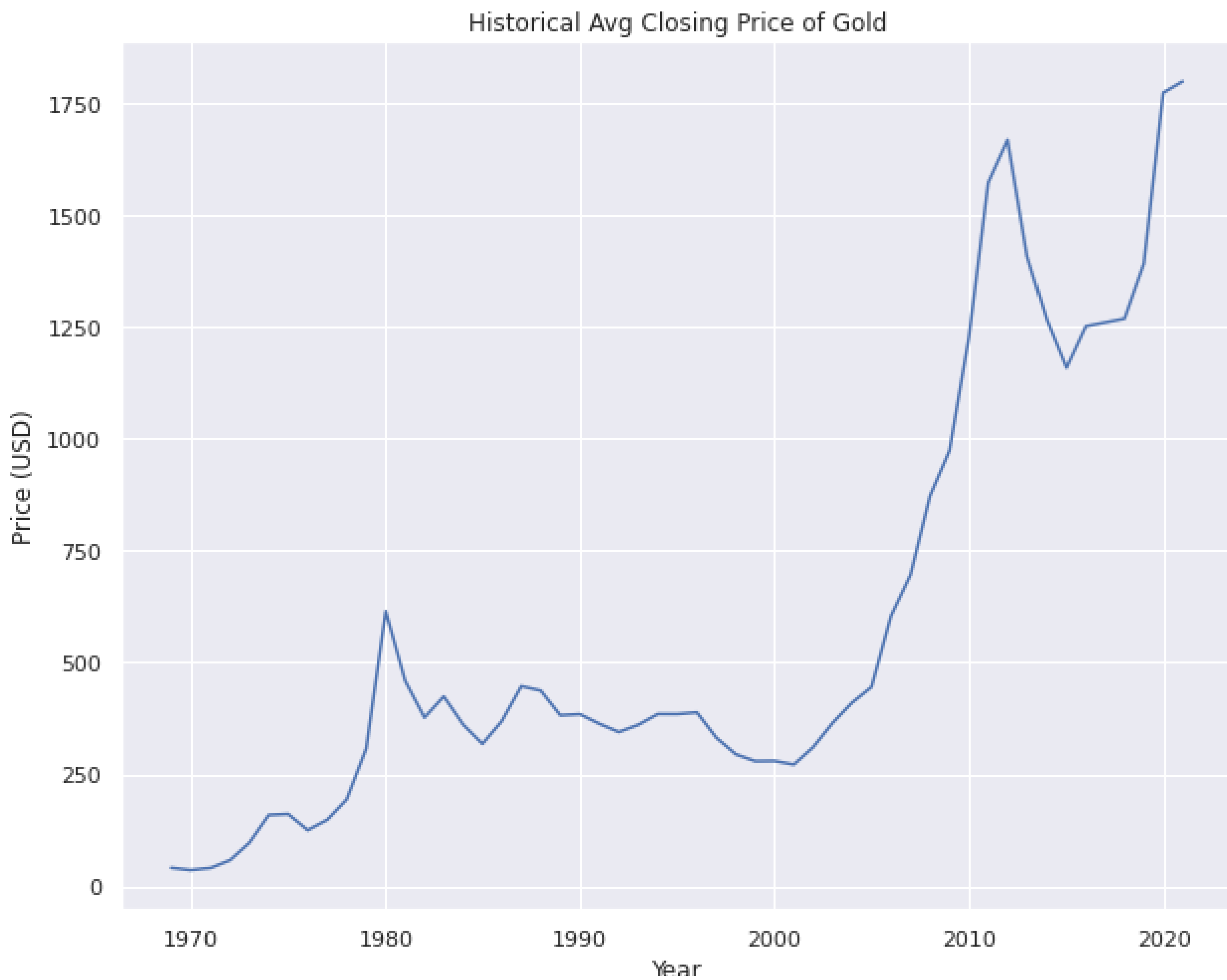
```python
#Importing libraries
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

#Setting seaborn default theme
sns.set()
```

```python
#Reading data
ts = pd.read_csv('/content/Gold_Yearly .csv')

#Viewing first 5 rows
ts.head()
```

