Import Library

```
from pandas_datareader import data
import matplotlib.pyplot as plt
import pandas as pd
import datetime
import numpy as np
import plotly.graph_objects as go
```

Import Data

```
companies_dict = {
    'Ace Hardware Indonesia Tbk'  :'ACES.JK',
    'Adaro Energy Tbk':'ADRO.JK',
    'Aneka Tambang Tbk':'ANTM.JK',
    'Astra International Tbk':'ASII.JK',
    'Bank Central Asia Tbk':'BBCA.JK',
    'Bank Negara Indonesia (Persero) Tbk':'BBNI.JK',
    'Bank Rakyat Indonesia (Persero) Tbk':'BBRI.JK',
    'Bank Tabungan Negara (Persero) Tbk':'BBTN.JK',
    'Bank Mandiri (Persero) Tbk':'BMRI.JK',
    'Bank BTPN Syariah Tbk':'BTPS.JK',
    'Charoen Pokphand Indonesia Tbk':'CPIN.JK',
    'Erajaya Swasembada Tbk'  :'ERAA.JK',
    'XL Axiata Tbk':'EXCL.JK',
    'Gudang Garam Tbk':'GGRM.JK',
    'H.M. Sampoerna Tbk':'HMSP.JK',
    'Indofood CBP Sukses Makmur Tbk':'ICBP.JK',
    'Vale Indonesia Tbk':'INCO.JK',
    'Indofood Sukses Makmur Tbk':'INDF.JK',
    'Indah Kiat Pulp & Paper Tbk':'INKP.JK',
    'Indocement Tunggal Prakarsa Tbk':'INTP.JK',
    'Japfa Comfeed Indonesia Tbk':'JPFA.JK',
    'Kalbe Farma Tbk':'KLBF.JK',
    'Media Nusantara Citra Tbk':'MNCN.JK',
    'Perusahaan Gas Negara (Persero) Tbk':'PGAS.JK',
    'Bukit Asam Tbk':'PTBA.JK',
    'Semen Indonesia (Persero) Tbk' :'SMGR.JK',
    'Telekomunikasi Indonesia (Persero) Tbk'  :'TLKM.JK',
    'Sarana Menara Nusantara Tbk':'TOWR.JK',
    'United Tractors Tbk':'UNTR.JK',
    'Unilever Indonesia Tbk.':'UNVR.JK' }
```

```
companies_data = pd.DataFrame({'No':[1,
2,
3,
4,
5
```

```
    5,
    6,
    7,
    8,
    9,
    10,
    11,
    12,
    13,
    14,
    15,
    16,
    17,
    18,
    19,
    20,
    21,
    22,
    23,
    24,
    25,
    26,
    27,
    28,
    29,
    30,
    ],'Company Name':['Ace Hardware Indonesia Tbk',
    'Adaro Energy Tbk',
    'Aneka Tambang Tbk',
    'Astra International Tbk',
    'Bank Central Asia Tbk',
    'Bank Negara Indonesia (Persero) Tbk',
    'Bank Rakyat Indonesia (Persero) Tbk',
    'Bank Tabungan Negara (Persero) Tbk',
    'Bank Mandiri (Persero) Tbk',
    'Bank BTPN Syariah Tbk',
    'Charoen Pokphand Indonesia Tbk',
    'Erajaya Swasembada Tbk',
    'XL Axiata Tbk',
    'Gudang Garam Tbk',
    'H.M. Sampoerna Tbk',
    'Indofood CBP Sukses Makmur Tbk',
    'Vale Indonesia Tbk',
    'Indofood Sukses Makmur Tbk',
    'Indah Kiat Pulp & Paper Tbk',
    'Indocement Tunggal Prakarsa Tbk',
    'Japfa Comfeed Indonesia Tbk',
    'Kalbe Farma Tbk',
    'Media Nusantara Citra Tbk',
    'Perusahaan Gas Negara (Persero) Tbk',
    'Bukit Asam Tbk',
    'Semen Indonesia (Persero) Tbk',
    'Telekomunikasi Indonesia (Persero) Tbk',
    'Sarana Menara Nusantara Tbk',
    'United Tractors Tbk',
    'Unilever Indonesia Tbk',
    'Unilever Indonesia Tbk.',
    ], 'Stock Code':['ACES.JK',
    'ADRO.JK',
    'ANTM.JK',
    'ASII.JK',
    'BBCA.JK',
    'BBNI.JK',
    'BBRI.JK',
    'BBTN.JK',
    'BMRI.JK',
    'BTPS.JK',
    'CPIN.JK',
    'ERAA.JK',
    'EXCL.JK',
    'GGRM.JK',
    'HMSP.JK',
    'ICBP.JK',
    'INCO.JK',
    'INDF.JK',
    'INKP.JK',
    'INTP.JK',
    'JPFA.JK',
    'KLBF.JK',
    'MNCN.JK',
    'PGAS.JK',
    'PTBA.JK',
    'SMGR.JK',
    'TLKM.JK',
    'TOWR.JK',
    'UNTR.JK',
    'UNVR.JK'
    ]})
    companies_data
```

	No	Company Name	Stock Code
0	1	Ace Hardware Indonesia Tbk	ACES.JK
1	2	Adaro Energy Tbk	ADRO.JK
2	3	Aneka Tambang Tbk	ANTM.JK
3	4	Astra International Tbk	ASII.JK
4	5	Bank Central Asia Tbk	BBCA.JK
5	6	Bank Negara Indonesia (Persero) Tbk	BBNI.JK
6	7	Bank Rakyat Indonesia (Persero) Tbk	BBRI.JK
7	8	Bank Tabungan Negara (Persero) Tbk	BBTN.JK
8	9	Bank Mandiri (Persero) Tbk	BMRI.JK
9	10	Bank BTPN Syariah Tbk	BTPS.JK
10	11	Charoen Pokphand Indonesia Tbk	CPIN.JK
11	12	Erajaya Swasembada Tbk	ERAA.JK
12	13	XL Axiata Tbk	EXCL.JK
13	14	Gudang Garam Tbk	GGRM.JK
14	15	H.M. Sampoerna Tbk	HMSP.JK
15	16	Indofood CBP Sukses Makmur Tbk	ICBP.JK
16	17	Vale Indonesia Tbk	INCO.JK

```
data_source = 'yahoo'
start_date = '2020-1-1'
end_date = '2020-11-30'
data = data.DataReader(list(companies_dict.values()),
 data_source,start_date,end_date)
```

```
data
```

Attributes	Adj Close														
Symbols	ACES.JK	ADRO.JK	ANTM.JK	ASII.JK	BBCA.JK	BBNI.JK	BBRI.JK	BBTN.JK	BMRI.JK	BTPS.JK	CPIN.JK	ERAA.JK	EXCL.JK	GGRM.JK	HMSP.JK
Date															
2020-01-02	1493.283813	1375.369995	836.116760	6620.207520	32881.570312	7546.740234	4244.426270	2125.546143	7377.428223	4070.430664	6488.402344	1830.0	3185.212402	53350.0	1960.93
2020-01-03	1498.228516	1409.506104	846.070496	6692.428223	33422.222656	7571.006348	4254.050781	2145.504150	7353.630371	4011.722412	6809.122070	1810.0	3175.289551	54100.0	2007.84
2020-01-06	1453.726685	1409.506104	880.908691	6499.840332	33102.746094	7401.144043	4205.928223	2125.546143	7234.639160	3904.090820	6759.780762	1725.0	3214.980713	54375.0	2017.23

```
data.describe()
```

