insurance

June 10, 2020

[1]:

```
import numpy as np
import pandas as pd
import os
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
data = pd.read_csv('datasets_13720_18513_insurance.csv')
data.head()
```

[1]:

```
   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
```

[2]:

```
data.isna().sum()
```

[2]:

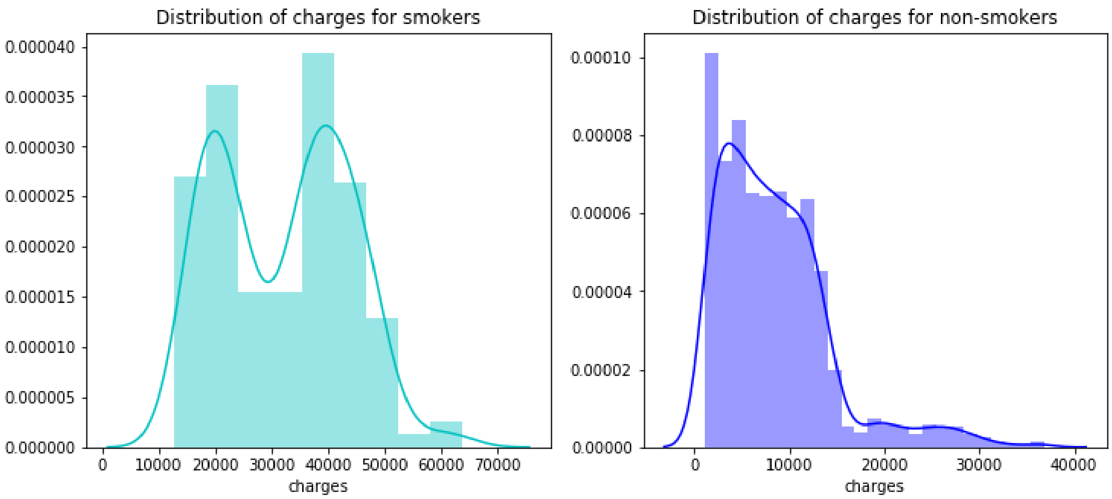
```
age         0
sex         0
bmi         0
children    0
smoker      0
region      0
charges     0
dtype: int64
```

[3]:

```
f= plt.figure(figsize=(12,5))

ax=f.add_subplot(121)
sns.distplot(data[(data.smoker == 'yes')]["charges"],color='c',ax=ax)
ax.set_title('Distribution of charges for smokers')

ax=f.add_subplot(122)
sns.distplot(data[(data.smoker == 'no')]['charges'],color='b',ax=ax)
ax.set_title('Distribution of charges for non-smokers')
```

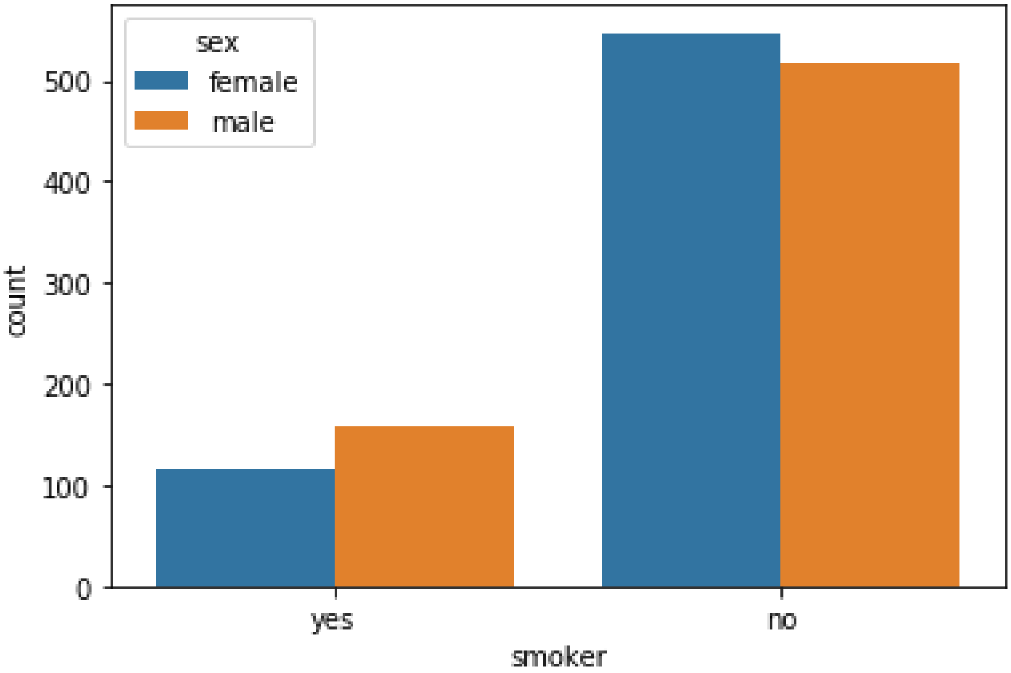
[3]:

```
Text(0.5, 1.0, 'Distribution of charges for non-smokers')
```



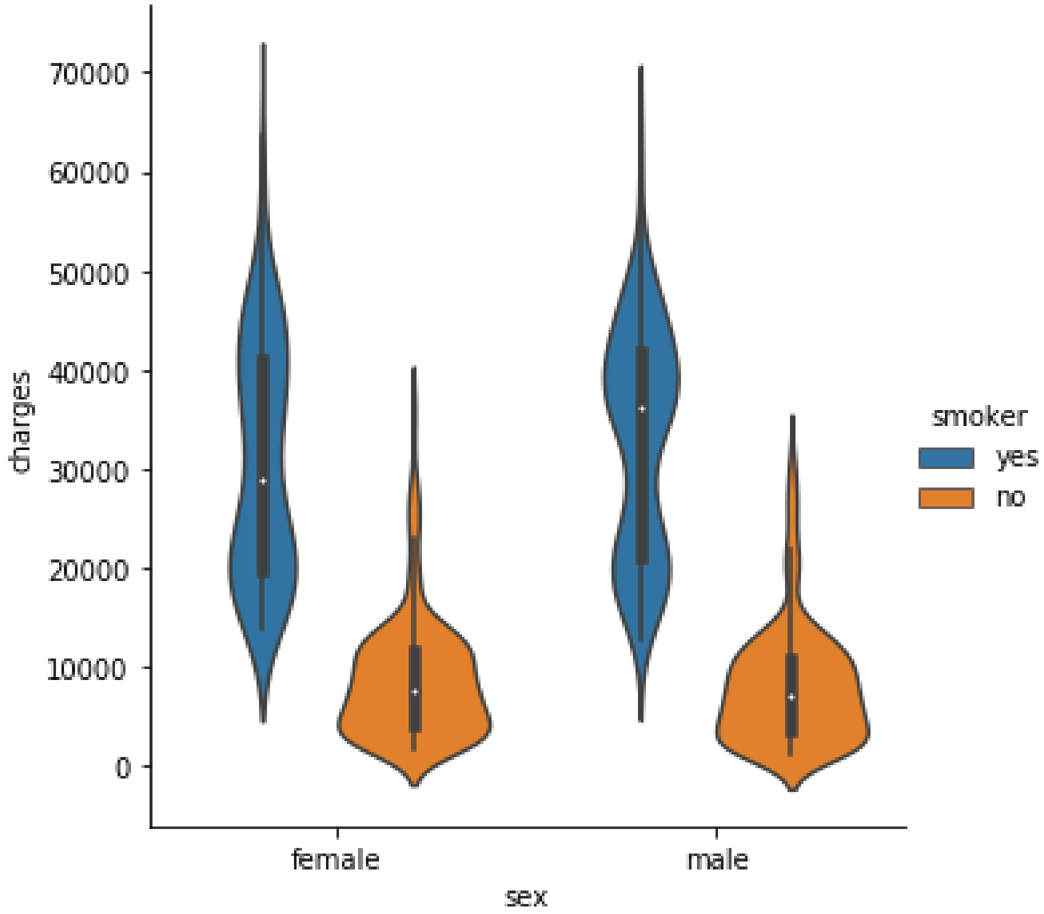
[4]:
```
sns.countplot(x = 'smoker', hue = 'sex', data = data)
```

