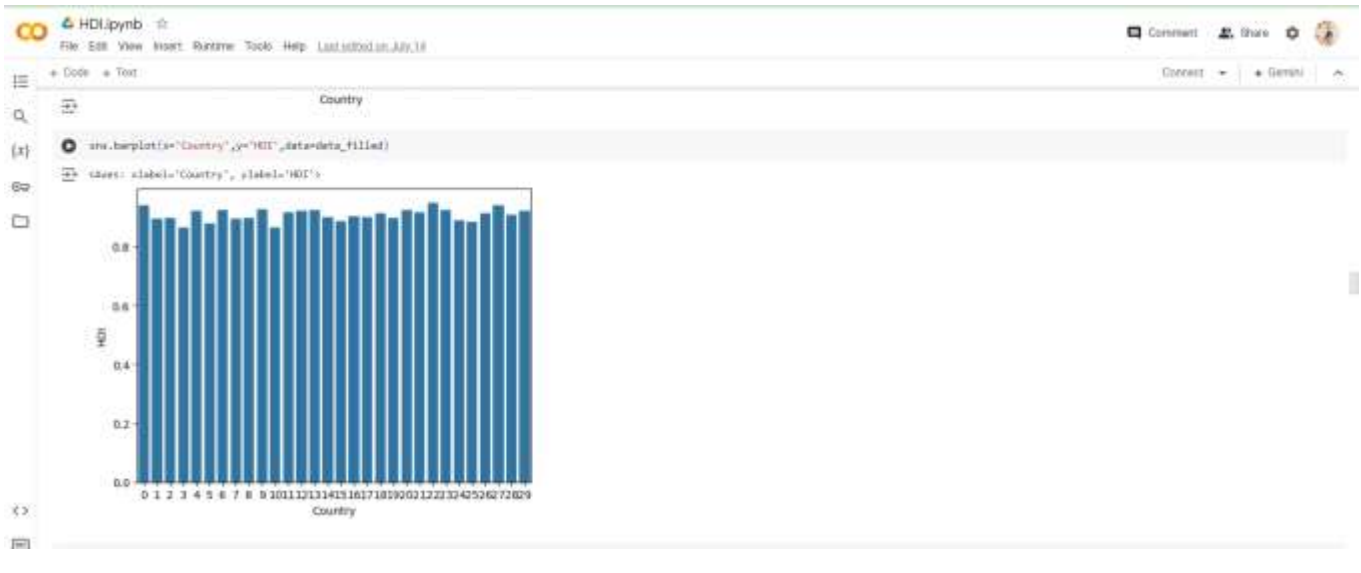
```
import seaborn as sns
```

```
sns.lineplot(x='Country',y='HDI',data=data_filled)
```

```
<Axes: xlabel='Country', ylabel='HDI'>
```




