Ex 2: Car Sales

- Cho dữ liệu bán xe hơi 4 năm trong tập tin Retail2.xlsx.
- Thực hiện việc dự báo bán xe hơi sử dụng thuật toán ARIMA
- Cho biết trong 6 tháng sau 4 năm trên thì giá trị bán sản phẩm như thế nào?

In [2]:
```
import pandas as pd
```

In [3]:
```
data = pd.read_excel("Retail2.xlsx", index_col=0)
```

In [4]:
```
data.index = pd.to_datetime(data.index)
```

In [5]:
```
data.index
```

Out[5]:
```
DatetimeIndex(['2015-06-01', '2015-07-01', '2015-08-01', '2015-09-01',
               '2015-10-01', '2015-11-01', '2015-12-01', '2016-01-01',
               '2016-02-01', '2016-03-01', '2016-04-01', '2016-05-01',
               '2016-06-01', '2016-07-01', '2016-08-01', '2016-09-01',
               '2016-10-01', '2016-11-01', '2016-12-01', '2017-01-01',
               '2017-02-01', '2017-03-01', '2017-04-01', '2017-05-01',
               '2017-06-01', '2017-07-01', '2017-08-01', '2017-09-01',
               '2017-10-01', '2017-11-01', '2017-12-01', '2018-01-01',
               '2018-02-01', '2018-03-01', '2018-04-01', '2018-05-01',
               '2018-06-01', '2018-07-01', '2018-08-01', '2018-09-01',
               '2018-10-01', '2018-11-01', '2018-12-01', '2019-01-01',
               '2019-02-01', '2019-03-01', '2019-04-01', '2019-05-01',
               '2019-06-01'],
              dtype='datetime64[ns]', name='Date', freq=None)
```

In [6]:
```
data.head()
```

Out[6]:

Date	Car sales
2015-06-01	67
2015-07-01	68
2015-08-01	66
2015-09-01	86
2015-10-01	84

