TIME SERIES FORECASTING PROJECT BUSINESS REPORT

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PGP-DSBA Online

Table of Contents

List of Figures

List of Tables

Problem

1. Read the data as an appropriate Time Series data and plot the data.

Time series is a collection of observations of well-defined data items obtained through repeated measurements over time, Thus, it is a sequence of discrete-time series.

	Sparkling
YearMonth	
1980-01-01	1686
1980-02-01	1591
1980-03-01	2304
1980-04-01	1712
1980-05-01	1471

Table 1: Sparkling wine head

	Rose
YearMonth	
1980-01-01	112.0
1980-02-01	118.0
1980-03-01	129.0
1980-04-01	99.0
1980-05-01	116.0

Table 2: Rose wine head

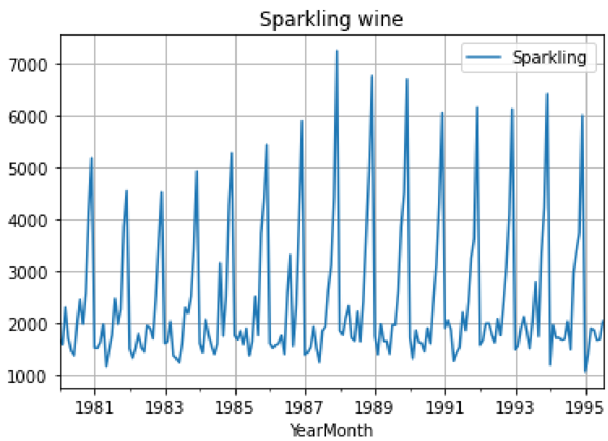

Figure 1: Sparkling wine graph

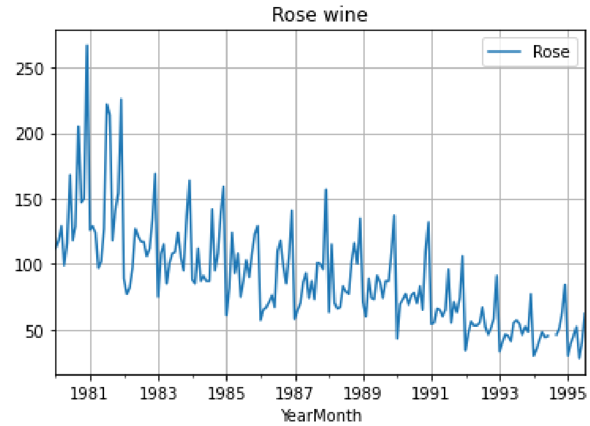

Figure 2: Rose wine graph

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 187 entries, 1980-01-01 to 1995-07-01
Data columns (total 1 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Sparkling  187 non-null    int64
dtypes: int64(1)
memory usage: 2.9 KB
```

Table 3: Sparkling wine info

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 187 entries, 1980-01-01 to 1995-07-01
Data columns (total 1 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   Rose    185 non-null    float64
dtypes: float64(1)
memory usage: 2.9 KB
```

Table 4: Rose wine info

There are a total of 187 entries in both of the wine datas.
Original Sparkling wine data has 0 null, whereas, Rose wine has 2 nulls which is filled.

2. Perform appropriate Exploratory Data Analysis to understand the data and also perform decomposition.

Decomposition is a statistical job that involves breaking down the Time-Series data into many components and trend from a series of data.
Here decomposition has 4 parts: Original data, Trend, Seasonality and Residual

	Sparkling
count	187.000
mean	2402.417
std	1295.112
min	1070.000
25%	1605.000
50%	1874.000
75%	2549.000
max	7242.000

Table 5: Sparkling wine description

	Rose
count	185.000
mean	90.395
std	39.175
min	28.000
25%	63.000
50%	86.000
75%	112.000
max	267.000

Table 6: Rose wine description

	Sparkling	Year	Month
YearMonth			
1980-01-01	1686	1980	1
1980-02-01	1591	1980	2
1980-03-01	2304	1980	3
1980-04-01	1712	1980	4
1980-05-01	1471	1980	5

Table 7: Sparkling wine with separate Year, Month

	Rose	Year	Month
YearMonth			
1980-01-01	112.0	1980	1
1980-02-01	118.0	1980	2
1980-03-01	129.0	1980	3
1980-04-01	99.0	1980	4
1980-05-01	116.0	1980	5

Table 8: Rose wine with separate Year, Month

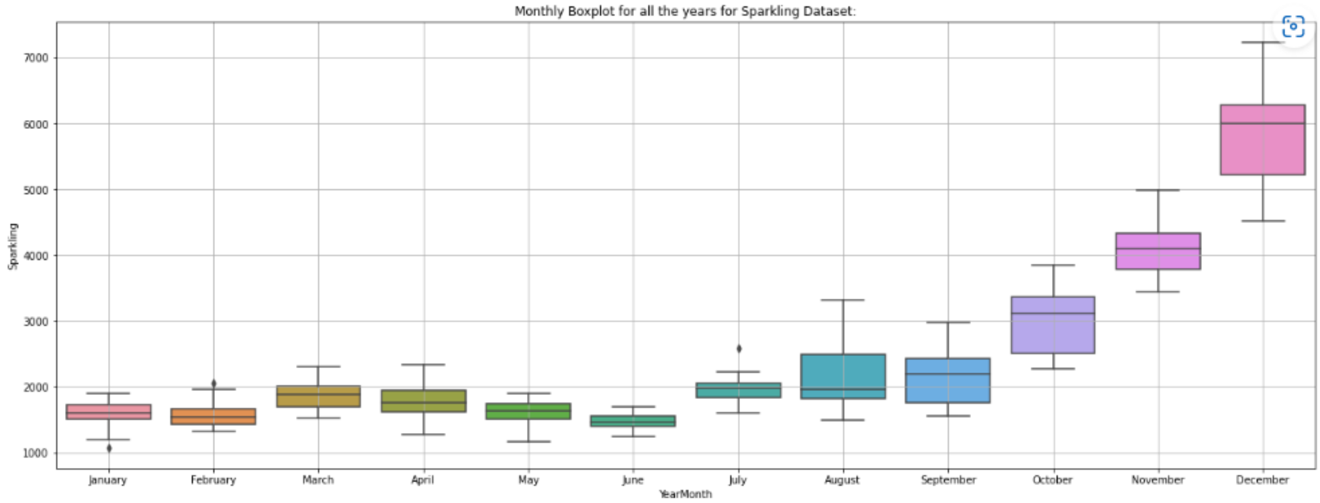

Figure 3: Sparkling wine-Monthly boxplot

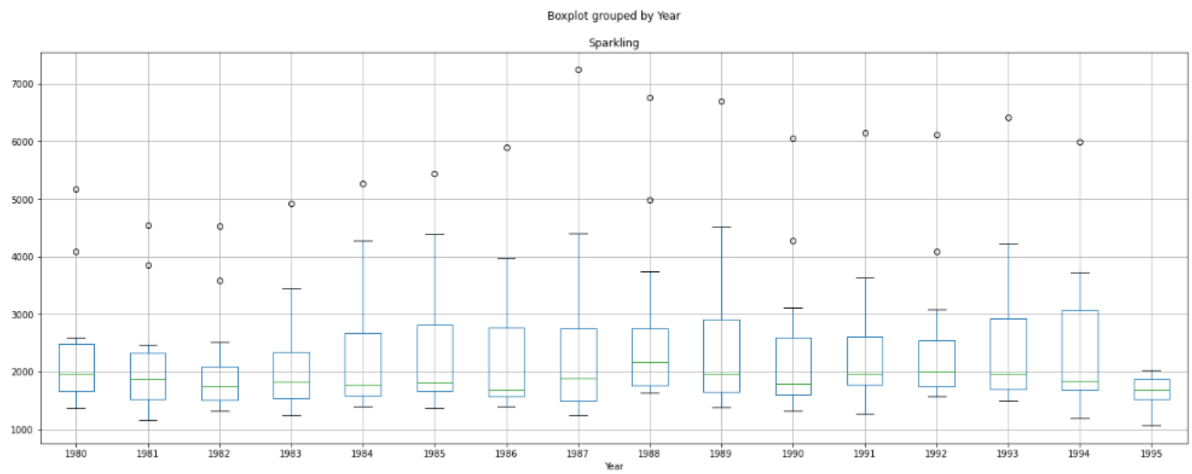

Figure 4: Sparkling wine-Yearly boxplot

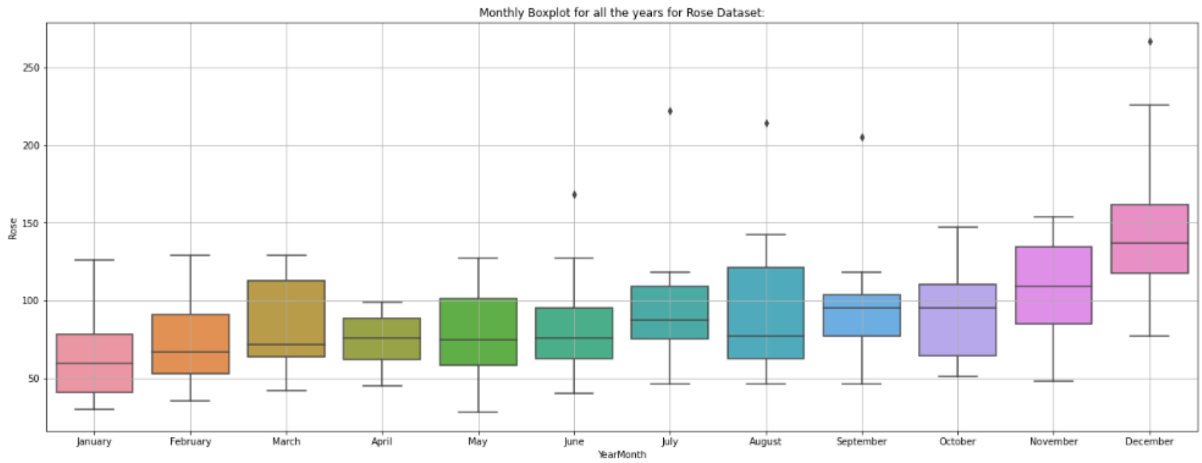

Figure 5: Rose wine-Monthly boxplot

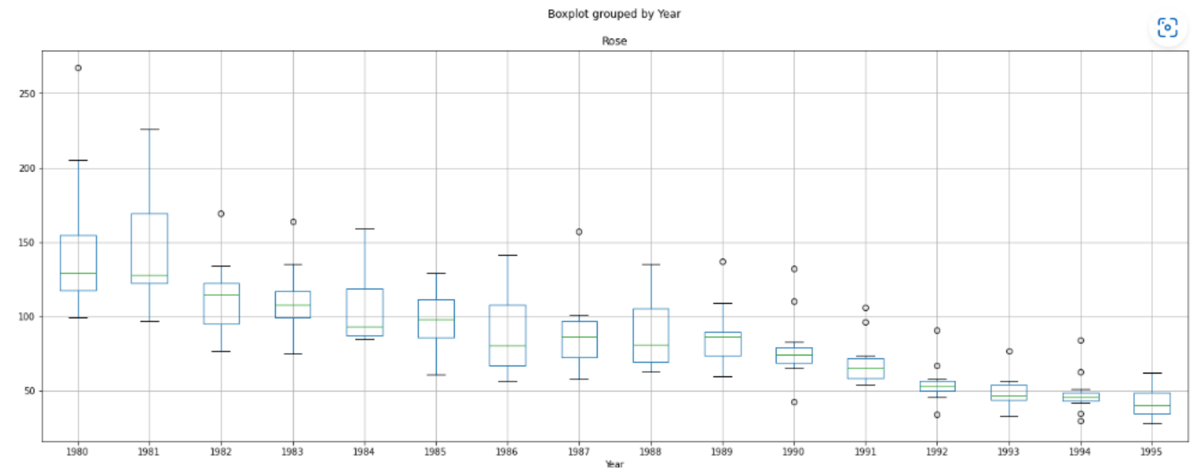

Figure 6: Rose wine-Yearly boxplot

Month	1	2	3	4	5	6	7	8	9	10	11	12
Year												
1980	1686.0	1591.0	2304.0	1712.0	1471.0	1377.0	1966.0	2453.0	1984.0	2596.0	4087.0	5179.0
1981	1530.0	1523.0	1633.0	1976.0	1170.0	1480.0	1781.0	2472.0	1981.0	2273.0	3857.0	4551.0
1982	1510.0	1329.0	1518.0	1790.0	1537.0	1449.0	1954.0	1897.0	1706.0	2514.0	3593.0	4524.0
1983	1609.0	1638.0	2030.0	1375.0	1320.0	1245.0	1600.0	2298.0	2191.0	2511.0	3440.0	4923.0
1984	1609.0	1435.0	2061.0	1789.0	1567.0	1404.0	1597.0	3159.0	1759.0	2504.0	4273.0	5274.0
1985	1771.0	1682.0	1846.0	1589.0	1896.0	1379.0	1645.0	2512.0	1771.0	3727.0	4388.0	5434.0
1986	1606.0	1523.0	1577.0	1605.0	1765.0	1403.0	2584.0	3318.0	1562.0	2349.0	3987.0	5891.0
1987	1389.0	1442.0	1548.0	1935.0	1518.0	1250.0	1847.0	1930.0	2638.0	3114.0	4405.0	7242.0
1988	1853.0	1779.0	2108.0	2336.0	1728.0	1661.0	2230.0	1645.0	2421.0	3740.0	4988.0	6757.0
1989	1757.0	1394.0	1982.0	1650.0	1654.0	1406.0	1971.0	1968.0	2608.0	3845.0	4514.0	6694.0
1990	1720.0	1321.0	1859.0	1628.0	1615.0	1457.0	1899.0	1605.0	2424.0	3116.0	4286.0	6047.0
1991	1902.0	2049.0	1874.0	1279.0	1432.0	1540.0	2214.0	1857.0	2408.0	3252.0	3627.0	6153.0
1992	1577.0	1667.0	1993.0	1997.0	1783.0	1625.0	2076.0	1773.0	2377.0	3088.0	4096.0	6119.0
1993	1494.0	1564.0	1898.0	2121.0	1831.0	1515.0	2048.0	2795.0	1749.0	3339.0	4227.0	6410.0
1994	1197.0	1968.0	1720.0	1725.0	1674.0	1693.0	2031.0	1495.0	2968.0	3385.0	3729.0	5999.0
1995	1070.0	1402.0	1897.0	1862.0	1670.0	1688.0	2031.0	NaN	NaN	NaN	NaN	NaN

Table 9: Sparkling wine data monthly mean aggregate, year-wise

Month	1	2	3	4	5	6	7	8	9	10	11	12
Year												
1980	112.0	118.0	129.0	99.0	116.0	168.0	118.0	129.0	205.0	147.0	150.0	267.0
1981	126.0	129.0	124.0	97.0	102.0	127.0	222.0	214.0	118.0	141.0	154.0	226.0
1982	89.0	77.0	82.0	97.0	127.0	121.0	117.0	117.0	106.0	112.0	134.0	169.0
1983	75.0	108.0	115.0	85.0	101.0	108.0	109.0	124.0	105.0	95.0	135.0	164.0
1984	88.0	85.0	112.0	87.0	91.0	87.0	87.0	142.0	95.0	108.0	139.0	159.0
1985	61.0	82.0	124.0	93.0	108.0	75.0	87.0	103.0	90.0	108.0	123.0	129.0
1986	57.0	65.0	67.0	71.0	76.0	67.0	110.0	118.0	99.0	85.0	107.0	141.0
1987	58.0	65.0	70.0	86.0	93.0	74.0	87.0	73.0	101.0	100.0	96.0	157.0
1988	63.0	115.0	70.0	66.0	67.0	83.0	79.0	77.0	102.0	116.0	100.0	135.0
1989	71.0	60.0	89.0	74.0	73.0	91.0	86.0	74.0	87.0	87.0	109.0	137.0
1990	43.0	69.0	73.0	77.0	69.0	76.0	78.0	70.0	83.0	65.0	110.0	132.0
1991	54.0	55.0	66.0	65.0	60.0	65.0	96.0	55.0	71.0	63.0	74.0	106.0
1992	34.0	47.0	56.0	53.0	53.0	55.0	67.0	52.0	46.0	51.0	58.0	91.0
1993	33.0	40.0	46.0	45.0	41.0	55.0	57.0	54.0	46.0	52.0	48.0	77.0
1994	30.0	35.0	42.0	48.0	44.0	45.0	46.0	46.0	46.0	51.0	63.0	84.0
1995	30.0	39.0	45.0	52.0	28.0	40.0	62.0	NaN	NaN	NaN	NaN	NaN

