In [1]:

```
import pandas as pd
import numpy as np
```

In [2]:

```
df_in = pd.read_csv('insurance2.csv')
```

In [3]:

```
df_in.head()
```

Out[3]:

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

In [4]:

```
df_in.isnull().sum()
```

Out[4]:

```
age               0
sex               0
bmi               0
children          0
smoker            0
region            0
charges           0
insuranceclaim    0
dtype: int64
```

In [5]:

```
df_in.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1338 entries, 0 to 1337
Data columns (total 8 columns):
age               1338 non-null int64
sex               1338 non-null int64
bmi               1338 non-null float64
children          1338 non-null int64
smoker            1338 non-null int64
region            1338 non-null int64
charges           1338 non-null float64
insuranceclaim    1338 non-null int64
dtypes: float64(2), int64(6)
memory usage: 83.7 KB
```

In [6]:
```
df_in.describe()
```

Out[6]:

| | age | sex | bmi | children | smoker | region | ch |
|---|---|---|---|---|---|---|---|
| **count** | 1338.000000 | 1338.000000 | 1338.000000 | 1338.000000 | 1338.000000 | 1338.000000 | 1338.0 |
| **mean** | 39.207025 | 0.505232 | 30.663397 | 1.094918 | 0.204783 | 1.515695 | 13270.4 |
| **std** | 14.049960 | 0.500160 | 6.098187 | 1.205493 | 0.403694 | 1.104885 | 12110.0 |
| **min** | 18.000000 | 0.000000 | 15.960000 | 0.000000 | 0.000000 | 0.000000 | 1121.8 |
| **25%** | 27.000000 | 0.000000 | 26.296250 | 0.000000 | 0.000000 | 1.000000 | 4740.2 |
| **50%** | 39.000000 | 1.000000 | 30.400000 | 1.000000 | 0.000000 | 2.000000 | 9382.0 |
| **75%** | 51.000000 | 1.000000 | 34.693750 | 2.000000 | 0.000000 | 2.000000 | 16639.9 |
| **max** | 64.000000 | 1.000000 | 53.130000 | 5.000000 | 1.000000 | 3.000000 | 63770.4 |

In [7]:
```
df_in['children'].value_counts()
```

Out[7]:
```
0    574
1    324
2    240
3    157
4     25
5     18
Name: children, dtype: int64
```

In [8]:
```
df_in['region'].value_counts()
```

Out[8]:
```
2    364
3    325
1    325
0    324
Name: region, dtype: int64
```

In [9]:
```
df_in['smoker'].value_counts()
```

Out[9]:
```
0    1064
1     274
Name: smoker, dtype: int64
```

In [10]:
```
df_in['insuranceclaim'].value_counts()
```

Out[10]:
```
1    783
0    555
Name: insuranceclaim, dtype: int64
```

In [11]:
```
df_in['sex'].value_counts()
```

Out[11]:
```
1    676
0    662
Name: sex, dtype: int64
```

In [12]:
```
df_in.columns
```

Out[12]:
```
Index(['age', 'sex', 'bmi', 'children', 'smoker', 'region', 'charges
',
       'insuranceclaim'],
      dtype='object')
```

In [13]:
```
df_in = df_in[['charges','age', 'sex', 'bmi', 'children', 'smoker', 're
gion','insuranceclaim']]
```

In [14]:
```
df_in.corr()
```

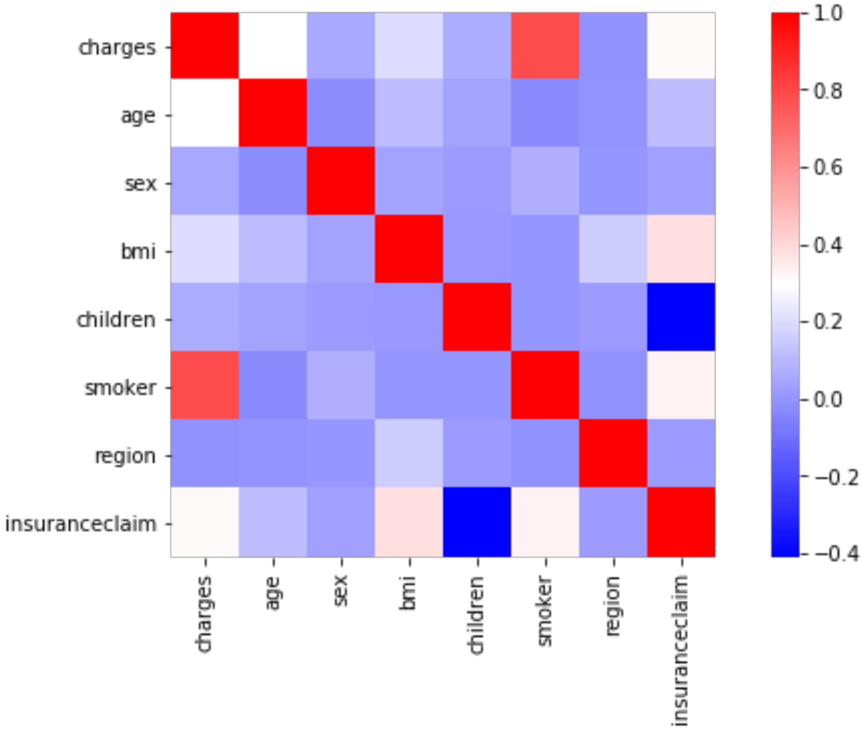
Out[14]:

| | charges | age | sex | bmi | children | smoker | region | insu |
|---|---|---|---|---|---|---|---|---|
| **charges** | 1.000000 | 0.299008 | 0.057292 | 0.198341 | 0.067998 | 0.787251 | -0.006208 | |
| **age** | 0.299008 | 1.000000 | -0.020856 | 0.109272 | 0.042469 | -0.025019 | 0.002127 | |
| **sex** | 0.057292 | -0.020856 | 1.000000 | 0.046371 | 0.017163 | 0.076185 | 0.004588 | |
| **bmi** | 0.198341 | 0.109272 | 0.046371 | 1.000000 | 0.012759 | 0.003750 | 0.157566 | |
| **children** | 0.067998 | 0.042469 | 0.017163 | 0.012759 | 1.000000 | 0.007673 | 0.016569 | |
| **smoker** | 0.787251 | -0.025019 | 0.076185 | 0.003750 | 0.007673 | 1.000000 | -0.002181 | |
| **region** | -0.006208 | 0.002127 | 0.004588 | 0.157566 | 0.016569 | -0.002181 | 1.000000 | |
| **insuranceclaim** | 0.309418 | 0.113723 | 0.031565 | 0.384198 | -0.409526 | 0.333261 | 0.020891 | |