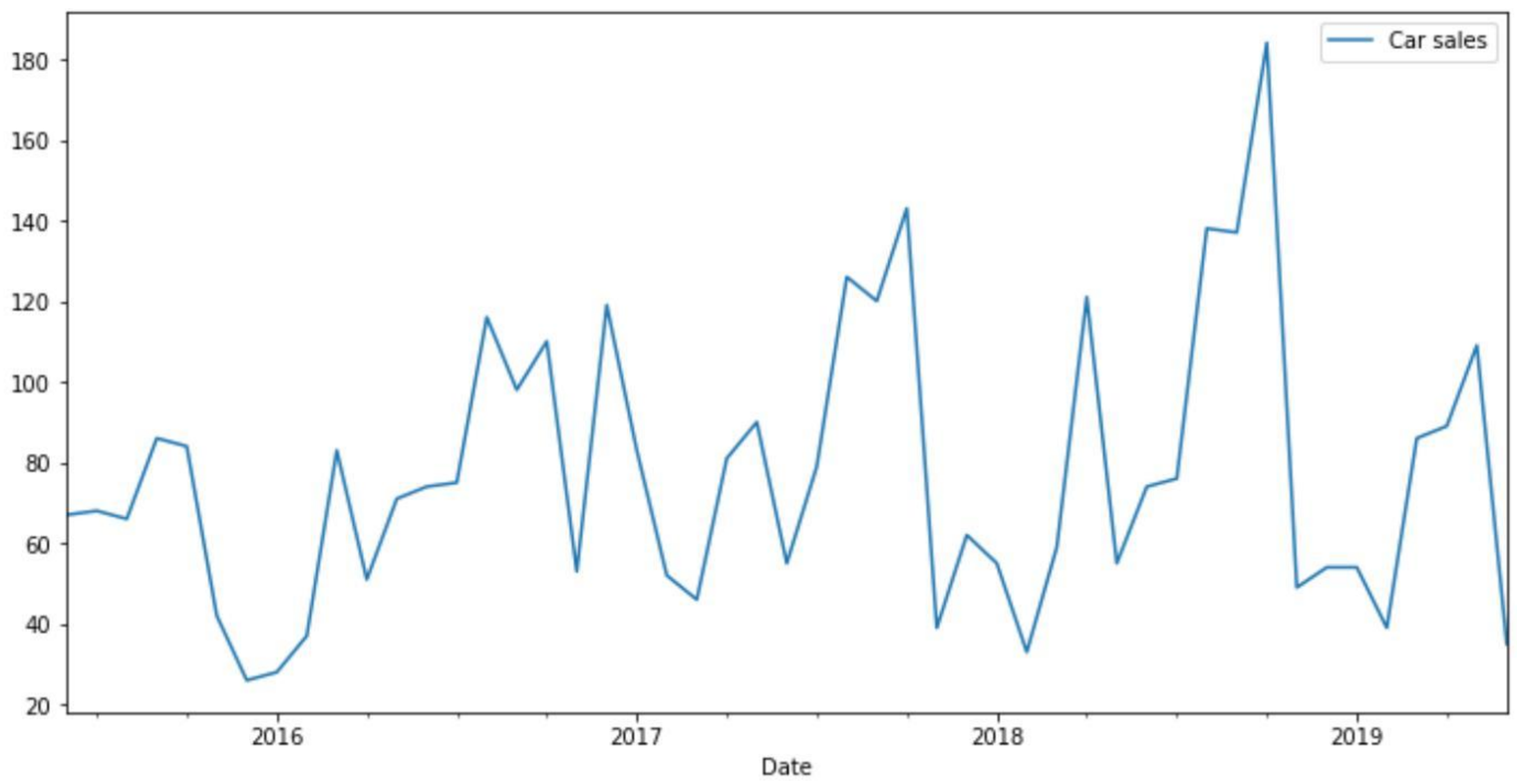
In [7]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 49 entries, 2015-06-01 to 2019-06-01
Data columns (total 1 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Car sales  49 non-null     int64
dtypes: int64(1)
memory usage: 784.0 bytes
```

In [8]:
```
import matplotlib.pyplot as plt
```

In [9]:
```
data.plot(figsize=(12,6))
```

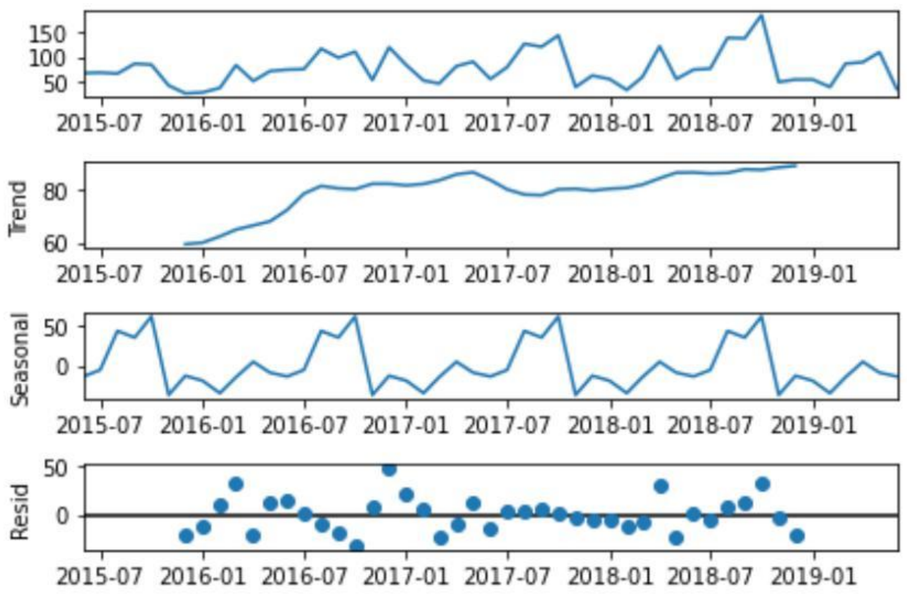
Out[9]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f78e3ed0978>
```



In [10]:
```
from statsmodels.tsa.seasonal import seasonal_decompose
result = seasonal_decompose(data, model='additive')
result
```

