AI-Powered Insurance Premium Estimator

Dynamic Pricing Model with CSV Integration

Ministry of Youth and Sports
AMG, ICAIL

AMG
A Multi Group

جمهورية مصر العربية
وزارة الشباب والرياضة
Ministry of Youth and Sports

ICAIL
International Certification of Artificial Intelligence License

AI-Powered Insurance Premium Estimator

Dynamic Pricing Model with CSV Integration

In partial fulfilment of the requirements for the license of

International Certificate of Artificial Intelligence.

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Contents

Project Overview

Our project developed a **machine learning system** to predict insurance premiums, and was built using **historical data, customer demographics, and medical risk factors**.

The system includes:

- A **CSV analyzer** for uploading datasets and running bulk predictions.
- A **trained predictive model**.
- An **interactive dashboard** for visualizing insights.

Problem Statement

Traditional pricing is often ***manual*** , ***very complex*** and ***time consuming***.

There’s a need in the market for:

- High-accuracy
- Data-driven predictions
- Transparency on how variables like BMI and smoking affect cost
- Real-time, bulk decision support

Goal and Objectives

Goal: Develop a machine learning-based system that accurately predicts insurance premiums using customer data.

Objectives:

- Read and parse CSV files.
- Generate statistical summaries.
- Display interactive dashboards.
- Implement an AI model for premiums prediction.
- Ensure the system is scalable and easy to update with new data or features.

Data Overview

Dataset used: Health care insurance (Kaggle) – 1338 records

Features:

- **age**: age of primary beneficiary
- **sex**: insurance contractor gender, female, male
- **bmi**: Body mass index, providing an understanding of body, weights that are relatively high or low relative to height
- **children**: Number of children covered by health insurance / Number of dependents
- **smoker**: Smoking status
- **region**: the beneficiary's residential area in the US, northeast, southeast, southwest, northwest.
- **charges**: Individual medical costs billed by health insurance

CSV Analyzer

```python
from kagglehub import dataset_download

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

from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import GridSearchCV
```

```python
def dataInfo(df):
    print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1338 entries, 0 to 1337
Data columns (total 7 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   age       1338 non-null   int64
 1   sex       1338 non-null   object
 2   bmi       1338 non-null   float64
 3   children  1338 non-null   int64
 4   smoker    1338 non-null   object
 5   region    1338 non-null   object
 6   charges   1338 non-null   float64
dtypes: float64(2), int64(2), object(3)
memory usage: 73.3+ KB
```

