In [2]:

```
#importing useful libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.stats.stats import pearsonr
from scipy.stats import chi2_contingency
from scipy.stats import chi2
```

In [3]:

```
#importing and loading the dataset
data = pd.read_csv('insurance.csv')
data = data.drop(columns = ['Unnamed: 7','Unnamed: 8'])
data
```

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

In [4]:

```
#statistical summary of the data
data.describe()
```

Out[4]:

	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 [7]:

```
#Average charge for smokers vs non smokers
mean_charges_by_smoker = data[['smoker','charges']].groupby('smoker').mean().reset_index()
mean_charges_by_smoker.rename(columns = {'charges':'average_charge'},inplace= True)
smoker_to_non_smoker_ratio = round(mean_charges_by_smoker['average_charge'][1]/mean_charges_by_smoker['average_charge'][0],2)
print("The average medical insurance charge on a smoker is",smoker_to_non_smoker_ratio*100,'%','higher than the charge on a non-smoker')
```

```
The average medical insurance charge on a smoker is 380.0 % higher than the charge on a non-smoker
```

In [6]:

```
mean_charges_by_smoker
```

Out[6]:

	smoker	average_charge
0	no	8434.268298
1	yes	32050.231832

In [8]:

```
#choosing the bins to divide the age values
bins_age = np.arange(17,68,4)
```

In [11]:

```
#viewing the average charges per age bin
mean_charges_by_age = data['charges'].groupby([pd.cut(data['age'],bins_age)]).mean().reset_index()
mean_charges_by_age
```

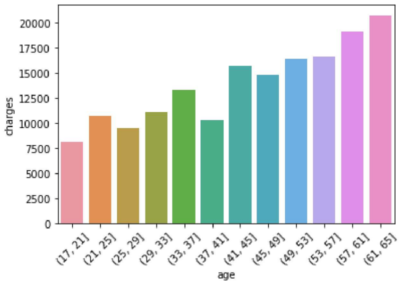
Out[11]:

	age	charges
0	(17, 21]	8138.613823
1	(21, 25]	10729.783529
2	(25, 29]	9445.678327
3	(29, 33]	11128.321890
4	(33, 37]	13269.712696
5	(37, 41]	10341.599360
6	(41, 45]	15737.673376
7	(45, 49]	14849.841783
8	(49, 53]	16408.959990
9	(53, 57]	16639.695399
10	(57, 61]	19077.698872
11	(61, 65]	20738.019768

In [13]:

```
#plotting the average charges per age bin
ax = sns.barplot(mean_charges_by_age['age'],mean_charges_by_age['charges'])
plt.xticks(rotation=45)
sns.color_palette('Set3')
plt.show()
```

```
C:\Users\ahmad\Anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the only valid positional arg
ument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```



In [16]:

```
#Grouping the age bins dataframe by smoker/non-smoker to see how much smokers and non-smokers are charged in each age group
mean_charges_by_age_smoker = data[['charges','smoker']].groupby([pd.cut(data['age'],bins_age),'smoker']).mean().reset_index()
mean_charges_by_age_smoker
```

Out[16]:

	age	smoker	charges
0	(17, 21]	no	3481.790476
1	(17, 21]	yes	25516.515581
2	(21, 25]	no	4911.724120
3	(21, 25]	yes	32062.668026
4	(25, 29]	no	5528.893702
5	(25, 29]	yes	26231.898146
6	(29, 33]	no	5471.080786
7	(29, 33]	yes	29457.783069
8	(33, 37]	no	6884.260747
9	(33, 37]	yes	32681.486620
10	(37, 41]	no	7363.154064
11	(37, 41]	yes	28013.708110
12	(41, 45]	no	8831.540882
13	(41, 45]	yes	33337.172312
14	(45, 49]	no	10269.743509
15	(45, 49]	yes	32216.047740
16	(49, 53]	no	12163.322155
17	(49, 53]	yes	35413.243634
18	(53, 57]	no	12855.540761
19	(53, 57]	yes	39596.900201
20	(57, 61]	no	14489.773056
21	(57, 61]	yes	42017.327956
22	(61, 65]	no	15100.126400
23	(61, 65]	yes	39061.173212

In [19]:

```
#adding a ratio column of smoker/non-smoker count for each age group
count_charges_by_age_smoker = data[['charges','smoker']].groupby([pd.cut(data['age'],bins_age),'smoker']).count().reset_index()
count_charges_by_age_smoker
i=0
j=1
ratio_age=[]
while i <= 22:
    while j <= 23:
        ratio_age.append(count_charges_by_age_smoker.loc[j]['charges']/count_charges_by_age_smoker.loc[i]['charges'])
        i=i+2
        j=j+2
ratio_full = []
for x in ratio_age:
    ratio_full.extend([x,x])
count_charges_by_age_smoker['smoker_to_none_ratio'] = ratio_full
count_charges_by_age_smoker
```

Out[19]:

	age	smoker	charges	smoker_to_none_ratio
0	(17, 21]	no	153	0.267974
1	(17, 21]	yes	41	0.267974
2	(21, 25]	no	88	0.272727
3	(21, 25]	yes	24	0.272727
4	(25, 29]	no	90	0.233333
5	(25, 29]	yes	21	0.233333
6	(29, 33]	no	81	0.308642
7	(29, 33]	yes	25	0.308642
8	(33, 37]	no	76	0.328947
9	(33, 37]	yes	25	0.328947
10	(37, 41]	no	89	0.168539
11	(37, 41]	yes	15	0.168539
12	(41, 45]	no	79	0.392405
13	(41, 45]	yes	31	0.392405
14	(45, 49]	no	91	0.263736
15	(45, 49]	yes	24	0.263736
16	(49, 53]	no	94	0.223404
17	(49, 53]	yes	21	0.223404
18	(53, 57]	no	91	0.164835
19	(53, 57]	yes	15	0.164835
20	(57, 61]	no	80	0.200000
21	(57, 61]	yes	16	0.200000
22	(61, 65]	no	52	0.307692

	age	smoker	charges	smoker_to_none_ratio
23	(61, 65]	yes	16	0.307692

In [21]:

```
#viewing average charges by gender
mean_charges_by_gender = data[['sex','charges']].groupby('sex').mean().reset_index()
mean_charges_by_gender
```

Out[21]:

	sex	charges
0	female	12569.578844
1	male	13956.751178

In [22]:

```
#Choosing bins for bmi values
bins_bmi = np.arange(15,57,3)
```

In [24]:

```
#dataframe showing average charges for each bmi range
mean_charges_by_bmi = data['charges'].groupby(pd.cut(data['bmi'],bins_bmi,'charges')).mean().reset_index()
mean_charges_by_bmi
```

Out[24]:

	bmi	charges
0	(15, 18]	7576.420217
1	(18, 21]	8687.396745
2	(21, 24]	10202.868942
3	(24, 27]	11335.007019
4	(27, 30]	11080.205884
5	(30, 33]	14372.889428
6	(33, 36]	15213.030909
7	(36, 39]	18431.374551
8	(39, 42]	14270.362134
9	(42, 45]	17238.756989
10	(45, 48]	18802.757881
11	(48, 51]	7750.768633
12	(51, 54]	22832.430450

In [26]:

```
#factoring in the smoker variable to each bmi range
mean_charges_by_bmi_smoker = data[['charges','smoker']].groupby([pd.cut(data['bmi'],bins_bmi),'smoker']).mean().reset_index()
mean_charges_by_bmi_smoker
```

Out[26]:

	bmi	smoker	charges
0	(15, 18]	no	3510.948941
1	(15, 18]	yes	18756.466225
2	(18, 21]	no	5897.926360
3	(18, 21]	yes	18323.748982
4	(21, 24]	no	7680.709710
5	(21, 24]	yes	20190.619498
6	(24, 27]	no	8496.093121
7	(24, 27]	yes	22136.728189
8	(27, 30]	no	8335.932055
9	(27, 30]	yes	22225.317963
10	(30, 33]	no	8675.168894
11	(30, 33]	yes	39517.177869
12	(33, 36]	no	8329.171368
13	(33, 36]	yes	40945.553477
14	(36, 39]	no	10409.321868
15	(36, 39]	yes	43249.600038
16	(39, 42]	no	9188.283437
17	(39, 42]	yes	44762.834314
18	(42, 45]	no	7257.240113
19	(42, 45]	yes	43440.238787
20	(45, 48]	no	7652.908055
21	(45, 48]	yes	49464.844903
22	(48, 51]	no	7750.768633
23	(48, 51]	yes	NaN
24	(51, 54]	no	1163.462700
25	(51, 54]	yes	44501.398200

In [27]:

```
#adding the proportion of smokers for each bmi range
count_charges_by_bmi_smoker = data[['charges','smoker']].groupby([pd.cut(data['bmi'],bins_bmi),'smoker']).agg('count').reset_index()
i=0
j=1
ratio=[]
while i <= 24:
    while j <= 25:
        ratio.append(count_charges_by_bmi_smoker.loc[j]['charges']/count_charges_by_bmi_smoker.loc[i]['charges'])
        i=i+2
        j=j+2
ratio_full = []
for x in ratio:
    ratio_full.extend([x,x])
```

In [28]:

```
count_charges_by_bmi_smoker['ratio_smoker_to_none'] = ratio_full
count_charges_by_bmi_smoker
```

Out[28]:

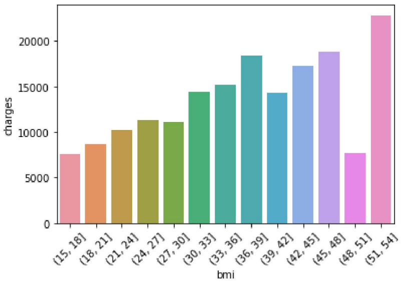
	bmi	smoker	charges	ratio_smoker_to_none
0	(15, 18]	no	11	0.363636

	bmi	smoker	charges	ratio_smoker_to_none
1	(15, 18]	yes	4	0.363636
2	(18, 21]	no	38	0.289474
3	(18, 21]	yes	11	0.289474
4	(21, 24]	no	99	0.252525
5	(21, 24]	yes	25	0.252525
6	(24, 27]	no	156	0.262821
7	(24, 27]	yes	41	0.262821
8	(27, 30]	no	199	0.246231
9	(27, 30]	yes	49	0.246231
10	(30, 33]	no	203	0.226601
11	(30, 33]	yes	46	0.226601
12	(33, 36]	no	157	0.267516
13	(33, 36]	yes	42	0.267516
14	(36, 39]	no	99	0.323232
15	(36, 39]	yes	32	0.323232
16	(39, 42]	no	66	0.166667
17	(39, 42]	yes	11	0.166667
18	(42, 45]	no	21	0.380952
19	(42, 45]	yes	8	0.380952
20	(45, 48]	no	11	0.363636
21	(45, 48]	yes	4	0.363636
22	(48, 51]	no	3	0.000000
23	(48, 51]	yes	0	0.000000
24	(51, 54]	no	1	1.000000
25	(51, 54]	yes	1	1.000000

In [30]:

```
#plotting the average costs for each bmi range
ax = sns.barplot(mean_charges_by_bmi['bmi'],mean_charges_by_bmi['charges'])
plt.xticks(rotation=45)
sns.color_palette('Set3')
plt.show()
```

```
C:\Users\ahmad\Anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the only valid positional arg
ument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```



In [32]:

```
#viewing the average charges for each possible number of children per family
charges_by_children = data[['children','charges']].groupby('children').mean().reset_index()
charges_by_children
```

Out[32]:

	children	charges
0	0	12365.975602
1	1	12731.171832
2	2	15073.563734
3	3	15355.318367
4	4	13850.656311
5	5	8786.035247

In [34]:

```
#finding by how much the southeast region is charged more than the other regions
charges_by_region = data[['region','charges']].groupby('region').mean().reset_index()
average_charge_all_regions = charges_by_region['charges'].mean()
se_to_avg_ratio = charges_by_region['charges'][charges_by_region['region']=='southeast']/average_charge_all_regions
se_to_avg_ratio*100
```