HDI.ipynb
File Edit View Insert Runtime Tools Help
Comment
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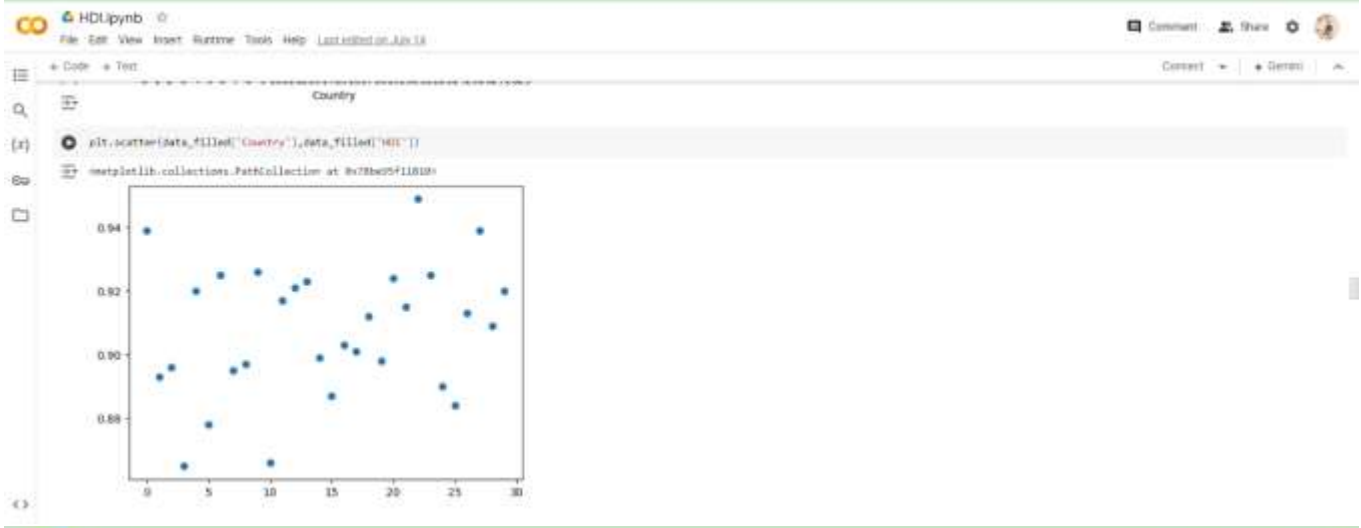
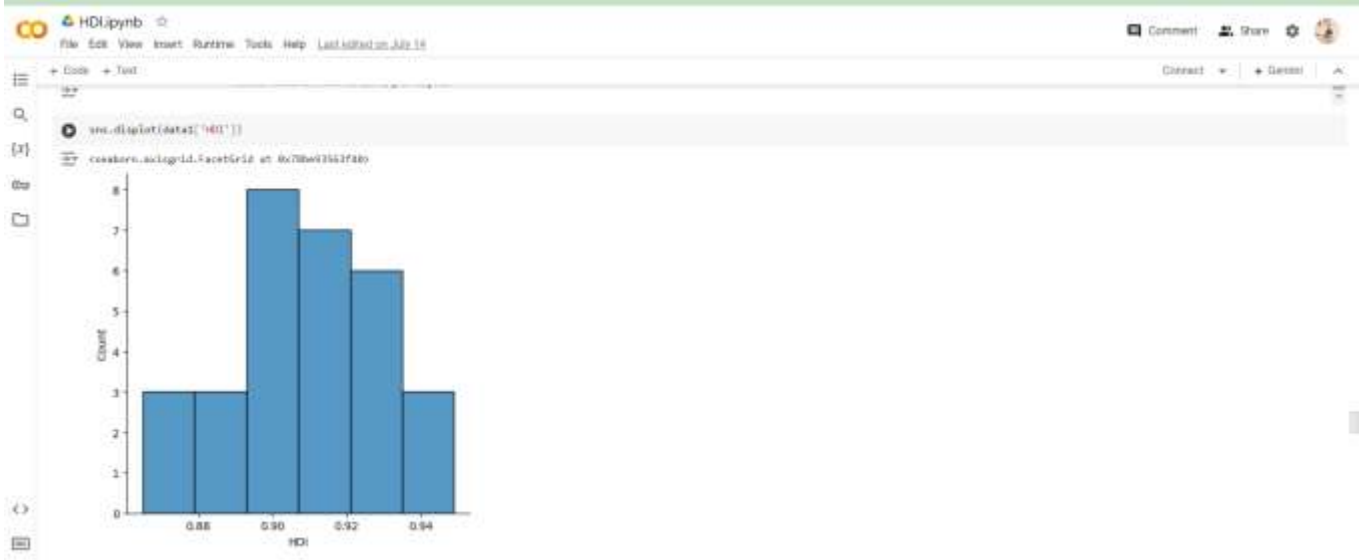
