Architecture Design

Insurance Premium Prediction

Document Version Control

Contents

Abstract

Machine Learning is a category of algorithms that allows software applications to become more accurate in predicting outcomes without being explicitly programmed. The basic premise of machine learning is to build models and employ algorithms that can receive input data and use statistical analysis to predict an output while updating outputs as new data becomes available. These models can be applied in different areas and trained to match management expectations so that proper steps can be taken to achieve the organization's target. In this project, we will estimate the insurance premium based on personal health information. Taking various aspects of a dataset collected from people and the methodology followed for building a predictive model.

1 Introduction

1.1 What is Architecture Design?

The goal of Architecture Design (AD) is to give the internal design of the actual program code for the `Insurance Premium Prediction`. AD describes the class diagrams with the methods and relation between classes and program specification. It describes the modules so that the programmer can directly code the program from the document.

1.2 Scope

Architecture Design (AD) is a component-level design process that follows a stepby-step refinement process. This process can be used for designing data structures, required software, architecture, source code, and ultimately, performance algorithms. Overall, the data organization may be defined during requirement analysis and then refined during data design work. And the complete workflow.

1.3 Constraints

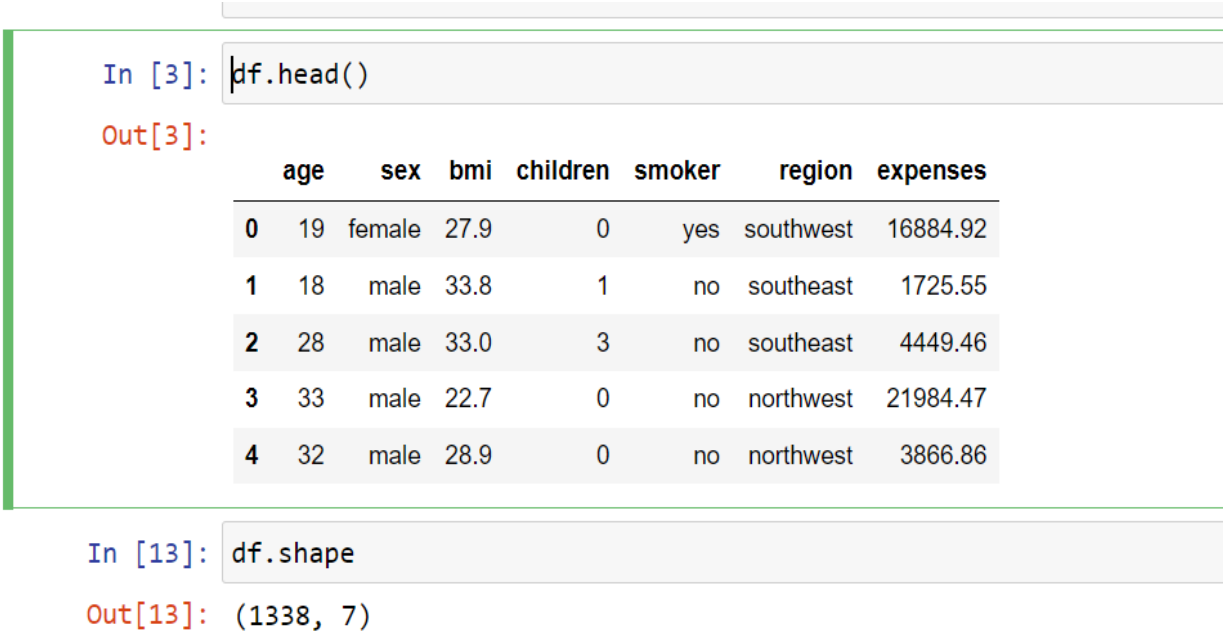
We only predict the expected estimating cost of expenses customers based on some personal health information.

2 Technical Specifications

2.1 Dataset

Collecting Data from database MongoDb using Pymongo module and creating dataframe.