Table 10: Rose wine data monthly mean aggregate, year-wise

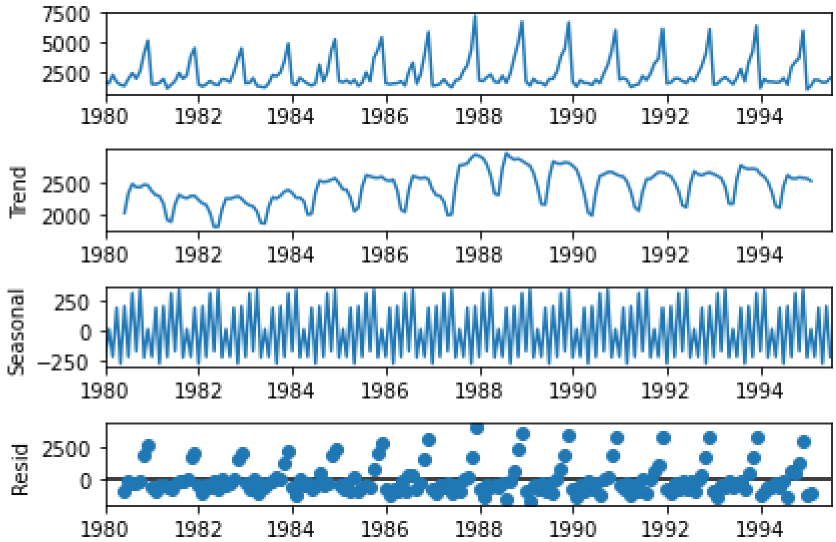

Figure 7: Sparkling wine additive decomposition

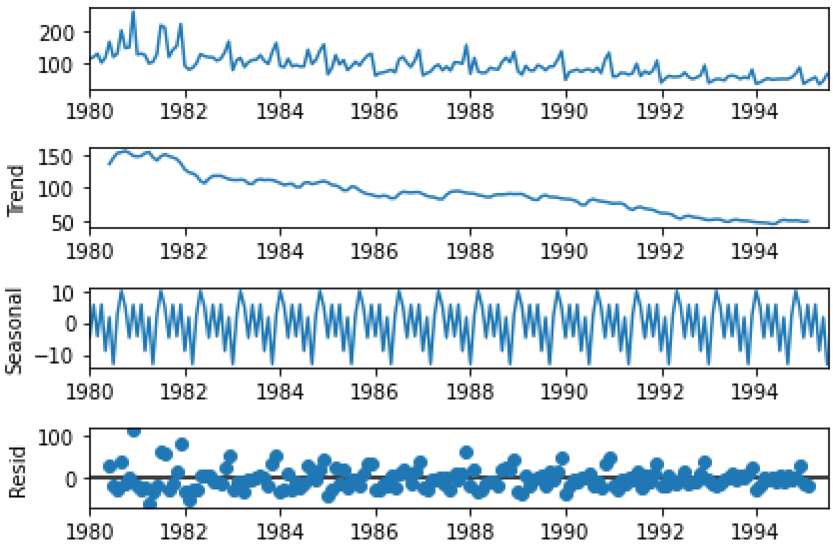

Figure 8: Rose wine additive decomposition

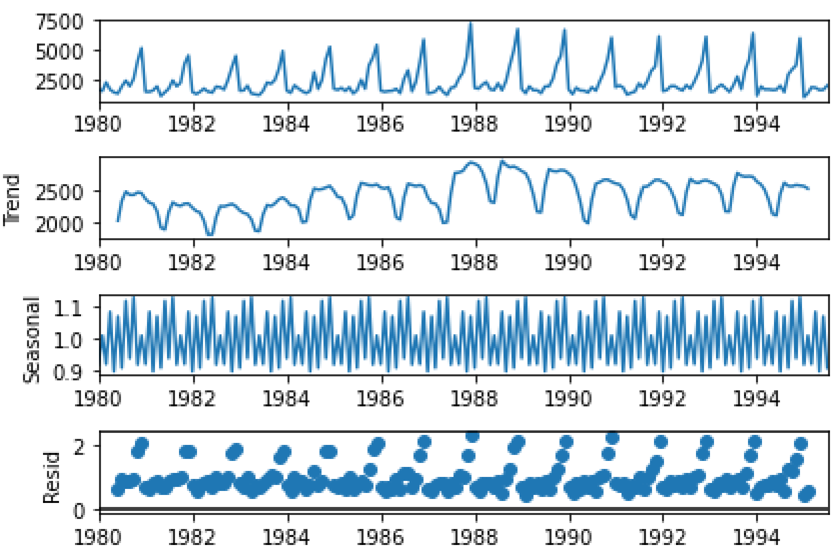

Figure 9: Sparkling wine multiplicative decomposition

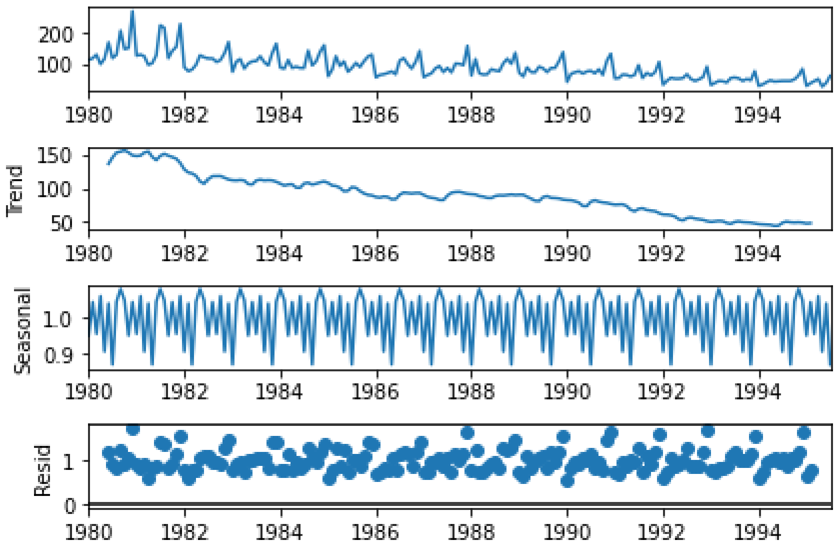

Figure 10: Rose wine multiplicative decomposition

3. Split the data into training and test. The test data should start in 1991.

The data is split into train and test. In time-series, the latest data is taken for testing.
Data until the year 1990 is taken as training data.
Data from 1991 is taken as testing data.
This split is applied for both Sparkling wine and Rise wine datas.
Training datas have the shape (132, 3)
Testing datas have the shape (55, 3)

YearMonth	Sparkling	Year	Month
1990-08-01	1605	1990	8
1990-09-01	2424	1990	9
1990-10-01	3116	1990	10
1990-11-01	4286	1990	11
1990-12-01	6047	1990	12

```
Train Data: (132, 3)
```

YearMonth	Sparkling	Year	Month
1991-01-01	1902	1991	1
1991-02-01	2049	1991	2
1991-03-01	1874	1991	3
1991-04-01	1279	1991	4
1991-05-01	1432	1991	5

```
Test Data: (55, 3)
```

Table 11: Sparkling wine train-test split

YearMonth	Rose	Year	Month
1990-08-01	70.0	1990	8
1990-09-01	83.0	1990	9
1990-10-01	65.0	1990	10
1990-11-01	110.0	1990	11
1990-12-01	132.0	1990	12

```
Train Data: (132, 3)
```

YearMonth	Rose	Year	Month
1991-01-01	54.0	1991	1
1991-02-01	55.0	1991	2
1991-03-01	66.0	1991	3
1991-04-01	65.0	1991	4
1991-05-01	60.0	1991	5

```
Test Data: (55, 3)
```

Table 12: Rose wine train-test split

4. Build all the exponential smoothing models on the training data and evaluate the model using RMSE on the test data. Other additional models such as regression, naïve forecast models, simple average models, moving average models should also be built on the training data and check the performance on the test data using RMSE.

(a) Linear regression

For Sparkling wine:

Training Time instance : [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132]

Test Time instance : [133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187]

Training data shape: (132, 3)

YearMonth	Sparkling	Year	Month	time
1980-01-01	1686	1980	1	1
1980-02-01	1591	1980	2	2
1980-03-01	2304	1980	3	3
1980-04-01	1712	1980	4	4
1980-05-01	1471	1980	5	5

YearMonth	Sparkling	Year	Month	time
1991-01-01	1902	1991	1	133
1991-02-01	2049	1991	2	134
1991-03-01	1874	1991	3	135
1991-04-01	1279	1991	4	136
1991-05-01	1432	1991	5	137

Table 13: Linear regression-Train and Test head

For Rose wine:

Training Time instance
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132]

Test Time instance
[133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187]

YearMonth	Rose	Year	Month	time
1980-01-01	112.0	1980	1	1
1980-02-01	118.0	1980	2	2
1980-03-01	129.0	1980	3	3
1980-04-01	99.0	1980	4	4
1980-05-01	116.0	1980	5	5

YearMonth	Rose	Year	Month	time
1991-01-01	54.0	1991	1	133
1991-02-01	55.0	1991	2	134
1991-03-01	66.0	1991	3	135
1991-04-01	65.0	1991	4	136
1991-05-01	60.0	1991	5	137