[4]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a169fdeb8>
```



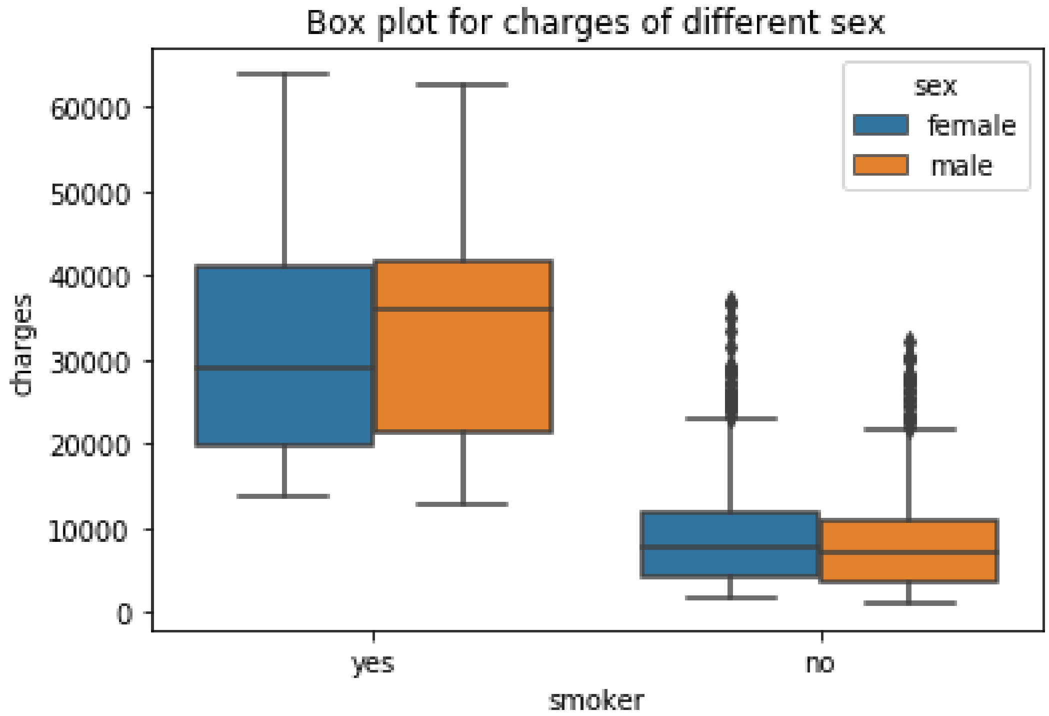
[5]:
```
sns.catplot(x = 'sex',y = 'charges', hue = 'smoker', data = data, kind =␣
 ↪'violin')
```

[5]:
```
<seaborn.axisgrid.FacetGrid at 0x1a16b9bf28>
```



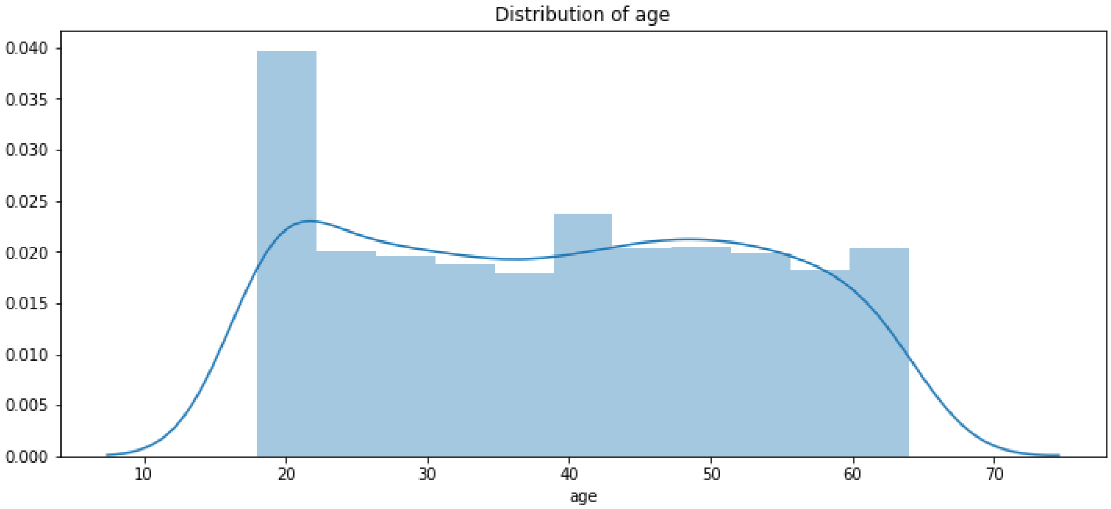
```
[6]: plt.title("Box plot for charges of different sex")
     sns.boxplot(x = 'smoker', y = 'charges', hue = 'sex', data= data)
```

```
[6]: <matplotlib.axes._subplots.AxesSubplot at 0x1a16c90198>
```



[7]:
```
plt.figure(figsize=(12,5))
plt.title("Distribution of age")
sns.distplot(data['age'])
```

[7]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a16d69a20>
```

