In [2]:
```
%pip install seaborn
%pip install folium
```

```
Requirement already satisfied: seaborn in c:\users\92330\anaconda3\lib\site-packa
ges (0.12.2)
Requirement already satisfied: numpy!=1.24.0,>=1.17 in c:\users\92330\anaconda3\l
ib\site-packages (from seaborn) (1.26.4)
Requirement already satisfied: pandas>=0.25 in c:\users\92330\anaconda3\lib\site-
packages (from seaborn) (2.1.4)
Requirement already satisfied: matplotlib!=3.6.1,>=3.1 in c:\users\92330\anaconda
3\lib\site-packages (from seaborn) (3.8.0)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\92330\anaconda3\lib\s
ite-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (1.2.0)
Requirement already satisfied: cycler>=0.10 in c:\users\92330\anaconda3\lib\site-
packages (from matplotlib!=3.6.1,>=3.1->seaborn) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\92330\anaconda3\lib
\site-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (4.25.0)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\92330\anaconda3\lib
\site-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (1.4.4)
Requirement already satisfied: packaging>=20.0 in c:\users\92330\anaconda3\lib\si
te-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (23.1)
Requirement already satisfied: pillow>=6.2.0 in c:\users\92330\anaconda3\lib\site
-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (10.2.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\92330\anaconda3\lib\s
ite-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\92330\anaconda3\l
ib\site-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in c:\users\92330\anaconda3\lib\site-
packages (from pandas>=0.25->seaborn) (2023.3.post1)
Requirement already satisfied: tzdata>=2022.1 in c:\users\92330\anaconda3\lib\sit
e-packages (from pandas>=0.25->seaborn) (2023.3)
Requirement already satisfied: six>=1.5 in c:\users\92330\anaconda3\lib\site-pack
ages (from python-dateutil>=2.7->matplotlib!=3.6.1,>=3.1->seaborn) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
Collecting folium
  Downloading folium-0.16.0-py2.py3-none-any.whl.metadata (3.6 kB)
Collecting branca>=0.6.0 (from folium)
  Downloading branca-0.7.2-py3-none-any.whl.metadata (1.5 kB)
Requirement already satisfied: jinja2>=2.9 in c:\users\92330\anaconda3\lib\site-p
ackages (from folium) (3.1.3)
Requirement already satisfied: numpy in c:\users\92330\anaconda3\lib\site-package
s (from folium) (1.26.4)
Requirement already satisfied: requests in c:\users\92330\anaconda3\lib\site-pack
ages (from folium) (2.31.0)
Requirement already satisfied: xyzservices in c:\users\92330\anaconda3\lib\site-p
ackages (from folium) (2022.9.0)
Requirement already satisfied: MarkupSafe>=2.0 in c:\users\92330\anaconda3\lib\si
te-packages (from jinja2>=2.9->folium) (2.1.3)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\92330\anacond
a3\lib\site-packages (from requests->folium) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\users\92330\anaconda3\lib\site-
packages (from requests->folium) (3.4)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\92330\anaconda3\lib
\site-packages (from requests->folium) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\92330\anaconda3\lib
\site-packages (from requests->folium) (2024.2.2)
Downloading folium-0.16.0-py2.py3-none-any.whl (100 kB)
   ---------------------------------------- 0.0/100.0 kB ? eta -:--:--
   ---- ----------------------------------- 10.2/100.0 kB ? eta -:--:--
   ---------------------- --------------- 61.4/100.0 kB 825.8 kB/s eta 0:00:01
   ---------------------------------------- 100.0/100.0 kB 823.6 kB/s eta 0:00:00
Downloading branca-0.7.2-py3-none-any.whl (25 kB)
Installing collected packages: branca, folium
```

```
Successfully installed branca-0.7.2 folium-0.16.0
Note: you may need to restart the kernel to use updated packages.
```

In [3]:
```
import numpy as np
import pandas as pd
%matplotlib inline
import matplotlib as mpl
import matplotlib.pyplot as plt
import seaborn as sns
import folium
```

In [6]:
```
df = pd.read_csv(r'https://cf-courses-data.s3.us.cloud-object-storage.appdomain.
df
```

Out[6]:

	Date	Year	Month	Recession	Consumer_Confidence	Seasonality_Weight	
0	1/31/1980	1980	Jan	1	108.24	0.50	2
1	2/29/1980	1980	Feb	1	98.75	0.75	2
2	3/31/1980	1980	Mar	1	107.48	0.20	2
3	4/30/1980	1980	Apr	1	115.01	1.00	3
4	5/31/1980	1980	May	1	98.72	0.20	2
...	...	...	...	...	...	...	
523	8/31/2023	2023	Aug	0	103.36	0.25	2
524	9/30/2023	2023	Sep	0	101.55	0.07	2
525	10/31/2023	2023	Oct	0	124.66	0.12	1
526	11/30/2023	2023	Nov	0	97.09	0.25	1
527	12/31/2023	2023	Dec	0	95.92	0.34	2

528 rows × 15 columns

In [7]:
```
df.describe()
```

Out[7]:

	Year	Recession	Consumer_Confidence	Seasonality_Weight	Price
count	528.000000	528.000000	528.000000	528.000000	528.000000
mean	2001.500000	0.214015	101.140170	0.575795	24964.991956
std	12.710467	0.410526	10.601154	0.454477	4888.073433
min	1980.000000	0.000000	73.900000	0.000000	8793.663000
25%	1990.750000	0.000000	94.035000	0.250000	21453.300500
50%	2001.500000	0.000000	100.740000	0.500000	25038.691500
75%	2012.250000	0.000000	108.240000	0.750000	28131.684750
max	2023.000000	1.000000	131.670000	1.500000	44263.657000