CSV Analyzer

```
def catEncoding(df):
```

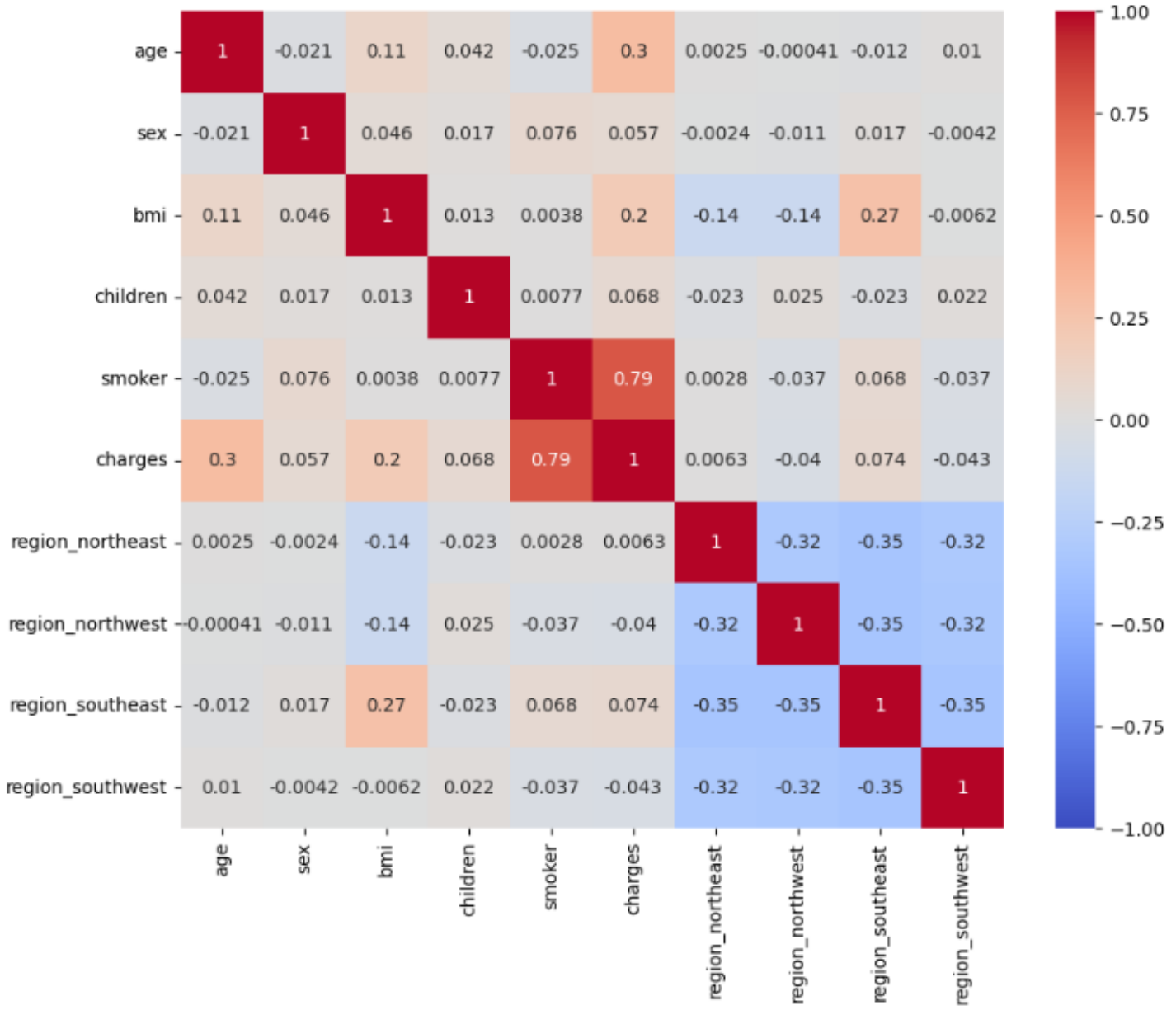
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1338 entries, 0 to 1337
Data columns (total 10 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   age                1338 non-null   int64
 1   sex                1338 non-null   int8
 2   bmi                1338 non-null   float64
 3   children           1338 non-null   int64
 4   smoker             1338 non-null   int8
 5   charges            1338 non-null   float64
 6   region_northeast   1338 non-null   int64
 7   region_northwest   1338 non-null   int64
 8   region_southeast   1338 non-null   int64
 9   region_southwest   1338 non-null   int64
dtypes: float64(2), int64(6), int8(2)
memory usage: 86.4 KB
```

```
   age     sex     bmi  children smoker     region      charges
0   19  female  27.900         0    yes  southwest  16884.92400
1   18    male  33.770         1     no  southeast   1725.55230
2   28    male  33.000         3     no  southeast   4449.46200
                              0     no  northwest  21984.47061
                              0     no  northwest   3866.85520
```

```
==========
es
alues
alues
==========
en   smoker      charges  region_northeast  \
 0        1  16884.92400                 0
 1        0   1725.55230                 0
 3        0   4449.46200                 0
 0        0  21984.47061                 0
 0        0   3866.85520                 0

_southeast  region_southwest
         0                1
         1                0
         1                0
         0                0
         0                0
```

CSV A

