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Practical 1 : To analyze time series data and develop a predictive model using the Seasonal AutoRegressive Integrated Moving Average (SARIMA) technique, identifying trends, seasonality, and making accurate forecasts for future time points

```
import pandas as pd  
data = pd.read_csv('/content/PRODUCT SALES DATA.csv')  
data.info
```

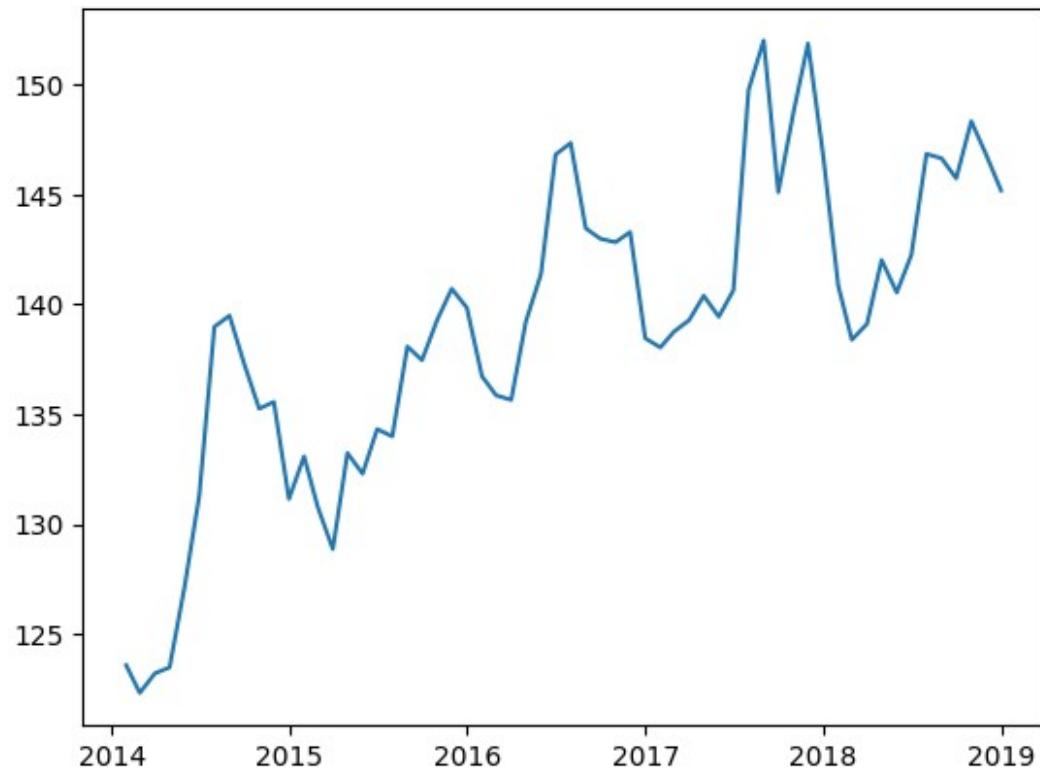
			Year	Month	Product1
	Product2	Product3			
0	2014	January	123.57	118.69	120.51
1	2014	February	122.31	120.07	115.83
2	2014	March	123.20	119.84	115.44
3	2014	April	123.47	119.41	118.30
4	2014	May	127.16	119.57	128.64
5	2014	June	131.29	118.56	113.22
6	2014	July	138.98	119.58	108.96
7	2014	August	139.49	117.47	122.25
8	2014	September	137.30	116.55	132.72
9	2014	October	135.25	115.49	125.82
10	2014	November	135.56	113.11	120.39
11	2014	December	131.14	116.22	125.79
12	2015	January	133.08	114.58	117.27
13	2015	February	130.78	114.93	114.64
14	2015	March	128.86	112.29	114.15
15	2015	April	133.23	113.64	107.33
16	2015	May	132.29	117.68	103.28
17	2015	June	134.32	118.71	109.01
18	2015	July	133.99	117.70	105.97
19	2015	August	138.08	119.06	106.92
20	2015	September	137.46	121.28	108.31
21	2015	October	139.29	121.08	97.22
22	2015	November	140.71	121.29	100.41
23	2015	December	139.85	122.95	120.52
24	2016	January	136.73	123.69	99.76
25	2016	February	135.86	119.56	102.47
26	2016	March	135.65	118.65	117.13
27	2016	April	139.21	123.79	106.36
28	2016	May	141.38	122.82	112.43
29	2016	June	146.82	125.31	119.23
30	2016	July	147.35	129.04	97.47
31	2016	August	143.46	126.89	129.76
32	2016	September	142.99	123.77	129.36
33	2016	October	142.83	121.09	105.58
34	2016	November	143.29	120.42	111.79
35	2016	December	138.46	121.19	116.69

36	2017	January	138.04	125.06	114.10
37	2017	February	138.76	124.13	115.51
38	2017	March	139.28	123.69	114.97
39	2017	April	140.39	124.17	117.82
40	2017	May	139.44	120.26	119.80
41	2017	June	140.65	119.36	120.29
42	2017	July	149.76	120.73	122.09
43	2017	August	152.02	123.12	120.81
44	2017	September	145.11	122.66	130.67
45	2017	October	148.73	120.45	123.74
46	2017	November	151.88	117.19	124.84
47	2017	December	146.79	121.66	122.51
48	2018	January	140.85	123.41	120.22
49	2018	February	138.39	122.29	122.43
50	2018	March	139.11	122.29	141.26
51	2018	April	142.02	121.81	142.22
52	2018	May	140.54	121.92	130.94
53	2018	June	142.25	124.40	125.91
54	2018	July	146.85	125.75	135.55
55	2018	August	146.65	124.47	131.67
56	2018	September	145.74	126.50	132.68
57	2018	October	148.34	123.72	141.43
58	2018	November	146.84	124.84	152.92
59	2018	December	145.19	126.43	142.45