Out[10]: <statsmodels.tsa.seasonal.DecomposeResult at 0x7f78e3ed0390>

In [11]:
```
fig = result.plot()
plt.show()
```



Áp dụng auto_arima để xây dựng mô hình

In [13]:
```
from pmdarima import auto_arima
```

In [14]:
```
stepwise_model = auto_arima(data, start_p=2, start_q=2,
                            max_p=5, max_q=5, m=12,
                            start_P=1, seasonal=True,
                            d=1, D=1, trace=True,
                            error_action='ignore',
                            suppress_warnings=True,
                            stepwise=True)
```

```
Performing stepwise search to minimize aic
 ARIMA(2,1,2)(1,1,1)[12]             : AIC=inf, Time=0.90 sec
 ARIMA(0,1,0)(0,1,0)[12]             : AIC=371.830, Time=0.02 sec
 ARIMA(1,1,0)(1,1,0)[12]             : AIC=363.598, Time=0.15 sec
 ARIMA(0,1,1)(0,1,1)[12]             : AIC=353.684, Time=0.37 sec
 ARIMA(0,1,1)(0,1,0)[12]             : AIC=355.305, Time=0.06 sec
 ARIMA(0,1,1)(1,1,1)[12]             : AIC=355.684, Time=0.57 sec
 ARIMA(0,1,1)(0,1,2)[12]             : AIC=355.683, Time=1.12 sec
 ARIMA(0,1,1)(1,1,0)[12]             : AIC=354.150, Time=0.27 sec
 ARIMA(0,1,1)(1,1,2)[12]             : AIC=inf, Time=2.05 sec
 ARIMA(0,1,0)(0,1,1)[12]             : AIC=368.014, Time=0.17 sec
 ARIMA(1,1,1)(0,1,1)[12]             : AIC=355.567, Time=0.75 sec
 ARIMA(0,1,2)(0,1,1)[12]             : AIC=355.575, Time=0.44 sec
 ARIMA(1,1,0)(0,1,1)[12]             : AIC=362.459, Time=0.25 sec
 ARIMA(1,1,2)(0,1,1)[12]             : AIC=357.552, Time=0.59 sec
 ARIMA(0,1,1)(0,1,1)[12] intercept   : AIC=inf, Time=0.67 sec

Best model:  ARIMA(0,1,1)(0,1,1)[12]
Total fit time: 8.409 seconds
```

In [15]:
```
print(stepwise_model.aic())
```

```
353.68422726240806
```

In [16]:
```
train = data.loc['2015-06-01':'2018-02-01']
test = data.loc['2018-02-01':]
```

In [17]:
```
test.head()
```

Out[17]:

Date	Car sales
2018-02-01	33
2018-03-01	59
2018-04-01	121
2018-05-01	55
2018-06-01	74

In [18]:
```
len(test)
```

Out[18]: 17

Bước 2: Fit mô hình

In [19]:
```
stepwise_model.fit(train)
```

Out[19]:
```
ARIMA(maxiter=50, method='lbfgs', order=(0, 1, 1), out_of_sample_size=0,
      scoring='mse', scoring_args={}, seasonal_order=(0, 1, 1, 12),
      start_params=None, suppress_warnings=True, trend=None,
      with_intercept=False)
```

Bước 3: Dự đoán kết quả

In [22]:
```
future_forecast = stepwise_model.predict(n_periods=len(test)) # so khoang thoi gian can du doan
```

In [23]:
```
future_forecast
```

Out[23]:
```
array([ 68.17928646,  69.68709326,  84.1672112 ,  75.47203818,
        84.13934054, 112.79966058, 111.47171382, 122.45976331,
        54.81572387,  79.13174188,  65.47015201,  50.80872709,
        75.85973745,  77.36754425,  91.84766219,  83.15248917,
        91.81979153])
```

In [24]:
```
from sklearn.metrics import mean_absolute_error
```

In [25]:
```
mean_absolute_error(test['Car sales'], future_forecast)
```

Out[25]:
```
29.186078315622016
```

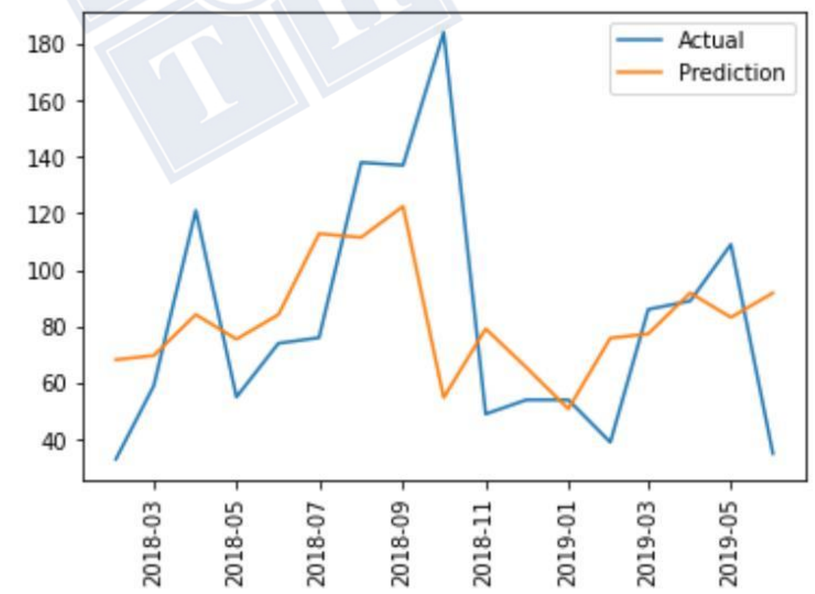
In [26]:
```
future_forecast = pd.DataFrame(future_forecast,
                               index = test.index,
                               columns=['Prediction'])
df_merge = test.join(future_forecast)
df_merge.tail()
```