Attributes	Adj Close													
Symbols	ACES.JK	ADRO.JK	ANTM.JK	ASII.JK	BBCA.JK	BBNI.JK	BBRI.JK	BBTN.JK	BMRI.JK	BTPS.JK	CPIN.JK	ERAA.JK	EXCL.JK	GGRM.JK
count	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000	224.000000
mean	1510.667052	1116.954753	723.379424	5014.199998	29643.401481	5161.833753	3430.321204	1370.445397	5738.943983	3440.899582	5804.676339	1496.026786	2462.940897	47533.816964
std	140.775638	156.135477	209.395126	896.803503	2792.520030	1216.038371	601.249892	377.104910	1061.529987	743.111783	808.055836	260.230269	392.237687	5409.516905
min	1028.486816	620.567505	346.391205	3158.440918	21773.595703	3160.000000	2170.000000	745.000000	3720.000000	1766.136353	3779.556152	840.000000	1399.111938	32900.000000
25%	1452.490509	1030.000000	571.097580	4580.572754	27593.750000	4440.000000	3040.000000	1122.500000	4947.500000	3100.000000	5520.076416	1255.000000	2190.000000	43956.250000
50%	1545.000000	1125.000000	709.206146	4933.038330	29512.500000	4735.000000	3215.000000	1315.000000	5637.500000	3415.000000	5987.500000	1565.000000	2460.849365	47137.500000
75%	1610.488861	1200.662567	805.000000	5657.835571	31956.250000	5731.250000	4012.500000	1650.000000	6406.250000	4013.791809	6272.533447	1716.250000	2722.500000	50806.250000
max	1755.000000	1505.718018	1255.000000	6933.163086	33790.851562	7692.336914	4562.036133	2155.483398	7615.409668	4941.268066	7277.865723	1860.000000	3334.053955	58325.000000

8 rows × 180 columns

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 224 entries, 2020-01-02 to 2020-12-01
Columns: 180 entries, ('Adj Close', 'ACES.JK') to ('Volume', 'UNVR.JK')
dtypes: float64(180)
memory usage: 316.8 KB
```

```
data.isnull().sum()
```

```
Attributes  Symbols
Adj Close   ACES.JK    0
            ADRO.JK    0
            ANTM.JK    0
            ASII.JK    0
            BBCA.JK    0
                      ..
Volume      SMGR.JK    0
            TLKM.JK    0
            TOWR.JK    0
            UNTR.JK    0
            UNVR.JK    0
     Length: 180, dtype: int64
```

```
stock_open = np.array(data['Open']).T # stock_open is numpy array of transpose of df['Open']
stock_close = np.array(data['Close']).T # stock_close is numpy array of transpose of df['Close']
```

```
movements = stock_close - stock_open
```

```
sum_of_movement = np.sum(movements,1)
```

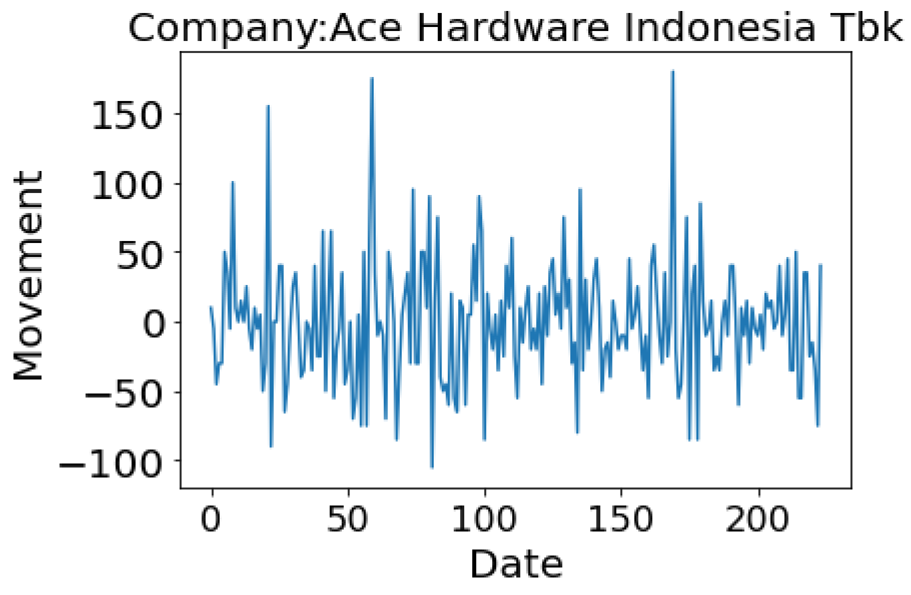
```
movements[0].size
```

```
     224
```

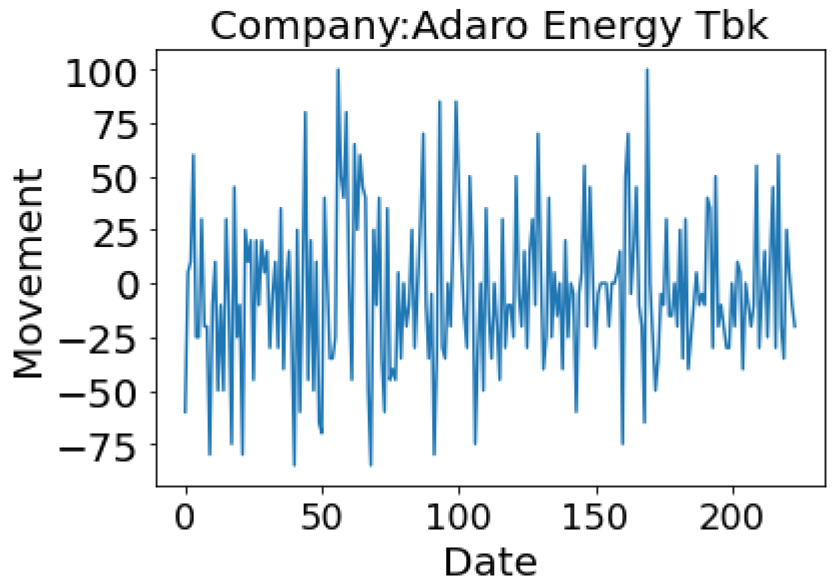
```
plt.figure(figsize = (900,30))
```

```
     <Figure size 64800x2160 with 0 Axes>
     <Figure size 64800x2160 with 0 Axes>
```

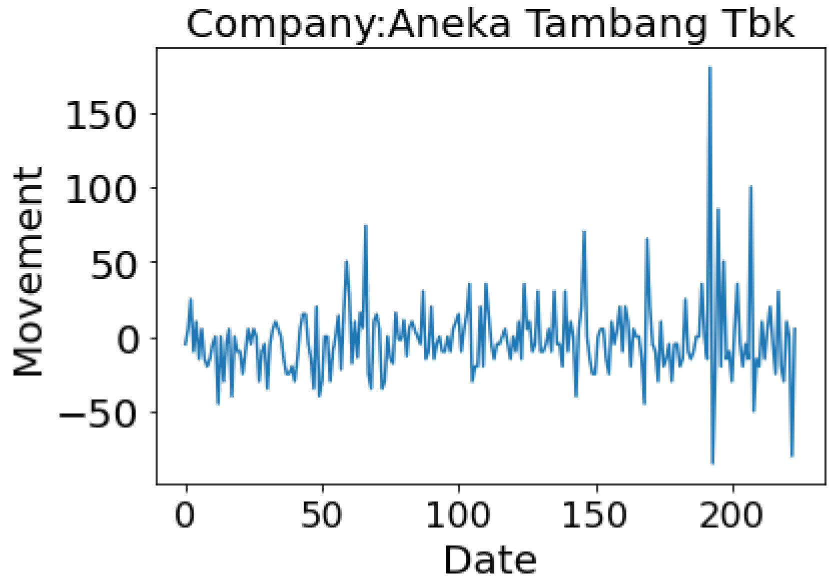
```
j = 0
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
j = j+1
```