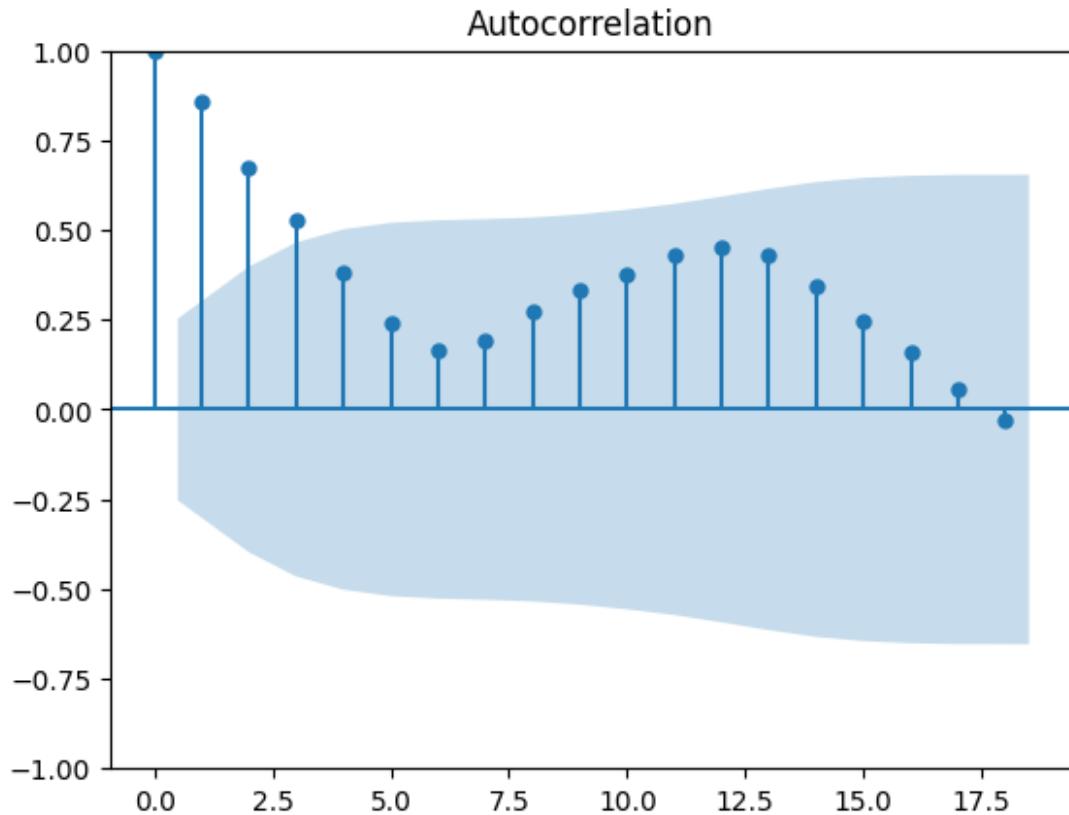
data

```
{"summary": {"name": "data", "rows": 60, "fields": [
  {"column": "Year", "properties": {"dtype": "number", "std": 1, "min": 2014, "max": 2018, "num_unique_values": 5, "samples": [2015, 2018, 2016], "semantic_type": "\\", "description": "\n"}, "column": "Month", "properties": {"dtype": "category", "num_unique_values": 12, "samples": ["November", "October", "January"], "semantic_type": "\\", "description": "\n"}, "column": "Product1", "properties": {"dtype": "number", "std": 7.005791669818905, "min": 122.31, "max": 152.02, "num_unique_values": 60, "samples": [123.57, 131.29, 138.04], "semantic_type": "\\", "description": "\n"}, "column": "Product2", "properties": {"dtype": "number", "std": 3.6138208335429622, "min": 112.29, "max": 129.04, "num_unique_values": 58, "samples": [118.69, 118.56, 120.42], "semantic_type": "\\", "description": "\n"}]}
```

```
n    },\n    {\n        \"column\": \"Product3\", \n        \"properties\":\n        {\n            \"dtype\": \"number\", \n            \"std\": 11.950044871437864, \n            \"min\": 97.22, \n            \"max\": 152.92, \n            \"num_unique_values\": 60, \n            \"samples\": [\n                120.51, \n                113.22, \n                114.1\n            ], \n            \"semantic_type\": \"\", \n            \"description\": \"\"\n        }\n    }\n},\n{\n    \"type\": \"dataframe\", \n    \"variable_name\": \"data\"\n}\n]\n}\n}\n\nrng = pd.date_range(start='2014', end='2019', freq='M')\n\n<ipython-input-14-e87bce45cccd4>:1: FutureWarning: 'M' is deprecated\nand will be removed in a future version, please use 'ME' instead.\n    rng = pd.date_range(start='2014', end='2019', freq='M')\n\nrng\n\nDatetimeIndex(['2014-01-31', '2014-02-28', '2014-03-31', '2014-04-30',\n                '2014-05-31', '2014-06-30', '2014-07-31', '2014-08-31',\n                '2014-09-30', '2014-10-31', '2014-11-30', '2014-12-31',\n                '2015-01-31', '2015-02-28', '2015-03-31', '2015-04-30',\n                '2015-05-31', '2015-06-30', '2015-07-31', '2015-08-31',\n                '2015-09-30', '2015-10-31', '2015-11-30', '2015-12-31',\n                '2016-01-31', '2016-02-29', '2016-03-31', '2016-04-30',\n                '2016-05-31', '2016-06-30', '2016-07-31', '2016-08-31',\n                '2016-09-30', '2016-10-31', '2016-11-30', '2016-12-31',\n                '2017-01-31', '2017-02-28', '2017-03-31', '2017-04-30',\n                '2017-05-31', '2017-06-30', '2017-07-31', '2017-08-31',\n                '2017-09-30', '2017-10-31', '2017-11-30', '2017-12-31',\n                '2018-01-31', '2018-02-28', '2018-03-31', '2018-04-30',\n                '2018-05-31', '2018-06-30', '2018-07-31', '2018-08-31',\n                '2018-09-30', '2018-10-31', '2018-11-30', '2018-12-\n            31'],\n            dtype='datetime64[ns]', freq='ME')\n\ns = data.Product1.values\nplseries = pd.Series(s,rng)\n\nimport matplotlib.pyplot as plt\nplt.plot(plseries)\n\n[<matplotlib.lines.Line2D at 0x7a8e0c9efb90>]
```