Table 14: Linear regression-Train and Test head

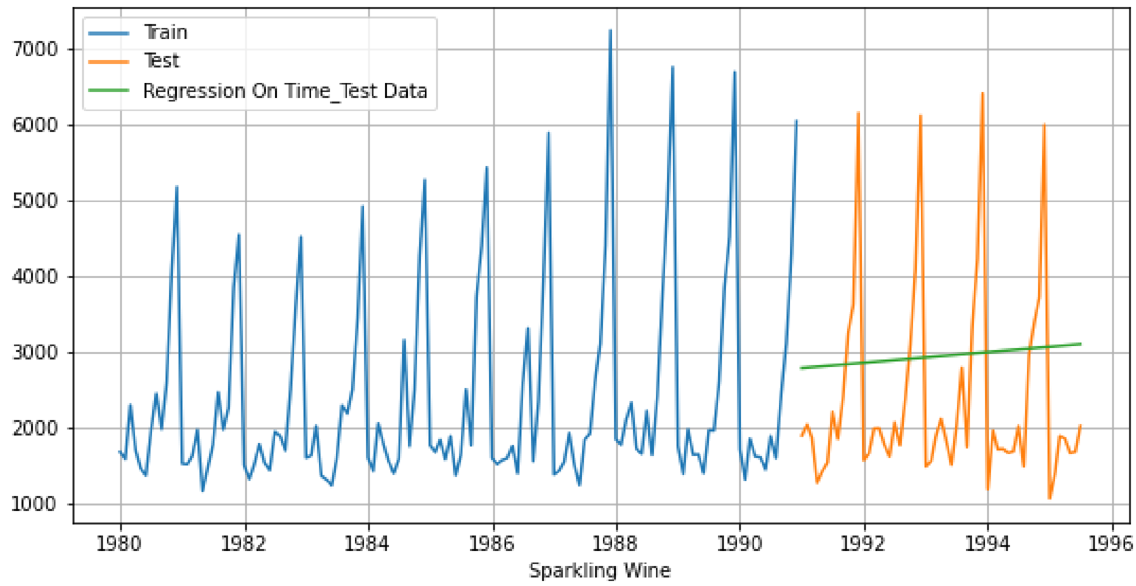

Figure 11: Linear regression on Sparkling data

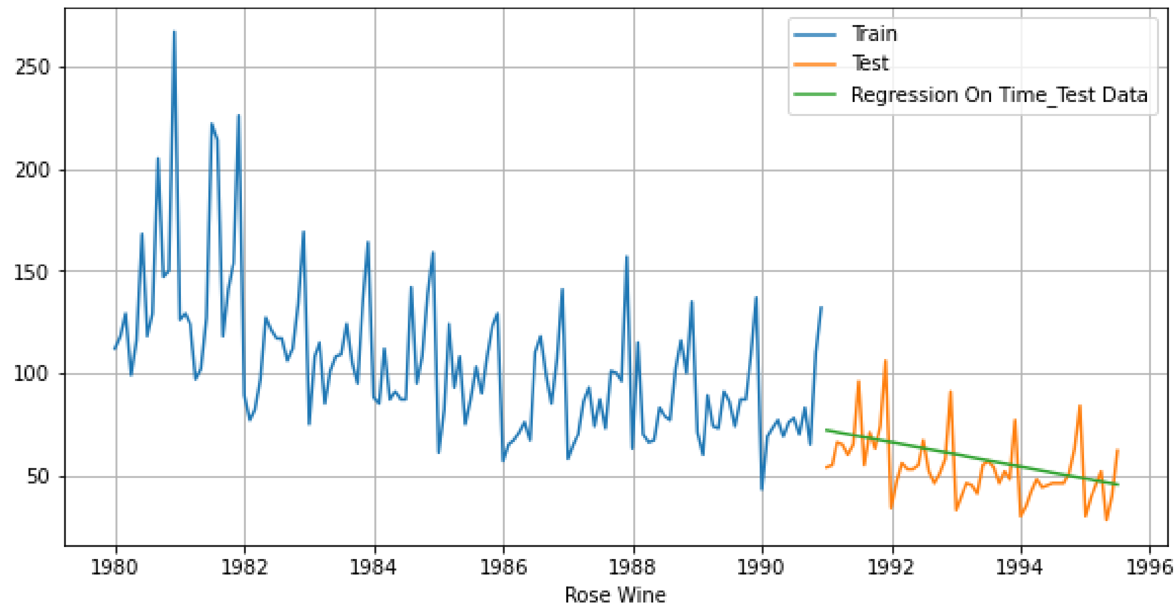

Figure 12: Linear regression on Rose data

	Test_Spark RMSE
Regression	1389.135175

	Test_Rose RMSE
Regression	15.262509

Figure 13: Linear regression-RMSE values

(b) Naïve's approach

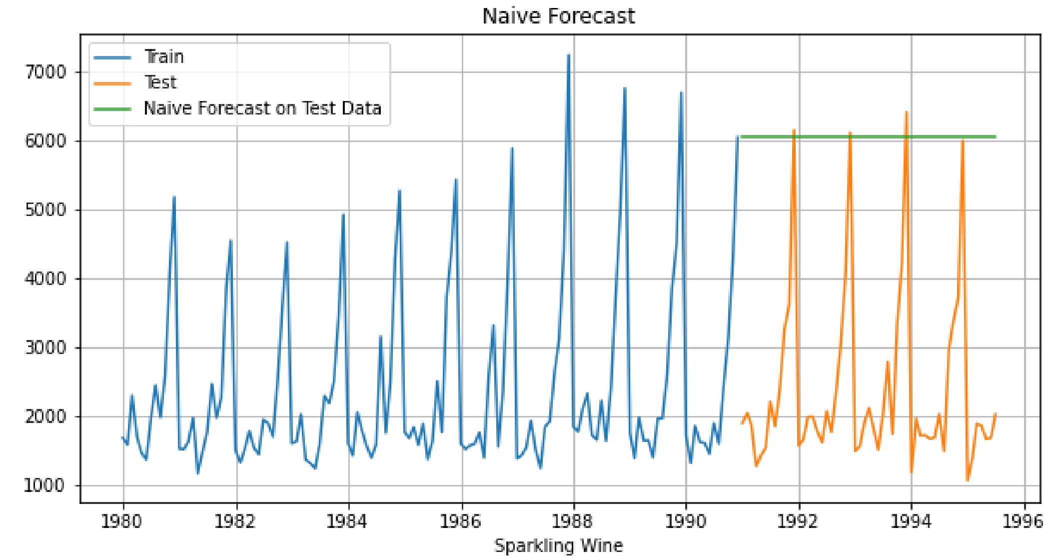

Figure 14: Naive for Sparkling wine

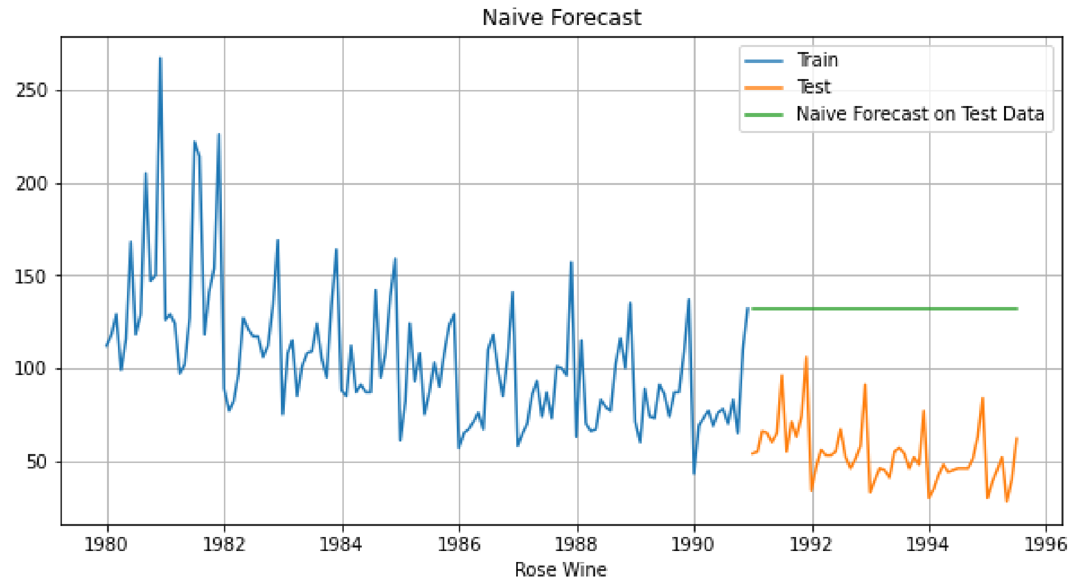

Figure 15: Naive for Rose wine

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093

Table 15: Naive-RMSE values

(c) Simple Average

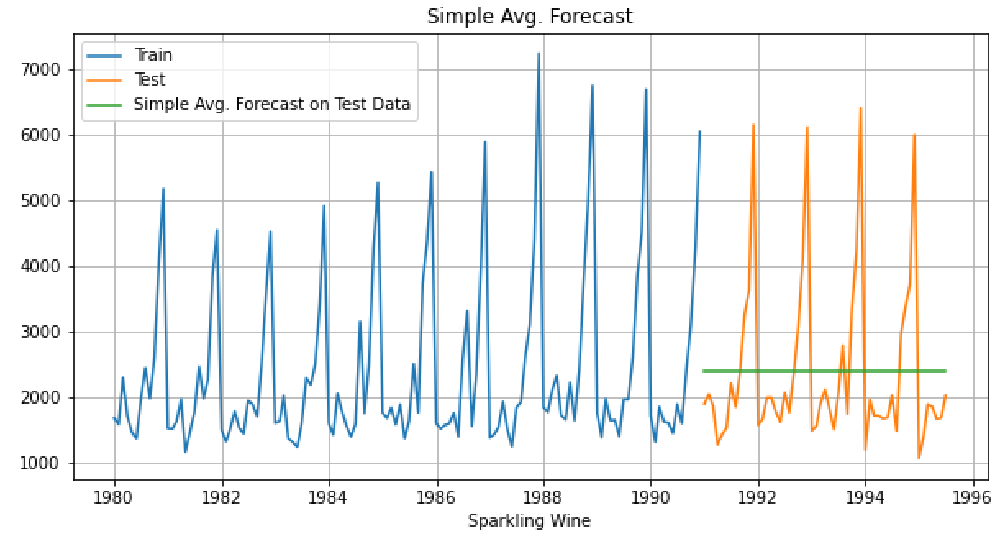

Figure 16: Simple average for Sparkling wine

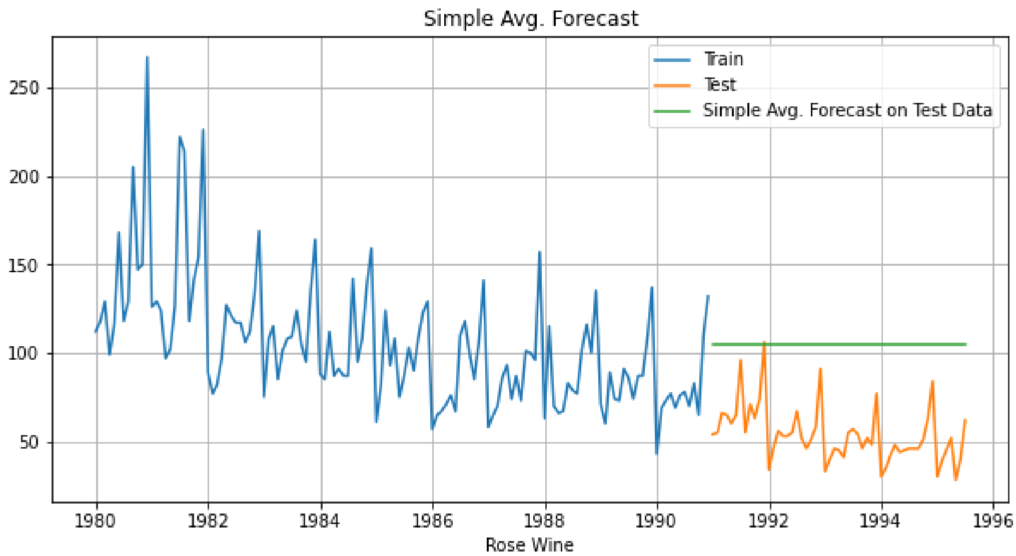

Figure 17: Simple average for Rose wine

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352
SimpleAvg	1275.081804

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093
SimpleAvg	53.440426

Table 16: Simple average-RMSE values

(d) Moving average

YearMonth	Sparkling	Year	Month	Trailing_2	Trailing_4	Trailing_6	Trailing_9
1980-01-01	1686	1980	1	NaN	NaN	NaN	NaN
1980-02-01	1591	1980	2	1638.5	NaN	NaN	NaN
1980-03-01	2304	1980	3	1947.5	NaN	NaN	NaN
1980-04-01	1712	1980	4	2008.0	1823.25	NaN	NaN
1980-05-01	1471	1980	5	1591.5	1769.50	NaN	NaN
1980-06-01	1377	1980	6	1424.0	1716.00	1690.166667	NaN
1980-07-01	1966	1980	7	1671.5	1631.50	1736.833333	NaN
1980-08-01	2453	1980	8	2209.5	1816.75	1880.500000	NaN
1980-09-01	1984	1980	9	2218.5	1945.00	1827.166667	1838.222222
1980-10-01	2596	1980	10	2290.0	2249.75	1974.500000	1939.333333

Table 17: Moving average for Sparkling wine

YearMonth	Rose	Year	Month	Trailing_2	Trailing_4	Trailing_6	Trailing_9
1980-01-01	112.0	1980	1	NaN	NaN	NaN	NaN
1980-02-01	118.0	1980	2	115.0	NaN	NaN	NaN
1980-03-01	129.0	1980	3	123.5	NaN	NaN	NaN
1980-04-01	99.0	1980	4	114.0	114.50	NaN	NaN
1980-05-01	116.0	1980	5	107.5	115.50	NaN	NaN
1980-06-01	168.0	1980	6	142.0	128.00	123.666667	NaN
1980-07-01	118.0	1980	7	143.0	125.25	124.666667	NaN
1980-08-01	129.0	1980	8	123.5	132.75	126.500000	NaN
1980-09-01	205.0	1980	9	167.0	155.00	139.166667	132.666667
1980-10-01	147.0	1980	10	176.0	149.75	147.166667	136.555556

Table 18: Moving average for Rose wine

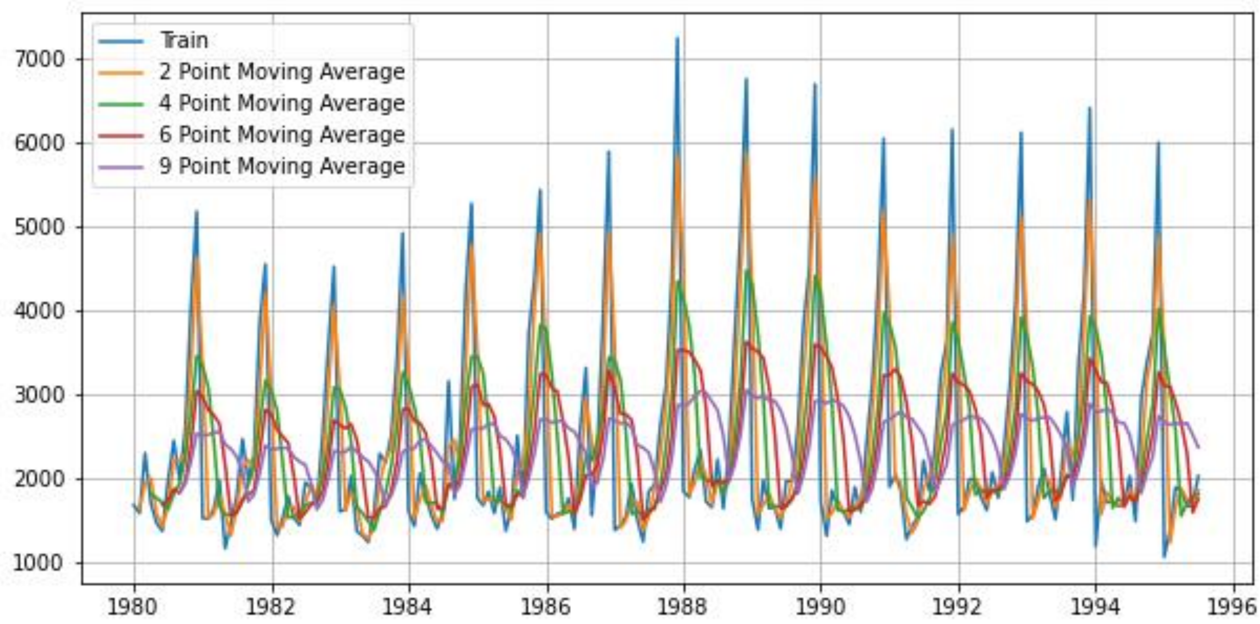

Figure 18: Moving averages for Sparkling wine

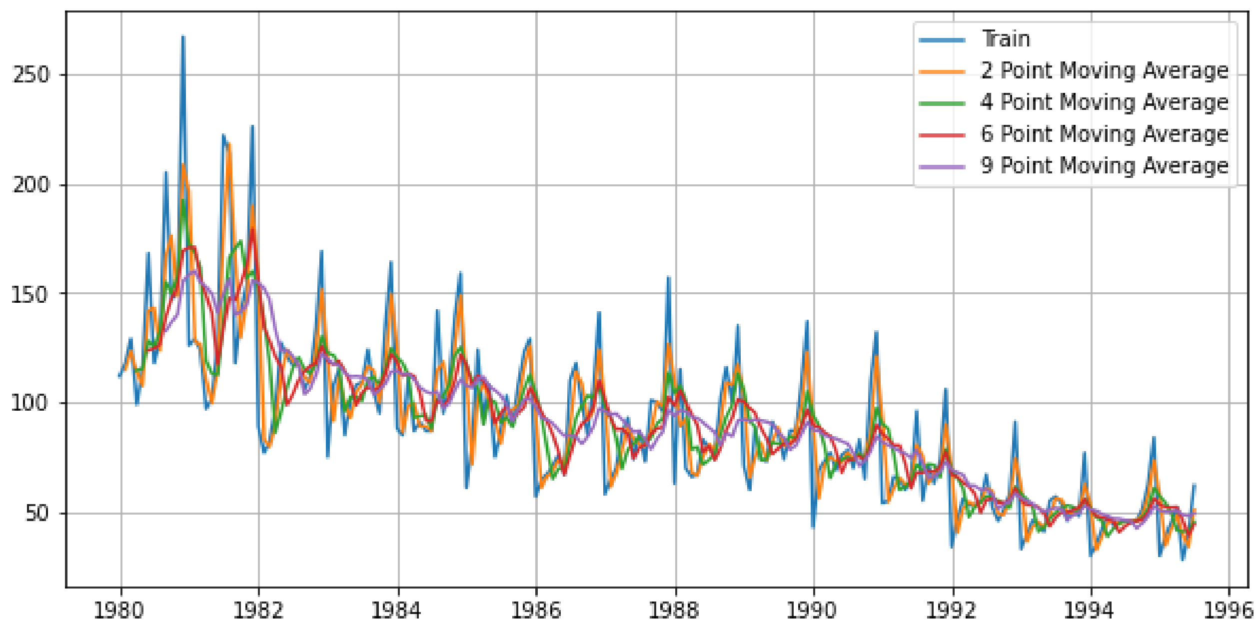

Figure 19: Moving averages for Rose wine

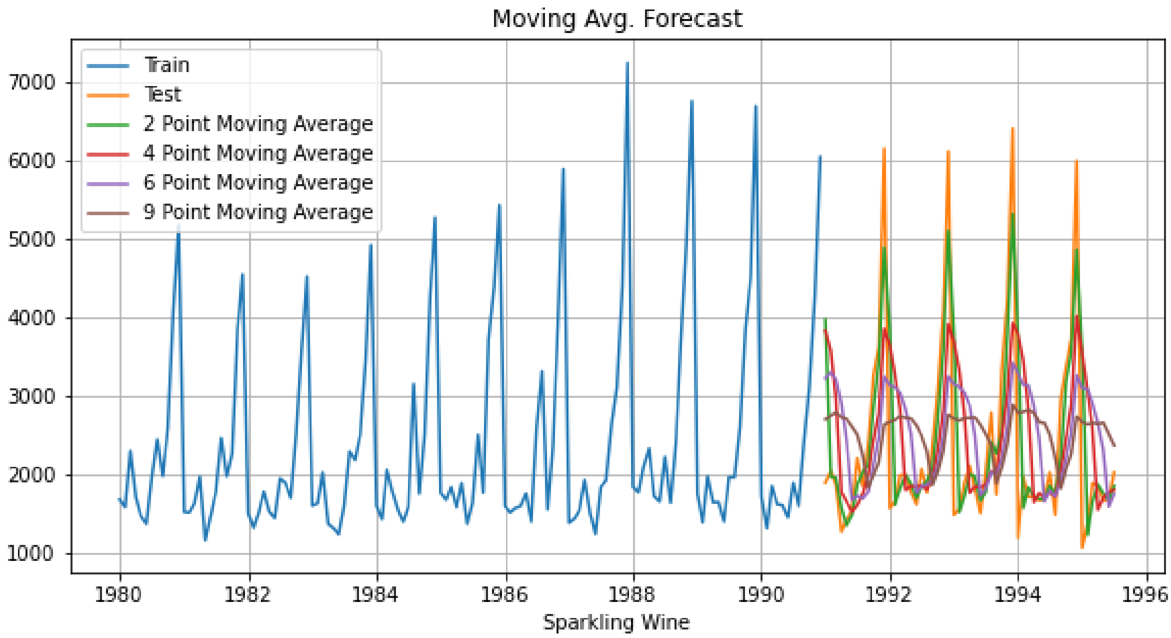

Figure 20: Moving average forecasts for Sparkling wine

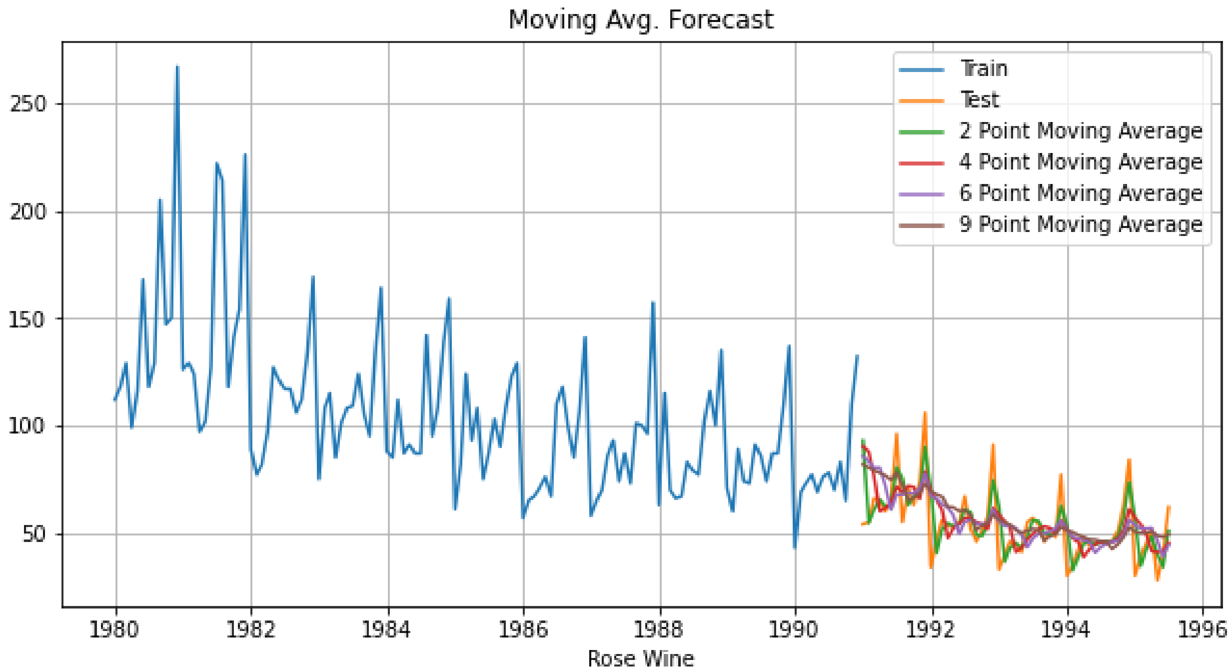

Figure 21: Moving average forecasts for Rose data

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352
SimpleAvg	1275.081804
MovingAvg2	813.400684
MovingAvg4	1156.589694
MovingAvg6	1283.927428
MovingAvg9	1346.278315

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093
SimpleAvg	53.440426
MovingAvg2	11.529409
MovingAvg4	14.448930
MovingAvg6	14.560046
MovingAvg9	14.724503

Table 19: Moving averages-RMSE values

(e) Simple Exponential Smoothing (SES)

```
{'smoothing_level': 0.049607360581862936,
 'smoothing_trend': nan,
 'smoothing_seasonal': nan,
 'damping_trend': nan,
 'initial_level': 1818.535750008871,
 'initial_trend': nan,
 'initial_seasons': array([], dtype=float64),
 'use_boxcox': False,
 'lamda': None,
 'remove_bias': False}
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{'smoothing_level': 0.0987493111726833,
 'smoothing_trend': nan,
 'smoothing_seasonal': nan,
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 'initial_level': 134.38720226208358,
 'initial_trend': nan,
 'initial_seasons': array([], dtype=float64),
 'use_boxcox': False,
 'lamda': None,
 'remove_bias': False}
```

Table 20: SES for Sparkling and Rose wine data

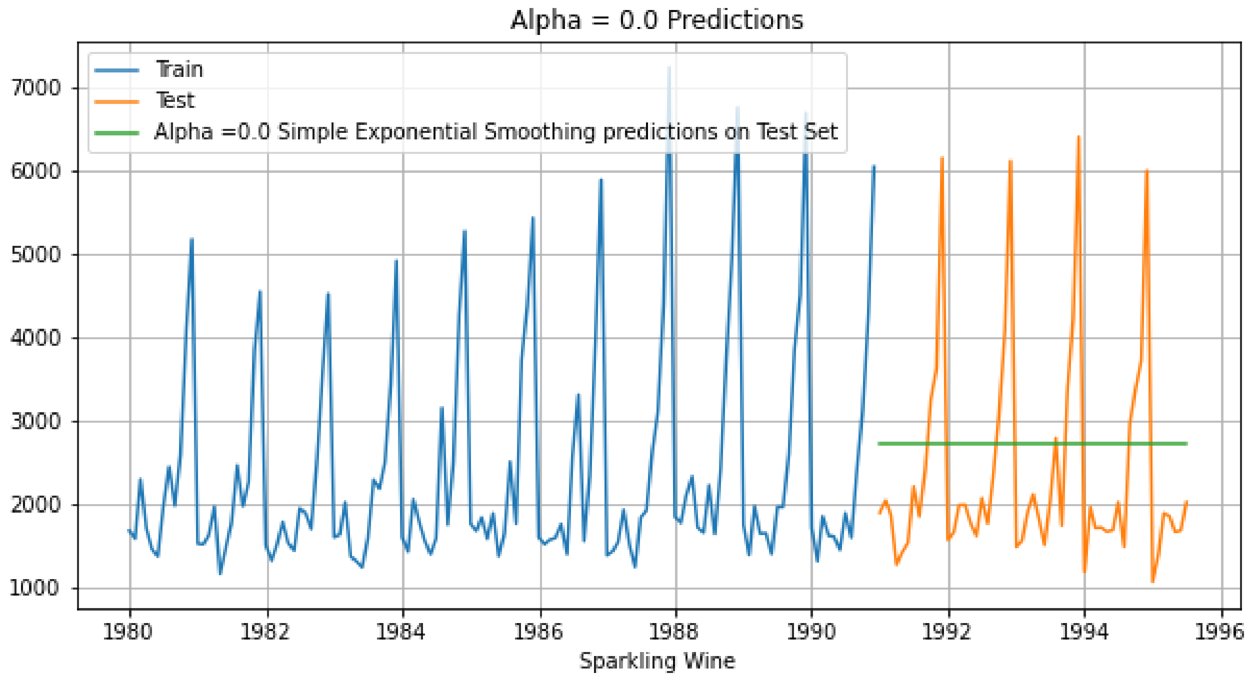

Figure 22: SES for Sparkling wine

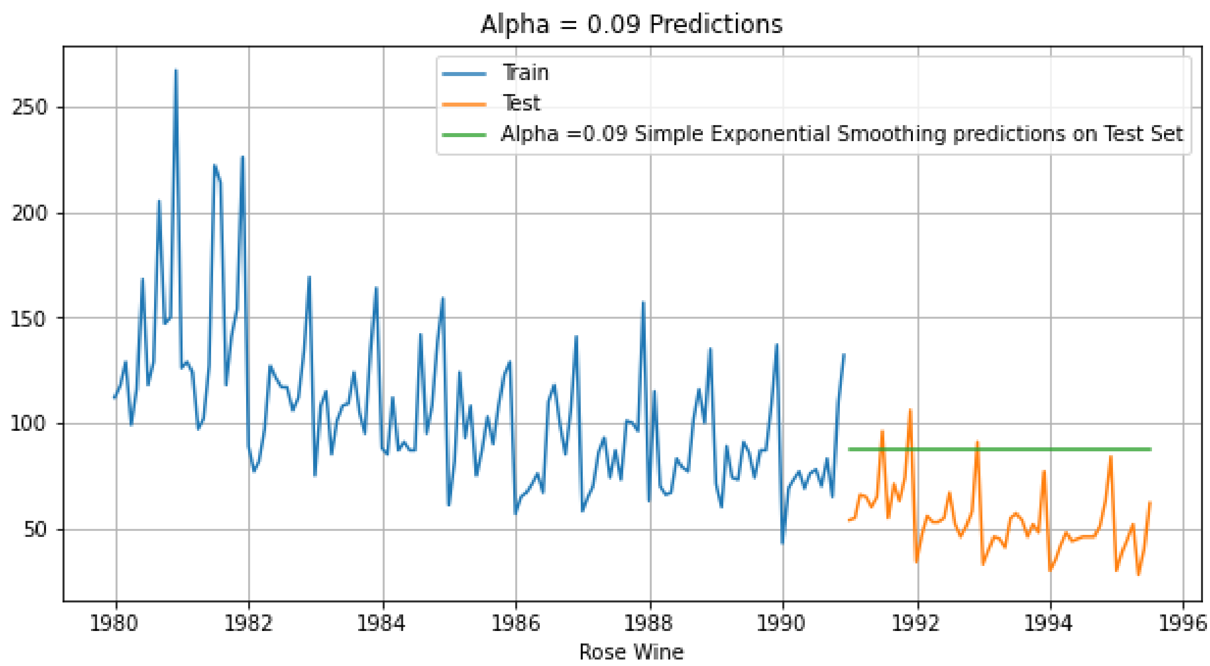

Figure 23: SES for Rose wine

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352
SimpleAvg	1275.081804
MovingAvg2	813.400684
MovingAvg4	1156.589694
MovingAvg6	1283.927428
MovingAvg9	1346.278315
SES	1316.035487

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093
SimpleAvg	53.440426
MovingAvg2	11.529409
MovingAvg4	14.448930
MovingAvg6	14.560046
MovingAvg9	14.724503
SES	36.775774

Figure 24: SES-RMSE values

(f) Double Exponential Smoothing (DES)

```
{'smoothing_level': 0.6885714285714285,
 'smoothing_trend': 9.999999999999999e-05,
 'smoothing_seasonal': nan,
 'damping_trend': nan,
 'initial_level': 1686.0,
 'initial_trend': -95.0,
 'initial_seasons': array([], dtype=float64),
 'use_boxcox': False,
 'lamda': None,
 'remove_bias': False}
```

```
{'smoothing_level': 0.017549790270679714,
 'smoothing_trend': 3.236153800377395e-05,
 'smoothing_seasonal': nan,
 'damping_trend': nan,
 'initial_level': 138.82081494774005,
 'initial_trend': -0.492580228245491,
 'initial_seasons': array([], dtype=float64),
 'use_boxcox': False,
 'lamda': None,
 'remove_bias': False}
```

Table 21: DES for Sparkling and Rose wine data

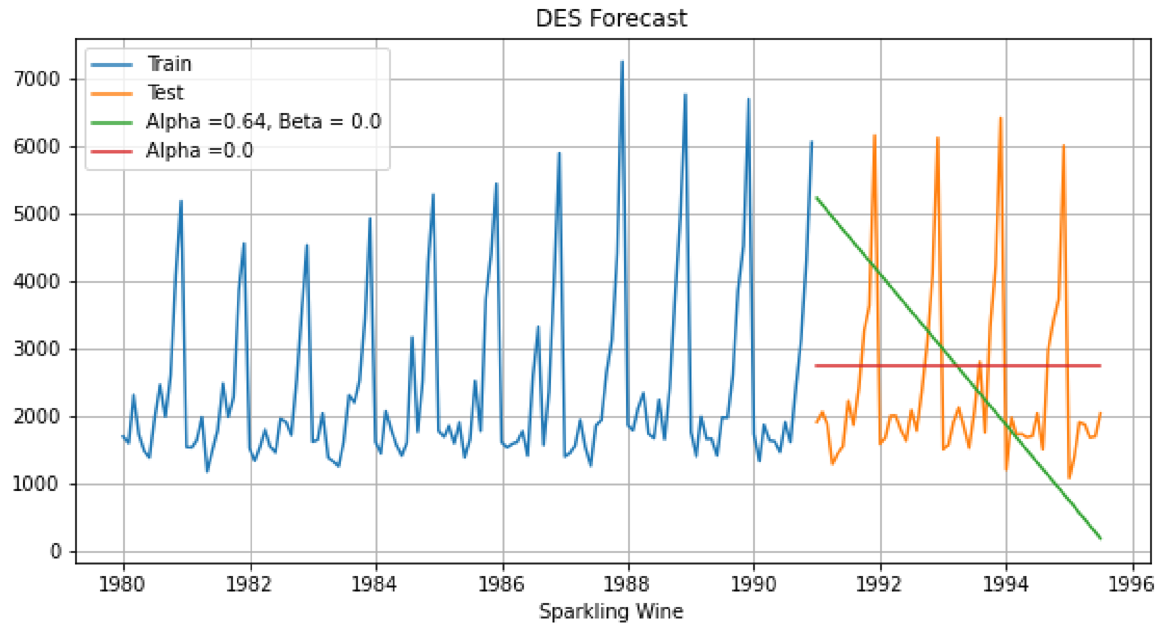

Figure 25: DES for Sparkling wine

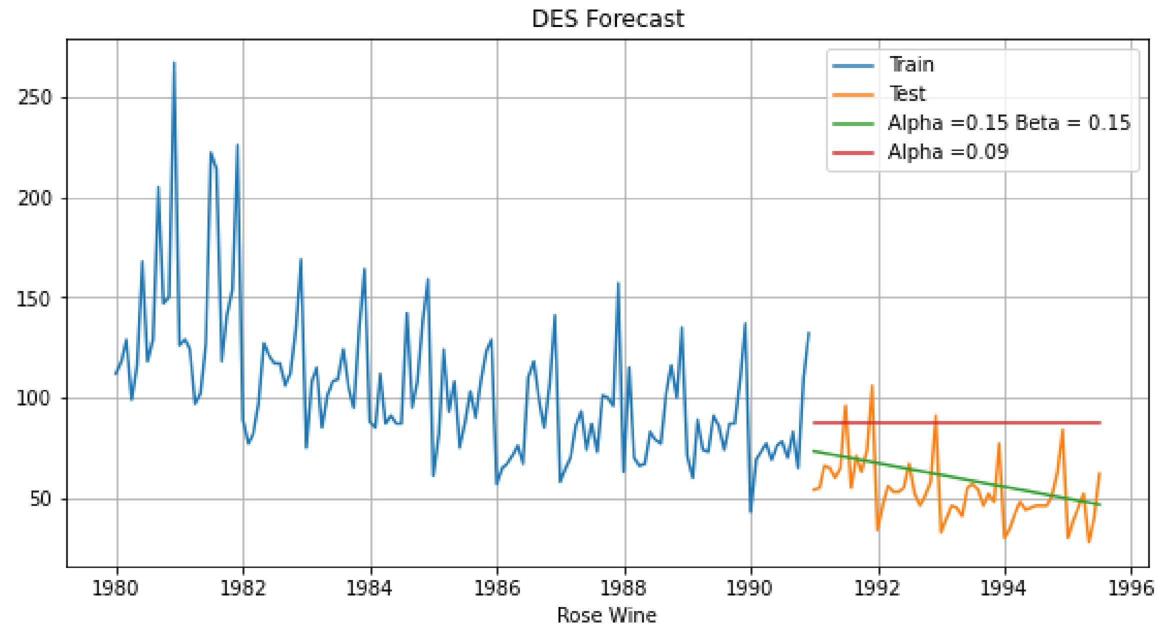

Figure 26: DES for Rose wine

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352
SimpleAvg	1275.081804
MovingAvg2	813.400684
MovingAvg4	1156.589694
MovingAvg6	1283.927428
MovingAvg9	1346.278315
SES	1316.035487
DES	2007.238526

Table 22: Sparkling wine-RMSE value

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093
SimpleAvg	53.440426
MovingAvg2	11.529409
MovingAvg4	14.448930
MovingAvg6	14.560046
MovingAvg9	14.724503
SES	36.775774
DES	15.699312

Table 23: Rose wine-RMSE value

Here, we see that the Double Exponential Smoothing model has picked up the trend component as well. Our data has seasonality too so we will include one more smoothing parameter for seasonality which is gamma. We will use ETS(A, A, A) Holt Winter's linear method with additive trend and seasonality for Sparkling data and ETS(A, A, M) Holt Winter's linear method with additive trend and multiplicative seasonality for Rose wine data

(g) Triple Exponential Smoothing

```
{'smoothing_level': 0.11127227248079453,
 'smoothing_trend': 0.012360804305088534,
 'smoothing_seasonal': 0.46071766688111543,
 'damping_trend': nan,
 'initial_level': 2356.577980956387,
 'initial_trend': -0.10243675533021725,
 'initial_seasons': array([-636.23319334, -722.9832009 , -398.64410813, -473.43045416,
        -808.42473284, -815.34991402, -384.23065038,   72.99484403,
        -237.44226045,  272.32608272, 1541.37737052, 2590.07692296]),
 'use_boxcox': False,
 'lamda': None,
 'remove_bias': False}
```

```
{'smoothing_level': 0.0715106306609405,
 'smoothing_trend': 0.04529179757535142,
 'smoothing_seasonal': 7.244325029450242e-05,
 'damping_trend': nan,
 'initial_level': 130.40839142502193,
 'initial_trend': -0.77985743179386,
 'initial_seasons': array([0.86218996, 0.977675  , 1.0687727 , 0.93403881, 1.050625  ,
        1.14410977, 1.25836944, 1.33937772, 1.26778766, 1.24131254,
        1.44724625, 1.99553681]),
 'use_boxcox': False,
 'lamda': None,
 'remove_bias': False}
```

Table 24: TES for Sparkling and Rose wine

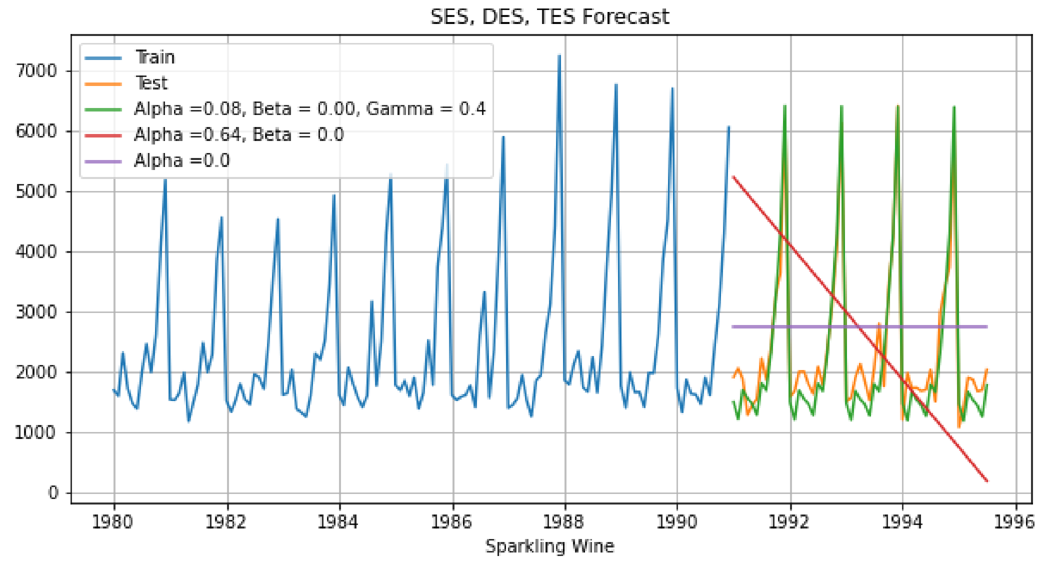

Figure 27: TES for Sparkling wine

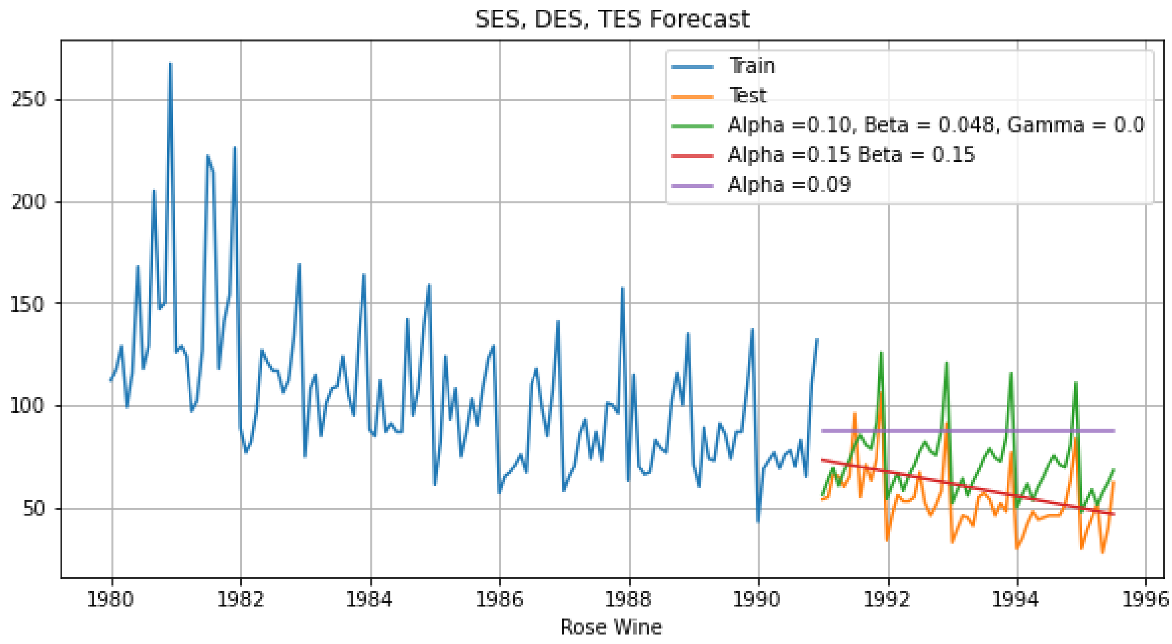

Figure 28: TES for Rose wine

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093
SimpleAvg	53.440426
MovingAvg2	11.529409
MovingAvg4	14.448930
MovingAvg6	14.560046
MovingAvg9	14.724503
SES	36.775774
DES	15.699312
TES	20.132468

Table 25: TES-RMSE value for Sparkling wine

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352
SimpleAvg	1275.081804
MovingAvg2	813.400684
MovingAvg4	1156.589694
MovingAvg6	1283.927428
MovingAvg9	1346.278315
SES	1316.035487
DES	2007.238526
TES	378.951023

Table 26: TES-RMSE value for Rose wine

From SES, DES and TES we can clearly see that forecast is the closest to the values from DES model

5. Check for the stationarity of the data on which the model is being built on using appropriate statistical tests and also mention the hypothesis for the statistical test. If the data is found to be non-stationary, take appropriate steps to make it stationary. Check the new data for stationarity and comment.
Note: Stationarity should be checked at alpha = 0.05.

Dickey-Fuller Test:

DF test statistic for Sparkling dataset -1.360
DF test p-value is 0.6011
DF test statistic for Rose dataset -1.877
DF test p-value is 0.3427

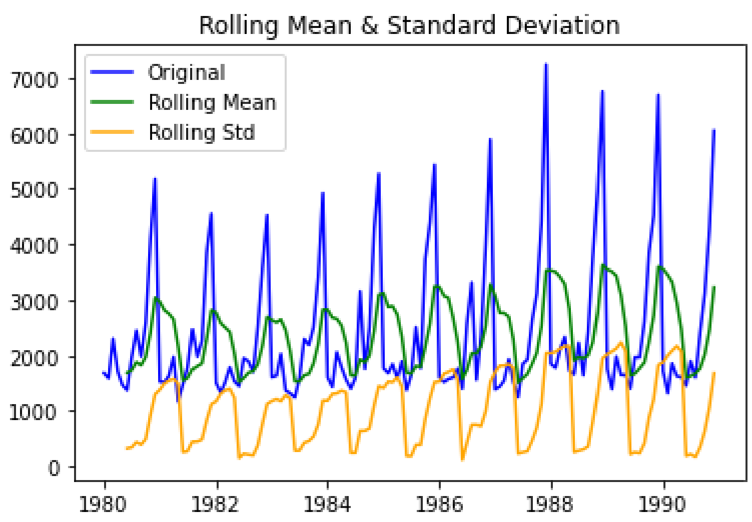

Figure 29: Rolling mean & Std deviation for Sparkling wine-Train data

Results of Dickey-Fuller Test:

Test Statistic :	-1.208926
p-value :	0.669744
#Lags Used	12.000000
Number of Observations Used :	119.000000
Critical Value (1%) :	-3.486535
Critical Value (5%) :	-2.886151
Critical Value (10%) :	-2.579896

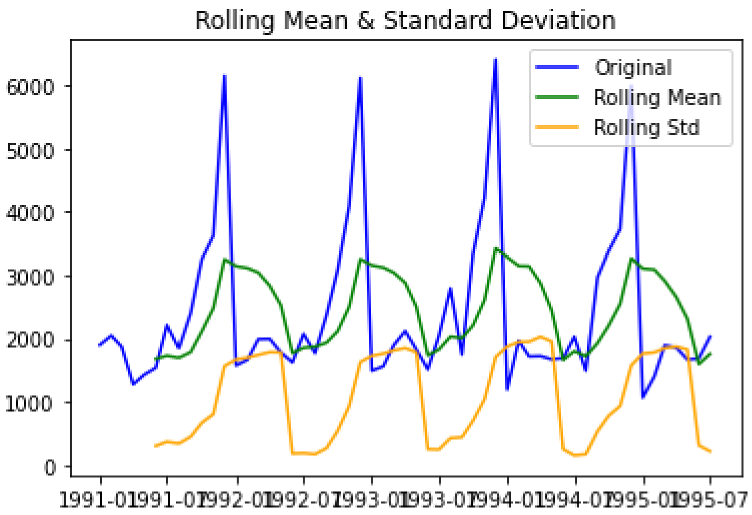

Figure 30: Rolling mean & Std deviation for Sparkling wine-Test data

Results of Dickey-Fuller Test:

Test Statistic :	-1.790189
p-value :	0.385343
#Lags Used	11.000000
Number of Observations Used :	43.000000
Critical Value (1%) :	-3.592504
Critical Value (5%) :	-2.931550
Critical Value (10%) :	-2.604066

6. Build an automated version of the ARIMA/SARIMA model in which the parameters are selected using the lowest Akaike Information Criteria (AIC) on the training data and evaluate this model on the test data using RMSE.

```
Some parameter combinations for the Model...
Model: (0, 1, 1)
Model: (0, 1, 2)
Model: (1, 1, 0)
Model: (1, 1, 1)
Model: (1, 1, 2)
Model: (2, 1, 0)
Model: (2, 1, 1)
Model: (2, 1, 2)
```

Figure 31: Some ARIMA models

```
ARIMA(0, 1, 0) - AIC:2267.6630357855465
ARIMA(0, 1, 1) - AIC:2263.060015591336
ARIMA(0, 1, 2) - AIC:2234.408323131676
ARIMA(1, 1, 0) - AIC:2266.6085393190087
ARIMA(1, 1, 1) - AIC:2235.755094673383
ARIMA(1, 1, 2) - AIC:2234.5272004508324
ARIMA(2, 1, 0) - AIC:2260.365743968086
ARIMA(2, 1, 1) - AIC:2233.7776263084434
ARIMA(2, 1, 2) - AIC:2213.5092122831566
```

Figure 32: AIC values for Sparkling wine

	param	AIC_Sparkling
8	(2, 1, 2)	2213.509212
7	(2, 1, 1)	2233.777626
2	(0, 1, 2)	2234.408323
5	(1, 1, 2)	2234.5272
4	(1, 1, 1)	2235.755095
6	(2, 1, 0)	2260.365744
1	(0, 1, 1)	2263.060016
3	(1, 1, 0)	2266.608539
0	(0, 1, 0)	2267.663036

Table 27: AIV values in ascending values for Sparkling wine

```
ARIMA(0, 1, 0) - AIC:1333.1546729124348
ARIMA(0, 1, 1) - AIC:1282.3098319748312
ARIMA(0, 1, 2) - AIC:1279.6715288535806
ARIMA(1, 1, 0) - AIC:1317.3503105381492
ARIMA(1, 1, 1) - AIC:1280.5742295380064
ARIMA(1, 1, 2) - AIC:1279.8707234231922
ARIMA(2, 1, 0) - AIC:1298.6110341605004
ARIMA(2, 1, 1) - AIC:1281.5078621868543
ARIMA(2, 1, 2) - AIC:1281.8707222264356
```

Figure 33: AIC values for Rose wine

	param	AIC_Rose
2	(0, 1, 2)	1279.671529
5	(1, 1, 2)	1279.870723
4	(1, 1, 1)	1280.57423
7	(2, 1, 1)	1281.507862
8	(2, 1, 2)	1281.870722
1	(0, 1, 1)	1282.309832
6	(2, 1, 0)	1298.611034
3	(1, 1, 0)	1317.350311
0	(0, 1, 0)	1333.154673

Table 28: AIC values in ascending order for Rose wine

Smaller the AIC value, better is the model.
The smallest AIC for Sparkling dataset is given by the model (2,1,2)
The smallest AIC for for Rose dataset is given by the model (0,1,2)

```
Sparkling Data:
                               SARIMAX Results
==============================================================================
Dep. Variable:              Sparkling   No. Observations:                  132
Model:                 ARIMA(2, 1, 2)   Log Likelihood               -1101.755
Date:                Sat, 17 Dec 2022   AIC                           2213.509
Time:                        12:15:22   BIC                           2227.885
Sample:                    01-01-1980   HQIC                          2219.351
                         - 12-01-1990
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          1.3121      0.046     28.781      0.000       1.223       1.401
ar.L2         -0.5593      0.072     -7.741      0.000      -0.701      -0.418
ma.L1         -1.9917      0.109    -18.218      0.000      -2.206      -1.777
ma.L2          0.9999      0.110      9.109      0.000       0.785       1.215
sigma2      1.099e+06   1.99e-07   5.51e+12      0.000     1.1e+06     1.1e+06
===================================================================================
Ljung-Box (L1) (Q):                   0.19   Jarque-Bera (JB):                14.46
Prob(Q):                              0.67   Prob(JB):                         0.00
Heteroskedasticity (H):               2.43   Skew:                             0.61
Prob(H) (two-sided):                  0.00   Kurtosis:                         4.08
===================================================================================
```

Table 29: ARIMA model summary for Sparkling wine


```
Sparkling Data:
                               SARIMAX Results
==============================================================================
Dep. Variable:              Sparkling   No. Observations:                  132
Model:                 ARIMA(2, 1, 2)   Log Likelihood               -1101.755
Date:                Sat, 17 Dec 2022   AIC                           2213.509
Time:                        12:15:22   BIC                           2227.885
Sample:                    01-01-1980   HQIC                          2219.351
                         - 12-01-1990
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          1.3121      0.046     28.781      0.000       1.223       1.401
ar.L2         -0.5593      0.072     -7.741      0.000      -0.701      -0.418
ma.L1         -1.9917      0.109    -18.218      0.000      -2.206      -1.777
ma.L2          0.9999      0.110      9.109      0.000       0.785       1.215
sigma2      1.099e+06   1.99e-07   5.51e+12      0.000     1.1e+06     1.1e+06
===================================================================================
Ljung-Box (L1) (Q):                   0.19   Jarque-Bera (JB):                14.46
Prob(Q):                              0.67   Prob(JB):                         0.00
Heteroskedasticity (H):               2.43   Skew:                             0.61
Prob(H) (two-sided):                  0.00   Kurtosis:                         4.08
===================================================================================
```


Table 30: ARIMA model summary for Rose wine

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352
SimpleAvg	1275.081804
MovingAvg2	813.400684
MovingAvg4	1156.589694
MovingAvg6	1283.927428
MovingAvg9	1346.278315
SES	1316.035487
DES	2007.238526
TES	378.951023
Auto ARIMA (2,1,2)	1299.979640

Table 31: Auto ARIMA Sparkling wine-RMSE value

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093
SimpleAvg	53.440426
MovingAvg2	11.529409
MovingAvg4	14.448930
MovingAvg6	14.560046
MovingAvg9	14.724503
SES	36.775774
DES	15.699312
TES	20.132468
Auto ARIMA (0,1,2)	57.109715

Table 32: Auto ARIMA Rose wine-RMSE value

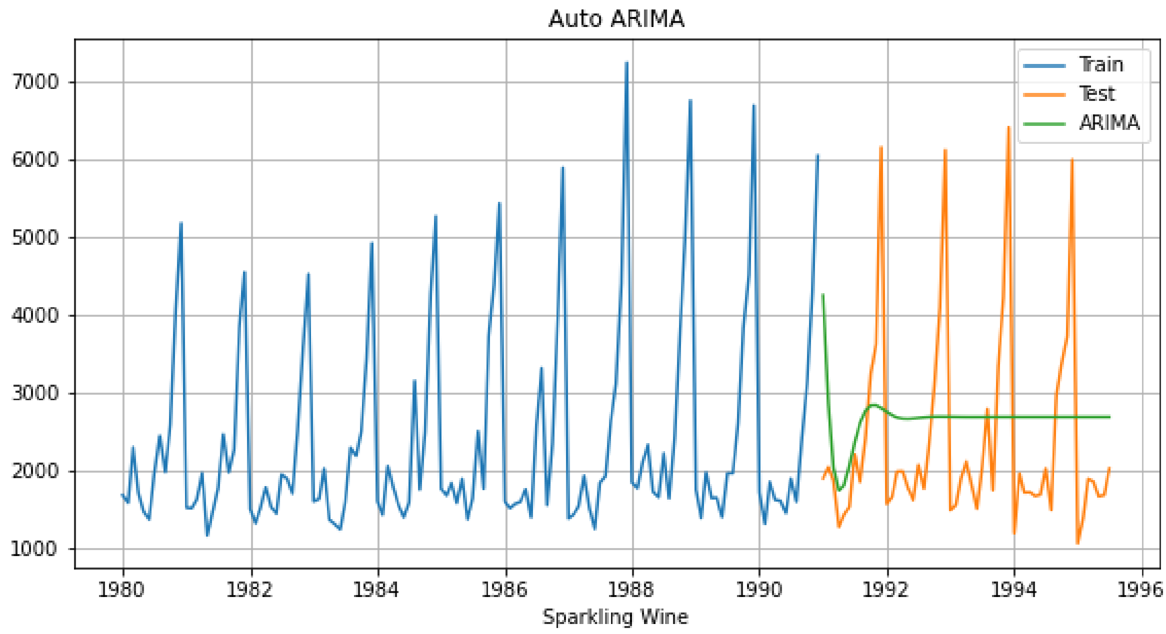

Figure 34: ARIMA Sparkling wine graph

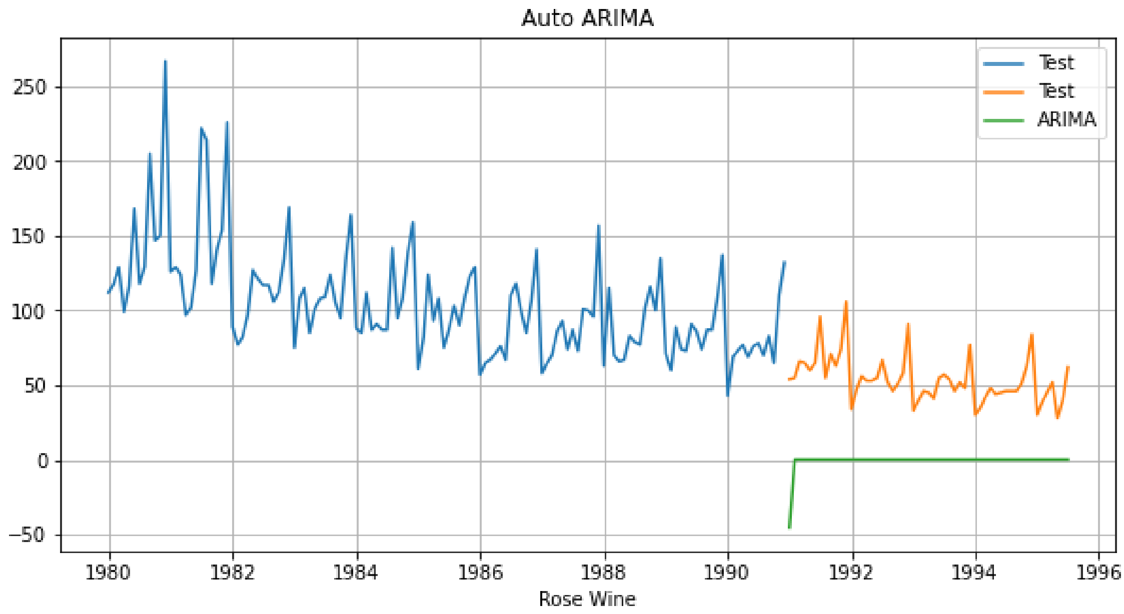

Figure 35: ARIMA Rose wine graph

7. Build ARIMA/SARIMA models based on the cut-off points of ACF and PACF on the training data and evaluate this model on the test data using RMSE.

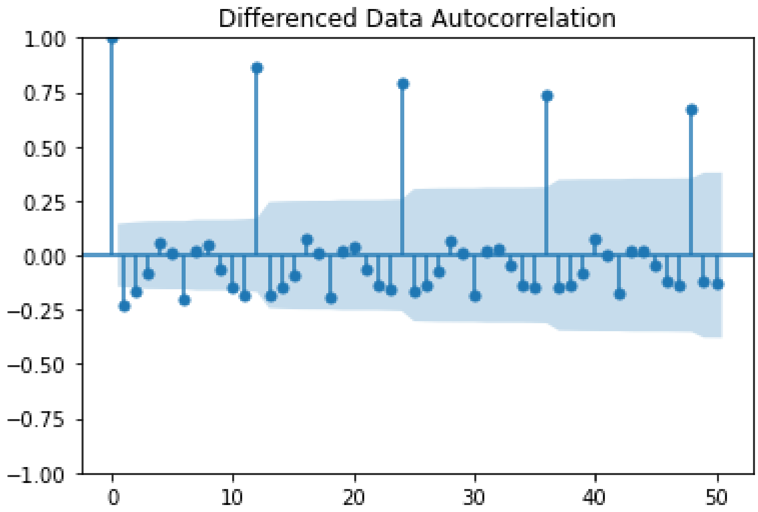

Figure 36: Autocorrelation for Sparkling wine

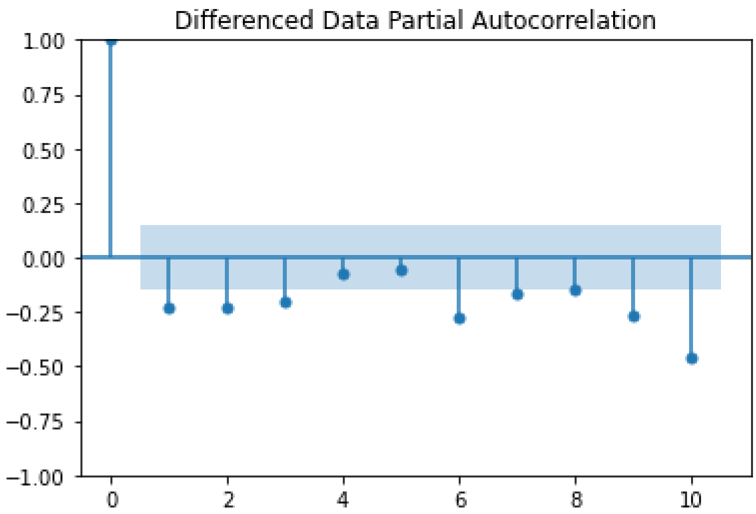

Figure 37: Partial Autocorrelation for Sparkling wine

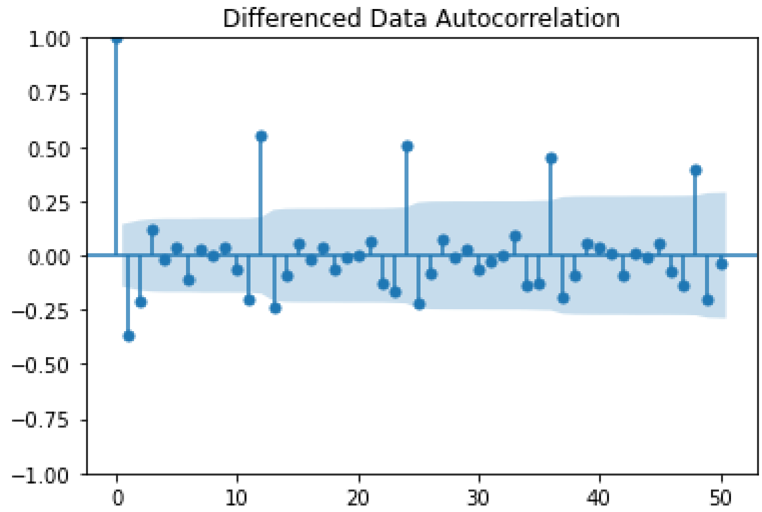

Figure 38: Autocorrelation for Rose wine

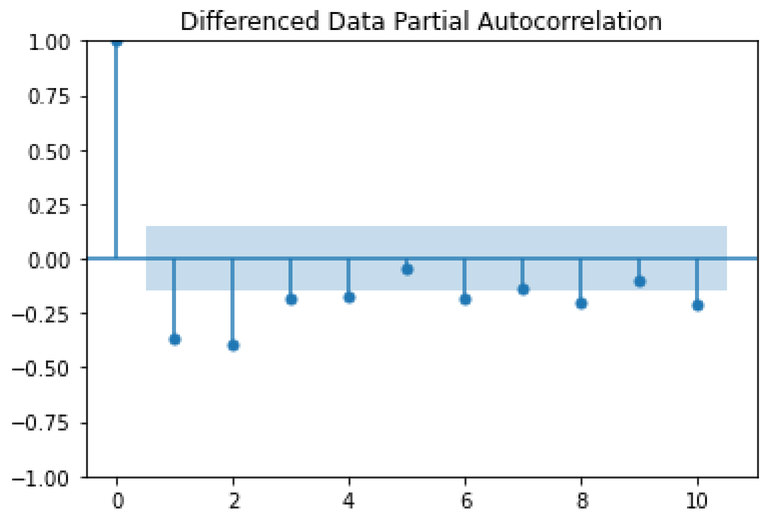

Figure 39: Partial Autocorrelation for Rose wine

Here, we have taken alpha=0.05.

The Auto-Regressive parameter in an ARIMA model is 'p' which comes from the significant lag before which the PACF plot cuts-off to 0. The Moving-Average parameter in an ARIMA model is 'q' which comes from the significant lag before the ACF plot cuts-off to 0.

By looking at the above plots for Sparkling data, we can say that the PACF cuts off at 3 and ACF plot cuts-off at lag 2.

By looking at the above plots for Rose data, we can say that PACF cuts off at 4 and ACF plot cuts-off at lag 2.

```
Sparkling Data:
                               SARIMAX Results
==============================================================================
Dep. Variable:              Sparkling   No. Observations:                  132
Model:                 ARIMA(3, 1, 2)   Log Likelihood               -1109.476
Date:                Sat, 17 Dec 2022   AIC                           2230.952
Time:                        12:18:48   BIC                           2248.204
Sample:                    01-01-1980   HQIC                          2237.962
                         - 12-01-1990
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1         -0.4155      0.043     -9.746      0.000      -0.499      -0.332
ar.L2          0.3242      0.120      2.704      0.007       0.089       0.559
ar.L3         -0.2603      0.077     -3.362      0.001      -0.412      -0.109
ma.L1          0.0218      0.134      0.163      0.871      -0.241       0.284
ma.L2         -0.9780      0.141     -6.918      0.000      -1.255      -0.701
sigma2      1.327e+06   1.94e-07   6.86e+12      0.000    1.33e+06    1.33e+06
===================================================================================
Ljung-Box (L1) (Q):                   0.12   Jarque-Bera (JB):                 3.62
Prob(Q):                              0.73   Prob(JB):                         0.16
Heteroskedasticity (H):               2.72   Skew:                             0.31
Prob(H) (two-sided):                  0.00   Kurtosis:                         3.52
===================================================================================
```

Figure 40: Manual ARIMA for Sparkling wine

```
Rose:
                               SARIMAX Results
==============================================================================
Dep. Variable:                   Rose   No. Observations:                  132
Model:                 ARIMA(4, 1, 2)   Log Likelihood                -635.859
Date:                Sat, 17 Dec 2022   AIC                           1285.718
Time:                        12:18:51   BIC                           1305.845
Sample:                    01-01-1980   HQIC                          1293.896
                         - 12-01-1990
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1         -0.3838      0.923     -0.416      0.677      -2.192       1.425
ar.L2          0.0046      0.258      0.018      0.986      -0.502       0.511
ar.L3          0.0414      0.113      0.366      0.714      -0.180       0.263
ar.L4         -0.0054      0.177     -0.031      0.976      -0.353       0.342
ma.L1         -0.3239      0.933     -0.347      0.729      -2.153       1.505
ma.L2         -0.5407      0.874     -0.619      0.536      -2.254       1.172
sigma2       951.1524     93.870     10.133      0.000     767.170    1135.135
===================================================================================
Ljung-Box (L1) (Q):                   0.02   Jarque-Bera (JB):                32.85
Prob(Q):                              0.88   Prob(JB):                         0.00
Heteroskedasticity (H):               0.37   Skew:                             0.77
Prob(H) (two-sided):                  0.00   Kurtosis:                         4.91
===================================================================================
```