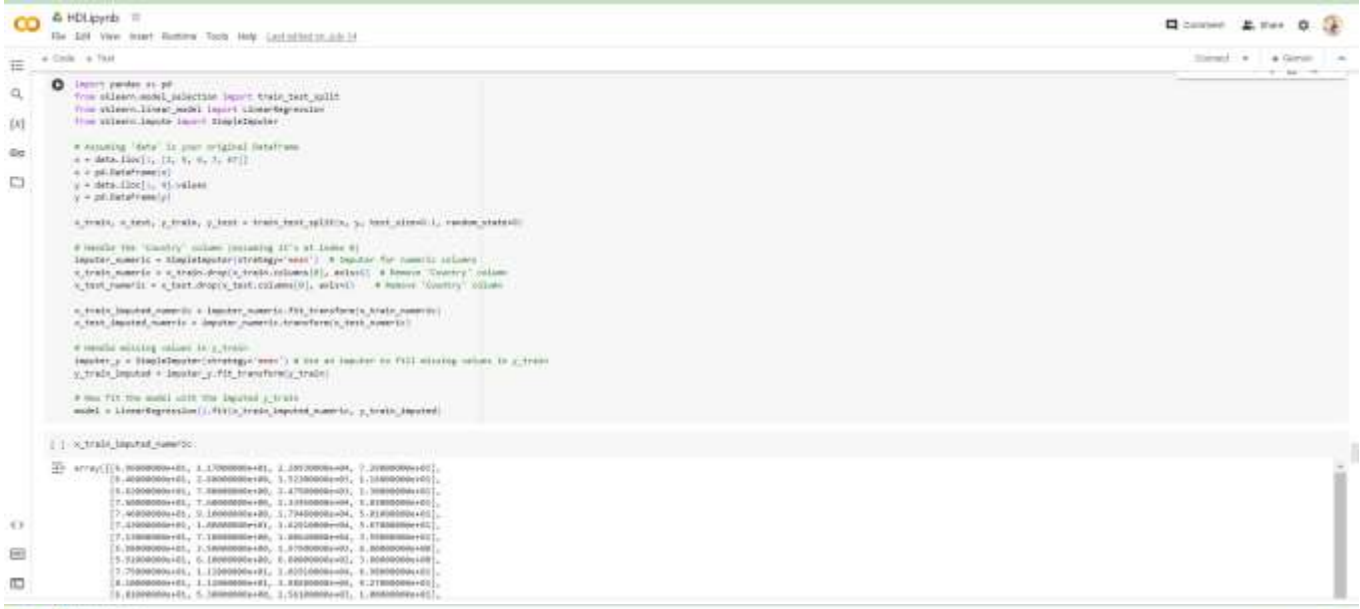
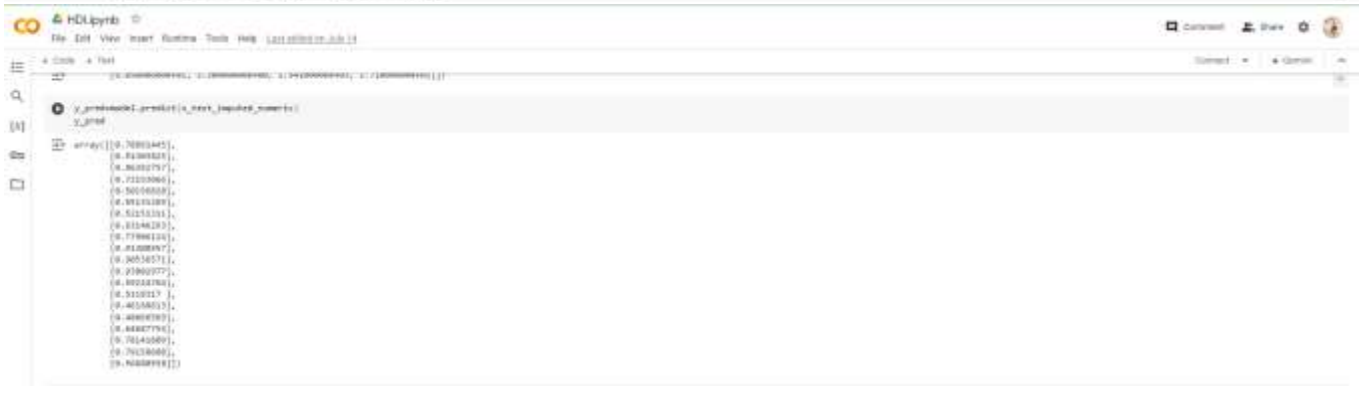
Country
sns.barplot(x='Country',y='HDI',data=data_filled)
<Axes: xlabel='Country', ylabel='HDI'>
HDI
Country