The dataset containing verified historical data, consisting of the aforementioned information and the actual medical expenses incurred by over 1300 customers. The objective is to find a way to estimate the value in the "expenses" column using the values in the other columns like their age, sex, BMI, no. of children, smoking habits and region. Using all the observations it is inferred what role certain properties of user and how they affect their expenses. The dataset looks like as follow:

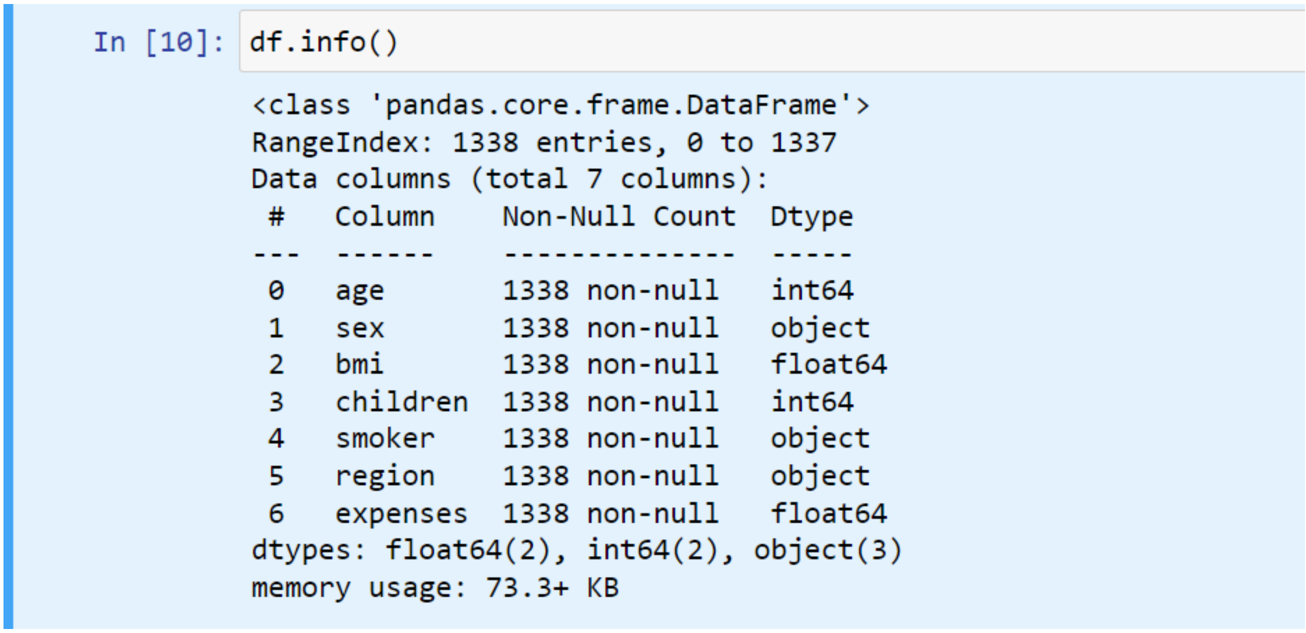


```
In [3]: df.head()
Out[3]:
```

	age	sex	bmi	children	smoker	region	expenses
0	19	female	27.9	0	yes	southwest	16884.92
1	18	male	33.8	1	no	southeast	1725.55
2	28	male	33.0	3	no	southeast	4449.46
3	33	male	22.7	0	no	northwest	21984.47
4	32	male	28.9	0	no	northwest	3866.86

```
In [13]: df.shape
Out[13]: (1338, 7)
```

