In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_validate
from sklearn.model_selection import GridSearchCV
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.neural_network import MLPRegressor
from sklearn.metrics import make_scorer
import random
import collections
%matplotlib inline
```

```
/opt/conda/lib/python3.9/site-packages/scipy/__init__.py:146: UserWarn
ing: A NumPy version >=1.16.5 and <1.23.0 is required for this version
of SciPy (detected version 1.24.3
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversio
n}"
```

Adatelőkészítés

In [2]:

```
df = pd.read_csv('data/DataSet_LakasArak.csv')
```

In [3]:

```
del df['ad_view_cnt']
del df['active_days']
del df['nr']
```

In [4]:

```
random.seed(8594726138)
columns = list(df.columns)
random.shuffle(columns)
df = df[columns]
df
```

Out[4]:

	elevator_type	county	room_cnt	view_type	balcony_area	garden_access	created_at
0	yes	Budapest	2.0	street view	0.0	NaN	2015-02-09
1	yes	Budapest	1.0	street view	0.0	NaN	2015-02-09
2	yes	Budapest	2.0	garden view	0.0	NaN	2015-02-09
3	none	Budapest	2.0	garden view	4.0	NaN	2015-02-09
4	yes	Budapest	2.0	NaN	3.0	NaN	2015-02-09
...	...	...	...	...	...	...	...
78534	none	Budapest	2.0	NaN	0.0	NaN	2016-08-29
78535	yes	Budapest	1.0	NaN	0.0	NaN	2016-08-29
78536	none	Budapest	1.0	NaN	0.0	NaN	2016-08-29
78537	none	Budapest	1.0	NaN	0.0	NaN	2016-08-29
78538	yes	Budapest	2.0	street view	0.0	NaN	2016-08-29

78539 rows × 19 columns

In [5]:

```
df.columns
```

Out[5]:

```
Index(['elevator_type', 'county', 'room_cnt', 'view_type', 'balcony_ar
ea',
       'garden_access', 'created_at', 'small_room_cnt', 'orientation',
       'property_type', 'postcode', 'property_area', 'building_floor_c
ount',
       'city', 'property_condition_type', 'property_subtype', 'heating
_type',
       'property_floor', 'price_created_at'],
      dtype='object')
```

In [6]:

```
df.isna().sum()
```

Out[6]:

```
elevator_type               14151
county                          0
room_cnt                        0
view_type                   35661
balcony_area                    0
garden_access               61339
created_at                      0
small_room_cnt                  0
orientation                 30892
property_type                   0
postcode                    28954
property_area                   0
building_floor_count        42110
city                          559
property_condition_type         0
property_subtype             1659
heating_type                11306
property_floor               3793
price_created_at                0
dtype: int64
```

Ennek a módszernek célja az idő dimenzió, és ezzel esetleges trend eliminálása a négyzetméterárból. Órán volt szó arról, hogy az adathalmaz születésének időszakában az ingatlanpiac erősödött, így aki irreálisan magas árat választott, azt a piac előbb-utóbb utolérte. Ez a jelenség rontja a modellünk általánosítóképességét, ezért a hagyományos négyzetméterár helyett egy jelenértékre számított négyzetméterárat számítok ki az órán tanult módon. Ez az érték minden ingatlanra az adathalmaz utolsó napjához arányosít.

In [7]:

```
# jelenértékű nmÁr
df['nmAr'] = df['price_created_at']*1000000/df['property_area']
df['datum'] = pd.to_datetime(df['created_at'])
stat = df.groupby('datum', as_index=False).agg({"nmAr":"median"})
df['daynum'] = (df['datum'] - df['datum'].min()).dt.days
stat['daynum'] = (stat['datum'] - stat['datum'].min()).dt.days
minlinreg = LinearRegression()
minlinreg.fit(stat[ ['daynum'] ], stat['nmAr'])
stat['trend_nmAr']= minlinreg.predict(stat[['daynum']])
del stat['nmAr']
del stat['daynum']
df = df.merge(stat, on='datum', how='left')
df['jelen_nmAr']= df['nmAr']/df['trend_nmAr']* stat['trend_nmAr'].ma
df
```

Out[7]:

	elevator_type	county	room_cnt	view_type	balcony_area	garden_access	created_at
0	yes	Budapest	2.0	street view	0.0	NaN	2015-02-09
1	yes	Budapest	1.0	street view	0.0	NaN	2015-02-09
2	yes	Budapest	2.0	garden view	0.0	NaN	2015-02-09
3	none	Budapest	2.0	garden view	4.0	NaN	2015-02-09
4	yes	Budapest	2.0	NaN	3.0	NaN	2015-02-09
...	...	...	...	...	...	...	...
78534	none	Budapest	2.0	NaN	0.0	NaN	2016-08-29
78535	yes	Budapest	1.0	NaN	0.0	NaN	2016-08-29
78536	none	Budapest	1.0	NaN	0.0	NaN	2016-08-29
78537	none	Budapest	1.0	NaN	0.0	NaN	2016-08-29
78538	yes	Budapest	2.0	street view	0.0	NaN	2016-08-29

78539 rows × 24 columns

Transzformációs függvények oszlopsorrendben

In [8]:
```
(df, input_cols):
e'] = df['elevator_type'].apply(lambda x: 1 if str(x)[0]=='y' else 0)
elevator_type']
_cols

put_cols):
mert minden érték azonos
_cols

input_cols):
room_cnt']
_cols

 input_cols):

d.get_dummies(df['view_type'], prefix = 'view_type=', drop_first = True)
ew_dummies, left_index = True, right_index = True, how = 'left')
st(view_dummies.columns)
_cols

df, input_cols):
balcony_area']
_cols

(df, input_cols):

mmies = pd.get_dummies(df['garden_access'], prefix = 'garden_access=', dr
rden_access_dummies, left_index = True, right_index = True, how = 'left')
st(garden_access_dummies.columns)
_cols

, input_cols):
 = pd.to_datetime(df['created_at'])
ated_at'].min()
 = (df['created_at'] - cr_min).dt.days
created_at']
_cols

t(df, input_cols):
small_room_cnt']
_cols

(df, input_cols):

ies = pd.get_dummies(df['orientation'], prefix = 'orientation=', drop_fir
ientation_dummies, left_index = True, right_index = True, how = 'left')
st(orientation_dummies.columns)
_cols

(df, input_cols):

given'] = df['orientation'].apply(lambda x: 0 if x==NaN else 1)
orientation_given']
_cols

(df, input_cols):
 mert minden érték azonos
_cols

, input_cols):
 df['postcode'].fillna(1000)
```

```
postcode']
_cols

, input_cols):
 df['postcode'].fillna(1000)
pply(lambda x: x % 1000)
postcode']
_cols

(df, input_cols):
property_area']
_cols

r_count(df, input_cols):
or_count'] = df['building_floor_count'].fillna('other')
or_count'] = df['building_floor_count'].apply(lambda x: 11 if str(x)[0]==
building_floor_count']
_cols

put_cols):

d.get_dummies(df['city'], prefix = 'city=', drop_first = True)
ty_dummies, left_index = True, right_index = True, how = 'left')
st(city_dummies.columns)
_cols

put_cols):
(1) vagy Csepel (2)?

0, 3:0, 4:1, 5:1, 6:1, 7:1, 8:1, 9:1, 10:1,
13:1, 14:1, 15:1, 16:1, 17:1, 18:1, 19:1, 20:1,
23:1

f['postcode'].fillna(1000).apply(lambda x: int(str(x)[1:3]))
y('city',as_index=False).agg({'ker_code':'max'})
0
13
ity','kerulet_sorszam']
,on='city',how='left')
zam']=df['kerulet_sorszam'].fillna(0)
ort']=df['kerulet_sorszam'].apply(lambda x: mapping[x])
kerulet_csoport']
_cols

put_cols):
rtek irányítószámból és kerületnevekből
f['postcode'].fillna(1000).apply(lambda x: int(str(x)[1:3]))
y('city',as_index=False).agg({'ker_code':'max'})
0
13
ity','kerulet_sorszam']
,on='city',how='left')
zam']=df['kerulet_sorszam'].fillna(0)
kerulet_sorszam']
_cols

ition_type1(df, input_cols):

on_type_dummies = pd.get_dummies(df['property_condition_type'], prefix =
operty_condition_type_dummies, left_index = True, right_index = True, how
st(property_condition_type_dummies.columns)
```