In [8]:
```
df.columns
```

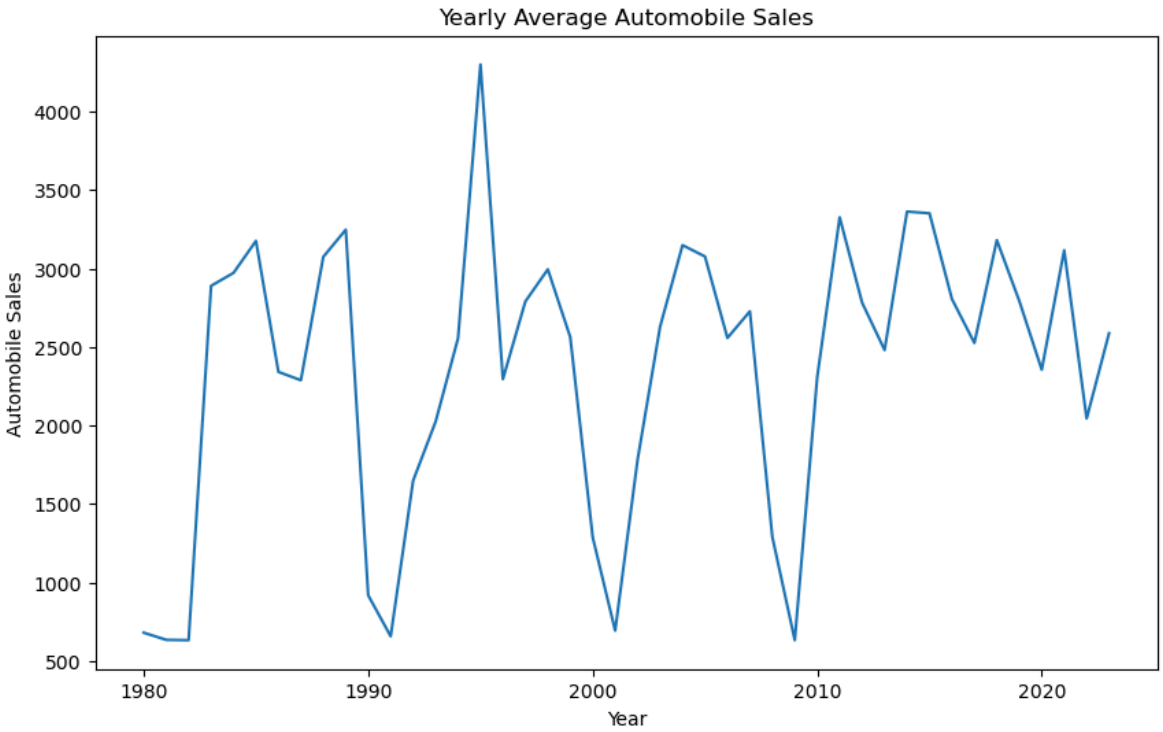
Out[8]:
```
Index(['Date', 'Year', 'Month', 'Recession', 'Consumer_Confidence',
       'Seasonality_Weight', 'Price', 'Advertising_Expenditure', 'Competition',
       'GDP', 'Growth_Rate', 'unemployment_rate', 'Automobile_Sales',
       'Vehicle_Type', 'City'],
      dtype='object')
```