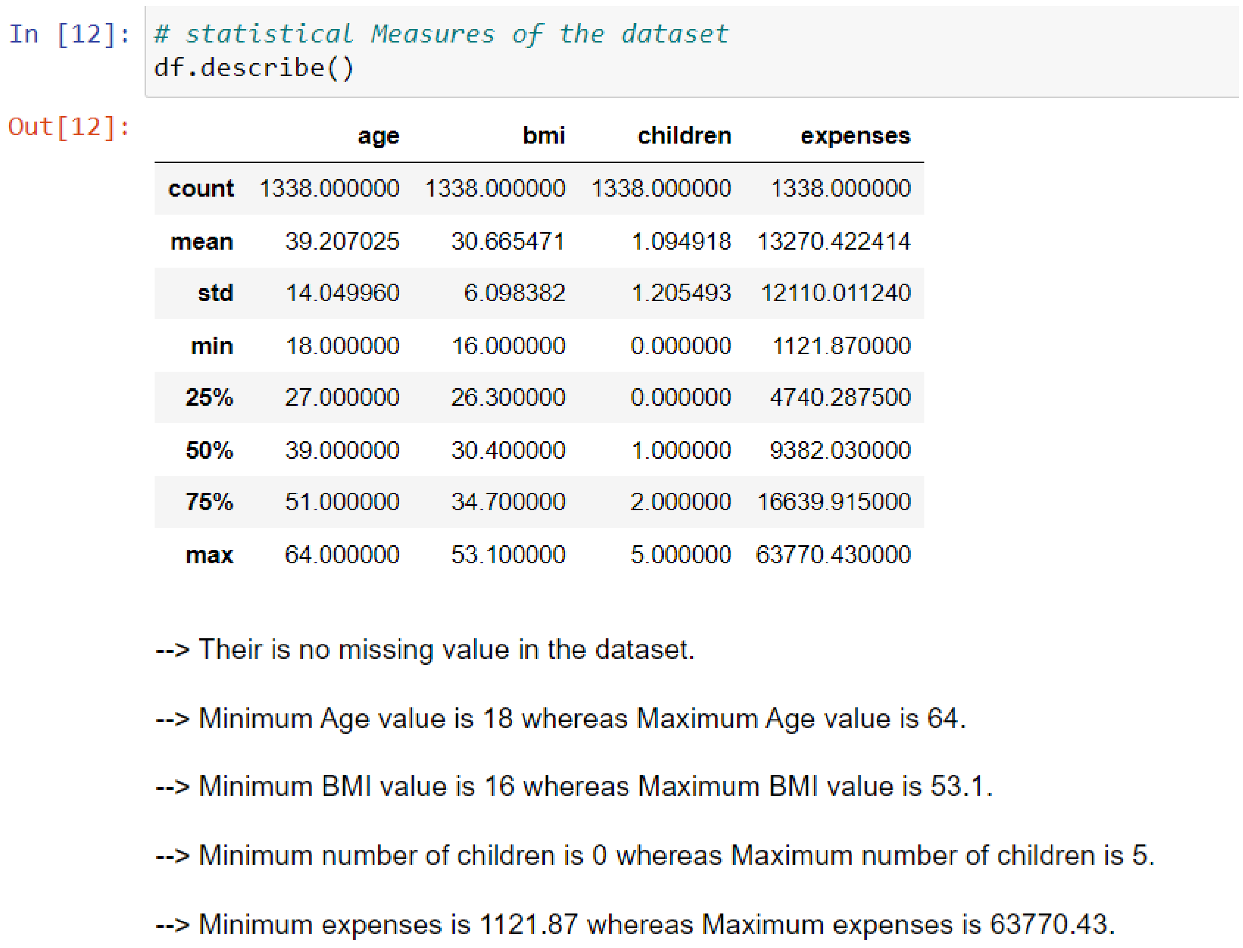
The data set consists of various data types from integer to floating to object as shown in Fig.



```
In [10]: 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   expenses  1338 non-null   float64
         dtypes: float64(2), int64(2), object(3)
         memory usage: 73.3+ KB
```

In the dataset, there can be various types of underlying patterns which also gives an in-depth knowledge about the subject of interest and provides insights into the problem. Looks like ‘age’, ‘children’, ‘Bmi’ (body mass index) and ‘expenses’ are numbers, whereas ‘sex’, ‘smoker’, and ‘region’ are strings (possibly categories). Various factors important by statistical means like mean, standard deviation, median, count of values and maximum value, etc. are shown below for numerical



```
In [12]: # statistical Measures of the dataset
         df.describe()
```

Out[12]:

	age	bmi	children	expenses
count	1338.000000	1338.000000	1338.000000	1338.000000
mean	39.207025	30.665471	1.094918	13270.422414
std	14.049960	6.098382	1.205493	12110.011240
min	18.000000	16.000000	0.000000	1121.870000
25%	27.000000	26.300000	0.000000	4740.287500
50%	39.000000	30.400000	1.000000	9382.030000
75%	51.000000	34.700000	2.000000	16639.915000
max	64.000000	53.100000	5.000000	63770.430000

--> Their is no missing value in the dataset.

