Problem Statement:

```
    for Insurance dataset implementing all models based on the accuracy,which
means which model is highest accuracy.That model is bestmodel for this dataset.
to finding bestmodel
```

In [2]:

```
import numpy as np,pandas as pd,matplotlib.pyplot as plt,seaborn as sns
from sklearn import preprocessing,svm
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
```

Data collection:

In [3]:

```
df=pd.read_csv(r"C:\Users\raja\Downloads\insurance (1).csv")
df
```

Out[3]:

	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
...	...	...	...	...	...	...	...
1333	50	male	30.970	3	no	northwest	10600.54830
1334	18	female	31.920	0	no	northeast	2205.98080
1335	18	female	36.850	0	no	southeast	1629.83350
1336	21	female	25.800	0	no	southwest	2007.94500
1337	61	female	29.070	0	yes	northwest	29141.36030

1338 rows × 7 columns

Data cleaning and Preprocessing

In [4]:

```
df.head()
```

Out[4]:

	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

In [5]:

```
df.tail()
```

Out[5]:

	age	sex	bmi	children	smoker	region	charges
1333	50	male	30.97	3	no	northwest	10600.5483
1334	18	female	31.92	0	no	northeast	2205.9808
1335	18	female	36.85	0	no	southeast	1629.8335
1336	21	female	25.80	0	no	southwest	2007.9450
1337	61	female	29.07	0	yes	northwest	29141.3603

In [6]:

```
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
```

In [7]:

```
df.describe()
```

Out[7]:

	age	bmi	children	charges
count	1338.000000	1338.000000	1338.000000	1338.000000
mean	39.207025	30.663397	1.094918	13270.422265
std	14.049960	6.098187	1.205493	12110.011237
min	18.000000	15.960000	0.000000	1121.873900
25%	27.000000	26.296250	0.000000	4740.287150
50%	39.000000	30.400000	1.000000	9382.033000
75%	51.000000	34.693750	2.000000	16639.912515
max	64.000000	53.130000	5.000000	63770.428010

In [8]:

```
df.size
```

Out[8]:

```
9366
```

In [9]:

```
df.shape
```

Out[9]:

```
(1338, 7)
```

In [10]:

```
df.isna().any()
```

Out[10]:

```
age         False
sex         False
bmi         False
children    False
smoker      False
region      False
charges     False
dtype: bool
```

In [11]:

```
df['sex'].value_counts()
```

Out[11]:

```
sex
male      676
female    662
Name: count, dtype: int64
```

In [12]:

```
df['smoker'].value_counts()
```

Out[12]:

```
smoker
no     1064
yes     274
Name: count, dtype: int64
```

In [13]:

```
convert={"region":{"southeast":1,"southwest":2,"northwest":3,"northeast":4}}
df=df.replace(convert)
df
```

Out[13]:

	age	sex	bmi	children	smoker	region	charges
0	19	female	27.900	0	yes	2	16884.92400
1	18	male	33.770	1	no	1	1725.55230
2	28	male	33.000	3	no	1	4449.46200
3	33	male	22.705	0	no	3	21984.47061
4	32	male	28.880	0	no	3	3866.85520
...	...	...	...	...	...	...	...
1333	50	male	30.970	3	no	3	10600.54830
1334	18	female	31.920	0	no	4	2205.98080
1335	18	female	36.850	0	no	1	1629.83350
1336	21	female	25.800	0	no	2	2007.94500
1337	61	female	29.070	0	yes	3	29141.36030

1338 rows × 7 columns

In [14]:

```
df['region'].value_counts()
```

Out[14]:

```
region
1    364
2    325
3    325
4    324
Name: count, dtype: int64
```

In [15]:

```
convert={"sex":{"male":0,"female":1}}
df=df.replace(convert)
df
```

Out[15]:

	age	sex	bmi	children	smoker	region	charges
0	19	1	27.900	0	yes	2	16884.92400
1	18	0	33.770	1	no	1	1725.55230
2	28	0	33.000	3	no	1	4449.46200
3	33	0	22.705	0	no	3	21984.47061
4	32	0	28.880	0	no	3	3866.85520
...	...	...	...	...	...	...	...
1333	50	0	30.970	3	no	3	10600.54830
1334	18	1	31.920	0	no	4	2205.98080
1335	18	1	36.850	0	no	1	1629.83350
1336	21	1	25.800	0	no	2	2007.94500
1337	61	1	29.070	0	yes	3	29141.36030