```
_cols

ition_type2(df, input_cols):

ction': 5,



,

o': 0,
ruction': -1,
': -2,
ated': -3

dition_type'] = df['property_condition_type'].apply(lambda x: mapping[x])
property_condition_type']
_cols

ype(df, input_cols):

_dummies = pd.get_dummies(df['property_subtype'], prefix = 'property_subt
operty_subtype_dummies, left_index = True, right_index = True, how = 'lef
st(property_subtype_dummies.columns)
_cols

1(df, input_cols):

']=df['heating_type'].fillna('other')
= pd.get_dummies(df['heating_type'], prefix = 'heating_type=', drop_first
ating_dummies, left_index = True, right_index = True, how = 'left')
st(heating_dummies.columns)
_cols

2(df, input_cols):
iság alapján

':10,
,
(gas)':8,
,
ting':6,
ting with own meter':5,

ating':3,
, circulating hot water':2,
gas burner':1

']=df['heating_type'].fillna('other')
]=df['heating_type'].apply(lambda x: mapping[x])
heating_num']
_cols


floor':

ne floor':

':

t':

```

```


r_1(df, input_cols):
or'] = df['property_floor'].fillna(0).apply(lambda x: prop_floor(x))
property_floor']
_cols


r_2(df, input_cols):

ummies = pd.get_dummies(df['property_floor'], prefix = 'property_floor=',
operty_floor_dummies, left_index = True, right_index = True, how = 'left'
st(property_floor_dummies.columns)
_cols

_at(df, input_cols):
ebből lett a származtatott jelen_nmAr célváltozó

_cols

f, input_cols):
= pd.to_datetime(df['created_at'])
] = df['created_at'].apply(lambda x: x.weekday())
day_of_week']
_cols

f, input_cols):
= pd.to_datetime(df['created_at'])
] = df['created_at'].apply(lambda x: x.weekday())
] = df['day_of_week'].apply(lambda x: 1 if x == 5 or x == 6 else 0)
day_of_week']
_cols

```

In [9]:

```
def mean_absolute_percentage_error(y_true,y_pred):
    y_true, y_pred = np.array(y_true), np.array(y_pred)
    return np.mean(np.abs((y_true - y_pred)/y_true))

mape_scorer = make_scorer(mean_absolute_percentage_error, greater_is
```

In [10]:

```
score_lin = []
score_gbm = []
score_neu = []

def learn_step(step_index, df, bemenok, kimeno):
    linreg = LinearRegression()
    gbm = GradientBoostingRegressor(random_state=42, max_depth=5, n_
    neural = MLPRegressor(learning_rate='adaptive', random_state=42,

    g_lin = GridSearchCV(estimator=linreg, param_grid={}, cv=3, scor
    g_lin.fit(df[bemenok], df[kimeno])
    score_lin.append( [step_index, len(bemenok), g_lin.cv_results_['

    g_gbm = GridSearchCV(estimator=gbm, param_grid={}, cv=3, scoring
    g_gbm.fit(df[bemenok], df[kimeno])
    score_gbm.append( [step_index, len(bemenok), g_gbm.cv_results_['

    g_neu = GridSearchCV(estimator=neural, param_grid={}, cv=3, scor
    g_neu.fit(df[bemenok], df[kimeno])
    score_neu.append( [step_index, len(bemenok), g_neu.cv_results_['

    return g_lin.cv_results_['mean_test_score'][0], g_gbm.cv_results
```

Oszlopok egyenkénti hozzáadása és tanítások:

In [11]:

```
bemenok = []
kimeno = 'jelen_nmAr'