```
def dfVisual
  plt.figure
  sns.heatma
```



Model Building

1. **Problem Understanding**
2. **Data Characteristics**
3. **Model Selection According to Evaluation**

Model Building

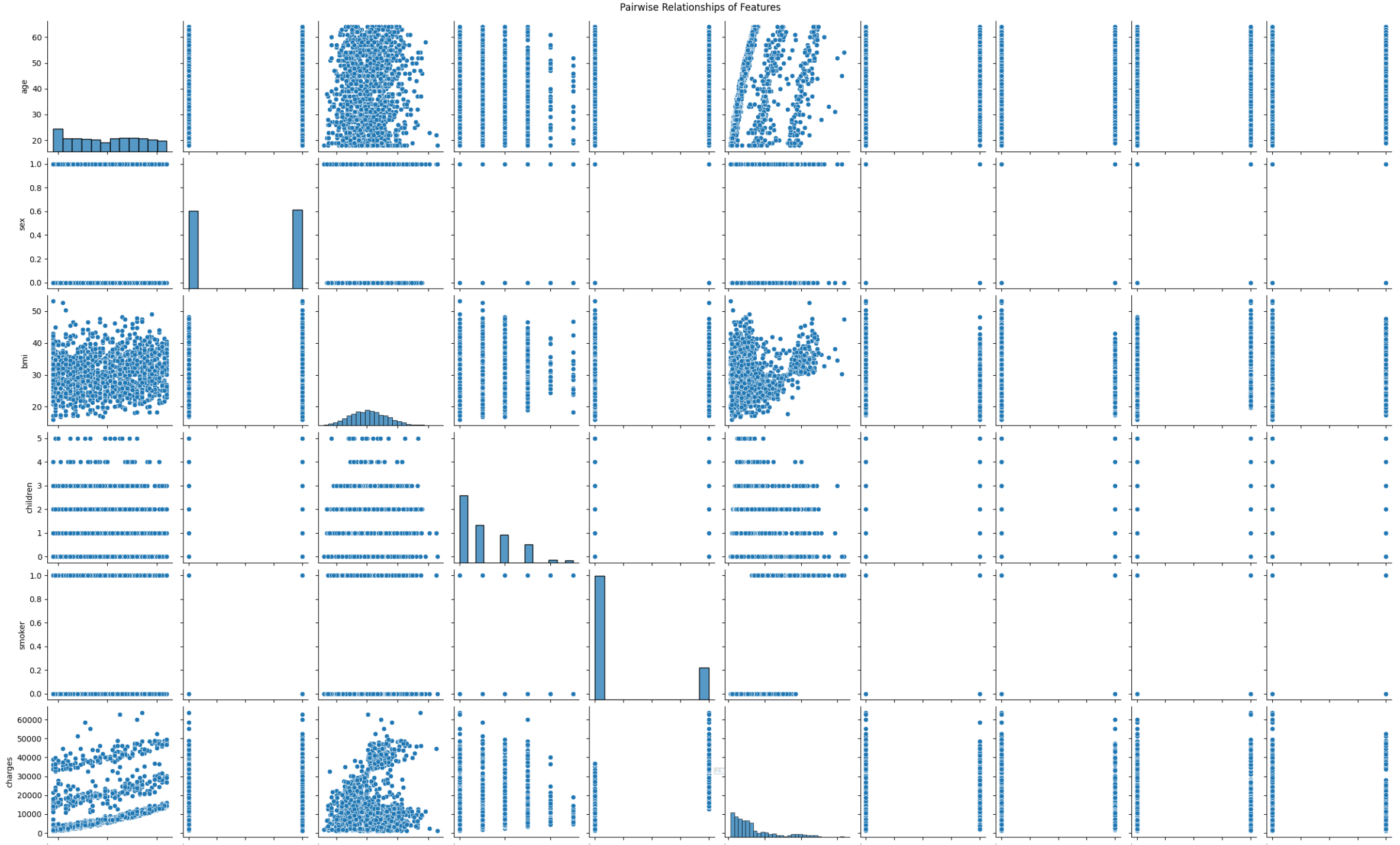
Problem Understanding

SUPERVISED LEARNING

	age	sex	bmi	children	smoker	region	charges
0	19	female	27.900	0	yes	southwest	16884.92400
1	18	male	33.770	1	no	southeast	1725.55230
2	28	male	33.000	3	no	southeast	4449.46200
3	33	male	22.705	0	no	northwest	21984.47061
4	32	male	28.880	0	no	northwest	3866.85520

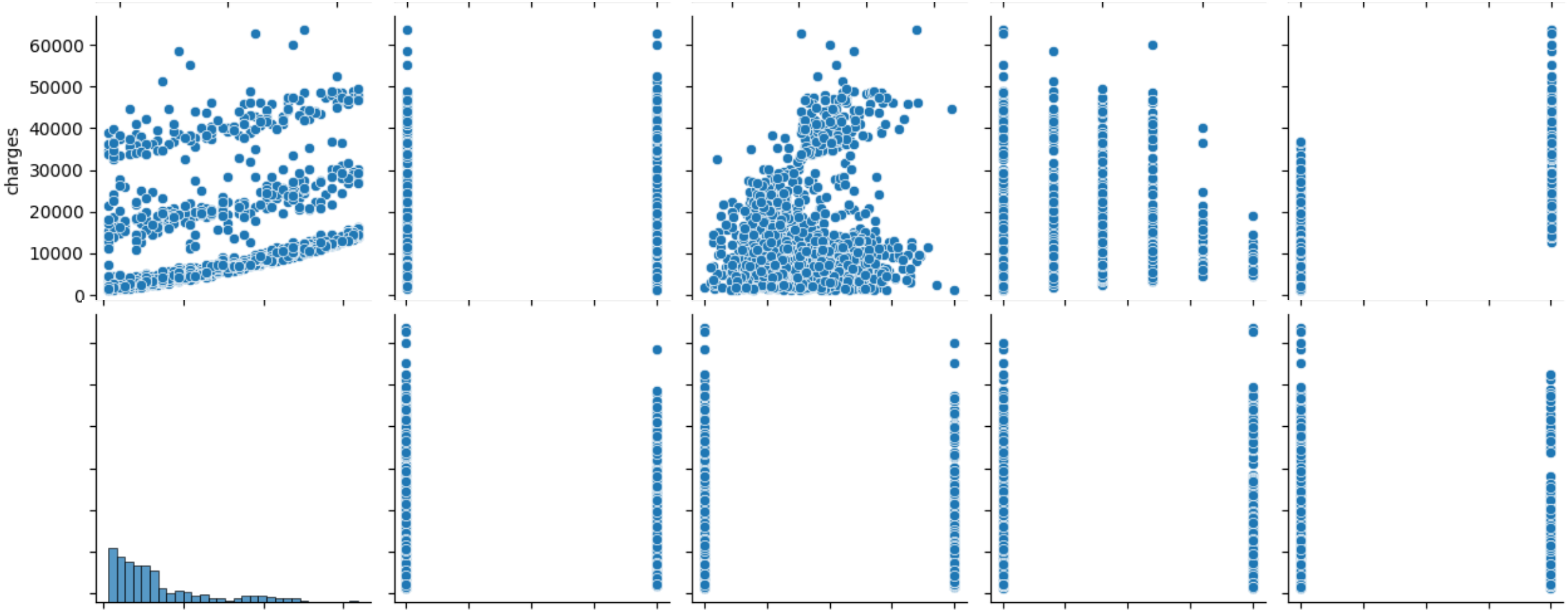
Predict insurance charges (continuous)

