

## Surakshith Shetty - 53026240013

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
```

```
<bound method DataFrame.info of      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": ""
        }
      },
      {
        "column": "Month",
        "properties": {
          "dtype": "category",
          "num_unique_values": 12,
          "samples": [
            "November", "October", "January"
          ],
          "semantic_type": "",
          "description": ""
        }
      },
      {
        "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": ""
        }
      },
      {
        "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        \"column\": \"Product3\", \n        \"properties\": \n    {\n        \"dtype\": \"number\", \n        \"std\": \n    11.950044871437864, \n        \"min\": 97.22, \n        \"max\": \n    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    }\", \"type\": \"dataframe\", \"variable_name\": \"data\"}
```

```
rng = pd.date_range(start='2014', end='2019', freq='M')
```

<ipython-input-14-e87bce45ccd4>:1: FutureWarning: 'M' is deprecated and will be removed in a future version, please use 'ME' instead.

```
rng = pd.date_range(start='2014', end='2019', freq='M')
```

```
rng
```

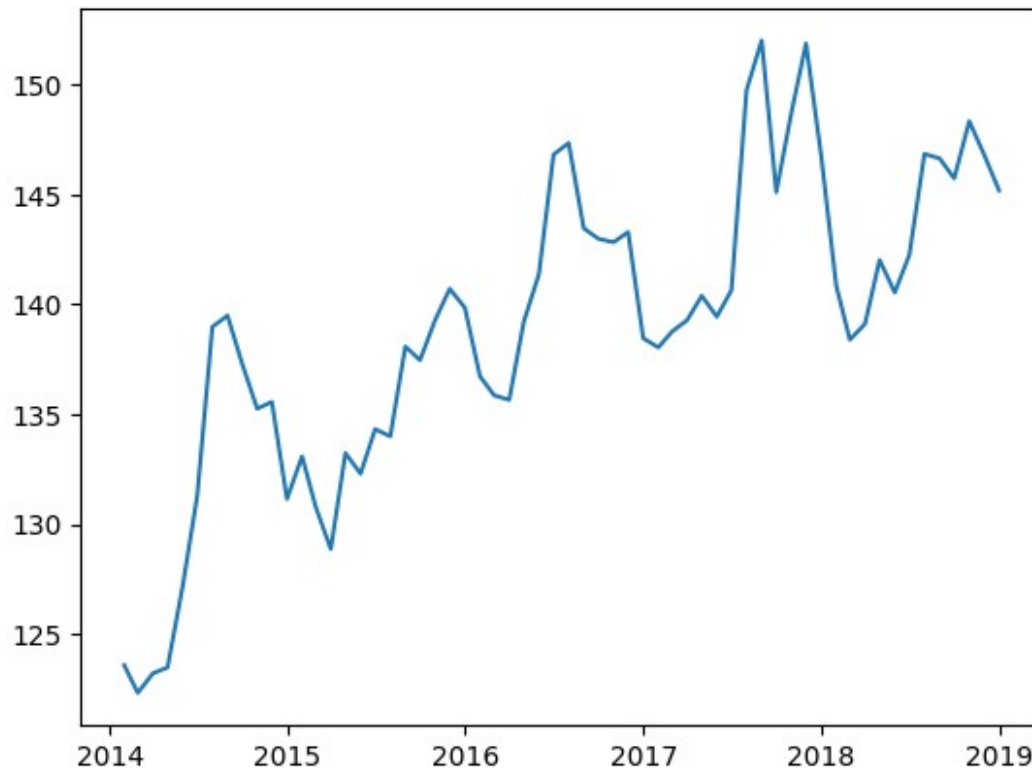
```
DatetimeIndex(['2014-01-31', '2014-02-28', '2014-03-31', '2014-04-30',
                '2014-05-31', '2014-06-30', '2014-07-31', '2014-08-31',
                '2014-09-30', '2014-10-31', '2014-11-30', '2014-12-31',
                '2015-01-31', '2015-02-28', '2015-03-31', '2015-04-30',
                '2015-05-31', '2015-06-30', '2015-07-31', '2015-08-31',
                '2015-09-30', '2015-10-31', '2015-11-30', '2015-12-31',
                '2016-01-31', '2016-02-29', '2016-03-31', '2016-04-30',
                '2016-05-31', '2016-06-30', '2016-07-31', '2016-08-31',
                '2016-09-30', '2016-10-31', '2016-11-30', '2016-12-31',
                '2017-01-31', '2017-02-28', '2017-03-31', '2017-04-30',
                '2017-05-31', '2017-06-30', '2017-07-31', '2017-08-31',
                '2017-09-30', '2017-10-31', '2017-11-30', '2017-12-31',
                '2018-01-31', '2018-02-28', '2018-03-31', '2018-04-30',
                '2018-05-31', '2018-06-30', '2018-07-31', '2018-08-31',
                '2018-09-30', '2018-10-31', '2018-11-30', '2018-12-
```

```
31'],
        dtype='datetime64[ns]', freq='ME')
```

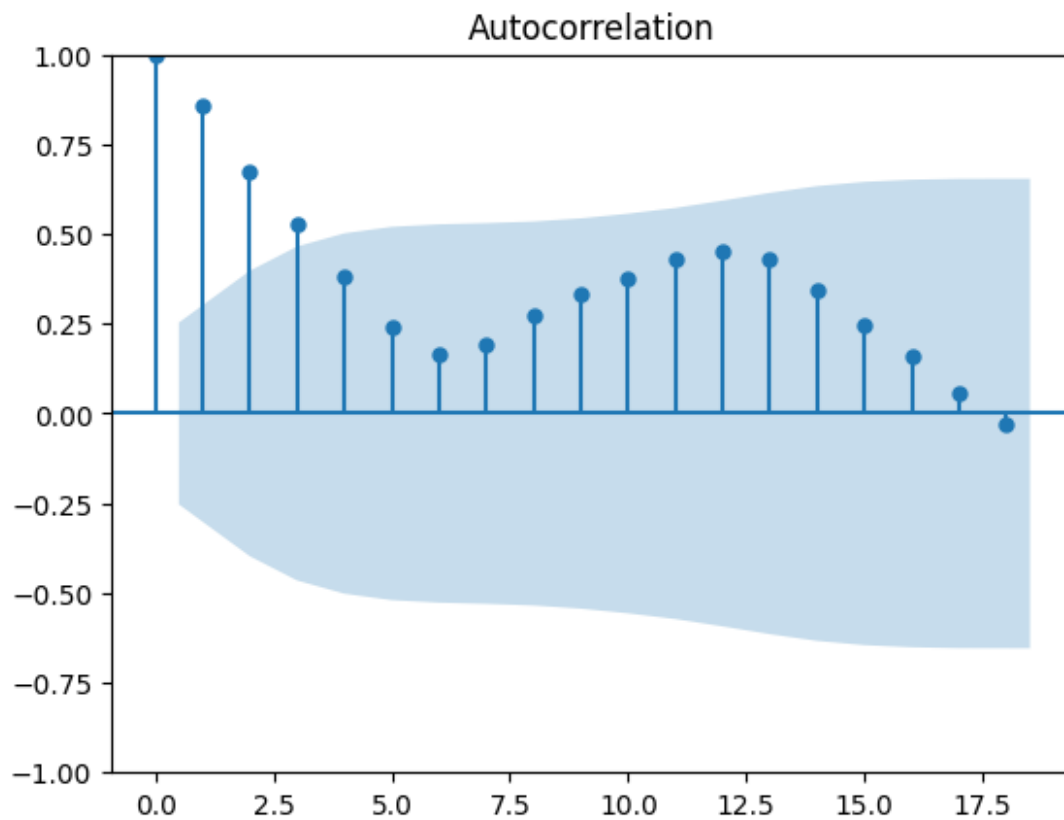
```
s = data.Product1.values
plseries = pd.Series(s, rng)
```

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

```
[<matplotlib.lines.Line2D at 0x7a8e0c9efb90>]
```

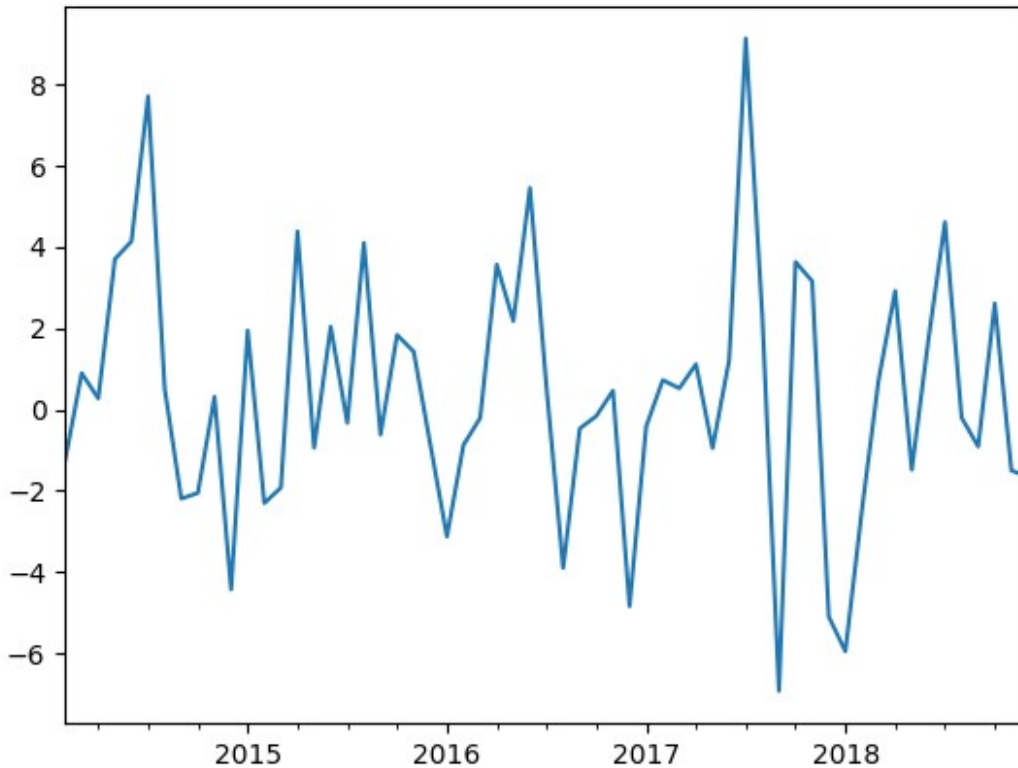


```
import matplotlib.pyplot as plt
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
plot_acf(plseries)
plt.show()
```



```
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(plseries,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(plseries)
```

```
/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(  
/usr/local/lib/python3.11/dist-packages/sklearn/utils/deprecation.py:1
```

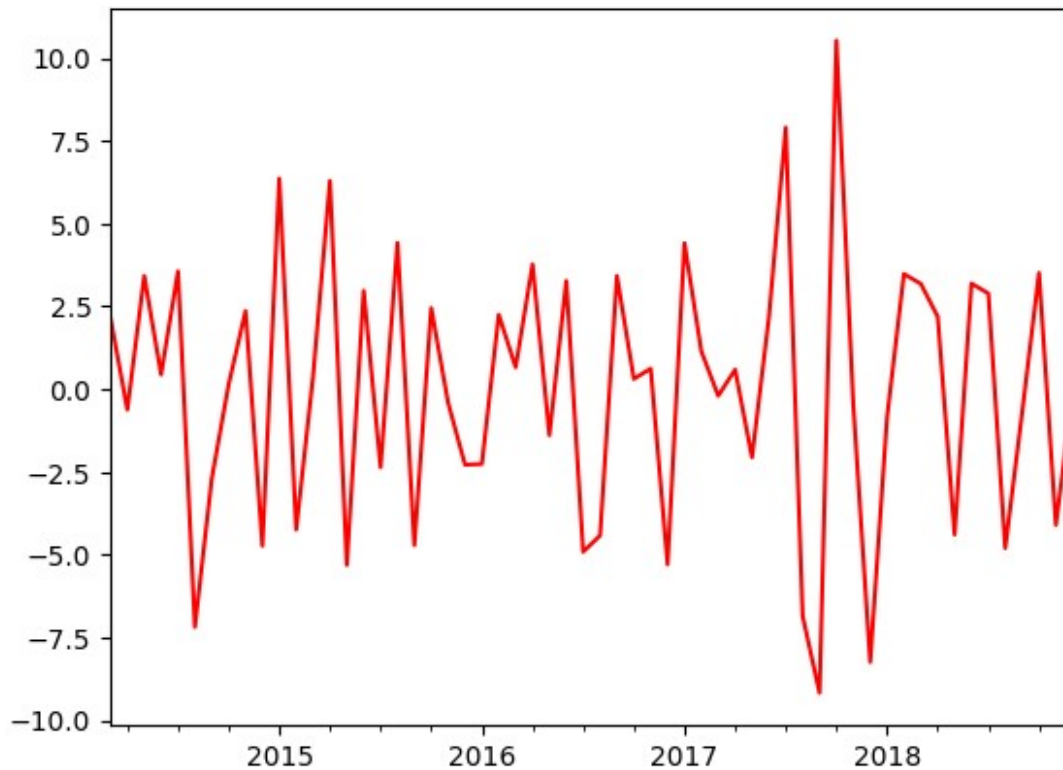
```
1
```

```
!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  
p1diff = diff(plseries)  
p1diff2 = diff(p1diff)  
p1diff2.plot(color='red')
```

```
<Axes: >
```



```
import pmdarima as pm
model1 = pm.auto_arima(plseries,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:151: 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: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)(1,1,0)[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')
resid = 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 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(
```

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

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

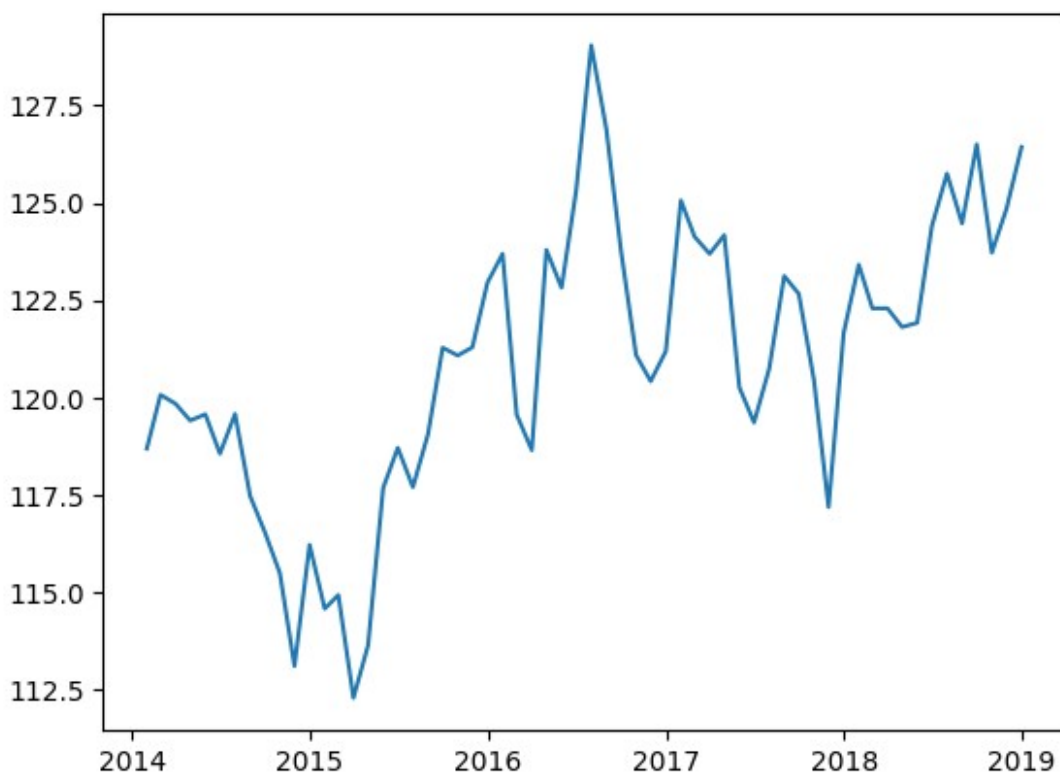
```
s = data.Product2.values
p2series = pd.Series(s,rng)
p2series
```

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

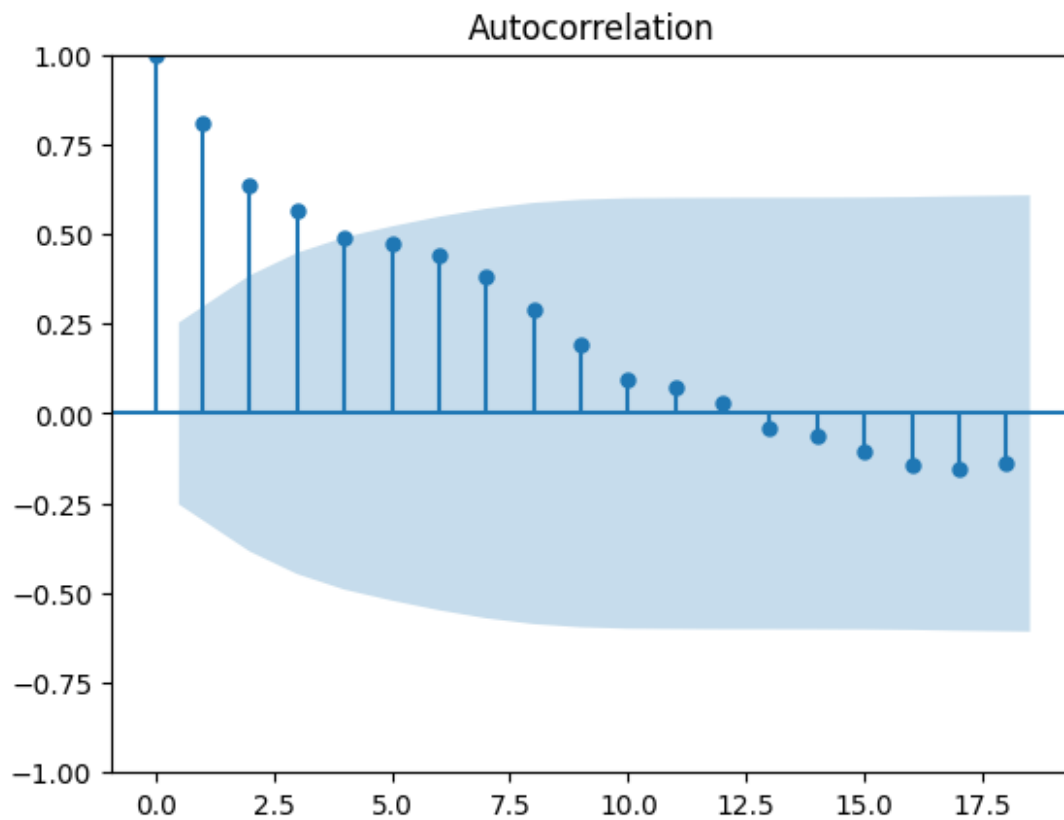
```
2017-11-30    117.19
2017-12-31    121.66
2018-01-31    123.41
2018-02-28    122.29
2018-03-31    122.29
2018-04-30    121.81
2018-05-31    121.92
2018-06-30    124.40
2018-07-31    125.75
2018-08-31    124.47
2018-09-30    126.50
2018-10-31    123.72
2018-11-30    124.84
2018-12-31    126.43
Freq: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

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

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



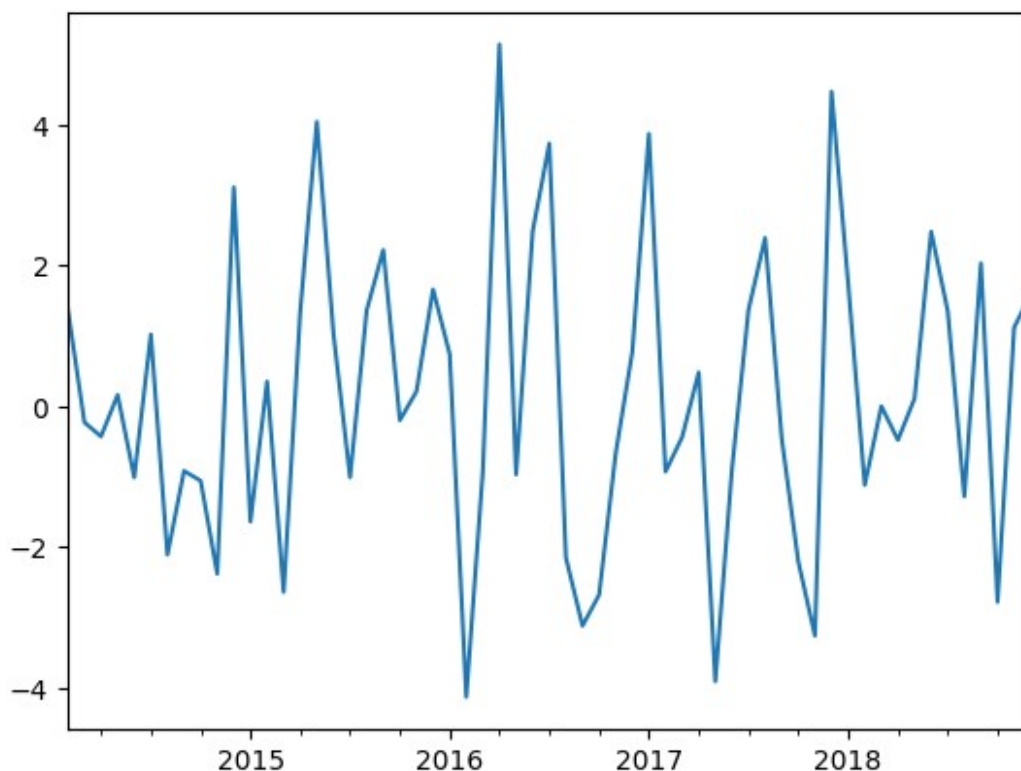
```
import matplotlib.pyplot as plt
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
plot_acf(p2series)
plt.show()
```



```
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

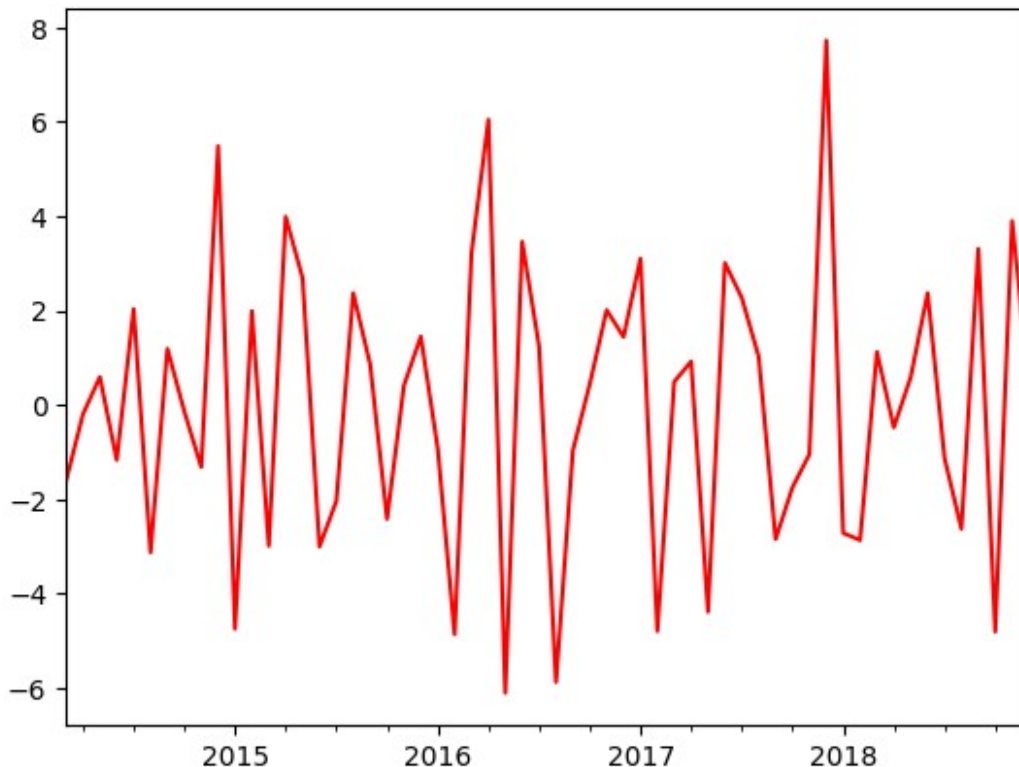
```

```
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 pmdarima 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:151: 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:151: FutureWarning: 'force\_all\_finite' was renamed to 'ensure\_all\_finite' in 1.6 and will be removed in 1.8.  
 warnings.warn(

```

    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 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(
```

```
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": ""
        },
        "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": ""
        },
        "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": ""
        },
        "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": ""
        }
      ]
    },
    "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
```

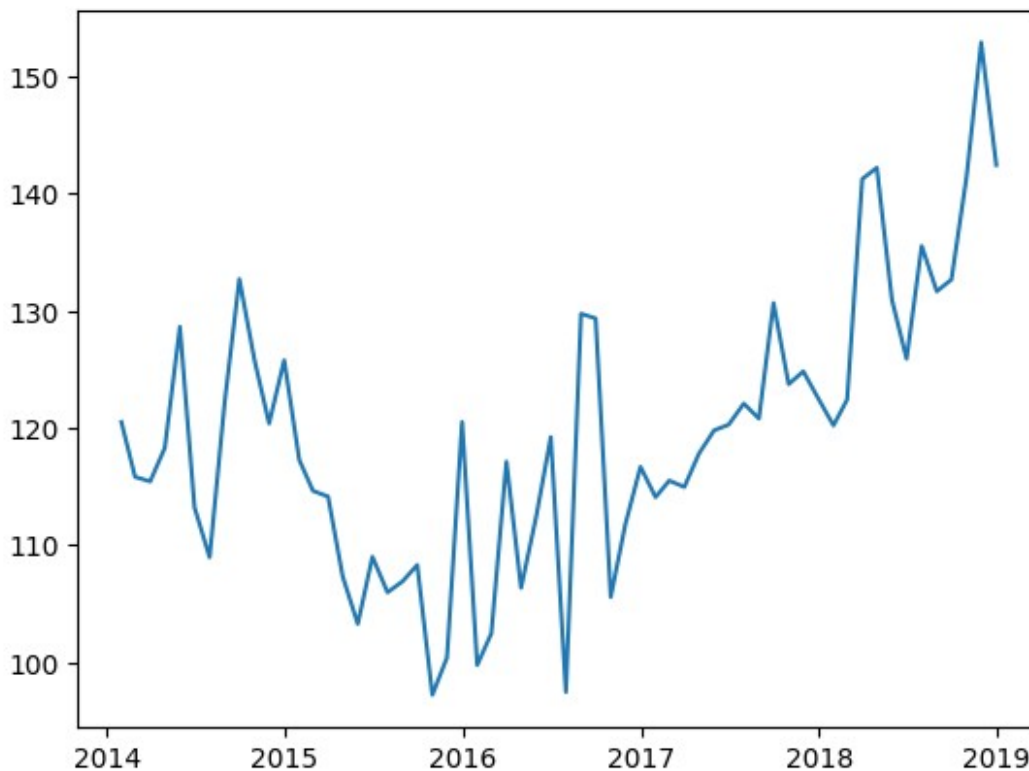
```
2014-01-31    120.51
2014-02-28    115.83
```

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
```

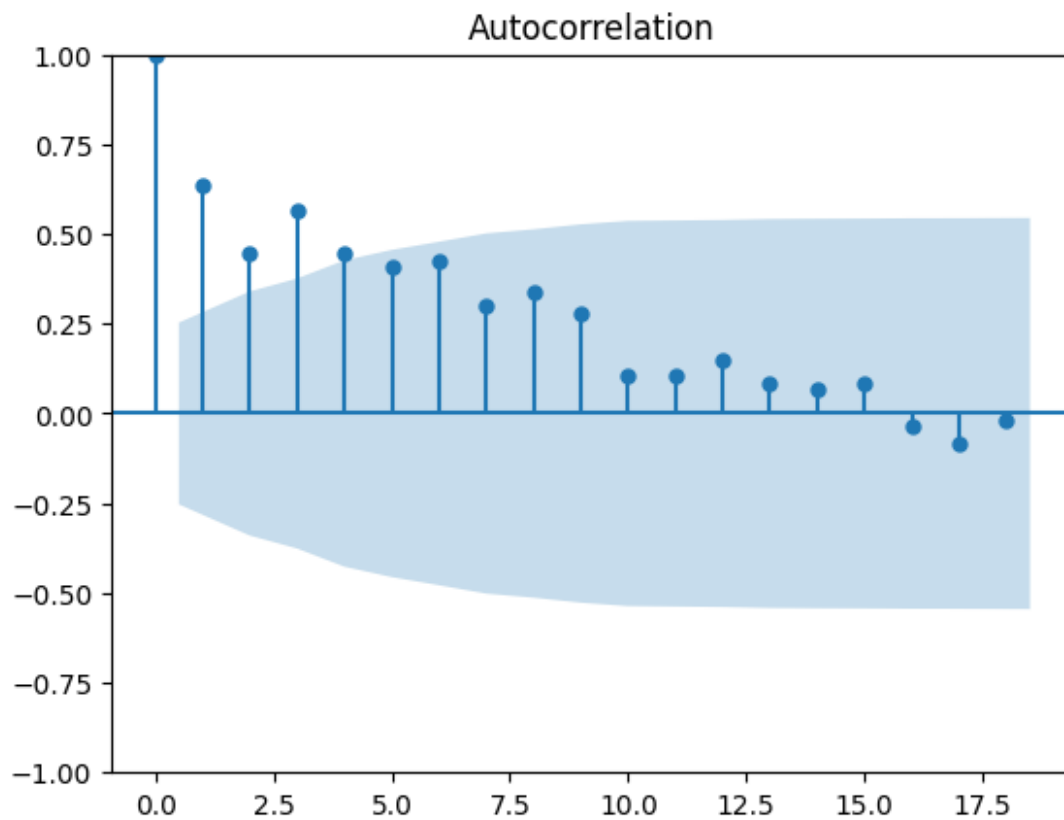
```
plt.plot(p3series)
```

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



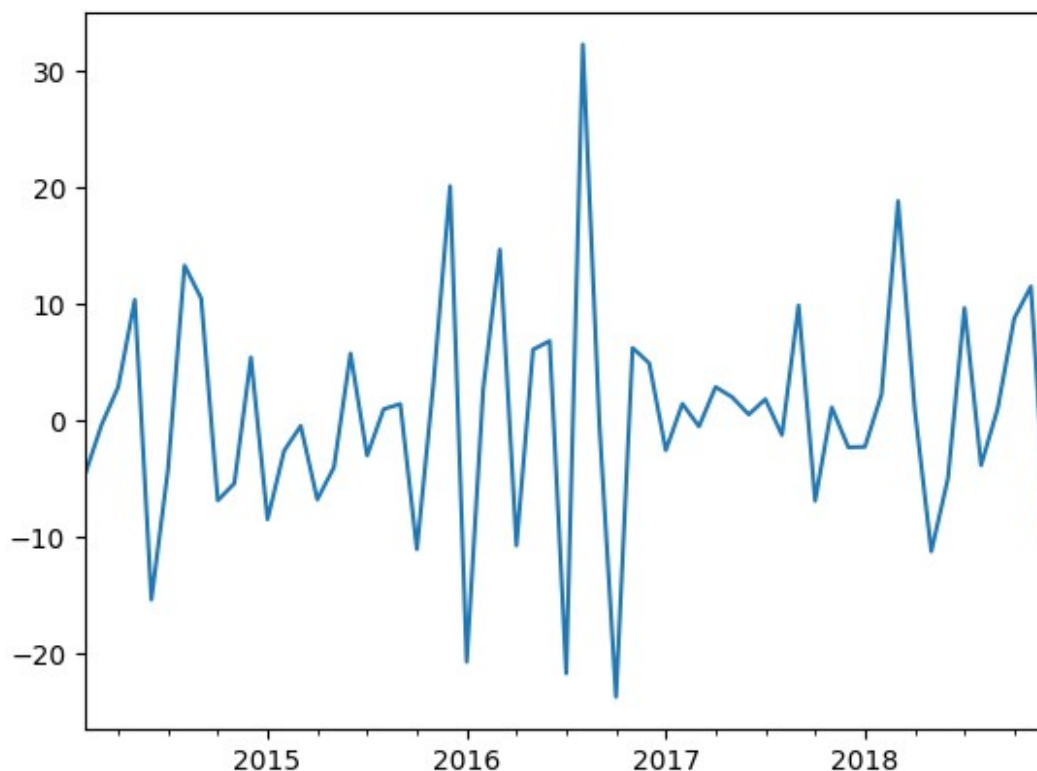
```
import matplotlib.pyplot as plt
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
plot_acf(p3series)
plt.show()
```





```
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

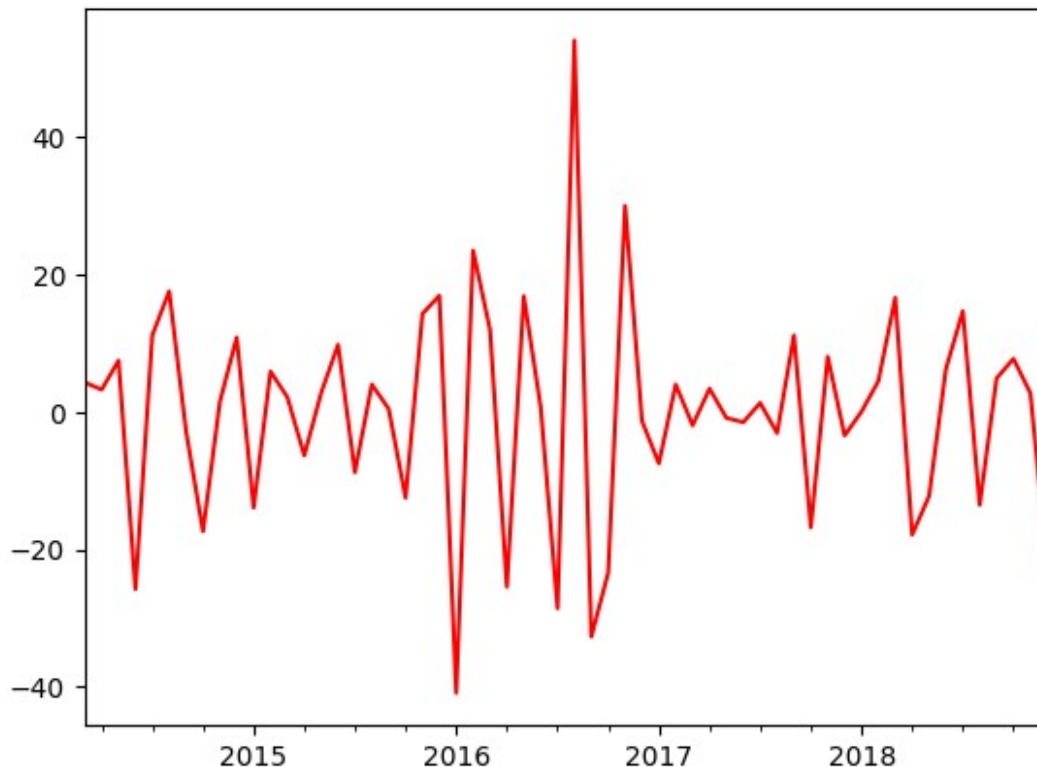
```

```
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 pmdarima 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:151: 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: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)(1,1,0)[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": "{\n  \"name\":\n  \"acorr_ljungbox(resi3, lags=8, boxpierce=True)\",\n  \"rows\": 8,\n  \"fields\": [\n    {\n      \"column\": \"lb_stat\",\n      \"properties\": {\n        \"dtype\": \"number\",\n        \"std\": 0.21563586156714049,\n        \"min\": 0.015610044966543982,\n        \"max\": 0.5247339947740206,\n        \"num_unique_values\": 8,\n        \"samples\": [\n          0.028854686401273023,\n          0.45872270481664523,\n          0.015610044966543982\n        ],\n        \"semantic_type\": \"\",\n        \"description\": \"\"\n      },\n      {\n        \"column\": \"lb_pvalue\",\n        \"properties\": {\n          \"dtype\": \"number\",\n          \"std\": 0.034274350925750846,\n          \"min\": 0.9005709199810072,\n          \"max\": 0.9998397955524018,\n          \"num_unique_values\": 8,\n          \"samples\": [\n            0.9856762322109889,\n            0.9983051333463484,\n            0.9005709199810072\n          ],\n          \"semantic_type\": \"\",\n          \"description\": \"\"\n        },\n        {\n          \"column\": \"bp_stat\",\n          \"properties\": {\n            \"dtype\": \"number\",\n            \"std\": 0.19033916109270094,\n            \"min\": 0.014854720210098307,\n            \"max\": 0.4634370652058917,\n            \"num_unique_values\": 8,\n            \"samples\": [\n              0.02724486864903838,\n              0.40784354459315586,\n              0.014854720210098307\n            ],\n            \"semantic_type\": \"\",\n            \"description\": \"\"\n          },\n          {\n            \"column\": \"bp_pvalue\",\n            \"properties\": {\n              \"dtype\": \"number\",\n              \"std\": 0.033528631294153836,\n              \"min\": 0.9029941013189297,\n              \"max\": 0.9999001289463127,\n              \"num_unique_values\": 8,\n              \"samples\": [\n                0.9864699311440799,\n                0.9987861628508189,\n                0.9029941013189297\n              ],\n              \"semantic_type\": \"\",\n              \"description\": \"\"\n            }\n          }\n        ]\n      },\n      \"type\": \"dataframe\"

```

```

p3model.aic

```

```

241.0583180837272

```



```
ma.L1      -0.153916
ma.S.L12   -0.999083
sigma2      5.798502
dtype: float64
```

```
/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
```