# 1 elevator_type
print('# 1 elevator_type START')
df, bemenok = tr_elevator_type(df, bemenok)
print(bemenok)
learn_step(1, df, bemenok, kimeno)
print('# 1 elevator_type END')

# 2 county
print('# 2 county START')
df, bemenok = tr_county(df, bemenok)
learn_step(2, df, bemenok, kimeno)
print('# 2 county END')

# 3 room_cnt
print('# 3 room_cnt START')
df, bemenok = tr_room_cnt(df, bemenok)
learn_step(3, df, bemenok, kimeno)
print('# 3 room_cnt END')

# 4 view_type
print('# 4 view_type START')
df, bemenok = tr_view_type(df, bemenok)
learn_step(4, df, bemenok, kimeno)
print('# 4 view_type END')

# 5 balcony_area
print('# 5 balcony_area START')
df, bemenok = tr_balcony_area(df, bemenok)
learn_step(5, df, bemenok, kimeno)
print('# 5 balcony_area END')

# 6 garden_access
print('# 6 garden_access START')
df, bemenok = tr_garden_access(df, bemenok)
learn_step(6, df, bemenok, kimeno)
print('# 6 garden_access END')


df_created_at_1 = df.copy()
df_created_at_2 = df.copy()
bem1 = bemenok.copy()
bem2 = bemenok.copy()
# 7 created_at 1
print('# 7 created_at => which_day 1 START')
df_created_at_1, bem1 = tr_which_day_1(df_created_at_1, bem1)
_,__, res1 = learn_step(7, df_created_at_1, bem1, kimeno)
print('# 7 created_at => which_day 1 END')

# 7 created_at 2
print('# 7 created_at => which_day 2 START')
df_created_at_2, bem2 = tr_which_day_2(df_created_at_2, bem2)
_,__, res2 = learn_step(7, df_created_at_2, bem2, kimeno)
print('# 7 created_at => which_day 2 END')
if (res1 > res2):
    df = df_created_at_1
    bemenok = bem1
else:
    df = df_created_at_2
    bemenok = bem2


# 8 small_room_cnt
print('# 8 small_room_cnt START')
df, bemenok = tr_small_room_cnt(df, bemenok)
learn_step(8, df, bemenok, kimeno)
print('# 8 small_room_cnt END')


df_orientation_1 = df.copy()
df_orientation_2 = df.copy()
bem1 = bemenok.copy()
bem2 = bemenok.copy()
# 9 orientation 1
print('# 9 orientation 1 START')
df_orientation_1, bem1 = tr_which_day_1(df_orientation_1, bem1)
_,__, res1 = learn_step(9, df_orientation_1, bem1, kimeno)
print('# 9 orientation 1 END')

# 9 orientation 2
print('# 9 orientation 2 START')
df_orientation_2, bem2 = tr_which_day_2(df_orientation_2, bem2)
_,__, res2 = learn_step(9, df_orientation_2, bem2, kimeno)
print('# 9 orientation 2 END')
if (res1 > res2):
    df = df_orientation_1
    bemenok = bem1
else:
    df = df_orientation_2
    bemenok = bem2


# 10 property_type
print('# 10 property_type START')
df, bemenok = tr_property_type(df, bemenok)
learn_step(10, df, bemenok, kimeno)
print('# 10 property_type END')


df_postcode_1 = df.copy()
df_postcode_2 = df.copy()
bem1 = bemenok.copy()
bem2 = bemenok.copy()
# 11 postcode 1
print('# 11 postcode 1 START')
df_postcode_1, bem1 = tr_postcode_1(df_postcode_1, bem1)
_,__, res1 = learn_step(11, df_postcode_1, bem1, kimeno)
print('# 11 postcode 1 END')

# 11 postcode 2
print('# 11 postcode 2 START')
df_postcode_2, bem2 = tr_postcode_2(df_postcode_2, bem2)
_,__, res2 = learn_step(11, df_postcode_2, bem2, kimeno)
print('# 11 postcode 2 END')
if (res1 > res2):
    df = df_postcode_1
    bemenok = bem1
else:
    df = df_postcode_2
    bemenok = bem2

