Topic: US.Regional Analysis of Medical Insurance cost

```
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Course: CISD41 Introduction to Data Science
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Data Source: Kaggle.com
```

- link (['kaggle kernels output mariapushkareva/medical-insurance-cost-with-linear-regression -p /path/to/dest'])

Purpose

- Medical Insurance is an important expenditure throughout individual's life. This will enhance individual's knowledge of United States Medical Insurance charges and related economic information.
- Learn Python data analysis tools.

Overview

```
Importing Data
Cleaning and Organizing the Data
Descriptive Statistic
Correlation
Pivot tables
Functions
Data Visualization
Quantitative Data Exploratory
Correlation, Coefficients, P-values
Testing Hypothesis, ANOVA
Chisquare, ANOVA, Normal-test, Z-test, Pearson Correlation
Summary and Conclusion
References
```

Attributes

Many factors that affect how much you pay for health insurance are not within your control. Nonetheless, it's good to have an understanding of what they are. Here are some factors that affect how much health insurance premiums cost

- Age: age of primary beneficiary
- Sex: Beneficiary gender, female = 1, male = 0
- Bmi: Body mass index, providing an understanding of body, weights that are relatively high or low relative to height, objective index of body weight (kg / m ^ 2) using the ratio of height to weight, ideally 18.5 to 24.9

- Children: Number of children covered by health insurance / Number of dependents
- Smoker: Smoking if person(Beneficiary) smokes its 1 and if person don't smoke its 0
- Region: The beneficiary's residential area in the US, northeast, southeast, southwest, northwest
- Charges: cost of Insurance In dollars per year.

IMPORTING DATA

In [1]:
```
#importing modules
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import plotly.express as px
import cufflinks as cf
import plotly.graph_objs as go
from plotly.offline import download_plotlyjs, init_notebook_mode,iplot,iplot
import scipy.stats as st
from scipy import stats
from scipy.stats import normaltest
from statsmodels.stats.weightstats import ztest
import seaborn as sns
from scipy.stats import norm
%matplotlib inline
init_notebook_mode(connected = True)
cf.go_offline()
```

In [2]:
```
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)
warnings.filterwarnings('ignore')
```

In [3]:
```
#let's load the data and save it into df dataframe.
df = pd.read_csv("data\insurance.csv")
```

In [4]:
```
#showing the head of the dataframe
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]:
```
#showing the tail of the dataframe
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

CLEANING AND ORGANISING DATA

In [6]:
```
#getting the number of rows and columns
df.shape
```

Out[6]:
```
(1338, 7)
```

In [7]:
```
#showing the info of dataframe df.
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 [8]:
```
#let's see the data types of  columns of the df dataframe
df.dtypes
```

Out[8]:
```
age           int64
sex          object
bmi         float64
children      int64
smoker       object
region       object
charges     float64
dtype: object
```

In [9]:
```
#let's check if the dataframe has any null value
df.isnull().sum().sort_values(ascending=False)
```

Out[9]:
```
age         0
sex         0
bmi         0
children    0
smoker      0
region      0
charges     0
dtype: int64
```

My data is clean with no null value

In [10]:
```
# let's change the data type for region
df[['region']] = df[['region']].astype('string')
df.dtypes
```

Out[10]:
```
age           int64
sex          object
bmi         float64
children      int64
smoker       object
region       string
charges     float64
dtype: object
```

In [11]:
```
# let's check the number of unique value for region,sex and smoker column column
df[['region','sex','smoker','children']].nunique()

```

Out[11]:
```
region      4
sex         2
smoker      2
children    6
dtype: int64
```

In [12]:
```
#let's check the unique values for sex coumn
df['region'].unique()
```

Out[12]:
```
<StringArray>
['southwest', 'southeast', 'northwest', 'northeast']
Length: 4, dtype: string
```

In [13]:
```
#let's check the unique value for smoker coumn
df['sex'].unique()
```

Out[13]:
```
array(['female', 'male'], dtype=object)
```

FUNCTION

In [14]:
```
#implementing function for the region column to replace the values with the new one.
def letter(x):
    if x == 'northeast':
        return 'North East'
    elif x == 'southeast':
        return 'South East'
    elif x == 'northwest':
        return 'North West'
    elif x == 'southwest':
        return 'South West'
    else:
        return x
```

In [15]:
```
#defining the function to chnage values from string to number
#for ex: for no and male its 0 and for yes and female it's 1
def smoke(x):
        if (x == 'no') | (x =='male'):
             return 0
        elif (x == 'yes') | (x =='female'):
             return 1
        else:
            return x

```

In [16]:
```
df['region'] = df['region'].apply(letter)
```

In [17]:
```
#applying the function to sex smoker column.
df['smoker'] = df['smoker'].apply(smoke)
df['sex'] = df['sex'].apply(smoke)
#showing the head of the dataframe after applying function
df.head()
```

Out[17]:

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

In [18]:
```
#changing the columns name from lowercase to uppercase.
df.columns = ['Age','Sex','BMI','Children','Smoker','Region','Charges']
```

In [19]:
```
#showing the data types after applying the function.
df.dtypes

```

Out[19]:
```
Age           int64
Sex           int64
BMI         float64
Children      int64
Smoker        int64
Region       object
Charges     float64
dtype: object
```

In [20]:
```
#showing the head of the dataframe.
df.head()
```

Out[20]:

	Age	Sex	BMI	Children	Smoker	Region	Charges
0	19	1	27.900	0	1	South West	16884.92400
1	18	0	33.770	1	0	South East	1725.55230
2	28	0	33.000	3	0	South East	4449.46200
3	33	0	22.705	0	0	North West	21984.47061
4	32	0	28.880	0	0	North West	3866.85520

Descriptive Statistic

In [21]:
```
1 df.describe().T
```

Out[21]:

	count	mean	std	min	25%	50%	75%	max
Age	1338.0	39.207025	14.049960	18.0000	27.00000	39.000	51.000000	64.00000
Sex	1338.0	0.494768	0.500160	0.0000	0.00000	0.000	1.000000	1.00000
BMI	1338.0	30.663397	6.098187	15.9600	26.29625	30.400	34.693750	53.13000
Children	1338.0	1.094918	1.205493	0.0000	0.00000	1.000	2.000000	5.00000
Smoker	1338.0	0.204783	0.403694	0.0000	0.00000	0.000	0.000000	1.00000
Charges	1338.0	13270.422265	12110.011237	1121.8739	4740.28715	9382.033	16639.912515	63770.42801

In [22]:
```
1 df.corr()
```

Out[22]:

	Age	Sex	BMI	Children	Smoker	Charges
Age	1.000000	0.020856	0.109272	0.042469	-0.025019	0.299008
Sex	0.020856	1.000000	-0.046371	-0.017163	-0.076185	-0.057292
BMI	0.109272	-0.046371	1.000000	0.012759	0.003750	0.198341
Children	0.042469	-0.017163	0.012759	1.000000	0.007673	0.067998
Smoker	-0.025019	-0.076185	0.003750	0.007673	1.000000	0.787251
Charges	0.299008	-0.057292	0.198341	0.067998	0.787251	1.000000

In [23]:
```
1 #Computing the median for Charges.
2 dem1charges = df['Charges']
3 np.median(dem1charges)
```

Out[23]: 9382.033

In [24]:
```
#Computing the standard deviation for charges.
Charges_std = np.std(dem1charges)
Charges_std
```

Out[24]: 12105.484975561605

In [25]:
```
#Computing the variance for charges
Charges_var = np.var(dem1charges)
Charges_var
```

Out[25]: 146542766.49354774

In [26]:
```
Chargespercent = np.percentile(df['Charges'],[25,50,75])
Chargespercent
```

Out[26]: array([4740.28715 , 9382.033   , 16639.912515])

In [27]:
```
#let's check if there is any duplicate value
df.duplicated().sum()
```

Out[27]: 1

In [28]:
```
#dropping the duplicate value.
df.drop_duplicates(inplace=True)
```

In [29]:
```
#checking it again if there is any duplicate value after dropping it.
df.duplicated().sum()
```

Out[29]: 0

PIVOTING AND GROUPBY

In [30]:

```
#getting the  pivot table by age
pivot1 = pd.pivot_table(df,index = 'Age')
pivot1
```

Out[30]:

Age	BMI	Charges	Children	Sex	Smoker
18	31.326159	7086.217556	0.449275	0.478261	0.173913
19	28.567164	9868.929428	0.432836	0.492537	0.268657
20	30.632759	10159.697736	0.862069	0.482759	0.310345
21	28.185714	4730.464330	0.785714	0.464286	0.071429
22	31.087679	10012.932802	0.714286	0.464286	0.214286
23	31.454464	12419.820040	1.000000	0.500000	0.250000
24	29.142679	10648.015962	0.464286	0.500000	0.214286
25	29.693929	9838.365311	1.285714	0.464286	0.178571
26	29.428929	6133.825309	1.071429	0.464286	0.107143
27	29.333571	12184.701721	0.964286	0.500000	0.321429
28	29.482143	9069.187564	1.285714	0.500000	0.107143
29	29.383148	10430.158727	1.259259	0.481481	0.222222
30	30.557593	12719.110358	1.555556	0.481481	0.333333
31	29.918333	10196.980573	1.407407	0.481481	0.185185
32	31.597692	9220.300291	1.269231	0.500000	0.192308
33	31.163077	12351.532987	1.538462	0.500000	0.230769
34	30.274038	11613.528121	1.153846	0.500000	0.192308
35	31.394800	11307.182031	1.680000	0.480000	0.200000
36	29.374200	12204.476138	1.240000	0.480000	0.240000
37	31.216600	18019.911877	1.520000	0.480000	0.360000
38	28.996600	8102.733674	1.480000	0.520000	0.080000

Age	BMI	Charges	Children	Sex	Smoker
39	29.910200	11778.242945	2.200000	0.520000	0.240000
40	30.139074	11772.251310	1.592593	0.481481	0.185185
41	31.506852	9653.745650	1.407407	0.481481	0.074074
42	30.328148	13061.038669	1.000000	0.481481	0.296296
43	30.204444	19267.278653	1.629630	0.518519	0.444444
44	30.844259	15859.396587	1.222222	0.518519	0.222222
45	29.778966	14830.199856	1.482759	0.482759	0.172414
46	31.340862	14342.590639	1.620690	0.482759	0.172414
47	30.664310	17653.999593	1.379310	0.517241	0.344828
48	31.925690	14632.500445	1.310345	0.517241	0.172414
49	30.313929	12696.006264	1.500000	0.500000	0.142857
50	31.132241	15663.003301	1.310345	0.482759	0.137931
51	31.727069	15682.255867	1.103448	0.517241	0.206897
52	32.936034	18256.269719	1.482759	0.517241	0.206897
53	30.360893	16020.930755	1.250000	0.500000	0.178571
54	31.234286	18758.546475	1.428571	0.500000	0.178571
55	31.950000	16164.545488	0.961538	0.500000	0.076923
56	31.600962	15025.515837	0.769231	0.500000	0.153846
57	30.844423	16447.185250	0.615385	0.500000	0.153846
58	32.718200	13878.928112	0.240000	0.520000	0.040000
59	30.572000	18895.869532	1.200000	0.520000	0.160000
60	30.332826	21979.418507	0.347826	0.478261	0.217391
61	32.548261	22024.457609	0.739130	0.521739	0.260870
62	32.342609	19163.856573	0.565217	0.521739	0.173913
63	31.923478	19884.998461	0.565217	0.521739	0.217391

Age	BMI	Charges	Children	Sex	Smoker
64	32.976136	23275.530837	0.772727	0.500000	0.318182

In [31]:
```
1 gb1 = df.groupby('Children')
2
```

In [32]:
```
1 gb1.first(6)
```

Out[32]:

Children	Age	Sex	BMI	Smoker	Charges
0	19	1	27.90	1	16884.9240
1	18	0	33.77	0	1725.5523
2	37	0	29.83	0	6406.4107
3	28	0	33.00	0	4449.4620
4	25	0	33.66	0	4504.6624
5	19	1	28.60	0	4687.7970

In [33]:
```
1 #grouping the data by the regions.
2 gb = df.groupby('Region')
```

In [34]:
```
#showing the data after grouping it
gb.first()
```

Out[34]:

Region	Age	Sex	BMI	Children	Smoker	Charges
North East	37	0	29.830	2	0	6406.41070
North West	33	0	22.705	0	0	21984.47061
South East	18	0	33.770	1	0	1725.55230
South West	19	1	27.900	0	1	16884.92400

In [35]:
```
#making the group for region Northeast.
dfgroupne = gb.get_group('North East')
```

In [36]:
```
dfgroupNE = dfgroupne.set_index('Region')
#showing the head of the northeast grouped data.
dfgroupNE.head()
```

Out[36]:

Region	Age	Sex	BMI	Children	Smoker	Charges
North East	37	0	29.830	2	0	6406.41070
North East	25	0	26.220	0	0	2721.32080
North East	52	1	30.780	1	0	10797.33620
North East	23	0	23.845	0	0	2395.17155
North East	60	1	36.005	0	0	13228.84695

In [37]:
```
#making the group for region Northwest.
dfgroupnw = gb.get_group('North West')
```

In [38]:
```
dfgroupNW = dfgroupnw.set_index('Region')
#showing the head of the northwest grouped data.
dfgroupNW.head()
```

Out[38]:

Region	Age	Sex	BMI	Children	Smoker	Charges
North West	33	0	22.705	0	0	21984.47061
North West	32	0	28.880	0	0	3866.85520
North West	37	1	27.740	3	0	7281.50560
North West	60	1	25.840	0	0	28923.13692
North West	37	0	28.025	2	0	6203.90175

In [39]:
```
#making the group for region Southeast.
dfgroupse = gb.get_group('South East')
```

In [40]:
```
dfgroupSE = dfgroupse.set_index('Region')
#showing the head of the southwest grouped data.
dfgroupSE.head()
```

Out[40]:

Region	Age	Sex	BMI	Children	Smoker	Charges
South East	18	0	33.77	1	0	1725.5523
South East	28	0	33.00	3	0	4449.4620
South East	31	1	25.74	0	0	3756.6216
South East	46	1	33.44	1	0	8240.5896
South East	62	1	26.29	0	1	27808.7251

In [41]:

```
#making the group for region Southwest.
dfgroupsw = gb.get_group('South West')
```

In [42]:

```
dfgroupSW = dfgroupsw.set_index('Region')
#showing the head of the southwest grouped data.
dfgroupSW.head()
```

Out[42]:

Region	Age	Sex	BMI	Children	Smoker	Charges
South West	19	1	27.9	0	1	16884.924
South West	23	0	34.4	0	0	1826.843
South West	19	0	24.6	1	0	1837.237
South West	56	0	40.3	0	0	10602.385
South West	30	0	35.3	0	1	36837.467

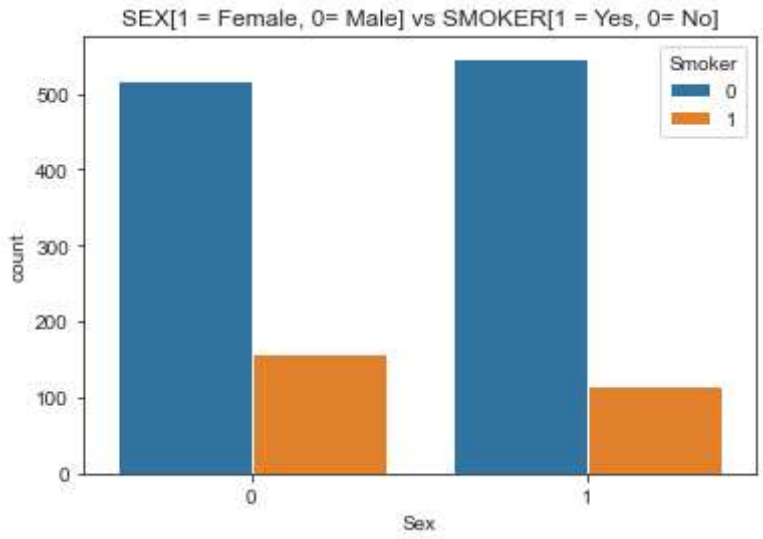
DATA VISUALIZATION

Question 1: Out of male and female who smokes more?

In [43]:

```
#showing the answer using countplot.
sns.set_style('ticks')
sns.countplot('Sex',data = df,hue = 'Smoker').set(title='SEX[1 = Female, 0= Male] vs SMOKER[1 = Yes, 0= No]')
```

Out[43]: [Text(0.5, 1.0, 'SEX[1 = Female, 0= Male] vs SMOKER[1 = Yes, 0= No]')]



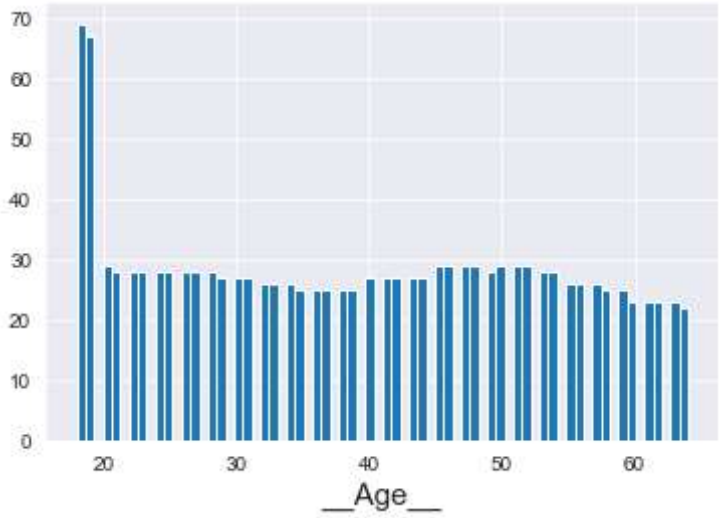
Observation:

- from the above plot it shows that female smoke less than male

Question 2: which age group is more in the data?

In [44]:
```
#plotting the histogram for Age
sns.set_style("darkgrid")
df['Age'].hist(bins = 70).set_xlabel('__Age__',fontsize = 15)

```

Out[44]: Text(0.5, 0, '__Age__')



Observation:

- from the above plot we get to know that most of the people have ages below 20

Question 3: How many males and females are in the data?

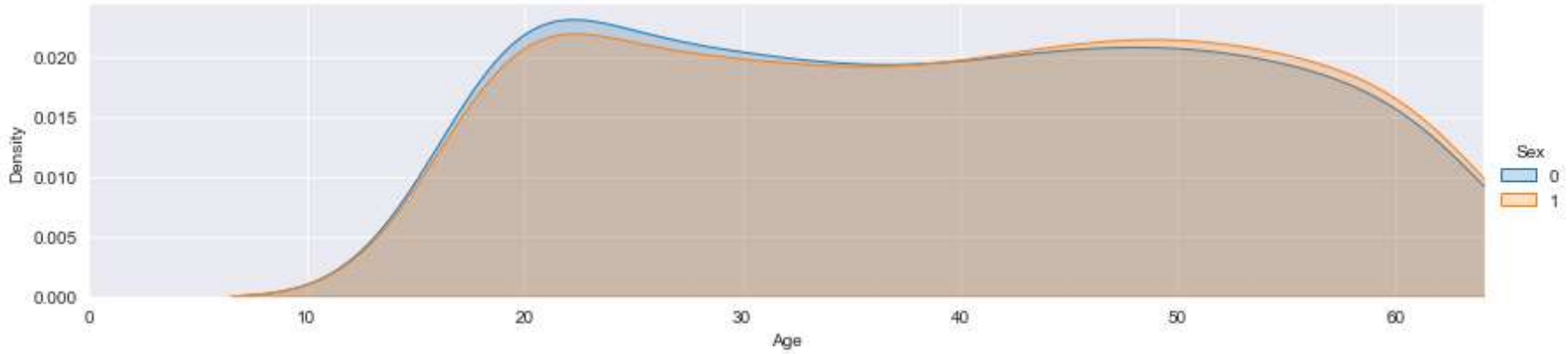
In [45]:
```
#counting  the value for male and female whereas male = 0 and female = 1.
df['Sex'].value_counts()
```

Out[45]:
```
0    675
1    662
Name: Sex, dtype: int64
```

Question 4: Out of Young male and female and old male and female who are more in the data?

In [46]:
```
fig  =  sns.FacetGrid(df,  hue="Sex",aspect=4)
# Next use map to plot all the possible kdeplots for the 'Age' column by the hue choice
fig.map(sns.kdeplot,'Age',shade=  True)
sns.set_style("darkgrid")
# Set the x max limit by the oldest passenger
oldest  =  df['Age'].max()
#Since we know no one can be negative years old set the x lower limit at 0
fig.set(xlim=(0,oldest))
#Finally add a legend
fig.add_legend()
```

Out[46]:
```
<seaborn.axisgrid.FacetGrid at 0x1f61f25ea90>
```



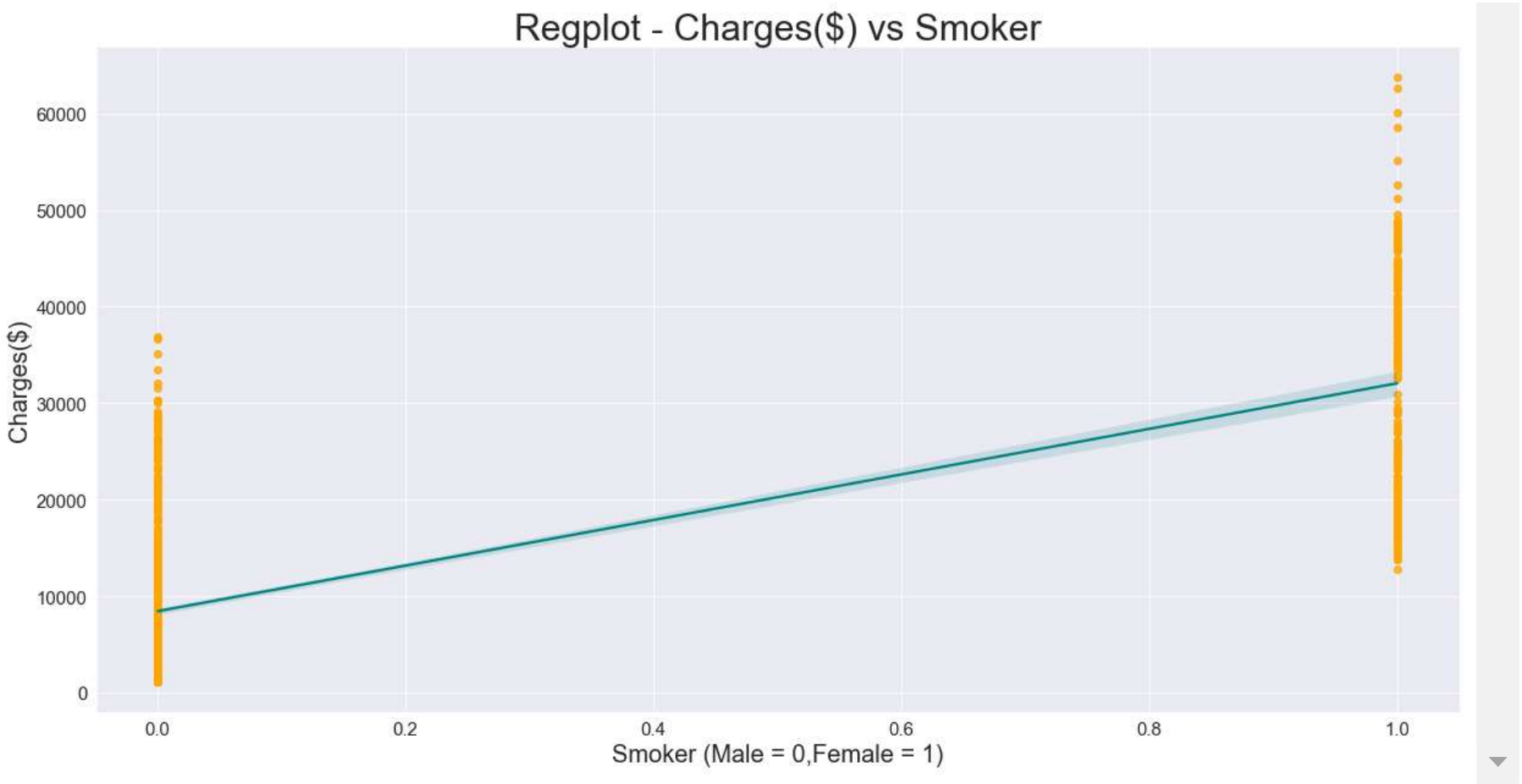
Observation:

- from the above plot its clear that young males are more than female but old females are more than old males

Question 5: Do smoking have an impact on the medical insurance charges?

In [47]:

```
# Regression plot of Charges vs Smokers
plt.figure(figsize=(20,10))
g = sns.regplot(data = df, y = 'Charges', x = 'Smoker', color='orange', line_kws={'color':'teal'})
plt.ticklabel_format(style='plain', axis='y')
plt.ticklabel_format(style='plain', axis='x')
sns.set_style("darkgrid")
# Annotation
plt.xlabel('Smoker (Male = 0,Female = 1)', fontsize=20)
plt.ylabel('Charges($)', fontsize = 20)
plt.yticks(fontsize=15)
plt.xticks(fontsize=15)
plt.title('Regplot - Charges($) vs Smoker', fontsize=30)
sns.set_style("darkgrid")
```



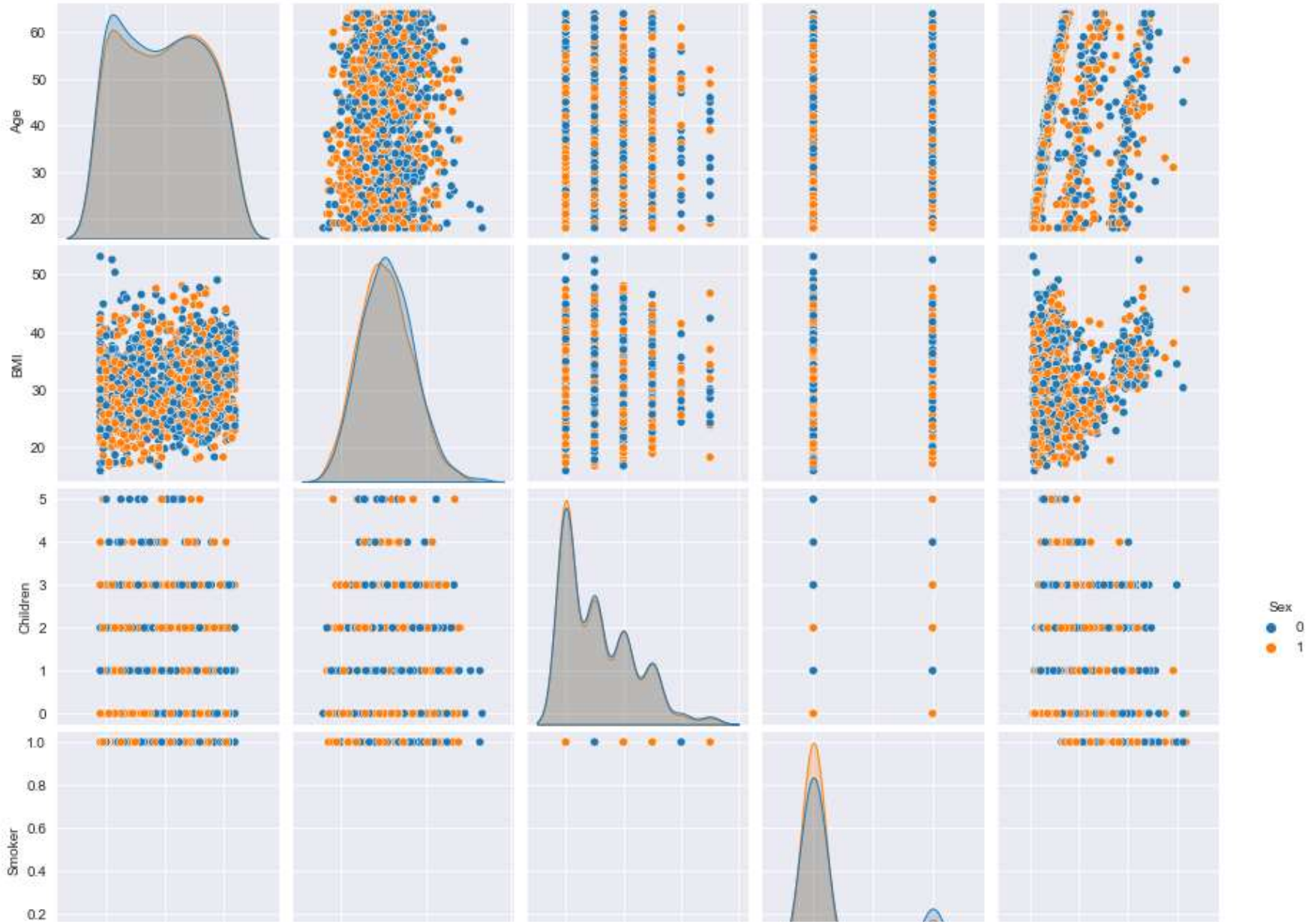
Observation:

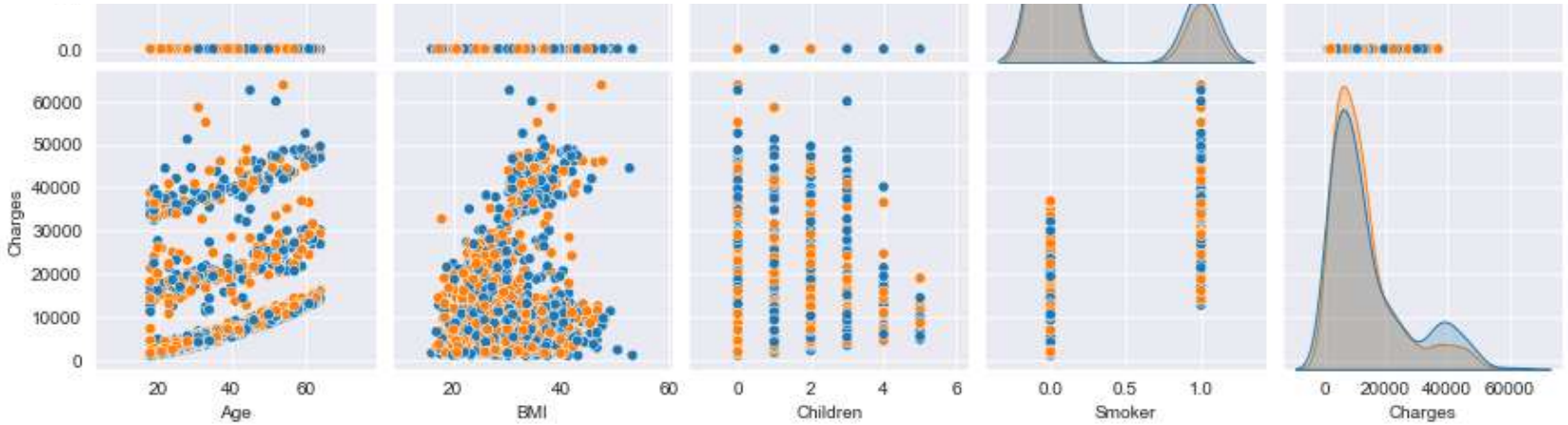
- Not so surprisingly from the above plot we can see that if person smokes then the charges of insurance are more as Smoking is injurious to health and leads to many diseases.

In [48]:

```
#plotting pairplot for dataframe df with hue Sex
sns.pairplot(df,hue = 'Sex')
```

Out[48]: <seaborn.axisgrid.PairGrid at 0x1f61f598700>

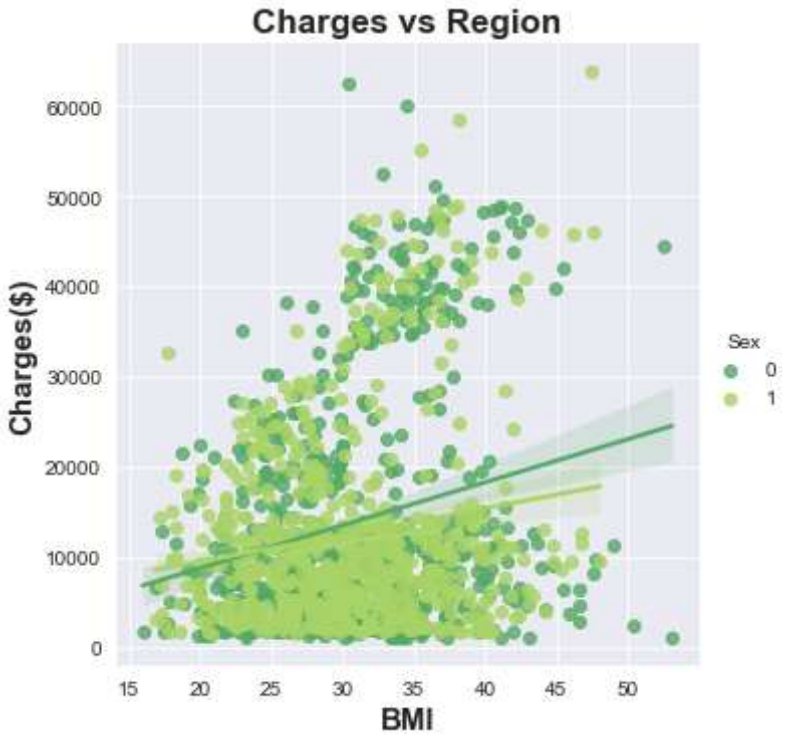



0.0
60000
50000
40000
30000
20000
10000
0
Charges
20
40
60
Age
20
40
60
BMI
0
2
4
6
Children
0.0
0.5
1.0
Smoker
0
20000
40000
60000
Charges

In [49]:

```
#plotting lmplot for BMI and charges with hue Sex
sns.lmplot(x = 'BMI',y = 'Charges',data = df,hue = 'Sex',palette = 'summer')
plt.xlabel('BMI', fontsize=15,fontweight = 'bold')
plt.ylabel('Charges($)', fontsize = 15,fontweight = 'bold')
plt.title('Charges vs Region',fontsize = 17,fontweight = 'bold')

```

Out[49]: Text(0.5, 1.0, 'Charges vs Region')



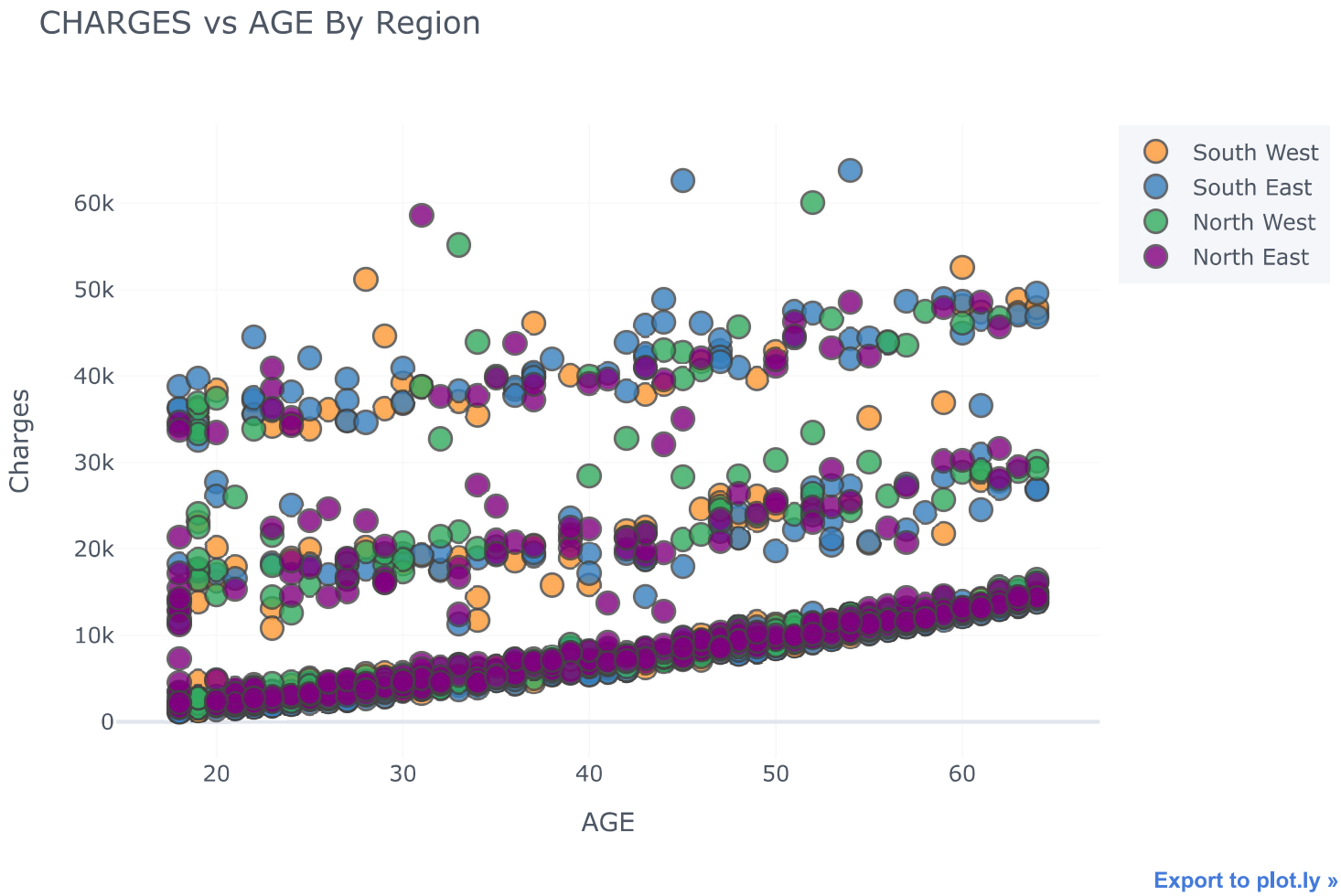
Observation:

- we can see in the above plot that BMI and charges have weak relationship where as if person smoke there charges are more.where as males have more Charges, BMI than female

Question 6: In every region which age group have more charges?

In [50]:

```
#plotting iplot for Charges and Age by Region.
df.iplot(kind = 'line',categories = 'Region',x = 'Age',y = 'Charges', xTitle = 'AGE', yTitle = 'Charges',title='
```



Observation:

- In North East charges for person above 30 is more

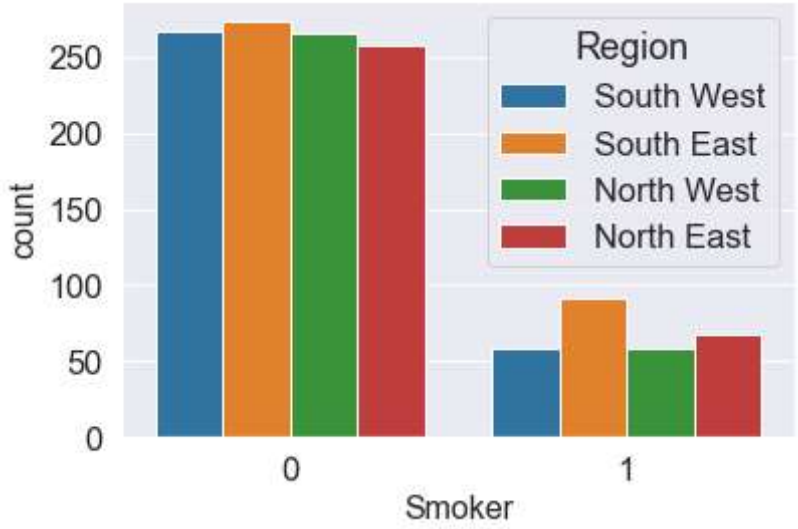
- In North West charges are more for person above 30 and 50 years
- In South East charges are more for a person above 45 and 54
- In South West charges are more for a person above 25 and 60 years
- where as charges continues to Increase by age.

Question:

Which region has maximum and minimum smokers?

In [51]:
```
#plotting countplot for Smoker and region
sns.set_context("notebook", font_scale=1.5, rc={"font.size":16,"axes.titlesize":16,"axes.labelsize":16})
sns.countplot('Smoker',data = df,hue = 'Region')
```

Out[51]: <AxesSubplot:xlabel='Smoker', ylabel='count'>



Observation:

- from the above plot we can see on top is the South East region which consist of people who smokes

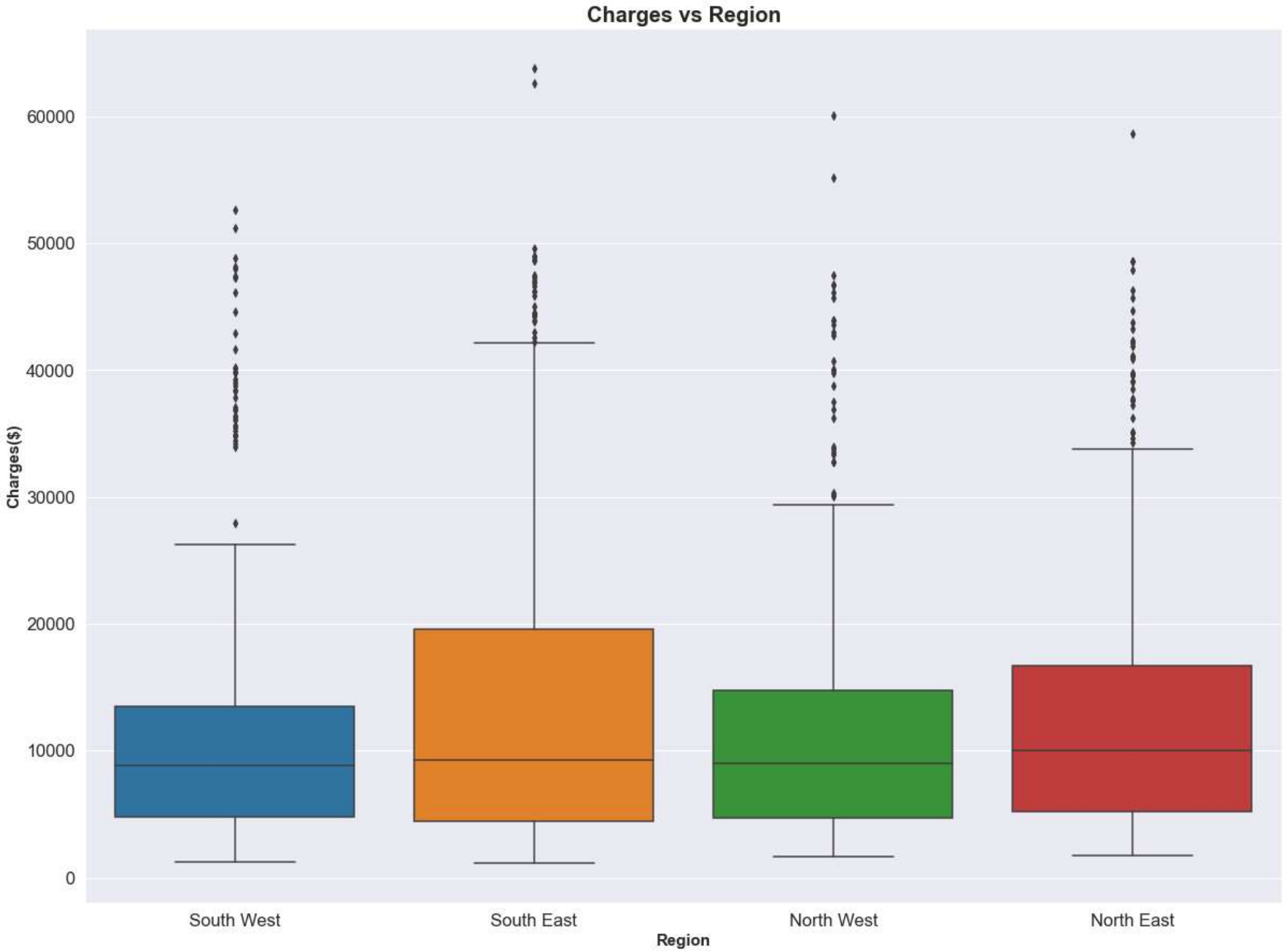
- where as smoker in every region is more than non smokers ,Northwest and Southwest is almost same when it comes to non smoker but have very little diffrence when it comes to smoker category.
- Northeast region have less smokers out of 4 regions.

Question 7: Which region have people with more BMI?

In [52]:

```
#plotting boxplot for charges and Region.
plt.figure(figsize=(20,15))
sns.set_context("notebook", font_scale=1.5, rc={"font.size":16,"axes.titlesize":16,"axes.labelsize":16})
sns.set_style("darkgrid")
sns.boxplot(data = df, x= 'Region', y = 'Charges').set_title('Charges($) vs Region')
plt.xlabel('Region', fontsize=15,fontweight = 'bold')
plt.ylabel('Charges($)', fontsize = 15,fontweight = 'bold')
plt.title('Charges vs Region',fontsize = 20,fontweight = 'bold')

```

Out[52]: Text(0.5, 1.0, 'Charges vs Region')


Charges vs Region
60000
50000
40000
30000
20000
10000
0
Charges($)
South West
South East
North West
North East
Region

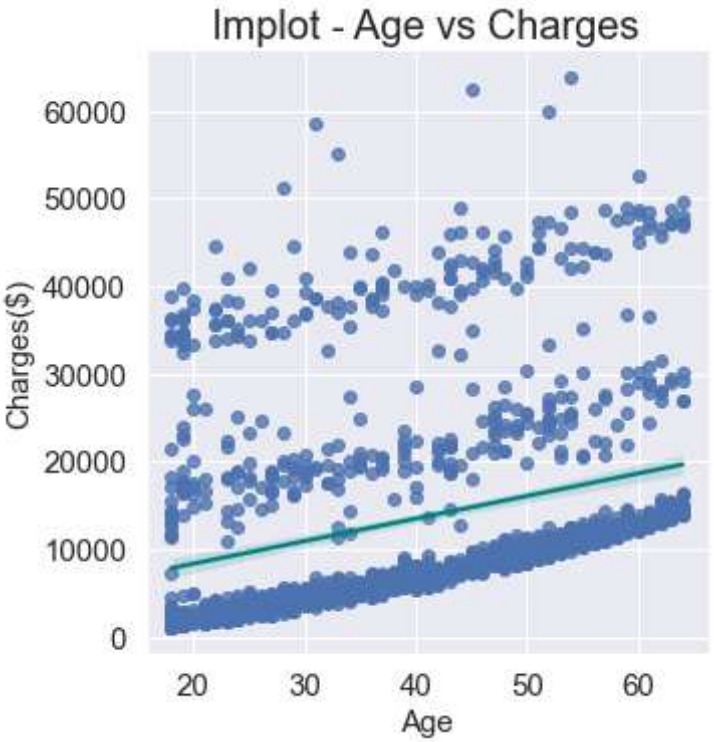
Observation:

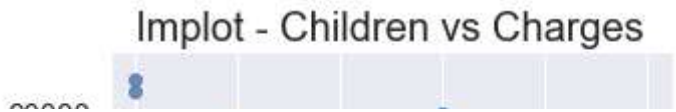
- In southeast region people have more Charges out of all regions
- out of All the four regions southwest people have less charges
- Where as there are outliers in every region

In [53]:

```
#plotting lmplot for Charges and Age
sns.set(style="ticks")
plt.figure(figsize=(20,10))
sns.set_style("darkgrid")

sns.lmplot(x = 'Age', y = 'Charges', data=df,palette= 'orange',line_kws={'color':'teal'})
plt.xlabel('Age', fontsize=15)
plt.ylabel('Charges($)', fontsize = 15)
plt.title('lmplot - Age vs Charges', fontsize=20)
plt.yticks(fontsize=15)
plt.xticks(fontsize=15)
plt.ticklabel_format(style='plain', axis='y')
plt.ticklabel_format(style='plain', axis='x')
#plotting lmplot for Children and Charges
sns.set_style("darkgrid")
sns.lmplot(x = 'Children', y = 'Charges', data=df, palette='coolwarm',line_kws={'color':'teal'})
plt.xlabel('Children', fontsize=15)
plt.ylabel('Charges($)', fontsize = 15)
plt.title('lmplot - Children vs Charges', fontsize=20)
plt.yticks(fontsize=15)
plt.xticks(fontsize=15)
plt.ticklabel_format(style='plain', axis='y')
plt.ticklabel_format(style='plain', axis='x')
```

```
<Figure size 1440x720 with 0 Axes>
```


Implot - Age vs Charges
60000
50000
40000
30000
20000
10000
0
Charges($)
20
30
40
50
60
Age



Observation

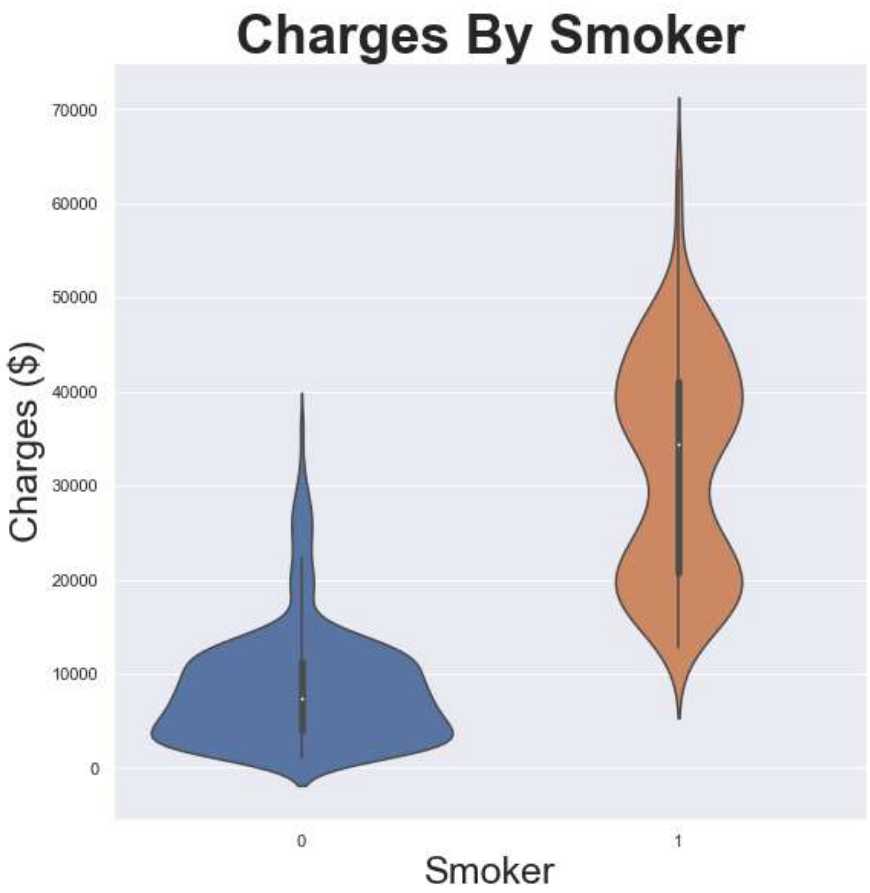
- Children and charges have weak relationship.
- Age and charges are correlated as age increase price also increase.

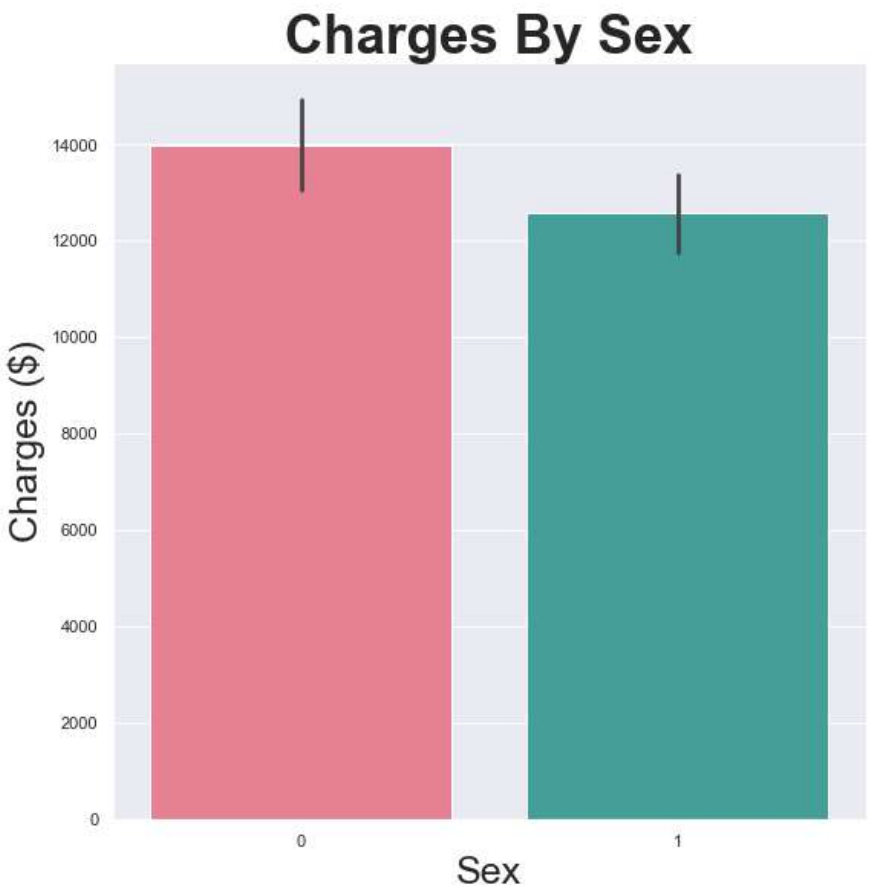
In [54]:

```
#plotting violinplot for charges by smoker
plt.figure(figsize=(30,20))
plt.subplot(2,3,1)
sns.set_style("darkgrid")
sns.violinplot(x = 'Smoker', y = 'Charges', data = df)
plt.xlabel('Smoker', fontsize=25)
plt.ylabel('Charges ($)', fontsize = 25)
plt.title('Charges By Smoker',fontweight="bold", size=35)
plt.title('Charges By Smoker',fontweight="bold", size=35)
#plotting barplot for charges by smoker
plt.subplot(2,3,2)
sns.set_style("darkgrid")
sns.barplot(x = 'Sex', y = 'Charges', data = df, palette= 'husl')
plt.xlabel('Sex', fontsize=25)
plt.ylabel('Charges ($)', fontsize = 25)
plt.title('Charges By Sex',fontweight="bold", size=35)
```

Out[54]:

```
Text(0.5, 1.0, 'Charges By Sex')
```





Observation:

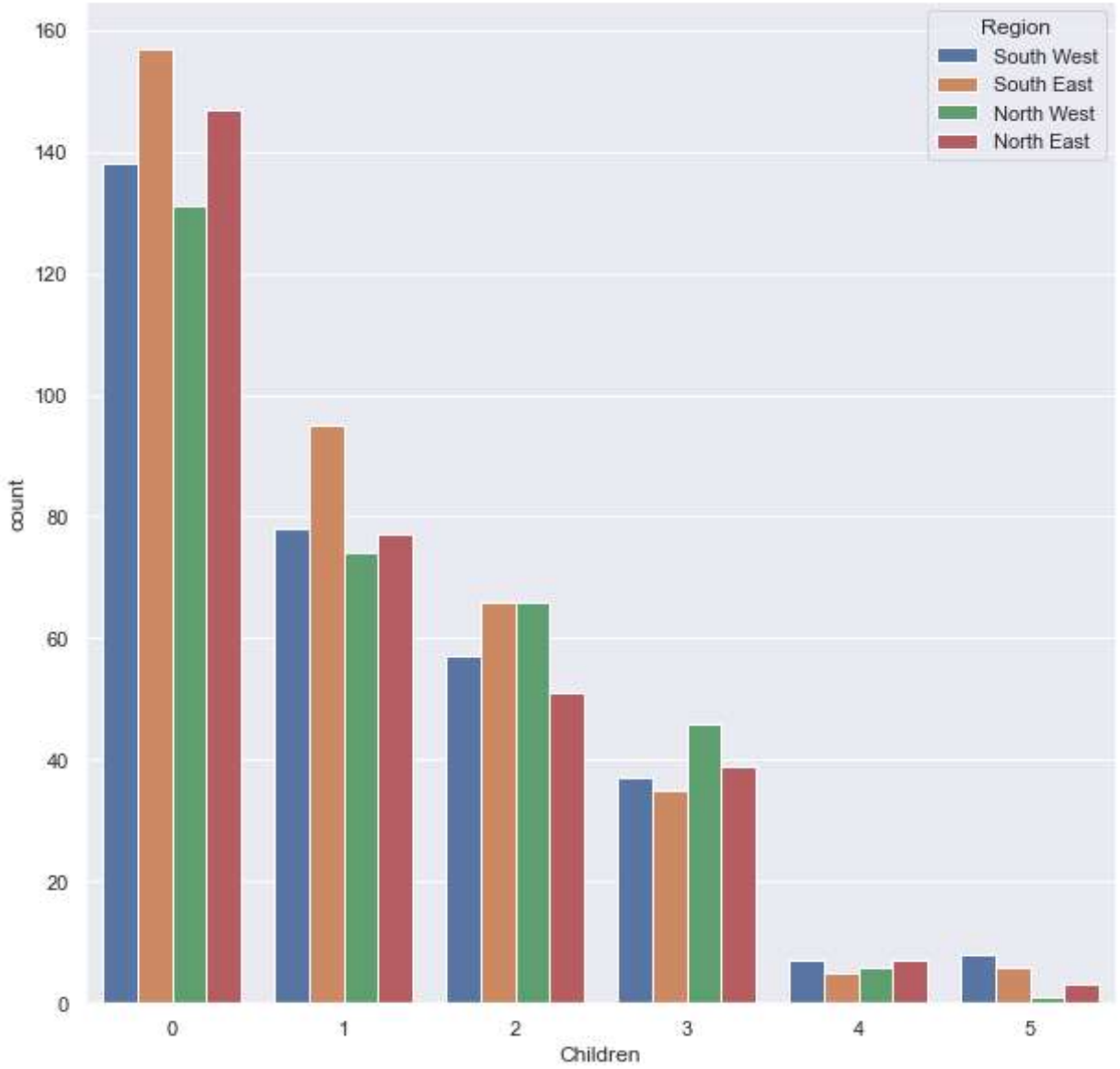
- People who smoke tend to have more Medical charges
- Male tend to have more Medical charges than female

Question: Which region has maximum and minimum number of children?

In [55]:

```
#plotting countplot for children with the hue of Region.
plt.figure(figsize=(10,10))
sns.set_style("darkgrid")
sns.countplot(data = df,x = 'Children', hue = 'Region')
```

Out[55]: <AxesSubplot:xlabel='Children', ylabel='count'>



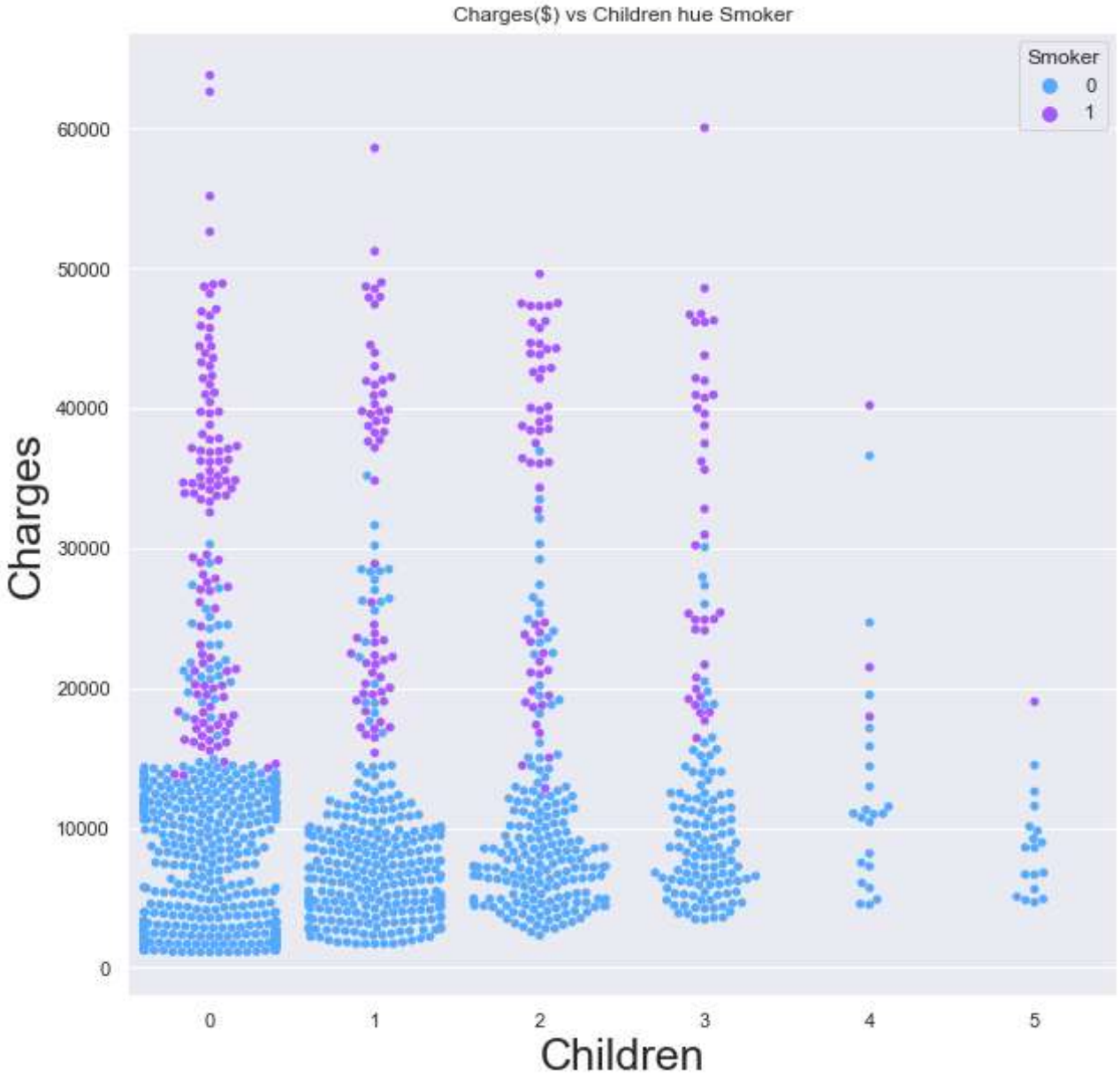
Observation:

- South-east and north east region have maximum people with no children.
- South-east and north west have same number of people with 1 children.
- North-west have maximum people with 3 childrens.

- South-east have 0 people with 5 children.
- South-west is on top of people with 4 and 5 children.

In [56]:

```
#plotting swarmplot for Charges by children with hue for Smoker.
f, ax = plt.subplots(1, 1, figsize=(10, 10))
sns.set_style("darkgrid")
ax.set_ylabel('Charges', fontsize = 25)
ax.set_xlabel('Children', fontsize = 25)
ax.set_title('Charges($) vs Children hue Smoker')
ax = sns.swarmplot(x = 'Children', y = 'Charges', data=df,
                   orient='v', hue='Smoker', palette='cool')

```



Observation:

- People who don't have children smoke more than people who have children and so there charges are more.

EXPLORATORY DATA ANALYSIS

Correlation

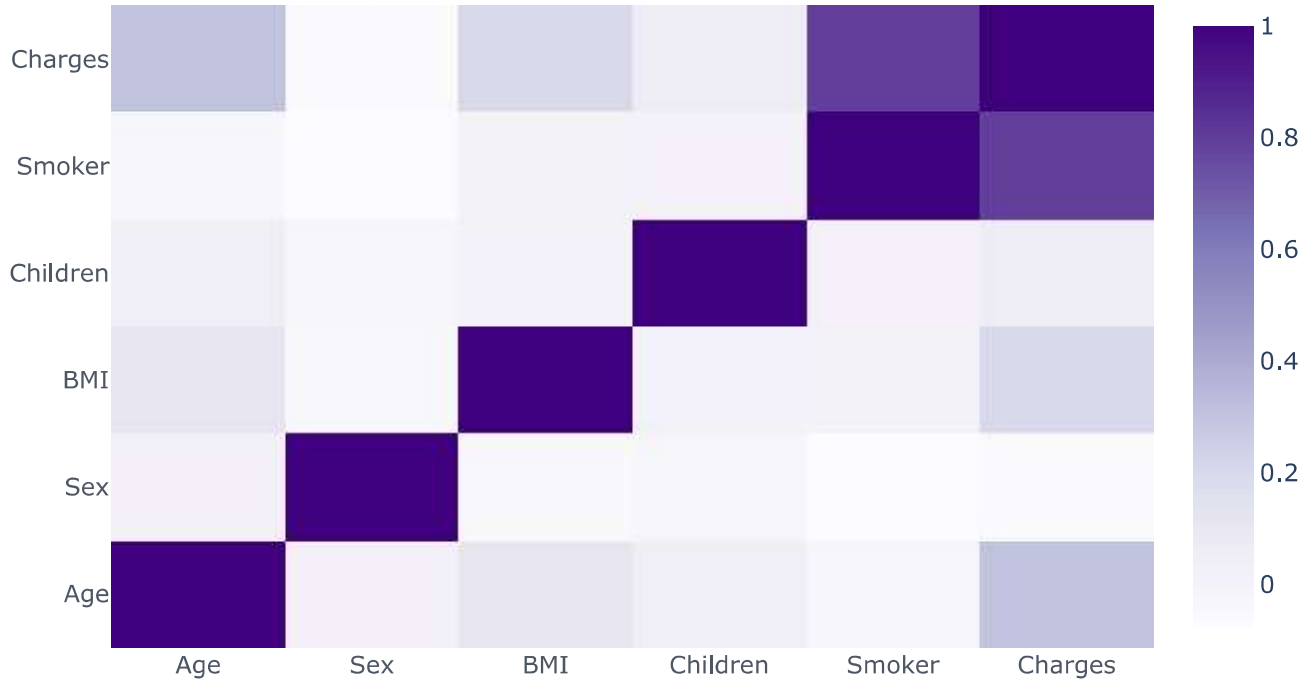
In [57]:
```
1 #Computing correlation for dataframe df.
2 df.corr()
```

Out[57]:

	Age	Sex	BMI	Children	Smoker	Charges
Age	1.000000	0.019814	0.109344	0.041536	-0.025587	0.298308
Sex	0.019814	1.000000	-0.046397	-0.017848	-0.076596	-0.058044
BMI	0.109344	-0.046397	1.000000	0.012755	0.003746	0.198401
Children	0.041536	-0.017848	0.012755	1.000000	0.007331	0.067389
Smoker	-0.025587	-0.076596	0.003746	0.007331	1.000000	0.787234
Charges	0.298308	-0.058044	0.198401	0.067389	0.787234	1.000000

In [58]:

```
#plotting heatmap for dataframe correlation.
df.corr().iplot(kind="heatmap",
                    colorscale = 'purples',
                    dimensions=(700,500))
```



Export to plot.ly »

Observation

- Smoker and charges have strong relationship
- There is weak negative correlation between sex and Charges

- There is weak correlation between Age,BMI and Charges

In [59]:
```
#Computing percentiles for charges.
np.percentile(df['Charges'],[25,50,75])
```

Out[59]:
```
array([ 4746.344  ,  9386.1613 , 16657.71745])
```

In [60]:
```
#descriptive statistic for dataframe df.
df.describe().T
```

Out[60]:

	count	mean	std	min	25%	50%	75%	max
Age	1337.0	39.222139	14.044333	18.0000	27.000	39.0000	51.00000	64.00000
Sex	1337.0	0.495138	0.500163	0.0000	0.000	0.0000	1.00000	1.00000
BMI	1337.0	30.663452	6.100468	15.9600	26.290	30.4000	34.70000	53.13000
Children	1337.0	1.095737	1.205571	0.0000	0.000	1.0000	2.00000	5.00000
Smoker	1337.0	0.204936	0.403806	0.0000	0.000	0.0000	0.00000	1.00000
Charges	1337.0	13279.121487	12110.359656	1121.8739	4746.344	9386.1613	16657.71745	63770.42801

In [61]:
```
#descriptive statistic for group South east region.
dfgroupSE.describe().T
```

Out[61]:

	count	mean	std	min	25%	50%	75%	max
Age	364.0	38.939560	14.164585	18.0000	26.7500	39.00000	51.0000	64.00000
Sex	364.0	0.480769	0.500318	0.0000	0.0000	0.00000	1.0000	1.00000
BMI	364.0	33.355989	6.477648	19.8000	28.5725	33.33000	37.8125	53.13000
Children	364.0	1.049451	1.177276	0.0000	0.0000	1.00000	2.0000	5.00000
Smoker	364.0	0.250000	0.433609	0.0000	0.0000	0.00000	0.2500	1.00000
Charges	364.0	14735.411438	13971.098589	1121.8739	4440.8862	9294.13195	19526.2869	63770.42801

In [62]:

```
#descriptive statistic for group South west region.
dfgroupSW.describe().T
```

Out[62]:

	count	mean	std	min	25%	50%	75%	max
Age	325.0	39.455385	13.959886	19.000	27.00	39.000	51.00	64.00000
Sex	325.0	0.498462	0.500769	0.000	0.00	0.000	1.00	1.00000
BMI	325.0	30.596615	5.691836	17.400	26.90	30.300	34.60	47.60000
Children	325.0	1.141538	1.275952	0.000	0.00	1.000	2.00	5.00000
Smoker	325.0	0.178462	0.383491	0.000	0.00	0.000	0.00	1.00000
Charges	325.0	12346.937377	11557.179101	1241.565	4751.07	8798.593	13462.52	52590.82939

In [63]:

```
#descriptive statistic for group North east region.
dfgroupNE.describe().T
```

Out[63]:

	count	mean	std	min	25%	50%	75%	max
Age	324.0	39.268519	14.069007	18.0000	27.000000	39.500000	51.00000	64.00000
Sex	324.0	0.496914	0.500764	0.0000	0.000000	0.000000	1.00000	1.00000
BMI	324.0	29.173503	5.937513	15.9600	24.866250	28.880000	32.89375	48.07000
Children	324.0	1.046296	1.198949	0.0000	0.000000	1.000000	2.00000	5.00000
Smoker	324.0	0.206790	0.405630	0.0000	0.000000	0.000000	0.00000	1.00000
Charges	324.0	13406.384516	11255.803066	1694.7964	5194.322288	10057.652025	16687.36410	58571.07448

In [64]:

```
#descriptive statistic for group North west region.
dfgroupNW.describe().T
```

Out[64]:

	count	mean	std	min	25%	50%	75%	max
Age	324.0	39.259259	14.028302	19.0000	26.000000	39.00000	51.250000	64.00000
Sex	324.0	0.506173	0.500735	0.0000	0.000000	1.00000	1.000000	1.00000
BMI	324.0	29.195494	5.144127	17.3850	25.745000	28.88000	32.775000	42.94000
Children	324.0	1.151235	1.171897	0.0000	0.000000	1.00000	2.000000	5.00000
Smoker	324.0	0.179012	0.383956	0.0000	0.000000	0.00000	0.000000	1.00000
Charges	324.0	12450.840844	11073.125699	1621.3402	4733.635288	8976.97725	14788.747863	60021.39897

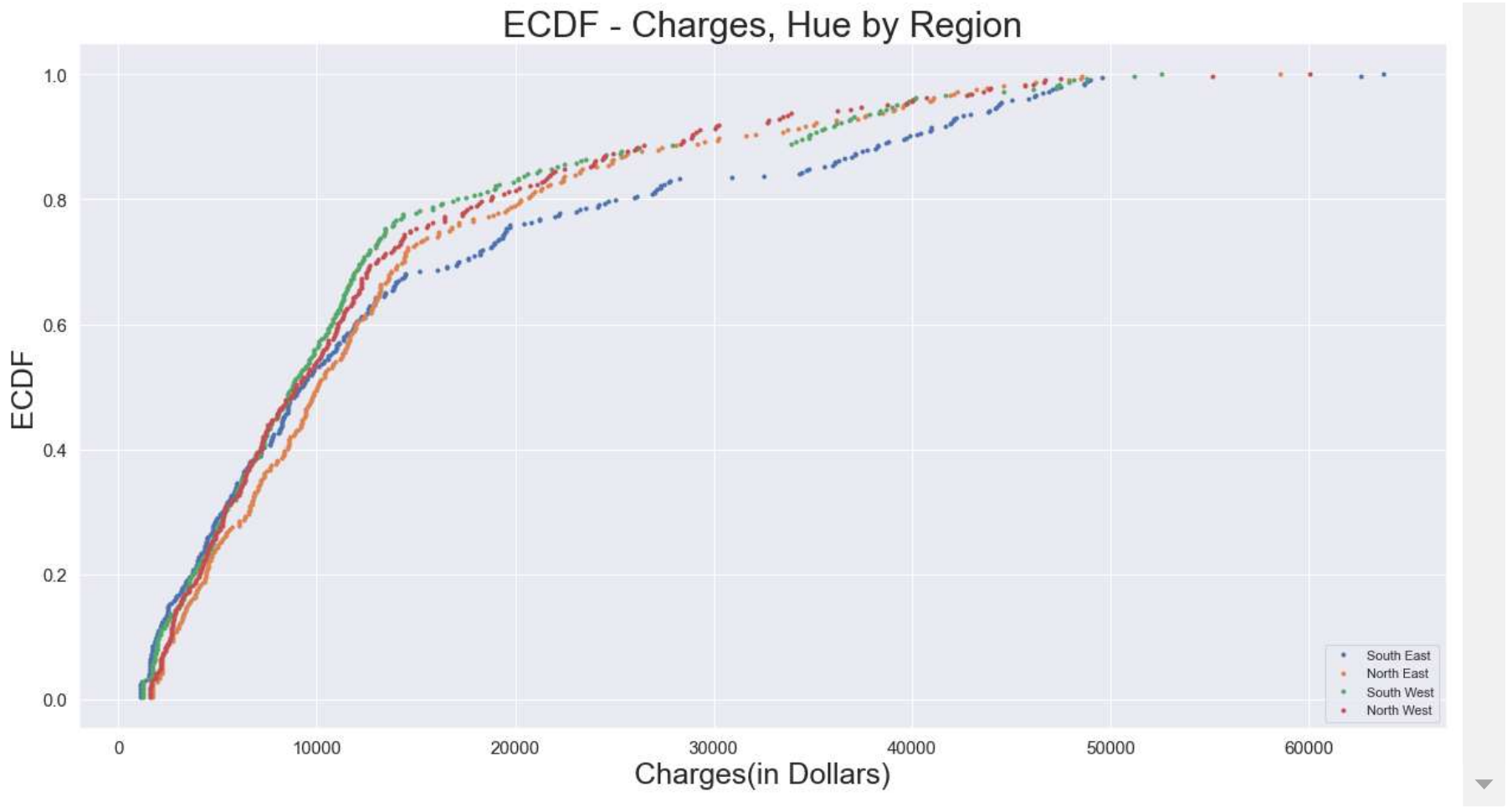
ECDF

In [65]:

```
def ecdf(data):
    """Compute ECDF for a one-dimensional array of measurements."""


    # Number of data points: n
    n = len(data)


    # x-data for the ECDF: x
    x = np.sort(data)


    # y-data for the ECDF: y
    y = np.arange(1, n+1) / n


    return x, y
```

In [66]:

```
# Figure size and axis
fig = plt.figure(figsize=(20,10))
axes = fig.add_axes([0.1,0.1,0.8,0.8])

x_se, y_se = ecdf(dfgroupSE['Charges'])
x_ne, y_ne = ecdf(dfgroupNE['Charges'])
x_sw, y_sw = ecdf(dfgroupSW['Charges'])
x_nw, y_nw = ecdf(dfgroupNW['Charges'])


# Plot all ECDFs on the same plot
_ = plt.plot(x_se, y_se, marker = '.', linestyle = 'none')
_ = plt.plot(x_ne, y_ne, marker = '.', linestyle = 'none')
_ = plt.plot(x_sw, y_sw, marker = '.', linestyle = 'none')
_ = plt.plot(x_nw, y_nw, marker = '.', linestyle = 'none')

# Make nice margins
plt.margins(0.05)

# Annotation,Label, Tick, Title
plt.legend(('South East', 'North East', 'South West','North West'), loc='lower right')
_ = plt.xlabel('Charges(in Dollars)',fontsize = 25)
_ = plt.ylabel('ECDF',fontsize = 25)
plt.title('ECDF - Charges, Hue by Region', fontsize=30)
plt.yticks(fontsize=15)
plt.xticks(fontsize=15)


# Display the plot
plt.show()
```



Observation:

- 70% charges are between 10,000 to 20000 for all regions.
- South west have less charges out of all 4 regions.
- North West and North East are almost same.
- More than 75% people in South East have 20,000 charges.

TESTING HYPOTHESIS AND ANNOVA

In [67]:
```
#making a dataframe named as annovadf for BMI,REGION,AGE,CHARGES.
annovadf = df[['Region','BMI','Age','Charges']]
annovadf.head(3)
```

Out[67]:

	Region	BMI	Age	Charges
0	South West	27.90	19	16884.9240
1	South East	33.77	18	1725.5523
2	South East	33.00	28	4449.4620

In [68]:
```
#grouping annovadf by Region.
grouped_anova=annovadf.groupby(["Region"])
```

In [69]:
```
#Computing annova test for charges column of South east and south west region.
anova_result_1=stats.f_oneway(grouped_anova.get_group("South East")["Charges"], grouped_anova.get_group("South W

print( "ANOVA results: F=",anova_result_1)
```

```
ANOVA results: F= F_onewayResult(statistic=5.8960452705730475, pvalue=0.015430651095692707)
```

Conclusion

- As the F-test score is small and p-value is less than 0.05 so there is evidence that The charges between South East and Northeast are significantly different. So the null hypothesis is rejected.

In [70]:
```
# Computing annova test for charges column for Northeast and Northwest region.
anova_result_1=stats.f_oneway(grouped_anova.get_group("North East")["Charges"], grouped_anova.get_group("North W

print( "ANOVA results: F=",anova_result_1)
```

```
ANOVA results: F= F_onewayResult(statistic=1.1866188531575284, pvalue=0.27641882562037406)
```

Conclusion

- As the F-test score is small and p-value is greater than 0.05 so there is evidence that The charges between South West and North West are not significantly different. so the null hypothesis is not rejected.

In [71]:
```
#use the stats.f_oneway method
#find the statistic F and P value calling the stats.f_oneway method from scipy
F, p = stats.f_oneway(dfgroupSW['Charges'],dfgroupNE['Charges'],dfgroupSE['Charges'],dfgroupNW['Charges'])
# pvalue < 0.05, at least one group does not have the same mean
if p < 0.05:
    print("reject null hypothesis: at least one group does not have the same mean")
else:
    print("accept null hypothesis: all the groups have the same mean")
```