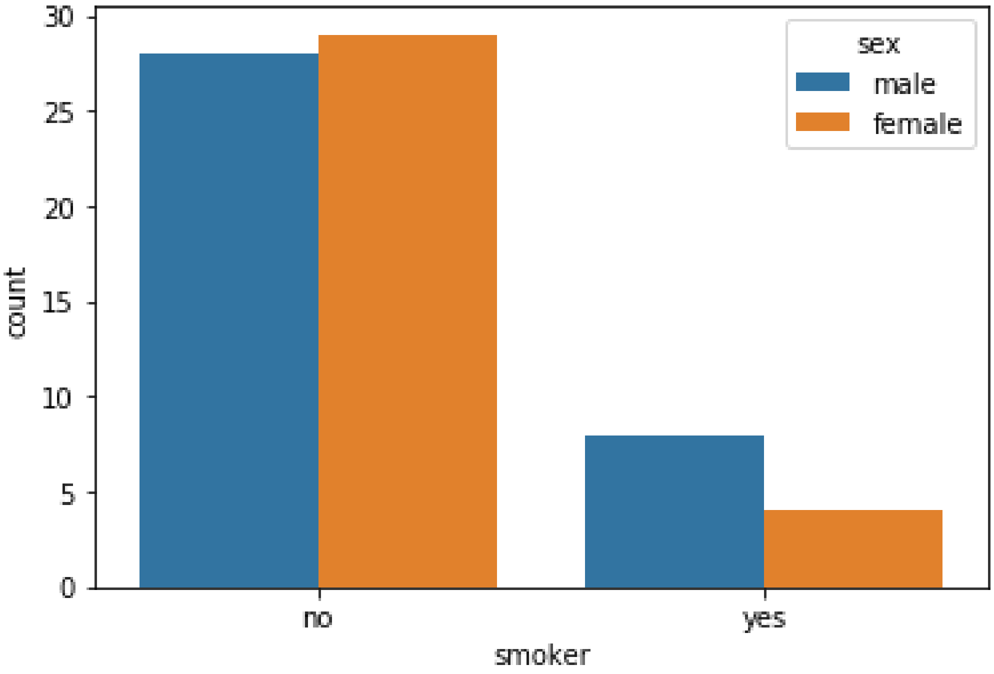


[8]:
```
data[data['age']==18]['smoker'].value_counts()
```

[8]:
```
no     57
yes    12
Name: smoker, dtype: int64
```

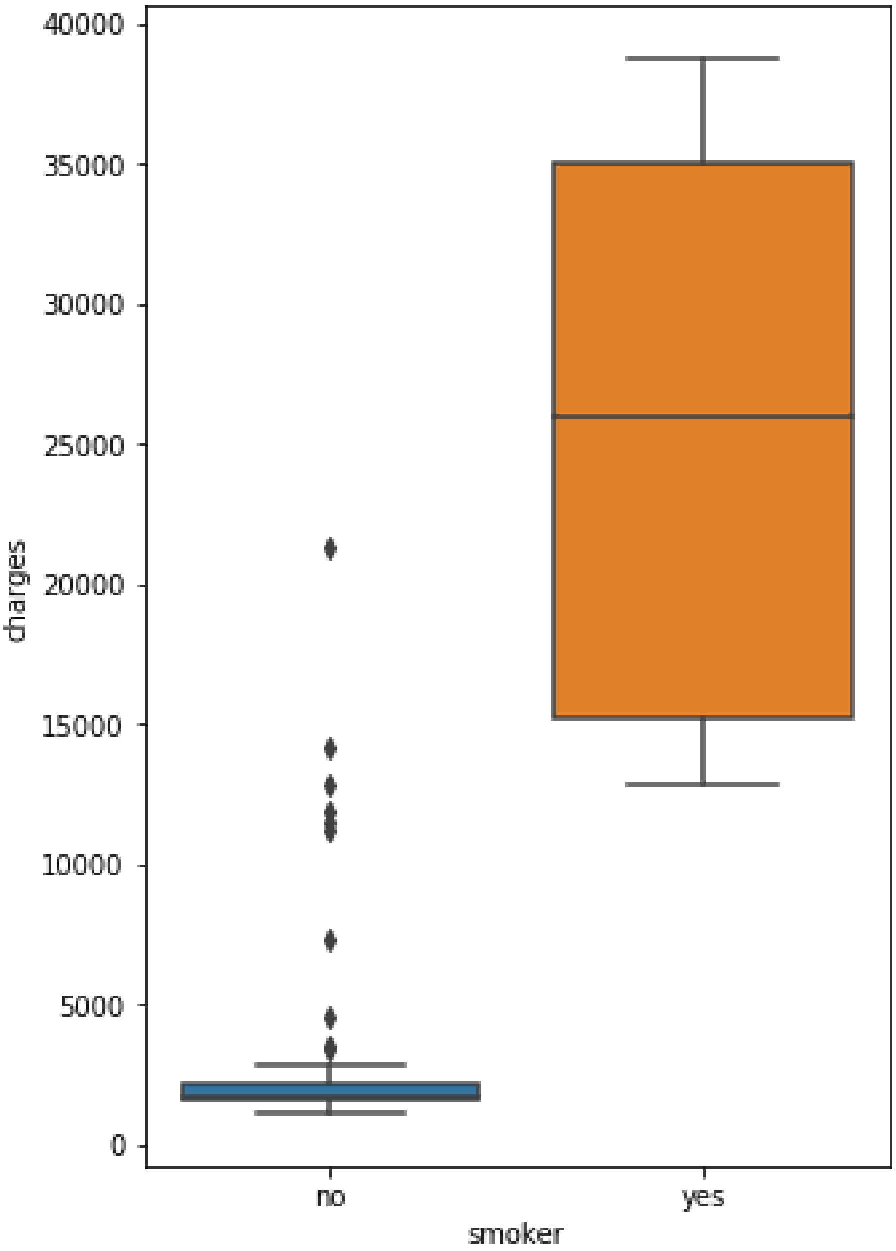
[9]:
```
sns.countplot(x = 'smoker', hue = 'sex', data = data[data['age'] == 18])
```

[9]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a16e523c8>
```



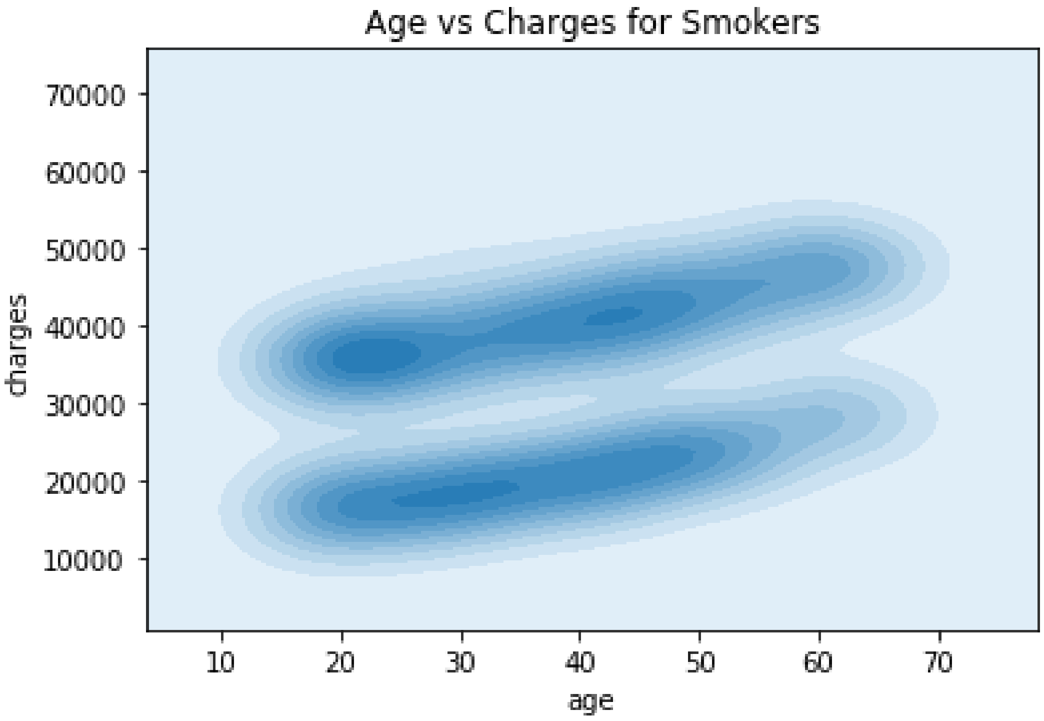
[10]:
```
# Does smoking affect the cost of treatment at age 18?
plt.figure(figsize = (5, 8))
sns.boxplot(x = 'smoker', y = 'charges', data = data[data['age'] == 18])
```

[10]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a16e739e8>
```