1338 rows × 7 columns

In [16]:

```
convert={"smoker":{"no":1,"yes":2}}
df=df.replace(convert)
df
```

Out[16]:

	age	sex	bmi	children	smoker	region	charges
0	19	1	27.900	0	2	2	16884.92400
1	18	0	33.770	1	1	1	1725.55230
2	28	0	33.000	3	1	1	4449.46200
3	33	0	22.705	0	1	3	21984.47061
4	32	0	28.880	0	1	3	3866.85520
...	...	...	...	...	...	...	...
1333	50	0	30.970	3	1	3	10600.54830
1334	18	1	31.920	0	1	4	2205.98080
1335	18	1	36.850	0	1	1	1629.83350
1336	21	1	25.800	0	1	2	2007.94500
1337	61	1	29.070	0	2	3	29141.36030

1338 rows × 7 columns

In [17]:

```
features=df.columns[0:5]
target=df.columns[-1]
```

Exploratory Data Analysis

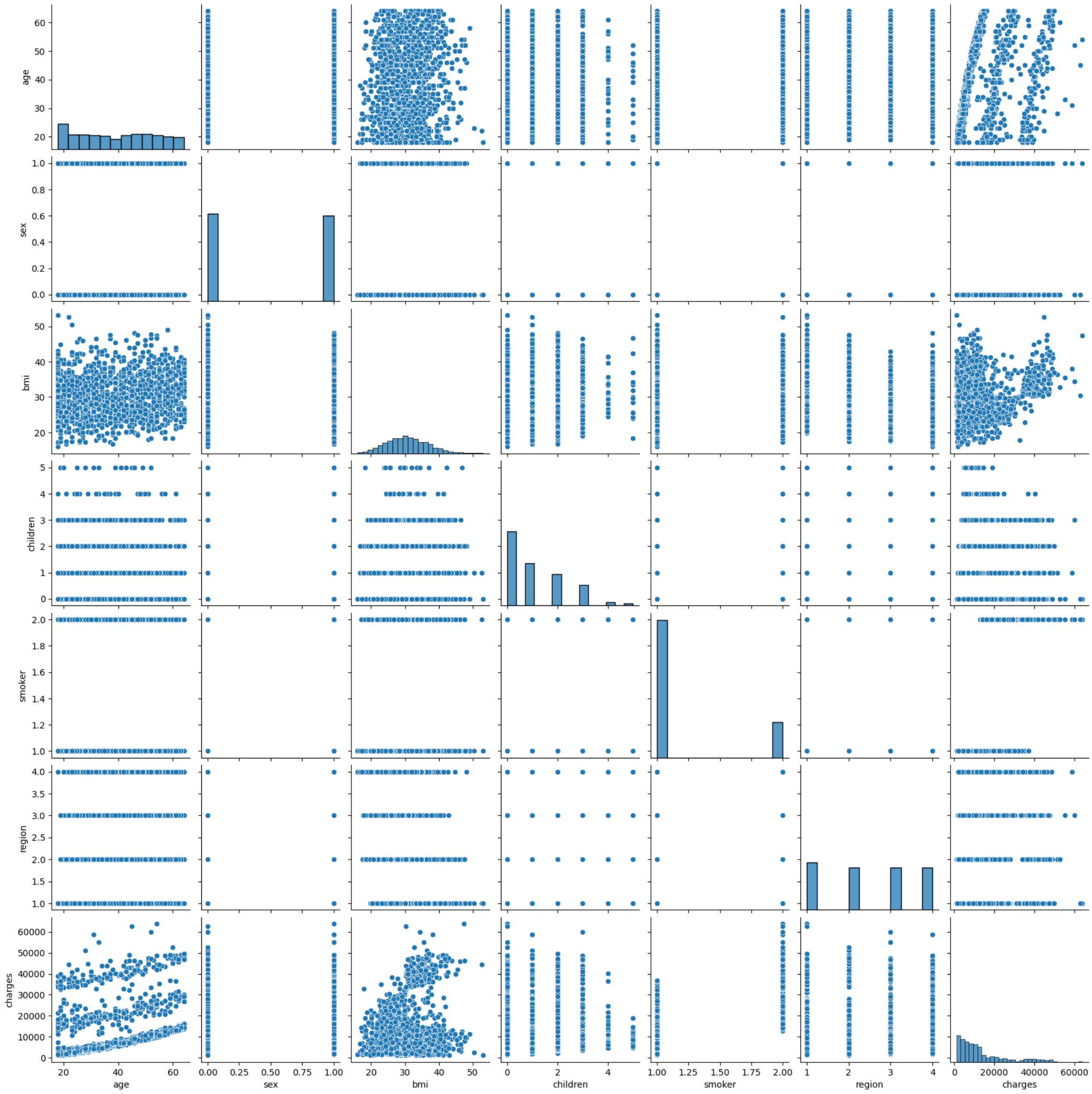
Data visualization

In [18]:

```
sns.pairplot(df)
```

Out[18]:

```
<seaborn.axisgrid.PairGrid at 0x1af0e8a4160>
```

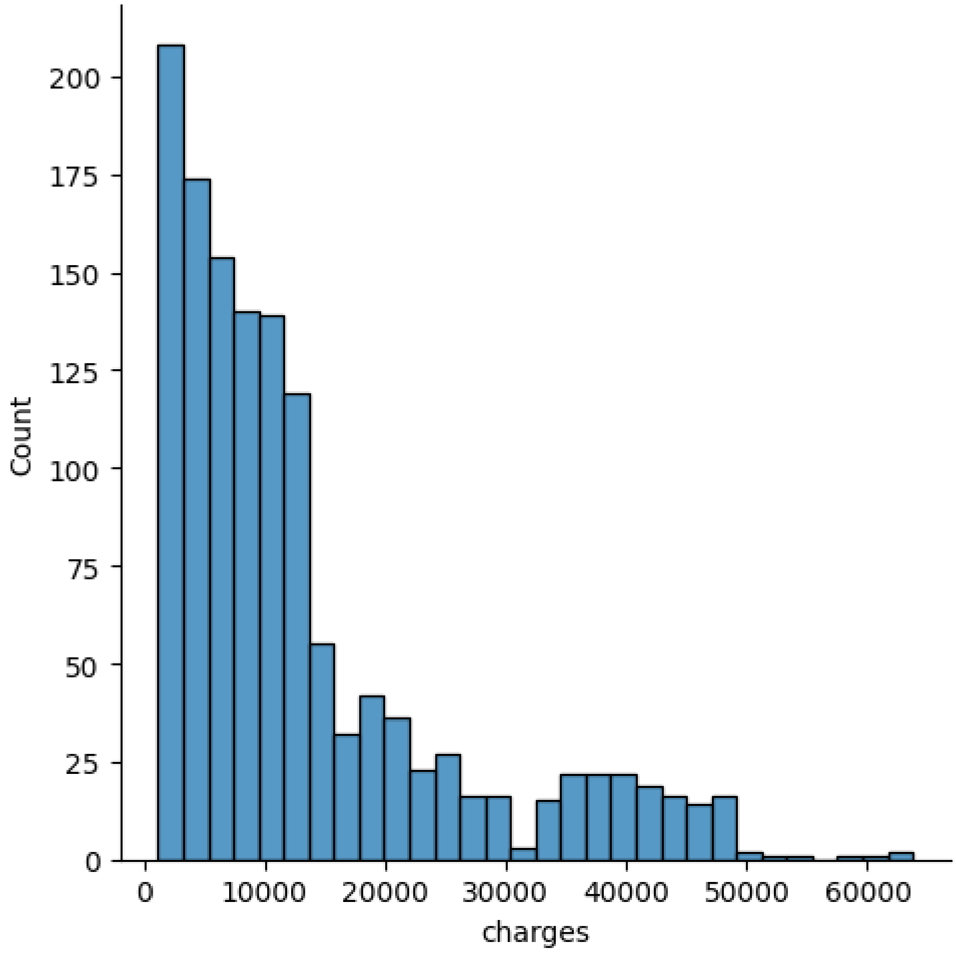


In [19]:

```
sns.displot(df["charges"])
```

Out[19]:

```
<seaborn.axisgrid.FacetGrid at 0x1af445eec50>
```



In [20]:

```
features=df.columns[0:6]
features
```

Out[20]:

```
Index(['age', 'sex', 'bmi', 'children', 'smoker', 'region'], dtype='objec
t')
```

In [21]:

```
target=df.columns[-1]
target
```

Out[21]:

```
'charges'
```

In [22]:

```
#training our model
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
x=df[features].values
y=df[target].values
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.50,random_state=17)
x_train.shape
x_test.shape
scaler=StandardScaler()
x_train=scaler.fit_transform(x_train)
x_test=scaler.fit_transform(x_test)
```

Data Modelling

Linear Regression

In [23]:

```
from sklearn.linear_model import LinearRegression
reg=LinearRegression()
```