```
reject null hypothesis: at least one group does not have the same mean
```

In [72]:
```
F, p = stats.f_oneway(dfgroupSE['Age'], dfgroupSW['Age'],dfgroupNE['Age'],dfgroupNW['Age'])
# pvalue < 0.05, at least one group does not have the same mean
if p < 0.05:
    print("reject null hypothesis: at least one group does not have the same mean")
else:
    print("accept null hypothesis: all the groups have the same mean")
```

```
accept null hypothesis: all the groups have the same mean
```

In [73]:
```
F, p = stats.f_oneway(dfgroupSE['BMI'], dfgroupSW['BMI'],dfgroupNE['BMI'],dfgroupNW['BMI'])
# pvalue < 0.05, at least one group does not have the same mean
if p < 0.05:
    print("reject null hypothesis: at least one group does not have the same mean")
else:
    print("accept null hypothesis: all the groups have the same mean")
```

```
reject null hypothesis: at least one group does not have the same mean
```

Chi-Squared Test

In [76]:

```python
#See if Charges and Age of SouthEast region are dependent
from scipy.stats import chi2_contingency
chi2_df = dfgroupSE[['Charges', 'Age']]
stat, p, dof,expected = chi2_contingency(chi2_df)

# H0 = Charges and Age are independent
# Ha = Charges and Age are dependent

# print out results
print(f'The Test Statistic is {stat:.4f} with a P-value of {p:.4f}')
if p < 0.05:
    print('Since p-value is < 0.05, they are dependent.') # We Reject H0, statistically significant
else:
    print('Since p-value is > 0.05, they are independent')
```

```
The Test Statistic is 11463.3524 with a P-value of 0.0000
Since p-value is < 0.05, they are dependent.
```

Normal Test

In [77]:

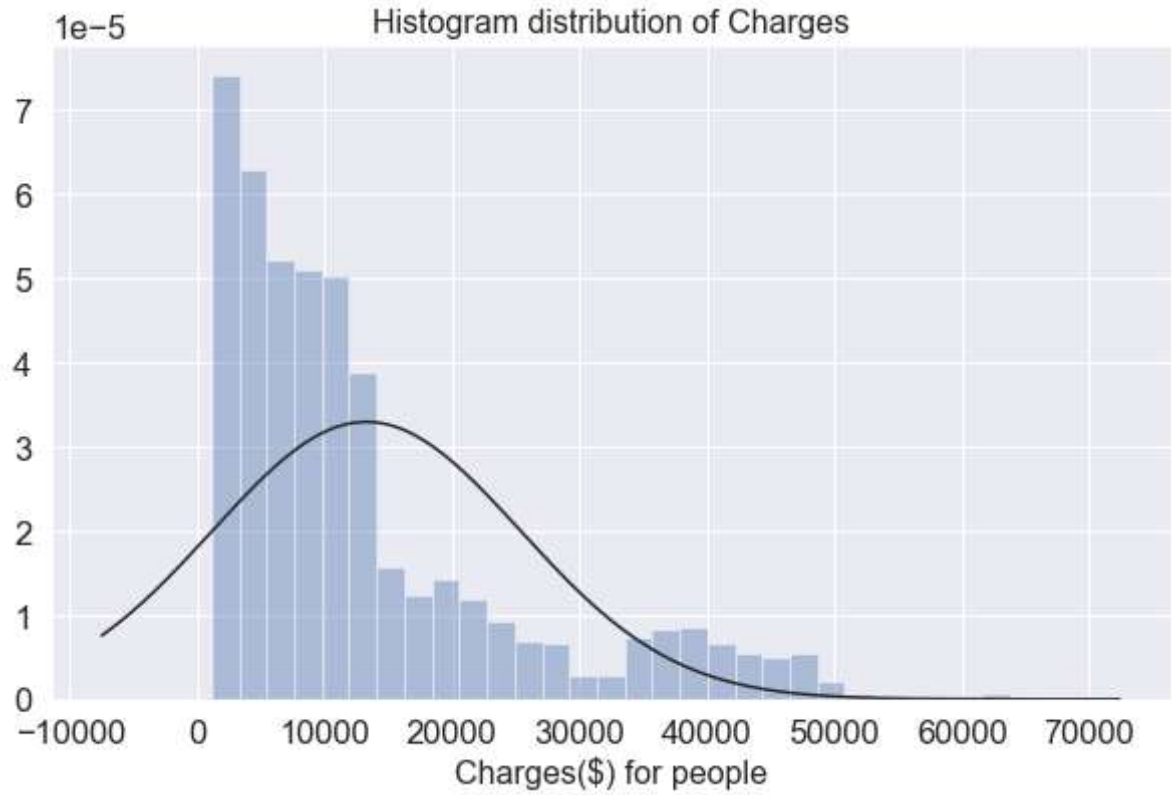
```python
#computing the normal test for charges column
normaltest(df['Charges'])
```

Out[77]:

```
NormaltestResult(statistic=336.4416065386955, pvalue=8.762608303862979e-74)
```

In [78]:

```
#plotting the distribution of Charges column.
plt.rcParams["figure.figsize"] = [10,6]
sns.set_style("darkgrid")
sns.set_context("notebook", font_scale=1.5, rc={"font.size":16,"axes.titlesize":16,"axes.labelsize":16})
sns.distplot(df['Charges'],fit=stats.norm,kde=False)
plt.title('Histogram distribution of Charges')
plt.xlabel('Charges($) for people')
plt.show()
```



Conclusion:

p-value is less than 0.05 so the null hypothesis can be rejected and as you can see in the plot the data is not normally distributed.

Pearson correlation coefficient.

In [79]:

```
# Calculate pearson coefficient and pvalue
pearson_coef, p_value = stats.pearsonr(df['Children'], df['Charges'])

# print out results
print(f'The Pearson Correlation Coefficient is {pearson_coef:.4f} with a P-value of {p_value:.4f}')
if p_value < 0.001:
    print('Since p-value is < 0.001, the correlation between Children and Charges is statistically significant,
else:
    print('Since p-value is > 0.001, the correlation between Children  and Charges is not statistically signific
```

```
The Pearson Correlation Coefficient is 0.0674 with a P-value of 0.0137
Since p-value is > 0.001, the correlation between Children  and Charges is not statistically significant.
```

In [80]:

```
# Calculate pearson coefficient and pvalue
pearson_coef, p_value = stats.pearsonr(df['Smoker'], df['Charges'])

# print out results
print(f'The Pearson Correlation Coefficient is {pearson_coef:.4f} with a P-value of {p_value:.4f}')
if p_value < 0.001:
    print('Since p-value is < 0.001, the correlation between Smoker and Charges is statistically significant, al
else:
    print('Since p-value is > 0.001, the correlation between Smoker and Charges is not statistically significant
```

```
The Pearson Correlation Coefficient is 0.7872 with a P-value of 0.0000
Since p-value is < 0.001, the correlation between Smoker and Charges is statistically significant, although the lin
ear relationship isn't extreamely strong.
```

In [81]:

```
# Calculate pearson coefficient and pvalue
pearson_coef, p_value = stats.pearsonr(df['Age'], df['Charges'])

# print out results
print(f'The Pearson Correlation Coefficient is {pearson_coef:.4f} with a P-value of {p_value:.4f}')
if p_value < 0.001:
    print('Since p-value is < 0.001, the correlation between Age and Charges is statistically significant, altho
else:
    print('Since p-value is > 0.001, the correlation between Age and Charges is not statistically significant.')
```

```
The Pearson Correlation Coefficient is 0.2983 with a P-value of 0.0000
Since p-value is < 0.001, the correlation between Age and Charges is statistically significant, although the linear
relationship isn't extreamely strong.
```

Z-Test

In [82]:

```
bygroup = df.groupby(['Region'])['Charges']
```

In [83]:
```
1 bygroup.head()
```

Out[83]:
```
0     16884.92400
1      1725.55230
2      4449.46200
3     21984.47061
4      3866.85520
5      3756.62160
6      8240.58960
7      7281.50560
8      6406.41070
9     28923.13692
10     2721.32080
11    27808.72510
12     1826.84300
15     1837.23700
16    10797.33620
17     2395.17155
18    10602.38500
19    36837.46700
20    13228.84695
24     6203.90175
Name: Charges, dtype: float64
```

In [84]:
```
1 bygroup.aggregate(['count',np.mean, np.std]).round(2)
```

Out[84]:

Region	count	mean	std
North East	324	13406.38	11255.80
North West	324	12450.84	11073.13
South East	364	14735.41	13971.10
South West	325	12346.94	11557.18

Z-Test Hypothesis -- Hypothesis and statistical test that assumes normal distribution to determine whether two population means are different. Variances are known and sample size is large.

- H0 : u <= u0
- South East Charges is higher than 15000 dollars
- H1 : u > u0
- South East charges is lower than 15000 dollars

Confidence Interval = 95%, since it is one tailed test, alpha = 0.05

Testing the hypothesis that the mean is 15000 against the alternative that it is SMALLER

- $H0{:}\mu >= \mu 0$
- $H1{:}\mu < \mu 0$

In [85]:

```
# Calculate test statistic and pvalue
(test_statistic, p_value) = ztest(df[df['Region'] == 'South East']['Charges'], value=15000, alternative='smaller

# print out results
print(f'The Test Statistic is {test_statistic:.4f} with a P-value of {p_value:.4f}')
if p_value < 0.05:
    print('Since p-value is < 0.05, we do not retain the null hypothesis.')
else:
    print('Since p-value is > 0.05, we retain the null hypothesis')
```

```
The Test Statistic is -0.3613 with a P-value of 0.3589
Since p-value is > 0.05, we retain the null hypothesis
```

Summary and Conclusion:

- This is a data of 1338 people for medical insurance cost in which most of them have age below 20.
- Female smoke less than the male
- There are more young males than young females whereas there are more old female than young male
- If a person is smoker then his/her charges increased as smoking is is positively correlated with the charges.
- South east region have maximum number of people who smoke where as Northeast have less smokers out of 4 regions.
- South east region have maximum people with 0 children.
- South east region have 0 people with 5 children.That mean this region have more young people.

- Children and charges have weak relationship.
- People who have no children smokes more may be that's why there charges are more
- Charges increased by Age as maybe because if person becomes old then eventually their charges increased.
- BMI have little effect on charges as it has weak strong relationship with charges.
- Charges and sex have negative relationship.
- The data shows that having more children does'nt increase charges.
- 70% percent charges are between 10,000 to 20,000 in all the regions
- Out of All the four regions South east people have more charges.

Type *Markdown* and LaTeX: α^2