In [9]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 528 entries, 0 to 527
Data columns (total 15 columns):
 #   Column                  Non-Null Count  Dtype  
---  ------                  --------------  -----  
 0   Date                    528 non-null    object 
 1   Year                    528 non-null    int64  
 2   Month                   528 non-null    object 
 3   Recession               528 non-null    int64  
 4   Consumer_Confidence     528 non-null    float64
 5   Seasonality_Weight      528 non-null    float64
 6   Price                   528 non-null    float64
 7   Advertising_Expenditure 528 non-null    int64  
 8   Competition             528 non-null    int64  
 9   GDP                     528 non-null    float64
 10  Growth_Rate             528 non-null    float64
 11  unemployment_rate       528 non-null    float64
 12  Automobile_Sales        528 non-null    float64
 13  Vehicle_Type            528 non-null    object 
 14  City                    528 non-null    object 
dtypes: float64(7), int64(4), object(4)
memory usage: 62.0+ KB
```

TASK 1.1: Develop a Line chart using the functionality of pandas to show how automobile sales fluctuate from year to year

In [10]:
```
df_line = df.groupby(df['Year'])['Automobile_Sales'].mean()
plt.figure(figsize=(10, 6))
df_line.plot(kind = 'line')
plt.xlabel('Year')
plt.ylabel('Automobile Sales')
plt.title('Yearly Average Automobile Sales')
plt.show()
```

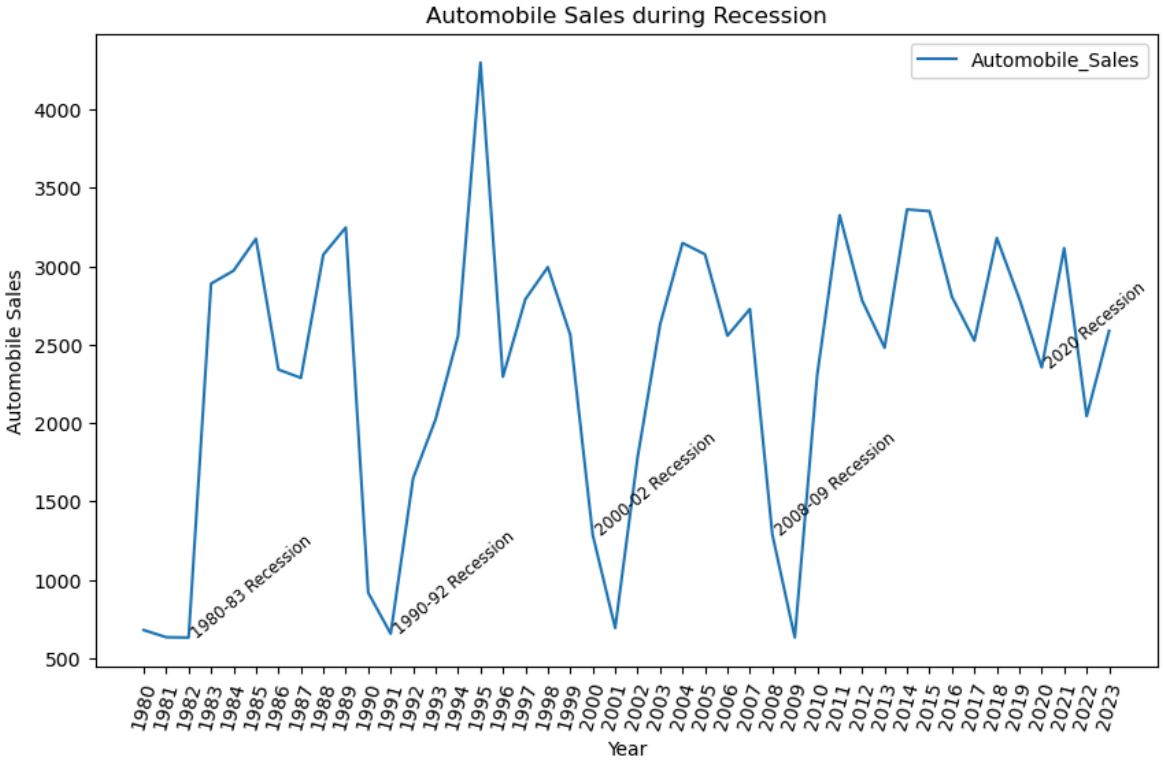


Showing Recession Periods Text

In [11]:
```
df2=df[df['Recession']==1]
df2['Year'].unique()
```

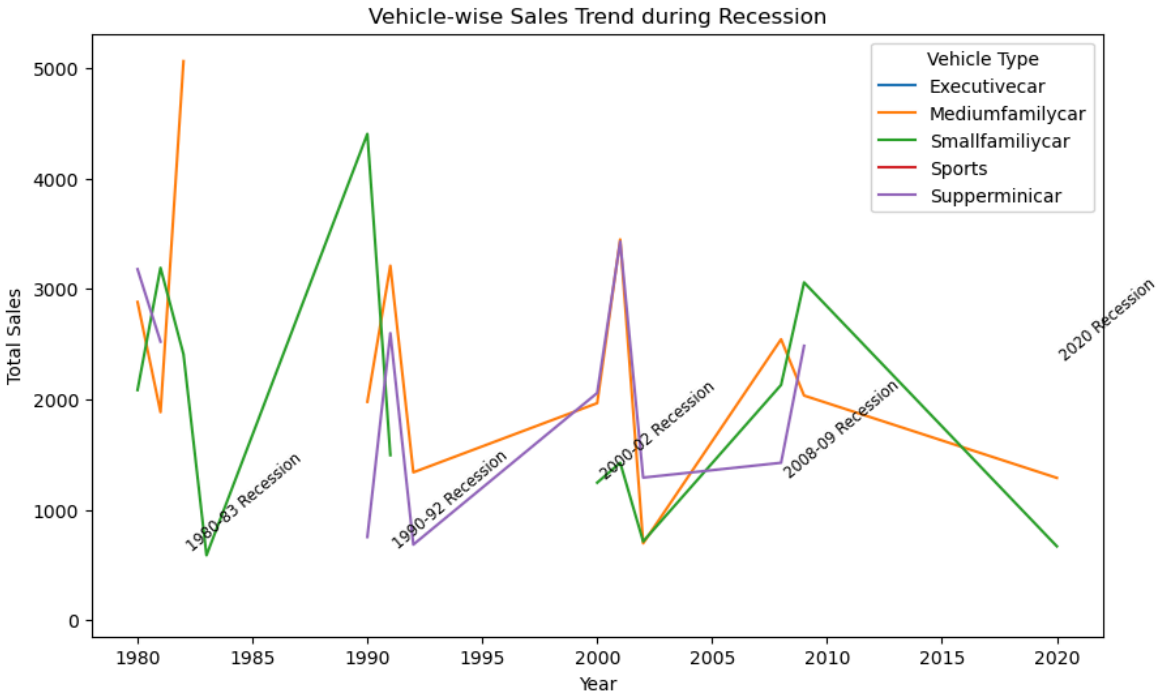
Out[11]:
```
array([1980, 1981, 1982, 1983, 1990, 1991, 1992, 2000, 2001, 2002, 2008,
       2009, 2020], dtype=int64)
```

In [12]:
```
plt.figure(figsize=(10, 6))
df_line.plot(kind = 'line')
plt.xticks(list(range(1980,2024)), rotation = 75)
plt.xlabel('Year')
plt.ylabel('Automobile Sales')
plt.title('Automobile Sales during Recession')
plt.text(1982, df_line[1982], '1980-83 Recession', size= 'small', rotation = 40)
plt.text(1991, df_line[1991], '1990-92 Recession', size= 'small', rotation=40)
plt.text(2000, df_line[2000], '2000-02 Recession', size= 'small', rotation=40)
plt.text(2008, df_line[2008], '2008-09 Recession', size= 'small', rotation=40)
plt.text(2020, df_line[2020], '2020 Recession', size= 'small', rotation=40)
plt.legend()
plt.show()
```



TASK 1.2: Plot different lines for categories of vehicle type and analyse the trend to answer the question Is there a noticeable difference in sales trends between different vehicle types during recession periods?

In [13]:
```
df_Vlines = df[df['Recession'] == 1].groupby(['Year', 'Vehicle_Type'])['Automobi
plt.figure(figsize=(10, 6))
df_Vlines.plot(kind='line', ax=plt.gca())
plt.xlabel('Year')
plt.ylabel('Total Sales')
plt.title('Vehicle-wise Sales Trend during Recession')
plt.text(1982, df_line[1982], '1980-83 Recession', size= 'small', rotation = 40)
plt.text(1991, df_line[1991], '1990-92 Recession', size= 'small', rotation=40)
plt.text(2000, df_line[2000], '2000-02 Recession', size= 'small', rotation=40)
plt.text(2008, df_line[2008], '2008-09 Recession', size= 'small', rotation=40)
plt.text(2020, df_line[2020], '2020 Recession', size= 'small', rotation=40)
plt.legend(title='Vehicle Type')
plt.show()
```



Comments: Data shows that superminicar and smallfamilycar sales kept on increased although at low rates. However, sales of Sports type vehicles' declined because of the high cost of the vehicle.

TASK 1.2: Plot different lines for categories of vehicle type and analyse the trend to answer the question Is there a noticeable difference in sales trends between different vehicle types during recession periods?

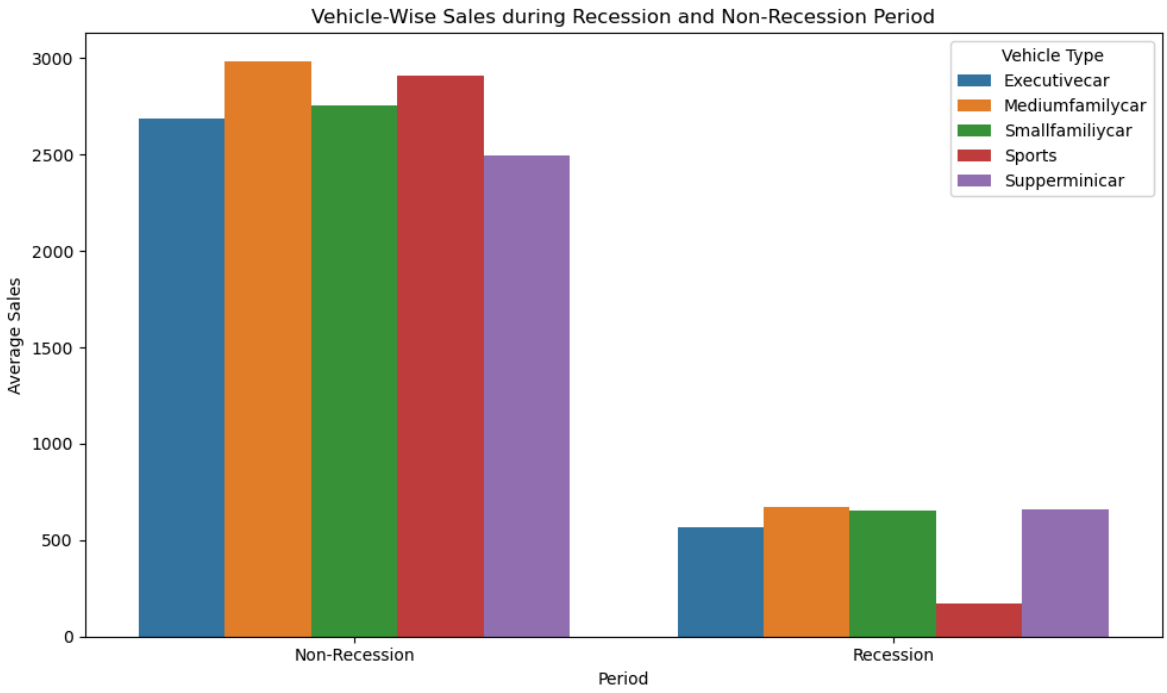
In [14]:
```
dd = df.groupby(['Recession', 'Vehicle_Type'])['Automobile_Sales'].mean().reset_
dd
```

Out[14]:

	Recession	Vehicle_Type	Automobile_Sales
0	0	Executivecar	2686.436232
1	0	Mediumfamilycar	2981.501935
2	0	Smallfamiliycar	2752.658140
3	0	Sports	2910.636264
4	0	Supperminicar	2495.242222
5	1	Executivecar	564.000000
6	1	Mediumfamilycar	674.847619
7	1	Smallfamiliycar	650.733333
8	1	Sports	170.333333
9	1	Supperminicar	659.270968

In [15]:
```
plt.figure(figsize=(10, 6))
sns.barplot(x='Recession', y='Automobile_Sales', hue='Vehicle_Type', data=dd)
plt.xticks(ticks=[0, 1], labels=['Non-Recession', 'Recession'])
plt.xlabel('Period')
```