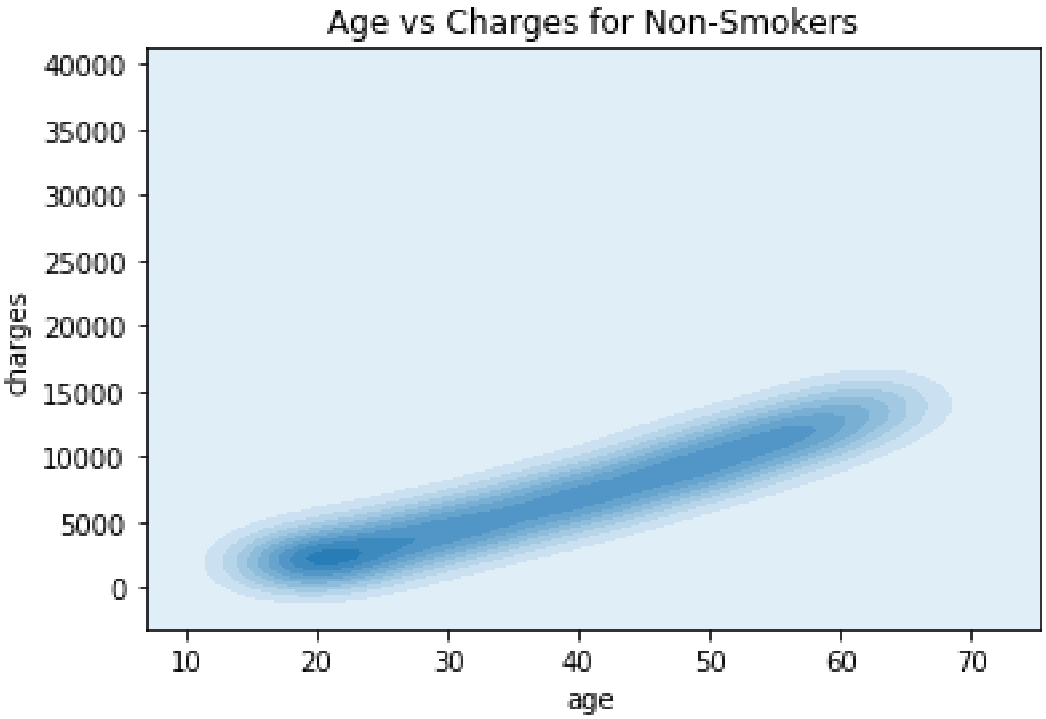
[11]:
```
sns.kdeplot(data[data['smoker'] == 'yes']['age'],data[data['smoker'] ==␣
 ↪'yes']['charges'], shade = True)
plt.title('Age vs Charges for Smokers')
```

[11]:
```
Text(0.5, 1.0, 'Age vs Charges for Smokers')
```



[12]:
```
sns.kdeplot(data[data['smoker'] == 'no']['age'],data[data['smoker'] ==␣
 ↪'no']['charges'], shade = True)
plt.title('Age vs Charges for Non-Smokers')
```

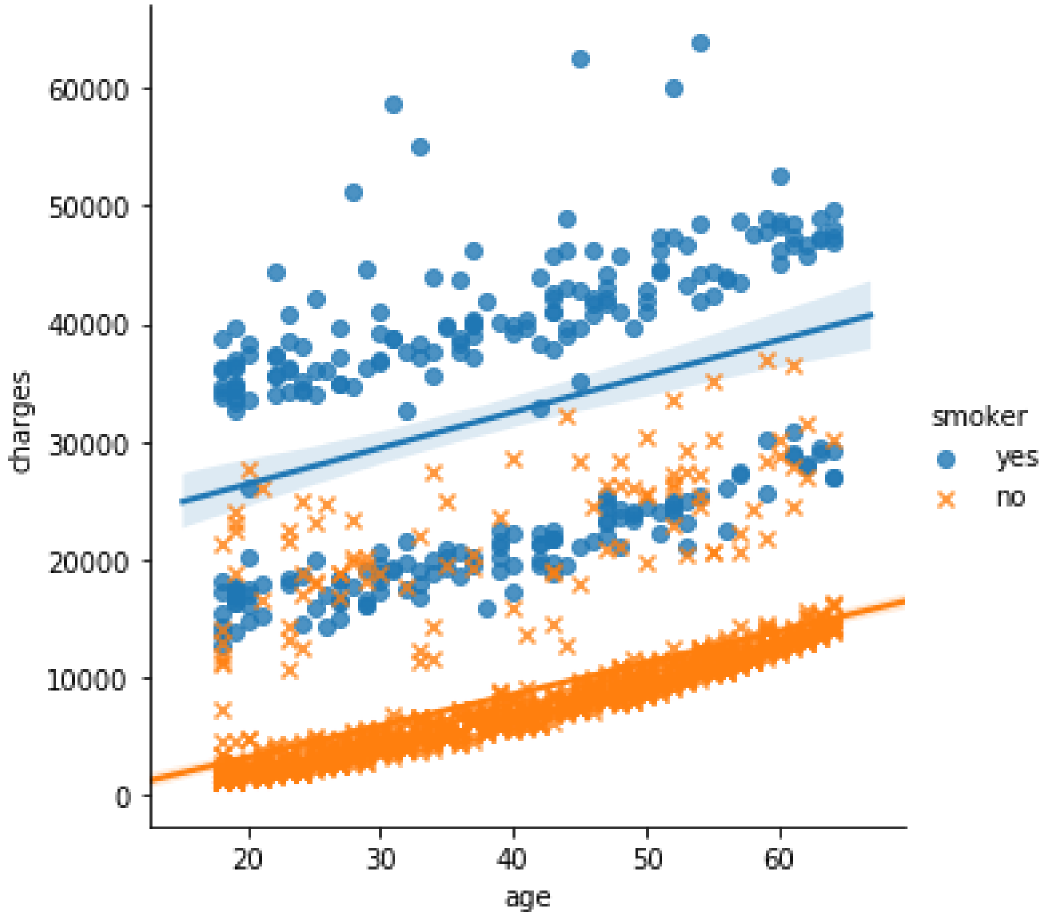
[12]:
```
Text(0.5, 1.0, 'Age vs Charges for Non-Smokers')
```



[14]:
```
plt.figure(figsize=(10,10))
sns.lmplot(x = 'age', y = 'charges', hue = 'smoker', data = data, markers =␣
 ↪['o', 'x'])
```

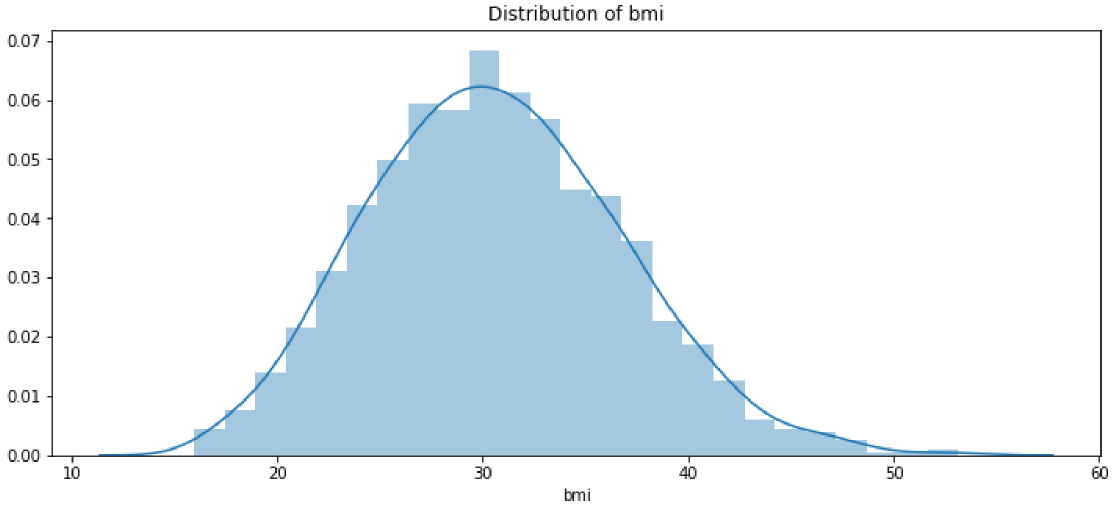
[14]:
```
<seaborn.axisgrid.FacetGrid at 0x1a176114e0>
```

```
<Figure size 720x720 with 0 Axes>
```