Out[34]:

```
2    111.407594
Name: charges, dtype: float64
```

In [36]:

```
#finding how much are smokers and non-smokers of each age category charged
charges_by_smoker_age = data[['smoker','charges']].groupby([pd.cut(data['age'],bins_age,'charges'),'smoker']).mean().reset_index()
charges_by_smoker_age
```

Out[36]:

	age	smoker	charges
0	(17, 21]	no	3481.790476
1	(17, 21]	yes	25516.515581
2	(21, 25]	no	4911.724120
3	(21, 25]	yes	32062.668026
4	(25, 29]	no	5528.893702
5	(25, 29]	yes	26231.898146
6	(29, 33]	no	5471.080786
7	(29, 33]	yes	29457.783069
8	(33, 37]	no	6884.260747
9	(33, 37]	yes	32681.486620

	age	smoker	charges
10	(37, 41]	no	7363.154064
11	(37, 41]	yes	28013.708110
12	(41, 45]	no	8831.540882
13	(41, 45]	yes	33337.172312
14	(45, 49]	no	10269.743509
15	(45, 49]	yes	32216.047740
16	(49, 53]	no	12163.322155
17	(49, 53]	yes	35413.243634
18	(53, 57]	no	12855.540761
19	(53, 57]	yes	39596.900201
20	(57, 61]	no	14489.773056
21	(57, 61]	yes	42017.327956
22	(61, 65]	no	15100.126400
23	(61, 65]	yes	39061.173212

In [39]:

```
#viewing the proportion of smokers in each region
smokers_by_region = data[['smoker','region']].groupby(['region','smoker']).size().groupby('region').transform(lambda x: x/x.sum()).reset_index()
smokers_by_region.rename(columns = {0:'Proportion'},inplace=True)
smokers_by_region
```

Out[39]:

	region	smoker	Proportion
0	northeast	no	0.793210
1	northeast	yes	0.206790
2	northwest	no	0.821538
3	northwest	yes	0.178462
4	southeast	no	0.750000
5	southeast	yes	0.250000
6	southwest	no	0.821538
7	southwest	yes	0.178462

In [41]:

```
#the average charge across all regions
average_charge_all_regions
```

Out[41]:

```
13226.577176314308
```

In [43]:

```
#the average bmi for every region
average_bmi_by_region = data[['region','bmi']].groupby(['region']).mean().reset_index()
average_bmi_by_region
```

Out[43]:

	region	bmi
0	northeast	29.173503
1	northwest	29.199785
2	southeast	33.355989
3	southwest	30.596615

In [45]:

```
#the male-female proportion of every region
gender_by_region = data[['region','sex']].groupby(['region','sex']).size().groupby('region').transform(lambda x: x/x.sum()).reset_index()
gender_by_region.rename(columns = {0:'Proportion'},inplace=True)
gender_by_region
```

Out[45]:

	region	sex	Proportion
0	northeast	female	0.496914
1	northeast	male	0.503086
2	northwest	female	0.504615
3	northwest	male	0.495385
4	southeast	female	0.480769
5	southeast	male	0.519231
6	southwest	female	0.498462
7	southwest	male	0.501538

In [47]:

```
#the number of occurences of each possible number of children in every region
children_by_region = data[['children','region']].groupby(['children','region']).size().reset_index()
children_by_region.rename(columns = {0:'#children'},inplace=True)
children_by_region
```

Out[47]:

	children	region	#children
0	0	northeast	147
1	0	northwest	132
2	0	southeast	157
3	0	southwest	138
4	1	northeast	77
5	1	northwest	74
6	1	southeast	95
7	1	southwest	78
8	2	northeast	51
9	2	northwest	66
10	2	southeast	66
11	2	southwest	57
12	3	northeast	39
13	3	northwest	46
14	3	southeast	35

	children	region	#children
15	3	southwest	37
16	4	northeast	7
17	4	northwest	6
18	4	southeast	5
19	4	southwest	7
20	5	northeast	3
21	5	northwest	1
22	5	southeast	6
23	5	southwest	8

In [49]:

```
#the average age of people from every region
age_by_region = data[['region','age']].groupby(['region']).mean().reset_index()
age_by_region
```

Out[49]:

	region	age
0	northeast	39.268519
1	northwest	39.196923
2	southeast	38.939560
3	southwest	39.455385