```
plt.ylabel('Average Sales')
plt.title('Vehicle-Wise Sales during Recession and Non-Recession Period')
plt.legend(title='Vehicle Type')
plt.tight_layout()
plt.show()
```

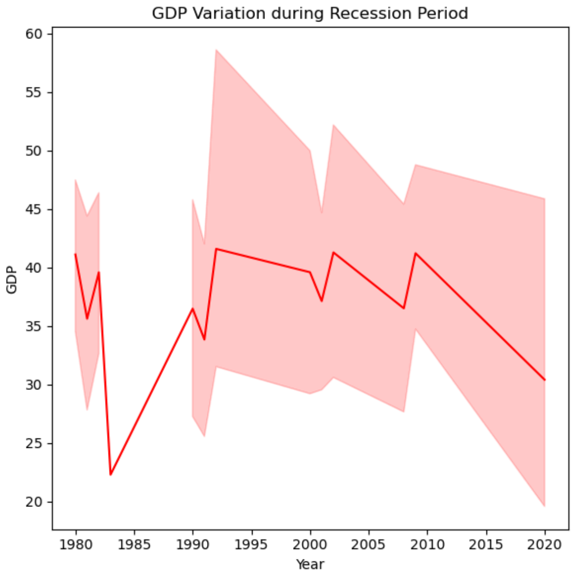


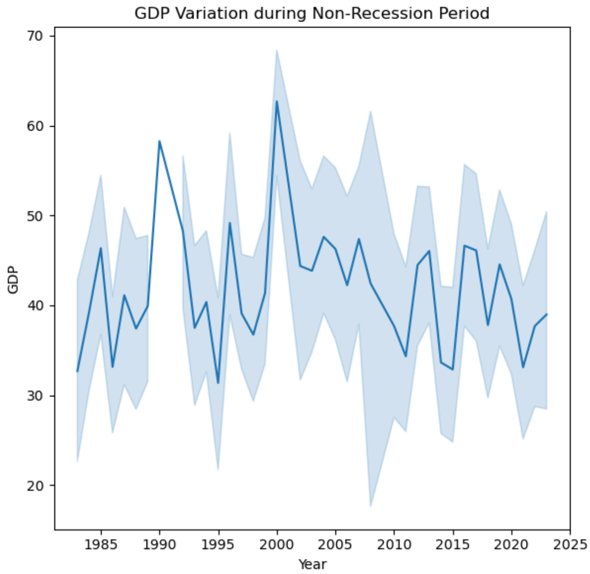
Comments: The Bar Chart shows that during the recession period, the sales of all vehicels have declined (with sports vehicles being affected the most)

TASK 1.4: Use sub plotting to compare the variations in GDP during recession and non-recession period by developing line plots for each period

In [16]:
```
rec_df = df[df['Recession'] == 1]
non_rec_df = df[df['Recession'] == 0]

fig, (ax0, ax1) = plt.subplots(nrows=1, ncols=2, figsize=(12, 6))

sns.lineplot(x='Year', y='GDP', data=rec_df, ax=ax0, c='red')
ax0.set_title('GDP Variation during Recession Period')
ax0.set_xlabel('Year')
ax0.set_ylabel('GDP')

sns.lineplot(x='Year', y='GDP', data=non_rec_df, ax=ax1)
ax1.set_title('GDP Variation during Non-Recession Period')
ax1.set_xlabel('Year')
ax1.set_ylabel('GDP')