--> Minimum Age value is 18 whereas Maximum Age value is 64.

--> Minimum BMI value is 16 whereas Maximum BMI value is 53.1.

--> Minimum number of children is 0 whereas Maximum number of children is 5.

--> Minimum expenses is 1121.87 whereas Maximum expenses is 63770.43.

Preprocessing of this dataset includes doing analysis on the independent variables like checking for null values in each column and then replacing or filling them with supported appropriate data types so that analysis and model fitting is not hindered from their way to accuracy. Shown above are some of the representations obtained by using Pandas tools which tell about variable count for numerical columns and model values for categorical columns. Maximum and minimum values in numerical columns, along with their percentile values for median, play an important factor in deciding which value to be chosen at priority for further exploration tasks and analysis. Data types of different columns are used further in label processing and a one-hot encoding scheme during the model building.

2.2 Logging

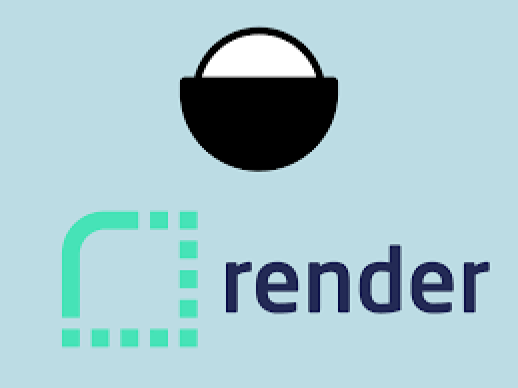
We should be able to log every activity done by the user.

- The system identifies at which step logging require.
- The system should be able to log each and every system flow.

- The system should be not be hung even after using so much logging. Logging just because we can easily debug issuing so logging is mandatory to do.