In [50]:

```
#splitting the main dataset into 4 based on the region
southwest_data = data[data['region'] == 'southwest']
southeast_data = data[data['region'] == 'southeast']
northwest_data = data[data['region'] == 'northwest']
northeast_data = data[data['region'] == 'northeast']
```

In [52]:

```
#replacing the 'yes' and 'no' values in the smoker column with a 1 for 'yes' and 0 otherwise
southeast_data['smoker'] = southeast_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
northeast_data['smoker'] = northeast_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
southwest_data['smoker'] = southwest_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
northwest_data['smoker'] = northwest_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
```

```
C:\Users\ahmad\AppData\Local\Temp/ipykernel_10740/2048862593.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  southeast_data['smoker'] = southeast_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
C:\Users\ahmad\AppData\Local\Temp/ipykernel_10740/2048862593.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  northeast_data['smoker'] = northeast_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
C:\Users\ahmad\AppData\Local\Temp/ipykernel_10740/2048862593.py:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  southwest_data['smoker'] = southwest_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
C:\Users\ahmad\AppData\Local\Temp/ipykernel_10740/2048862593.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  northwest_data['smoker'] = northwest_data['smoker'].apply(lambda x: int(1) if x == 'yes' else int(0))
```

In [ ]:

```
corr_heatmap_SW = sns.heatmap(southwest_data.corr())
```

In [ ]:

```
corr_heatmap_SE = sns.heatmap(southeast_data.corr())
```

In [ ]:

```
corr_heatmap_NW = sns.heatmap(northwest_data.corr())
```

Similar to the NW region, age has the highest correlation to charges.

In [ ]:

```
corr_heatmap_NE = sns.heatmap(northeast_data.corr())
```

In the northeast, southeast and southwest regions, the average medical insurance charges is highly correlated with whether the person is a smoker or not. The correlation factor across all regions is around 0.8. Smoking is the highest correlated predictor variable to insurance charges. Then, the 2nd and 3rd predictor variables with the highest correlation factor are age and bmi, respectively, with values between 0.3 and 0.4.