→ This is a regression problem


Pairwise Relationships of Features
age
sex
bmi
children
smoker
charges

Mixed features (numeric: age, bmi; categorical: sex, smoker, region)

(potential non-linear relationships, and outliers)



Model Building

Model Selection Criteria

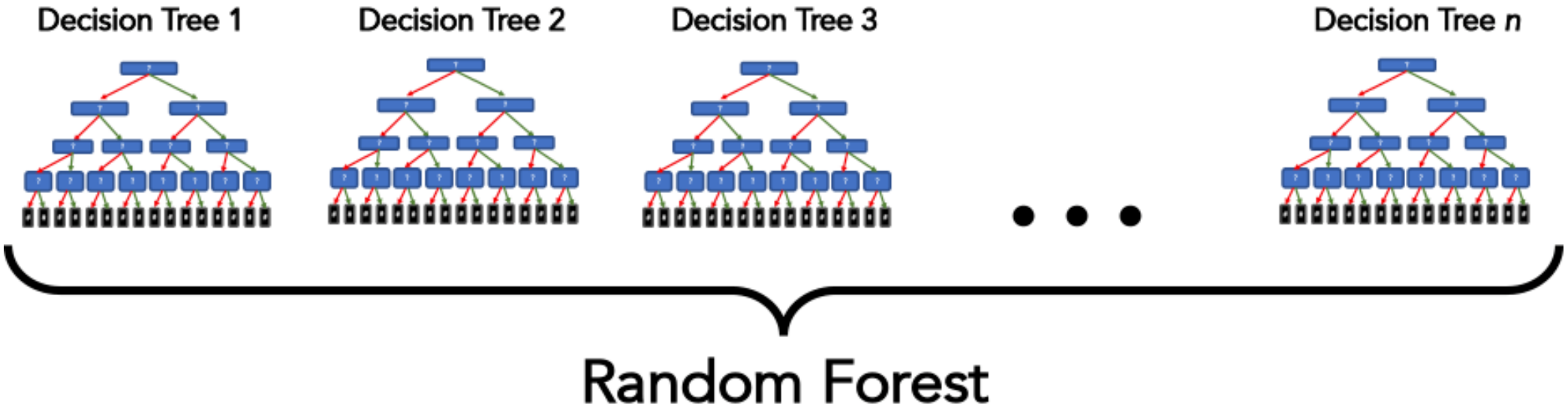
- Regression Model
- Capture non-linear relationships

Models to Evaluate

- **Linear Regression**
- **Decision Tree**

Model Building

Models Evaluated



- Addressed Decision Tree's overfitting via ensemble learning and showed better accuracy.

Random Forest Regression Model

3.1 Model Training

Random Forest Regressor