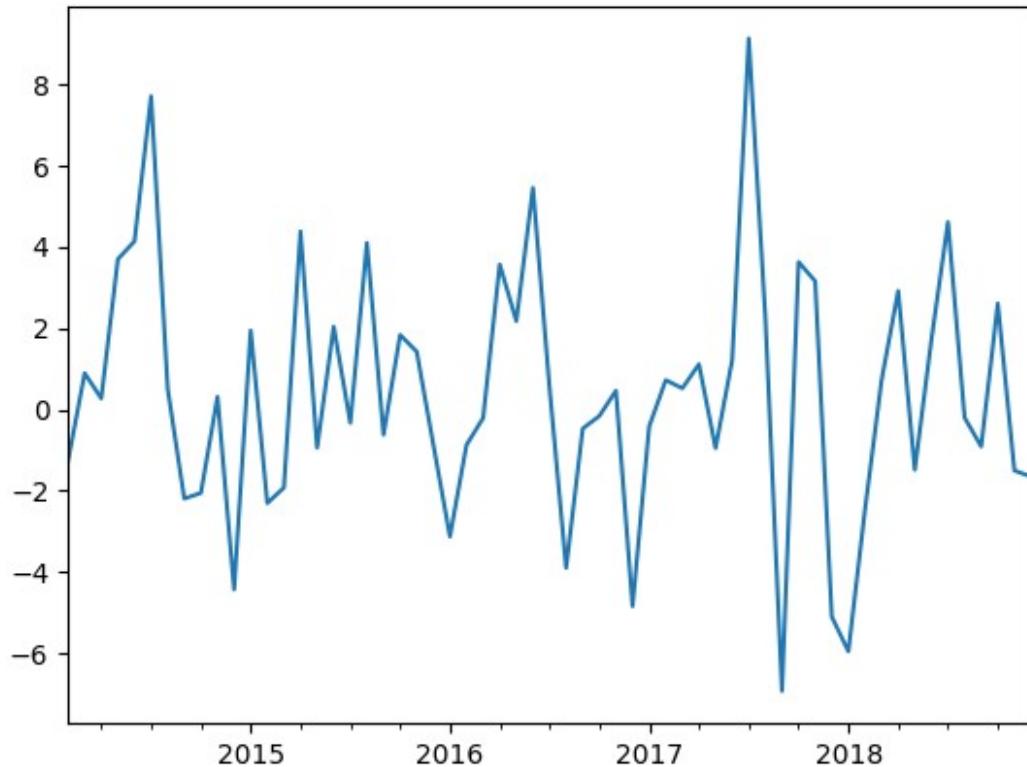


```
import matplotlib.pyplot as plt
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
plot_acf(plseries)
plt.show()
```



```
from statsmodels.tsa.statespace.tools import diff
pldiff = diff(plseries)
pldiff.plot()
pldiff.head()

2014-02-28    -1.26
2014-03-31     0.89
2014-04-30     0.27
2014-05-31     3.69
2014-06-30     4.13
Freq: ME, Name: None, dtype: float64
```



```
!pip install arch

Collecting arch
  Downloading arch-7.2.0-cp311-cp311-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (13 kB)
Requirement already satisfied: numpy>=1.22.3 in
/usr/local/lib/python3.11/dist-packages (from arch) (1.26.4)
Requirement already satisfied: scipy>=1.8 in
/usr/local/lib/python3.11/dist-packages (from arch) (1.13.1)
Requirement already satisfied: pandas>=1.4 in
/usr/local/lib/python3.11/dist-packages (from arch) (2.2.2)
Requirement already satisfied: statsmodels>=0.12 in
/usr/local/lib/python3.11/dist-packages (from arch) (0.14.4)
Requirement already satisfied: python-dateutil>=2.8.2 in
/usr/local/lib/python3.11/dist-packages (from pandas>=1.4->arch)
(2.8.2)
Requirement already satisfied: pytz>=2020.1 in
/usr/local/lib/python3.11/dist-packages (from pandas>=1.4->arch)
(2024.2)
Requirement already satisfied: tzdata>=2022.7 in
/usr/local/lib/python3.11/dist-packages (from pandas>=1.4->arch)
(2024.2)
Requirement already satisfied: patsy>=0.5.6 in
/usr/local/lib/python3.11/dist-packages (from statsmodels>=0.12->arch)
(1.0.1)
```

```
Requirement already satisfied: packaging>=21.3 in
/usr/local/lib/python3.11/dist-packages (from statsmodels>=0.12->arch)
(24.2)
Requirement already satisfied: six>=1.5 in
/usr/local/lib/python3.11/dist-packages (from python-dateutil>=2.8.2-
>pandas>=1.4->arch) (1.17.0)
Downloading arch-7.2.0-cp311-cp311-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (985 kB)
=====
          0.0/985.3 kB ? eta -:--:--
=====
          983.0/985.3 kB 51.4 MB/s eta
0:00:01 -----
          985.3/985.3 kB 26.5
MB/s eta 0:00:00

from arch.unitroot import ADF
adf = ADF(p1series, lags=0)
adf.summary()

<class 'statsmodels.iolib.summary.Summary'>
"""
    Augmented Dickey-Fuller Results
=====
Test Statistic           -2.372
P-value                  0.150
Lags                      0
-----
Trend: Constant
Critical Values: -3.55 (1%), -2.91 (5%), -2.59 (10%)
Null Hypothesis: The process contains a unit root.
Alternative Hypothesis: The process is weakly stationary.
"""

!pip install pmdarima

Collecting pmdarima
  Downloading pmdarima-2.0.4-cp311-cp311-
manylinux_2_17_x86_64.manylinux2014_x86_64.manylinux_2_28_x86_64.whl.m
etadata (7.8 kB)
Requirement already satisfied: joblib>=0.11 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (1.4.2)
Requirement already satisfied: Cython!=0.29.18,!0.29.31,>=0.29 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (3.0.11)
Requirement already satisfied: numpy>=1.21.2 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (1.26.4)
Requirement already satisfied: pandas>=0.19 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (2.2.2)
Requirement already satisfied: scikit-learn>=0.22 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (1.6.0)
Requirement already satisfied: scipy>=1.3.2 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (1.13.1)
```

```
Requirement already satisfied: statsmodels>=0.13.2 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (0.14.4)
Requirement already satisfied: urllib3 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (2.3.0)
Requirement already satisfied: setuptools!=50.0.0,>=38.6.0 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (75.1.0)
Requirement already satisfied: packaging>=17.1 in
/usr/local/lib/python3.11/dist-packages (from pmdarima) (24.2)
Requirement already satisfied: python-dateutil>=2.8.2 in
/usr/local/lib/python3.11/dist-packages (from pandas>=0.19->pmdarima)
(2.8.2)
Requirement already satisfied: pytz>=2020.1 in
/usr/local/lib/python3.11/dist-packages (from pandas>=0.19->pmdarima)
(2024.2)
Requirement already satisfied: tzdata>=2022.7 in
/usr/local/lib/python3.11/dist-packages (from pandas>=0.19->pmdarima)
(2024.2)
Requirement already satisfied: threadpoolctl>=3.1.0 in
/usr/local/lib/python3.11/dist-packages (from scikit-learn>=0.22-
>pmdarima) (3.5.0)
Requirement already satisfied: patsy>=0.5.6 in
/usr/local/lib/python3.11/dist-packages (from statsmodels>=0.13.2-
>pmdarima) (1.0.1)
Requirement already satisfied: six>=1.5 in
/usr/local/lib/python3.11/dist-packages (from python-dateutil>=2.8.2-
>pandas>=0.19->pmdarima) (1.17.0)
Downloading pmdarima-2.0.4-cp311-cp311-
manylinux_2_17_x86_64.manylinux2014_x86_64.manylinux_2_28_x86_64.whl
(2.2 MB)
----- 2.2/2.2 MB 43.7 MB/s eta
0:00:00
darima
Successfully installed pmdarima-2.0.4

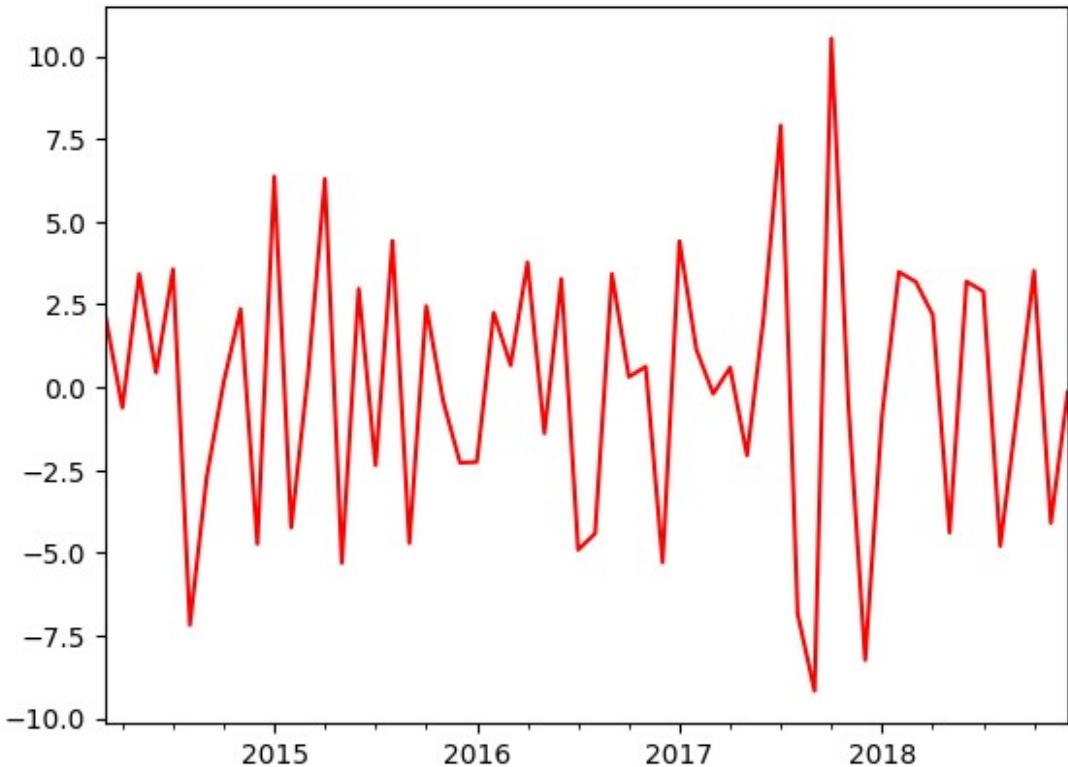
import pmdarima
pmdarima.arima.ndiffs(p1series)

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
```

```
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
1
!pip install statsmodels.tsa.stattools
ERROR: Could not find a version that satisfies the requirement
statsmodels.tsa.stattools (from versions: none)
ERROR: No matching distribution found for statsmodels.tsa.stattools

from statsmodels.tsa.statespace.tools import diff
pldiff = diff(plseries)
pldiff2 = diff(pldiff)
pldiff2.plot(color='red')

<Axes: >
```



```

import pmдарима as pm
model1 = pm.auto_arima(p1series,max_p=2, max_q=2, max_P=2, max_Q=2,
start_P=0, seasonal=True,
                      D=1,d=1,m=12,trace=True)
model1

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
Performing stepwise search to minimize aic
ARIMA(2,1,2)(0,1,1)[12] : AIC=inf, Time=3.19 sec
ARIMA(0,1,0)(0,1,0)[12] : AIC=259.386, Time=0.06 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to