# 12 property_area
print('# 12 property_area START')
df, bemenok = tr_property_area(df, bemenok)
learn_step(12, df, bemenok, kimeno)
print('# 12 property_area END')

# 13 building_floor_count
print('# 13 building_floor_count START')
df, bemenok = tr_building_floor_count(df, bemenok)
learn_step(13, df, bemenok, kimeno)
print('# 13 building_floor_count END')


df_city_1 = df.copy()
df_city_2 = df.copy()
df_city_3 = df.copy()
bem1 = bemenok.copy()
bem2 = bemenok.copy()
bem3 = bemenok.copy()
# 14 city 1
print('# 14 city 1 START')
df_city_1, bem1 = tr_city_1(df_city_1, bem1)
_,__, res1 = learn_step(14, df_city_1, bem1, kimeno)
print('# 14 city 1 END')

# 14 city 2
print('# 14 city 2 START')
df_city_2, bem2 = tr_city_2(df_city_2, bem2)
_,__, res2 = learn_step(14, df_city_2, bem2, kimeno)
print('# 14 city 2 END')

# 14 city 3
print('# 14 city 3 START')
df_city_3, bem3 = tr_city_2(df_city_3, bem3)
_,__, res3 = learn_step(14, df_city_3, bem3, kimeno)
print('# 14 city 3 END')
if (res1 > res2):
    if(res1 > res3):
        df = df_city_1
        bemenok = bem1
elif (res2 > res3):
    df = df_city_2
    bemenok = bem2
else:
    df = df_city_3
    bemenok = bem3


df_pct_1 = df.copy()
df_pct_2 = df.copy()
bem1 = bemenok.copy()
bem2 = bemenok.copy()
# 15 property_condition_type 1
print('# 15 property_condition_type 1 START')
df_pct_1, bem1 = tr_property_condition_type1(df_pct_1, bem1)
_,__, res1 = learn_step(15, df_pct_1, bem1, kimeno)
print('# 15 property_condition_type 1 END')

# 15 property_condition_type 2
```

```python
print('# 15 property_condition_type 2 START')
df_pct_2, bem2 = tr_property_condition_type2(df_pct_2, bem2)
_,__, res2 = learn_step(15, df_pct_2, bem2, kimeno)
print('# 15 property_condition_type 2 END')
if (res1 > res2):
    df = df_pct_1
    bemenok = bem1
else:
    df = df_pct_2
    bemenok = bem2

# 16 property_subtype
print('# 16 property_subtype START')
df, bemenok = tr_property_subtype(df, bemenok)
learn_step(16, df, bemenok, kimeno)
print('# 16 property_subtype END')


df_heating_1 = df.copy()
df_heating_2 = df.copy()
bem1 = bemenok.copy()
bem2 = bemenok.copy()
# 17 heating_type 1
print('# 17 heating_type 1 START')
df_heating_1, bem1 = tr_heating_type_1(df_heating_1, bem1)
_,__, res1 = learn_step(17, df_heating_1, bem1, kimeno)
print('# 17 heating_type 1 END')

# 17 heating_type 2
print('# 17 heating_type 2 START')
df_heating_2, bem2 = tr_heating_type_2(df_heating_2, bem2)
_,__, res2 = learn_step(17, df_heating_2, bem2, kimeno)
print('# 17 heating_type 2 END')
if (res1 > res2):
    df = df_heating_1
    bemenok = bem1
else:
    df = df_heating_2
    bemenok = bem2

# 18 property_floor
df_pfloor_1 = df.copy()
df_pfloor_2 = df.copy()
bem1 = bemenok.copy()
bem2 = bemenok.copy()
# 18 property_floor 1
print('# 18 property_floor 1 START')
df_pfloor_1, bem1 = tr_property_floor_1(df_pfloor_1, bem1)
_,_, res1 = learn_step(18, df_pfloor_1, bem1, kimeno)
print('# 18 property_floor 1 END')