In [15]:
```
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
```

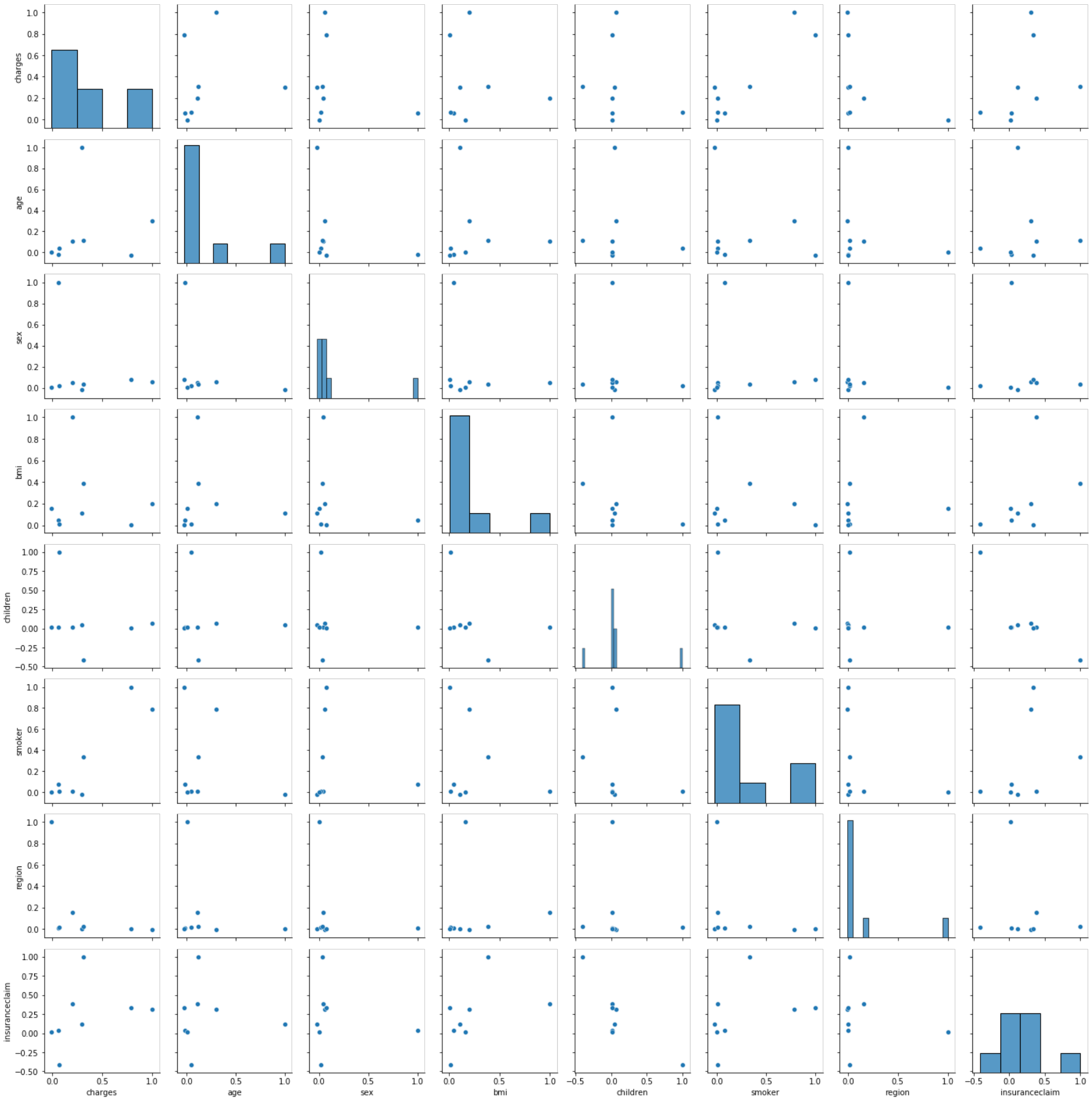
In [16]:

```
plt.figure(figsize=(10,5))
sns.heatmap(df_in.corr(), square=True, cmap='bwr')
plt.show()
```



In [17]:
```
plt.figure(figsize=(15,5))
sns.pairplot(data=df_in.corr())
plt.show()
```

```
<Figure size 1080x360 with 0 Axes>
```



# Observation:

## by looking at te Heatmap and the pairplots, we can clearly see that

```
## Sex, Children,bmi and region has almost zero corelation with the charge
s
## major features afecting the cost/chanrges is smoker
## age and insurance calim has some impact on the charges
```

In [18]:
```
# Normalizing the inputs
```

In [19]:
```
df_in.head()
```

Out[19]:

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

In [20]:
```
from sklearn.preprocessing import StandardScaler
```

In [21]:
```
df_in_scaler = StandardScaler()
```

In [22]:
```
df_in[['age','bmi','children','region']] = df_in_scaler.fit_transform(d
f_in[['age','bmi','children','region']])
df_in.head()
```

```
C:\Users\SujitSonar\Anaconda3\lib\site-packages\sklearn\preprocessin
g\data.py:645: DataConversionWarning: Data with input dtype int64, fl
oat64 were all converted to float64 by StandardScaler.
  return self.partial_fit(X, y)
C:\Users\SujitSonar\Anaconda3\lib\site-packages\sklearn\base.py:464:
DataConversionWarning: Data with input dtype int64, float64 were all
converted to float64 by StandardScaler.
  return self.fit(X, **fit_params).transform(X)
```

Out[22]:

| | charges | age | sex | bmi | children | smoker | region | insuranceclaim |
|---|---|---|---|---|---|---|---|---|
| **0** | 16884.92400 | -1.438764 | 0 | -0.453320 | -0.908614 | 1 | 1.343905 | 1 |
| **1** | 1725.55230 | -1.509965 | 1 | 0.509621 | -0.078767 | 0 | 0.438495 | 1 |
| **2** | 4449.46200 | -0.797954 | 1 | 0.383307 | 1.580926 | 0 | 0.438495 | 0 |
| **3** | 21984.47061 | -0.441948 | 1 | -1.305531 | -0.908614 | 0 | -0.466915 | 0 |
| **4** | 3866.85520 | -0.513149 | 1 | -0.292556 | -0.908614 | 0 | -0.466915 | 1 |