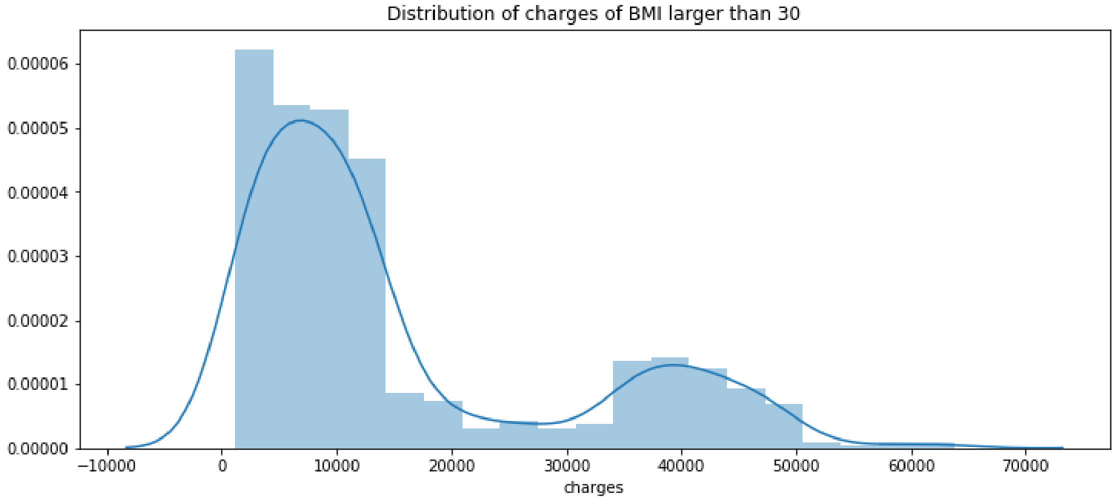
[17]:

```
### bmi distribution
plt.figure(figsize=(12,5))
plt.title("Distribution of bmi")
ax = sns.distplot(data["bmi"])
```



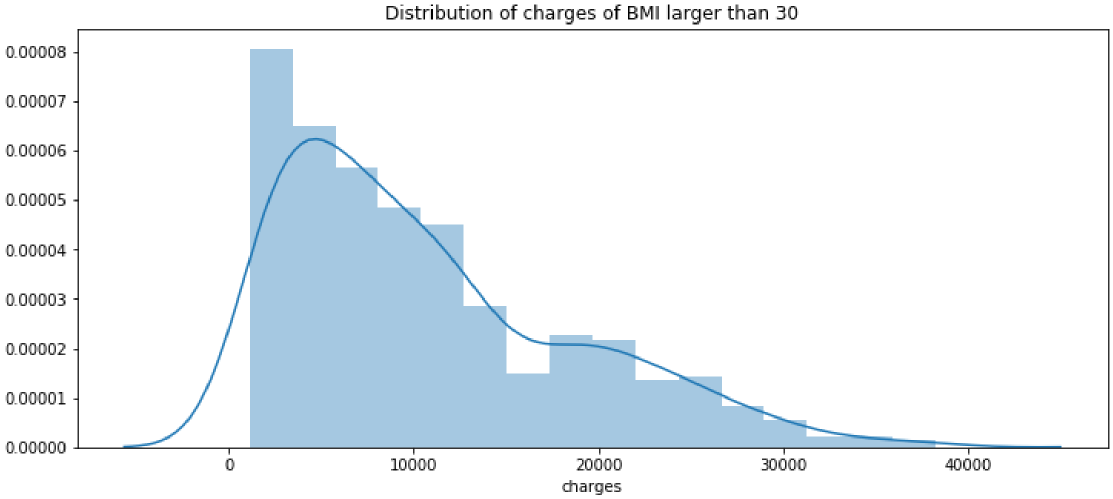
[19]:
```
### bmi score of 30 is a cutoff point
plt.figure(figsize = (12, 5))
plt.title('Distribution of charges of BMI larger than 30')
sns.distplot(data[data['bmi'] >= 30]['charges'])
```

[19]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a19252e80>
```



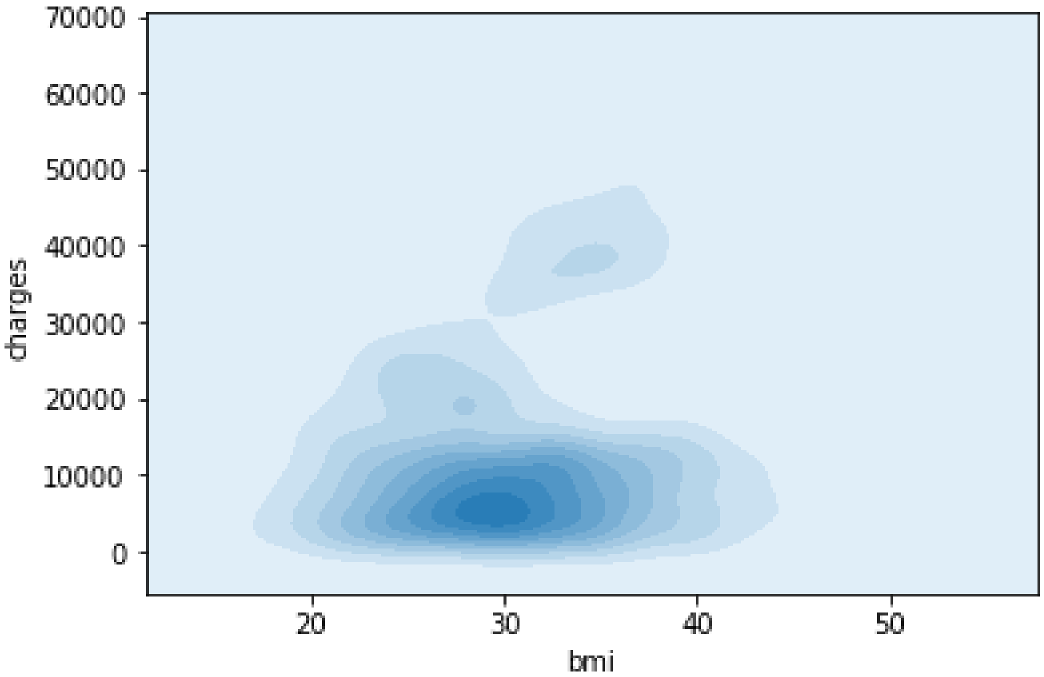
[20]:
```
plt.figure(figsize = (12, 5))
plt.title('Distribution of charges of BMI smaller than 30')
sns.distplot(data[data['bmi'] < 30]['charges'])
```

[20]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a18c39c50>
```