Out[26]:

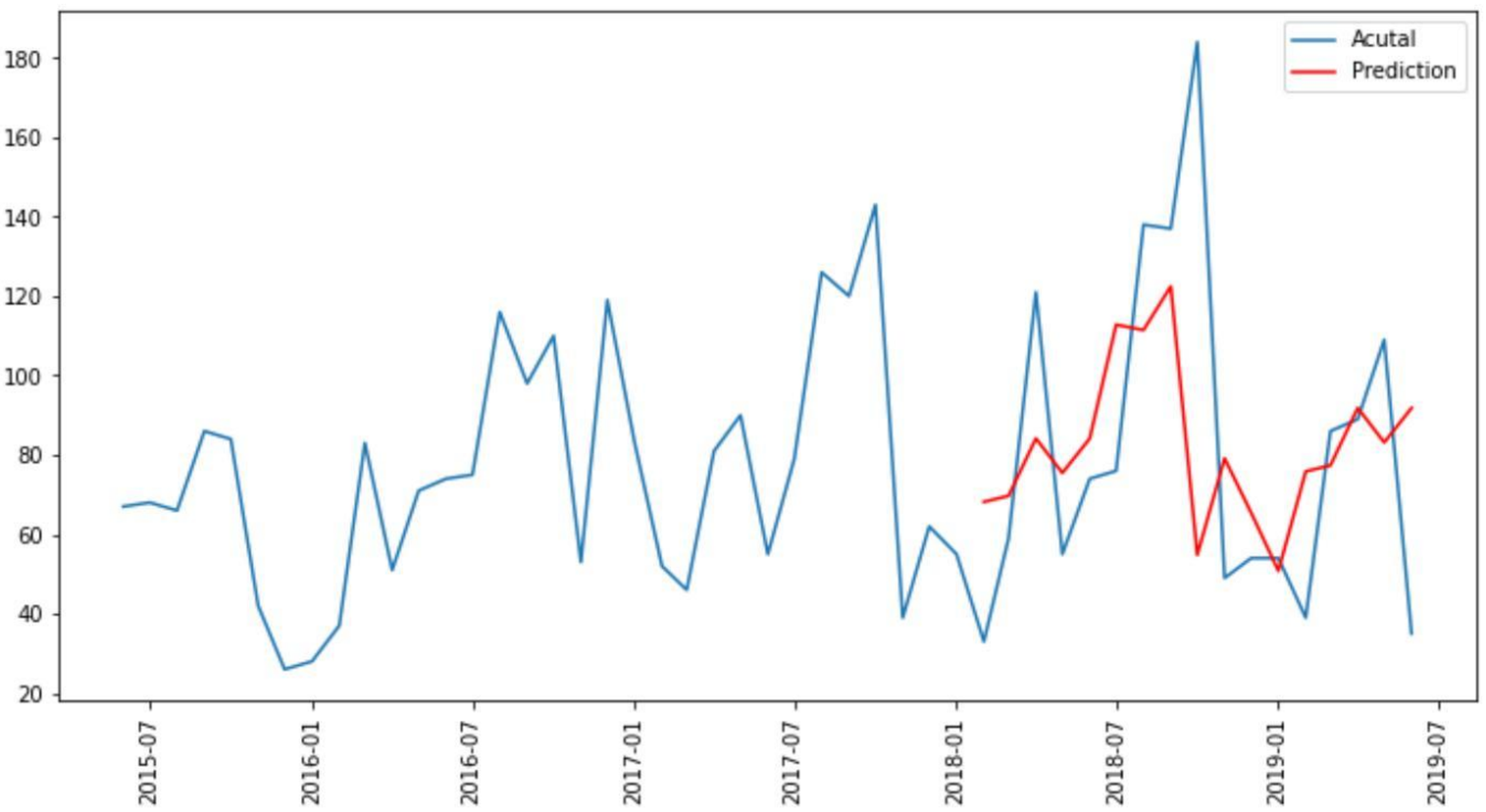
Date	Car sales	Prediction
2019-02-01	39	75.859737
2019-03-01	86	77.367544
2019-04-01	89	91.847662
2019-05-01	109	83.152489
2019-06-01	35	91.819792