```
[ ]  x = df.drop('charges', axis=1)
     y = df['charges']
```

```
[ ]  x_train, x_test, y_train, y_test = train_test_split(x,y, test_size=0.2)
```

```
[ ]  model = RandomForestRegressor()
     model.fit(x_train, y_train)
```

```
RandomForestRegressor
RandomForestRegressor()
```

3.2 Model Accuracy

```
[33] model.score(x_test, y_test)
```

```
0.8822523530318137
```

Grid Search Cross-Validation

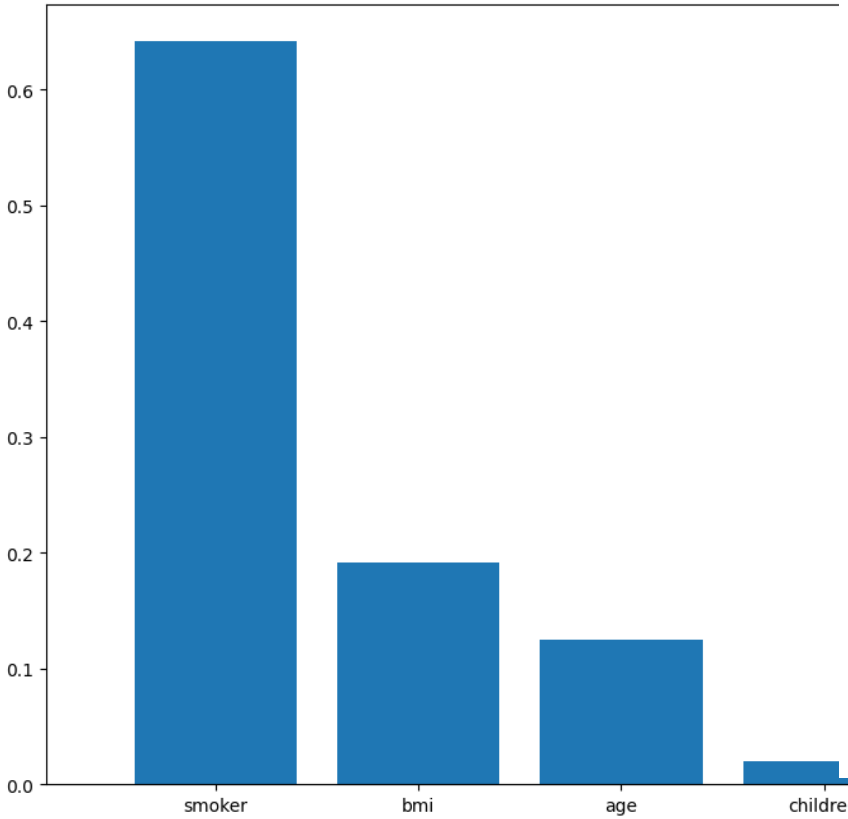
```
[28] param_
         'r
         'm
         'm
     }