```

```
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()

ARIMA(1,1,0)(1,1,0)[12] : AIC=246.003, Time=1.13 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()

ARIMA(0,1,1)(0,1,1)[12] : AIC=inf, Time=0.42 sec
ARIMA(1,1,0)(0,1,0)[12] : AIC=261.049, Time=0.03 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()

ARIMA(1,1,0)(2,1,0)[12] : AIC=241.518, Time=0.30 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()

ARIMA(1,1,0)(2,1,1)[12] : AIC=inf, Time=1.41 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()

ARIMA(1,1,0)(1,1,1)[12] : AIC=inf, Time=0.54 sec
ARIMA(0,1,0)(2,1,0)[12] : AIC=239.838, Time=0.15 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn()

ARIMA(0,1,0)(1,1,0)[12] : AIC=244.197, Time=0.06 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
```

```
'ensure_all_finite' in 1.6 and will be removed in 1.8.
warnings.warn(
    ARIMA(0,1,0)(2,1,1)[12] : AIC=inf, Time=1.16 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(0,1,0)(1,1,1)[12] : AIC=inf, Time=0.37 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(0,1,1)(2,1,0)[12] : AIC=241.008, Time=0.30 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(1,1,1)(2,1,0)[12] : AIC=239.839, Time=0.54 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(0,1,0)(2,1,0)[12] intercept : AIC=241.478, Time=0.33 sec
Best model: ARIMA(0,1,0)(2,1,0)[12]
Total fit time: 10.023 seconds
ARIMA(order=(0, 1, 0), scoring_args={}, seasonal_order=(2, 1, 0, 12),
      suppress_warnings=True, with_intercept=False)

plseries = pd.to_numeric(plseries.astype(float))
from statsmodels.tsa.statespace.sarimax import SARIMAX
plmodel = SARIMAX(plseries, order=(0,1,0),
                  seasonal_order=(2,1,0,12)).fit(trend='nc')
res1 = plmodel.resid

/usr/local/lib/python3.11/dist-packages/statsmodels/base/
optimizer.py:19: FutureWarning: Keyword arguments have been passed to
the optimizer that have no effect. The list of allowed keyword
arguments for method lbfsgs is: m, pgtol, factr, maxfun, epsilon,
approx_grad, bounds, loglike_and_score, iprint. The list of
unsupported keyword arguments passed include: trend. After release
```

```

0.14, this will raise.

warnings.warn(
    "0.14, this will raise.

from statsmodels.stats.diagnostic import acorr_ljungbox
acorr_ljungbox(res1, lags=8, boxpierce=True)

{"summary": {
    "name": "acorr_ljungbox(res1, lags=8, boxpierce=True)", "rows": 8,
    "fields": [
        {"column": "lb_stat", "properties": {
            "dtype": "number", "min": 0.010441335431886172, "max": 0.21545063058685746, "samples": [0.02374572910313025, 0.45141412861718416, 0.010441335431886172], "semantic_type": {
                "description": "The Ljung-Box test statistic for each lag.", "column": "lb_pvalue", "properties": {
                    "dtype": "number", "min": 0.9186115378913251, "max": 0.9998461695202044, "samples": [0.9881973397878796, 0.9983804783857223, 0.9186115378913251], "semantic_type": {
                        "description": "The p-value for each lag.", "column": "bp_stat", "properties": {
                            "dtype": "number", "min": 0.00993610952389168, "max": 0.4587497308014039, "samples": [0.02238215521634582, 0.00993610952389168], "semantic_type": {
                                "description": "The Breusch-Pagan test statistic for each lag.", "column": "bp_pvalue", "properties": {
                                    "dtype": "number", "min": 0.9205983507666765, "max": 0.9999039300086362, "samples": [0.9888713095574295, 0.9205983507666765], "semantic_type": {
                                        "description": "The p-value for each lag.", "type": "dataframe"
                                    }
                                }
                            }
                        }
                    }
                }
            }
        ]
    }
}
model1.predict(n_periods=3)

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
  warnings.warn(
2019-01-31    142.830310
2019-02-28    142.416922
2019-03-31    142.625007
Freq: ME, dtype: float64

```

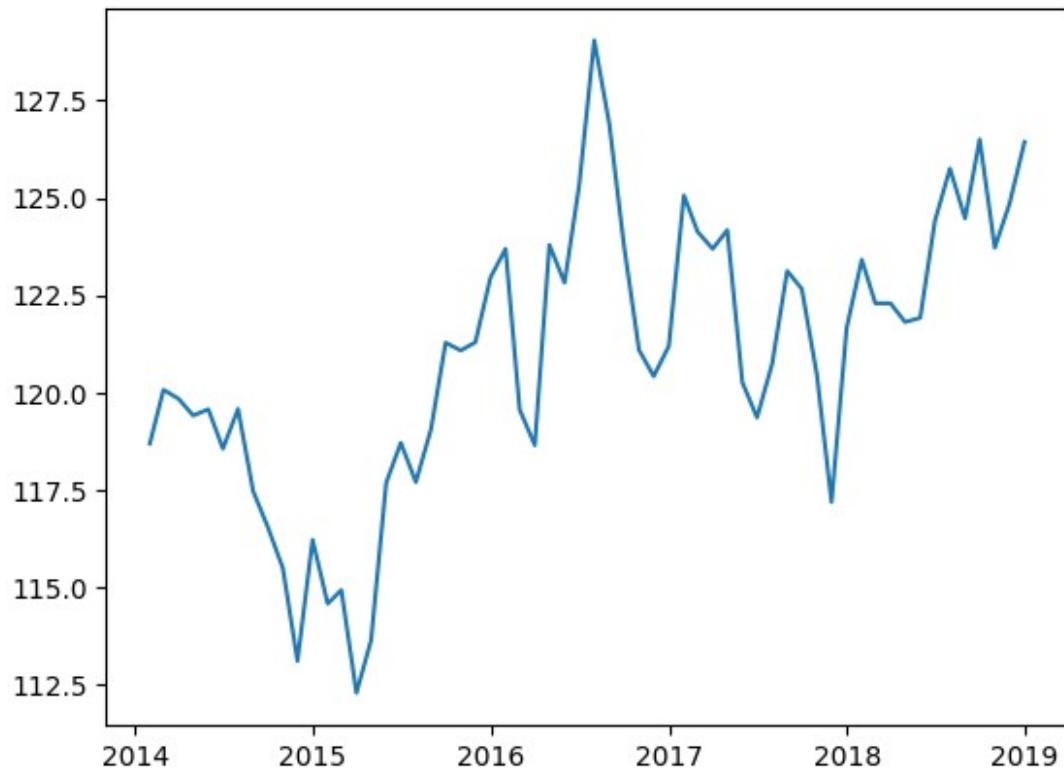
```
s = data.Product2.values  
p2series = pd.Series(s,rng)  
p2series
```

2014-01-31	118.69
2014-02-28	120.07
2014-03-31	119.84
2014-04-30	119.41
2014-05-31	119.57
2014-06-30	118.56
2014-07-31	119.58
2014-08-31	117.47
2014-09-30	116.55
2014-10-31	115.49
2014-11-30	113.11
2014-12-31	116.22
2015-01-31	114.58
2015-02-28	114.93
2015-03-31	112.29
2015-04-30	113.64
2015-05-31	117.68
2015-06-30	118.71
2015-07-31	117.70
2015-08-31	119.06
2015-09-30	121.28
2015-10-31	121.08
2015-11-30	121.29
2015-12-31	122.95
2016-01-31	123.69
2016-02-29	119.56
2016-03-31	118.65
2016-04-30	123.79
2016-05-31	122.82
2016-06-30	125.31
2016-07-31	129.04
2016-08-31	126.89
2016-09-30	123.77
2016-10-31	121.09
2016-11-30	120.42
2016-12-31	121.19
2017-01-31	125.06
2017-02-28	124.13
2017-03-31	123.69
2017-04-30	124.17
2017-05-31	120.26
2017-06-30	119.36
2017-07-31	120.73
2017-08-31	123.12
2017-09-30	122.66
2017-10-31	120.45

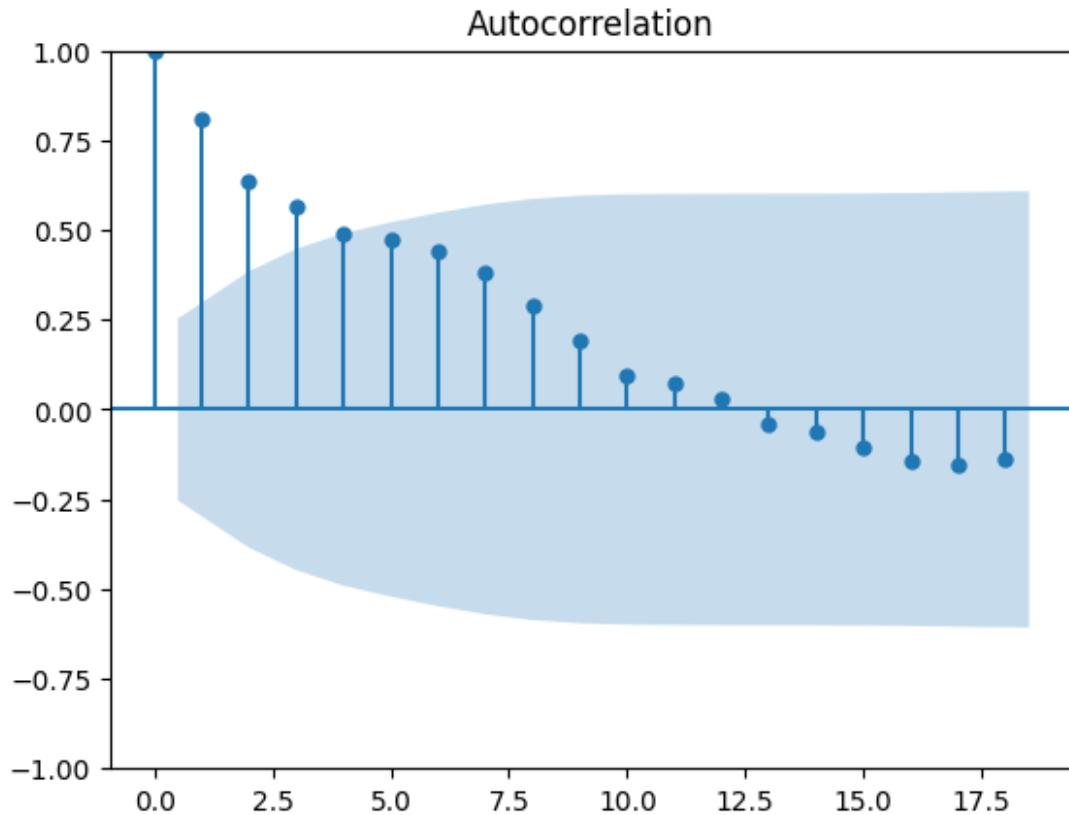
```
2017-11-30    117.19
2017-12-31    121.66
2018-01-31    123.41
2018-02-28    122.29
2018-03-31    122.29
2018-04-30    121.81
2018-05-31    121.92
2018-06-30    124.40
2018-07-31    125.75
2018-08-31    124.47
2018-09-30    126.50
2018-10-31    123.72
2018-11-30    124.84
2018-12-31    126.43
Freq: ME, dtype: float64
```

```
import matplotlib.pyplot as plt
plt.plot(p2series)
```

```
[<matplotlib.lines.Line2D at 0x7a8dfde26c90>]
```