# 18 property_floor 2
print('# 18 property_floor 2 START')
df_pfloor_2, bem2 = tr_property_floor_2(df_pfloor_2, bem2)
_,_, res2 = learn_step(18, df_pfloor_2, bem2, kimeno)
print('# 18 property_floor 2 END')
if (res1 > res2):
    df = df_pfloor_1
    bemenok = bem1
else:
    df = df_pfloor_2
    bemenok = bem2
```

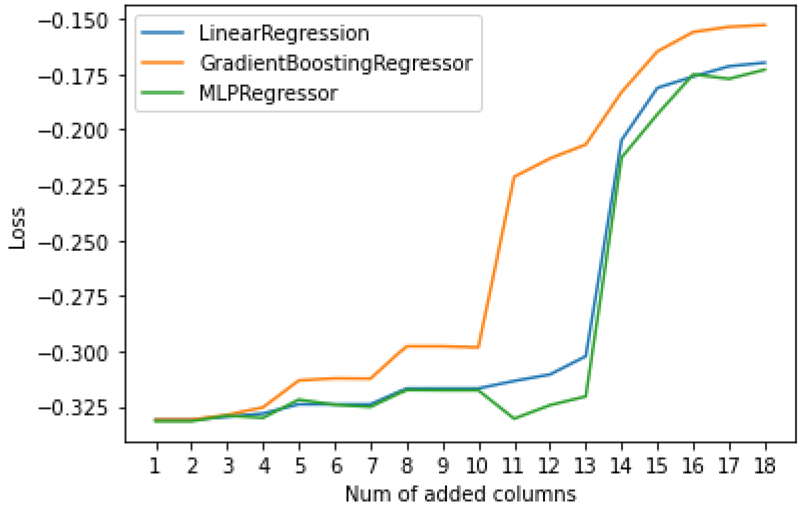
```
# 1 elevator_type START
['elevator_type']
Fitting 3 folds for each of 1 candidates, totalling 3 fits
Fitting 3 folds for each of 1 candidates, totalling 3 fits
Fitting 3 folds for each of 1 candidates, totalling 3 fits
[CV 1/3] END ................................, score=-0.326 total ti
me=  21.0s
[CV 2/3] END ................................, score=-0.344 total ti
me=  22.7s
[CV 3/3] END ................................, score=-0.326 total ti
me=  28.5s
# 1 elevator_type END
# 2 county START
Fitting 3 folds for each of 1 candidates, totalling 3 fits
Fitting 3 folds for each of 1 candidates, totalling 3 fits
Fitting 3 folds for each of 1 candidates, totalling 3 fits
[CV 1/3] END ................................, score=-0.326 total ti
me=  21.0s
[CV 2/3] END ................................, score=-0.344 total ti
me=  22.7s
```

In [12]:

```
def filter_and_find_largest(data):
    grouped_data = collections.defaultdict(list)

    for item in data:
        first_element = item[0]
        third_element = item[2]
        grouped_data[first_element].append((third_element, item))

    filtered_data = []

    for key, group in grouped_data.items():
        max_element = max(group, key=lambda x: x[0])
        filtered_data.append(max_element[1])

    filtered_data.sort(key=lambda x: x[0])

    return filtered_data
```

In [17]:

```
score_lin = filter_and_find_largest(score_lin)
score_gbm = filter_and_find_largest(score_gbm)
score_neu = filter_and_find_largest(score_neu)

with open("score_lin.txt", "w") as file:
    file.write(str(score_lin))

with open("score_gbm.txt", "w") as file:
    file.write(str(score_gbm))

with open("score_neu.txt", "w") as file:
    file.write(str(score_neu))


x_values1 = [point[0] for point in score_lin]
y_values1 = [point[2] for point in score_lin]

x_values2 = [point[0] for point in score_gbm]
y_values2 = [point[2] for point in score_gbm]

x_values3 = [point[0] for point in score_neu]
y_values3 = [point[2] for point in score_neu]

# Create a scatter plot for each dataset
plt.xticks(np.arange(min(x_values1), max(x_values1)+1, 1.0))
plt.plot(x_values1, y_values1, label='LinearRegression', linestyle='
plt.plot(x_values2, y_values2, label='GradientBoostingRegressor', li
plt.plot(x_values3, y_values3, label='MLPRegressor', linestyle='-')

# Label the axes
plt.xlabel('Num of added columns')
plt.ylabel('Loss')

plt.legend()
plt.show()
```



A táblázatban látható a loss-ok alakulása az újabb és újabb oszlopok hozzáadásával, modellenként külön-külön. A paraméterek hozzáadásával általában nő a modellek pontossága. (Kivétel volt ezazlól az MLPRegressor, ami két esetben is gyengébb eredményt hozott új paraméter hozzáadásakor: irányítószámok, fűtéstípus)

A 11. paraméter hozzáadásával a GradientBoostigRegressor nagyot javult, ez az irányítószámok hozzáadása volt. A másik két modell a 14. paraméternél, a kerület hozzáadásakor javult sokat.

Végső adatelemzési folyamat

In [27]:

```
df_final = df.copy()
bemenok_final = bemenok.copy()
```

In [26]:

```
pd.set_option('display.max_columns', None)

```

In [28]:

```
p_grid = {
    'max_depth': [4,5,6,7],
    'n_estimators': [100, 150, 200]
}
g_final = GridSearchCV(
    estimator=GradientBoostingRegressor(random_state=42),
    param_grid=p_grid,
    cv=3, scoring=mape_scorer,
    verbose=3
)
g_final.fit(df_final[bemenok_final], df_final[kimeno])
```

```
Fitting 3 folds for each of 12 candidates, totalling 36 fits
[CV 1/3] END ....max_depth=4, n_estimators=100;, score=-0.165 total ti
me=  18.7s
[CV 2/3] END ....max_depth=4, n_estimators=100;, score=-0.161 total ti
me=  18.0s
[CV 3/3] END ....max_depth=4, n_estimators=100;, score=-0.152 total ti
me=  18.4s
[CV 1/3] END ....max_depth=4, n_estimators=150;, score=-0.158 total ti
me=  25.2s
[CV 2/3] END ....max_depth=4, n_estimators=150;, score=-0.154 total ti
me=  26.3s
[CV 3/3] END ....max_depth=4, n_estimators=150;, score=-0.146 total ti
me=  26.9s
[CV 1/3] END ....max_depth=4, n_estimators=200;, score=-0.155 total ti
me=  35.5s
[CV 2/3] END ....max_depth=4, n_estimators=200;, score=-0.150 total ti
me=  35.4s
[CV 3/3] END ....max_depth=4, n_estimators=200;, score=-0.143 total ti
me=  34.2s
[CV 1/3] END ....max_depth=5, n_estimators=100;, score=-0.160 total ti
me=  21.8s
[CV 2/3] END ....max_depth=5, n_estimators=100;, score=-0.154 total ti
me=  22.5s
[CV 3/3] END ....max_depth=5, n_estimators=100;, score=-0.146 total ti
me=  22.0s
[CV 1/3] END ....max_depth=5, n_estimators=150;, score=-0.154 total ti
me=  33.8s
[CV 2/3] END ....max_depth=5, n_estimators=150;, score=-0.147 total ti
me=  33.1s
[CV 3/3] END ....max_depth=5, n_estimators=150;, score=-0.141 total ti
me=  32.7s
[CV 1/3] END ....max_depth=5, n_estimators=200;, score=-0.150 total ti
me=  46.0s
[CV 2/3] END ....max_depth=5, n_estimators=200;, score=-0.144 total ti
me=  44.4s
[CV 3/3] END ....max_depth=5, n_estimators=200;, score=-0.138 total ti
me=  39.9s
[CV 1/3] END ....max_depth=6, n_estimators=100;, score=-0.154 total ti
me=  23.5s
[CV 2/3] END ....max_depth=6, n_estimators=100;, score=-0.148 total ti
me=  22.8s
[CV 3/3] END ....max_depth=6, n_estimators=100;, score=-0.142 total ti
me=  22.7s
[CV 1/3] END ....max_depth=6, n_estimators=150;, score=-0.150 total ti
me=  33.7s
[CV 2/3] END ....max_depth=6, n_estimators=150;, score=-0.143 total ti
me=  34.0s
[CV 3/3] END ....max_depth=6, n_estimators=150;, score=-0.137 total ti
me=  33.8s
[CV 1/3] END ....max_depth=6, n_estimators=200;, score=-0.147 total ti
me=  46.2s
[CV 2/3] END ....max_depth=6, n_estimators=200;, score=-0.140 total ti
me=  46.5s
[CV 3/3] END ....max_depth=6, n_estimators=200;, score=-0.136 total ti
me=  44.9s
[CV 1/3] END ....max_depth=7, n_estimators=100;, score=-0.152 total ti
me=  26.3s
[CV 2/3] END ....max_depth=7, n_estimators=100;, score=-0.144 total ti
me=  26.6s
[CV 3/3] END ....max_depth=7, n_estimators=100;, score=-0.139 total ti
me=  26.3s
```

```
[CV 1/3] END ....max_depth=7, n_estimators=150;, score=-0.148 total ti
me=  45.5s
[CV 2/3] END ....max_depth=7, n_estimators=150;, score=-0.140 total ti
me=  46.7s
[CV 3/3] END ....max_depth=7, n_estimators=150;, score=-0.135 total ti
me=  43.1s
[CV 1/3] END ....max_depth=7, n_estimators=200;, score=-0.147 total ti
me=  52.0s
[CV 2/3] END ....max_depth=7, n_estimators=200;, score=-0.138 total ti
me=  52.3s
[CV 3/3] END ....max_depth=7, n_estimators=200;, score=-0.134 total ti
me=  52.6s
```

Out[28]:

```
GridSearchCV(cv=3, estimator=GradientBoostingRegressor(random_state=4
2),
             param_grid={'max_depth': [4, 5, 6, 7],
                         'n_estimators': [100, 150, 200]},
             scoring=make_scorer(mean_absolute_percentage_error, great
er_is_better=False),
             verbose=3)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [39]:

```
best = g_final.best_estimator_
type(best)
g_final.best_estimator_
```

Out[39]:

```
GradientBoostingRegressor(max_depth=7, n_estimators=200, random_state=
42)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

A legjobb modell a vizsgáltak közül: GradientBoostingRegressor(max_depth=7, n_estimators=200, random_state=42)

In [40]:

```
def kiertekelo_fuggveny(df, tipp_oszlop_neve, target_oszlop_neve):
    mean_absolute_error=   (abs(df[tipp_oszlop_neve]-df[target_oszlo

    MAPE=(abs((df[target_oszlop_neve] - df[tipp_oszlop_neve])/df[tar
    rmse =  np.sqrt( ( (df[tipp_oszlop_neve]-df[target_oszlop_neve])
    print("RMSE",rmse)
    print("MAE:",mean_absolute_error)
    print("MAPE:",MAPE)
    df["tipp_arany"] = df[target_oszlop_neve]/df[tipp_oszlop_neve]
    erdekesek = df[ (df['tipp_arany']> 0.75) & (df['tipp_arany'] < 0
    print("Atnezendok aranya", len(erdekesek)/len(df))
    return erdekesek
```

In [45]:

```
# A feladat egy olyan gépi tanulási megoldás elkészítése, ami egy in

test_df = df.copy()
test_df['tipp']=best.predict(test_df[bemenok_final])
erdekesek = kiertekelo_fuggveny(test_df, 'tipp', 'jelen_nmAr')

df_to_write = pd.read_csv('data/DataSet_LakasArak.csv')
df_to_write = df_to_write.filter(items=erdekesek.index, axis=0)
df_to_write.to_csv('Results_O78UXU.csv', index=False)
```

```
RMSE 84395.73240336076
MAE: 55183.947416220566
MAPE: 0.115254033852456
Atnezendok aranya 0.33756477673512525
```