Figure 41: Manual ARIMA for Rose wine

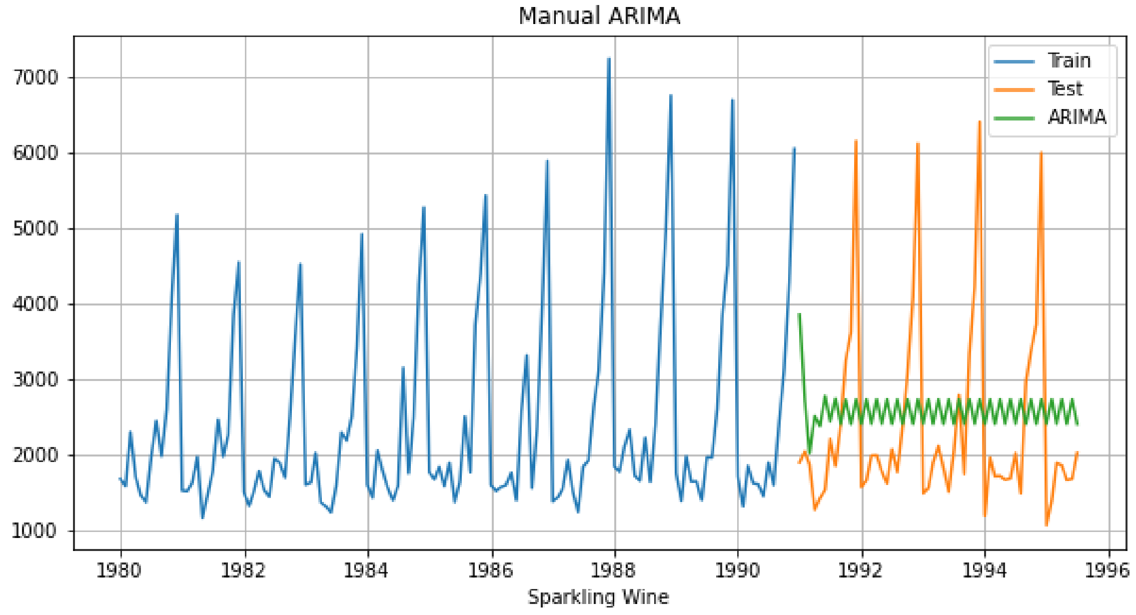

Figure 42: Manual ARIMA for Sparkling wine

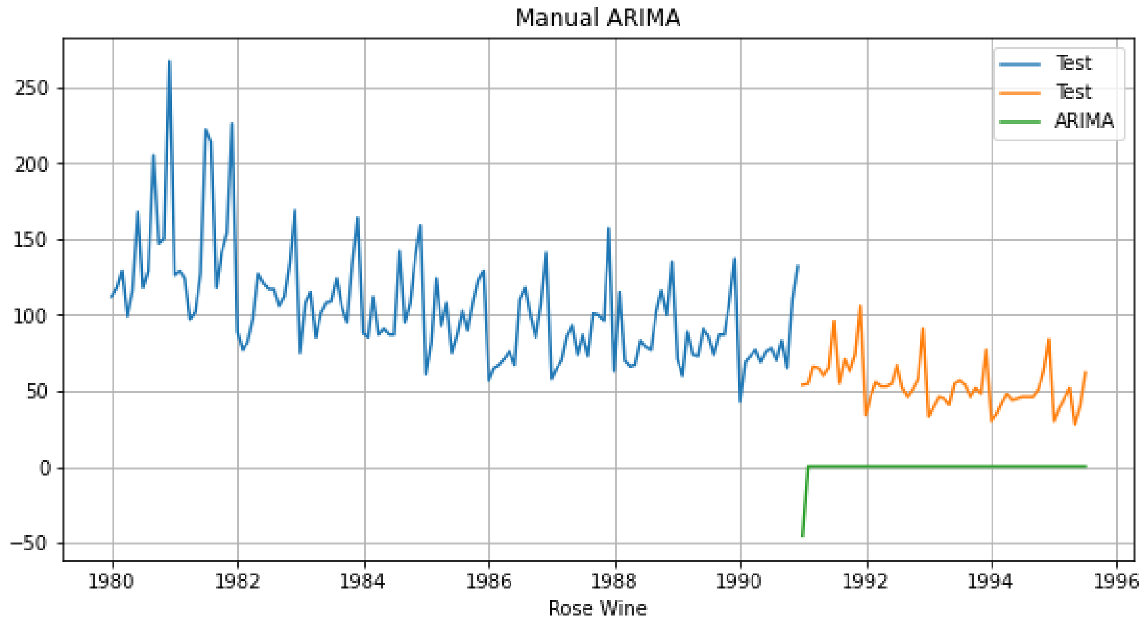

Figure 43: Manual ARIMA for Rose wine

Manual ARIMA (3,1,2) RMSE value for test Sparkling : 1286.234646
Manual ARIMA (4,1,2) RMSE value for test Rose data: 37.017231

From the ACF plot we see a significant seasonal correlation after every 11th interval Setting the seasonality as 12 for the first iteration of the auto SARIMA model.

```
Examples of some parameter combinations for Model...
Model: (0, 1, 1)(0, 0, 1, 12)
Model: (0, 1, 2)(0, 0, 2, 12)
Model: (0, 1, 3)(0, 0, 3, 12)
Model: (1, 1, 0)(1, 0, 0, 12)
Model: (1, 1, 1)(1, 0, 1, 12)
Model: (1, 1, 2)(1, 0, 2, 12)
Model: (1, 1, 3)(1, 0, 3, 12)
Model: (2, 1, 0)(2, 0, 0, 12)
Model: (2, 1, 1)(2, 0, 1, 12)
Model: (2, 1, 2)(2, 0, 2, 12)
Model: (2, 1, 3)(2, 0, 3, 12)
Model: (3, 1, 0)(3, 0, 0, 12)
Model: (3, 1, 1)(3, 0, 1, 12)
Model: (3, 1, 2)(3, 0, 2, 12)
Model: (3, 1, 3)(3, 0, 3, 12)
```

Figure 44: Some models of SARIMA

	param	seasonal	AIC_Sparkling
115	(1, 1, 3)	(0, 0, 3, 12)	16.0
51	(0, 1, 3)	(0, 0, 3, 12)	591.111768
252	(3, 1, 3)	(3, 0, 0, 12)	1387.497014
220	(3, 1, 1)	(3, 0, 0, 12)	1387.788331
237	(3, 1, 2)	(3, 0, 1, 12)	1388.602616
...	...	...	...
19	(0, 1, 1)	(0, 0, 3, 12)	7427.391419
3	(0, 1, 0)	(0, 0, 3, 12)	7441.156432
195	(3, 1, 0)	(0, 0, 3, 12)	7503.735447
131	(2, 1, 0)	(0, 0, 3, 12)	7504.526807
67	(1, 1, 0)	(0, 0, 3, 12)	7508.163889

Table 33: SARIMA AIC values for Sparkling wine

```
                              SARIMAX Results
==========================================================================================
Dep. Variable:                                  y   No. Observations:                  132
Model:             SARIMAX(3, 1, 2)x(3, 0, [], 12)   Log Likelihood                -691.356
Date:                            Sat, 15 Jan 2022   AIC                           1400.712
Time:                                    15:06:04   BIC                           1423.408
Sample:                                         0   HQIC                          1409.873
                                            - 132
Covariance Type:                              opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1         -0.5564      1.286     -0.433      0.665      -3.076       1.963
ar.L2         -0.4446      0.737     -0.604      0.546      -1.888       0.999
ar.L3         -0.1011      0.552     -0.183      0.854      -1.182       0.980
ma.L1       -194.7064   7324.804     -0.027      0.979   -1.46e+04    1.42e+04
ma.L2       5766.2906    242.888     23.741      0.000    5290.239    6242.342
ar.S.L12       0.5585      0.100      5.595      0.000       0.363       0.754
ar.S.L24       0.2633      0.117      2.248      0.025       0.034       0.493
ar.S.L36       0.2511      0.108      2.326      0.020       0.040       0.463
sigma2         0.0059      0.001      8.274      0.000       0.005       0.007
===================================================================================
Ljung-Box (L1) (Q):                   0.06   Jarque-Bera (JB):                20.78
Prob(Q):                              0.80   Prob(JB):                         0.00
Heteroskedasticity (H):               1.03   Skew:                             0.51
Prob(H) (two-sided):                  0.94   Kurtosis:                         5.09
===================================================================================
```

Figure 45: Auto SARIMA summary for Sparkling wine

```
                                   SARIMAX Results
============================================================================================
Dep. Variable:                                  y   No. Observations:                  132
Model:             SARIMAX(3, 1, 1)x(3, 0, [1, 2], 11)   Log Likelihood            -437.103
Date:                            Sat, 15 Jan 2022   AIC                            894.205
Time:                                    15:06:07   BIC                            919.744
Sample:                                         0   HQIC                           904.525
                                            - 132
Covariance Type:                              opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          0.1884      0.121      1.551      0.121      -0.050       0.426
ar.L2          0.0208      0.123      0.170      0.865      -0.219       0.261
ar.L3          0.0146      0.140      0.104      0.917      -0.259       0.288
ma.L1         -0.9339      0.076    -12.309      0.000      -1.083      -0.785
ar.S.L11      -0.2380      0.421     -0.565      0.572      -1.063       0.587
ar.S.L22      -0.0357      0.170     -0.210      0.834      -0.369       0.298
ar.S.L33      -0.0042      0.115     -0.036      0.971      -0.229       0.221
ma.S.L11       0.1810      0.448      0.404      0.686      -0.697       1.059
ma.S.L22      -0.1736      0.234     -0.742      0.458      -0.632       0.285
sigma2       565.7118     98.703      5.731      0.000     372.258     759.165
===================================================================================
Ljung-Box (L1) (Q):                   0.02   Jarque-Bera (JB):                 0.17
Prob(Q):                              0.90   Prob(JB):                         0.92
Heteroskedasticity (H):               0.91   Skew:                            -0.06
Prob(H) (two-sided):                  0.80   Kurtosis:                         3.17
===================================================================================
```

Figure 46: Auto SARIMA summary for Rose wine

Auto SARIMA (3,1,2)(3,0,0,12) RMSE value for test Sparkling : 1827.354980
Auto SARIMA (3,1,2)(3,0,0,2,12) RMSE value for test Rose data: 38.034261

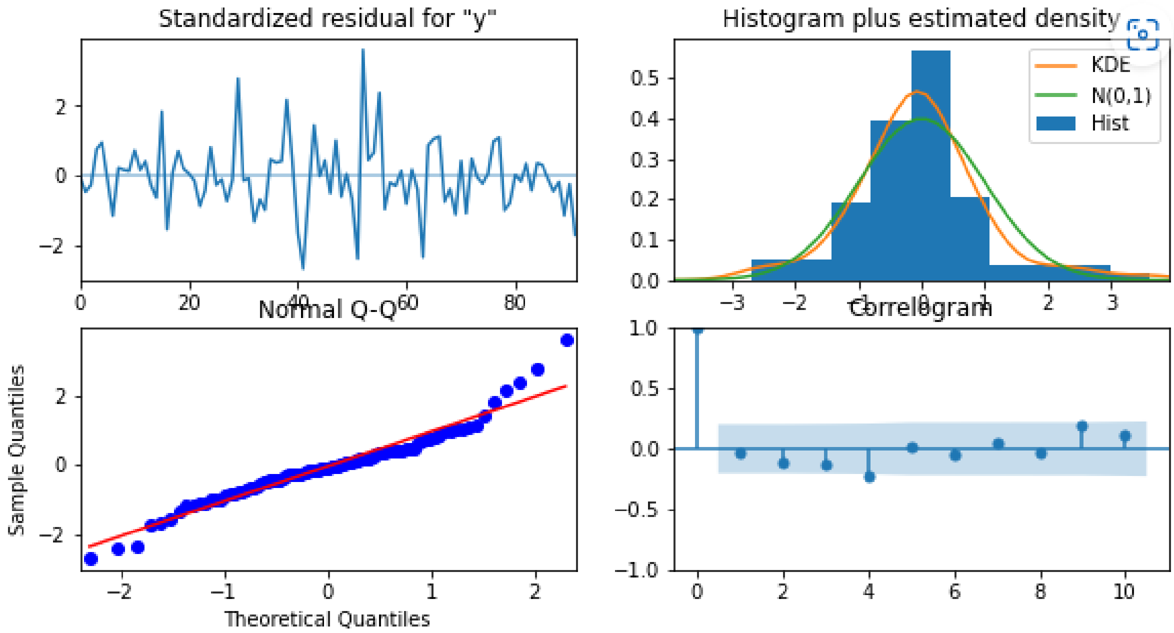

Figure 47: Auto SARIMA for Sparkling wine-Graph

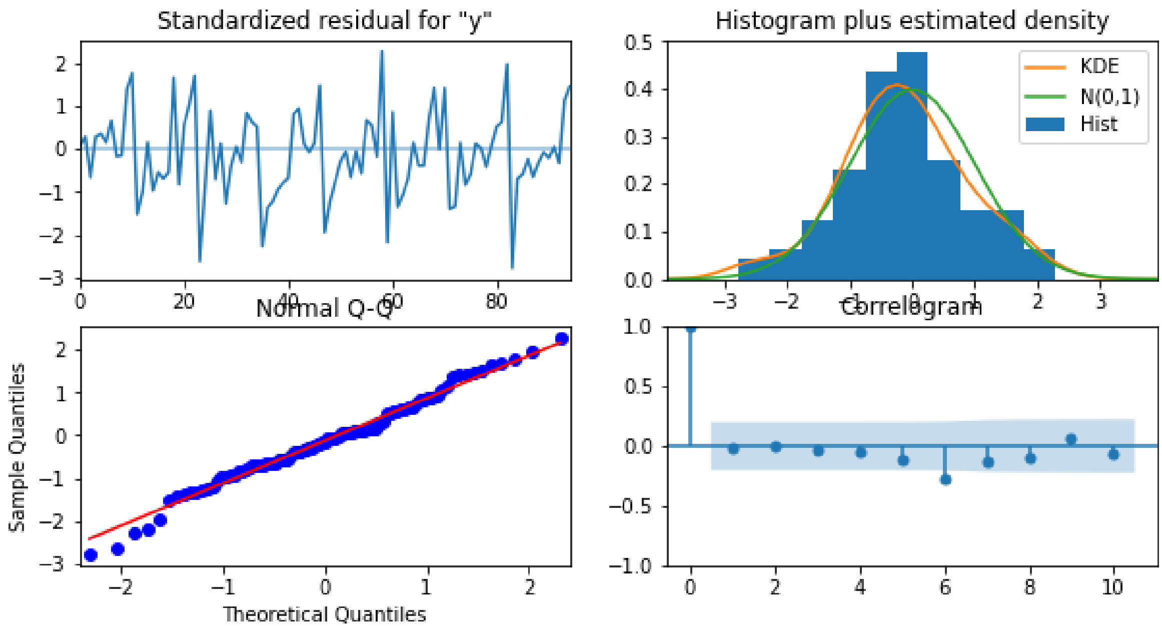

Figure 48: Auto SARIMA for Rose wine-Graph

AIC for sparkling data is the lowest for the model (3,1,2), also we saw the from ACF and PACG plots that the cut off of p and q are at 3 and 2 resp. so we conclude that the auto SARIMAX and the manual SARIMAX models are the same.