2.3 Deployment

For the hosting of the project, we will use Render



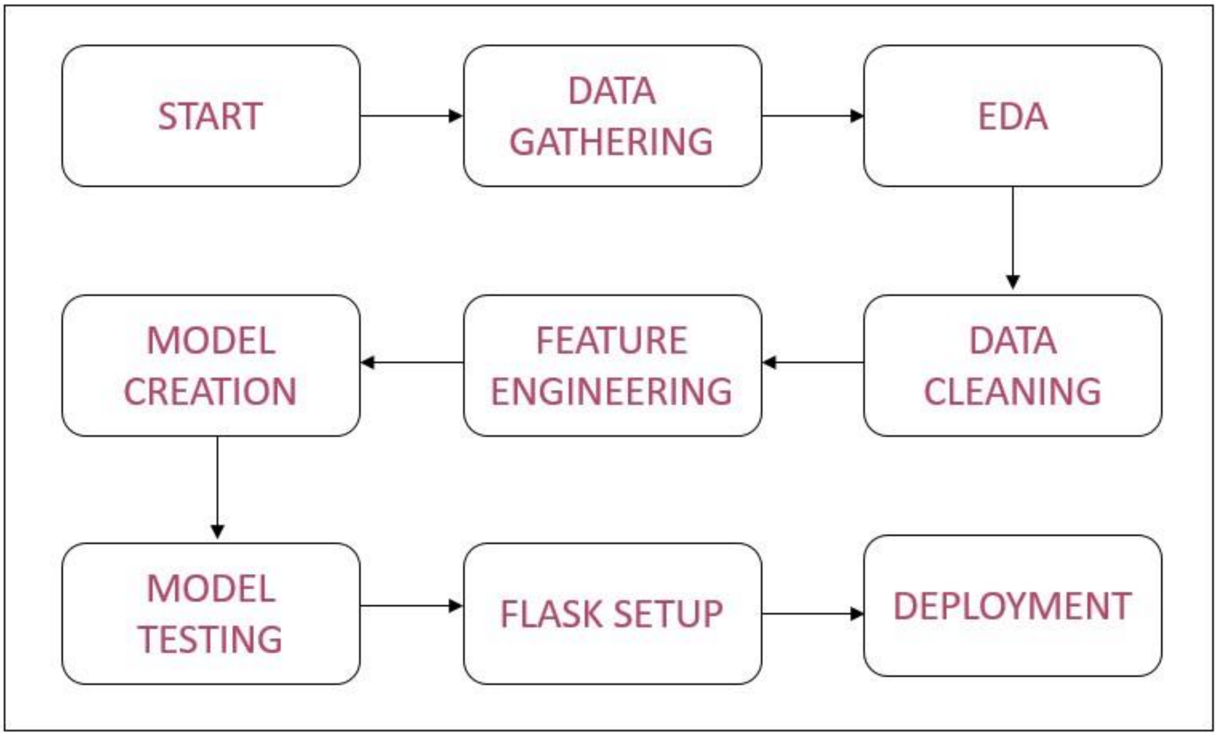
3 Technology Stack

Front End	HTML/CSS
Backend	Python/Flask
Deployment	Render

4 Proposed Solution

We will use performed EDA to find the important relation between different attributes and will use a machine-learning algorithm to estimate the cost of expenses. The client will be filled the required feature as input and will get results through the web application. The system will get features and it will be passed into the backend where the features will be validated and preprocessed and then it will be passed to a hyper parameter tuned machine learning model to predict the final outcome.

5 Architecture



5.1 Data Gathering

Data source: https://www.kaggle.com/noordeen/insurance-premium-prediction
Dataset is stored in .csv format.

5.2 Raw Data Validation

After data is loaded, various types of validation are required before we proceed further with any operation. Validations like checking for zero standard deviation for all the columns, checking for complete missing values in any columns, etc. These are required because the attributes which contain these are of no use. It will not play role in contributing to the estimating cost of the premium.

5.3 Exploratory Data Analysis

Visualized the relationship between the dependent and independent features. Also checked relationship between independent features to get more insights about the data.

5.4 Feature Engineering

After pre-processing standard scalar is performed to scale down all the numeric features. Even one hot encoding is also performed to convert the categorical features into numerical features. For this process, pipeline is created to scale numerical features and encoding the categorical features.

5.5 Model Building

After doing all kinds of pre-processing operations mention above and performing scaling and encoding, the data set is passed through a pipeline to all the models, Linear Regression, Decision tree, Random Forest and ExtraTreeRegresser. It was found that CatBoost Regresser performs best with the on test data after that we perform on our model performance increases.

5.6 Model Saving

Model is saved using dill library in .pkl format.

5.7 Flask Setup for Web Application

After saving the model, the API building process started using Flask. Web application creation was created in Flask for testing purpose. Whatever user will enter the data and then that data will be extracted by the model to estimate the premium of insurance, this is performed in this stage.

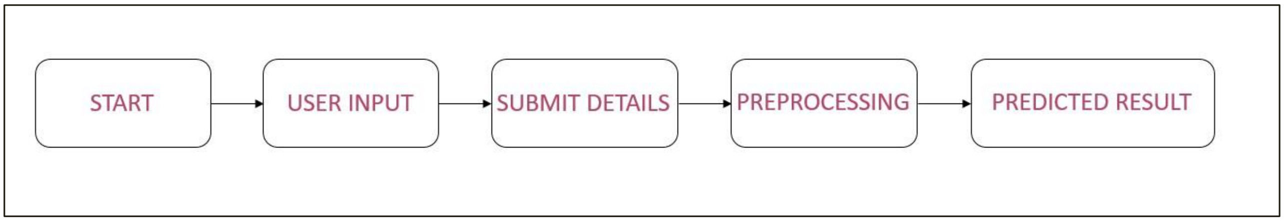
5.8 GitHub

The whole project directory will be pushed into the GitHub repository.

5.9 Deployment

The project was deployed from GitHub into the Render platform.

6 User I/O Workflow


START
USER INPUT
SUBMIT DETAILS
PREPROCESSING
PREDICTED RESULT