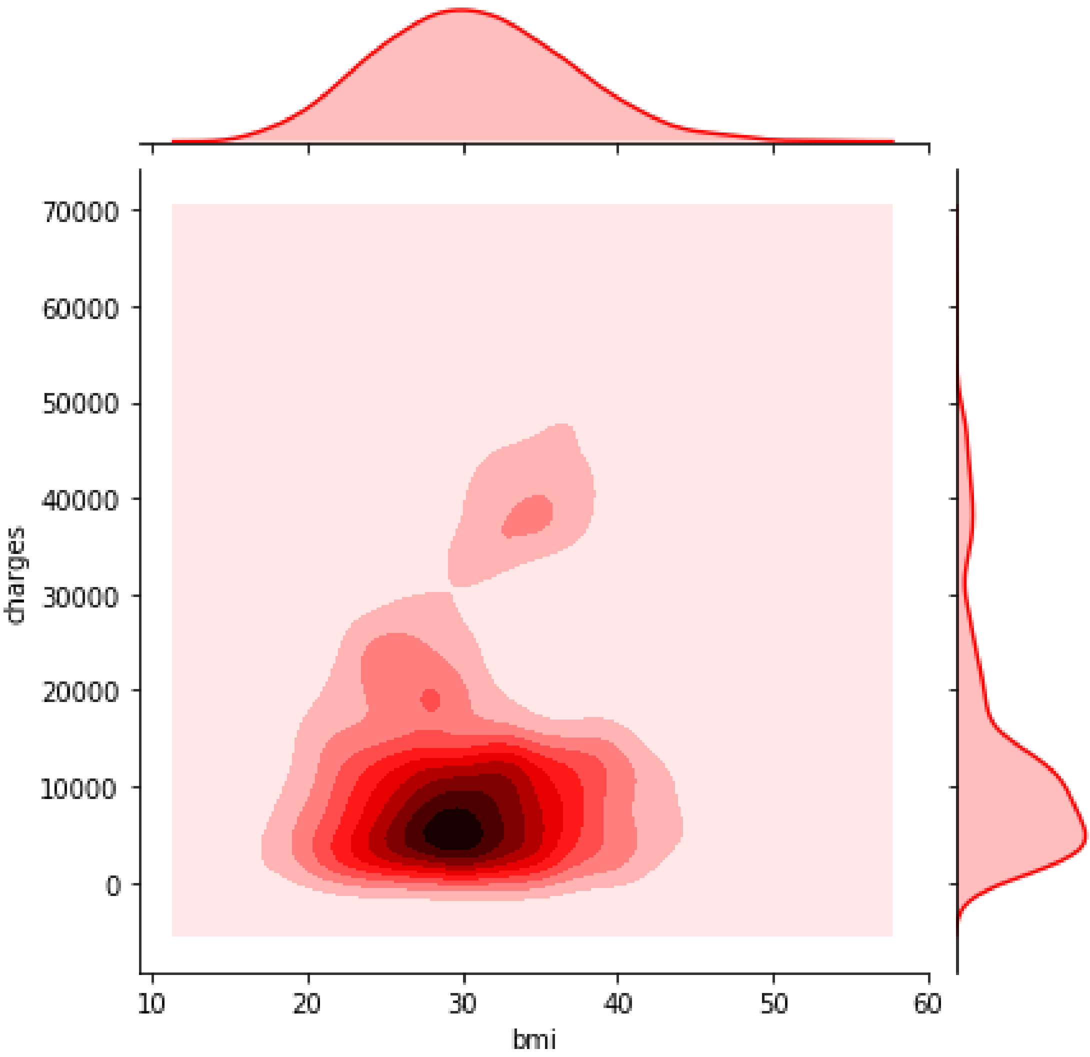
```
[23]: sns.kdeplot(data['bmi'], data['charges'], shade = True)
```

```
[23]: <matplotlib.axes._subplots.AxesSubplot at 0x1a18d0aef0>
```



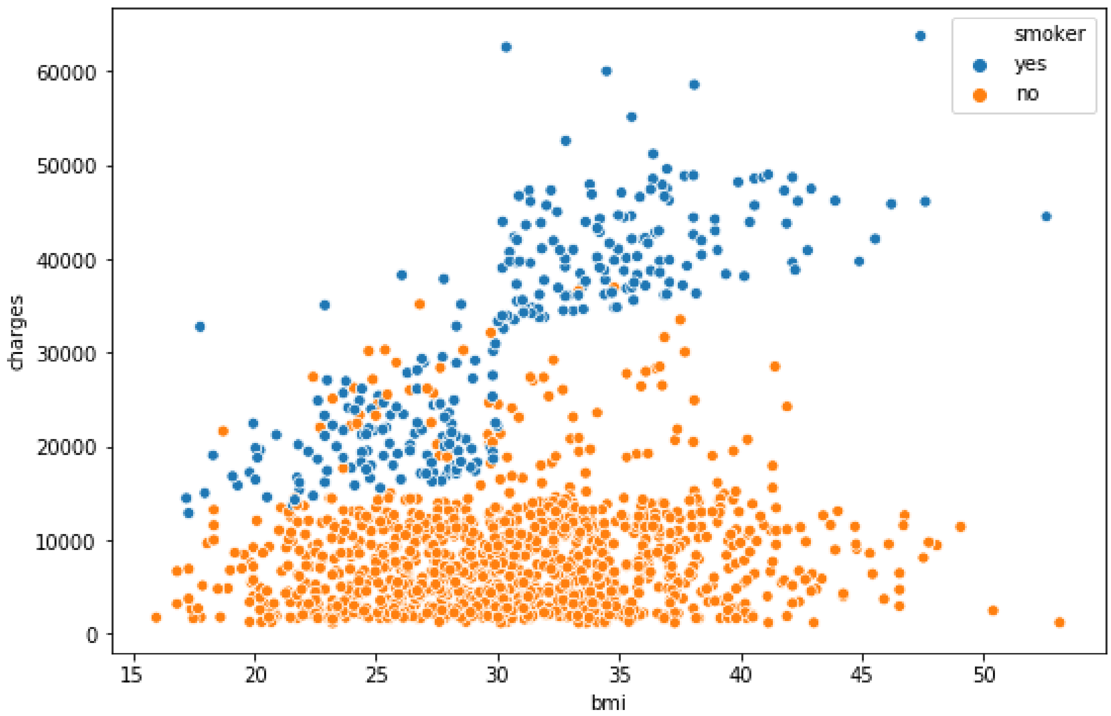
```
[24]: sns.jointplot(x="bmi", y="charges", data = data,kind="kde", color="r")
```

```
[24]: <seaborn.axisgrid.JointGrid at 0x1a190243c8>
```