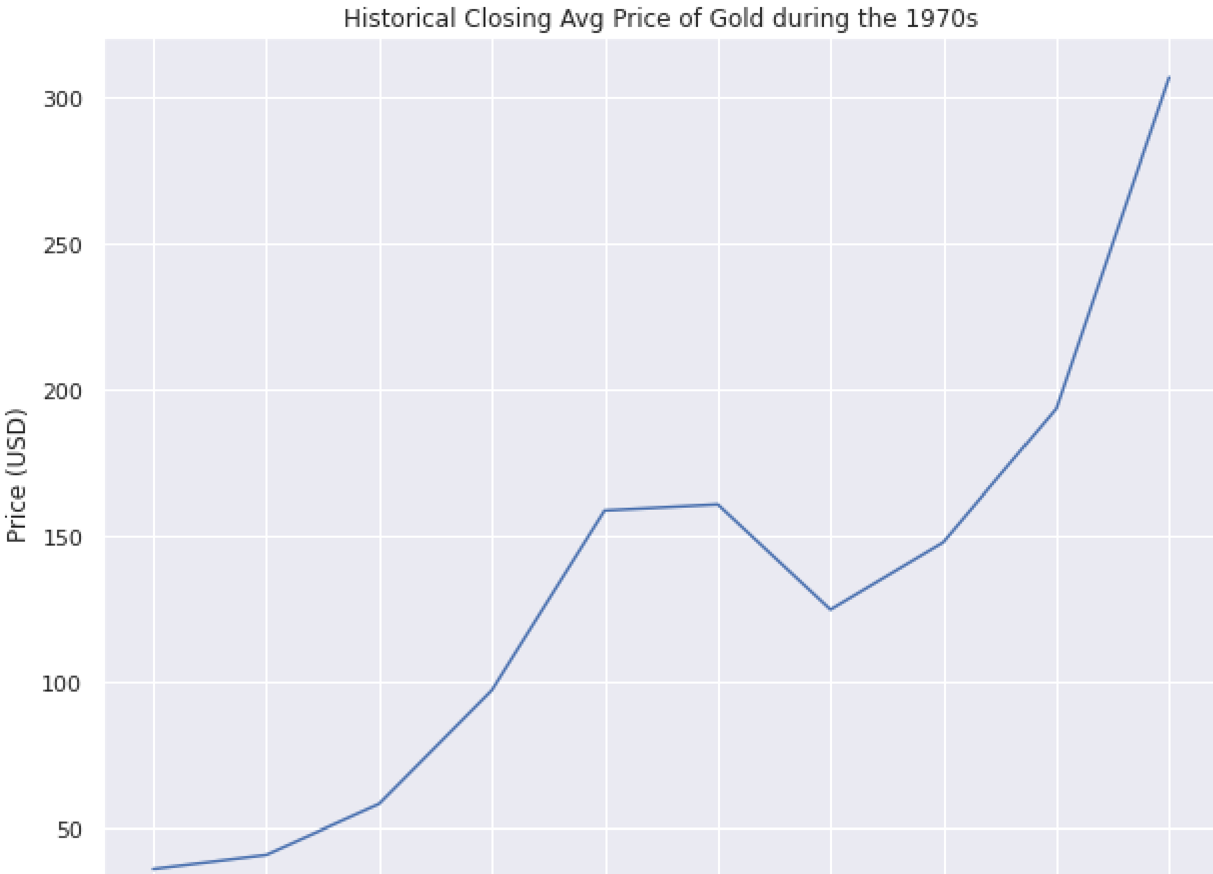
	Year	Average\nClosing Price	Year Open	Year High	Year Low	Year Close	Annual\n% Change
0	1969	41.10	41.80	43.75	35.00	35.21	-0.1607
1	1970	35.96	35.13	39.19	34.78	37.38	0.0616
2	1971	40.80	37.33	43.90	37.33	43.50	0.1637
3	1972	58.17	43.73	70.00	43.73	64.70	0.4874
4	1973	97.12	64.99	127.00	64.10	112.25	0.7349

```python
#Renaming columns
ts = ts.rename(columns={'Average\nClosing Price': 'Avg Closing Price',
                        'Annual\n% Change':'Annual Percentage Change'})

#Setting index to year
ts = ts.set_index('Year')
```

```python
#Create a figure and one subplot
fig, ax = plt.subplots(figsize=(10,8))

#Plotting
ax.plot(ts.index, ts['Avg Closing Price'])


#Modifying Labels
ax.set_title('Historical Avg Closing Price of Gold')
ax.set_xlabel('Year')
ax.set_ylabel('Price (USD)')

#Displaying figure
plt.show()
```




```
# Create a figure and only one subplot
fig, ax = plt.subplots(figsize=(10,8))

#List with x-tick values
x = [1970,1971,1972,1973,1974,1975,1976,1977,1978,1979]

#Subsetting data
seventies = ts.loc[1970:1979]

#Plotting
ax.plot(seventies.index, seventies['Avg Closing Price'])

#Modifying Labels
plt.xticks(x)
plt.title('Historical Closing Avg Price of Gold during the 1970''s')
plt.xlabel('Year')
plt.ylabel('Price (USD)')

#Displaying figure
plt.show()
```