In [24]:

```
reg.fit(x_train,y_train)
```

Out[24]:

```
LinearRegression()
```

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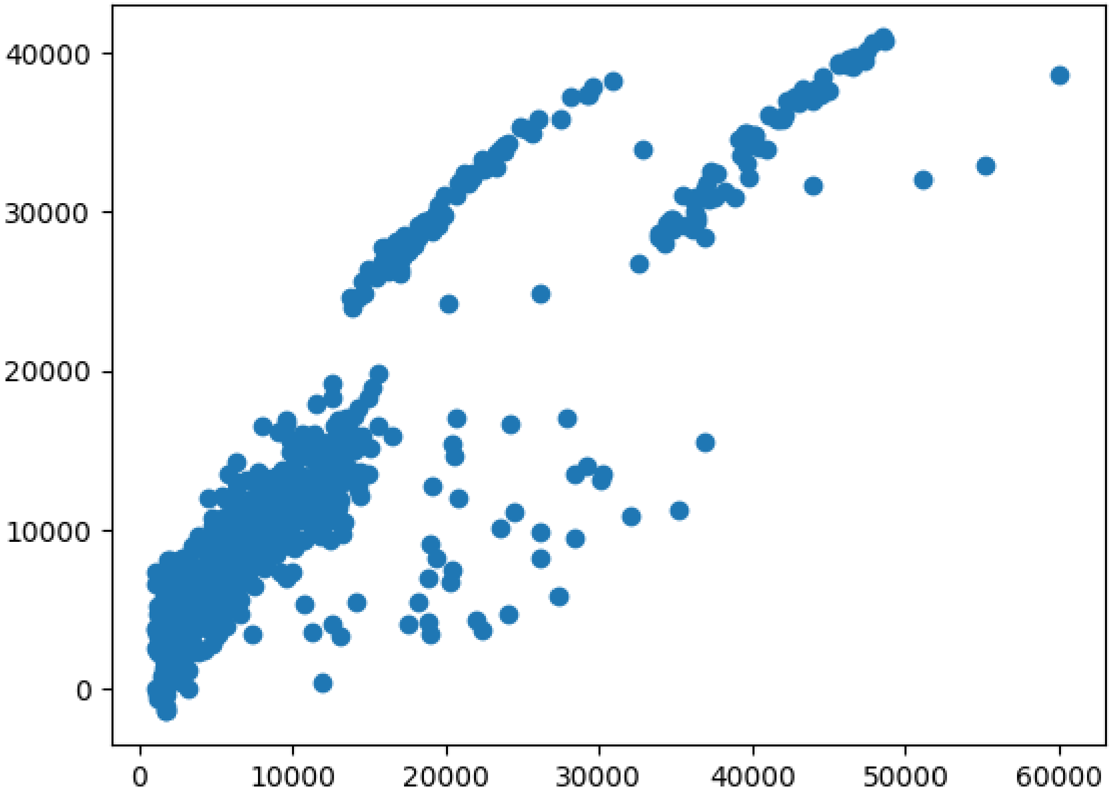
In [25]:

```
print(reg.score(x_test,y_test))
```

```
0.7553050021744551
```

In [26]:

```
y_pred=reg.predict(x_test)
plt.scatter(y_test,y_pred)
plt.show()
```



In [27]:

```
#evaluation of model
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
```

In [28]:

```
model=LinearRegression()
model.fit(x_train,y_train)
```

Out[28]:

```
LinearRegression()
```

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In [29]:

```
y_pred=model.predict(x_test)
r2=r2_score(y_test,y_pred)
print("R2 score:",r2)
```

```
R2 score: 0.7553050021744551
```

RIDGE

In [30]:

```
from sklearn.linear_model import Ridge,Lasso,ElasticNet
from sklearn import preprocessing
from sklearn.preprocessing import StandardScaler
```

In [31]:

```
#ridge regression model
ridgeReg=Ridge(alpha=10)
ridgeReg.fit(x_train,y_train)
train_score_ridge=ridgeReg.score(x_train,y_train)
test_score_ridge=ridgeReg.score(x_test,y_test)
print("\nRidge Model\n")
print("Train Score for ridge model is",(train_score_ridge))
print("Test Score for ridge model is",(test_score_ridge))
```

