Architecture Design

Insurance Premium Prediction

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 the expectations of management so that accurate steps can be taken to achieve the organization's target. In this project, we will estimate the amount of insurance premium on the basis of 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 step-by-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 Specification

2.1 Dataset

The dataset containing verified historical data, consisting of the information and the actual medical expenses incurred by over 1338 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 [38]: df
```

Out[38]:

	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
...	...	...	...	...	...	...	...
1333	50	male	31.0	3	no	northwest	10600.55
1334	18	female	31.9	0	no	northeast	2205.98
1335	18	female	36.9	0	no	southeast	1629.83
1336	21	female	25.8	0	no	southwest	2007.95
1337	61	female	29.1	0	yes	northwest	29141.36

1338 rows × 7 columns

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

```
In [39]: # Print the more information about the features
         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, BMI, No. of children, Expenses are numbers, whereas Sex, Smoker and Region are strings (possibly categories).

Various factors important by Statistical methods like mean, standard deviation, median, count of values and maximum value, etc. are shown below for numerical attributes

```
In [10]: # Let us look at the statistical information about the dataset(min, max, mean, count etc.)
         merged_data.describe()
```

Out[10]:

	Item_Weight	Item_Visibility	Item_MRP	Outlet_Establishment_Year	Item_Outlet_Sales
count	11765.000000	14204.000000	14204.000000	14204.000000	14204.000000
mean	12.792854	0.065953	141.004977	1997.830681	1308.865489
std	4.652502	0.051459	62.086938	8.371664	1699.791423
min	4.555000	0.000000	31.290000	1985.000000	0.000000
25%	8.710000	0.027036	94.012000	1987.000000	0.000000
50%	12.600000	0.054021	142.247000	1999.000000	559.272000
75%	16.750000	0.094037	185.855600	2004.000000	2163.184200
max	21.350000	0.328391	266.888400	2009.000000	13086.964800

Pre-processing 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 Heroku and AWS.

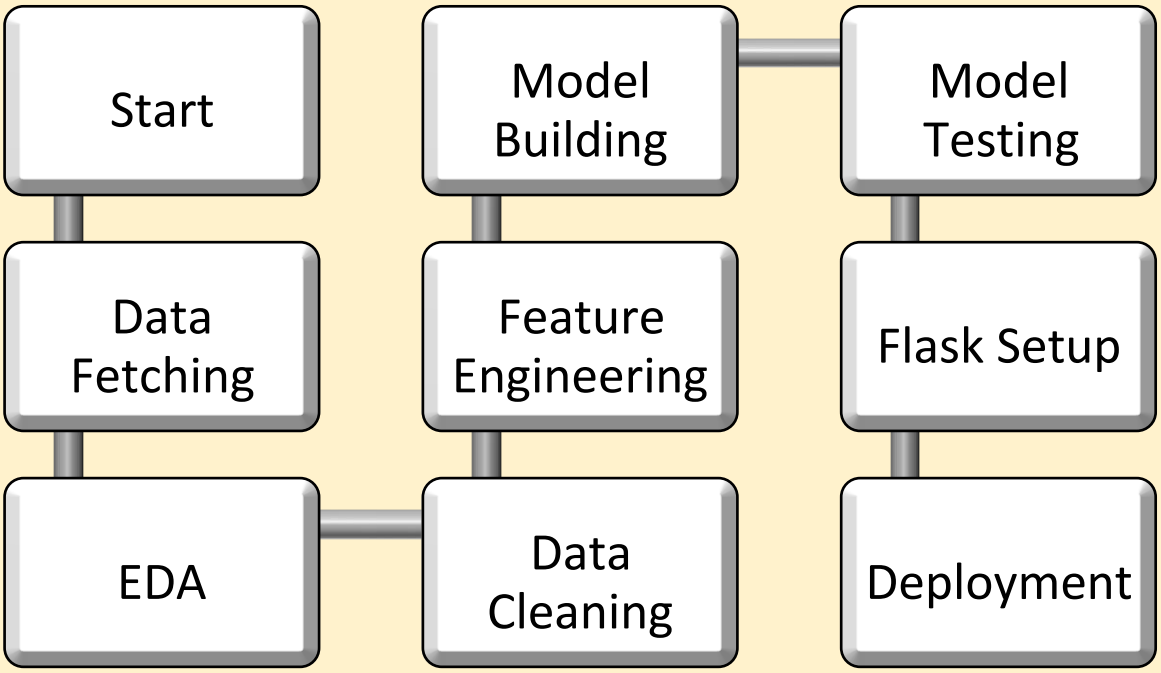
3. Technology Stack

Front End	HTML/CSS
Backend	Python/ Flask
Deployment	Heroku , AWS

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 pre-processed and then it will be passed to a hyperparameter 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, Gradient boost, KNN and XG Boost regressor using EvalML. It was found that random Forest performs best with the smallest RMSE value 4562.0256 and the model accuracy equals 0.8650 . Therefore Random Forest performed well with train and test dataset in this problem.

5.6 Model Saving

Model is saved using pickle library in pickle 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 Heroku and AWS

platform.

6. User Input / Output Workflow.