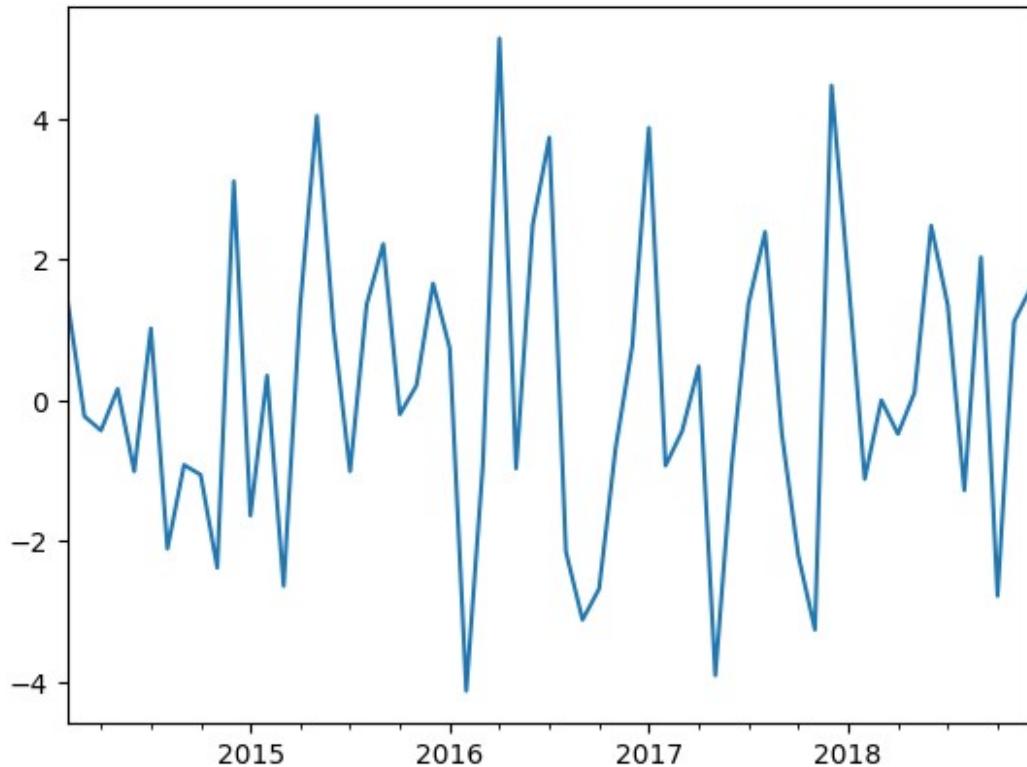


```
import matplotlib.pyplot as plt
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
plot_acf(p2series)
plt.show()
```



```
from statsmodels.tsa.statespace.tools import diff
p2diff = diff(p2series)
p2diff.plot()
p2diff.head()

2014-02-28    1.38
2014-03-31   -0.23
2014-04-30   -0.43
2014-05-31    0.16
2014-06-30   -1.01
Freq: ME, dtype: float64
```



```
from arch.unitroot import ADF
adf = ADF(p2series, lags=0)
adf.summary()

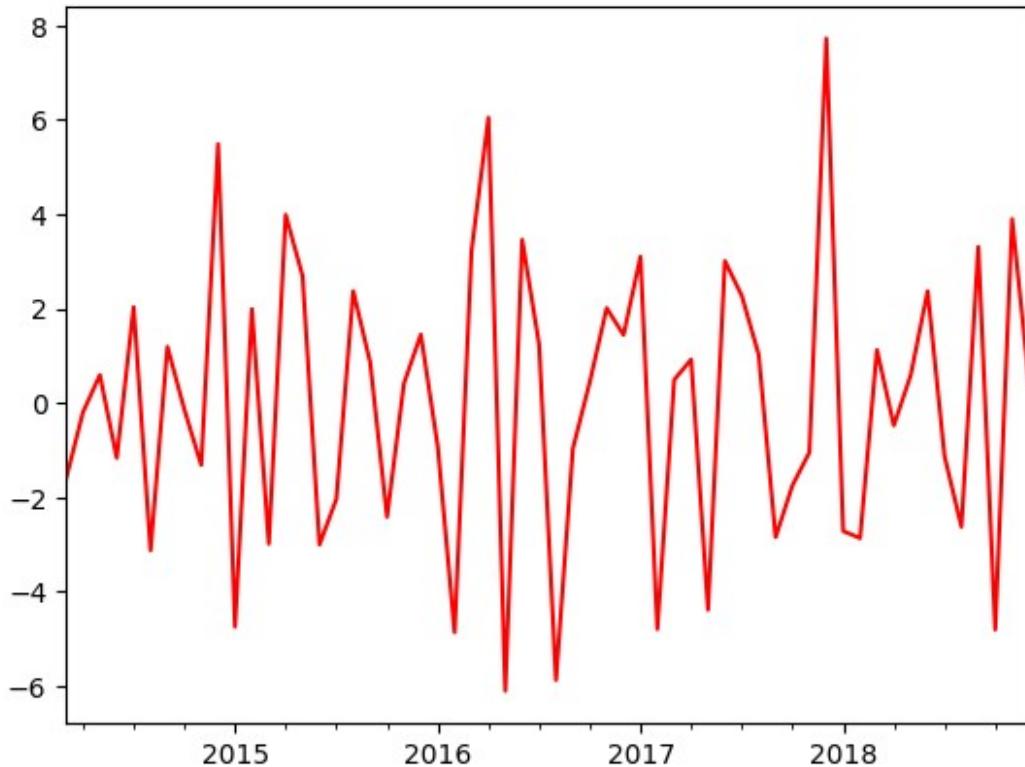
<class 'statsmodels.iolib.summary.Summary'>
"""
    Augmented Dickey-Fuller Results
=====
Test Statistic          -2.087
P-value                0.250
Lags                   0
-----
Trend: Constant
Critical Values: -3.55 (1%), -2.91 (5%), -2.59 (10%)
Null Hypothesis: The process contains a unit root.
Alternative Hypothesis: The process is weakly stationary.
"""

pmdarima.arima.ndiffs(p2series)

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
  warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
```

```
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
1
p2diff = diff(p2series)
p2diff2 = diff(p2diff)
p2diff2.plot(color='red')

<Axes: >
```



```

import pmдарима as pm
model2 = pm.auto_arima(p2series,max_p=2, max_q=2, d=1,max_P=2,
max_Q=2, start_P=0, D=1,m = 12,seasonal=True,trace=True)
model2

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
Performing stepwise search to minimize aic
ARIMA(2,1,2)(0,1,1)[12] : AIC=inf, Time=0.78 sec
ARIMA(0,1,0)(0,1,0)[12] : AIC=236.357, Time=0.02 sec
ARIMA(1,1,0)(1,1,0)[12] : AIC=229.754, Time=0.07 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.