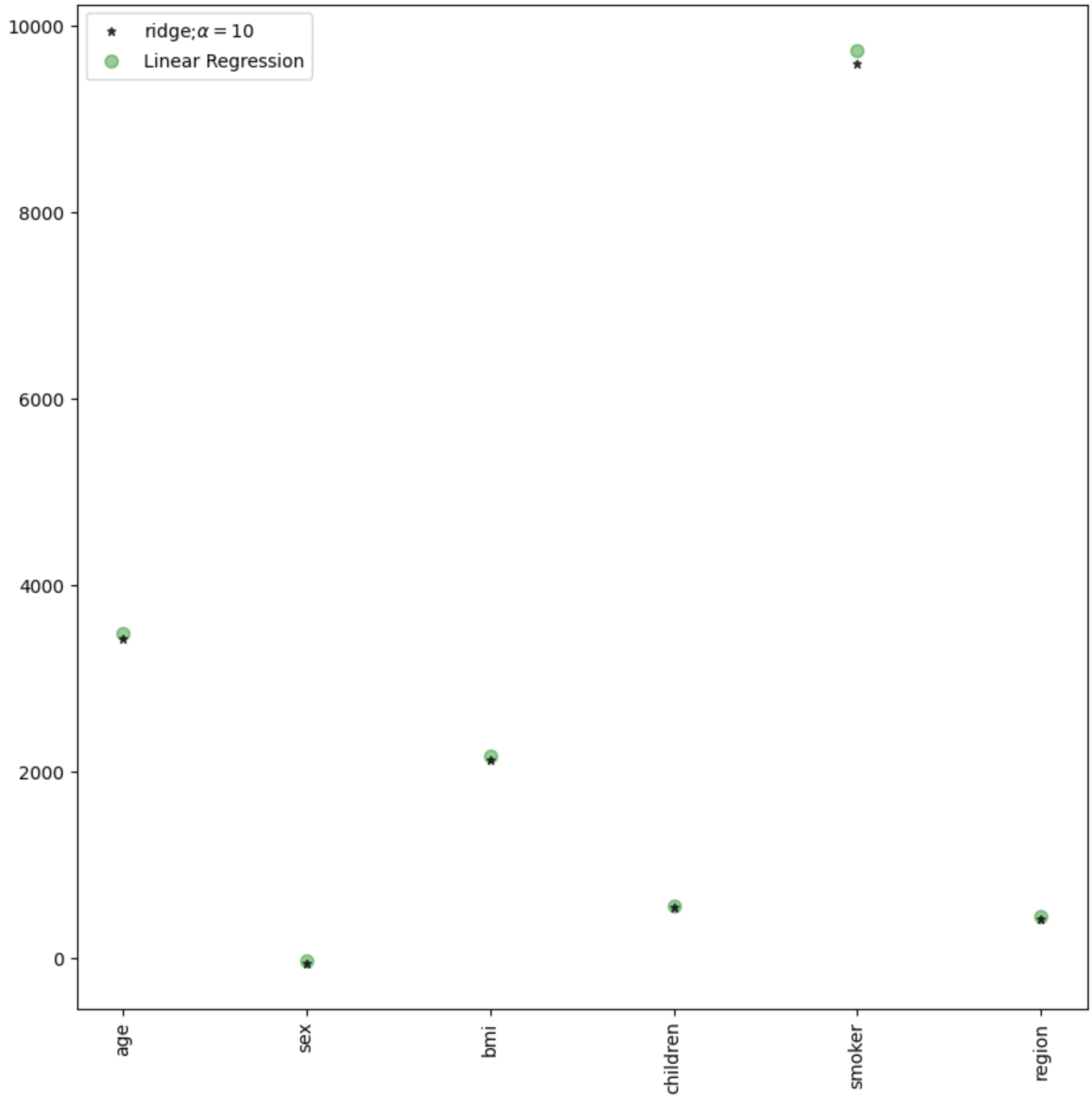
```

Ridge Model

Train Score for ridge model is 0.7408189083612313
Test Score for ridge model is 0.7555036308713557
```

In [32]:

```
plt.figure(figsize=(10,10))
plt.plot(features,ridgeReg.coef_,alpha=0.7,linestyle='none',marker="*",markersize=5,colo
plt.plot(features,reg.coef_,alpha=0.4,linestyle='none',marker='o',markersize=7,color="gr
plt.xticks(rotation=90)
plt.legend()
plt.show()
```



LASSO Regression

In [33]:

```
#Elastic Net
re=ElasticNet()
re.fit(x,y)
print(re.coef_)
#print(re.intercept_)
```

```
[ 244.53200843 -323.29321608  327.88975459  389.15389489 5841.24528723
   75.2866119 ]
```

In [34]:

```
#lasso regression
lassoReg=Lasso(alpha=10)
lassoReg.fit(x_train,y_train)
train_score_lasso=lassoReg.score(x_train,y_train)
test_score_lasso=lassoReg.score(x_test,y_test)
print("\nlasso Model\n")
print("Train Score for lasso model is",(train_score_lasso))
print("Test Score for lasso model is",(test_score_lasso))
```

```
lasso Model

Train Score for lasso model is 0.7409768055935853
Test Score for lasso model is 0.7553619179215416
```

ElasticNet

In [35]:

```
re.score(x,y)
```

Out[35]:

```
0.3919002752780354
```

In [36]:

```
y_pred_elastic=re.predict(x_train)
mean_squared_error=np.mean((y_pred_elastic-y_train)**2)
print("Mean Squared Error on test set",mean_squared_error)
```

```
Mean Squared Error on test set 830429140.4997891
```

Logistic Regression

In [37]:

```
from sklearn.linear_model import LogisticRegression
```

In [38]:

```
pd.set_option("display.max_rows",10000000000)
pd.set_option('display.max_columns',10000000000)
pd.set_option('display.width',95)
```

In [39]:

```
print("this dataframe has %d rows and %d columns"%(df.shape))
```

```
this dataframe has 1338 rows and 7 columns
```

In [40]:

```
df.head()
```

Out[40]:

	age	sex	bmi	children	smoker	region	charges
0	19	1	27.900	0	2	2	16884.92400
1	18	0	33.770	1	1	1	1725.55230
2	28	0	33.000	3	1	1	4449.46200
3	33	0	22.705	0	1	3	21984.47061
4	32	0	28.880	0	1	3	3866.85520

In [41]:

```
features_matrix=df[["age","sex","bmi","region"]]
features_matrix.columns=["age","sex","bmi","region"]
target_matrix=df.iloc[:,-3]
```