     model
     grid_s
     grid_s

     print(

     Best h
```

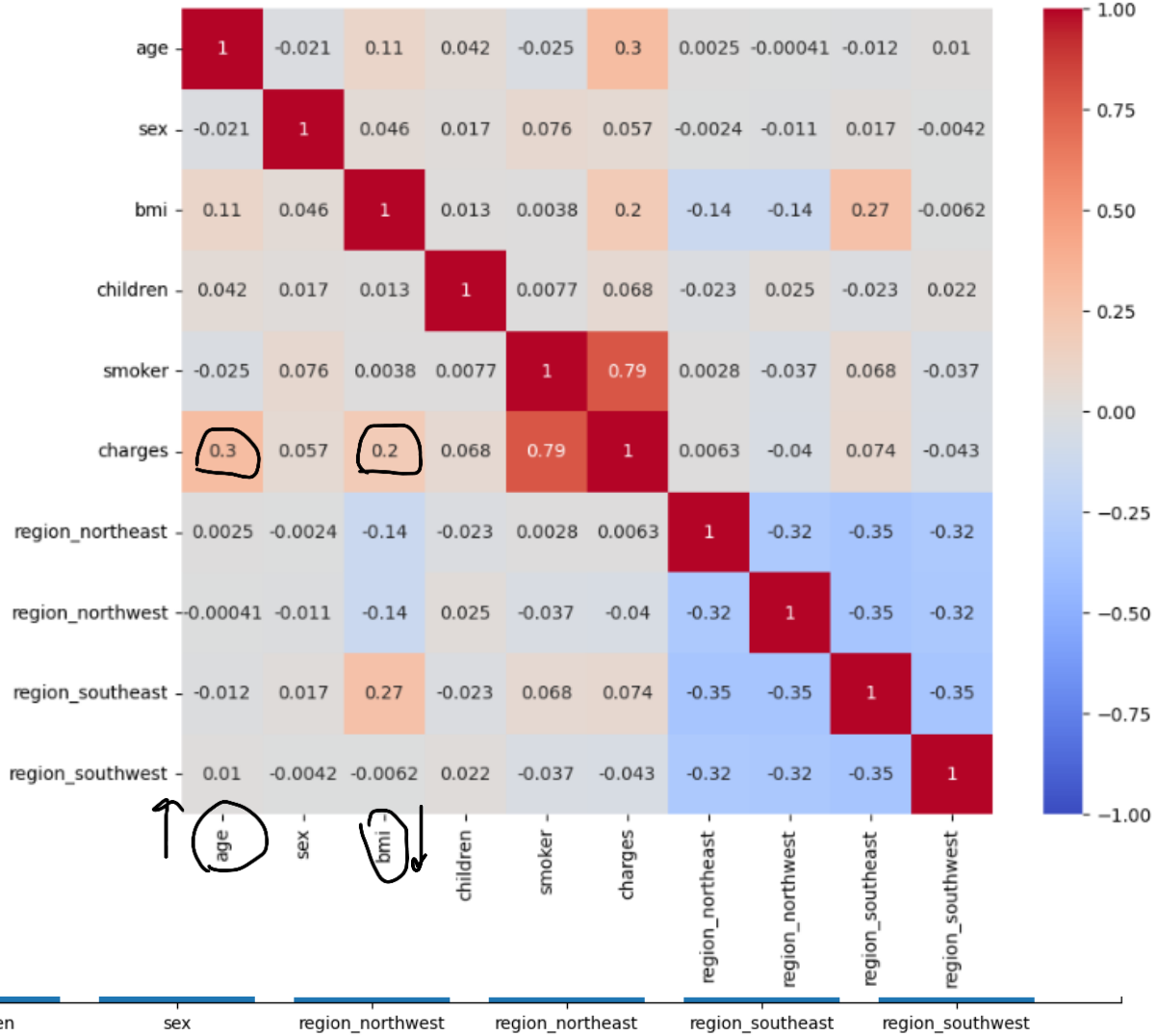
```
[29] best_params = {'max_depth': 5, 'min_samples_split': 10, 'n_estimators': 200}

     optimized_model = RandomForestRegressor(
         max_depth=best_params['max_depth'],
         min_samples_split=best_params['min_samples_split'],
         n_estimators=best_params['n_estimators'],
         random_state=42
     )

     optimized_model.fit(x_train, y_train)

     y_pred = optimized_model.predict(x_test)
```

```
[30] optimized_model.score(x_test, y_test)