plt.tight_layout()
plt.show()
```

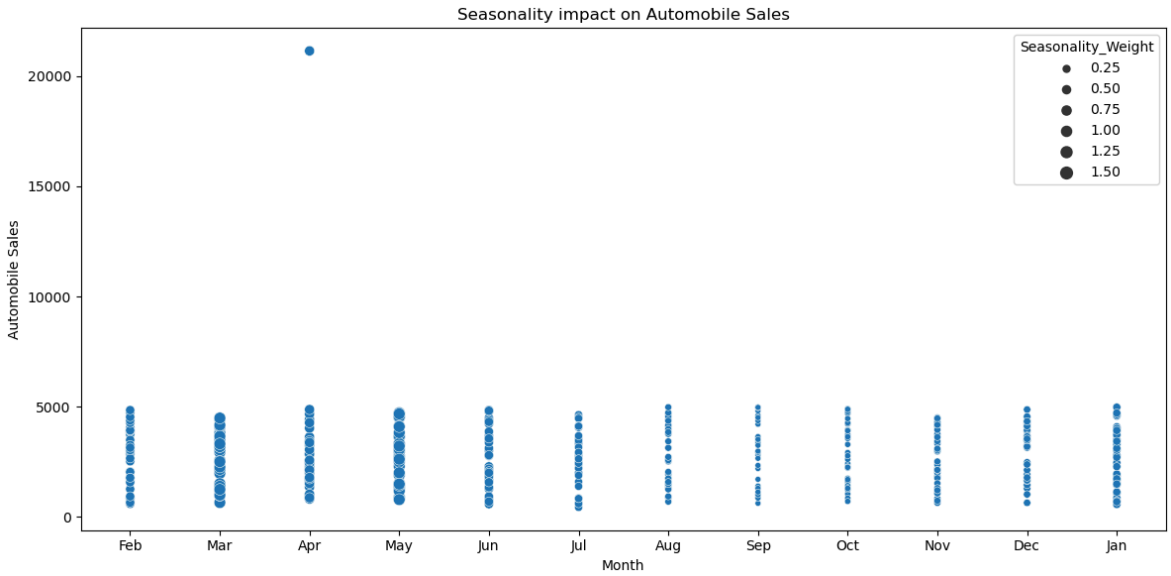
```
C:\Users\92330\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119: FutureWarnin
g: use_inf_as_na option is deprecated and will be removed in a future version. Co
nvert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
C:\Users\92330\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119: FutureWarnin
g: use_inf_as_na option is deprecated and will be removed in a future version. Co
nvert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
C:\Users\92330\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119: FutureWarnin
g: use_inf_as_na option is deprecated and will be removed in a future version. Co
nvert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
C:\Users\92330\anaconda3\Lib\site-packages\seaborn\_oldcore.py:1119: FutureWarnin
g: use_inf_as_na option is deprecated and will be removed in a future version. Co
nvert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
```





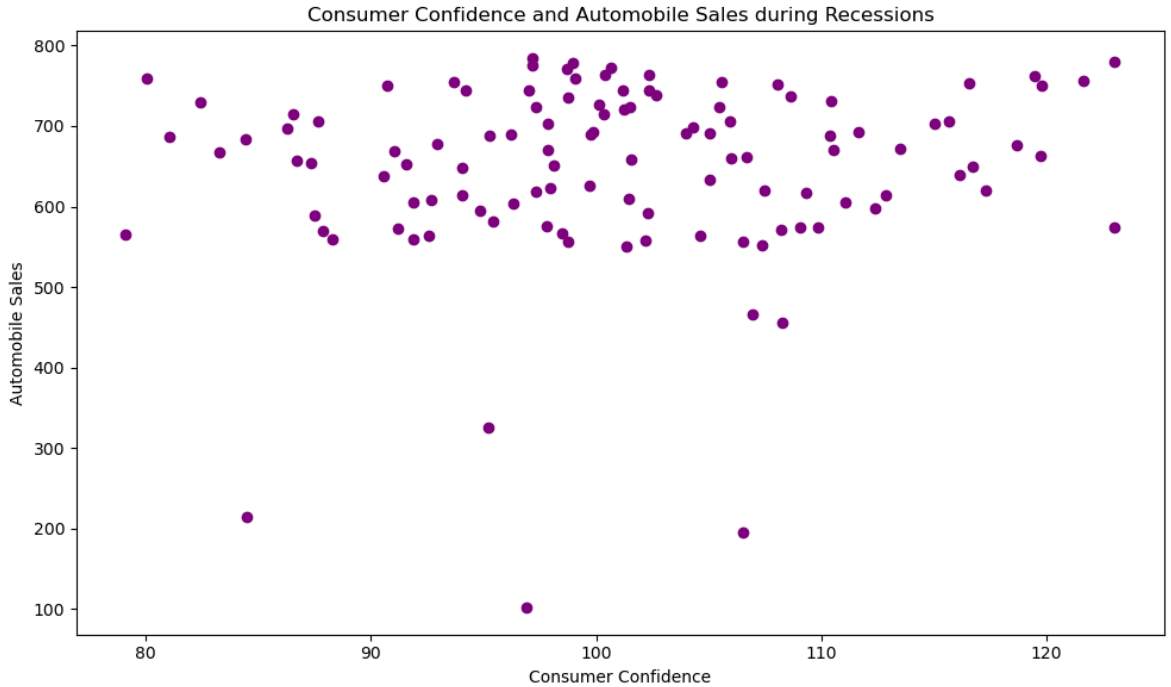
TASK 1.5: Develop a Bubble plot for displaying the impact of seasonality on Automobile Sales.

In [17]:
```
non_rec_df = df[df['Recession'] == 0]

s = non_rec_df['Seasonality_Weight']