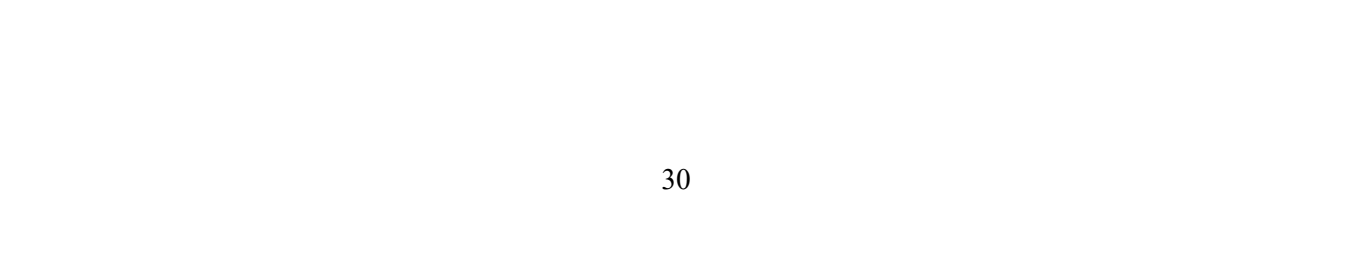

HDI.ipynb
File Edit View Insert Runtime Tools Help
Comment
Share
Country
plt.scatter(data_filled['Country'],data_filled['HDI'])
<matplotlib.collections.PathCollection at 0x78be05f11810>