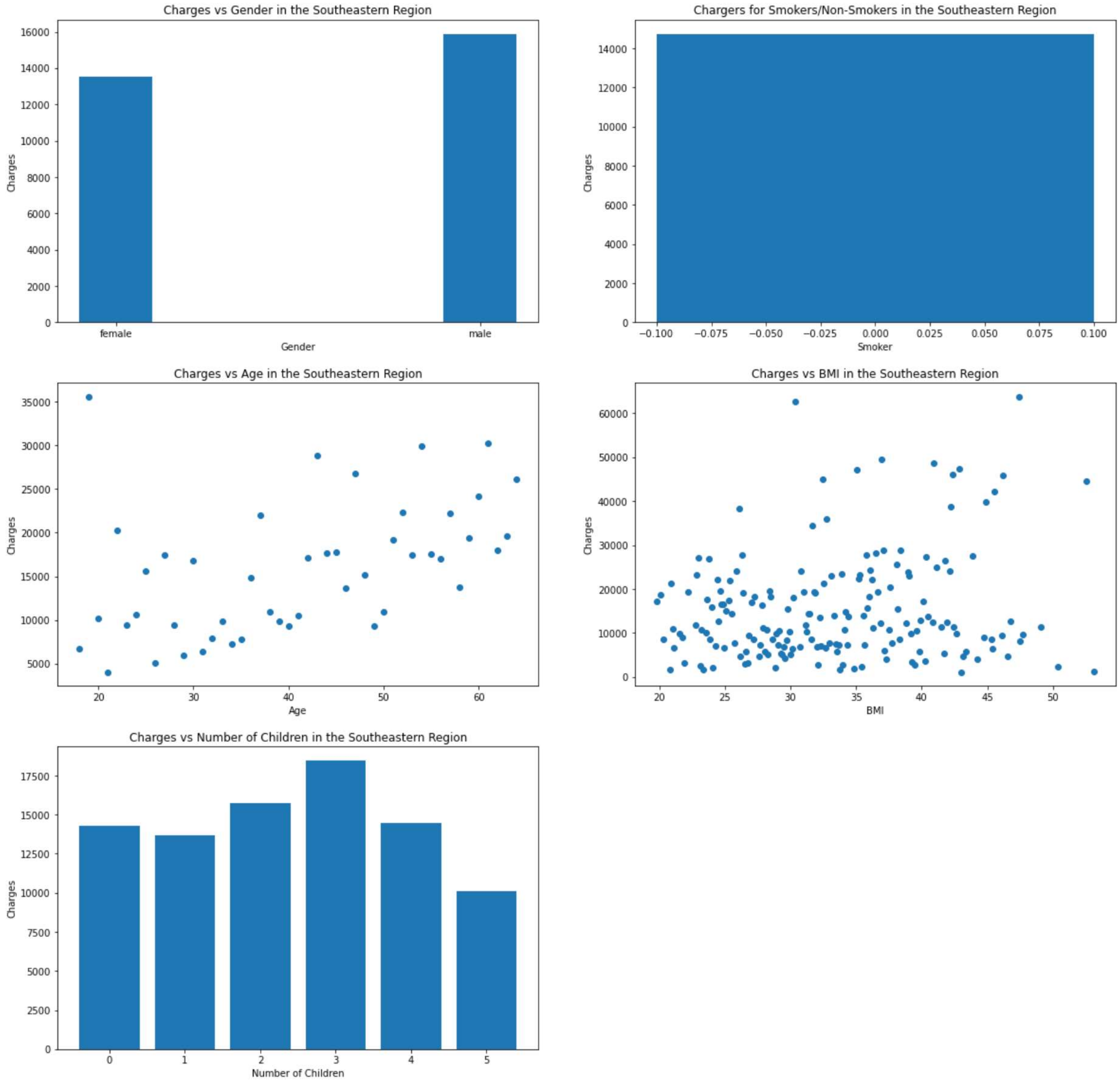
In [55]:

```
SE_by_sex = southeast_data[['charges','sex']].groupby(['sex']).mean().reset_index()
SE_by_age = southeast_data[['charges','age']].groupby('age').mean().reset_index()
SE_by_bmi = southeast_data[['charges','bmi']].groupby('bmi').mean().reset_index()
SE_by_children = southeast_data[['charges','children']].groupby(['children']).mean().reset_index()
SE_by_smoker = southeast_data[['charges','smoker']].groupby(['smoker']).mean().reset_index()
```

In [56]:

```
fig,axs = plt.subplots(3,2,figsize=(20,20))

axs[0,0].bar(SE_by_sex['sex'],SE_by_sex['charges'],width=0.2)
plt.ylim(0,20000)
plt.yticks(np.arange(0,20000,2500))
axs[0,0].title.set_text('Charges vs Gender in the Southeastern Region')
axs[0,0].set_xlabel('Gender')
axs[0,0].set_ylabel('Charges')

axs[0,1].bar(SE_by_smoker['smoker'],SE_by_smoker['charges'],width=0.2)
plt.ylim(0,45000)
plt.yticks(np.arange(0,45000,10000))
axs[0,1].title.set_text('Chargers for Smokers/Non-Smokers in the Southeastern Region')
axs[0,1].set_xlabel('Smoker')
axs[0,1].set_ylabel('Charges')


axs[1,0].scatter(SE_by_age['age'],SE_by_age['charges'])
axs[1,0].title.set_text('Charges vs Age in the Southeastern Region')
axs[1,0].set_xlabel('Age')
axs[1,0].set_ylabel('Charges')


axs[1,1].scatter(SE_by_bmi['bmi'],SE_by_bmi['charges'])
axs[1,1].title.set_text('Charges vs BMI in the Southeastern Region')
axs[1,1].set_xlabel('BMI')
axs[1,1].set_ylabel('Charges')
```

```
fig.delaxes(axs[2,1])

axs[2,0].bar(SE_by_children['children'],SE_by_children['charges'])
axs[2,0].title.set_text('Charges vs Number of Children in the Southeastern Region')
axs[2,0].set_xlabel('Number of Children')
axs[2,0].set_ylabel('Charges')


plt.show()
```



Statistical tests to test the significance of the relationships between variables

In [57]:

```
pearsonr(SE_by_age['age'],SE_by_age['charges'])
```

Out[57]:

```
(0.46687712914098806, 0.0009389122764438713)
```

In [58]:

```
pearsonr(SE_by_children['children'],SE_by_children['charges'])
```

Out[58]:

```
(-0.3134838254333364, 0.5451776201513118)
```

In [59]:

```
pearsonr(SE_by_bmi['bmi'],SE_by_bmi['charges'])
```

Out[59]:

```
(0.1843348339553679, 0.01377215043777106)
```

In [60]:

```
SE_by_sex
```

Out[60]:

	sex	charges
0	female	13499.669243
1	male	15879.617173

In [61]:

```
SE_by_smoker
```

Out[61]:

	smoker	charges
0	0	14735.411438

Insights:

1 - Smokers are charged more for insurance across all regions. the average charge on a smoker is 380% higher than the average charge on a non-smoker.

2 - Generally, older people are charged more for medical insurance. However, the age range of 37-41 does not follow the trend. People in this age range are charged less compared to the people who are older than them. We can explain why the age group of 37-41 has a reasonably low insurance cost and that's because it has less than half the proportion of smokers compared to the age ranges right below or above it. This is why the insurance cost seriously dropped for that range and it doesn't align with the trend. Again we witness the significance of the smoker effect on the insurance costs.

3 - Males are charged more on average compared to females.

4 - The general trend is that medical insurance charges increase with BMI. However, there is one BMI range that had an average of charges equivalent to the lowest one and that is the BMI range of 48-51. Digging deeper into the dataset, we see that there are only 3 people in the bmi range of 48-51 and none of them are smokers. This is what dropped the insurance cost. In contrast,the people with bmi in the range of 36-39 are more likely to be smokers. the proportion of smokers in that bmi range is considerably higher than the proportions in the near bmi ranges. Which is why there is a peak in insurance cost at that bmi range. As for the bmi range of 48-51, there are only 2 people in that range and one of which is a smoker. that's why the average cost is high for that bin. Smoking has a significant effect on insurance cost in general.

5 - We can see that having more than 4 children drops the insurance cost by a reasonable amount while having 2 or 3 children will result in the same cost. Having 1 or 0 children result in very similar costs as well. The trend is that insurance costs rise with the number of children until the latter exceeds 3; then it becomes cheaper.

6 - The average medical insurance charges in the southeast region is 111.4% higher than the average across all four regions. Both the northwest and southwest regions have below average medical insurance costs while the charges in the northeast are slightly above higher albeit nowhere near as high as the charges in the southeast region.

7 - The southeast region has the highest proportion of smokers which is one of the reasons why the average insurance cost there is the highest compared to other regions.

8 - The southeast region also has the highest average bmi of all regions which is in the range of 33-36. Based on the average charges per BMI range, the 33-36 BMI range is charged 15,213$ on average while the 27-30 and 30-33 ranges are charged anywhere between 11,000 and 14,372 (the other 3 regions). This also relates to the aforementioned fact that the southeast region has the highest proportion of smokers.

9 - The southeast region has a slightly higher proportion of males which also raises the cost of insurance a bit; but not that significantly.

10 - The age spread across the regions is very similar so the age isn't really playing a role in increasing insurance costs in the southeast region.

11 - The southeast region has the highest number of families with 0-2 children which increases the insurance cost as mentioned earlier. Families with up to 3 children pay more insurance compared to families with 4 or more.

12 - In the northeast, southeast and southwest regions, the average medical insurance charges is highly correlated with whether the person is a smoker or not. The correlation factor across all regions is around 0.8. Smoking is the highest correlated predictor variable to insurance charges. Then, the 2nd and 3rd predictor variables with the highest correlation factor are age and bmi, respectively, with values between 0.3 and 0.4.

13 - BMI and age have a significant effect on the charges (low p-value) while the number of children does not.

14 - In summary, what explains the higher cost of insurance in the southeast region compared to the other 3 regions is it's high proportion of smokers and high average bmi. The average number of children in the southeast also raises the charge but the effect is moderately significant. the correlation between bmi/smokers and charges is the highest of all predictor variables.