plt.figure(figsize=(12, 6))
sns.scatterplot(data=non_rec_df, x='Month', size=s, y='Automobile_Sales')
plt.xlabel('Month')
plt.ylabel('Automobile Sales')
plt.title('Seasonality impact on Automobile Sales')
plt.tight_layout()
plt.show()
```



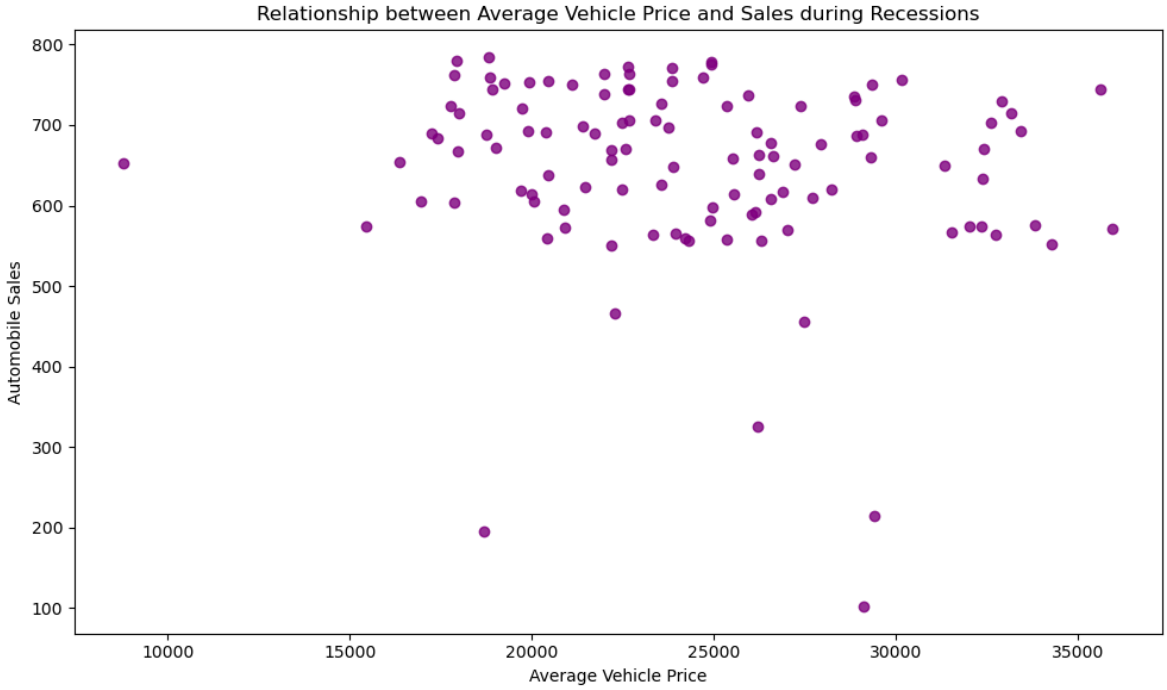
TASK 1.6: Use the functionality of Matplotlib to develop a scatter plot to identify the correlation between average vehicle price relate to the sales volume during recessions.

In [18]:
```
rec_df = df[df['Recession'] == 1]

plt.figure(figsize=(10, 6))
plt.scatter(rec_df['Consumer_Confidence'], rec_df['Automobile_Sales'], c='purple
plt.xlabel('Consumer Confidence')
plt.ylabel('Automobile Sales')
plt.title('Consumer Confidence and Automobile Sales during Recessions')
plt.tight_layout()
plt.show()
```



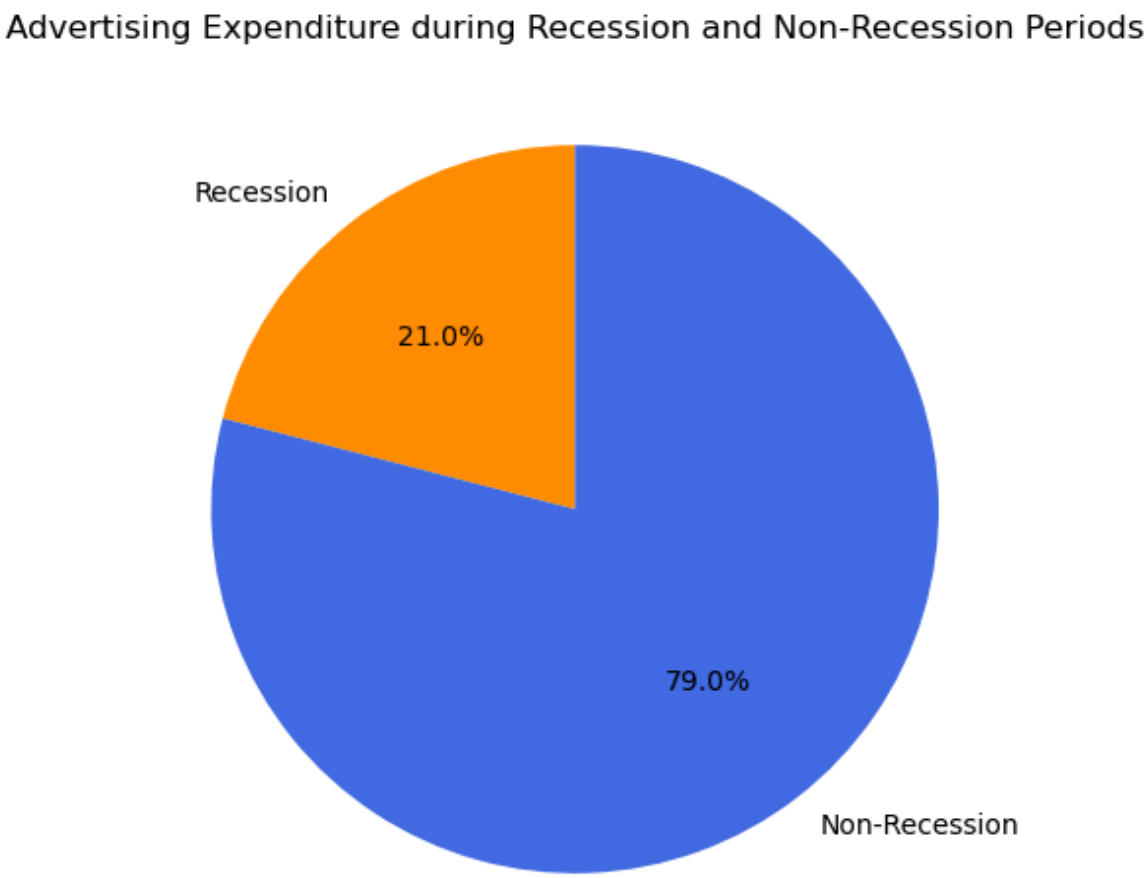
How does the average vehicle price relate to the sales volume during recessions?

In [19]:
```
plt.figure(figsize=(10, 6))
plt.scatter(rec_df['Price'], rec_df['Automobile_Sales'], alpha=0.8, color='purpl
plt.xlabel('Average Vehicle Price')
plt.ylabel('Automobile Sales')
plt.title('Relationship between Average Vehicle Price and Sales during Recession
plt.tight_layout()
plt.show()
```



TASK 1.7: Create a pie chart to display the portion of advertising expenditure of XYZAutomotives during recession and non-recession periods.

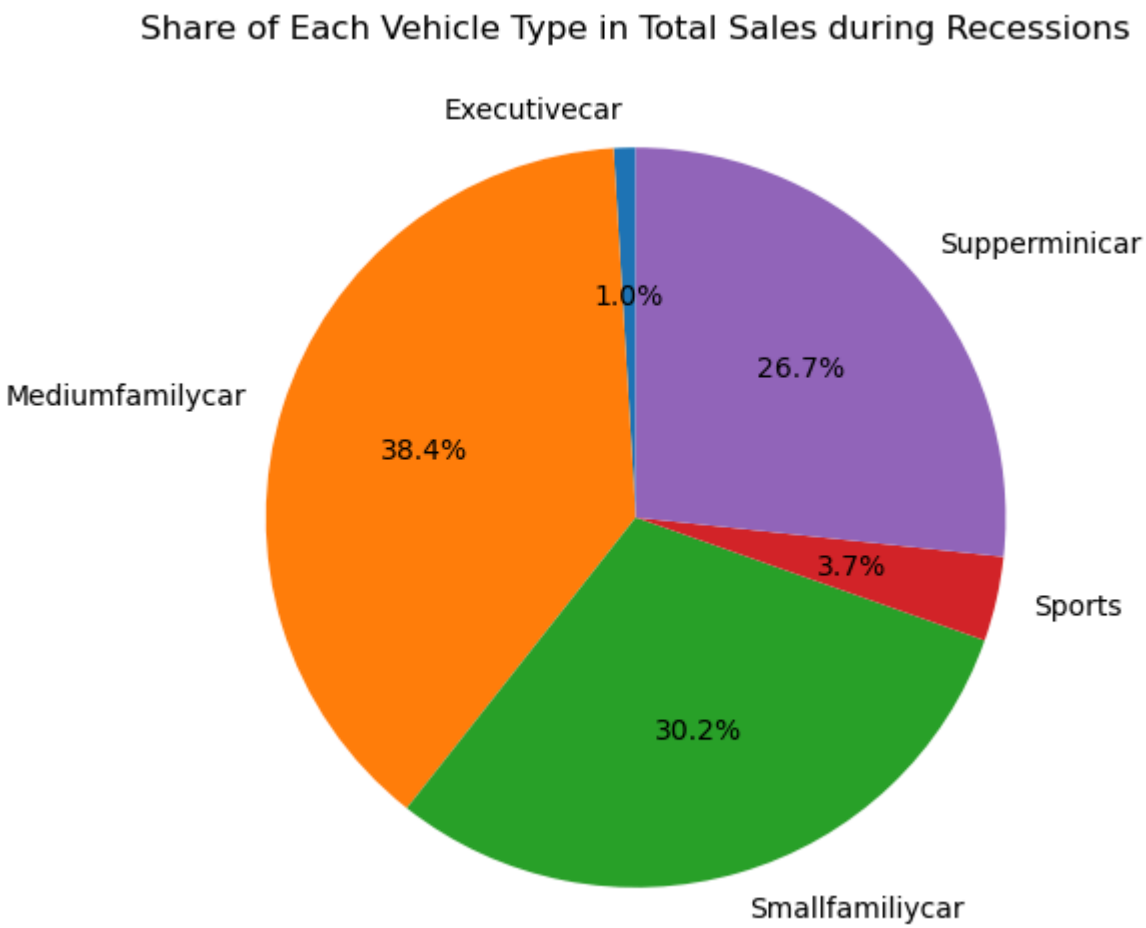
In [20]:
```
rec_df = df[df['Recession'] == 1]
non_rec_df = df[df['Recession'] == 0]