```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
j = j+1
```



```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
j = j+1
```



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plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
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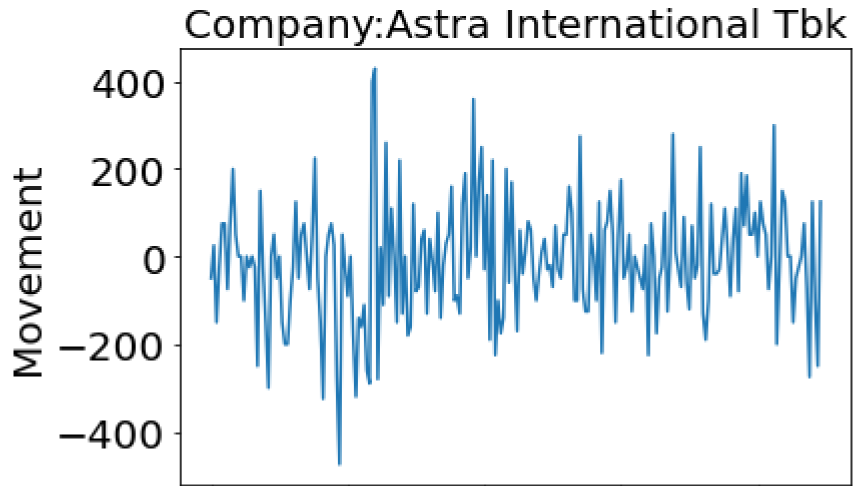
```



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plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
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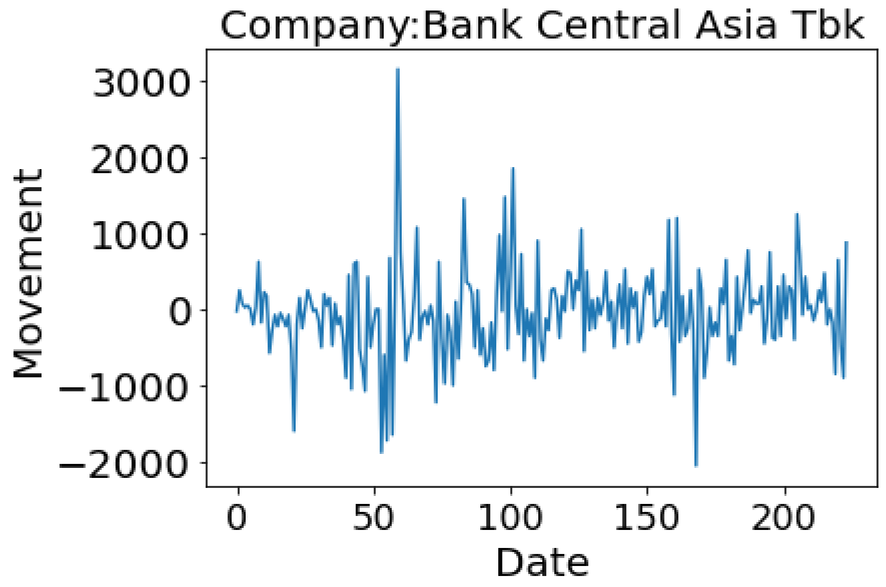

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
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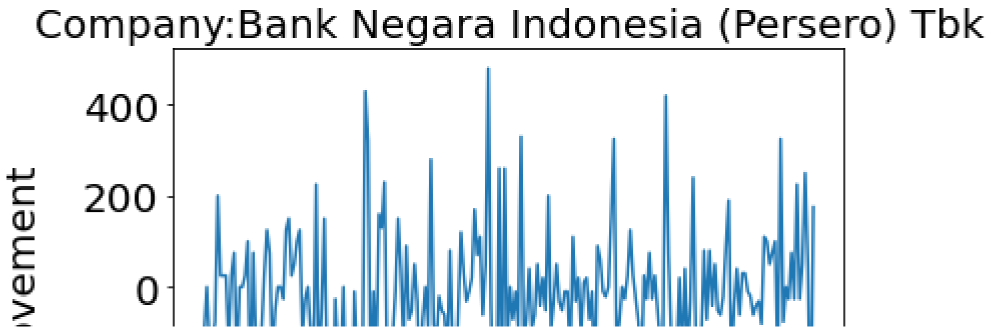

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
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```

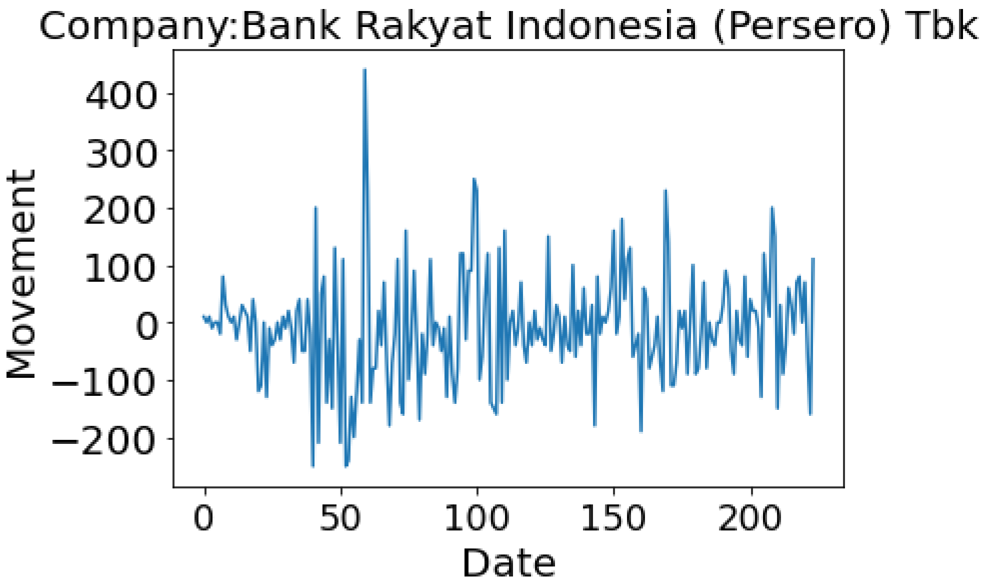

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
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```

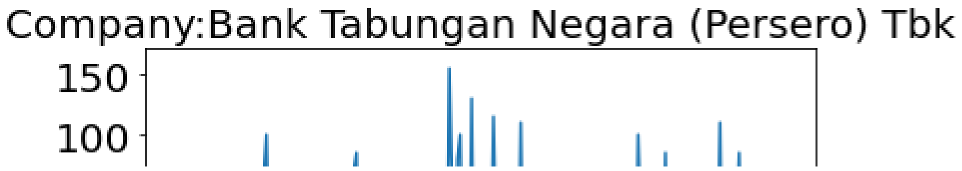

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
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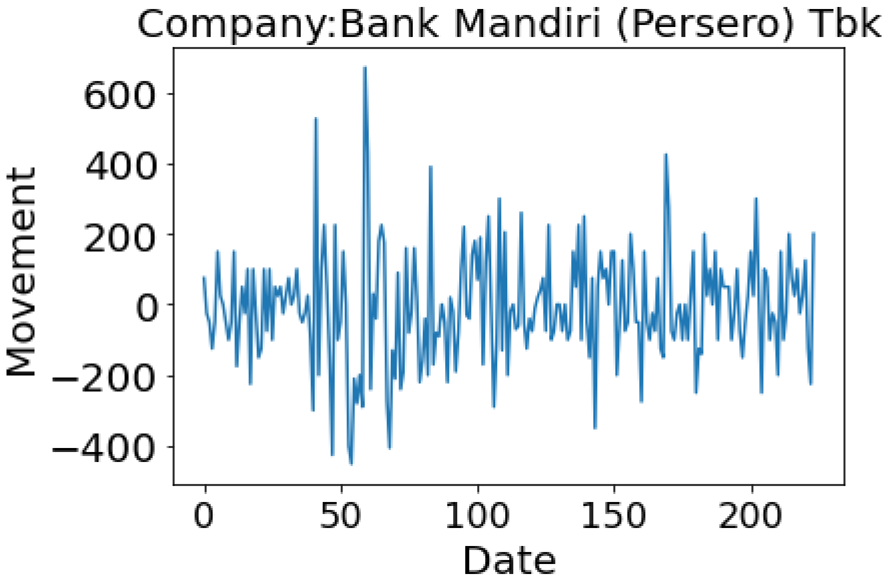

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
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plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
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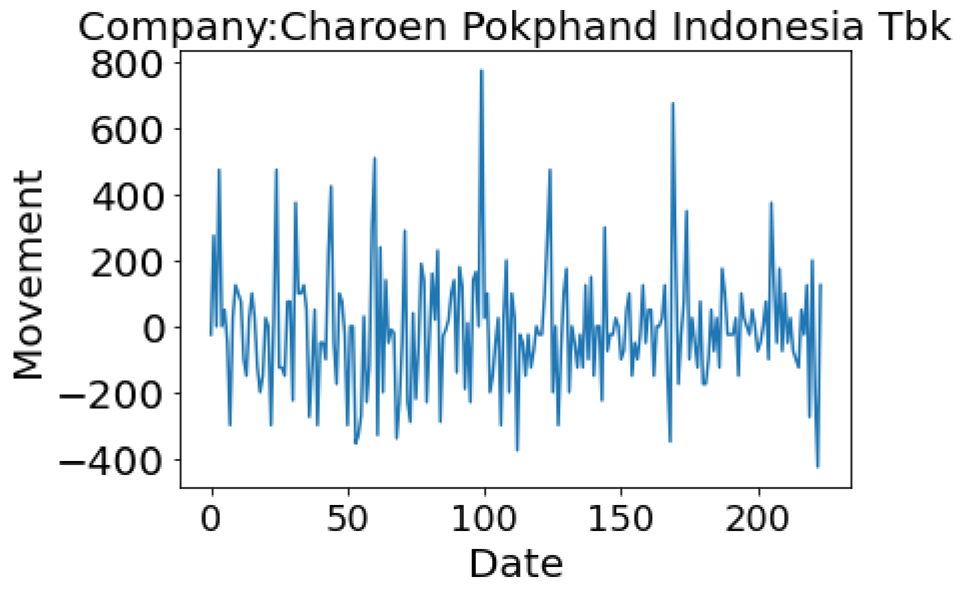

```
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plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
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j = j+1
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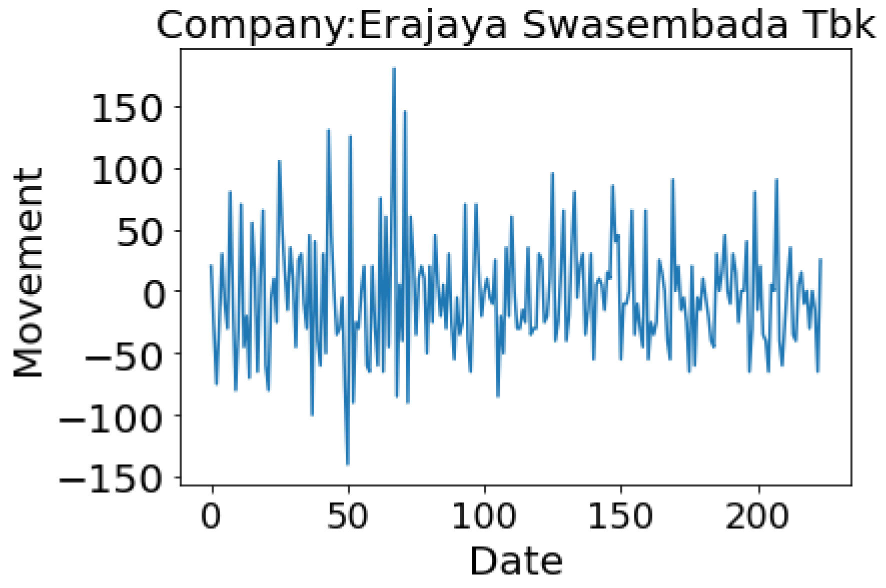

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
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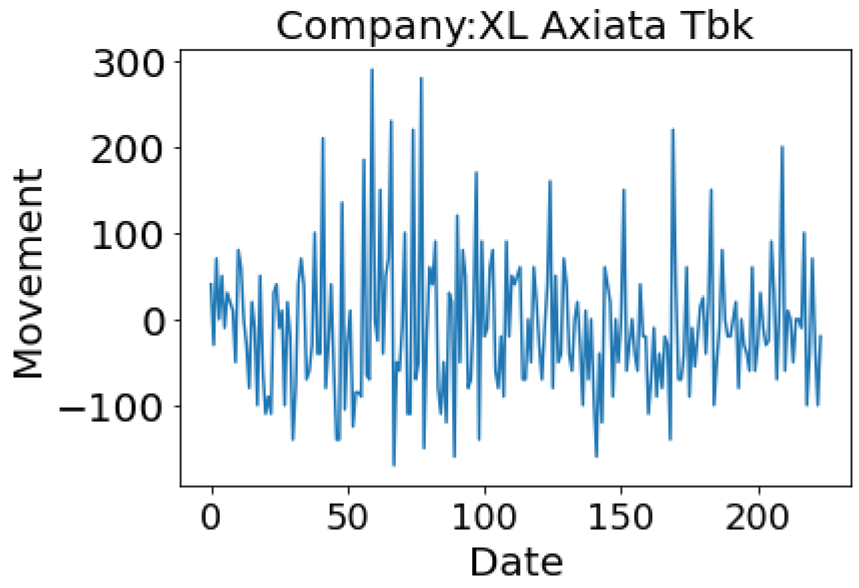

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
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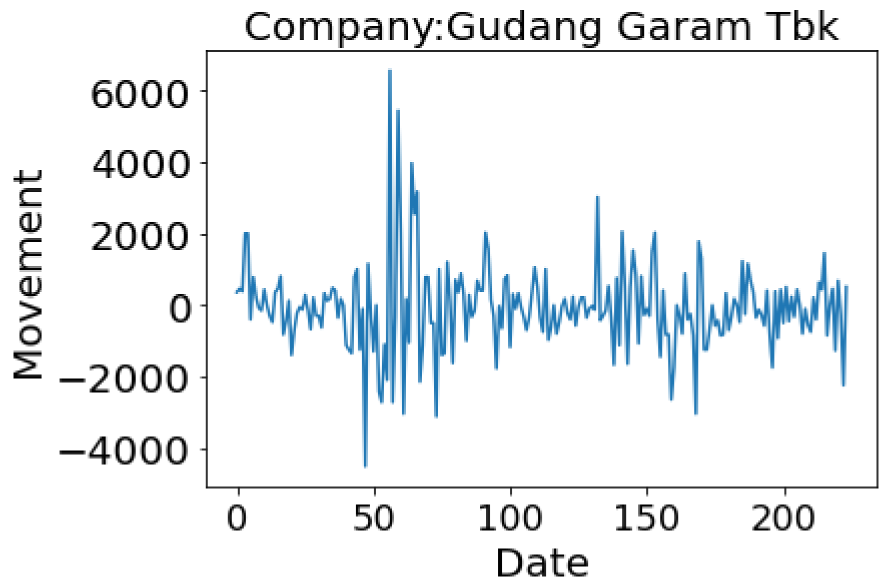

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
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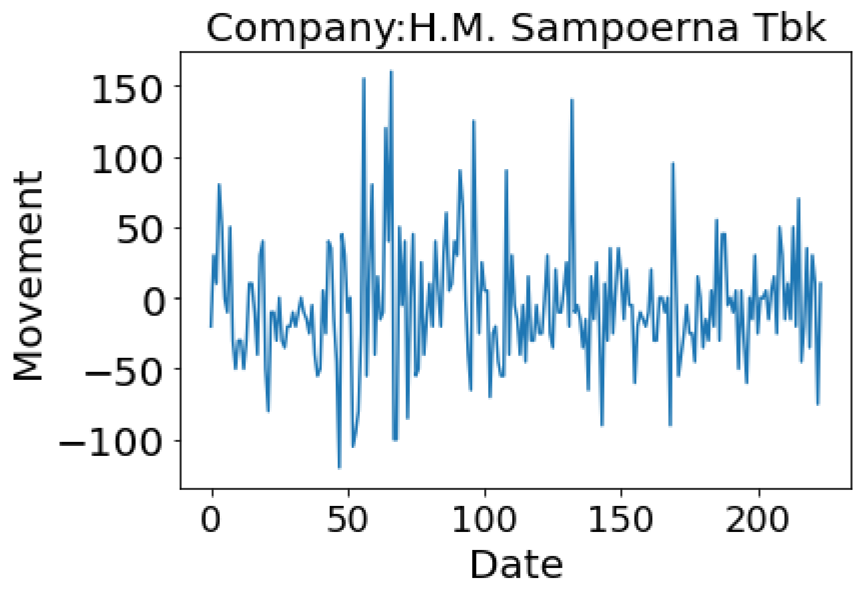

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
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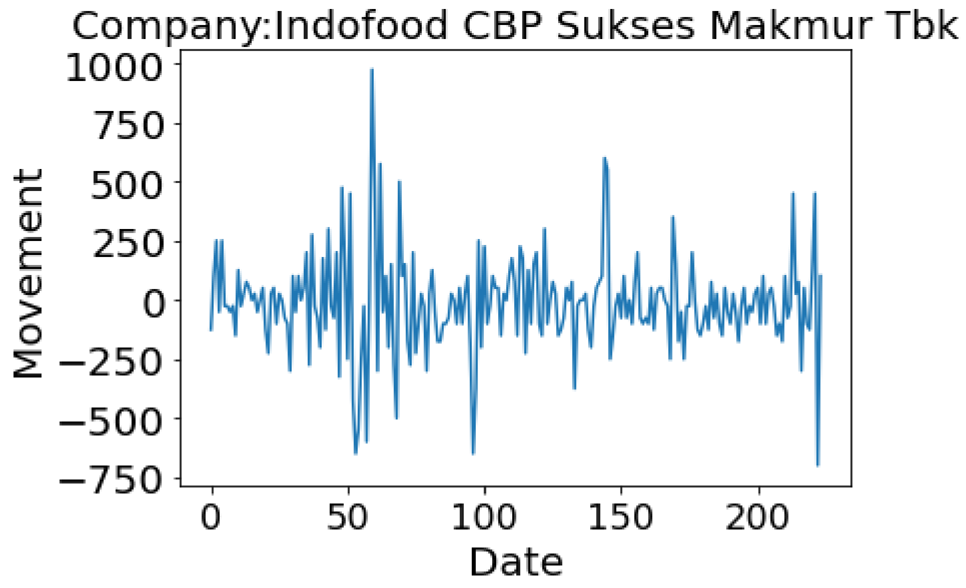

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
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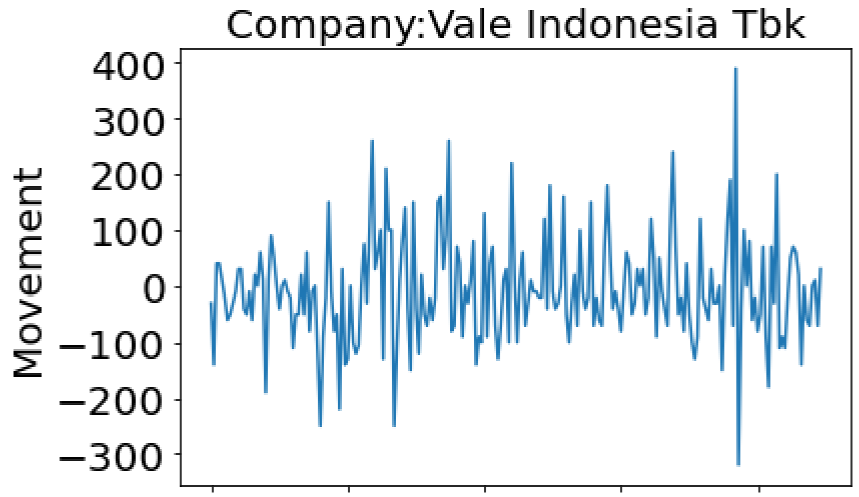

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plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
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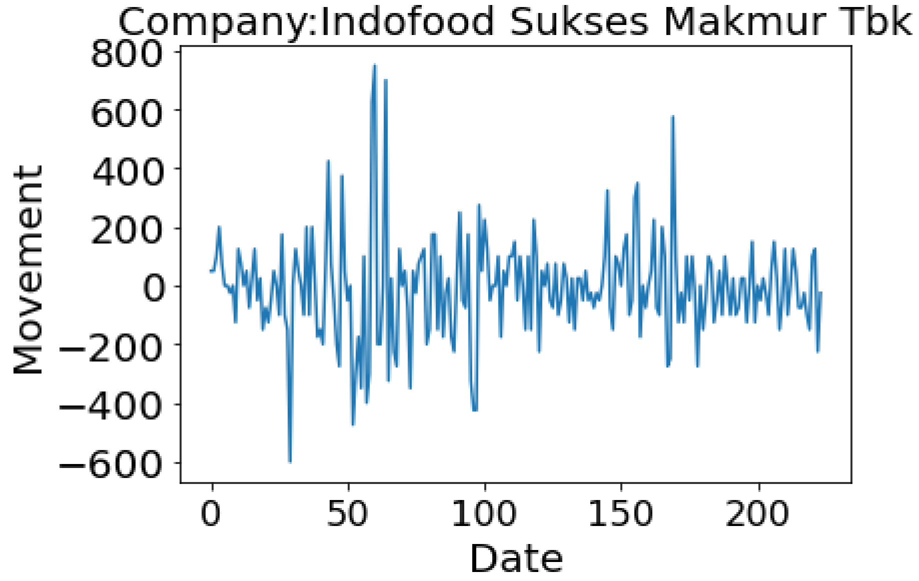

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
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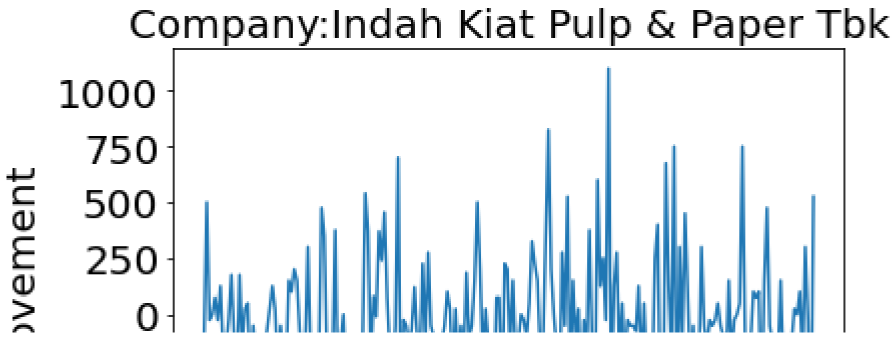

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plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
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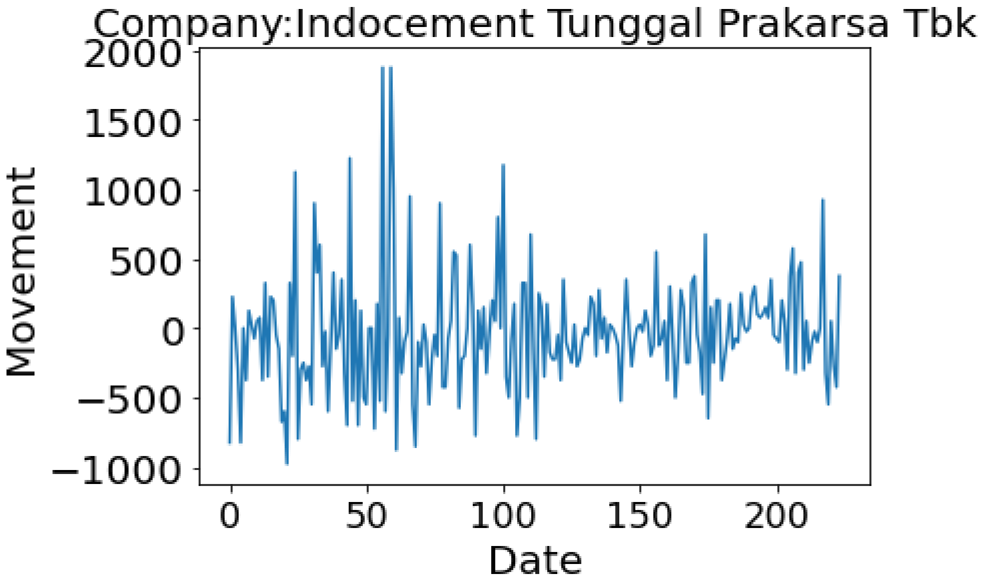

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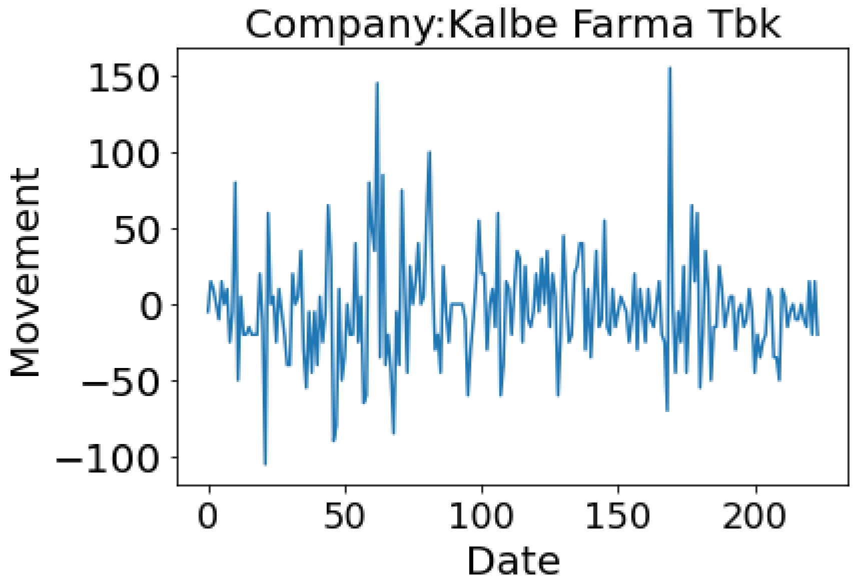

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plt.yticks(fontsize = 20)
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```
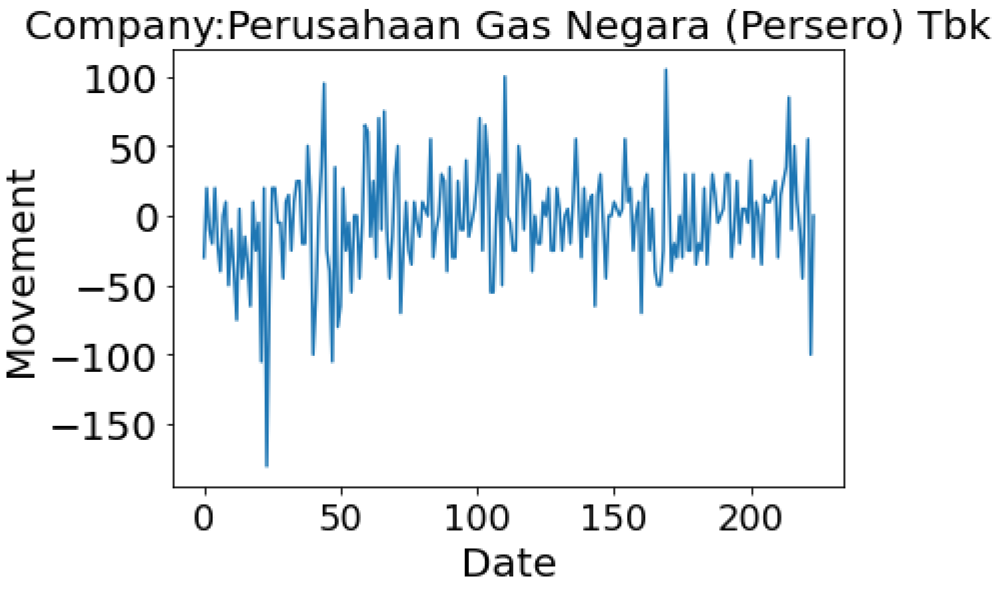
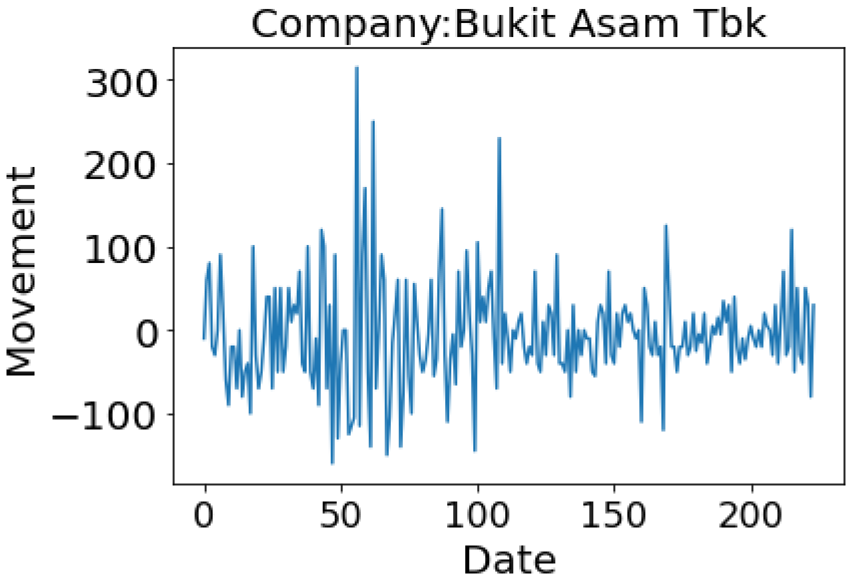

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
j = j+1
```

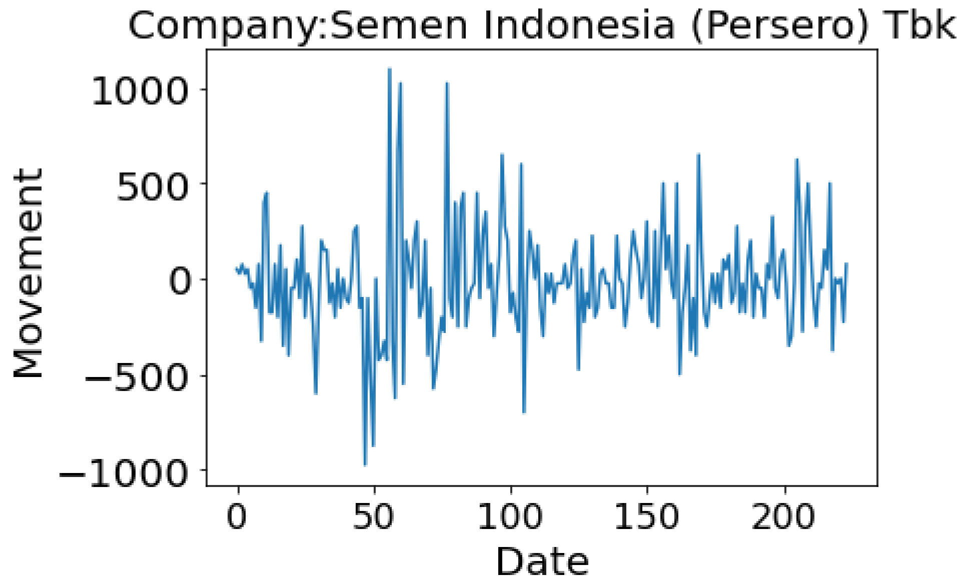

Company:Perusahaan Gas Negara (Persero) Tbk

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
j = j+1
```

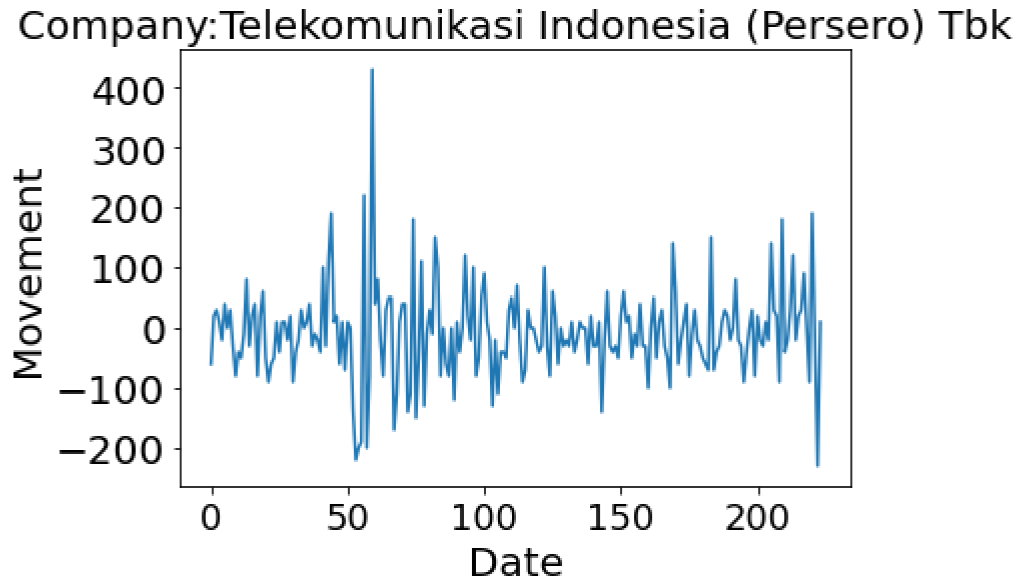

Company:Bukit Asam Tbk

```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
```

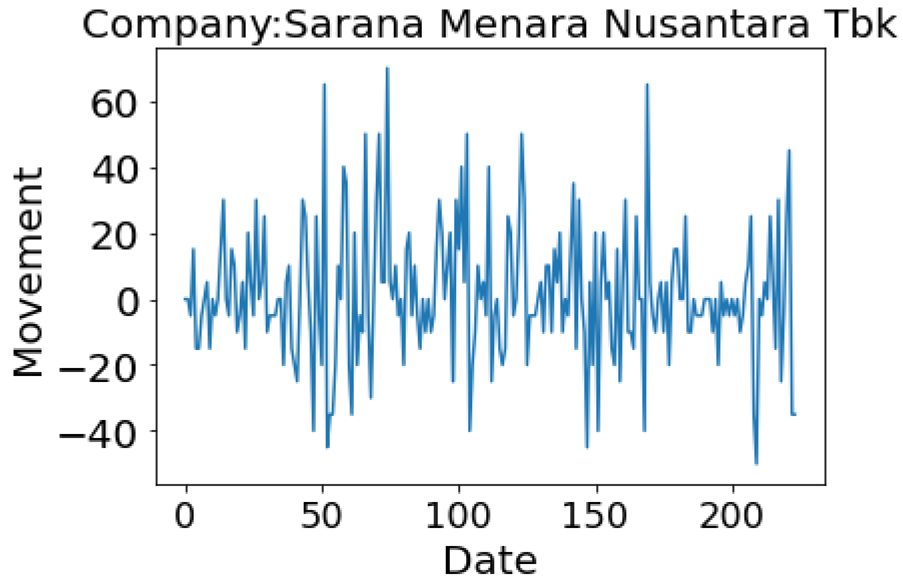
```
    plt.xlabel('Date',fontsize = 20)
    plt.ylabel('Movement',fontsize = 20)
    plt.plot(movements[j][0:movements[j].size])
    j = j+1
```



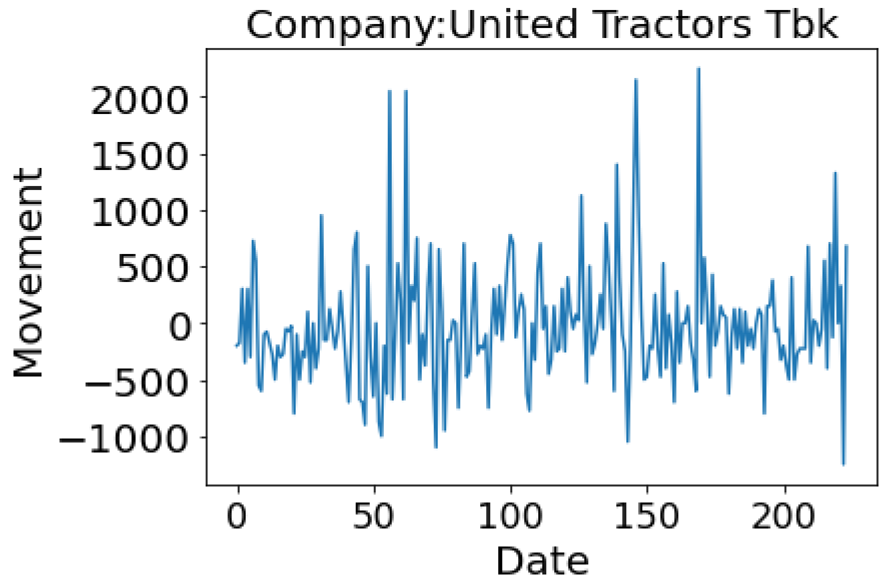
```
    plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
    plt.xticks(fontsize = 18)
    plt.yticks(fontsize = 20)
    plt.xlabel('Date',fontsize = 20)
    plt.ylabel('Movement',fontsize = 20)
    plt.plot(movements[j][0:movements[j].size])
    j = j+1
```



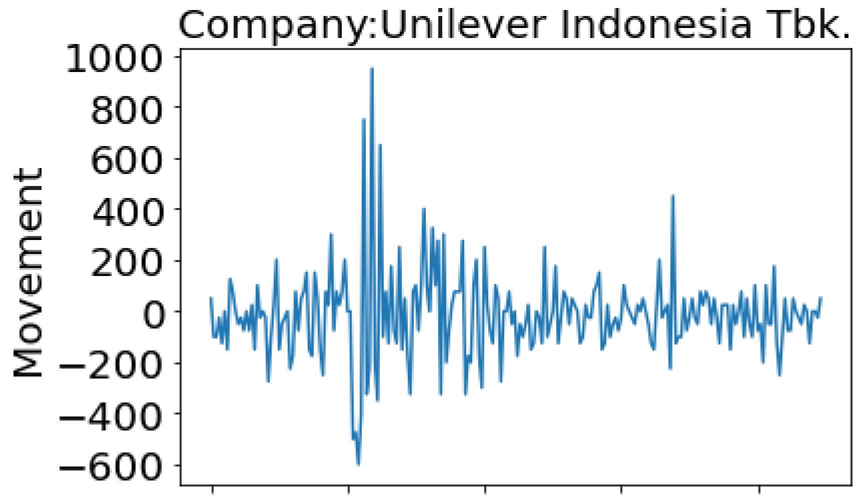
```
    plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
    plt.xticks(fontsize = 18)
    plt.yticks(fontsize = 20)
    plt.xlabel('Date',fontsize = 20)
    plt.ylabel('Movement',fontsize = 20)
    plt.plot(movements[j][0:movements[j].size])
    j = j+1
```



```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
j = j+1
```



```
plt.title('Company:'+companies_data['Company Name'][j],fontsize = 20)
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('Date',fontsize = 20)
plt.ylabel('Movement',fontsize = 20)
plt.plot(movements[j][0:movements[j].size])
j = j+1
```

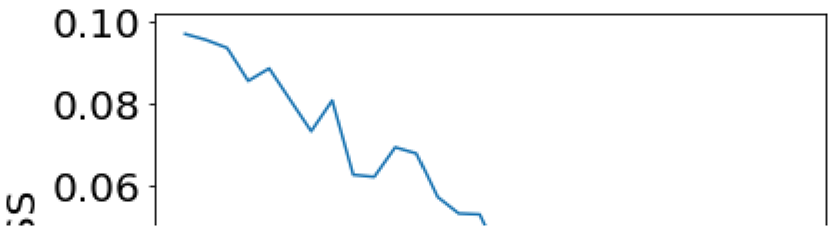


```
from sklearn.preprocessing import Normalizer
normalizer = Normalizer() # Define a Normalizer
movements = normalizer.fit_transform(movements)
```

```
from sklearn.cluster import KMeans

# function returns WSS score for k values from 1 to kmax
def calculate_WSS(points, kmax):
  sse = []
  for k in range(1, kmax+1):
    kmeans = KMeans(n_clusters = k).fit(points)
    centroids = kmeans.cluster_centers_
    pred_clusters = kmeans.predict(points)
    curr_sse = 0

    # calculate square of Euclidean distance of each point from its cluster center and add to current WSS
    for i in range(len(points)):
      curr_center = centroids[pred_clusters[i]]
      curr_sse += (points[i, 0] - curr_center[0]) ** 2 + (points[i, 1] - curr_center[1]) ** 2

    sse.append(curr_sse)
  return sse
```

```
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('K',fontsize = 20)
plt.ylabel('WSS',fontsize = 20)
plt.plot(calculate_WSS(movements,30))
```

```
[<matplotlib.lines.Line2D at 0x7f2bc566a898>]
```



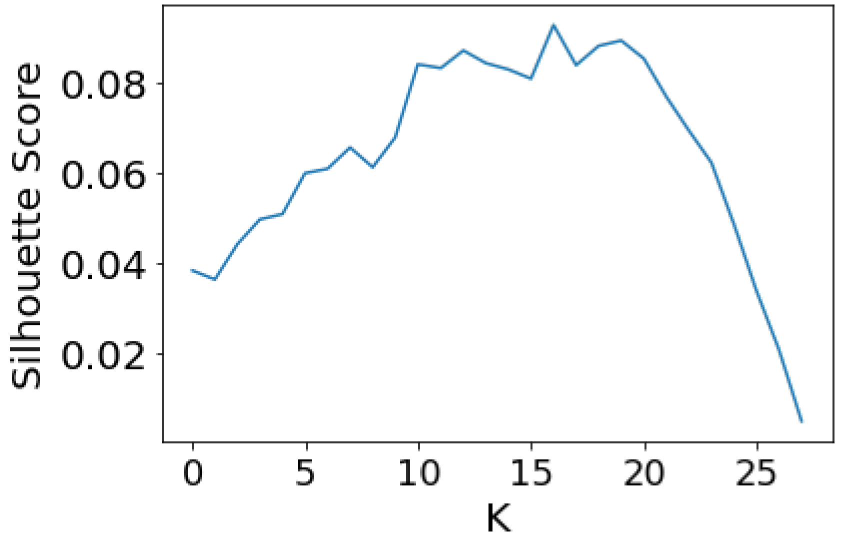
```
from sklearn.metrics import silhouette_score

sil = []
kmax =29

# dissimilarity would not be defined for a single cluster, thus, minimum number of clusters should be 2
for k in range(2, kmax+1):
  kmeans = KMeans(n_clusters = k).fit(movements)
  labels = kmeans.labels_
  sil.append(silhouette_score(movements, labels, metric = 'euclidean'))
```

```
sil
```

```
[0.038287575356544284,
 0.036299348431427854,
 0.04411310982926312,
 0.04959868640470362,
 0.05076498047882819,
 0.05981256184262388,
 0.060788058572870014,
 0.06549855812673164,
 0.061119824030860324,
 0.0677147442767221,
 0.08387821311300377,
 0.08305919834751739,
 0.08694817642989915,
 0.08415175642501015,
 0.0827578780982142,
 0.08072206835552793,
 0.09257861992986133,
 0.08369648525979805,
 0.08797171257897121,
 0.08915676780656065,
 0.08517359364463171,
 0.07673258530367286,
 0.06925252840394891,
 0.06216788580428493,
 0.04850661220544575,
 0.03378599414858584,
 0.02073361419438687,
 0.004962906432272605]
```

```
plt.xticks(fontsize = 18)
plt.yticks(fontsize = 20)
plt.xlabel('K',fontsize = 20)
plt.ylabel('Silhouette Score',fontsize = 20)
plt.plot(sil)
```

```
[<matplotlib.lines.Line2D at 0x7f2bc5733400>]
```



```
from sklearn.pipeline import make_pipeline
from sklearn.preprocessing import Normalizer
from sklearn.cluster import KMeans
# Define a normalizer
normalizer = Normalizer()
# Create Kmeans model
kmeans = KMeans(n_clusters = 19,max_iter = 1000)
# Make a pipeline chaining normalizer and kmeans
pipeline = make_pipeline(normalizer,kmeans)
# Fit pipeline to daily stock movements
pipeline.fit(movements)
labels = pipeline.predict(movements)
```

```
df1 = pd.DataFrame({'Cluster':labels+1,'companies':list(companies_data['Company Name'])}).sort_values(by=['Cluster'],axis = 0)
```

```
df1
```

	Cluster	companies
14	1	H.M. Sampoerna Tbk
13	1	Gudang Garam Tbk
8	2	Bank Mandiri (Persero) Tbk
6	2	Bank Rakyat Indonesia (Persero) Tbk
5	2	Bank Negara Indonesia (Persero) Tbk
23	2	Perusahaan Gas Negara (Persero) Tbk
2	3	Aneka Tambang Tbk
16	3	Vale Indonesia Tbk
24	4	Bukit Asam Tbk
1	4	Adaro Energy Tbk
28	4	United Tractors Tbk
27	5	Sarana Menara Nusantara Tbk
17	6	Indofood Sukses Makmur Tbk
15	6	Indofood CBP Sukses Makmur Tbk
11	7	Erajaya Swasembada Tbk
21	8	Kalbe Farma Tbk
10	9	Charoen Pokphand Indonesia Tbk
12	10	XL Axiata Tbk
26	10	Telekomunikasi Indonesia (Persero) Tbk

```
tmp = data.describe()
```

```
means = pd.DataFrame({'Cluster':labels+1,'companies':list(companies_data['Company Name']),
                      'adj close' : list(tmp['Adj Close'].mean()),
                      'close' :  list(tmp['Close'].mean()),
                      'Open' :  list(tmp['Open'].mean()),
                      'Volume' : list(tmp['Volume'].mean()),
                      'High' : list(tmp['High'].mean()),
                      'Low': list(tmp['Low'].mean())}).sort_values(by=['Cluster'],axis = 0)
```

7	15	Bank Tabungan Negara (Persero) Tbk

```
means.groupby('Cluster').mean()
```

	adj close	close	Open	Volume	High	Low
Cluster						
1	18532.308964	18556.516525	18574.250046	6.773208e+07	18915.771601	18221.114122
2	3016.804350	3065.333811	3071.974747	1.226295e+08	3125.330058	3018.078827
3	1560.802281	1561.325872	1564.248274	1.424549e+08	1591.028381	1531.282885
4	5622.013925	5771.931866	5789.467323	5.637914e+07	5888.137369	5637.749836
5	736.892142	740.703459	740.106309	3.827540e+08	753.460510	728.955440
6	6310.646541	6438.101212	6463.862083	2.377223e+07	6572.738532	6350.218766
7	1152.063382	1152.063382	1160.053854	2.227556e+07	1182.279103	1128.622271
8	1087.455697	1099.900115	1103.199283	7.593404e+07	1125.203723	1079.674898
9	4459.282989	4505.347783	4516.326192	9.079563e+06	4600.149694	4432.046287
10	2144.929842	2188.189606	2190.752740	1.043818e+08	2227.904207	2144.711701
11	5729.262710	5841.679187	5853.377327	1.864936e+07	5964.096872	5747.420574
12	852.112292	852.112292	855.981227	1.010572e+08	871.343938	836.594509
13	8716.303023	8882.286123	8928.870230	5.928168e+06	9099.467042	8679.578519
14	2705.525949	2737.295458	2744.066200	2.896323e+07	2815.061990	2680.572512
15	1033.873725	1038.019094	1040.009097	8.413678e+07	1059.634536	1019.282967
16	5488.674874	5509.000555	5525.070055	1.014708e+07	5654.208005	5375.690371
17	1158.363610	1165.398134	1164.805874	1.614854e+07	1194.235942	1138.551794
18	3924.756770	4013.679247	4006.861576	6.481208e+07	4115.421733	3955.051327
19	22160.858597	22366.822464	22476.455953	2.149392e+07	22953.803883	22080.748517