```

```
warnings.warn(  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1  
51: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
  
    ARIMA(0,1,1)(0,1,1)[12] : AIC=inf, Time=0.33 sec  
    ARIMA(1,1,0)(0,1,0)[12] : AIC=238.353, Time=0.03 sec  
  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/  
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1  
51: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
  
    ARIMA(1,1,0)(2,1,0)[12] : AIC=220.195, Time=0.25 sec  
  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/  
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
  
    ARIMA(1,1,0)(2,1,1)[12] : AIC=inf, Time=3.90 sec  
  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/  
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
  
    ARIMA(1,1,0)(1,1,1)[12] : AIC=inf, Time=1.30 sec  
    ARIMA(0,1,0)(2,1,0)[12] : AIC=218.365, Time=0.17 sec  
  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/  
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1  
51: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
  
    ARIMA(0,1,0)(1,1,0)[12] : AIC=227.795, Time=0.06 sec  
  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/  
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
  
    ARIMA(0,1,0)(2,1,1)[12] : AIC=inf, Time=1.14 sec
```

```

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(0,1,0)(1,1,1)[12] : AIC=inf, Time=0.38 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(0,1,1)(2,1,0)[12] : AIC=220.110, Time=0.26 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(1,1,1)(2,1,0)[12] : AIC=inf, Time=1.11 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
    ARIMA(0,1,0)(2,1,0)[12] intercept : AIC=220.364, Time=0.29 sec

Best model: ARIMA(0,1,0)(2,1,0)[12]
Total fit time: 10.138 seconds

ARIMA(order=(0, 1, 0), scoring_args={}, seasonal_order=(2, 1, 0, 12),
      suppress_warnings=True, with_intercept=False)

p2series = pd.to_numeric(p2series.astype(float))
from statsmodels.tsa.statespace.sarimax import SARIMAX
p2model = SARIMAX(p1series, order=(0,1,0),
                   seasonal_order=(2,1,0,12)).fit(trend='nc')
resi2 = p2model.resid

/usr/local/lib/python3.11/dist-packages/statsmodels/base/
optimizer.py:19: FutureWarning: Keyword arguments have been passed to
the optimizer that have no effect. The list of allowed keyword
arguments for method lbfsgs is: m, pgtol, factr, maxfun, epsilon,
approx_grad, bounds, loglike_and_score, iprint. The list of
unsupported keyword arguments passed include: trend. After release
0.14, this will raise.
    warnings.warn(
from statsmodels.stats.diagnostic import acorr_ljungbox
acorr_ljungbox(resi2, lags=8, boxpierce=True)

```

```

{
  "summary": {
    "name": "acorr_ljungbox(resi2, lags=8, boxpierce=True)", "rows": 8,
    "fields": [
      {
        "column": "lb_stat",
        "properties": {
          "dtype": "number",
          "std": 0.21545063058685746,
          "min": 0.010441335431886172,
          "max": 0.5191474118558914,
          "num_unique_values": 8,
          "samples": [
            0.02374572910313025,
            0.45141412861718416,
            0.010441335431886172
          ],
          "semantic_type": "\",
          "description": "\n"
        }
      },
      {
        "column": "lb_pvalue",
        "properties": {
          "dtype": "number",
          "std": 0.027953421441787914,
          "min": 0.9186115378913251,
          "max": 0.9998461695202044,
          "num_unique_values": 8,
          "samples": [
            0.9881973397878796,
            0.9983804783857223,
            0.9186115378913251
          ],
          "semantic_type": "\",
          "description": "\n"
        }
      },
      {
        "column": "bp_stat",
        "properties": {
          "dtype": "number",
          "std": 0.1904348318626193,
          "min": 0.00993610952389168,
          "max": 0.4587497308014039,
          "num_unique_values": 8,
          "samples": [
            0.02238215521634582,
            0.4015703206895609,
            0.00993610952389168
          ],
          "semantic_type": "\",
          "description": "\n"
        }
      },
      {
        "column": "bp_pvalue",
        "properties": {
          "dtype": "number",
          "std": 0.02736179473805415,
          "min": 0.9205983507666765,
          "max": 0.9999039300086362,
          "num_unique_values": 8,
          "samples": [
            0.9888713095574295,
            0.9988386165902478,
            0.9205983507666765
          ],
          "semantic_type": "\",
          "description": "\n"
        }
      }
    ],
    "type": "dataframe"
  }
}

model2.predict(n_periods=3)

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
  warnings.warn(
2019-01-31    127.793553
2019-02-28    124.776073
2019-03-31    124.141877
Freq: ME, dtype: float64

s = data.Product3.values
p3series = pd.Series(s, rng)
p3series

2014-01-31    120.51
2014-02-28    115.83

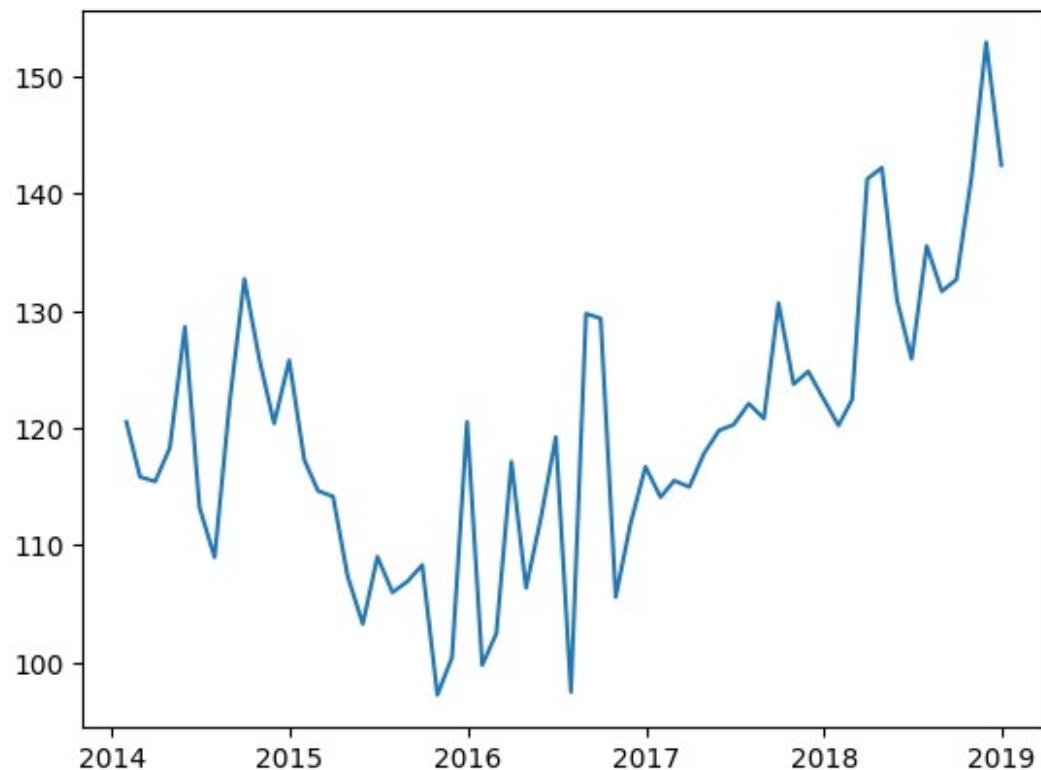
```

2014-03-31	115.44
2014-04-30	118.30
2014-05-31	128.64
2014-06-30	113.22
2014-07-31	108.96
2014-08-31	122.25
2014-09-30	132.72
2014-10-31	125.82
2014-11-30	120.39
2014-12-31	125.79
2015-01-31	117.27
2015-02-28	114.64
2015-03-31	114.15
2015-04-30	107.33
2015-05-31	103.28
2015-06-30	109.01
2015-07-31	105.97
2015-08-31	106.92
2015-09-30	108.31
2015-10-31	97.22
2015-11-30	100.41
2015-12-31	120.52
2016-01-31	99.76
2016-02-29	102.47
2016-03-31	117.13
2016-04-30	106.36
2016-05-31	112.43
2016-06-30	119.23
2016-07-31	97.47
2016-08-31	129.76
2016-09-30	129.36
2016-10-31	105.58
2016-11-30	111.79
2016-12-31	116.69
2017-01-31	114.10
2017-02-28	115.51
2017-03-31	114.97
2017-04-30	117.82
2017-05-31	119.80
2017-06-30	120.29
2017-07-31	122.09
2017-08-31	120.81
2017-09-30	130.67
2017-10-31	123.74
2017-11-30	124.84
2017-12-31	122.51
2018-01-31	120.22
2018-02-28	122.43
2018-03-31	141.26

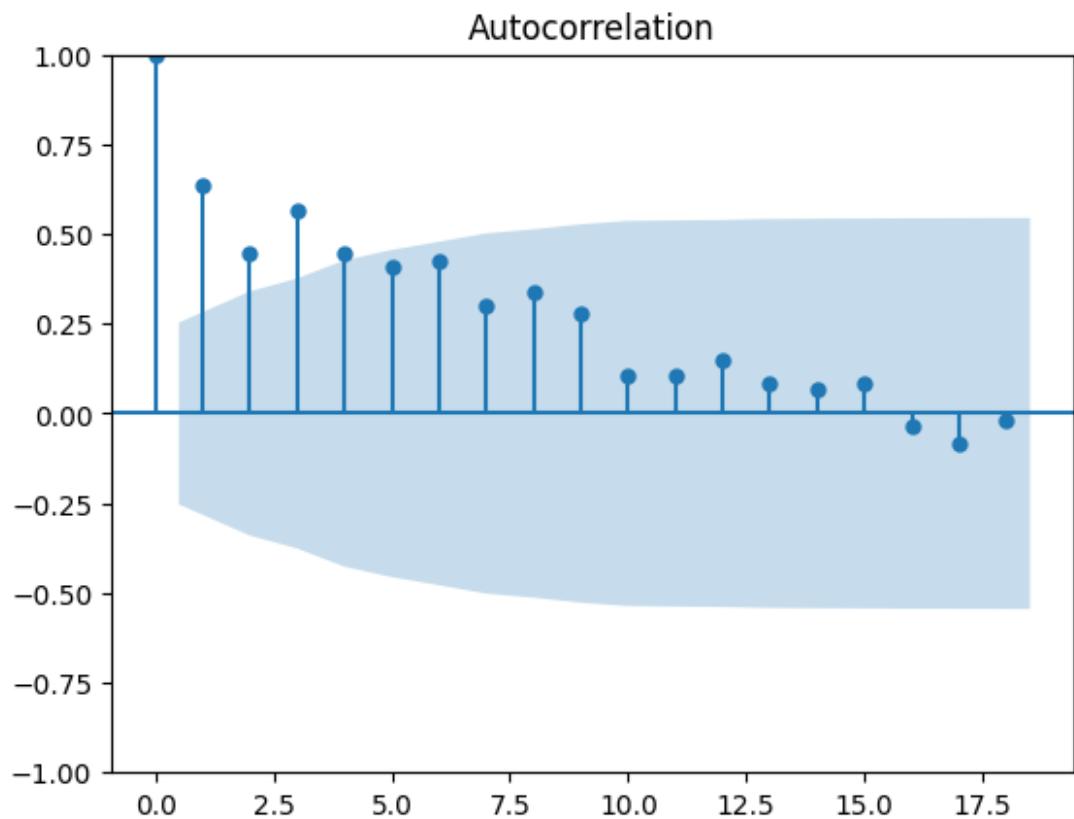
```
2018-04-30    142.22
2018-05-31    130.94
2018-06-30    125.91
2018-07-31    135.55
2018-08-31    131.67
2018-09-30    132.68
2018-10-31    141.43
2018-11-30    152.92
2018-12-31    142.45
Freq: ME, dtype: float64
```

```
plt.plot(p3series)
```

```
[<matplotlib.lines.Line2D at 0x7a8e0c4fe890>]
```

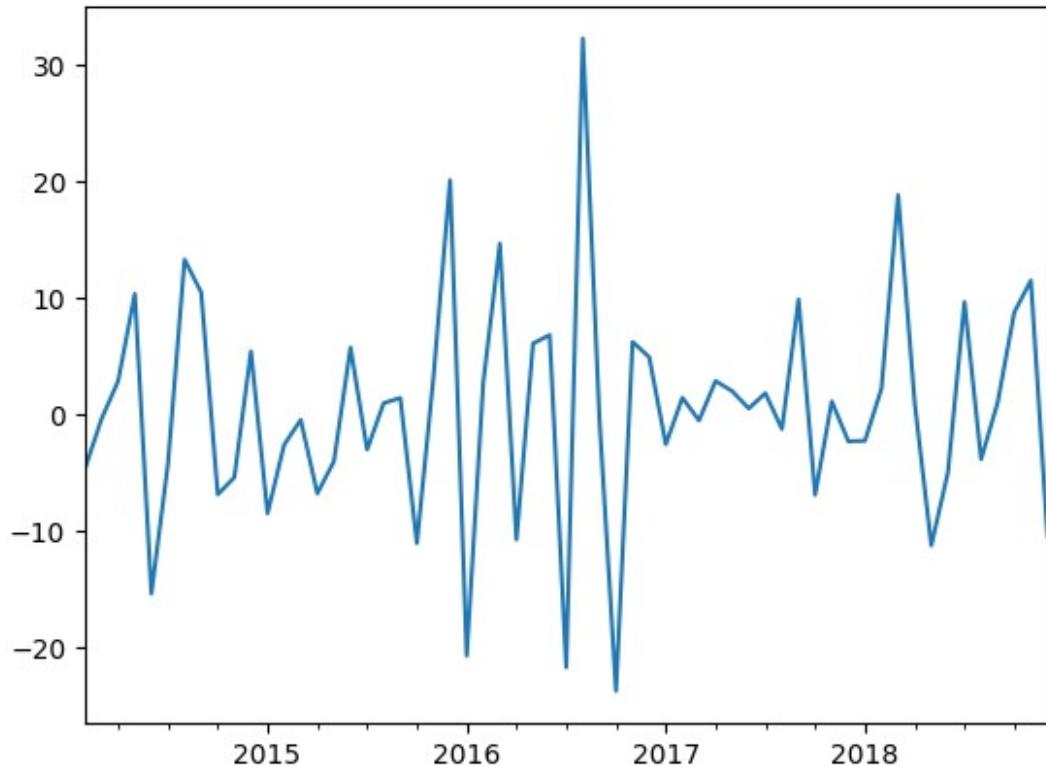


```
import matplotlib.pyplot as plt
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
plot_acf(p3series)
plt.show()
```



```
p3diff = diff(p3series)
p3diff.plot()
p3diff.head()

2014-02-28    -4.68
2014-03-31     -0.39
2014-04-30      2.86
2014-05-31     10.34
2014-06-30    -15.42
Freq: ME, dtype: float64
```



```
from arch.unitroot import ADF
adf = ADF(p3series, lags=0)
adf.summary()

<class 'statsmodels.iolib.summary.Summary'>
"""
    Augmented Dickey-Fuller Results
=====
Test Statistic              -3.120
P-value                      0.025
Lags                          0
-----
Trend: Constant
Critical Values: -3.55 (1%), -2.91 (5%), -2.59 (10%)
Null Hypothesis: The process contains a unit root.
Alternative Hypothesis: The process is weakly stationary.
"""

pmdarima.arima.ndiffs(p3series)

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
  warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
```

```
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(

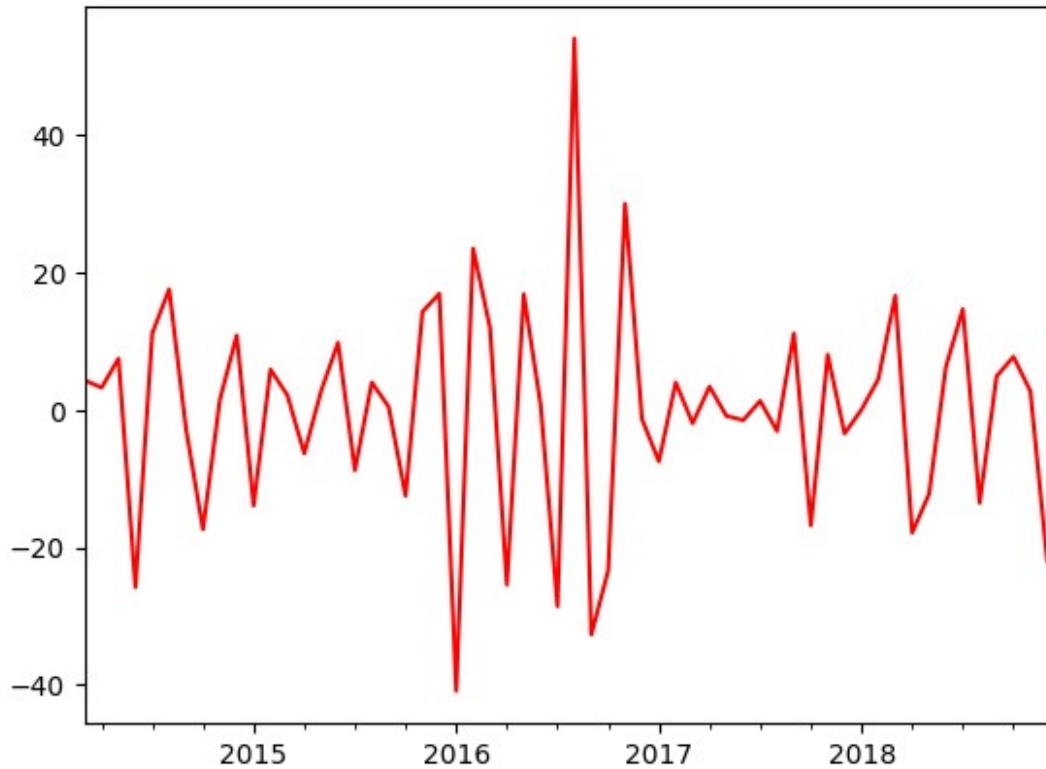

1



```
p3diff = diff(p3series)
p3diff2 = diff(p3diff)
p3diff2.plot(color='red')

<Axes: >
```


```



```
import pmдарима as pm
model3 = pm.auto_arima(p3series,max_p=2, max_q=2, d=1,max_P=2,
max_Q=2, start_P=0, D=1,m = 12,seasonal=True,trace=True)
model3

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
Performing stepwise search to minimize aic
ARIMA(2,1,2)(0,1,1)[12] : AIC=356.513, Time=1.12 sec
ARIMA(0,1,0)(0,1,0)[12] : AIC=374.830, Time=0.05 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
```

```
ARIMA(1,1,0)(1,1,0)[12] : AIC=367.152, Time=0.43 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
ARIMA(0,1,1)(0,1,1)[12] : AIC=356.136, Time=0.33 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
ARIMA(0,1,1)(0,1,0)[12] : AIC=362.328, Time=0.45 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
ARIMA(0,1,1)(1,1,1)[12] : AIC=358.032, Time=1.08 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
ARIMA(0,1,1)(0,1,2)[12] : AIC=358.015, Time=0.38 sec
ARIMA(0,1,1)(1,1,0)[12] : AIC=358.388, Time=0.11 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
ARIMA(0,1,1)(1,1,2)[12] : AIC=inf, Time=1.38 sec
ARIMA(0,1,0)(0,1,1)[12] : AIC=366.946, Time=0.10 sec
/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn(
```

```
ARIMA(1,1,1)(0,1,1)[12] : AIC=357.841, Time=0.21 sec
ARIMA(0,1,2)(0,1,1)[12] : AIC=357.178, Time=0.20 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(1,1,0)(0,1,1)[12] : AIC=364.335, Time=0.15 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(1,1,2)(0,1,1)[12] : AIC=356.740, Time=0.24 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(0,1,1)(0,1,1)[12] intercept : AIC=353.955, Time=0.26 sec
ARIMA(0,1,1)(0,1,0)[12] intercept : AIC=363.225, Time=0.10 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(0,1,1)(1,1,1)[12] intercept : AIC=355.951, Time=0.41 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(0,1,1)(0,1,2)[12] intercept : AIC=355.949, Time=0.62 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()
```

```
ARIMA(0,1,1)(1,1,0)[12] intercept : AIC=357.538, Time=0.25 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(0,1,1)(1,1,2)[12] intercept : AIC=inf, Time=1.64 sec
ARIMA(0,1,0)(0,1,1)[12] intercept : AIC=368.653, Time=0.15 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(1,1,1)(0,1,1)[12] intercept : AIC=inf, Time=0.85 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(0,1,2)(0,1,1)[12] intercept : AIC=inf, Time=0.73 sec
ARIMA(1,1,0)(0,1,1)[12] intercept : AIC=365.692, Time=0.19 sec

/usr/local/lib/python3.11/dist-packages/sklearn/utils/
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
51: FutureWarning: 'force_all_finite' was renamed to
'ensure_all_finite' in 1.6 and will be removed in 1.8.
    warnings.warn()

ARIMA(1,1,2)(0,1,1)[12] intercept : AIC=inf, Time=0.86 sec

Best model: ARIMA(0,1,1)(0,1,1)[12] intercept
Total fit time: 12.307 seconds

ARIMA(order=(0, 1, 1), scoring_args={}, seasonal_order=(0, 1, 1, 12),
      suppress_warnings=True)

p3series = pd.to_numeric(p3series.astype(float))
from statsmodels.tsa.statespace.sarimax import SARIMAX
p3model = SARIMAX(p1series, order=(0,1,1),
                  seasonal_order=(0,1,1,12)).fit(trend='n')
resi3 = p3model.resid
```

```

/usr/local/lib/python3.11/dist-packages/statsmodels/tsa/statespace/
sarimax.py:1009: UserWarning: Non-invertible starting seasonal moving
average Using zeros as starting parameters.
    warn('Non-invertible starting seasonal moving average')
/usr/local/lib/python3.11/dist-packages/statsmodels/base/optimizer.py:
19: FutureWarning: Keyword arguments have been passed to the optimizer
that have no effect. The list of allowed keyword arguments for method
lbfgs is: m, pgtol, factr, maxfun, epsilon, approx_grad, bounds,
loglike_and_score, iprint. The list of unsupported keyword arguments
passed include: trend. After release 0.14, this will raise.
    warnings.warn(
acorr_ljungbox(resi3, lags=8, boxpierce=True)

{"summary": {
  "name": "acorr_ljungbox(resi3, lags=8, boxpierce=True)", "rows": 8, "fields": [
    {"column": "lb_stat", "properties": {"dtype": "number", "min": 0.21563586156714049, "max": 0.5247339947740206, "samples": [0.45872270481664523, 0.9983051333463484, 0.40784354459315586, 0.9987861628508189], "semantic_type": "description", "type": "dataframe"}, "properties": {"dtype": "number", "min": 0.015610044966543982, "max": 0.9856762322109889, "samples": [0.015610044966543982, 0.9005709199810072, 0.014854720210098307, 0.9029941013189297], "semantic_type": "description", "type": "dataframe"}, {"column": "lb_pvalue", "properties": {"dtype": "number", "min": 0.015610044966543982, "max": 0.9856762322109889, "samples": [0.015610044966543982, 0.9005709199810072, 0.014854720210098307, 0.9029941013189297], "semantic_type": "description", "type": "dataframe"}, "properties": {"dtype": "number", "min": 0.9005709199810072, "max": 0.9029941013189297, "samples": [0.9005709199810072, 0.9029941013189297], "semantic_type": "description", "type": "dataframe"}, {"column": "bp_stat", "properties": {"dtype": "number", "min": 0.014854720210098307, "max": 0.9864699311440799, "samples": [0.014854720210098307, 0.9029941013189297], "semantic_type": "description", "type": "dataframe"}, "properties": {"dtype": "number", "min": 0.014854720210098307, "max": 0.9029941013189297, "samples": [0.014854720210098307, 0.9029941013189297], "semantic_type": "description", "type": "dataframe"}, {"column": "bp_pvalue", "properties": {"dtype": "number", "min": 0.014854720210098307, "max": 0.9864699311440799, "samples": [0.014854720210098307, 0.9029941013189297], "semantic_type": "description", "type": "dataframe"}, "properties": {"dtype": "number", "min": 0.014854720210098307, "max": 0.9029941013189297, "samples": [0.014854720210098307, 0.9029941013189297], "semantic_type": "description", "type": "dataframe"}], "type": "dataframe"}}, "type": "dataframe"}}

p3model.aic

```

241.0583180837272

```
p3model.params  
ma.L1      -0.153916  
ma.S.L12    -0.999083  
sigma2      5.798502  
dtype: float64  
  
model3.predict(n_periods=3)  
  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/  
deprecation.py:151: FutureWarning: 'force_all_finite' was renamed to  
'ensure_all_finite' in 1.6 and will be removed in 1.8.  
    warnings.warn(  
  
2019-01-31    141.120486  
2019-02-28    142.817895  
2019-03-31    151.491547  
Freq: ME, dtype: float64
```