DataQualityCheck

April 21, 2022

[2]:
```
import numpy
import pandas as pd
import matplotlib.pyplot as plt
```

[12]:
```
holidays_events = pd.read_csv("https://www.dropbox.com/s/bxyamlpevkiwwoq/
 ↪holidays_events.csv?dl=1")
oil = pd.read_csv("https://www.dropbox.com/s/l6ln0ztl4m0pw3a/oil.csv?
 ↪dl=1",parse_dates=['date'],index_col='date')
sample_submission = pd.read_csv("https://www.dropbox.com/s/68jjl61x6u3klos/
 ↪sample_submission.csv?dl=1")
stores = pd.read_csv("https://www.dropbox.com/s/lcxn6r9bs2exguq/stores.csv?
 ↪dl=1")
test = pd.read_csv("https://www.dropbox.com/s/cvdo1gn7r5lu2uz/test.csv?
 ↪dl=1",index_col='id')
train = pd.read_csv("https://www.dropbox.com/s/s8p2b5awnuqfk0d/train.csv?
 ↪dl=1",index_col='id')
transactions = pd.read_csv("https://www.dropbox.com/s/92fij9bcwt0e0cj/
 ↪transactions.csv?dl=1")
```

```
C:\Users\ndzad\anaconda3\lib\site-packages\numpy\lib\arraysetops.py:583:
FutureWarning: elementwise comparison failed; returning scalar instead, but in
the future will perform elementwise comparison
  mask |= (ar1 == a)
```

Zbiór holidays_events zawiera informacje o świętach. date - data święta (od 2012-03-02 do 2017-12-26) type - typ święta: Addition, Bridge, Event, Transfer, Holiday, Work Day locale - Local, National, Regional locale_name - nazwa jednostki administracyjnej odpowiedniej dla zmiennej 'locale' description - opis święta transferred - zmienna binarna, gdy święto zostało przesunięte na inny dzień

[3]:
```
holidays_events.head(10)
```

[3]:

	date	type	locale	locale_name	description
0	2012-03-02	Holiday	Local	Manta	Fundacion de Manta
1	2012-04-01	Holiday	Regional	Cotopaxi	Provincializacion de Cotopaxi
2	2012-04-12	Holiday	Local	Cuenca	Fundacion de Cuenca
3	2012-04-14	Holiday	Local	Libertad	Cantonizacion de Libertad
4	2012-04-21	Holiday	Local	Riobamba	Cantonizacion de Riobamba

```
5  2012-05-12  Holiday     Local        Puyo         Cantonizacion del Puyo
6  2012-06-23  Holiday     Local    Guaranda      Cantonizacion de Guaranda
7  2012-06-25  Holiday  Regional    Imbabura  Provincializacion de Imbabura
8  2012-06-25  Holiday     Local   Latacunga     Cantonizacion de Latacunga
9  2012-06-25  Holiday     Local     Machala           Fundacion de Machala

   transferred
0        False
1        False
2        False
3        False
4        False
5        False
6        False
7        False
8        False
9        False
```

Zbiór oil zawiera informacje o cenach ropy. date - data raportu (od 2013-01-01 do 2017-08-31) dcoilwtico - cena ropy w dolarach

[15]:
```
oil.head()
```

[15]:
```
         date  dcoilwtico
0  2013-01-01         NaN
1  2013-01-02       93.14
2  2013-01-03       92.97
3  2013-01-04       93.12
4  2013-01-07       93.20
```

Zbiór sample_submission to zbiór techniczny

Zbiór stores zawiera informacje o sklepach: store_nbr - id sklepu city - miasto lokalizacji state - stan type - rodzaj sklepu: A, B, C, D, E cluster - grupa podobnych sklepów

[19]:
```
stores.head()
```

[19]:
```
   store_nbr           city                          state type  cluster
0          1          Quito                      Pichincha    D       13
1          2          Quito                      Pichincha    D       13
2          3          Quito                      Pichincha    D        8
3          4          Quito                      Pichincha    D        9
4          5  Santo Domingo  Santo Domingo de los Tsachilas    D        4
```

Zbiór test zawiera informacje o zakupionych produktach: 1. id - id produktu 2. date - data sprzedaży (pierwsza data 15 dni od ostatniej daty ze zbioru train) 3. store_nbr - id sklepu 4. family - rodzaj zakupionej rzeczy 5. onpromotion - liczba produktów w danej 'family' na promocji w dnaym sklepie w danym sklepie

[35]:
```
test.head(10)
```

[35]:

id	date	store_nbr	family	onpromotion
3000888	2017-08-16	1	AUTOMOTIVE	0
3000889	2017-08-16	1	BABY CARE	0
3000890	2017-08-16	1	BEAUTY	2
3000891	2017-08-16	1	BEVERAGES	20
3000892	2017-08-16	1	BOOKS	0
3000893	2017-08-16	1	BREAD/BAKERY	12
3000894	2017-08-16	1	CELEBRATION	0
3000895	2017-08-16	1	CLEANING	25
3000896	2017-08-16	1	DAIRY	45
3000897	2017-08-16	1	DELI	18

Zbiór train zawiera informacje o zakupionych produktach: 1. id - id produktu 2. date - data sprzedaży 3. store_nbr - id sklepu 4. family - rodzaj zakupionej rzeczy 5. sales - liczba zakupionych produktów z danej 'family' w danym dniu i sklepie 6. onpromotion - liczba produktów w danej 'family' na promocji w danym dniu i sklepie

[34]:
```
train.tail(10)
```

[34]:

id	date	store_nbr	family	sales	onpromotion
3000878	2017-08-15	9	MAGAZINES	11.000	0
3000879	2017-08-15	9	MEATS	449.228	0
3000880	2017-08-15	9	PERSONAL CARE	522.000	11
3000881	2017-08-15	9	PET SUPPLIES	6.000	0
3000882	2017-08-15	9	PLAYERS AND ELECTRONICS	6.000	0
3000883	2017-08-15	9	POULTRY	438.133	0
3000884	2017-08-15	9	PREPARED FOODS	154.553	1
3000885	2017-08-15	9	PRODUCE	2419.729	148
3000886	2017-08-15	9	SCHOOL AND OFFICE SUPPLIES	121.000	8
3000887	2017-08-15	9	SEAFOOD	16.000	0

Zbiór transactions zawiera informacje o liczbie transakcji w danym sklepie i dniu: data - data store_nbr - id sklepu transactions - liczba transakcji

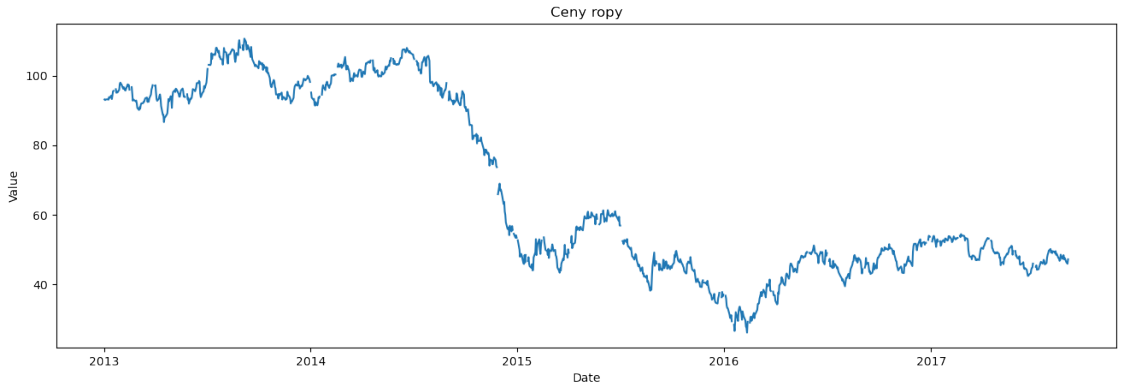
[36]:
```
transactions.head(10)
```

[36]:

	date	store_nbr	transactions
0	2013-01-01	25	770
1	2013-01-02	1	2111
2	2013-01-02	2	2358
3	2013-01-02	3	3487
4	2013-01-02	4	1922
5	2013-01-02	5	1903
6	2013-01-02	6	2143
7	2013-01-02	7	1874
8	2013-01-02	8	3250
9	2013-01-02	9	2940

[10]:
```
#Funkcja pomocniczna do rysowania wykresów
def plot_df(df, x, y, title="", xlabel='Date', ylabel='Value', dpi=100,␣
↪axiscolor ='black'):
    plt.figure(figsize=(16,5), dpi=dpi)
    plt.plot(x, y, color='tab:blue')
    plt.gca().set(title=title, xlabel=xlabel, ylabel=ylabel)
    plt.gca().title.set_color(axiscolor)
    plt.gca().xaxis.label.set_color(axiscolor)
    plt.gca().yaxis.label.set_color(axiscolor)
    plt.tick_params(colors=axiscolor, which='both')
    plt.show()
```

[13]:
```
plot_df(oil,x=oil.index, y=oil.dcoilwtico, title='Ceny ropy', axiscolor='black')
```



[14]:
```
oil.isna().sum()
```

[14]:
```
dcoilwtico    43
dtype: int64
```

Zauważmy, że w danych o ropie są braki w cenach . Jednym z zadań musi być interpolacja danych w celu uzupełnienia braków danych.

[96]:
```
train.isna().sum()
```

[96]:
```
date           0
store_nbr      0
family         0
sales          0
onpromotion    0
dtype: int64
```

[97]:
```
test.isna().sum()
```

[97]:
```
date           0
store_nbr      0
family         0
onpromotion    0
dtype: int64
```

[98]:
```
holidays_events.isna().sum()
```

[98]:
```
date           0
type           0
locale         0
locale_name    0
description    0
transferred    0
dtype: int64
```

[99]:
```
stores.isna().sum()
```

[99]:
```
store_nbr    0
city         0
state        0
type         0
cluster      0
dtype: int64
```

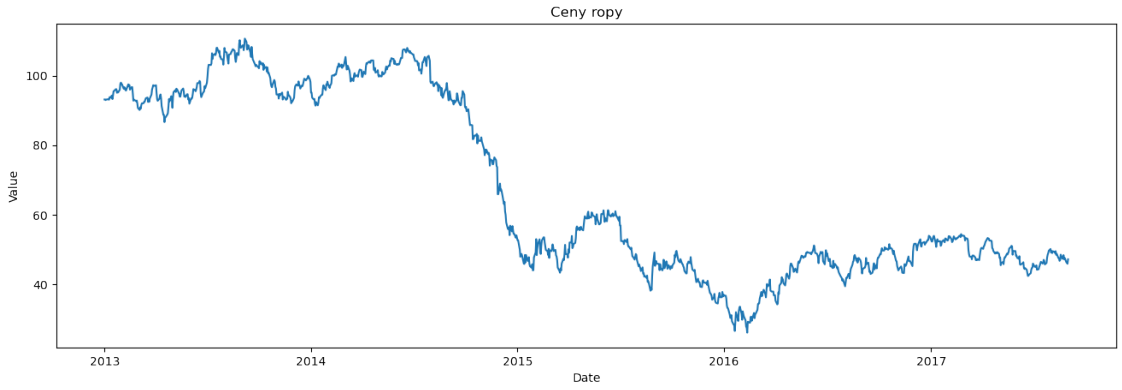
[100]:
```
transactions.isna().sum()
```

[100]:
```
date            0
store_nbr       0
transactions    0
```

```
dtype: int64
```

[15]:
```
oil.fillna(method='bfill',inplace=True)
```

[16]:
```
plot_df(oil,x=oil.index, y=oil.dcoilwtico, title='Ceny ropy', axiscolor='black')
```



OilAnalysis

April 21, 2022

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import statsmodels.api as sm
import statsmodels.formula.api as smf
```

[2]:
```
holidays_events = pd.read_csv("https://www.dropbox.com/s/bxyamlpevkiwwoq/
 ↪holidays_events.csv?dl=1")
oil = pd.read_csv("https://www.dropbox.com/s/l6ln0ztl4m0pw3a/oil.csv?
 ↪dl=1",parse_dates=['date'],index_col='date')
sample_submission = pd.read_csv("https://www.dropbox.com/s/68jjl61x6u3klos/
 ↪sample_submission.csv?dl=1")
stores = pd.read_csv("https://www.dropbox.com/s/lcxn6r9bs2exguq/stores.csv?
 ↪dl=1")
test = pd.read_csv("https://www.dropbox.com/s/cvdo1gn7r5lu2uz/test.csv?
 ↪dl=1",index_col='id')
train = pd.read_csv("https://www.dropbox.com/s/s8p2b5awnuqfk0d/train.csv?
 ↪dl=1",index_col='id')
transactions = pd.read_csv("https://www.dropbox.com/s/92fij9bcwt0e0cj/
 ↪transactions.csv?dl=1")
```

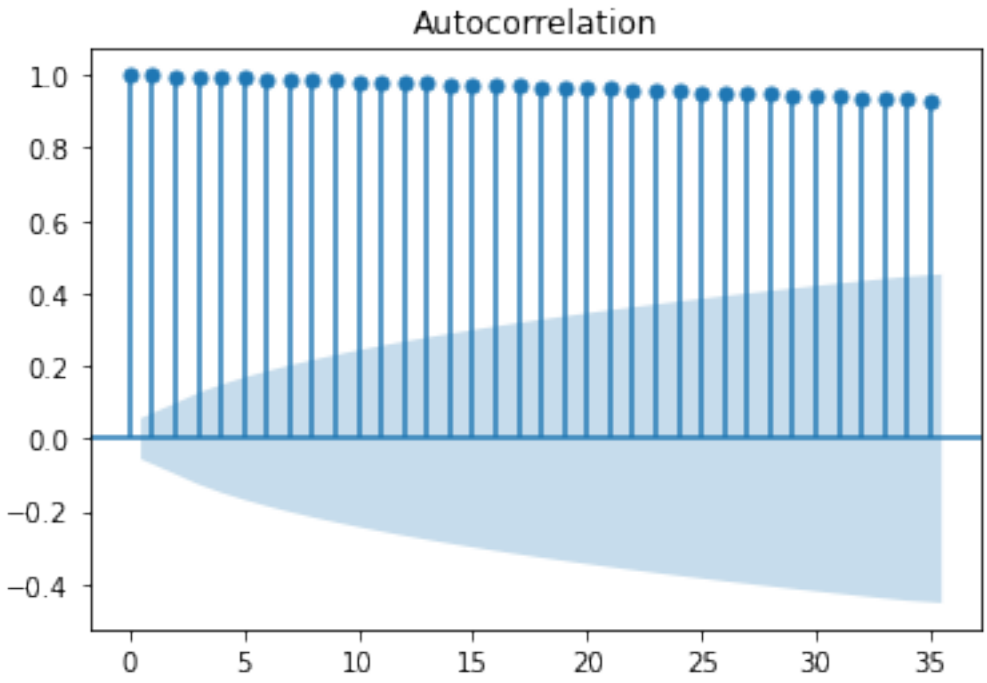
```
C:\Users\ndzad\anaconda3\lib\site-packages\numpy\lib\arraysetops.py:583:
FutureWarning: elementwise comparison failed; returning scalar instead, but in
the future will perform elementwise comparison
  mask |= (ar1 == a)
```

Wypełnienie braków

[3]:
```
oil.fillna(method='bfill',inplace=True)
```

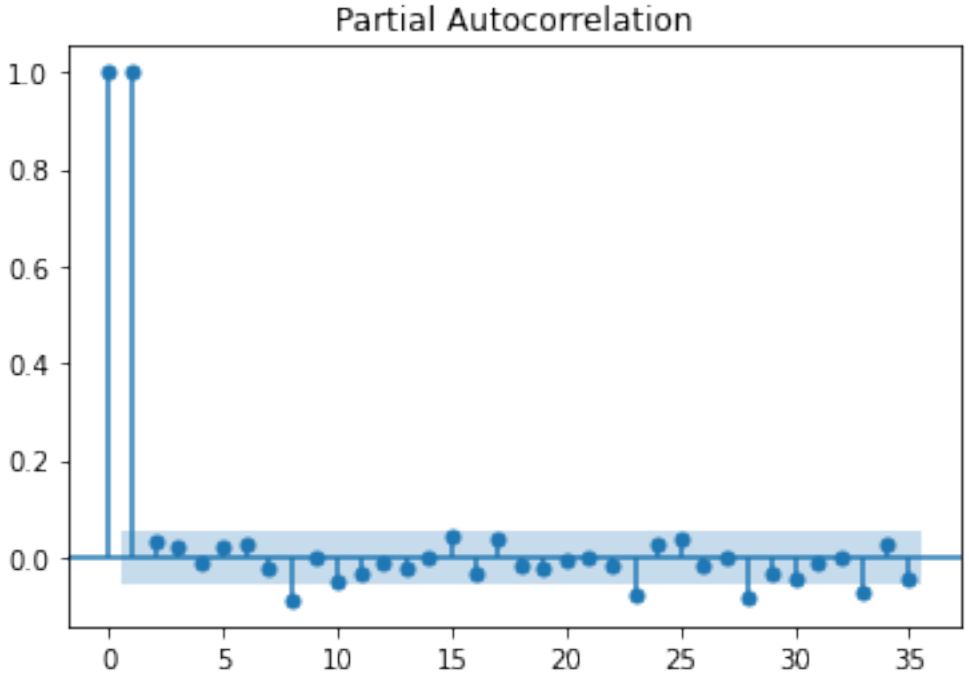
Wykres autokorelacji (ACF)

[4]:
```
sm.graphics.tsa.plot_acf(oil,lags=np.round(np.sqrt(len(oil))))
plt.show()
```



Wykres cześciowych korelacji (PACF)

[5]:
```
sm.graphics.tsa.plot_pacf(oil,lags=np.round(np.sqrt(len(oil))))
plt.show()
```



Różnicujemy szereg czasowy

[6]:
```
oil_diff = oil.shift().diff().dropna()
```

Test Boxa-Ljunga

[7]:
```
sm.stats.acorr_ljungbox(oil_diff, lags=[np.round(np.sqrt(len(oil_diff)))],␣
↪return_df=True)
```

[7]:

	lb_stat	lb_pvalue
35	33.245083	0.552998

p-value = 0.552998, zatem przyjmujemy H_0, że szereg jest białym szumem

Z powyższych rozważań wynika, że różnice między kolejnymi wartościami są losowe, więc nie możemy w sensowny sposób robić predykcji.

[ ]:
```

```

Kod R

21.04.2022

```
train<-read.csv("C:\\Studia\\MAGISTERKA\\2. semestr\\Warsztaty\\dane\\train.csv")
head(train)

train<-train[,-1]
str(train)
train$date<-as.Date(train$date)
train2<-train[train$date<as.Date('2016-06-01'),]
test2<-train[train$date>=as.Date('2016-06-01'),]

train2_mean<-aggregate(train2$sales, list(train2$date), FUN=mean)
head(train2_mean)

plot(train2_mean$x~train2_mean$Group.1,type="l")


ts<-ts(train2_mean$x)
head(ts)
ts.plot(ts)

acf(ts) #widac sezonosc i trend
ts_diff<-diff(ts)

ts.plot(ts_diff)
acf(ts_diff) #pozbylismy si  trendu, ale zostala sezonowosc
pacf(ts_diff)

#wyznaczmy okres
spec<-spectrum(ts_diff)
#widac ze nie jest to bialy szum
#wyznaczmy okres
cpgram(ts_diff)

(spec$freq[order(-spec$spec)[1:2]])
# 0.2864583 0.1435185

#czyli okresy
1/(spec$freq[order(-spec$spec)[1:2]])
#4(takie 3.5) i 7

1/spec$freq[which.max(spec$spec)] #oko o 7 przy freq=1
#0.0190897 przy freq=365
#czyli okres to oko o tydzie

okres<-ceiling(1/spec$freq[which.max(spec$spec)])
okres

#roznicujemy o okres
ts_diff2<-diff(ts_diff,lag=7)
```

```
acf(ts_diff2)
pacf(ts_diff2,lag.max=100)

#jedno roznicowanie z lagiem -> D=1
#jedno zwykle roznicowanie => d=1
#z acf(ts_diff2) bysmy moze wzieli q=6 alob q=2, Q=1
#z pacf => p=6, P=5
ar(ts_diff2)
30/7

sarima<-arima(ts,order=c(7,1,2),seasonal=list(order=c(8,1,6),period=7))
?arima
#AIC(arima(ts,order=c(6,1,6),seasonal=list(order=c(6,1,1),period=7)))
Box.test(sarima$residuals,lag=round(sqrt(length(sarima$residuals))),
type="Ljung-Box",fitdf=22)
#p-value = 8.818e-05 => nie jest to bialy szum

acf(sarima$residuals)
pacf(sarima$residuals,lag.max=100)
```

Modelling

April 21, 2022

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import statsmodels
import statsmodels.api as sm
import statsmodels.formula.api as smf
import datetime as dt
import scipy.signal as ss
```

[2]:
```
from statsmodels.tsa.seasonal import seasonal_decompose
```

[3]:
```
holidays_events = pd.read_csv("https://www.dropbox.com/s/bxyamlpevkiwwoq/
 ↪holidays_events.csv?dl=1")
oil = pd.read_csv("https://www.dropbox.com/s/l6ln0ztl4m0pw3a/oil.csv?
 ↪dl=1",parse_dates=['date'],index_col='date')
sample_submission = pd.read_csv("https://www.dropbox.com/s/68jjl61x6u3klos/
 ↪sample_submission.csv?dl=1")
stores = pd.read_csv("https://www.dropbox.com/s/lcxn6r9bs2exguq/stores.csv?
 ↪dl=1")
test = pd.read_csv("https://www.dropbox.com/s/cvdo1gn7r5lu2uz/test.csv?
 ↪dl=1",index_col='id')
train = pd.read_csv("https://www.dropbox.com/s/s8p2b5awnuqfk0d/train.csv?
 ↪dl=1",index_col='id')
transactions = pd.read_csv("https://www.dropbox.com/s/92fij9bcwt0e0cj/
 ↪transactions.csv?dl=1")
```

[4]:
```
train['date'] = pd.to_datetime(train['date'])
```

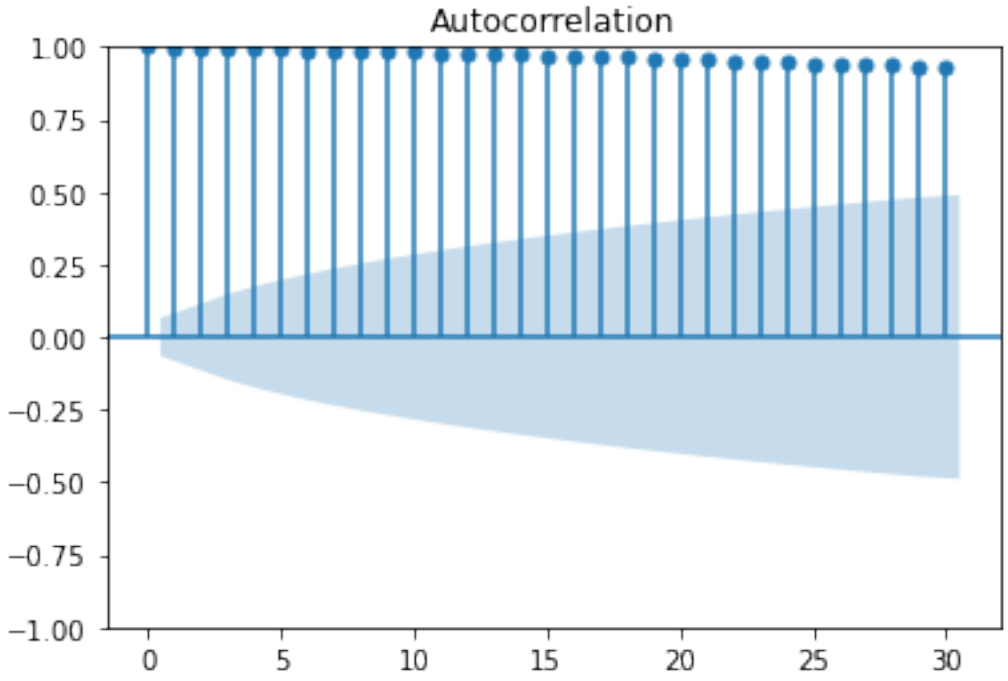
Dzielimy próbkę na treningową i testową.

[5]:
```
train2 = train.loc[(train['date']<'2016-06-01')]
```

[6]:
```
test2 = train.loc[(train['date']>='2016-06-01')]
```

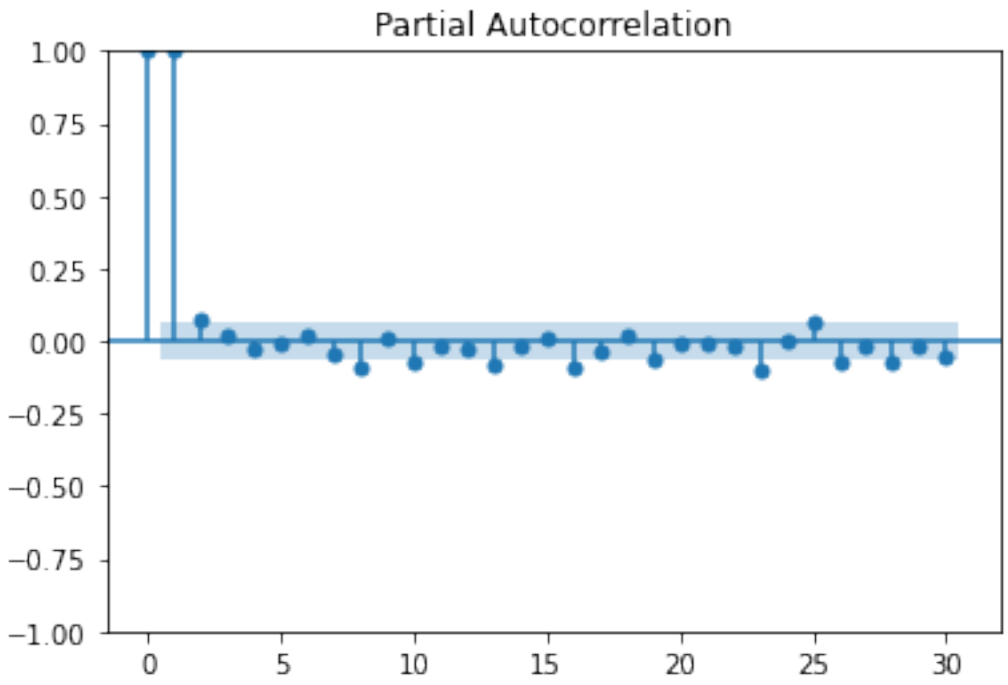
[7]:
```
oil_train2 = oil.loc[(oil.index<'2016-06-01')].fillna(method ="bfill")
oil_test2 = oil.loc[(oil.index>='2016-06-01')].fillna(method ="bfill")
```

[8]:
```
sm.graphics.tsa.plot_acf(oil_train2,lags=np.round(np.sqrt(len(oil_train2))))
plt.show()
```



[9]:
```
sm.graphics.tsa.plot_pacf(oil_train2,lags=np.round(np.sqrt(len(oil_train2))))
plt.show()
```

```
C:\Users\Lenovo\AppData\Local\Programs\Python\Python39\lib\site-
packages\statsmodels\graphics\tsaplots.py:348: FutureWarning: The default method
'yw' can produce PACF values outside of the [-1,1] interval. After 0.13, the
default will change tounadjusted Yule-Walker ('ywm'). You can use this method
now by setting method='ywm'.
  warnings.warn(
```



[10]:
```
oil_diff = oil_train2.shift().diff().dropna()
```

[11]:
```
sm.stats.acorr_ljungbox(oil_diff, lags=[np.round(np.sqrt(len(oil_diff)))],␣
↪return_df=True)
```

[11]:

	lb_stat	lb_pvalue
30	33.33492	0.308193

Zatem jest to biały szum.

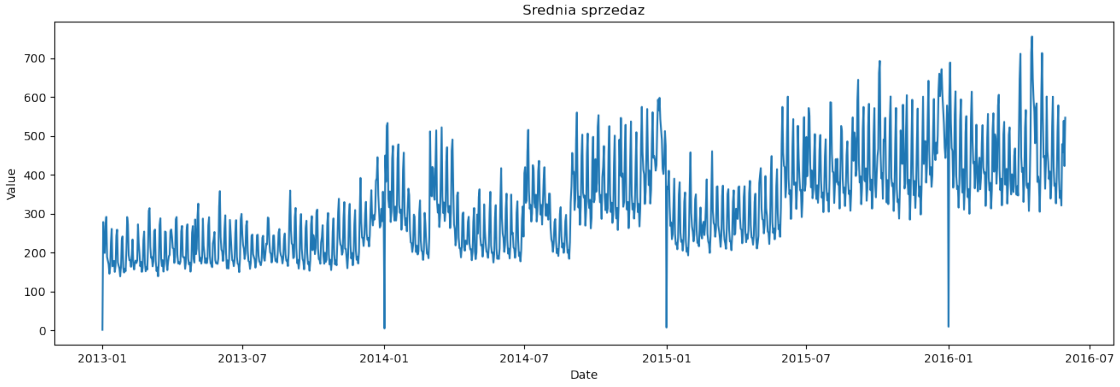
[13]:
```
mod_oil = sm.tsa.arima.ARIMA(oil_train2,order=(0,1,0)).fit()
```

```
C:\Users\ndzad\anaconda3\lib\site-
packages\statsmodels\tsa\base\tsa_model.py:524: ValueWarning: No frequency
information was provided, so inferred frequency B will be used.
  warnings.warn('No frequency information was'
C:\Users\ndzad\anaconda3\lib\site-
packages\statsmodels\tsa\base\tsa_model.py:524: ValueWarning: No frequency
information was provided, so inferred frequency B will be used.
  warnings.warn('No frequency information was'
C:\Users\ndzad\anaconda3\lib\site-
packages\statsmodels\tsa\base\tsa_model.py:524: ValueWarning: No frequency
information was provided, so inferred frequency B will be used.
  warnings.warn('No frequency information was'
```

[14]:
```
train2_avg= train2.groupby('date')['sales'].mean().to_frame()
```

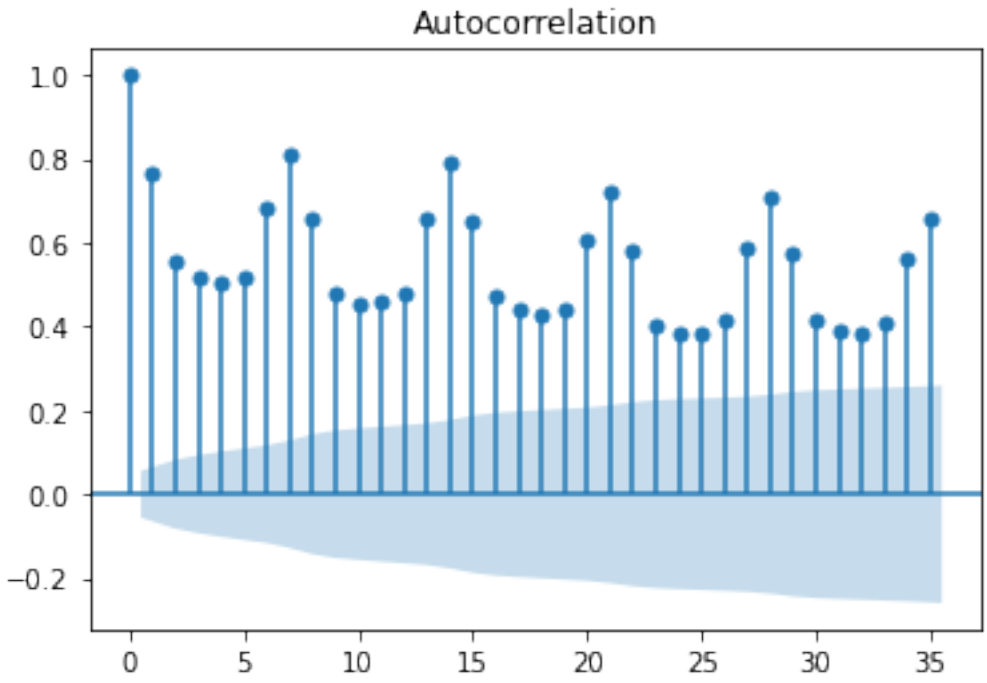
[15]:
```
#Funkcja pomocniczna do rysowania wykresów
def plot_df(df, x, y, title="", xlabel='Date', ylabel='Value', dpi=100,␣
↪axiscolor ='black'):
    plt.figure(figsize=(16,5), dpi=dpi)
    plt.plot(x, y, color='tab:blue')
    plt.gca().set(title=title, xlabel=xlabel, ylabel=ylabel)
    plt.gca().title.set_color(axiscolor)
    plt.gca().xaxis.label.set_color(axiscolor)
    plt.gca().yaxis.label.set_color(axiscolor)
    plt.tick_params(colors=axiscolor, which='both')
    plt.show()
```

[16]:
```
plot_df(train2_avg,x=train2_avg.index, y=train2_avg.sales, title='Srednia␣
↪sprzedaz', axiscolor='black')
```



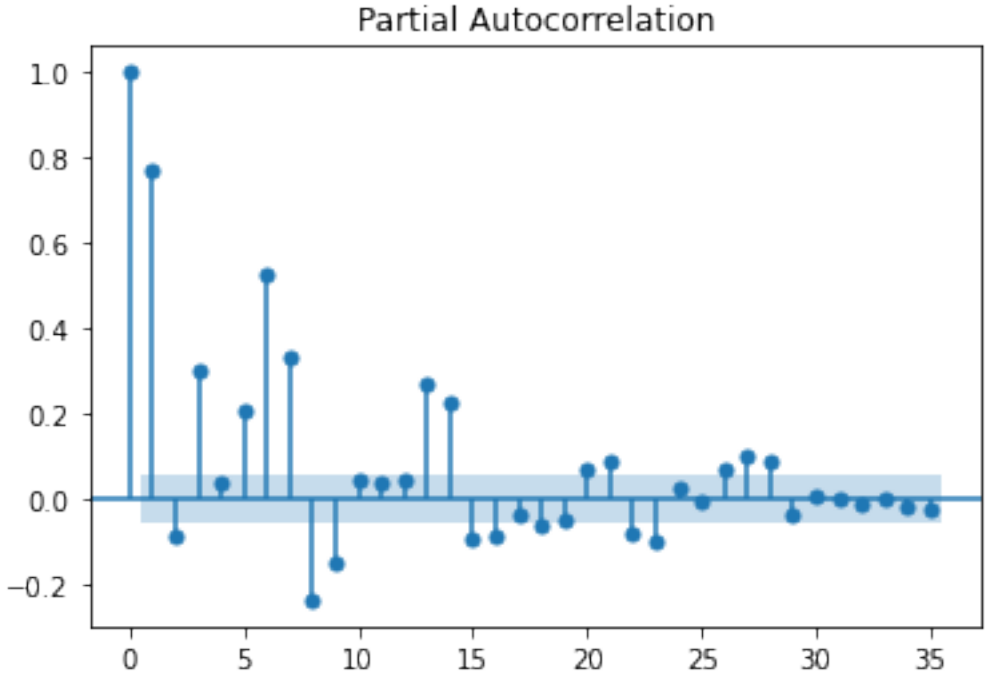
Wykres autokorelacji (ACF)

[17]:
```
sm.graphics.tsa.plot_acf(train2_avg,lags=np.round(np.sqrt(len(train2_avg))))
plt.show()
```



Wykres cześciowych korelacji (PACF)

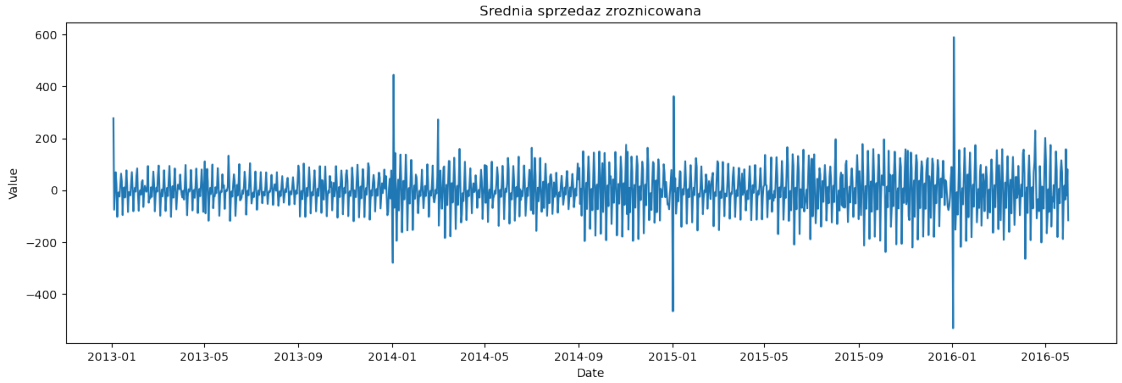
[18]:
```
sm.graphics.tsa.plot_pacf(train2_avg,lags=np.round(np.sqrt(len(train2_avg))))
plt.show()
```



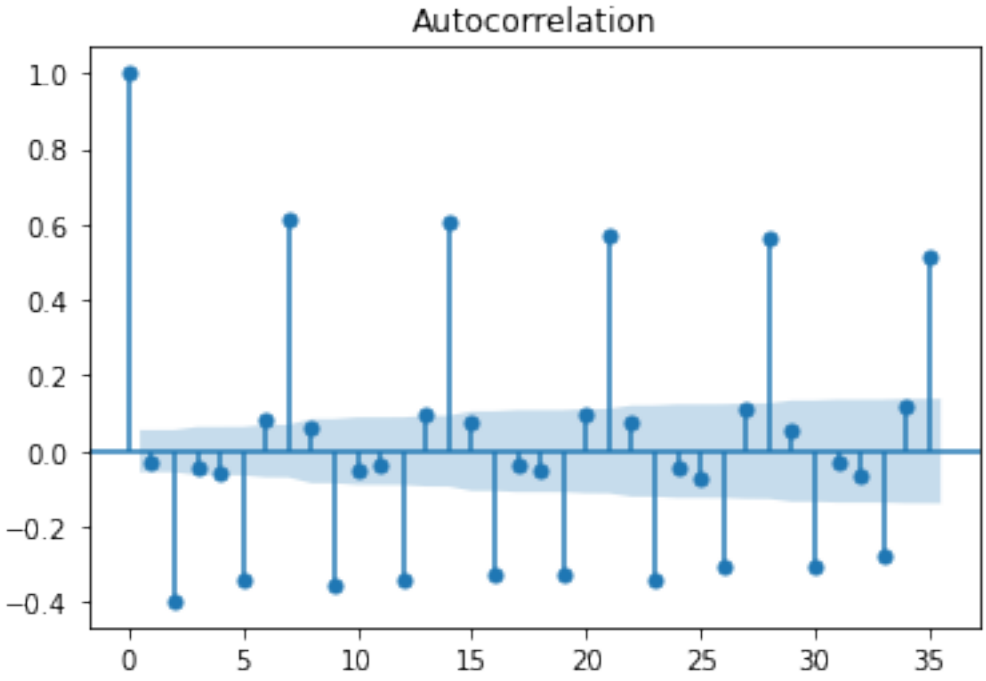
Różnicujemy szereg

[19]:
```
train2_avg_diff = train2_avg.shift().diff().dropna()
```

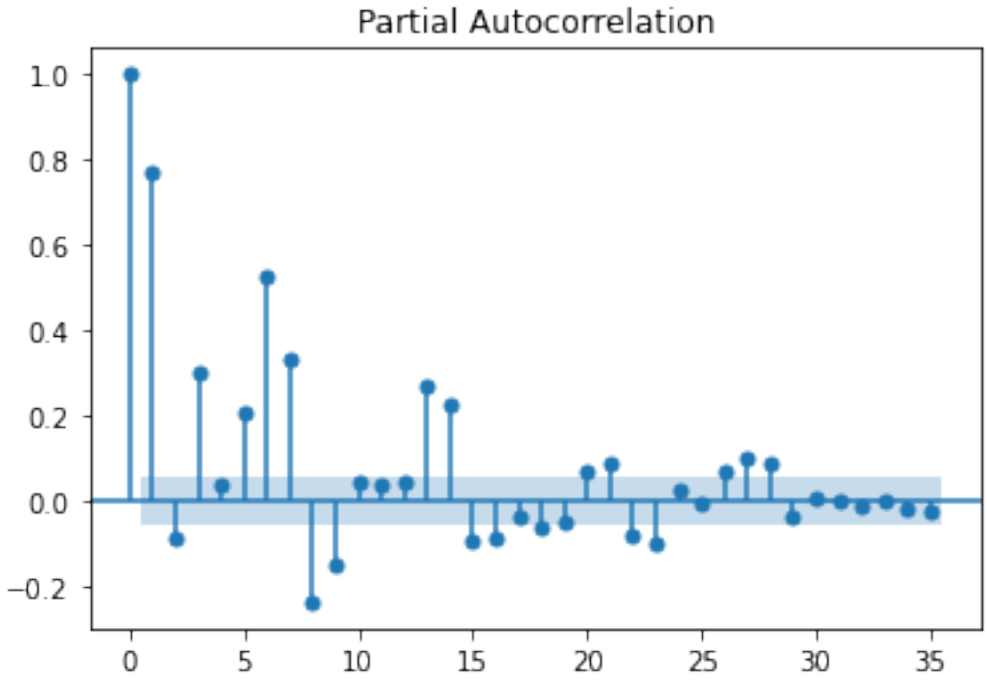
[32]:
```
plot_df(train2_avg_diff,x=train2_avg_diff.index, y=train2_avg_diff.sales,␣
↪title='Srednia sprzedaz zroznicowana', axiscolor='black')
```



[20]:
```
sm.graphics.tsa.plot_acf(train2_avg_diff,lags=np.round(np.
↪sqrt(len(train2_avg_diff))))
plt.show()
```



[21]:
```
sm.graphics.tsa.plot_pacf(train2_avg,lags=np.round(np.sqrt(len(train2_avg))))
plt.show()
```



[88]:
```
f, Pxx=ss.periodogram(train2_avg_diff,365)
```

[90]:
```
Pxx
```

[90]:
```
array([[0.],
       [0.],
       [0.],
       …,
       [0.],
       [0.],
       [0.]])
```

[59]:
```
analysis = train2_avg_diff[['sales']].copy()
```

[38]:
```
analysis.head(365)
```

[38]:

date	sales
2013-01-01	1.409438

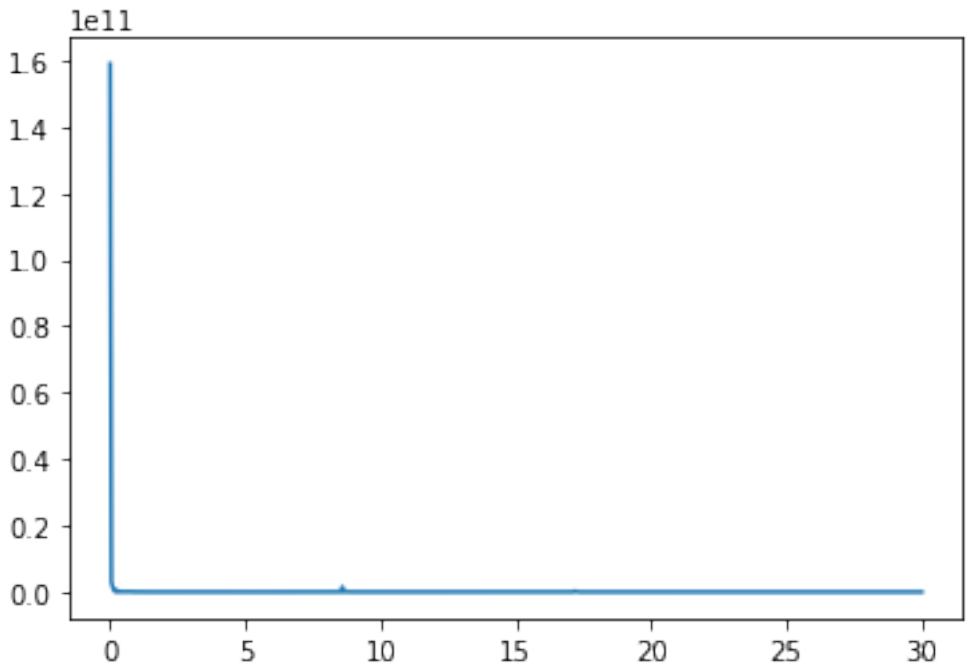
```
2013-01-02  278.390807
2013-01-03  202.840197
2013-01-04  198.911154
2013-01-05  267.873244
…                  …
2013-12-28  312.543382
2013-12-29  280.426209
2013-12-30  356.416799
2013-12-31  284.660305
2014-01-01    4.827197

[365 rows x 1 columns]
```

[60]:
```
decompose_result_add = seasonal_decompose(analysis,model="additive",freq=365)
```

```
C:\Users\ndzad\AppData\Local\Temp/ipykernel_14372/3939235887.py:1:
FutureWarning: the 'freq'' keyword is deprecated, use 'period' instead
  decompose_result_add = seasonal_decompose(analysis,model="additive",freq=365)
```

[98]:
```
fourier_transform = np.fft.rfft(train2_avg['sales'])

abs_fourier_transform = np.abs(fourier_transform)

power_spectrum = np.square(abs_fourier_transform)

frequency = np.linspace(0, 30, len(power_spectrum))

plt.plot(frequency, power_spectrum)
```

[98]:
```
[<matplotlib.lines.Line2D at 0x16a66f68070>]
```



[97]:
```
power_spectrum
```

[97]:
```
array([1.59001702e+11, 3.02906674e+09, 1.49353573e+09, 5.18029454e+08,
       1.00869311e+08, 5.89838015e+08, 2.21398735e+07, 8.11218716e+07,
       1.13933789e+08, 8.74962096e+07, 9.66002254e+07, 3.37104385e+07,
       5.83902176e+07, 1.08142605e+08, 1.22123753e+08, 7.54546592e+07,
       1.30685279e+07, 6.27719461e+07, 2.17099013e+07, 1.05621241e+08,
       3.46946163e+06, 4.15632494e+07, 3.87117969e+07, 2.70529026e+07,
       2.15227676e+07, 3.08356684e+06, 1.79380148e+07, 9.30038951e+06,
       6.56590360e+06, 2.95658957e+06, 1.68079513e+06, 3.61347386e+07,
       5.64471074e+06, 7.34638383e+06, 2.42738931e+07, 2.99809416e+04,
       3.74773287e+06, 6.93868227e+06, 3.27015925e+07, 7.65861101e+06,
       1.49680456e+06, 7.76926064e+07, 7.72051266e+06, 5.29216095e+06,
       6.80140231e+06, 5.51919223e+05, 6.78136834e+06, 2.68732768e+05,
       7.11964080e+06, 6.42707396e+06, 6.56755773e+04, 1.31116314e+07,
       2.90434330e+06, 1.36922912e+06, 2.60621140e+05, 1.27779557e+07,
       1.88454342e+06, 3.15555548e+06, 7.61812380e+06, 7.13714438e+06,
       3.97206781e+06, 1.78535909e+07, 3.72979405e+06, 1.88046436e+07,
       3.86725222e+06, 7.69212365e+06, 4.17715565e+06, 3.17131224e+06,
       1.66839938e+06, 1.11652681e+07, 7.09918826e+06, 1.58362391e+06,
       6.80855002e+06, 6.88635439e+06, 2.85031142e+06, 1.26719471e+07,
       3.70858617e+06, 1.28709430e+06, 1.37126504e+07, 1.72970198e+07,
       3.71960246e+06, 3.60701674e+06, 1.47920555e+08, 4.41618952e+06,
       4.79256076e+06, 1.09035539e+07, 4.07634546e+06, 5.03140203e+06,
       2.16764746e+06, 7.38655451e+05, 1.77745025e+06, 4.72308340e+06,
```

1.01586120e+05, 7.06212693e+06, 5.01728891e+06, 7.47160999e+06,
1.58448847e+07, 8.67071186e+06, 1.46704517e+06, 7.54438141e+06,
2.72506323e+05, 4.58186342e+06, 3.48305561e+06, 5.55014493e+06,
5.44362771e+06, 4.45017338e+05, 1.11039521e+07, 1.22962303e+05,
3.55248500e+04, 2.92946071e+06, 1.65136045e+06, 7.81459759e+05,
6.97745515e+04, 5.53351226e+05, 4.26287139e+05, 1.83042754e+06,
3.84715423e+05, 7.53164232e+05, 4.81686888e+05, 4.39204352e+06,
2.39622852e+06, 1.34681999e+06, 1.05659908e+05, 1.89546952e+07,
3.73127120e+06, 4.29043925e+06, 5.80300912e+06, 7.39542821e+06,
2.96936582e+06, 5.31218697e+06, 2.15392051e+06, 2.07773096e+06,
2.13722232e+06, 1.14506462e+05, 5.56905848e+06, 1.51942829e+06,
4.53810387e+05, 2.62619655e+05, 1.08198296e+06, 4.47888478e+05,
7.05792564e+05, 6.98171015e+05, 6.38248778e+05, 2.63948674e+06,
5.23966182e+05, 2.82315714e+06, 3.36330001e+06, 4.51501824e+05,
2.89295292e+06, 3.12977014e+06, 5.74582936e+06, 1.28619489e+07,
3.11201301e+05, 1.92085516e+06, 1.35974596e+06, 4.23670819e+06,
1.43110252e+06, 1.47560478e+06, 1.85266336e+07, 2.94148589e+04,
1.68263357e+06, 5.92988330e+06, 2.09000950e+06, 6.41881607e+05,
1.72757512e+07, 3.08886720e+06, 1.52409654e+06, 3.81051568e+06,
1.33175317e+07, 1.62294835e+06, 2.11420307e+06, 2.01632745e+07,
2.53057509e+07, 8.81008138e+06, 2.77324378e+07, 5.04957300e+07,
1.25630492e+07, 3.06026777e+07, 1.51154356e+09, 1.01484848e+08,
2.51731140e+07, 3.39157976e+07, 2.07259936e+07, 3.09218335e+06,
2.57899475e+06, 1.79212995e+06, 3.30974799e+05, 7.02463241e+05,
6.61592104e+06, 4.76851271e+06, 4.99809688e+06, 6.20326859e+06,
7.10656478e+06, 6.28608410e+05, 1.34279202e+06, 5.32561346e+05,
3.84360549e+05, 1.17671971e+06, 2.56872513e+06, 1.11606162e+07,
1.53714642e+06, 1.12939647e+07, 1.25309487e+07, 1.63376316e+06,
1.32259738e+05, 9.07831063e+05, 2.37863177e+06, 2.86108446e+06,
1.70884144e+06, 5.51513416e+05, 1.23885900e+06, 6.09458012e+04,
3.21524506e+06, 9.24063274e+04, 2.01716619e+06, 2.50171516e+06,
8.25720944e+05, 4.66878758e+04, 5.15549174e+05, 2.37064368e+06,
1.09603573e+06, 4.39618475e+04, 1.06898266e+07, 1.02003543e+06,
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4.13242813e+06, 1.26641376e+07, 2.56794274e+06, 1.14968888e+06,
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3.61397888e+05, 1.45731748e+02, 4.84147789e+05, 2.45030843e+06,
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6.61622614e+05, 3.20000282e+05, 1.29949849e+05, 7.77370181e+04,
1.93654950e+05, 7.54236831e+06, 8.34184629e+05, 7.97399585e+04,
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1.58330128e+07, 1.30000386e+06, 4.23380506e+06, 8.74499297e+06,
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5.80121232e+04, 4.50405482e+06, 7.60205108e+06, 2.23685556e+06,
2.95451420e+06, 1.18640258e+07, 2.32946235e+07, 5.22864027e+06,
1.16438644e+07, 7.54309616e+07, 1.37218072e+07, 2.22082280e+07,
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2.07669182e+05, 1.75320260e+06, 2.60261990e+06, 1.73725434e+06,
8.23603662e+06, 3.20629918e+06, 1.72477221e+06, 4.40710477e+06,
1.50256777e+05, 1.09551827e+06, 1.18432301e+06, 2.11267028e+06,
2.46791250e+04, 9.08826527e+05, 2.93714583e+06, 6.15834257e+05,
2.78652948e+05, 1.53218419e+06, 2.57850916e+06, 1.48002318e+06,
4.57074103e+05, 3.58287897e+06, 2.12878997e+05, 3.28289910e+05,
2.05466926e+06, 1.18044150e+06, 3.42442320e+06, 1.15777794e+06,
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3.53474533e+05, 1.45624646e+06, 1.17888805e+06, 5.38815223e+05,
8.62151311e+04, 4.85939141e+06, 9.70667312e+05, 6.45828396e+04,
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1.53371652e+06, 8.50451344e+05, 1.08336671e+05, 2.18694842e+06,
2.83620562e+06, 4.48609131e+05, 8.77427137e+05, 2.73111832e+06,
9.83290336e+05, 3.15141862e+05, 2.19906094e+06, 6.05394966e+05,
2.92750859e+05, 6.18170483e+06, 1.21395055e+05, 8.77233474e+05,
1.23802809e+05, 5.28085287e+06, 5.02504448e+05, 1.50443663e+05,
3.76566382e+06, 8.19433514e+05, 5.09639568e+04, 1.10431514e+06,
3.26773792e+06, 6.92304567e+05, 1.54258516e+06, 1.66370312e+06,
2.25505098e+06, 1.85970889e+05, 5.64403687e+05, 1.93043369e+04,
3.78806940e+06, 6.49824964e+05, 6.82135812e+06, 2.72147166e+05,
6.26237588e+04, 6.25750975e+05, 1.59227097e+06, 2.17604212e+06,
3.65808843e+05, 4.66496002e+06, 1.51347477e+06, 4.43625860e+05,

```
2.75809746e+06, 2.71125554e+06, 1.47578643e+06, 1.87718142e+06,
1.81977287e+06, 2.40843442e+06, 2.33603406e+05, 3.87546593e+06,
1.61120008e+06, 1.35558334e+06, 1.31496239e+06, 4.68638862e+05,
7.97565540e+04, 3.81208257e+05, 1.79616922e+06, 7.85362117e+04,
3.60047768e+05, 9.16002195e+05, 6.29838029e+05, 4.31064476e+05,
2.45586465e+06, 2.33188300e+06, 1.55477914e+05, 1.07255421e+05,
2.09026696e+06, 1.25907110e+05, 8.93212329e+04, 4.16804802e+05,
5.42400938e+05, 1.70315899e+06, 2.51382673e+04, 3.41780187e+06,
7.67005699e+05, 8.82985302e+05, 1.54107889e+06, 7.28702894e+05,
3.18280218e+06, 5.38391399e+05, 3.39047300e+06, 7.29722392e+05,
1.39247847e+06, 2.24200842e+06, 7.78327734e+05, 1.44580444e+04,
1.16917343e+06, 2.81960520e+06, 2.34791999e+06, 3.44259596e+05,
2.38748612e+06, 1.21180400e+06, 9.77704780e+05, 1.33473253e+06,
9.32421986e+05, 1.78174327e+05, 1.40159966e+05, 1.55101304e+06,
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1.34654033e+06, 4.66564743e+06, 4.73284259e+06, 1.82197375e+05,
2.55347573e+06, 2.35509627e+05, 2.09880122e+05, 2.24863382e+06,
9.63992528e+05, 2.78029800e+05, 3.74356805e+04, 2.49425824e+06,
1.89079544e+05, 8.67642141e+05, 2.72656546e+06, 3.85280931e+05,
5.44821023e+05, 4.92561852e+05, 2.63745621e+06, 5.68414184e+05,
6.43709139e+05, 1.89804474e+06, 1.63548423e+06, 1.40435330e+06,
2.67315014e+06, 1.28755811e+06, 3.12334192e+06, 9.80350014e+05,
6.20572349e+06, 5.84437130e+05, 2.40590301e+05, 5.02289867e+06,
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1.60200993e+05, 5.02857573e+06, 2.42053632e+05, 1.16472851e+05,
1.97208867e+06, 1.70401093e+05, 3.08545145e+05, 7.03839470e+05,
3.87398842e+06, 1.54963747e+06, 5.66769691e+05, 1.05344195e+06,
4.23638864e+04, 2.72389260e+05, 7.46946395e+05, 2.56728552e+06,
4.53662176e+05, 6.09584207e+05, 2.05995797e+06, 5.46923309e+05,
1.21137242e+05, 1.48262728e+05, 5.34029049e+05, 7.56146567e+05,
3.88916156e+05, 4.23916825e+06, 1.70263162e+06, 5.88294907e+05,
2.21103373e+06, 6.14201988e+05, 1.05505484e+06, 3.38056265e+05,
3.77348215e+06, 1.39127386e+06, 1.50576788e+06, 1.77485838e+06,
1.40819166e+06, 1.77289250e+06, 2.24920804e+05, 1.41027291e+06,
1.00628854e+06, 1.17508837e+06, 2.88886079e+06])
```

modelling_v2

April 21, 2022

[40]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import statsmodels
import statsmodels.api as sm
import statsmodels.formula.api as smf
import datetime as dt
import scipy.signal as ss
```

[41]:
```
from sklearn.metrics import mean_squared_error
```

[42]:
```
from sklearn.preprocessing import OneHotEncoder
```

[43]:
```
holidays_events = pd.read_csv("https://www.dropbox.com/s/bxyamlpevkiwwoq/
↪holidays_events.csv?dl=1")
oil = pd.read_csv("https://www.dropbox.com/s/l6ln0ztl4m0pw3a/oil.csv?
↪dl=1",parse_dates=['date'],index_col='date')
oil2 = pd.read_csv("https://www.dropbox.com/s/l6ln0ztl4m0pw3a/oil.csv?dl=1")
sample_submission = pd.read_csv("https://www.dropbox.com/s/68jjl61x6u3klos/
↪sample_submission.csv?dl=1")
stores = pd.read_csv("https://www.dropbox.com/s/lcxn6r9bs2exguq/stores.csv?
↪dl=1")
test = pd.read_csv("https://www.dropbox.com/s/cvdo1gn7r5lu2uz/test.csv?
↪dl=1",index_col='id')
train = pd.read_csv("https://www.dropbox.com/s/s8p2b5awnuqfk0d/train.csv?
↪dl=1",index_col='id')
transactions = pd.read_csv("https://www.dropbox.com/s/92fij9bcwt0e0cj/
↪transactions.csv?dl=1")
```

Wybieramy obserwacje dla family=AUTOMOTIVE

[44]:
```
train_automotive = train.loc[(train['family']=='AUTOMOTIVE')]
```

[45]:
```
train_automotive.tail()
```

[45]:
```
                date  store_nbr      family  sales  onpromotion
id
```

```
3000723  2017-08-15         54  AUTOMOTIVE    8.0           0
3000756  2017-08-15          6  AUTOMOTIVE    7.0           0
3000789  2017-08-15          7  AUTOMOTIVE    5.0           0
3000822  2017-08-15          8  AUTOMOTIVE    4.0           0
3000855  2017-08-15          9  AUTOMOTIVE   15.0           0
```

Wyliczamy średnią sprzedaż na daną datę

[46]:
```
train_automotive2= train_automotive.groupby(['date'])['sales'].mean().to_frame()
```

[47]:
```
train_automotive2.head()
```

[47]:
```
                sales
date
2013-01-01   0.000000
2013-01-02   4.722222
2013-01-03   2.981481
2013-01-04   3.129630
2013-01-05   6.333333
```

Dołączamy informacje o zmiennych i robimy one-hot encoding zmiennej locale

[48]:
```
train_automotive_merged = train_automotive2.
 ↪merge(holidays_events,how="left",left_on=['date'],right_on=['date'])

encoder = OneHotEncoder(handle_unknown='ignore')

encoder_df = pd.DataFrame(encoder.
 ↪fit_transform(train_automotive_merged[['locale']]).toarray())

final_train_automotive = train_automotive_merged.join(encoder_df)

final_train_automotive.drop('locale', axis=1, inplace=True)

final_train_automotive.columns = ['date',␣
 ↪'sales','type','local_name','description','transferred','isLocal','isNational','isRegional'
```

[49]:
```
final_train_automotive.head()
```

[49]:
```
         date     sales      type local_name              description  \
0  2013-01-01  0.000000   Holiday    Ecuador       Primer dia del ano
1  2013-01-02  4.722222       NaN        NaN                      NaN
2  2013-01-03  2.981481       NaN        NaN                      NaN
3  2013-01-04  3.129630       NaN        NaN                      NaN
4  2013-01-05  6.333333  Work Day    Ecuador  Recupero puente Navidad

  transferred  isLocal  isNational  isRegional  isNormalDay
```

```
0       False      0.0         1.0         0.0          0.0
1         NaN      0.0         0.0         0.0          1.0
2         NaN      0.0         0.0         0.0          1.0
3         NaN      0.0         0.0         0.0          1.0
4       False      0.0         1.0         0.0          0.0
```

Tworzymy zmienną dayofweek

[50]:
```
final_train_automotive['dayofweek'] = pd.
↪DatetimeIndex(final_train_automotive['date']).dayofweek + 1
```

[51]:
```
final_train_automotive.head()
```

[51]:
```
         date     sales      type local_name              description  \
0  2013-01-01  0.000000   Holiday    Ecuador       Primer dia del ano
1  2013-01-02  4.722222       NaN        NaN                      NaN
2  2013-01-03  2.981481       NaN        NaN                      NaN
3  2013-01-04  3.129630       NaN        NaN                      NaN
4  2013-01-05  6.333333  Work Day    Ecuador  Recupero puente Navidad

  transferred  isLocal  isNational  isRegional  isNormalDay  dayofweek
0       False      0.0         1.0         0.0          0.0          2
1         NaN      0.0         0.0         0.0          1.0          3
2         NaN      0.0         0.0         0.0          1.0          4
3         NaN      0.0         0.0         0.0          1.0          5
4       False      0.0         1.0         0.0          0.0          6
```

Dodajemy oil jako zmienną objaśniającą.

[52]:
```
train_automotive_oil = final_train_automotive.
↪merge(oil2,how="left",left_on=['date'],right_on=['date'])
```

[53]:
```
train_automotive_oil.head()
```

[53]:
```
         date     sales      type local_name              description  \
0  2013-01-01  0.000000   Holiday    Ecuador       Primer dia del ano
1  2013-01-02  4.722222       NaN        NaN                      NaN
2  2013-01-03  2.981481       NaN        NaN                      NaN
3  2013-01-04  3.129630       NaN        NaN                      NaN
4  2013-01-05  6.333333  Work Day    Ecuador  Recupero puente Navidad

  transferred  isLocal  isNational  isRegional  isNormalDay  dayofweek  \
0       False      0.0         1.0         0.0          0.0          2
1         NaN      0.0         0.0         0.0          1.0          3
2         NaN      0.0         0.0         0.0          1.0          4
3         NaN      0.0         0.0         0.0          1.0          5
4       False      0.0         1.0         0.0          0.0          6
```

```
   dcoilwtico
0         NaN
1       93.14
2       92.97
3       93.12
4         NaN
```

Interpolacja

[54]:
```
train_automotive_oil.interpolate(method ='linear', limit_direction ='backward',␣
↪inplace=True)
```

[55]:
```
train_automotive_oil.tail(10)
```

[55]:

	date	sales	type	local_name	description	transferred	isLocal	isNational	isRegional	isNormalDay	dayofweek	dcoilwtico
1704	2017-08-06	10.796296	NaN	NaN	NaN	NaN	0.0	0.0	0.0	1.0	7	49.436667
1705	2017-08-07	6.574074	NaN	NaN	NaN	NaN	0.0	0.0	0.0	1.0	1	49.370000
1706	2017-08-08	6.055556	NaN	NaN	NaN	NaN	0.0	0.0	0.0	1.0	2	49.070000
1707	2017-08-09	5.814815	NaN	NaN	NaN	NaN	0.0	0.0	0.0	1.0	3	49.590000
1708	2017-08-10	5.796296	Holiday	Ecuador	Primer Grito de Independencia	True	0.0	1.0	0.0	0.0	4	48.540000
1709	2017-08-11	8.166667	Transfer	Ecuador	Traslado Primer Grito de Independencia	False	0.0	1.0	0.0	0.0	5	48.810000
1710	2017-08-12	7.462963	NaN	NaN	NaN	NaN	0.0	0.0	0.0	1.0	6	48.403333
1711	2017-08-13	8.907407	NaN	NaN	NaN	NaN	0.0	0.0	0.0	1.0	7	47.996667
1712	2017-08-14	5.407407	NaN	NaN	NaN	NaN	0.0	0.0	0.0	1.0	1	47.710000
1713	2017-08-15	6.240741	Holiday	Riobamba	Fundacion de Riobamba	False	1.0	0.0	0.0	0.0	2	47.423333

```
1712          0.0           1.0           1    47.590000
1713          0.0           0.0           2    47.570000
```

Dzielimy próbkę train na treningową i testową.

[56]:
```
train2 = train_automotive_oil.loc[(train_automotive_oil['date']<'2016-06-01')]
test2 = train_automotive_oil.loc[(train_automotive_oil['date']>='2016-06-01')].
 ↪reset_index(drop=True)
```

[57]:
```
test2.head()
```

[57]:
```
         date      sales type local_name description transferred  isLocal  \
0  2016-06-01   6.425926  NaN        NaN         NaN         NaN      0.0
1  2016-06-02   5.740741  NaN        NaN         NaN         NaN      0.0
2  2016-06-03   5.888889  NaN        NaN         NaN         NaN      0.0
3  2016-06-04   9.000000  NaN        NaN         NaN         NaN      0.0
4  2016-06-05  11.185185  NaN        NaN         NaN         NaN      0.0

   isNational  isRegional  isNormalDay  dayofweek  dcoilwtico
0         0.0         0.0          1.0          3       49.07
1         0.0         0.0          1.0          4       49.14
2         0.0         0.0          1.0          5       48.69
3         0.0         0.0          1.0          6       49.03
4         0.0         0.0          1.0          7       49.37
```

[58]:
```
train2_date = train2.copy()
train2.
 ↪drop(["description","date","type","local_name","transferred"],axis=1,inplace=True)
test2.
 ↪drop(["description","date","type","local_name","transferred"],axis=1,inplace=True)
```

```
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_15988\2658594707.py:2:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  train2.drop(["description","date","type","local_name","transferred"],axis=1,in
place=True)
```

Tworzymy model liniowy

[59]:
```
X = train2.drop(['sales'],axis=1)
Y = train2['sales']
```

[60]:
```
model = sm.OLS(Y,X).fit()
```

[61]:
```
print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                  sales   R-squared:                       0.487
Model:                            OLS   Adj. R-squared:                  0.485
Method:                 Least Squares   F-statistic:                     239.3
Date:                Thu, 21 Apr 2022   Prob (F-statistic):          1.08e-179
Time:                        21:26:18   Log-Likelihood:                -2206.9
No. Observations:                1264   AIC:                             4426.
Df Residuals:                    1258   BIC:                             4457.
Df Model:                           5
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
isLocal         6.2705      0.206     30.386      0.000       5.866       6.675
isNational      6.7287      0.181     37.276      0.000       6.375       7.083
isRegional      6.2289      0.407     15.288      0.000       5.430       7.028
isNormalDay     6.1840      0.143     43.316      0.000       5.904       6.464
dayofweek       0.5017      0.020     25.632      0.000       0.463       0.540
dcoilwtico     -0.0329      0.001    -22.276      0.000      -0.036      -0.030
==============================================================================
Omnibus:                       65.606   Durbin-Watson:                   1.098
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              209.515
Skew:                           0.148   Prob(JB):                     3.19e-46
Kurtosis:                       4.972   Cond. No.                         849.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
```

[62]:
```
test2.head()
```

[62]:

	sales	isLocal	isNational	isRegional	isNormalDay	dayofweek	dcoilwtico
0	6.425926	0.0	0.0	0.0	1.0	3	49.07
1	5.740741	0.0	0.0	0.0	1.0	4	49.14
2	5.888889	0.0	0.0	0.0	1.0	5	48.69
3	9.000000	0.0	0.0	0.0	1.0	6	49.03
4	11.185185	0.0	0.0	0.0	1.0	7	49.37

[63]:
```
train2.head()
```

[63]:

	sales	isLocal	isNational	isRegional	isNormalDay	dayofweek	dcoilwtico
0	0.000000	0.0	1.0	0.0	0.0	2	93.140000
1	4.722222	0.0	0.0	0.0	1.0	3	93.140000
2	2.981481	0.0	0.0	0.0	1.0	4	92.970000
3	3.129630	0.0	0.0	0.0	1.0	5	93.120000
4	6.333333	0.0	1.0	0.0	0.0	6	93.146667

[64]:
```
test2_drop = test2.drop(['sales'],axis=1)
Y_test = test2['sales']
```

[65]:
```
test2.head()
```

[65]:

	sales	isLocal	isNational	isRegional	isNormalDay	dayofweek	dcoilwtico
0	6.425926	0.0	0.0	0.0	1.0	3	49.07
1	5.740741	0.0	0.0	0.0	1.0	4	49.14
2	5.888889	0.0	0.0	0.0	1.0	5	48.69
3	9.000000	0.0	0.0	0.0	1.0	6	49.03
4	11.185185	0.0	0.0	0.0	1.0	7	49.37

[66]:
```
Y_pred = model.predict(test2_drop)
```

Policzmy MSE.

[67]:
```
mean_squared_error(Y_test,Y_pred)
```

[67]: 2.775696197477054