RAtotal = rec_df['Advertising_Expenditure'].sum()
NRAtotal = non_rec_df['Advertising_Expenditure'].sum()

plt.figure(figsize=(10, 6))
labels = ['Recession', 'Non-Recession']
pie = [RAtotal, NRAtotal]
plt.pie(pie, labels=labels, autopct='%1.1f%%', startangle=90, colors=['darkorang
plt.title('Advertising Expenditure during Recession and Non-Recession Periods')


plt.show()
```



Comments: Pie chart shows that ABCAutomotives has been spending much more on the advertisements during non-recession periods as compared to during recession times

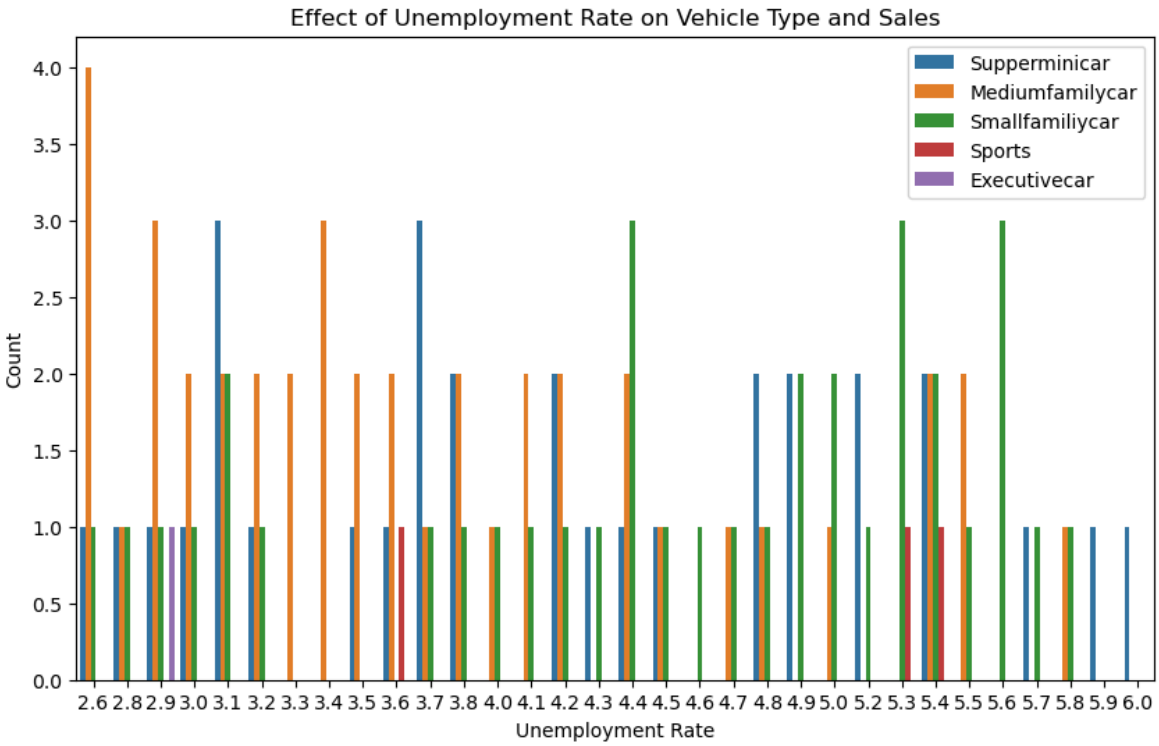
TASK 1.8: Develop a pie chart to display the total Advertisement expenditure for each vehicle type during recession period.

In [21]:
```
Rdata = df[df['Recession'] == 1]