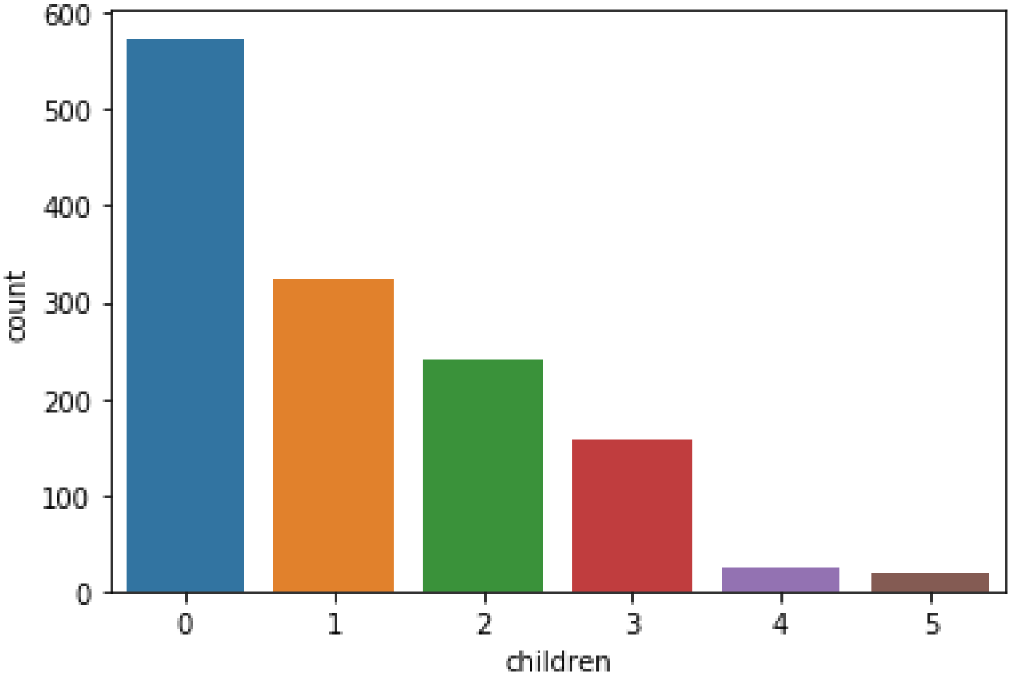
[27]:
```
### bmi score vs charges smoker and non-smoker
plt.figure(figsize = (9, 6))
sns.scatterplot(x = 'bmi', y = 'charges', hue = 'smoker', data = data)
```

[27]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a197bfd30>
```



[29]:
```
sns.countplot(data['children'])
```

[29]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a19b314e0>
```

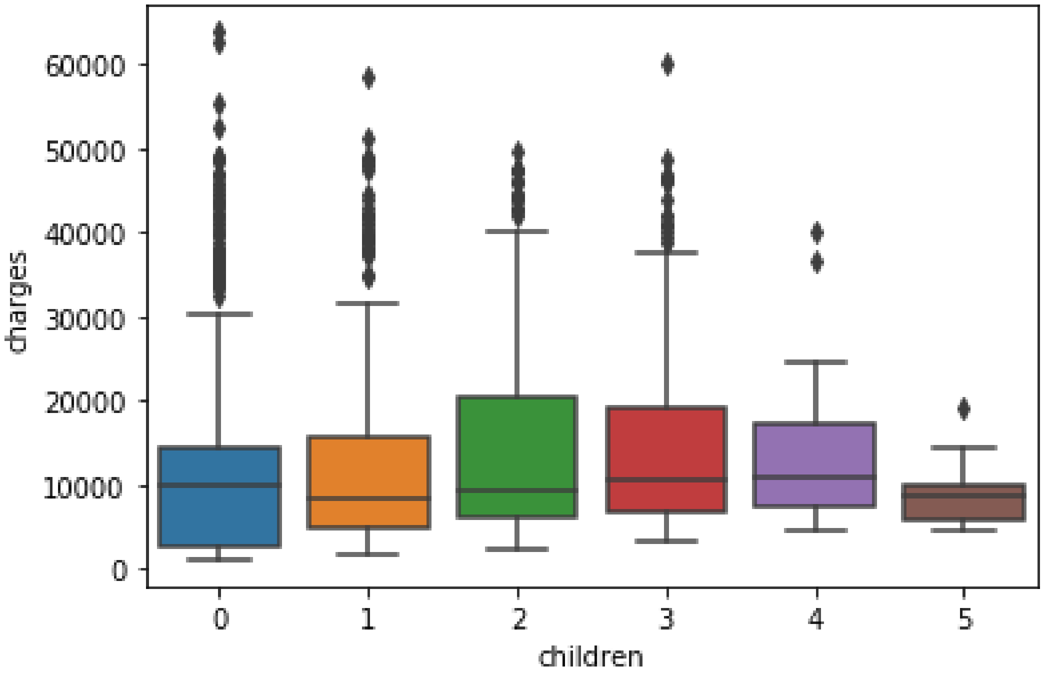


[30]:

```
sns.boxplot(x = 'children', y = 'charges', data = data)
```

[30]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a1a3b2908>
```

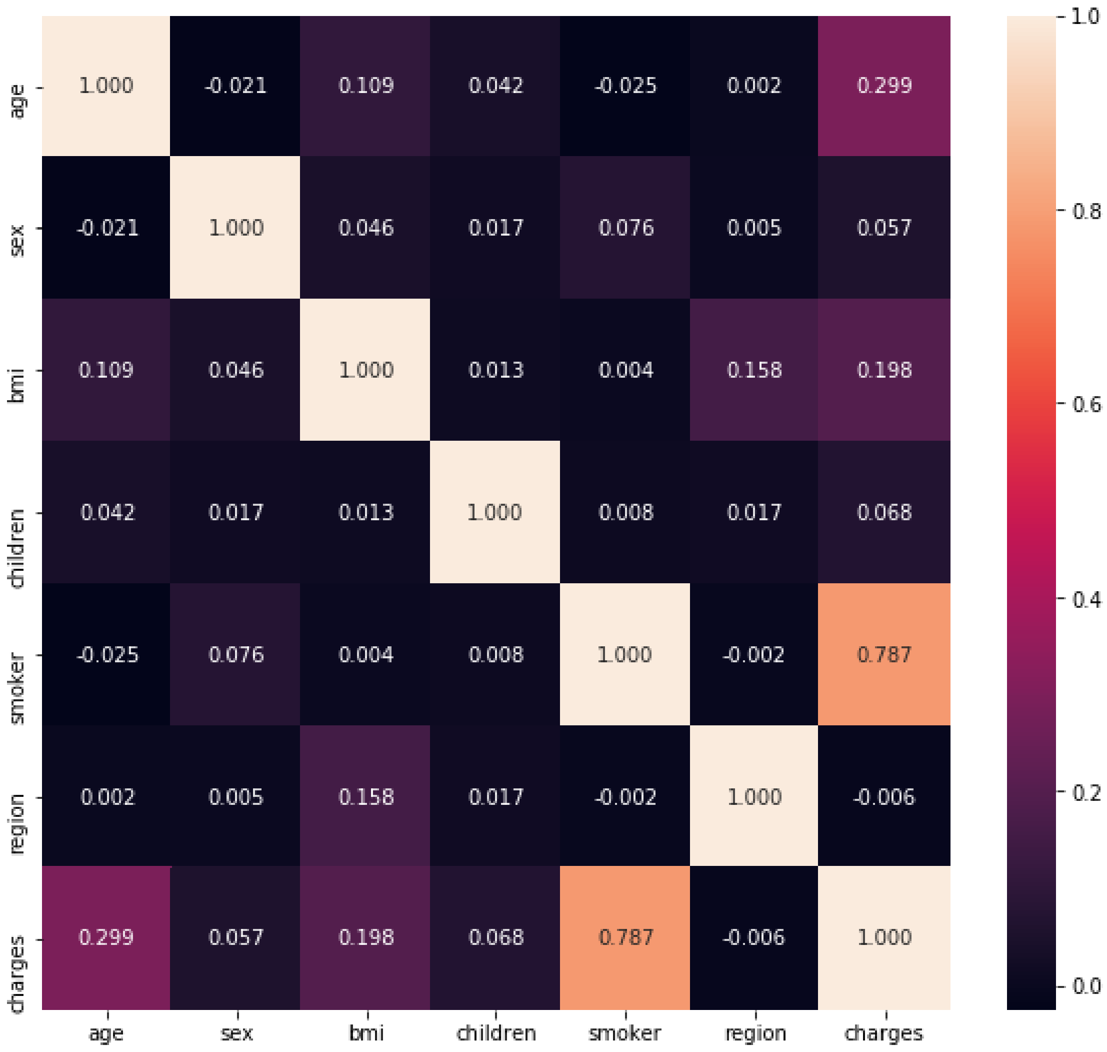


[31]:

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
le.fit(data.sex)
data['sex'] = le.transform(data['sex'])

le.fit(data.smoker)
data.smoker = le.transform(data.smoker)

le.fit(data.region)
data.region = le.transform(data.region)

plt.figure(figsize = (10, 9))
sns.heatmap(data.corr(),annot = True, fmt = '.3f')
```