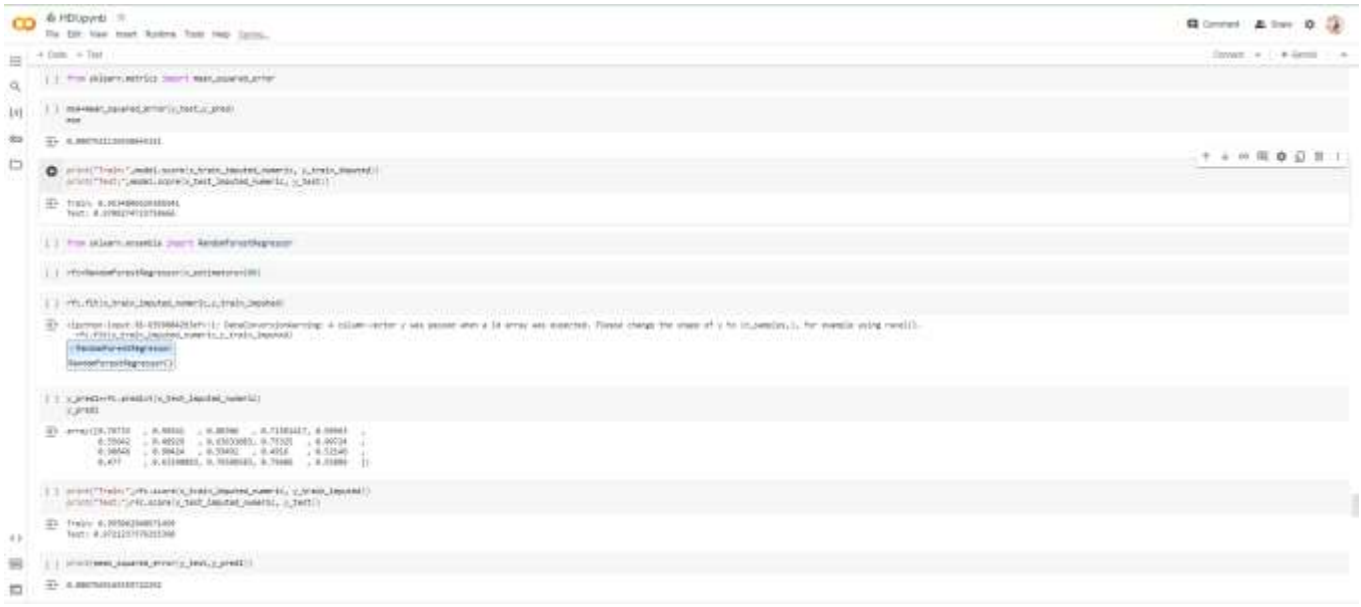

HDI.ipynb
File Edit View Insert Runtime Tools Help
Comment
Share
sns.displot(data1['HDI'])
<seaborn.axisgrid.FacetGrid at 0x78be03563f40>
Count
HDI

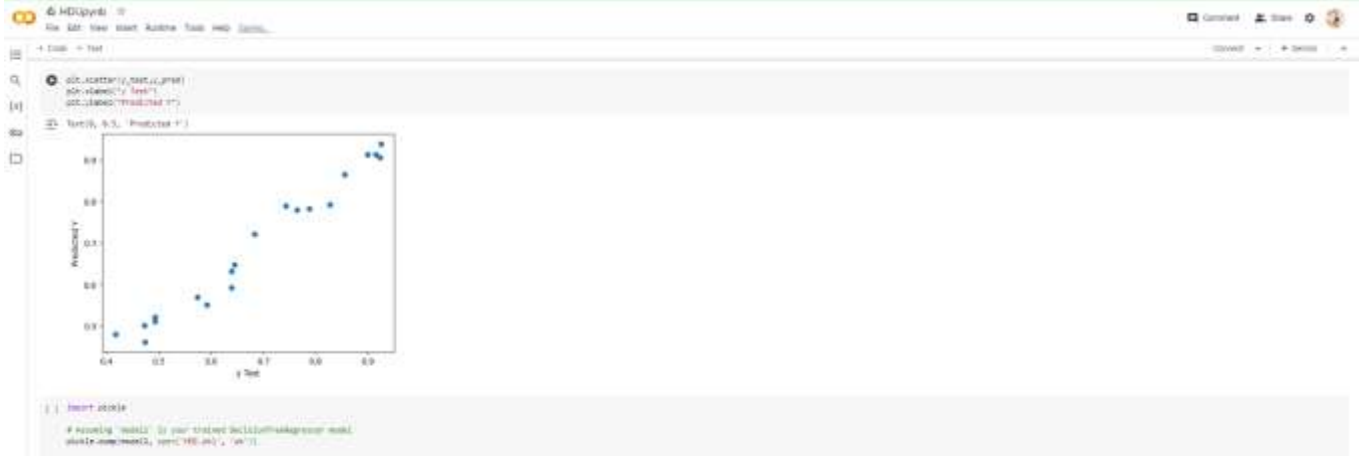

HDI.ipynb
Unnamed: 0
Country
HDI Rank
HDI Rank
Life expectancy
Mean years of schooling
Gross national income (GNI) per capita
Internet users


HDI.ipynb
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.impute import SimpleImputer


HDI.ipynb
x_train_imputed_numeric
array([[


HDI.ipynb
y_pred
array([[




Predicted Y
y Test

PAIRPLOT

HEAT MAP

DESCRIPTIVE ANALYSIS