In [42]:

```

print('The features matrix has %d Rows and %d columns'%(features_matrix.shape))
print('The features matrix has %d Rows and %d columns'%(np.array(target_matrix).reshape(
```

```
The features matrix has 1338 Rows and 4 columns
The features matrix has 1338 Rows and 1 columns
```

In [43]:

```
features_matrix_Standardized=StandardScaler().fit_transform(features_matrix)
```

In [44]:

```
algorithm=LogisticRegression(max_iter=100)
```

In [45]:

```
Logistic_Regression_model=algorithm.fit(features_matrix_Standardized,target_matrix)
```

In [46]:

```
observation=[[28,1,28.880,2]]
```

In [47]:

```
predictions=Logistic_Regression_model.predict(observation)
print('The model predicted the observtaion to belong to class %s'%(predictions))
print('The algorithm was trained to predict one of the two calsses : %s'%(algorithm.clas
```

```
The model predicted the observtaion to belong to class [1]
The algorithm was trained to predict one of the two calsses : [1 2]
```

In [48]:

```
print("""The model says the prbability of the observation we passed belonging to calss [
print()
print("""The model says the prbability of the observation we passed belonging to calss [
```

```
The model says the prbability of the observation we passed belonging to ca
lss ['0'] Is 0.9800486899442347

The model says the prbability of the observation we passed belonging to ca
lss ['1'] Is 0.019951310055765316
```

In [49]:

```
x1=np.array(df['charges']).reshape(-1,1)
```

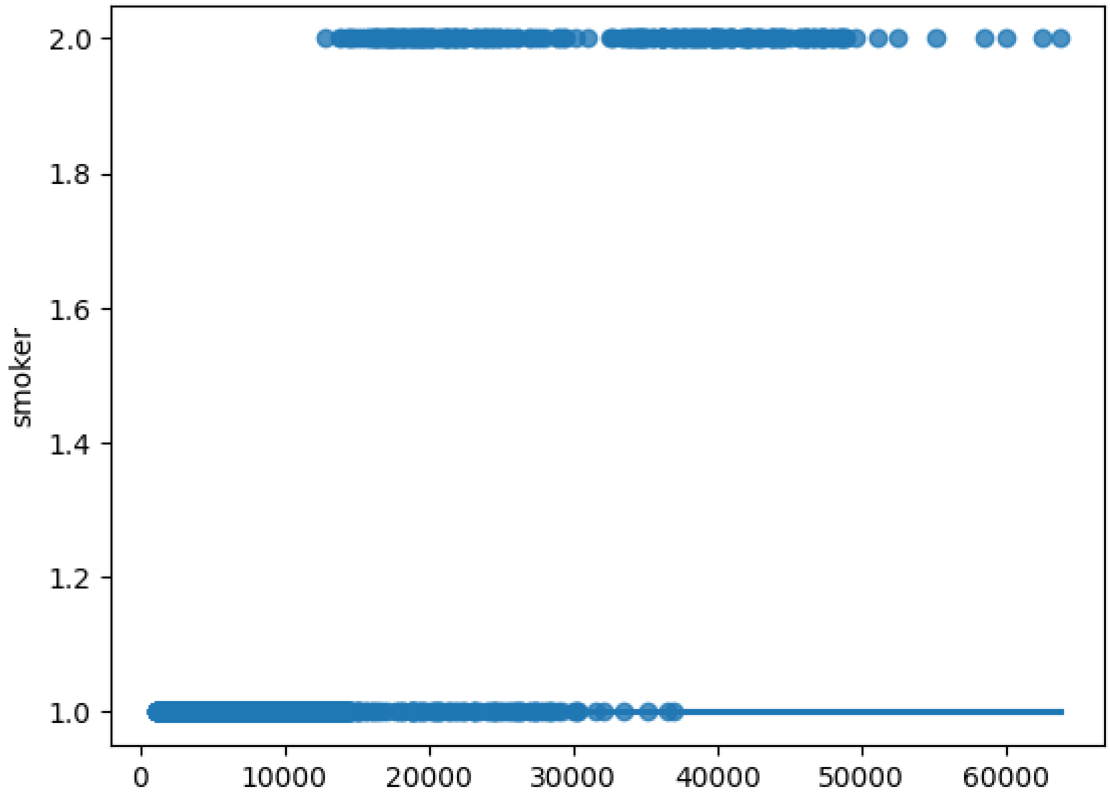
In [50]:

```
sns.regplot(x=x1,y=target_matrix,data=df,logistic=True,ci=None)
```

```
C:\Users\raja\AppData\Local\Programs\Python\Python310\lib\site-packages\st
atsmodels\genmod\families\links.py:198: RuntimeWarning: overflow encounter
ed in exp
  t = np.exp(-z)
```

Out[50]:

```
<Axes: ylabel='smoker'>
```



Decision trees

In [51]:

```
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import train_test_split
```

In [52]:

```
df
```

Out[52]:

	age	sex	bmi	children	smoker	region	charges
0	19	1	27.900	0	2	2	16884.924000
1	18	0	33.770	1	1	1	1725.552300
2	28	0	33.000	3	1	1	4449.462000
3	33	0	22.705	0	1	3	21984.470610
4	32	0	28.880	0	1	3	3866.855200
5	31	1	25.740	0	1	1	3756.621600
6	46	1	33.440	1	1	1	8240.589600
7	37	1	27.740	3	1	3	7281.505600
8	37	0	29.830	2	1	4	6406.410700
9	60	1	25.840	0	1	3	28923.136920
10	25	0	26.220	0	1	4	2721.320800

In [53]:

```
df["sex"].value_counts()
```

Out[53]:

```
sex
0    676
1    662
Name: count, dtype: int64
```

In [54]:

```
df["smoker"].value_counts()
```

Out[54]:

```
smoker
1    1064
2     274
Name: count, dtype: int64
```

In [55]:

```
x=["age","sex","children","bmi"]
y=["0","1"]
all_inputs=df[x]
all_classes=df["smoker"]
```

In [56]:

```
x_train,x_test,y_train,y_test=train_test_split(all_inputs,all_classes,test_size=0.25)
x_train.shape,x_test.shape
```

Out[56]:

```
((1003, 4), (335, 4))
```

In [57]:

```
clf=DecisionTreeClassifier(random_state=0)
```

In [58]:

```
clf.fit(x_train,y_train)
```

Out[58]:

```
DecisionTreeClassifier(random_state=0)
```

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In [59]:

```
score=clf.score(x_test,y_test)
```

In [60]:

```
print(score)
```

```
0.6895522388059702
```

In [61]:

```
clf.score(x_train,y_train)
```

Out[61]:

```
0.9990029910269193
```

Random Forest

In [62]:

```
df1=df.drop("charges",axis=1)
df1
```

Out[62]:

	age	sex	bmi	children	smoker	region
0	19	1	27.900	0	2	2
1	18	0	33.770	1	1	1
2	28	0	33.000	3	1	1
3	33	0	22.705	0	1	3
4	32	0	28.880	0	1	3
5	31	1	25.740	0	1	1
6	46	1	33.440	1	1	1
7	37	1	27.740	3	1	3
8	37	0	29.830	2	1	4
9	60	1	25.840	0	1	3
10	25	0	26.220	0	1	4

In [63]:

```
df2=df1.drop("children",axis=1)
df2
```

Out[63]:

	age	sex	bmi	smoker	region
0	19	1	27.900	2	2
1	18	0	33.770	1	1
2	28	0	33.000	1	1
3	33	0	22.705	1	3
4	32	0	28.880	1	3
5	31	1	25.740	1	1
6	46	1	33.440	1	1
7	37	1	27.740	1	3
8	37	0	29.830	1	4
9	60	1	25.840	1	3
10	25	0	26.220	1	4

In [64]:

```
x=df2.drop("smoker",axis=1)
y=df2["smoker"]
```

In [65]:

```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.25,random_state=0)
x_train.shape,x_test.shape
```

Out[65]:

```
((1003, 4), (335, 4))
```

In [66]:

```
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier()
rfc.fit(x_train,y_train)
```

Out[66]:

```
RandomForestClassifier()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [67]:

```
rf=RandomForestClassifier()
```

In [68]:

```
params={"max_depth":[2,3,5,10,20],'min_samples_leaf':[5,10,20,50,100,200],'n_estimators'
```

In [69]:

```
from sklearn.model_selection import GridSearchCV
grid_search=GridSearchCV(estimator=rf,param_grid=params,cv=2,scoring="accuracy")
grid_search.fit(x_train,y_train)
```

Out[69]:

```
GridSearchCV(cv=2, estimator=RandomForestClassifier(),
             param_grid={'max_depth': [2, 3, 5, 10, 20],
                         'min_samples_leaf': [5, 10, 20, 50, 100, 200],
                         'n_estimators': [10, 25, 30, 50, 100, 200]},
             scoring='accuracy')
```

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In [70]:

```
grid_search.best_score_
```

Out[70]:

```
0.7996039792924112
```

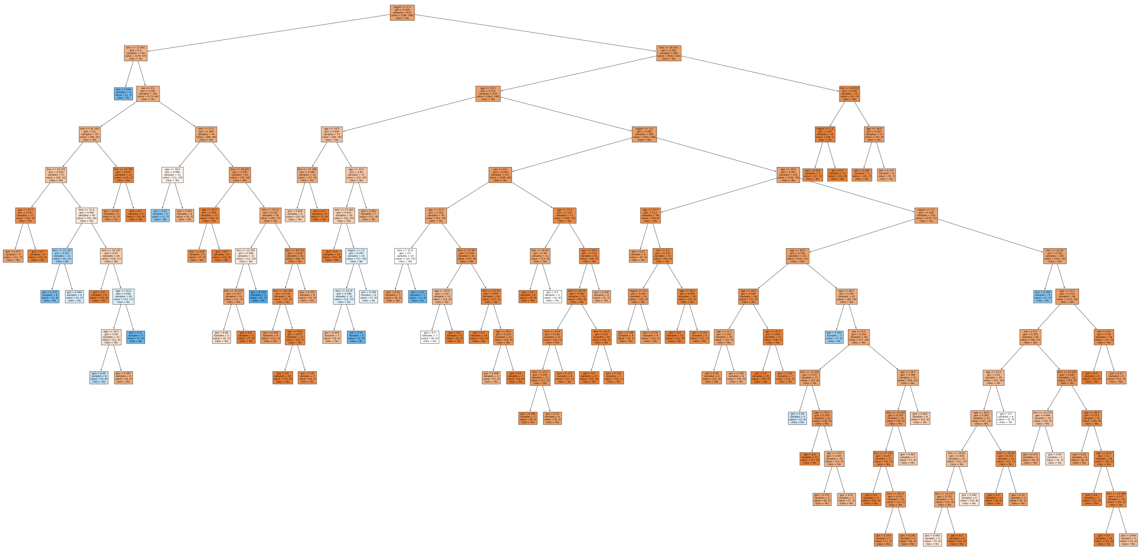
In [71]:

```
rf_best=grid_search.best_estimator_
print(rf_best)
```

```
RandomForestClassifier(max_depth=20, min_samples_leaf=5, n_estimators=25)
```

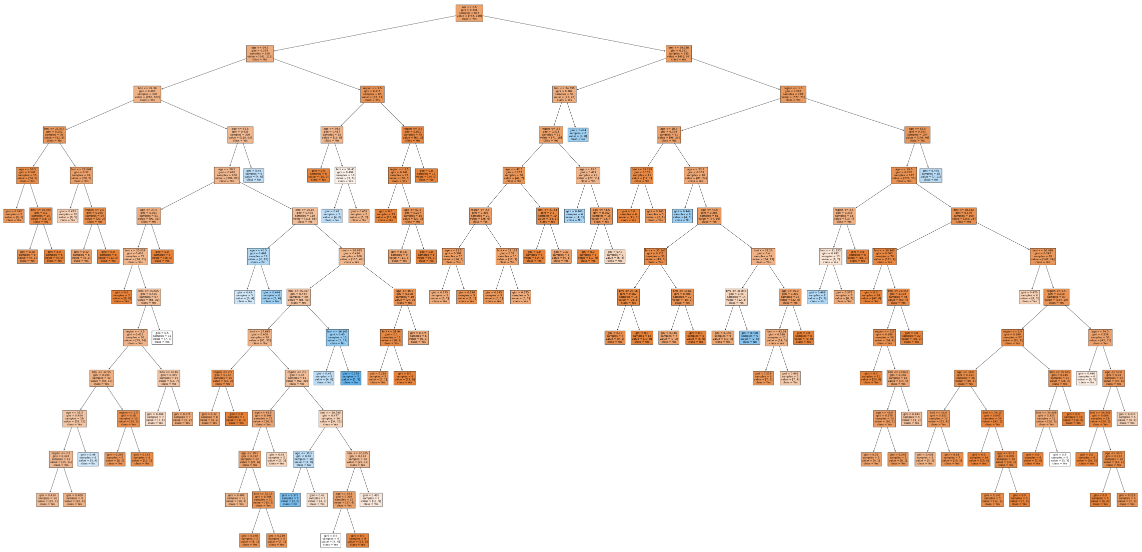
In [72]:

```
from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(rf_best.estimators_[5],feature_names=x.columns,class_names=['Yes','No'],filled
```



In [73]:

```
from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(rf_best.estimators_[7],feature_names=x.columns,class_names=['Yes','No'],filled
```



In [74]:

```
rf_best.feature_importances_
```

Out[74]:

```
array([0.39397304, 0.0469756 , 0.46710501, 0.09194635])
```

In [75]:

```
imp_df=pd.DataFrame({"Varname":x_train.columns,"Imp":rf_best.feature_importances_})
imp_df.sort_values(by="Imp",ascending=False)
```

Out[75]:

	Varname	Imp
2	bmi	0.467105
0	age	0.393973
3	region	0.091946
1	sex	0.046976

In [83]:

```
print(rfc.score(x_train,y_train))
```

```
0.9990029910269193
```

In [84]:

```
print(rfc.score(x_test,y_test))
```

```
0.7044776119402985
```

Conclusion:

After implementing all models in the dataset RandomForest got highest accuracy. so in this dataset RandomForest is the bestmodel