In [23]:
```
# building the model
```

In [24]:
```
import statsmodels.formula.api as smf
```

In [25]:
```
sm_df_in_model  = smf.ols(formula = 'charges~ smoker + age +insuranceclaim + sex+ children + bmi + region', data=df_in).fit()
sm_df_in_model.summary()
```

Out[25]:

OLS Regression Results

| | | | |
|---|---|---|---|
| **Dep. Variable:** | charges | **R-squared:** | 0.753 |
| **Model:** | OLS | **Adj. R-squared:** | 0.751 |
| **Method:** | Least Squares | **F-statistic:** | 578.3 |
| **Date:** | Tue, 14 Sep 2021 | **Prob (F-statistic):** | 0.00 |
| **Time:** | 22:05:28 | **Log-Likelihood:** | -13543. |
| **No. Observations:** | 1338 | **AIC:** | 2.710e+04 |
| **Df Residuals:** | 1330 | **BIC:** | 2.714e+04 |
| **Df Model:** | 7 | | |
| **Covariance Type:** | nonrobust | | |

| | **coef** | **std err** | **t** | **P>\|t\|** | **[0.025** | **0.975]** |
|---|---|---|---|---|---|---|
| **Intercept** | 9190.9641 | 333.138 | 27.589 | 0.000 | 8537.431 | 9844.497 |
| **smoker** | 2.442e+04 | 450.110 | 54.257 | 0.000 | 2.35e+04 | 2.53e+04 |
| **age** | 3684.1336 | 167.746 | 21.963 | 0.000 | 3355.059 | 4013.208 |
| **insuranceclaim** | -1458.7404 | 448.606 | -3.252 | 0.001 | -2338.794 | -578.687 |
| **sex** | -134.6896 | 331.622 | -0.406 | 0.685 | -785.249 | 515.870 |
| **children** | 275.3737 | 189.624 | 1.452 | 0.147 | -96.622 | 647.369 |
| **bmi** | 2302.3689 | 188.439 | 12.218 | 0.000 | 1932.699 | 2672.039 |
| **region** | -413.5136 | 167.347 | -2.471 | 0.014 | -741.807 | -85.221 |

| | | | |
|---|---|---|---|
| **Omnibus:** | 293.974 | **Durbin-Watson:** | 2.091 |
| **Prob(Omnibus):** | 0.000 | **Jarque-Bera (JB):** | 690.125 |
| **Skew:** | 1.194 | **Prob(JB):** | 1.38e-150 |
| **Kurtosis:** | 5.583 | **Cond. No.** | 4.71 |

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

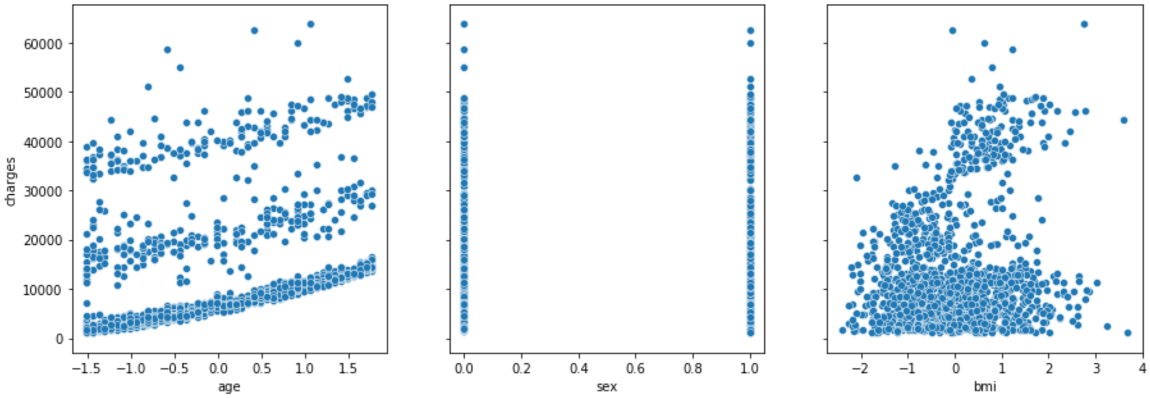
# from the above model Smoker, and Age has the greater impact on the insurance cost

In [ ]:
```

```

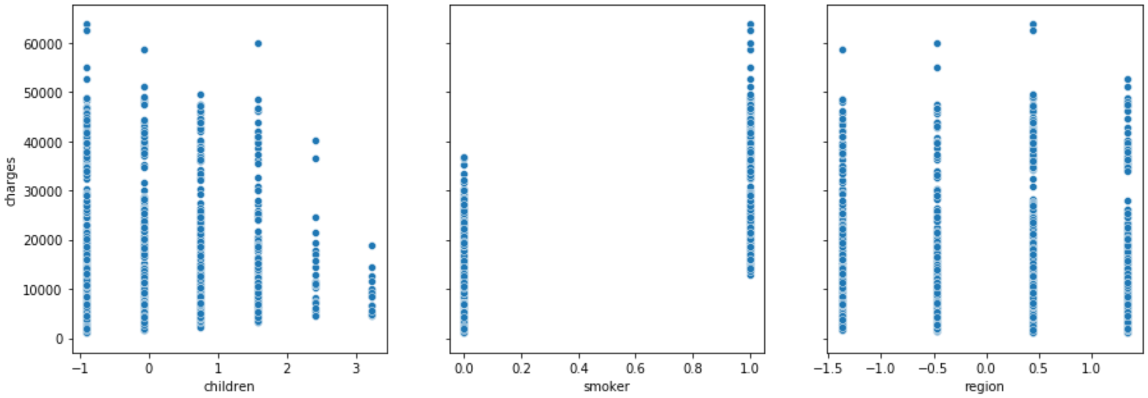
In [26]:

```
fig,axs = plt.subplots(1,3,sharey=True, figsize=(15,5))
sns.scatterplot(data=df_in, x='age', y='charges', ax=axs[0])
sns.scatterplot(data=df_in, x='sex', y='charges',ax=axs[1])
sns.scatterplot(data=df_in, x='bmi', y='charges',ax=axs[2])
plt.show()
```