VTsales = Rdata.groupby('Vehicle_Type')['Advertising_Expenditure'].sum()

plt.figure(figsize=(10, 6))

labels = VTsales.index
sizes = VTsales.values
plt.pie(sizes, labels=labels, autopct='%1.1f%%', startangle=90)
plt.title('Share of Each Vehicle Type in Total Sales during Recessions')
plt.show()
```



TASK 1.9: Develop a lineplot to analyse the effect of the unemployment rate on vehicle type and sales during the Recession Period

In [22]:
```
Rdata= df[df['Recession'] == 1]

plt.figure(figsize=(10, 6))
sns.countplot(data=Rdata, x='unemployment_rate', hue='Vehicle_Type')

plt.xlabel('Unemployment Rate')
plt.ylabel('Count')
plt.title('Effect of Unemployment Rate on Vehicle Type and Sales')
plt.legend(loc='upper right')

plt.show()
```



Comments: From the count plot visualizing the effect of the unemployment rate on vehicle type sales during the recession, the following observations can be made:

Superminicar: As the unemployment rate increases, sales of superminicars tend to increase. This suggests that during times of economic downturn, consumers may prefer more economical and affordable vehicles.

Smallfamilycar: Similarly, the sales of small family cars also show an upward trend with increasing unemployment rates. This further supports the notion that during a recession, consumers might be more inclined towards vehicles that are more cost-effective and provide better value for money.

Mediumminicar: The sales trend for medium minicars appears to be somewhat consistent across varying unemployment rates. This suggests that medium minicars might be a popular choice irrespective of the economic conditions, possibly due to their balance between affordability and features.

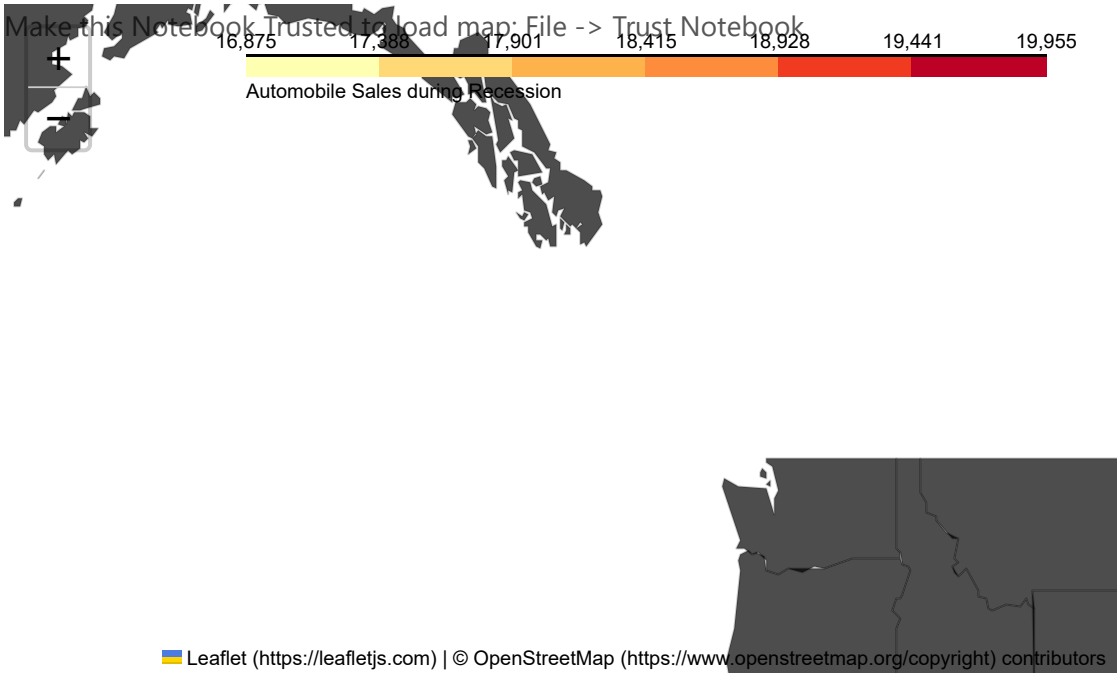
In summary, during recession periods characterized by higher unemployment rates, there seems to be a shift in consumer preference towards more affordable vehicle options. This behavior can be attributed to the financial constraints and uncertainty that people face during such times, leading them to make more conservative spending decisions.

TASK 1.10 Create a map on the hightest sales region/offices of the company during recession period using folium library

In [25]:
```
import folium

Rdata = df[df['Recession'] == 1]

sales_by_city = Rdata.groupby('City')['Automobile_Sales'].sum().reset_index()
```

```
map1 = folium.Map(location=[37.0902, -95.7129], zoom_start=4)
choropleth = folium.Choropleth(
    geo_data= 'https://cf-courses-data.s3.us.cloud-object-storage.appdomain.clou
    data=sales_by_city,
    columns=['City', 'Automobile_Sales'],
    key_on='feature.properties.name',
    fill_color='YlOrRd',
    fill_opacity=0.7,
    line_opacity=0.2,
    legend_name='Automobile Sales during Recession'
).add_to(map1)


choropleth.geojson.add_child(
    folium.features.GeoJsonTooltip(['name'], labels=True)
)

map1
```

Out[25]:



In [ ]: