In [ ]:

```
# Resources
# US Census Bureau. (2019). Population Time Series. [Version 63].
# Retrieved October 31, 2020 from https://www.kaggle.com/census/population-time-series-data/metadata
```

In [22]:

```
## SAMPLE TIME SERIES USING CENSUS DATA

from pandas import Series

from sklearn.metrics import mean_squared_error
from statsmodels.tsa.arima_model import ARIMA
from statsmodels.tsa.arima_model import ARIMAResults
from math import sqrt
from pandas import DataFrame
from scipy.stats import boxcox
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from statsmodels.graphics.tsaplots import plot_acf
from statsmodels.graphics.tsaplots import plot_pacf
```

In [10]:

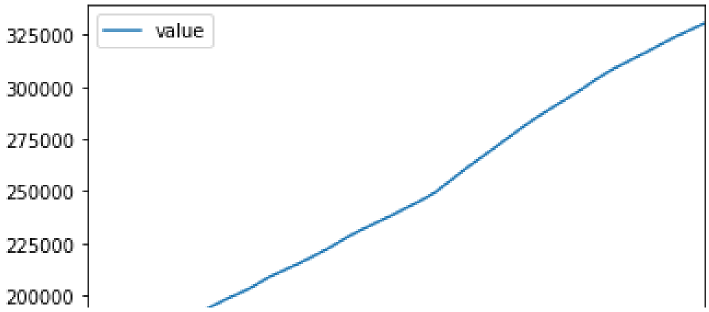
```
df = pd.read_csv('/content/POP.csv')
df = df.drop(['realtime_start','realtime_end'],axis=1)
df['date'] = pd.to_datetime(df['date'])
df.set_index('date',inplace=True)
df.describe()
```

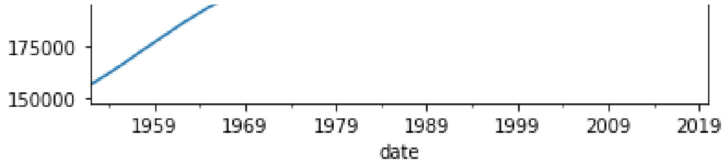
Out[10]:

	value
count	816.000000
mean	243847.767826
std	50519.140567
min	156309.000000
25%	201725.250000
50%	239557.500000
75%	289364.250000
max	330309.946000

In [13]:

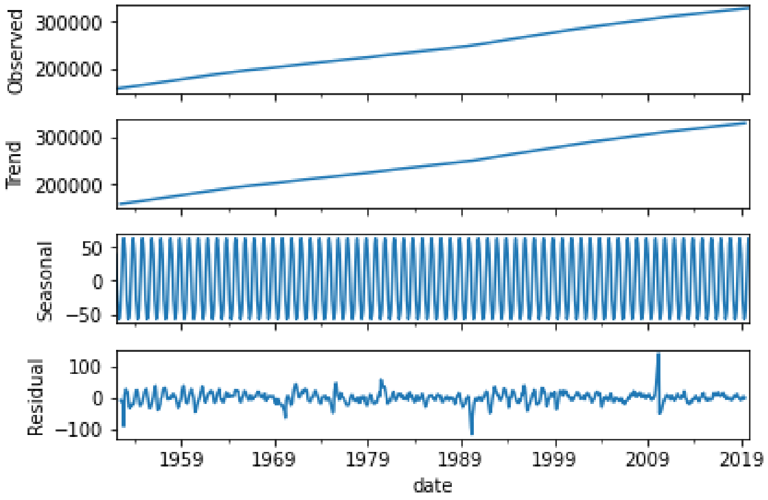
```
from matplotlib import pyplot

df.plot()
pyplot.show()
```





In [17]:

```
from statsmodels.tsa.seasonal import seasonal_decompose

decomposed = seasonal_decompose(df['value'])
x = decomposed.plot()
```

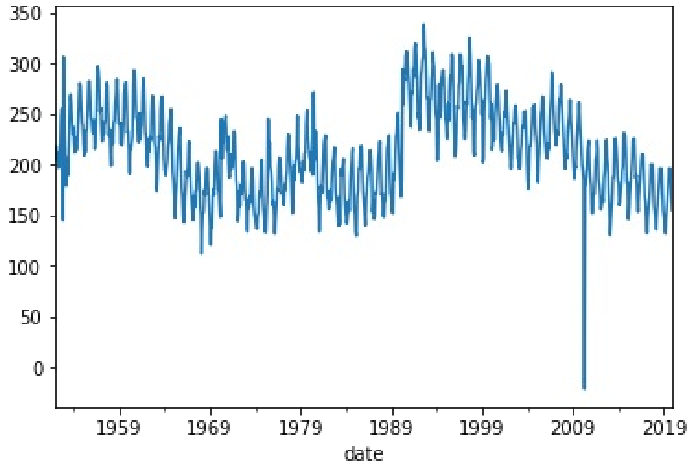


In [19]:

```
df['stationary'] = df['value'].diff()
df['stationary'].plot()
```

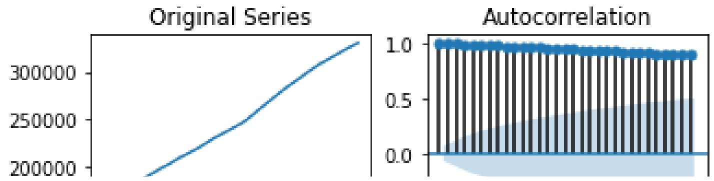
Out[19]:

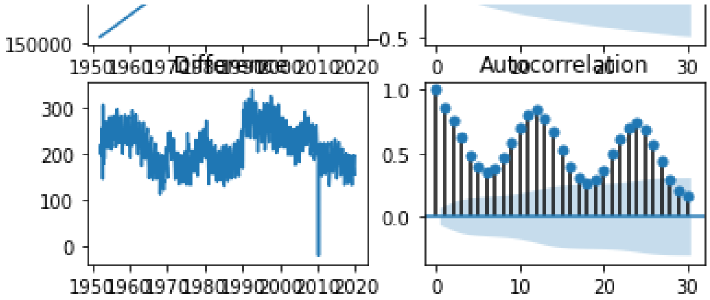
```
<matplotlib.axes._subplots.AxesSubplot at 0x7effb3527828>
```



In [24]:

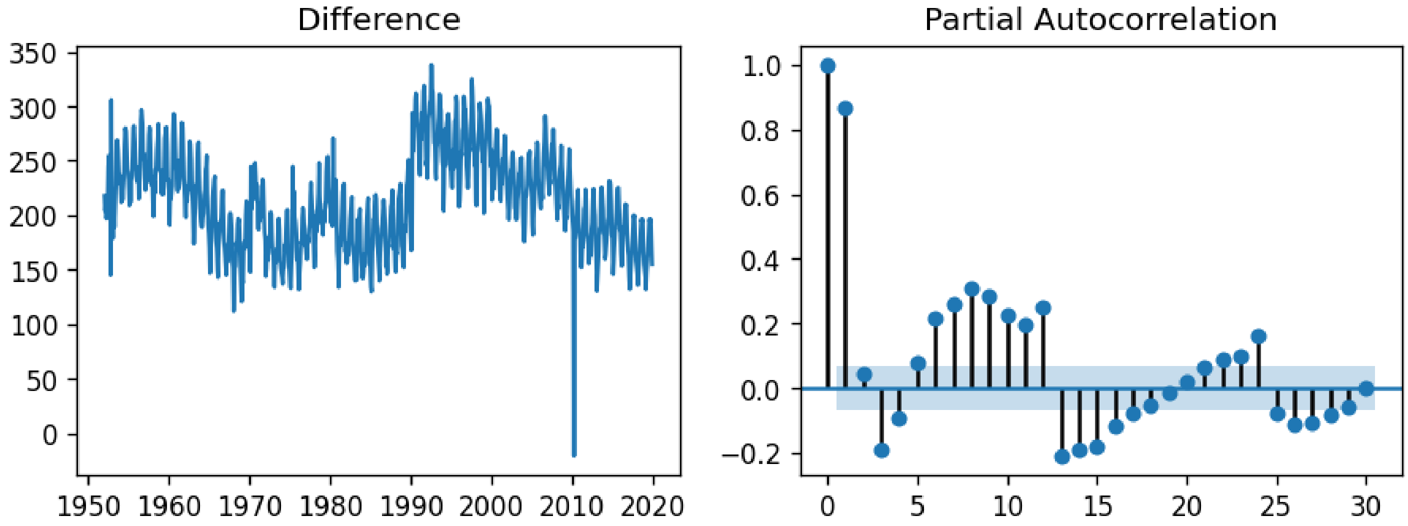
```
fig,axes = plt.subplots(2,2)

x = axes[0,0].plot(df['value']); axes[0,0].set_title('Original Series')
a = plot_acf(df['value'].values,ax=axes[0,1])

y = axes[1,0].plot(df['value'].diff()); axes[1,0].set_title(' Difference')
b = plot_acf(df['value'].diff().dropna(),ax=axes[1,1])
```





In [25]:

```python
plt.rcParams.update({'figure.figsize':(9,3),'figure.dpi':120})

fig,axes = plt.subplots(1,2)

a = axes[0].plot(df['value'].diff()); axes[0].set_title('Difference')
b = plot_pacf(df['value'].diff().dropna(),ax=axes[1])

plt.show()
```



In [26]:

```python
model = ARIMA(df['value'].diff().dropna(),(1,1,2))
model_fit = model.fit(disp=0)
print(model_fit.summary())
```

```
/usr/local/lib/python3.6/dist-packages/statsmodels/tsa/base/tsa_model.py:165: ValueWarnin
g: No frequency information was provided, so inferred frequency MS will be used.
  % freq, ValueWarning)
/usr/local/lib/python3.6/dist-packages/statsmodels/tsa/base/tsa_model.py:165: ValueWarnin
g: No frequency information was provided, so inferred frequency MS will be used.
  % freq, ValueWarning)
```

```
                             ARIMA Model Results
==============================================================================
Dep. Variable:                D.value   No. Observations:                  814
Model:                 ARIMA(1, 1, 2)   Log Likelihood               -3651.467
Method:                       css-mle   S.D. of innovations             21.465
Date:                Sat, 31 Oct 2020   AIC                           7312.934
Time:                        15:07:33   BIC                           7336.444
Sample:                    03-01-1952   HQIC                          7321.958
                         - 12-01-2019
=================================================================================
                    coef    std err          z      P>|z|      [0.025      0.975]
---------------------------------------------------------------------------------
const            -0.0712      0.135     -0.527      0.598      -0.336       0.194
ar.L1.D.value     0.7105      0.037     19.061      0.000       0.637       0.784
ma.L1.D.value    -0.9259      0.041    -22.504      0.000      -1.007      -0.845
ma.L2.D.value    -0.0232      0.035     -0.658      0.511      -0.092       0.046
                                    Roots
=============================================================================
                  Real          Imaginary           Modulus         Frequency
```

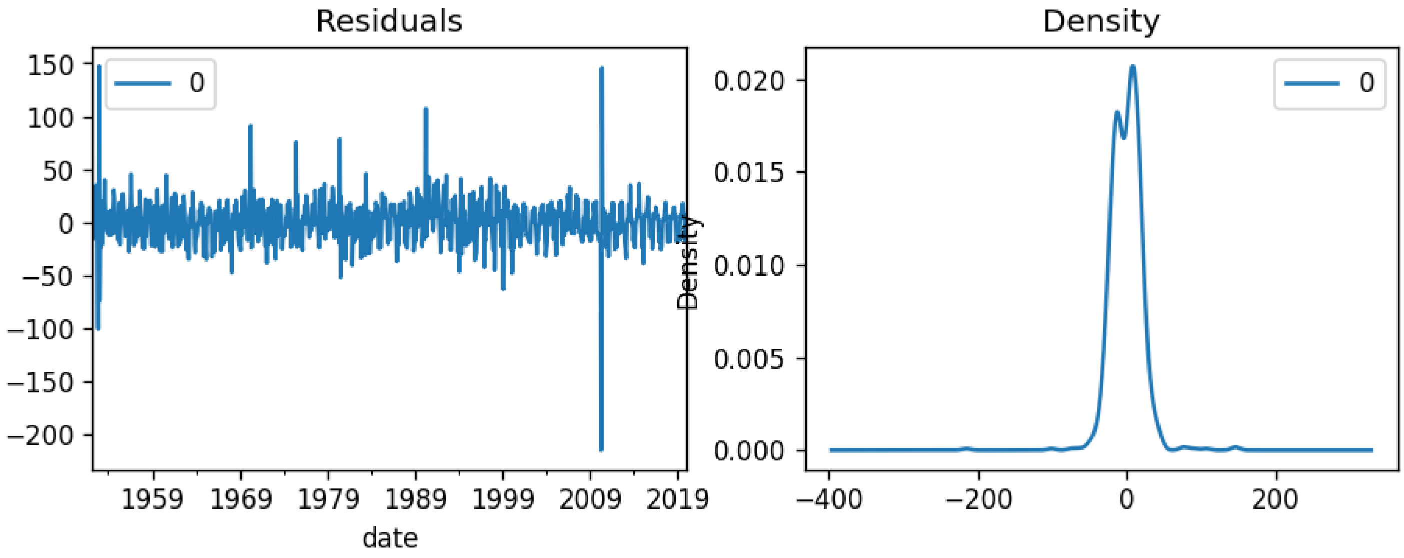
```
                 Real          Imaginary           Modulus         Frequency
-----------------------------------------------------------------------------
AR.1            1.4074           +0.0000j           1.4074           0.0000
MA.1            1.0523           +0.0000j           1.0523           0.0000
MA.2          -40.9406           +0.0000j          40.9406           0.5000
-----------------------------------------------------------------------------
```

In [27]:

```
residuals = pd.DataFrame(model_fit.resid)

fig,axes = plt.subplots(1,2)

residuals.plot(title='Residuals',ax= axes[0])
residuals.plot(kind= 'kde', title='Density',ax= axes[1])
```

Out[27]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7effb0ae9208>
```



In [29]:

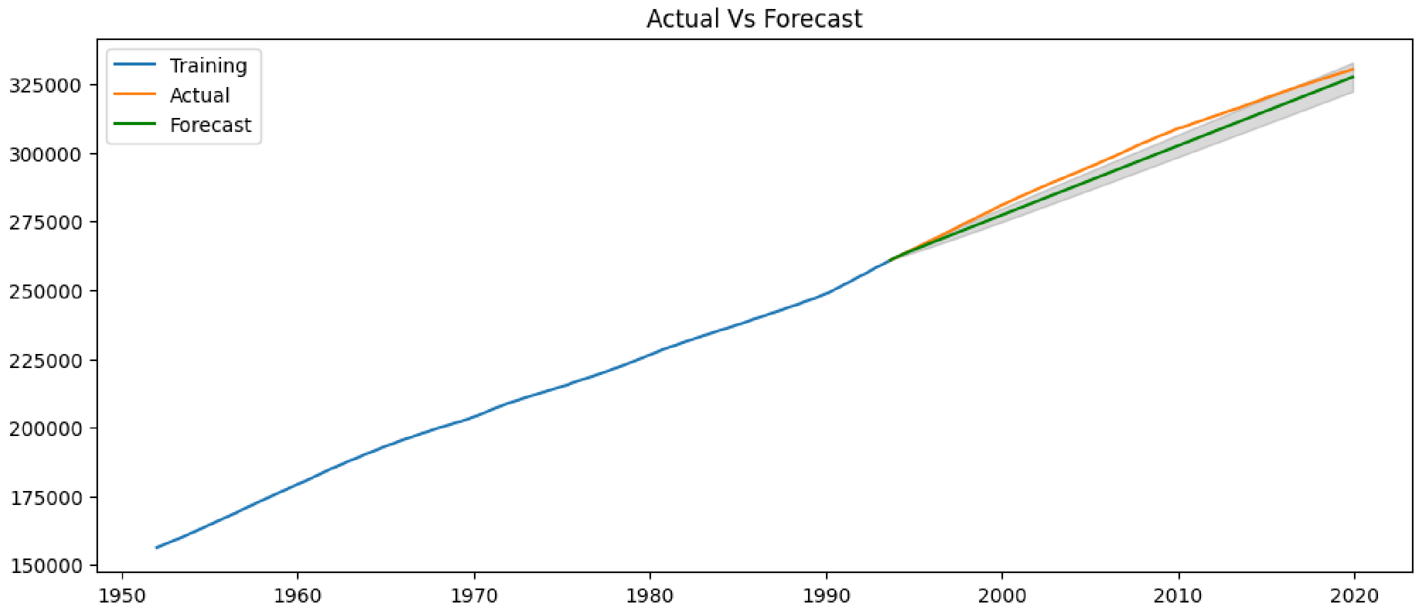
```
#Train & Test Data
train = df['value'][:500]
test = df['value'][500:]

model1 = ARIMA(train,order=(1,1,2))
model_fitted1 = model1.fit(disp= -1)

fc,se,conf = model_fitted1.forecast(316)

fc_series = Series(fc,index=test.index)
lower_series = Series(conf[:,0],index=test.index)
upper_series = Series(conf[:,1],index=test.index)

plt.figure(figsize=(12,5), dpi=100)

plt.plot(train,label='Training')
plt.plot(test,label='Actual')
plt.plot(fc_series,label='Forecast',color='green')

plt.fill_between(lower_series.index,lower_series,upper_series,color='k',alpha=.15)

plt.title('Actual Vs Forecast')
plt.legend(loc='upper left')
```

```
/usr/local/lib/python3.6/dist-packages/statsmodels/tsa/base/tsa_model.py:165: ValueWarnin
g: No frequency information was provided, so inferred frequency MS will be used.
  % freq, ValueWarning)
/usr/local/lib/python3.6/dist-packages/statsmodels/tsa/base/tsa_model.py:165: ValueWarnin
g: No frequency information was provided, so inferred frequency MS will be used.
  % freq, ValueWarning)
```

Out[29]:

Out[29]:

```
<matplotlib.legend.Legend at 0x7effb39ffe80>
```



Actual Vs Forecast
Training
Actual
Forecast
325000
300000
275000
250000
225000
200000
175000
150000
1950
1960
1970
1980
1990
2000
2010
2020