     0.9011441343410856
```

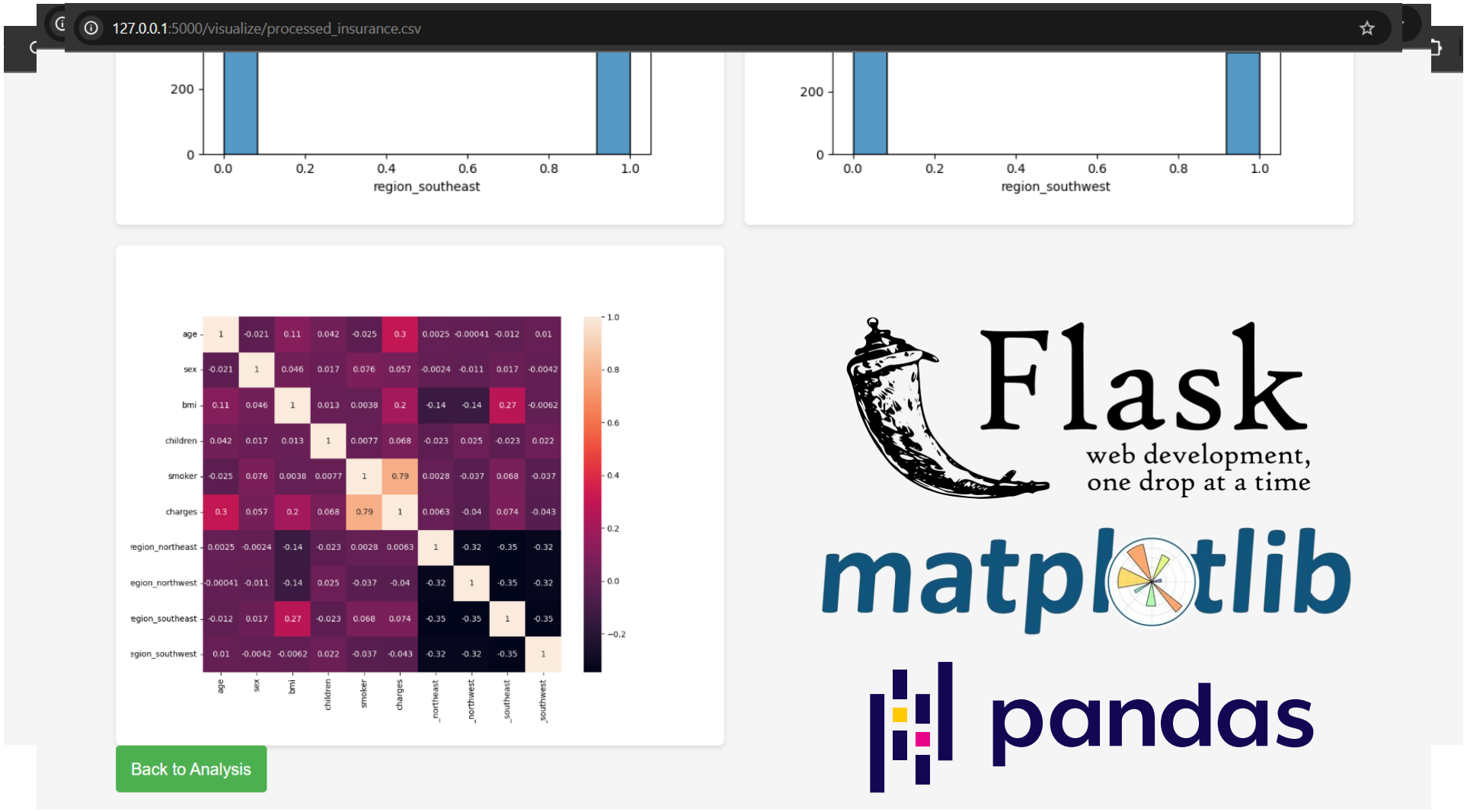
Importance Features

```
[35] feature_importances = zip(model.feature_names_i
[36]
[39]
```





Dashboard


127.0.0.1:5000/visualize/processed_insurance.csv
200
0
0.0
0.2
0.4
0.6
0.8
1.0
region_southeast
region_southwest
age
sex
bmi
children
smoker
charges
region_northeast
region_northwest
region_southeast
region_southwest
Back to Analysis
Flask
web development,
one drop at a time
matplotlib
pandas

Conclusion and Future Work

A **CSV analyzer** for uploading datasets and running bulk predictions.
A **trained predictive model using Random forest Regressor.**
A **Dashboard** for visualizing insights.

Updating the analyzer to fetch data from different sources and warehouses

GitHub Repository

Scan QR Code

GitHub

Thank You!

Any Questions?