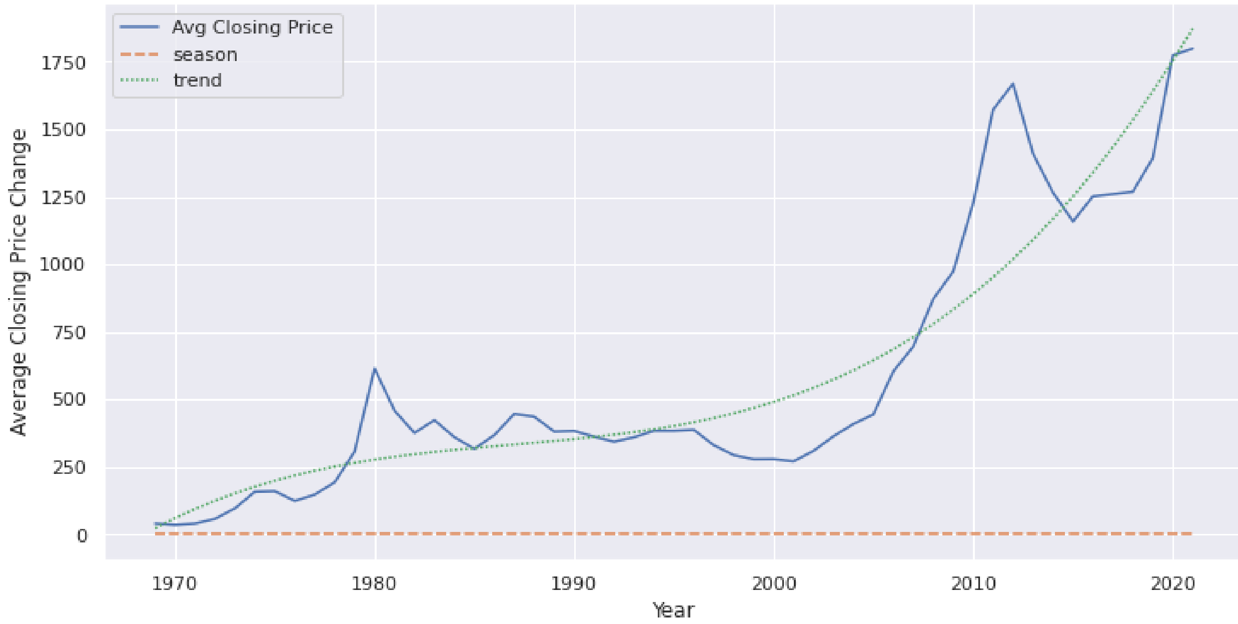
Use NumPy's polyfit to fit a polynomial function

```
from numpy import polyfit
import numpy as np
def fit(X, y, degree=3):
    coef = polyfit(X, y, degree)
    trendpoly = np.poly1d(coef)
    return trendpoly(X)
def get_season(s, yearly_periods=4, degree=3):
    X = [i%(365/4) for i in range(0, len(s))]
    seasonal = fit(X, s.values, degree)
    return pd.Series(data=seasonal, index=s.index)
def get_trend(s, degree=3):
    X = list(range(len(s)))
    trend = fit(X, s.values, degree)
    return pd.Series(data=trend, index=s.index)
```

Plot seasonality and trend on top of Average Closing Price

```
import seaborn as sns
plt.figure(figsize=(12, 6))
ts['trend'] = get_trend(ts['Avg Closing Price'])
ts['season'] = get_season(ts['Avg Closing Price'] - ts['trend'])
```