For Rose data let's build a model at the p and q cut off at 4, 2 respectively.

```
                                      SARIMAX Results
==========================================================================================
Dep. Variable:                                   y   No. Observations:                  132
Model:             SARIMAX(4, 1, 2)x(3, 0, 2, 12)   Log Likelihood                -371.081
Date:                            Sat, 15 Jan 2022   AIC                            766.161
Time:                                    17:16:38   BIC                            796.292
Sample:                                         0   HQIC                           778.317
                                            - 132
Covariance Type:                              opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1         -0.7986      0.188     -4.250      0.000      -1.167      -0.430
ar.L2         -0.0111      0.159     -0.070      0.944      -0.322       0.300
ar.L3         -0.1475      0.153     -0.963      0.335      -0.448       0.153
ar.L4         -0.2441      0.108     -2.269      0.023      -0.455      -0.033
ma.L1         -0.0888      0.186     -0.477      0.634      -0.454       0.276
ma.L2         -0.7649      0.183     -4.185      0.000      -1.123      -0.407
ar.S.L12       0.7669      0.165      4.637      0.000       0.443       1.091
ar.S.L24       0.0839      0.148      0.565      0.572      -0.207       0.375
ar.S.L36       0.0765      0.093      0.824      0.410      -0.106       0.259
ma.S.L12      -0.5259      0.288     -1.824      0.068      -1.091       0.039
ma.S.L24      -0.2332      0.230     -1.014      0.311      -0.684       0.218
sigma2       181.2721     39.757      4.560      0.000     103.350     259.194
===================================================================================
Ljung-Box (L1) (Q):                   0.04   Jarque-Bera (JB):                 0.93
Prob(Q):                              0.85   Prob(JB):                         0.63
Heteroskedasticity (H):               1.24   Skew:                             0.25
Prob(H) (two-sided):                  0.56   Kurtosis:                         2.99
===================================================================================
```

Figure 49: Manual SARIMA model SUMMARY for Rose wine

Manual SARIMA (4,1,2)(3,0,0,2,12) RMSE value for test Rose data: 18.291551

8. Build a table with all the models built along with their corresponding parameters and the respective RMSE values on the test data.

	Test_Spark RMSE
Regression	1389.135175
NaiveModel	3864.279352
SimpleAvg	1275.081804
MovingAvg2	813.400684
MovingAvg4	1156.589694
MovingAvg6	1283.927428
MovingAvg9	1346.278315
SES	1316.035487
DES	2007.238526
TES	473.152417
Auto ARIMA (2,1,2)	1374.037009
Manual ARIMA (3,1,2)	1379.049123
Auto SARIMA (3,1,2)(3,0,0,12)	1827.354980

Table 34: RMSE values for various models - Sparkling wine

	Test_Rose RMSE
Regression	15.262509
NaiveModel	79.699093
SimpleAvg	53.440426
MovingAvg2	11.529409
MovingAvg4	14.448930
MovingAvg6	14.560046
MovingAvg9	14.724503
SES	36.775774
DES	15.699312
TES	20.995338
Auto ARIMA (0,1,2)	56.252559
Manual ARIMA (4,1,2)	33.930983
Auto SARIMA (3,1,1)(3,0,2,12)	38.034261
Manual SARIMA (4,1,2)(3,0,2,12)	18.291551
Auto SARIMA (3,1,1)(3,0,2,12)	38.034261
Manual SARIMA (4,1,2)(3,0,2,12)	18.291551

Table 35: RMSE values for various models - Rose wine

9. Based on the model-building exercise, build the most optimum model(s) on the complete data and predict 12 months into the future with appropriate confidence intervals/bands.

```
{'smoothing_level': 0.0761188250859012,
 'smoothing_trend': 0.05438010806798877,
 'smoothing_seasonal': 0.3762312949436105,
 'damping_trend': nan,
 'initial_level': 1579.9891770683585,
 'initial_trend': -4.690545983628159,
 'initial_seasons': array([ 105.94461239,   10.9817497 ,  723.56984375,  132.18271564,
        -108.94726499, -202.83394312,  386.00063663,  873.07639675,
         404.11215468, 1016.09273715, 2506.93251613, 3598.8745819 ]),
 'use_boxcox': False,
 'lamda': None,
 'remove_bias': False}
```

Figure 50: TES on full Sparkling wine

Time	Sparkling Forecast	lower CI	upper CI
1995-08-31	1869.308465	1084.725597	2653.891334
1995-09-30	2395.901557	1611.318689	3180.484425
1995-10-31	3231.674754	2447.091886	4016.257623
1995-11-30	3910.933211	3126.350342	4695.516079
1995-12-31	6106.418347	5321.835478	6891.001215
1996-01-31	1249.948453	465.365584	2034.531321
1996-02-29	1579.006231	794.423363	2363.589099
1996-03-31	1818.420376	1033.837508	2603.003245
1996-04-30	1792.725965	1008.143097	2577.308834
1996-05-31	1637.530692	852.947823	2422.113560
1996-06-30	1571.584281	787.001412	2356.167149
1996-07-31	1958.453664	1173.870796	2743.036532

Table 36: TES predict for 12 months for full Sparkling wine

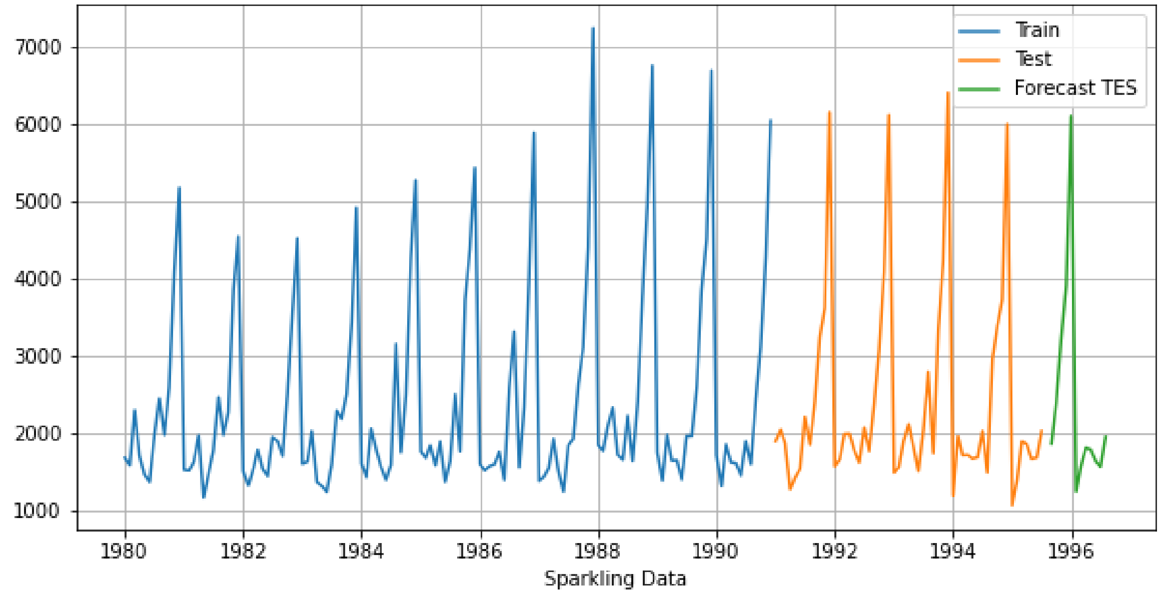

Figure 51: TES full Sparkling data prediction – Graph

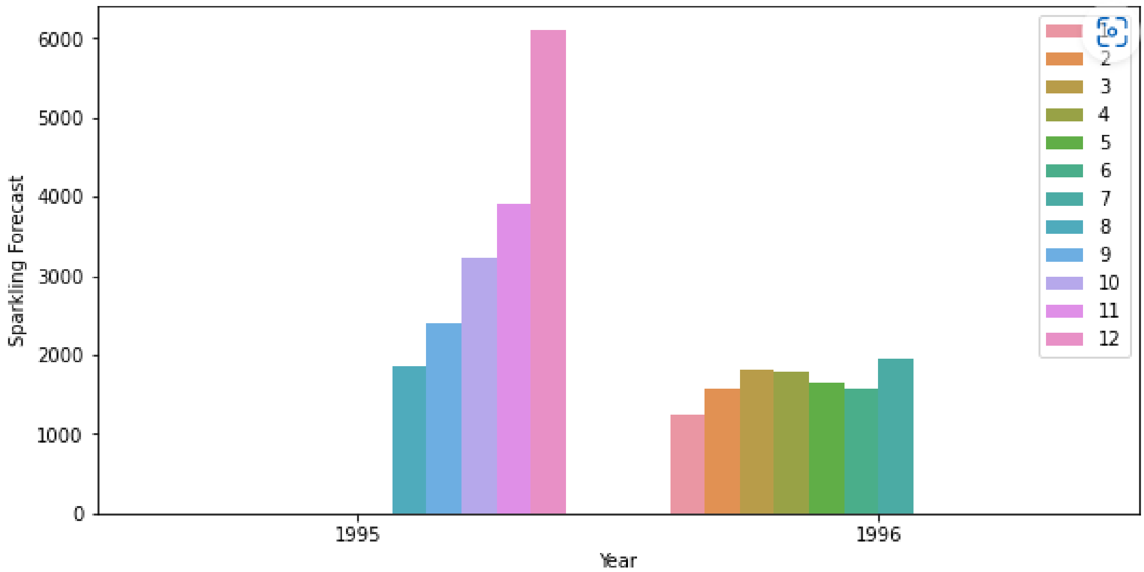

Figure 52: TES full Sparkling data – Monthly Graph

For Rose dataset rolling avg shows the best RMSE, however since the window chosen was very small(2,4,6,9) it was natural it was going to work well on Test set. The other model which gave the best RMSE was TES and Manual SARIMAX (4,1,2)(3,0,2,12). We will built a final model on the entire Rose dataset using SARIMAX

y	mean	mean_se	mean_ci_lower	mean_ci_upper
Time				
1995-08-31	46.415270	11.969966	22.954568	69.875973
1995-09-30	48.793452	12.040545	25.194418	72.392487
1995-10-31	47.510293	12.109043	23.777006	71.243580
1995-11-30	56.270704	12.121642	32.512722	80.028685
1995-12-31	77.865599	12.122119	54.106682	101.624516
1996-01-31	28.708299	12.215011	4.767319	52.649280
1996-02-29	37.191667	12.375455	12.936221	61.447112
1996-03-31	42.403273	12.562727	17.780780	67.025767
1996-04-30	40.942663	12.729238	15.993815	65.891511
1996-05-31	36.442595	12.842775	11.271219	61.613971
1996-06-30	40.436958	12.934480	15.085843	65.788073
1996-07-31	49.550765	13.022823	24.026502	75.075029

Table 37: SARIMA full Rose data

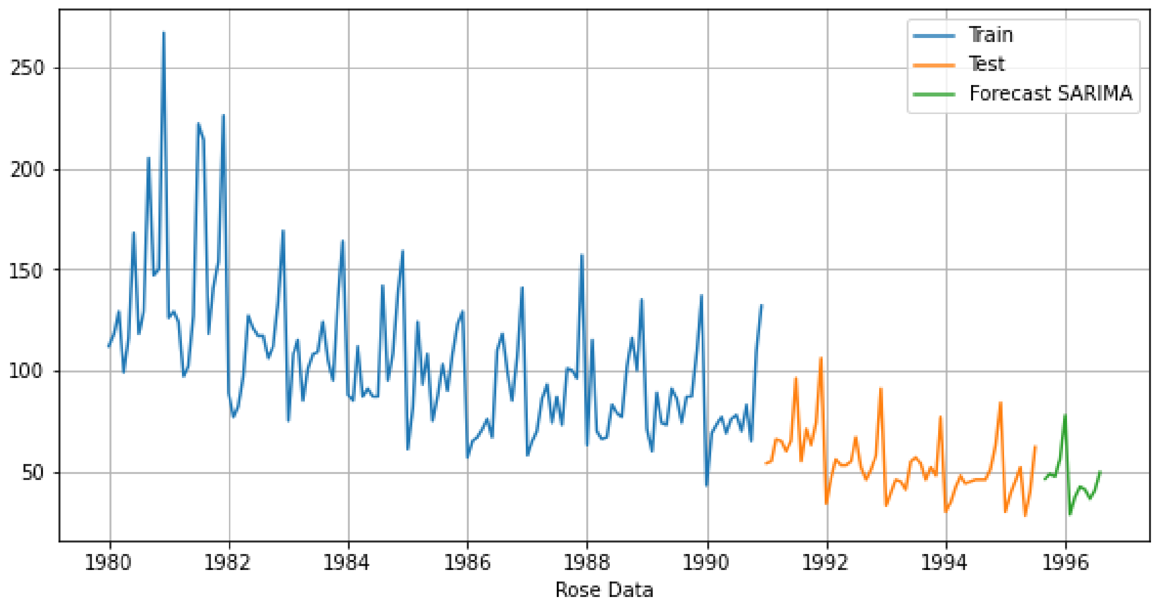

Figure 53: SARIMA full Rose data prediction-Graph

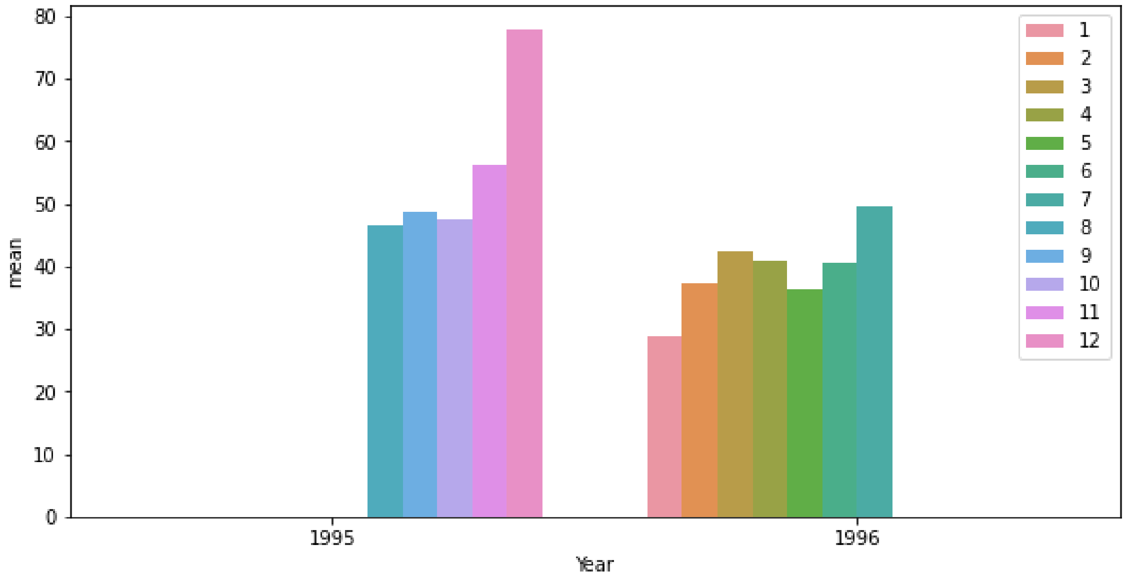

Figure 54: SARIMA full Rose data – Monthly Graph

10. Comment on the model thus built and report your findings and suggest the measures that the company should be taking for future sales.

Sparkling Wine data:

TES (Triple Exponential Smoothing) has worked the best for the forecast with lowest RMSE on test data You can see from the above chart that the forecast for next 12 months is slightly over the sales of the previous 12 months however, there isn't a considerable increase. Observed from the month wise bar plots previously, we can say that the sales of Sparkling wine tend to go up in last two months probably because it's a holiday season than the rest and its lowest around Jun and July ABC can take various measures to increase the sales towards the beginning and mid of the year, it can introduce promotional activities or discounts during the low sales period. ABC can tie up with events like concerts, weddings etc. and do some sponsorships to boost sales during the slack

Rose Wine data:

We chose manual SARIMAX model to predict for the Rose wine data. The model was passed the cut offs found through ACF and PACF plots of q and p respectively and seasonality of 12 as the plots showed a patterned significance after 11 lags. You can see from the above plot for Rose wine data the forecast for 1996 is more or less same as of for 1995. Observed from the monthly bar plot sales shows an increasing trend from August towards December, it’s on the lower side beginning of the year ABC can take sought promotional activities and implement some discounts during the first half of the year