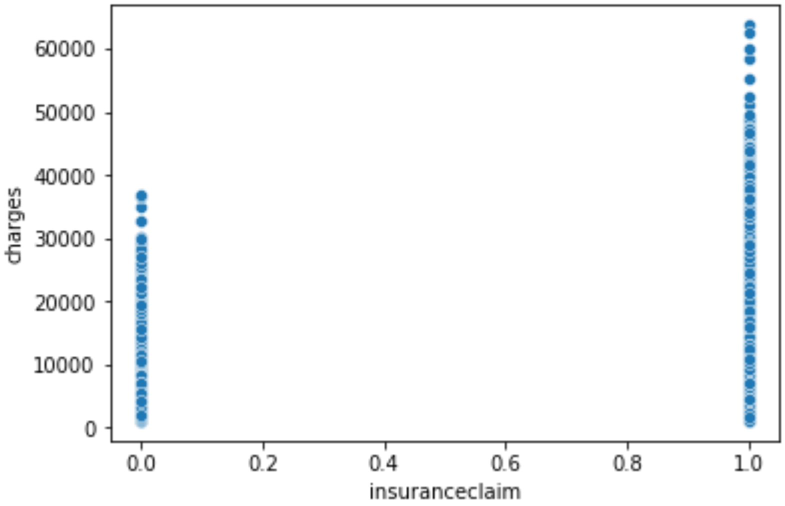


In [27]:

```
fig,axs = plt.subplots(1,3,sharey=True, figsize=(15,5))
sns.scatterplot(data=df_in, x='children', y='charges', ax=axs[0])
sns.scatterplot(data=df_in, x='smoker', y='charges',ax=axs[1])
sns.scatterplot(data=df_in, x='region', y='charges',ax=axs[2])
plt.show()
```



In [28]:
```
sns.scatterplot(data=df_in, x='insuranceclaim', y='charges')
plt.show()
```



In [29]:
```
X= df_in.drop(['charges'],axis=1)
y= df_in[['charges']]
```

In [30]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y, train_size=0.
7, random_state=42)
```

```
C:\Users\SujitSonar\Anaconda3\lib\site-packages\sklearn\model_selecti
on\_split.py:2179: FutureWarning: From version 0.21, test_size will a
lways complement train_size unless both are specified.
  FutureWarning)
```

In [31]:
```
from sklearn.linear_model import LinearRegression
```

In [32]:
```
df_in_model = LinearRegression()
```

In [33]:
```
df_in_model.fit(X_train,y_train)
```

Out[33]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False)
```

In [34]:
```
y_pred_train = df_in_model.predict(X_train)
```

In [35]:

```
y_pred_train
```

```
Out[35]: array([[13686.07220011],
                [ 7671.17363171],
                [13770.32813607],
                [36638.98471529],
                [34068.68719181],
                [35946.92336274],
                [ 6640.15629165],
                [ 5480.59200768],
                [17540.81546584],
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                [ 9803.80531756],
                [28006.06129827],
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                [14291.6730345 ],
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                [29174.22371919],
                [15806.12922342],
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                [36501.99765367],
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```

In [36]:

```
from sklearn.metrics import r2_score, mean_squared_error
```

In [37]:

```
print(r2_score(y_pred= y_pred_train, y_true = y_train))
print(np.sqrt(mean_squared_error(y_pred= y_pred_train, y_true = y_trai
n)))
```

```
0.7443935414225542
6118.681827376069
```

In [38]:

```
y_pred_test = df_in_model.predict(X_test)
```

In [39]:

```
print(r2_score(y_pred= y_pred_test, y_true = y_test))
print(np.sqrt(mean_squared_error(y_pred= y_pred_test, y_true = y_tes
t)))
```

```
0.7709743113284253
5794.88853140811
```

In [40]:

```
# ridge regresion

from sklearn.linear_model import Ridge

Ridgereg = Ridge(alpha=0.001, normalize=True)

Ridgereg.fit(X_train,y_train)

pred_train_ridge=Ridgereg.predict(X_train)
pred_test_ridge=Ridgereg.predict(X_test)

print(np.sqrt(mean_squared_error(pred_train_ridge,y_train)))
print(np.sqrt(mean_squared_error(pred_test_ridge,y_test)))
Ridgereg.score(X_test,y_test)
```

```
6118.696030756459
5794.89778513408
```

Out[40]:

```
0.7709735798759931
```

In [41]:

```
# lasso regresion

from sklearn.linear_model import Lasso

Lassoreg = Lasso(alpha=0.001, normalize=True)

Lassoreg.fit(X_train,y_train)

pred_train_lasso=Lassoreg.predict(X_train)
pred_test_lasso=Lassoreg.predict(X_test)

print(np.sqrt(mean_squared_error(pred_train_lasso,y_train)))
print(np.sqrt(mean_squared_error(pred_test_lasso,y_test)))
Lassoreg.score(X_test,y_test)
```

```
6118.681828153133
5794.8851067461
```

Out[41]:

```
0.7709745820274523
```

In [42]:
```
from sklearn.linear_model import ElasticNet


Elasreg = ElasticNet(alpha=0.001, normalize=True)

Elasreg.fit(X_train,y_train)

pred_train_Elas=Elasreg.predict(X_train)
pred_test_Elas=Elasreg.predict(X_test)

print(np.sqrt(mean_squared_error(pred_train_Elas,y_train)))
print(np.sqrt(mean_squared_error(pred_test_Elas,y_test)))
Elasreg.score(X_test,y_test)
```

```
7026.697936182537
6829.950612864106
```

Out[42]:
```
0.6818520336488385
```

In [43]:
```
#Results:

# from the above model Smoker, and Age has the greater impact on the in
surance cost
# Using various linear regresiion, we get an r2_score of 77% and RMSe o
f 5795
```

In [44]:
```
#Visualize how your model uses the different features and which feature
s have a greater effect.
```

In [45]:
```
df_in.head()
```

Out[45]:

| | charges | age | sex | bmi | children | smoker | region | insuranceclaim |
|---|---|---|---|---|---|---|---|---|
| **0** | 16884.92400 | -1.438764 | 0 | -0.453320 | -0.908614 | 1 | 1.343905 | 1 |
| **1** | 1725.55230 | -1.509965 | 1 | 0.509621 | -0.078767 | 0 | 0.438495 | 1 |
| **2** | 4449.46200 | -0.797954 | 1 | 0.383307 | 1.580926 | 0 | 0.438495 | 0 |
| **3** | 21984.47061 | -0.441948 | 1 | -1.305531 | -0.908614 | 0 | -0.466915 | 0 |
| **4** | 3866.85520 | -0.513149 | 1 | -0.292556 | -0.908614 | 0 | -0.466915 | 1 |

In [46]:
```
coeff_1  = list(df_in_model.coef_[0])
coeff_1
```

Out[46]:
```
[3758.9039323849206,
 114.41692172035894,
 2396.5256286667227,
 201.2301656809181,
 24273.480192626852,
 -394.9436917204082,
 -1523.4192944045428]
```

In [47]:
```
features_1 = df_in.columns
features_1=features_1[1:8]
features_1
```

Out[47]:
```
Index(['age', 'sex', 'bmi', 'children', 'smoker', 'region', 'insuranceclaim'], dtype='object')
```

In [48]:
```
df_importance_1 = pd.DataFrame(coeff_1, features_1)
df_importance_1.reset_index(inplace=True)
df_importance_1.rename(columns={'index':'features', 0:'importance'}, inplace = True)
```

In [49]:
```
df_importance_1
```

Out[49]:

|  | features | importance |
|---|---:|---:|
| **0** | age | 3758.903932 |
| **1** | sex | 114.416922 |
| **2** | bmi | 2396.525629 |
| **3** | children | 201.230166 |
| **4** | smoker | 24273.480193 |
| **5** | region | -394.943692 |
| **6** | insuranceclaim | -1523.419294 |

In [50]:
```
df_importance_1['positive'] = df_importance_1['importance'] >0
```

In [51]:
```
df_importance_1.sort_values(by=['positive','importance'], ascending=[True, True], inplace=True)
df_importance_1.set_index('features', inplace=True)
df_importance_1
```

Out[51]:

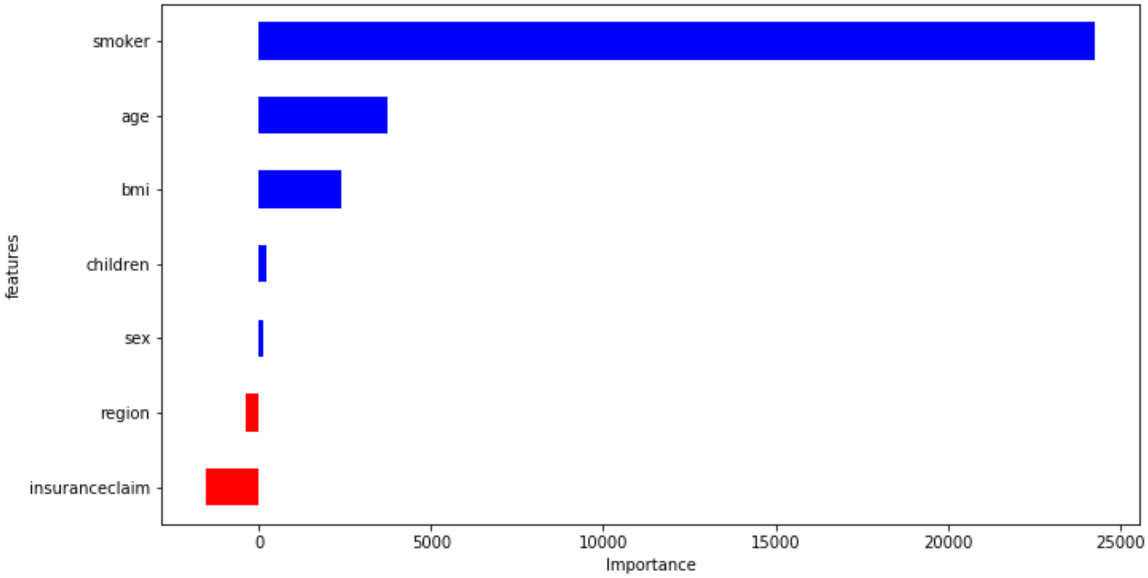
|  | importance | positive |
|---:|---:|---:|
| **features** |  |  |
| **insuranceclaim** | -1523.419294 | False |
| **region** | -394.943692 | False |
| **sex** | 114.416922 | True |
| **children** | 201.230166 | True |
| **bmi** | 2396.525629 | True |
| **age** | 3758.903932 | True |
| **smoker** | 24273.480193 | True |

In [52]:

```
df_importance_1.importance.plot(kind='barh', figsize=(11, 6),color = df
_importance_1.positive.map({True: 'blue', False: 'red'}))
plt.xlabel('Importance')
```

Out[52]:

```
Text(0.5, 0, 'Importance')
```



# results:

### from the above model Smoker, and Age has the greater impact on the insurance cost

In [ ]:

In [ ]:

In [ ]:

# Model for InsuranceClaim

In [53]:
```
df_in.head()
```

Out[53]:

| | charges | age | sex | bmi | children | smoker | region | insuranceclaim |
|---|---|---|---|---|---|---|---|---|
| **0** | 16884.92400 | -1.438764 | 0 | -0.453320 | -0.908614 | 1 | 1.343905 | 1 |
| **1** | 1725.55230 | -1.509965 | 1 | 0.509621 | -0.078767 | 0 | 0.438495 | 1 |
| **2** | 4449.46200 | -0.797954 | 1 | 0.383307 | 1.580926 | 0 | 0.438495 | 0 |
| **3** | 21984.47061 | -0.441948 | 1 | -1.305531 | -0.908614 | 0 | -0.466915 | 0 |
| **4** | 3866.85520 | -0.513149 | 1 | -0.292556 | -0.908614 | 0 | -0.466915 | 1 |

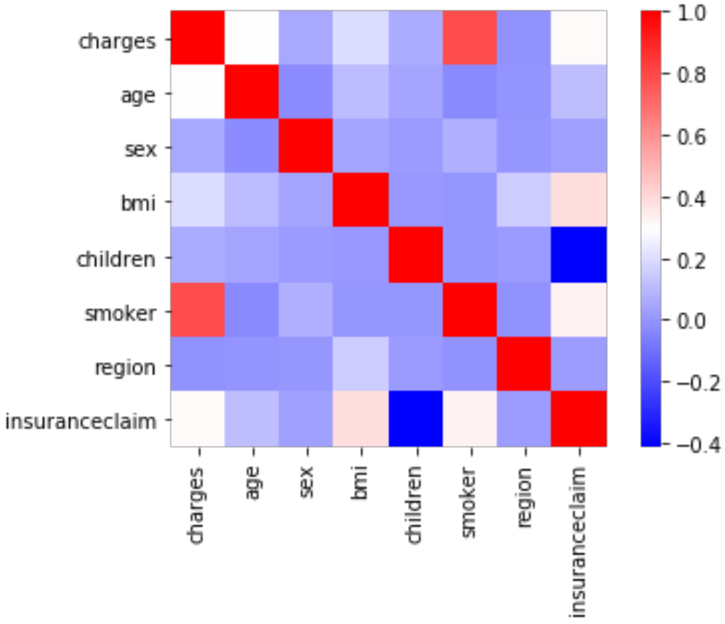
In [54]:
```
df_in.corr()
```

Out[54]:

| | charges | age | sex | bmi | children | smoker | region | insu |
|---|---|---|---|---|---|---|---|---|
| **charges** | 1.000000 | 0.299008 | 0.057292 | 0.198341 | 0.067998 | 0.787251 | -0.006208 | |
| **age** | 0.299008 | 1.000000 | -0.020856 | 0.109272 | 0.042469 | -0.025019 | 0.002127 | |
| **sex** | 0.057292 | -0.020856 | 1.000000 | 0.046371 | 0.017163 | 0.076185 | 0.004588 | |
| **bmi** | 0.198341 | 0.109272 | 0.046371 | 1.000000 | 0.012759 | 0.003750 | 0.157566 | |
| **children** | 0.067998 | 0.042469 | 0.017163 | 0.012759 | 1.000000 | 0.007673 | 0.016569 | |
| **smoker** | 0.787251 | -0.025019 | 0.076185 | 0.003750 | 0.007673 | 1.000000 | -0.002181 | |
| **region** | -0.006208 | 0.002127 | 0.004588 | 0.157566 | 0.016569 | -0.002181 | 1.000000 | |
| **insuranceclaim** | 0.309418 | 0.113723 | 0.031565 | 0.384198 | -0.409526 | 0.333261 | 0.020891 | |

In [55]:
```
sns.heatmap(df_in.corr(), square=True, cmap='bwr')
```

Out[55]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1bd45d74b70>
```



# Observations:

```
# as per the correlation heatmap, we can see that sex, region and age are
having a very weak corelation with insurance calaim
# children s have a negative corelation, which indiates that more children
means less or no policy claim
# charges, smoker and bmi shows postive corelation which means the policy
claims increse with the increase in these features
```

In [56]:

```python
X_1 = df_in.drop(['insuranceclaim'], axis=1)
X_1.head()
```

Out[56]:

| | charges | age | sex | bmi | children | smoker | region |
|---|---|---|---|---|---|---|---|
| **0** | 16884.92400 | -1.438764 | 0 | -0.453320 | -0.908614 | 1 | 1.343905 |
| **1** | 1725.55230 | -1.509965 | 1 | 0.509621 | -0.078767 | 0 | 0.438495 |
| **2** | 4449.46200 | -0.797954 | 1 | 0.383307 | 1.580926 | 0 | 0.438495 |
| **3** | 21984.47061 | -0.441948 | 1 | -1.305531 | -0.908614 | 0 | -0.466915 |
| **4** | 3866.85520 | -0.513149 | 1 | -0.292556 | -0.908614 | 0 | -0.466915 |

In [57]:

```python
y_1 = df_in[['insuranceclaim']]
y_1.head()
```

Out[57]:

| | insuranceclaim |
|---|---|
| **0** | 1 |
| **1** | 1 |
| **2** | 0 |
| **3** | 0 |
| **4** | 1 |

In [58]:

```python
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
```

In [59]:

```python
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report
from sklearn.metrics import recall_score
from sklearn.metrics import f1_score
from sklearn import metrics
```

In [60]:

```
X_1_train, X_1_test, y_1_train, y_1_test = train_test_split(X_1,y_1,tra
in_size=0.7, random_state=1234)
```

```
C:\Users\SujitSonar\Anaconda3\lib\site-packages\sklearn\model_selecti
on\_split.py:2179: FutureWarning: From version 0.21, test_size will a
lways complement train_size unless both are specified.
  FutureWarning)
```

In [61]:

```
InsuranceClaim_Model = LogisticRegression()
```

In [62]:

```
InsuranceClaim_Model.fit(X_1_train,y_1_train)
```

```
C:\Users\SujitSonar\Anaconda3\lib\site-packages\sklearn\linear_model\
logistic.py:433: FutureWarning: Default solver will be changed to 'lb
fgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
C:\Users\SujitSonar\Anaconda3\lib\site-packages\sklearn\utils\validat
ion.py:761: DataConversionWarning: A column-vector y was passed when
a 1d array was expected. Please change the shape of y to (n_samples,
), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[62]:

```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercep
t=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='warn
',
          tol=0.0001, verbose=0, warm_start=False)
```

In [63]:

```
y_1_pred_train= InsuranceClaim_Model.predict(X_1_train)
y_1_pred_train
```

```
Out[63]: array([1, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0,
         1,
                0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1,
         0,
                0, 0, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1,
         1,
                1, 0, 1, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1,
         0,
                1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0,
         1,
                1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1,
         0,
                0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1,
         1,
                1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1,
         1,
                1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1,
         1,
                1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0, 1, 1, 1,
         1,
                1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1,
         0,
                0, 0, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1,
         0,
                0, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 1,
         0,
                1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0,
         1,
                1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1,
         0,
                1, 0, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 0,
         1,
                1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1,
         1,
                1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1,
         1,
                1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1,
         1,
                1, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 0,
         0,
                0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1,
         1,
                0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
         1,
                1, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1,
         0,
                1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1,
         1,
                0, 0, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0,
         1,
                0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 1, 1, 1, 0, 0, 1, 1, 0,
         0,
                0, 1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0, 1,
         1,
                1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0,
         1,
        1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1,
0,
        0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1,
1,
        1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1,
1,
        1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1,
1,
        0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 0,
0,
        1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1,
1,
        1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 1, 0, 0, 0, 1, 0,
1,
        0, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 1,
1,
        0, 1, 0, 1, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1,
1,
        1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 0, 0,
1,
        1, 0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1,
1,
        1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1,
0,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 0, 1,
1,
        1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1], dtype=int64)
```

In [64]:

```
y_1_prob_train= InsuranceClaim_Model.predict_proba(X_1_train)
y_1_prob_train
```

Out[64]:

```
array([[0.05626059, 0.94373941],
       [0.66076272, 0.33923728],
       [0.26874972, 0.73125028],
       ...,
       [0.49920131, 0.50079869],
       [0.27701283, 0.72298717],
       [0.34749917, 0.65250083]])
```

In [65]:

```
confusion_matrix(y_pred=y_1_pred_train, y_true=y_1_train)
```

Out[65]:

```
array([[235, 144],
       [ 39, 518]], dtype=int64)
```

In [66]:

```
(235+518)/(235+144+39+518)
```

Out[66]:

```
0.8044871794871795
```

In [67]:

```
print(accuracy_score(y_pred=y_1_pred_train, y_true=y_1_train))
print(precision_score(y_pred=y_1_pred_train, y_true=y_1_train))
print(recall_score(y_pred=y_1_pred_train, y_true=y_1_train))
```

```
0.8044871794871795
0.7824773413897281
0.9299820466786356
```

In [68]:

```
print(classification_report(y_pred=y_1_pred_train, y_true=y_1_train))
```

```
              precision    recall  f1-score   support

           0       0.86      0.62      0.72       379
           1       0.78      0.93      0.85       557

   micro avg       0.80      0.80      0.80       936
   macro avg       0.82      0.78      0.78       936
weighted avg       0.81      0.80      0.80       936
```

In [69]:

```
y_1_pred_test = InsuranceClaim_Model.predict(X_1_test)
y_1_pred_test
```

Out[69]:

```
array([0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1,
1,
       1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0,
1,
       1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1,
1,
       1, 0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0,
0,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1,
1,
       0, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1,
0,
       1, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0,
1,
       1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0,
1,
       0, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1,
1,
       1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 0,
0,
       1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
1,
       0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 1, 0,
1,
       0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0,
0,
       1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1,
1,
       1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0, 0,
1,
       0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1,
1,
       1, 0, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1,
1,
       1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
       0, 1, 1, 1, 1, 0], dtype=int64)
```

In [70]:

```
y_1_prob_test = InsuranceClaim_Model.predict_proba(X_1_test)
y_1_prob_test
```

```
Out[70]: array([[0.51101907, 0.48898093],
                [0.61107494, 0.38892506],
                [0.41075147, 0.58924853],
                [0.44004535, 0.55995465],
                [0.07430648, 0.92569352],
                [0.19611822, 0.80388178],
                [0.270756  , 0.729244  ],
                [0.34474404, 0.65525596],
                [0.08340169, 0.91659831],
                [0.51929938, 0.48070062],
                [0.33296946, 0.66703054],
                [0.33653142, 0.66346858],
                [0.12194445, 0.87805555],
                [0.16344246, 0.83655754],
                [0.5123597 , 0.4876403 ],
                [0.70434443, 0.29565557],
                [0.42766109, 0.57233891],
                [0.23784697, 0.76215303],
                [0.19084007, 0.80915993],
                [0.41559379, 0.58440621],
                [0.20587179, 0.79412821],
                [0.49245759, 0.50754241],
                [0.26432482, 0.73567518],
                [0.72622707, 0.27377293],
                [0.64307273, 0.35692727],
                [0.43131561, 0.56868439],
                [0.19213794, 0.80786206],
                [0.03809276, 0.96190724],
                [0.25455156, 0.74544844],
                [0.28018168, 0.71981832],
                [0.54198214, 0.45801786],
                [0.69359951, 0.30640049],
                [0.34857796, 0.65142204],
                [0.26304363, 0.73695637],
                [0.82918402, 0.17081598],
                [0.35006559, 0.64993441],
                [0.71624509, 0.28375491],
                [0.43165199, 0.56834801],
                [0.04841129, 0.95158871],
                [0.74207606, 0.25792394],
                [0.62338423, 0.37661577],
                [0.42330764, 0.57669236],
                [0.65919394, 0.34080606],
                [0.25729976, 0.74270024],
                [0.45038226, 0.54961774],
                [0.42048502, 0.57951498],
                [0.47441745, 0.52558255],
                [0.35245897, 0.64754103],
                [0.28127097, 0.71872903],
                [0.04526465, 0.95473535],
                [0.77694582, 0.22305418],
                [0.09428579, 0.90571421],
                [0.70897218, 0.29102782],
                [0.34006637, 0.65993363],
                [0.29191216, 0.70808784],
                [0.32321985, 0.67678015],
                [0.34031439, 0.65968561],
                [0.30836561, 0.69163439],
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```

In [71]:

```
print(accuracy_score(y_pred=y_1_pred_test, y_true=y_1_test))
print(precision_score(y_pred=y_1_pred_test, y_true=y_1_test))
print(recall_score(y_pred=y_1_pred_test, y_true=y_1_test))
```

```
0.7810945273631841
0.7464285714285714
0.9247787610619469
```

In [72]:

```
print(classification_report(y_pred=y_1_pred_test, y_true=y_1_test))
```

```
              precision    recall  f1-score   support

           0       0.86      0.60      0.70       176
           1       0.75      0.92      0.83       226

   micro avg       0.78      0.78      0.78       402
   macro avg       0.80      0.76      0.77       402
weighted avg       0.80      0.78      0.77       402
```

# Observation:

```
#prediction results is hitting 78% accuracy
```

In [73]:

```
#Visualize how your model uses the different features and which feature
s have a greater effect.
```

In [74]:

```
InsuranceClaim_Model.coef_
```

Out[74]:

```
array([[ 5.86215481e-05,  4.31129192e-02, -2.03792149e-02,
         5.37574262e-01, -7.02022613e-01,  9.91577681e-02,
         4.56221510e-02]])
```