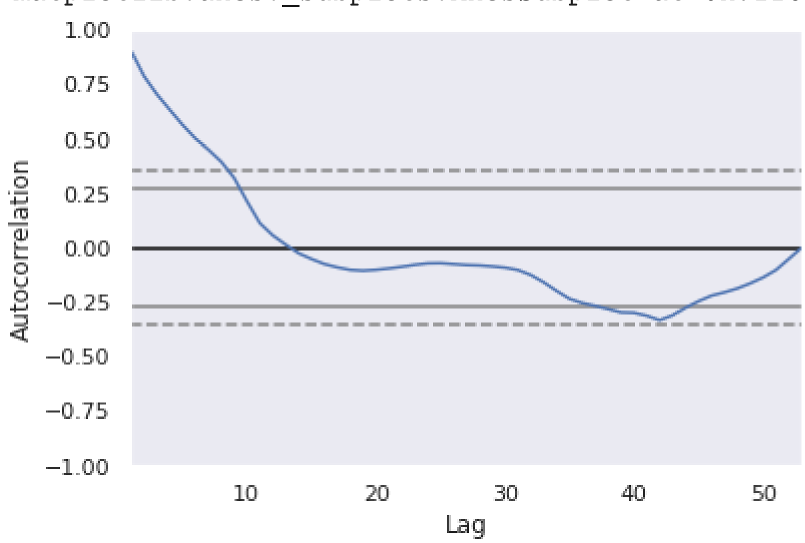
```
5 sns.lineplot(data=ts[['Avg Closing Price', 'season', 'trend']])
```



Autocorrelation Plot

```
1 pd.plotting.autocorrelation_plot(ts['Avg Closing Price'])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f269ead7850>
```



Test stationarity of the model

```
1 from statsmodels.tsa import stattools
2 stattools.adfuller(ts['Avg Closing Price'])
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tools/_testing.py:19: FutureW
```

```
  import pandas.util.testing as tm
(-0.25863925675492744,
 0.9311614073211184,
 1,
 51,
 {'1%': -3.5656240522121956,
  '10%': -2.598014675124952,
  '5%': -2.920142229157715},
 508.31060814763543)
```

With a p-value of 0.93, we cannot assume that the data are stationary

Frequency Domain Analysis

```
!pip install quantecon
```

```
Collecting quantecon
  Downloading quantecon-0.5.2-py3-none-any.whl (269 kB)
     |████████████████████████████████| 269 kB 5.1 MB/s
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: scipy>=1.0.0 in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: sympy in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (
Requirement already satisfied: numba>=0.38 in /usr/local/lib/python3.7/dist-pack
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: llvmlite<0.35,>=0.34.0.dev0 in /usr/local/lib/pyt
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dis
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/di
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/l
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: mpmath>=0.19 in /usr/local/lib/python3.7/dist-pac
Installing collected packages: quantecon
Successfully installed quantecon-0.5.2
```

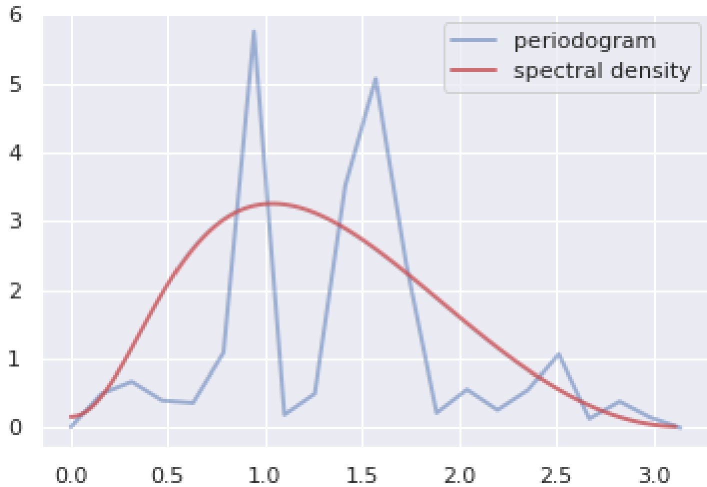
```
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
from quantecon import ARMA, periodogram, ar_periodogram
```

```
/usr/local/lib/python3.7/dist-packages/numba/np/ufunc/parallel.py:363: NumbaWarn
  warnings.warn(problem)
```

```
n = 40                          # Data size
ϕ, θ = 0.5, (0, -0.8)           # AR and MA parameters
lp = ARMA(ϕ, θ)
X = lp.simulation(ts_length=n)

fig, ax = plt.subplots()
x, y = periodogram(X)
ax.plot(x, y, 'b-', lw=2, alpha=0.5, label='periodogram')
```