[31]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a1a1d7a20>
```



[32]:

```
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import PolynomialFeatures
from sklearn.metrics import r2_score,mean_squared_error
from sklearn.ensemble import RandomForestRegressor
```

[42]:

```
X = data.drop(['charges'], axis = 1)
y = data['charges']

X_train, X_test, y_train, y_test = train_test_split(X, y, random_state = 0)
```

[45]:

```
lr = LinearRegression()
lr.fit(X_train, y_train)
y_pred = lr.predict(X_test)
print('r2 train:',lr.score(X_train, y_train))
print('r2 test:',lr.score(X_test, y_test))
print(mean_squared_error(y_test, y_pred))
```

```
r2 train: 0.7337162219022217
r2 test: 0.7962732059725786
32073628.56010921
```

[46]:

```
n = list(range(2, 6))
r2_train = []
r2_test = []
mse = []
for i in range(2, 6):
    quad = PolynomialFeatures(degree = i)
    x_quad = quad.fit_transform(X)
    X_train, X_test, y_train, y_test = train_test_split(x_quad,y, random_state␣
 ↪= 0)

    plr = LinearRegression()
    plr.fit(X_train, y_train)

    y_pred = plr.predict(X_test)
    r2_train.append(plr.score(X_train, y_train))
    r2_test.append(plr.score(X_test,y_test))
    mse.append(mean_squared_error(y_test, y_pred))
result = pd.DataFrame(np.column_stack([n, r2_train, r2_test, mse]),
                               columns=['Degree', 'train Rsquared', 'test␣
 ↪Rsquared', 'Mse'])
result
```

[46]:

```
   Degree  train Rsquared  test Rsquared           Mse
0     2.0        0.831481       0.884628  1.816348e+07
1     3.0        0.841715       0.879056  1.904082e+07
2     4.0        0.856473       0.857891  2.237286e+07
3     5.0        0.884269       0.781857  3.434326e+07
```

[65]:

```
X = data.drop(['charges'], axis = 1)
y = data['charges']

X_train, X_test, y_train, y_test = train_test_split(X, y, random_state = 0)
```

[73]:

```
rf  = RandomForestRegressor(oob_score = True, random_state = 1, criterion= 'mse')
rf.fit(X_train, y_train)

y_pred = rf.predict(X_test)

print(r2_score(y_test, y_pred))
print(mean_squared_error(y_test, y_pred))
```

```
0.8707069513939738
20355188.114508193
```

[61]:

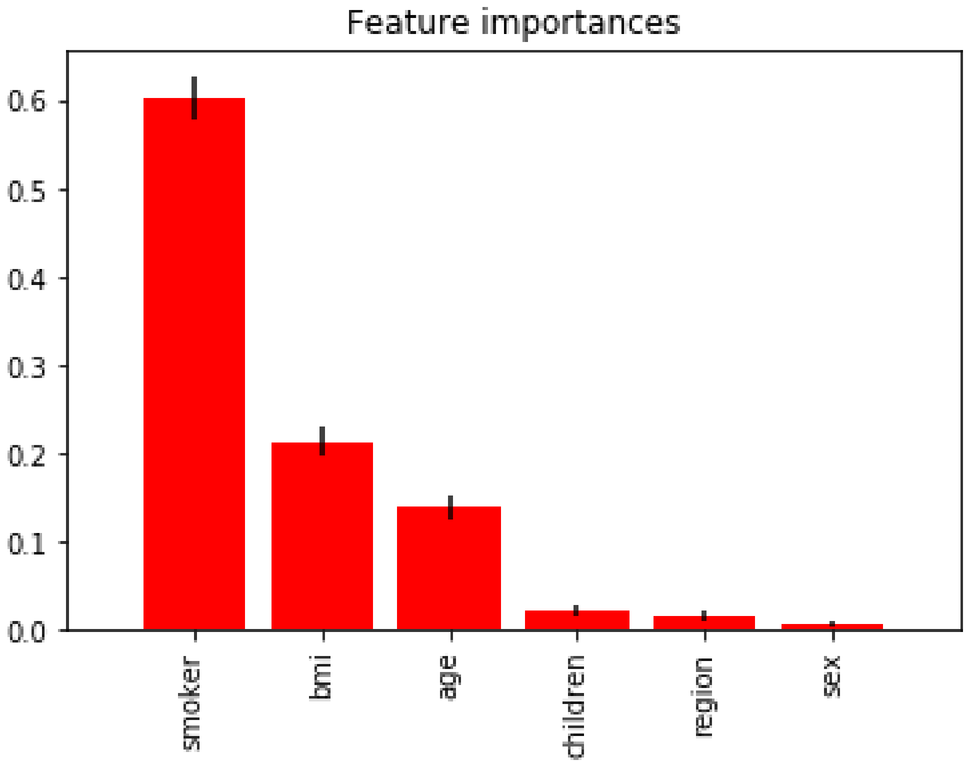
```
#print(rf.oob_score_)
```

```
     ␣
↪---------------------------------------------------------------------------

       AttributeError                            Traceback (most recent call␣
↪last)

       <ipython-input-61-07119920495b> in <module>
   ----> 1 print(rf.oob_score_)


       AttributeError: 'RandomForestRegressor' object has no attribute␣
↪'oob_score_'
```

[51]:

```
importances = rf.feature_importances_
std = np.std([tree.feature_importances_ for tree in rf.estimators_],
             axis=0)
indices = np.argsort(importances)[::-1]

# Print the feature ranking
print("Feature ranking:")

for f in range(X.shape[1]):
    print("%d. feature %d (%f)" % (f + 1, indices[f], importances[indices[f]]))

# Plot the feature importances of the forest
plt.figure()
plt.title("Feature importances")
plt.bar(range(X.shape[1]), importances[indices],
       color="r", yerr=std[indices], align="center")

plt.xticks(range(X_train.shape[1]), X.columns[indices],rotation=90)

plt.xlim([-1, X.shape[1]])
plt.show()
```

```
Feature ranking:
1. feature 4 (0.603241)
2. feature 2 (0.213779)
3. feature 0 (0.138449)
4. feature 3 (0.021509)
5. feature 5 (0.016149)
6. feature 1 (0.006872)
```


Feature importances
0.6
0.5
0.4
0.3
0.2
0.1
0.0
smoker
bmi
age
children
region
sex