Bước 4: Trực quan hóa dữ liệu

In [27]:
```
plt.plot(test, label='Actual')
plt.plot(future_forecast, label='Prediction')
plt.xticks(rotation='vertical')
plt.legend()
plt.show()
```



In [28]:
```
plt.figure(figsize=(12,6))
plt.plot(data, label='Acutal')
plt.plot(future_forecast, label='Prediction', color='red')
plt.xticks(rotation='vertical')
plt.legend()
plt.show()
```

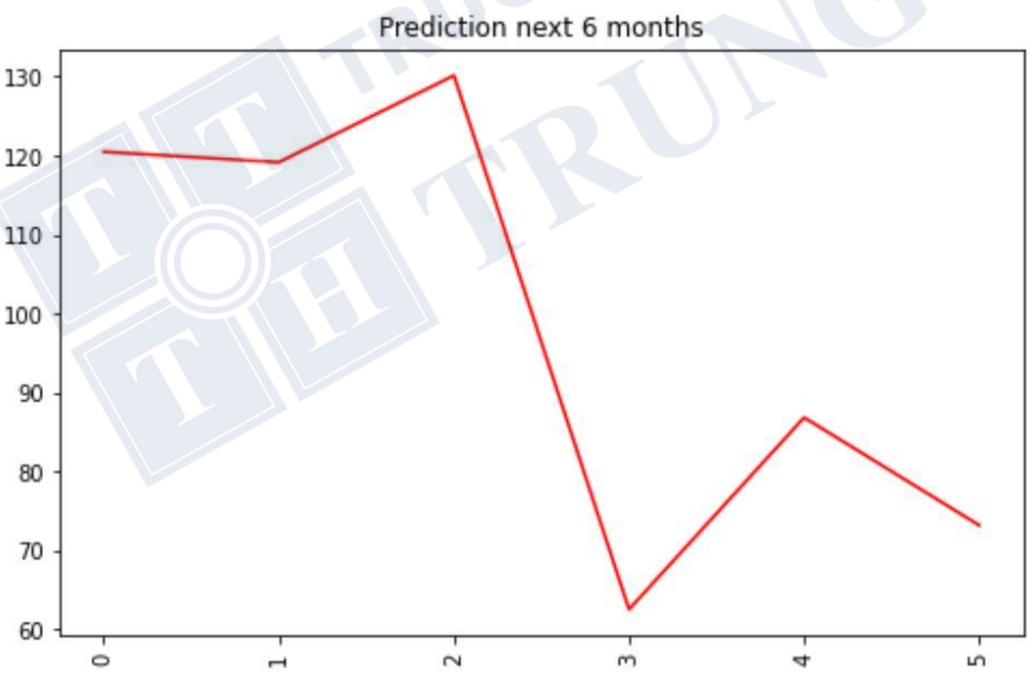


Dự đoán 6 tháng tiếp theo

In [29]:
```
future_forecast = stepwise_model.predict(n_periods=len(test)+6)
future_forecast
```

Out[29]:
```
array([ 68.17928646,  69.68709326,  84.1672112 ,  75.47203818,
        84.13934054, 112.79966058, 111.47171382, 122.45976331,
        54.81572387,  79.13174188,  65.47015201,  50.80872709,
        75.85973745,  77.36754425,  91.84766219,  83.15248917,
        91.81979153, 120.48011157, 119.15216481, 130.1402143 ,
        62.49617486,  86.81219287,  73.150603  ])
```

In [30]:
```
plt.figure(figsize=(8,5))
plt.plot(future_forecast[len(test):], color='red')
plt.xticks(rotation='vertical')
plt.title("Prediction next 6 months")
plt.show()
```



In [31]:
```
future_forecast[len(test):]
```

Out[31]:
```
array([120.48011157, 119.15216481, 130.1402143 ,  62.49617486,
        86.81219287,  73.150603  ])
```

In [32]:
```
months = pd.date_range('2019-07-01','2019-12-01',
              freq='MS').strftime("%Y-%m-%d").tolist()
```

In [33]:
```
months
```

Out[33]:
```
['2019-07-01',
 '2019-08-01',
 '2019-09-01',
 '2019-10-01',
 '2019-11-01',
 '2019-12-01']
```

In [34]:
```
new_predict = pd.DataFrame({
    'DATE' : months,
    'Energy Production': future_forecast[len(test):]}
    )
new_predict
```

Out[34]:

	DATE	Energy Production
0	2019-07-01	120.480112
1	2019-08-01	119.152165
2	2019-09-01	130.140214
3	2019-10-01	62.496175
4	2019-11-01	86.812193
5	2019-12-01	73.150603