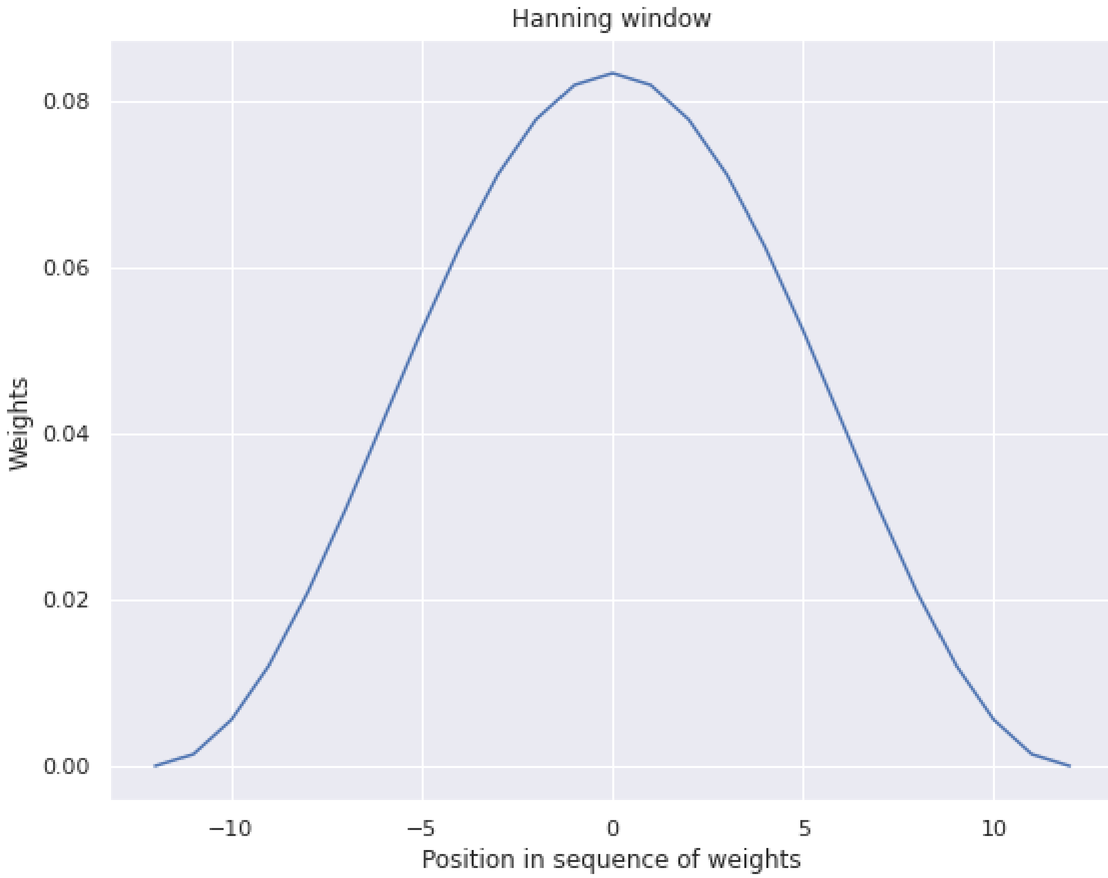
```
x_sd, y_sd = lp.spectral_density(two_pi=False, res=120)
ax.plot(x_sd, y_sd, 'r-', lw=2, alpha=0.8, label='spectral density')
ax.legend()
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/numpy/core/_asarray.py:83: ComplexWa
  return array(a, dtype, copy=False, order=order)
```



Computers cannot do computations with an infinite number of data points. Therefore, all signals are "cut off" at either end. This causes the ripple on either side of the peak illustrated below. The Hamming window reduces this ripple, providing a more accurate idea of the original signal's frequency spectrum

```
def hanning_window(M):
    w = [0.5 - 0.5 * np.cos(2 * np.pi * n/(M-1)) for n in range(M)]
    return w

window = hanning_window(25) / np.abs(sum(hanning_window(25)))
x = np.linspace(-12, 12, 25)
fig, ax = plt.subplots(figsize=(9,·7))
ax.plot(x,·window)
ax.set_title("Hanning·window")
ax.set_ylabel("Weights")
ax.set_xlabel("Position in sequence of weights")
plt.show()
```



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