In [75]:

```
InsuranceClaim_Model.intercept_
```

Out[75]:

```
array([-0.14919909])
```

In [76]:

```
df_in.corr()
```

Out[76]:

| | charges | age | sex | bmi | children | smoker | region | insu |
|---|---|---|---|---|---|---|---|---|
| **charges** | 1.000000 | 0.299008 | 0.057292 | 0.198341 | 0.067998 | 0.787251 | -0.006208 | |
| **age** | 0.299008 | 1.000000 | -0.020856 | 0.109272 | 0.042469 | -0.025019 | 0.002127 | |
| **sex** | 0.057292 | -0.020856 | 1.000000 | 0.046371 | 0.017163 | 0.076185 | 0.004588 | |
| **bmi** | 0.198341 | 0.109272 | 0.046371 | 1.000000 | 0.012759 | 0.003750 | 0.157566 | |
| **children** | 0.067998 | 0.042469 | 0.017163 | 0.012759 | 1.000000 | 0.007673 | 0.016569 | |
| **smoker** | 0.787251 | -0.025019 | 0.076185 | 0.003750 | 0.007673 | 1.000000 | -0.002181 | |
| **region** | -0.006208 | 0.002127 | 0.004588 | 0.157566 | 0.016569 | -0.002181 | 1.000000 | |
| **insuranceclaim** | 0.309418 | 0.113723 | 0.031565 | 0.384198 | -0.409526 | 0.333261 | 0.020891 | |

In [77]:

```
coeff= list(InsuranceClaim_Model.coef_[0])
coeff
```

Out[77]:

```
[5.862154814685306e-05,
 0.043112919210255424,
 -0.020379214942318015,
 0.5375742621562051,
 -0.702022612780083,
 0.09915776810628518,
 0.04562215104675707]
```

In [78]:

```
features=list(df_in.columns)
features=features[0:7]
features
```

Out[78]:

```
['charges', 'age', 'sex', 'bmi', 'children', 'smoker', 'region']
```

In [79]:

```
type(features[0:6])
```

Out[79]:

```
list
```

In [80]:

```
type(coeff)
```

Out[80]:

```
list
```

In [81]:

```
df_importance = pd.DataFrame(coeff, features)
df_importance.reset_index(inplace=True)
df_importance.rename(columns={'index':'features', 0:'importance'}, inpl
ace = True)
```

In [82]:

```
df_importance.sort_values(by=['features'], ascending=True, inplace=Tru
e)
```

In [83]:

```
df_importance
```

Out[83]:

| | features | importance |
|---|---|---|
| **1** | age | 0.043113 |
| **3** | bmi | 0.537574 |
| **0** | charges | 0.000059 |
| **4** | children | -0.702023 |
| **6** | region | 0.045622 |
| **2** | sex | -0.020379 |
| **5** | smoker | 0.099158 |

In [84]:

```
df_importance['positive'] = df_importance['importance'] > 0
```

In [85]:

```
df_importance
```

Out[85]:

| | features | importance | positive |
|---|---|---|---|
| **1** | age | 0.043113 | True |
| **3** | bmi | 0.537574 | True |
| **0** | charges | 0.000059 | True |
| **4** | children | -0.702023 | False |
| **6** | region | 0.045622 | True |
| **2** | sex | -0.020379 | False |
| **5** | smoker | 0.099158 | True |

In [86]:

```
df_importance.set_index('features', inplace=True)
```

In [87]:

```
df_importance.sort_values(by=['positive','importance'], ascending=[True,True], inplace=True)
df_importance
```

Out[87]:

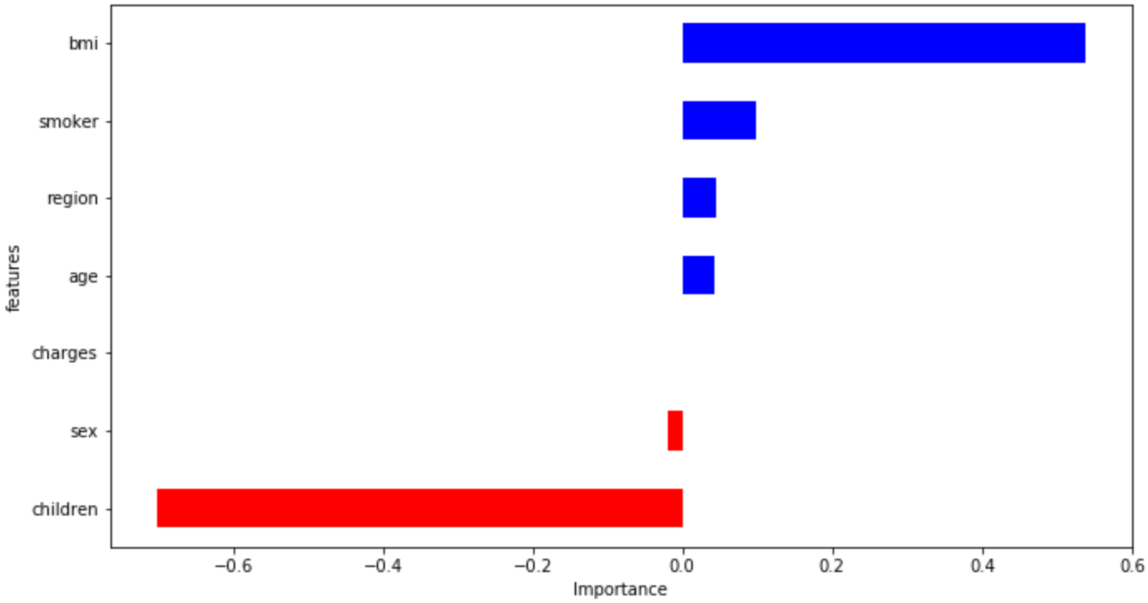
| | importance | positive |
|---|---|---|
| **features** | | |
| **children** | -0.702023 | False |
| **sex** | -0.020379 | False |
| **charges** | 0.000059 | True |
| **age** | 0.043113 | True |
| **region** | 0.045622 | True |
| **smoker** | 0.099158 | True |
| **bmi** | 0.537574 | True |

In [88]:

```
df_importance.importance.plot(kind='barh', figsize=(11, 6),color = df_i
mportance.positive.map({True: 'blue', False: 'red'}))
plt.xlabel('Importance')
```

Out[88]:

```
Text(0.5, 0, 'Importance')
```



# results:

### from the above model Children, and bmi has the greater impact on the insurance claim

In [ ]: