```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

```
df = pd.read_csv('train_1.csv')
```

```
exog = pd.read_csv('Exog_Campaign_eng')
exog
```

	Exog
0	0
1	0
2	0
3	0
4	0
...	...
545	1
546	1
547	1
548	0
549	0

```
df
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
0	2NE1_zh.wikipedia.org_all-access_spider	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	...	32.0	63.0	15.0	26.0	14.0	20.0	22.0	19.0	18.0	20.0
1	2PM_zh.wikipedia.org_all-access_spider	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	...	17.0	42.0	28.0	15.0	9.0	30.0	52.0	45.0	26.0	20.0
2	3C_zh.wikipedia.org_all-access_spider	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	...	3.0	1.0	1.0	7.0	4.0	4.0	6.0	3.0	4.0	17.0
3	4minute_zh.wikipedia.org_all-access_spider	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	...	32.0	10.0	26.0	27.0	16.0	11.0	17.0	19.0	10.0	11.0
4	52_Hz_I_Love_You_zh.wikipedia.org_all-access_s...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	48.0	9.0	25.0	13.0	3.0	11.0	27.0	13.0	36.0	10.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145058	Underworld_(serie_de_películas)_es.wikipedia.o...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	13.0	12.0	13.0	3.0	5.0	10.0
145059	Resident_Evil:_Capítulo_Final_es.wikipedia.org...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
145060	Enamorándome_de_Ramón_es.wikipedia.org_all-acc...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
145061	Hasta_el_último_hombre_es.wikipedia.org_all-ac...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
145062	Francisco_el_matemático_(serie_de_televisión_d...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Problem Statement: To come up with a TimeSeries forecast model that is able to predict the future viewership based on language, region for client's page and optimise the placement of Ads.

EDA - Estimatory Data Analysis.

```
exog['Exog'].value_counts()
```

```
Exog
0    496
1     54
Name: count, dtype: int64
```

```
df.info
```

```
<bound method DataFrame.info of                                                   Page  2015-07-01  \
0                2NE1_zh.wikipedia.org_all-access_spider        18.0
1                 2PM_zh.wikipedia.org_all-access_spider        11.0
2                  3C_zh.wikipedia.org_all-access_spider         1.0
3             4minute_zh.wikipedia.org_all-access_spider        35.0
4       52_Hz_I_Love_You_zh.wikipedia.org_all-access_s...         NaN
...                                                   ...         ...
145058  Underworld_(serie_de_películas)_es.wikipedia.o...         NaN
145059  Resident_Evil:_Capítulo_Final_es.wikipedia.org...         NaN
145060  Enamorándome_de_Ramón_es.wikipedia.org_all-acc...         NaN
145061  Hasta_el_último_hombre_es.wikipedia.org_all-ac...         NaN
145062  Francisco_el_matemático_(serie_de_televisión_d...         NaN

        2015-07-02  2015-07-03  2015-07-04  2015-07-05  2015-07-06  \
0             11.0         5.0        13.0        14.0         9.0
1             14.0        15.0        18.0        11.0        13.0
2              0.0         1.0         1.0         0.0         4.0
3             13.0        10.0        94.0         4.0        26.0
4              NaN         NaN         NaN         NaN         NaN
...            ...         ...         ...         ...         ...
145058         NaN         NaN         NaN         NaN         NaN
145059         NaN         NaN         NaN         NaN         NaN
145060         NaN         NaN         NaN         NaN         NaN
145061         NaN         NaN         NaN         NaN         NaN
145062         NaN         NaN         NaN         NaN         NaN

        2015-07-07  2015-07-08  2015-07-09  ...  2016-12-22  2016-12-23  \
0              9.0        22.0        26.0  ...        32.0        63.0
1             22.0        11.0        10.0  ...        17.0        42.0
2              0.0         3.0         4.0  ...         3.0         1.0
3             14.0         9.0        11.0  ...        32.0        10.0
4              NaN         NaN         NaN  ...        48.0         9.0
...            ...         ...         ...  ...         ...         ...
145058         NaN         NaN         NaN  ...         NaN         NaN
145059         NaN         NaN         NaN  ...         NaN         NaN
145060         NaN         NaN         NaN  ...         NaN         NaN
145061         NaN         NaN         NaN  ...         NaN         NaN
145062         NaN         NaN         NaN  ...         NaN         NaN

        2016-12-24  2016-12-25  2016-12-26  2016-12-27  2016-12-28  \
0             15.0        26.0        14.0        20.0        22.0
1             28.0        15.0         9.0        30.0        52.0
2              1.0         7.0         4.0         4.0         6.0
3             26.0        27.0        16.0        11.0        17.0
4             25.0        13.0         3.0        11.0        27.0
...            ...         ...         ...         ...         ...
145058         NaN         NaN        13.0        12.0        13.0
```

```
145059         NaN         NaN         NaN         NaN         NaN
145060         NaN         NaN         NaN         NaN         NaN
145061         NaN         NaN         NaN         NaN         NaN
145062         NaN         NaN         NaN         NaN         NaN

        2016-12-29  2016-12-30  2016-12-31
0             19.0        18.0        20.0
1             45.0        26.0        20.0
2              3.0         4.0        17.0
3             19.0        10.0        11.0
```

```
df.shape
```

```
(145063, 551)
```

```
df.describe()
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-
count	1.243230e+05	1.242470e+05	1.245190e+05	1.244090e+05	1.244040e+05	1.245800e+05	1.243990e+05	1.247690e+05	1.248190e+05	1.247210e+05	...	1.412100e+05	1.414790e+05	1.418740e+05	1.413190e+05	1.411450e+05	1.413620e+
mean	1.195857e+03	1.204004e+03	1.133676e+03	1.170437e+03	1.217769e+03	1.290273e+03	1.239137e+03	1.193092e+03	1.197992e+03	1.189651e+03	...	1.394096e+03	1.377482e+03	1.393099e+03	1.523740e+03	1.679607e+03	1.678302e+
std	7.275352e+04	7.421515e+04	6.961022e+04	7.257351e+04	7.379612e+04	8.054448e+04	7.576288e+04	6.820002e+04	7.149717e+04	7.214536e+04	...	8.574880e+04	7.732794e+04	8.478533e+04	8.752210e+04	9.794534e+04	9.232482e+
min	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	...	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+
25%	1.300000e+01	1.300000e+01	1.200000e+01	1.300000e+01	1.400000e+01	1.100000e+01	1.300000e+01	1.300000e+01	1.400000e+01	1.400000e+01	...	2.200000e+01	2.200000e+01	2.000000e+01	2.100000e+01	2.200000e+01	2.300000e+
50%	1.090000e+02	1.080000e+02	1.050000e+02	1.050000e+02	1.130000e+02	1.130000e+02	1.150000e+02	1.170000e+02	1.150000e+02	1.130000e+02	...	1.490000e+02	1.430000e+02	1.320000e+02	1.450000e+02	1.600000e+02	1.620000e+
75%	5.240000e+02	5.190000e+02	5.040000e+02	4.870000e+02	5.400000e+02	5.550000e+02	5.510000e+02	5.540000e+02	5.490000e+02	5.450000e+02	...	6.070000e+02	5.980000e+02	5.690000e+02	6.280000e+02	6.590000e+02	6.680000e+
max	2.038124e+07	2.075219e+07	1.957397e+07	2.043964e+07	2.077211e+07	2.254467e+07	2.121089e+07	1.910791e+07	1.999385e+07	2.020182e+07	...	2.420108e+07	2.253925e+07	2.505662e+07	2.586575e+07	2.834288e+07	2.691699e+

8 rows × 550 columns

```
df.iloc[5:15,:]
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
5	5566_zh.wikipedia.org_all-access_spider	12.0	7.0	4.0	5.0	20.0	8.0	5.0	17.0	24.0	...	16.0	27.0	8.0	17.0	32.0	19.0	23.0	17.0	17.0	50.0
6	91Days_zh.wikipedia.org_all-access_spider	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.0	7.0	33.0	8.0	11.0	4.0	15.0	6.0	8.0	6.0
7	A'N'D_zh.wikipedia.org_all-access_spider	118.0	26.0	30.0	24.0	29.0	127.0	53.0	37.0	20.0	...	64.0	35.0	35.0	28.0	20.0	23.0	32.0	39.0	32.0	17.0
8	AKB48_zh.wikipedia.org_all-access_spider	5.0	23.0	14.0	12.0	9.0	9.0	35.0	15.0	14.0	...	34.0	105.0	72.0	36.0	33.0	30.0	36.0	38.0	31.0	97.0
9	ASCII_zh.wikipedia.org_all-access_spider	6.0	3.0	5.0	12.0	6.0	5.0	4.0	13.0	9.0	...	25.0	17.0	22.0	29.0	30.0	29.0	35.0	44.0	26.0	41.0
10	ASTRO_zh.wikipedia.org_all-access_spider	NaN	NaN	NaN	NaN	NaN	1.0	1.0	NaN	NaN	...	11.0	38.0	85.0	79.0	30.0	14.0	10.0	38.0	12.0	51.0
11	Ahq_e-Sports_Club_zh.wikipedia.org_all-access_...	2.0	1.0	4.0	4.0	2.0	6.0	3.0	6.0	9.0	...	8.0	17.0	18.0	48.0	19.0	14.0	9.0	23.0	11.0	7.0
12	All_your_base_are_belong_to_us_zh.wikipedia.or...	2.0	5.0	5.0	1.0	3.0	3.0	5.0	3.0	17.0	...	5.0	4.0	4.0	5.0	2.0	9.0	7.0	4.0	5.0	0.0
13	AlphaGo_zh.wikipedia.org_all-access_spider	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	14.0	13.0	14.0	17.0	19.0	56.0	21.0	13.0	21.0	11.0
14	Android_zh.wikipedia.org_all-access_spider	8.0	27.0	9.0	25.0	25.0	10.0	34.0	22.0	17.0	...	36.0	36.0	46.0	42.0	40.0	40.0	66.0	43.0	38.0	74.0

```
df.isna().sum(axis = 0)
```

```
Page              0
2015-07-01    20740
2015-07-02    20816
```

```
2015-07-03    20544
2015-07-04    20654
              ...
2016-12-27     3701
2016-12-28     3822
2016-12-29     3826
2016-12-30     3635
2016-12-31     3465
Length: 551, dtype: int64
```

```
df.isna().sum(axis = 1)
```

```
0           0
1           0
2           0
3           0
4         291
         ...
145058    544
145059    550
145060    550
145061    550
145062    550
Length: 145063, dtype: int64
```

```
dates = df.columns[1:]
dates.min(), dates.max()
```

```
('2015-07-01', '2016-12-31')
```

```
pd.to_datetime(dates.max()) - pd.to_datetime(dates.min())
```

```
Timedelta('549 days 00:00:00')
```

```
df['Page'].str.contains('wikipedia.org').sum()
```

```
127208
```

```
df[~df['Page'].str.contains('wikipedia.org')]
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
13332	Accueil_commons.wikimedia.org_all-access_spider	55.0	48.0	44.0	35.0	46.0	41.0	32.0	43.0	40.0	...	69.0	74.0	34.0	62.0	88.0	57.0	74.0	61.0	51.0	60.0
13333	Atlas_of_Asia_commons.wikimedia.org_all-access...	5.0	3.0	4.0	6.0	3.0	1.0	5.0	6.0	6.0	...	49.0	43.0	44.0	38.0	31.0	29.0	37.0	32.0	29.0	34.0
13334	Atlas_of_Europe_commons.wikimedia.org_all-acce...	4.0	6.0	9.0	7.0	6.0	4.0	5.0	6.0	13.0	...	34.0	44.0	47.0	46.0	35.0	31.0	31.0	34.0	28.0	27.0
13335	Atlas_of_World_War_II_commons.wikimedia.org_al...	5.0	2.0	6.0	6.0	8.0	11.0	5.0	5.0	6.0	...	12.0	18.0	13.0	11.0	8.0	8.0	13.0	5.0	11.0	6.0
13336	Atlas_of_colonialism_commons.wikimedia.org_all...	8.0	6.0	15.0	5.0	5.0	9.0	10.0	3.0	9.0	...	46.0	32.0	40.0	38.0	29.0	19.0	30.0	29.0	26.0	26.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
84730	help:contents_www.mediawiki.org_all-access_spider	NaN	0.0	NaN	NaN	0.0	0.0	NaN	NaN	0.0	...	17.0	7.0	8.0	15.0	7.0	18.0	17.0	15.0	3.0	11.0
84731	how_to_contribute_www.mediawiki.org_all-access...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	183.0	37.0	4.0	18.0	2.0	172.0	19.0	29.0	2.0	178.0
84732	mediawiki_www.mediawiki.org_all-access_spider	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	30.0	48.0	13.0	24.0	11.0	12.0	51.0	23.0	3.0	48.0
84733	special:book_www.mediawiki.org_all-access_spider	0.0	0.0	0.0	0.0	0.0	NaN	0.0	0.0	0.0	...	180.0	40.0	3.0	53.0	300.0	3.0	44.0	6.0	0.0	154.0
84734	special:translate_www.mediawiki.org_all-access...	0.0	0.0	0.0	0.0	0.0	1.0	NaN	NaN	0.0	...	333.0	26.0	1.0	39.0	346.0	2.0	28.0	4.0	163.0	1.0

```
df_other = df[~df['Page'].str.contains('wikipedia.org')]
df_other.head(50).tail(20)
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
13362	Category:All_media_needing_categories_as_of_20...	12.0	2.0	9.0	2.0	5.0	3.0	2.0	6.0	2.0	...	3.0	1.0	3.0	1.0	7.0	2.0	5.0	2.0	4.0	0.0
13363	Category:All_media_needing_categories_as_of_20...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	40.0	31.0	35.0	45.0	39.0	48.0	154.0	30.0	31.0	45.0
13364	Category:Alt_porn_commons.wikimedia.org_all-ac...	0.0	0.0	2.0	0.0	1.0	2.0	0.0	1.0	0.0	...	2.0	3.0	1.0	4.0	3.0	3.0	2.0	3.0	5.0	6.0
13365	Category:Anal_and_vaginal_sex_in_threesome_in_...	0.0	0.0	1.0	2.0	2.0	1.0	1.0	3.0	2.0	...	3.0	4.0	4.0	3.0	4.0	4.0	5.0	1.0	3.0	2.0
13366	Category:Anal_balls_commons.wikimedia.org_all-...	3.0	2.0	2.0	3.0	2.0	1.0	2.0	58.0	49.0	...	0.0	0.0	4.0	2.0	0.0	1.0	0.0	0.0	0.0	2.0
13367	Category:Anal_beads_commons.wikimedia.org_all-...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	4.0	4.0	1.0	4.0	3.0	5.0	4.0	0.0	4.0	1.0
13368	Category:Anal_fisting_commons.wikimedia.org_al...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.0	0.0	0.0	1.0	3.0	5.0	0.0	1.0	2.0	1.0
13369	Category:Anal_sex_commons.wikimedia.org_all-ac...	9.0	10.0	10.0	3.0	4.0	5.0	3.0	8.0	8.0	...	8.0	9.0	7.0	13.0	28.0	12.0	17.0	21.0	11.0	20.0
13370	Category:Anal_sex_(gay)_in_art_commons.wikimed...	6.0	1.0	1.0	6.0	1.0	1.0	2.0	5.0	2.0	...	2.0	5.0	3.0	5.0	3.0	1.0	1.0	1.0	6.0	0.0
13371	Category:Anal_sex_in_art_commons.wikimedia.org...	0.0	0.0	1.0	0.0	3.0	2.0	3.0	0.0	2.0	...	4.0	3.0	2.0	5.0	2.0	5.0	2.0	1.0	2.0	2.0
13372	Category:Anal_use_of_dildos_commons.wikimedia....	2.0	0.0	0.0	0.0	0.0	1.0	2.0	3.0	0.0	...	0.0	3.0	0.0	3.0	3.0	0.0	3.0	1.0	1.0	0.0
13373	Category:Anatomy_of_human_vaginas_commons.wiki...	1.0	2.0	1.0	2.0	1.0	2.0	3.0	2.0	0.0	...	3.0	5.0	2.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
13374	Category:Andy_San_Dimas_commons.wikimedia.org_...	1.0	1.0	1.0	2.0	0.0	1.0	1.0	5.0	0.0	...	38.0	15.0	4.0	6.0	16.0	14.0	15.0	19.0	13.0	20.0
13375	Category:Animalia_commons.wikimedia.org_all-ac...	25.0	23.0	14.0	17.0	15.0	29.0	12.0	23.0	12.0	...	27.0	28.0	27.0	25.0	60.0	25.0	27.0	30.0	34.0	27.0
13376	Category:Animations_commons.wikimedia.org_all-...	9.0	17.0	8.0	10.0	8.0	13.0	12.0	25.0	19.0	...	21.0	21.0	17.0	28.0	52.0	14.0	20.0	21.0	13.0	21.0
13377	Category:Animations_of_machinery_commons.wikim...	1.0	0.0	1.0	1.0	1.0	1.0	0.0	4.0	1.0	...	4.0	3.0	2.0	2.0	3.0	1.0	3.0	2.0	1.0	3.0
13378	Category:Anus_commons.wikimedia.org_all-access...	7.0	6.0	3.0	7.0	4.0	2.0	4.0	10.0	14.0	...	8.0	7.0	3.0	8.0	9.0	7.0	2.0	5.0	7.0	13.0
13379	Category:Apple_Inc._employees_commons.wikimedi...	5.0	0.0	NaN	1.0	2.0	2.0	1.0	3.0	NaN	...	1.0	3.0	0.0	3.0	2.0	1.0	1.0	1.0	0.0	1.0
13380	Category:Art_commons.wikimedia.org_all-access_...	32.0	32.0	16.0	20.0	10.0	25.0	20.0	56.0	24.0	...	32.0	37.0	42.0	49.0	58.0	36.0	46.0	42.0	42.0	53.0
13381	Category:Ashlynn_Brooke_commons.wikimedia.org_...	3.0	5.0	2.0	0.0	3.0	2.0	2.0	8.0	2.0	...	21.0	9.0	8.0	7.0	9.0	10.0	15.0	15.0	12.0	12.0

Feature Engineering: Creation of new columns using the Page Name column by splitting the string

Here we find that there are two sets of data in our data:

One whose domain name is wikipedia.org and the other whose domain is either wikimedia and mediawiki. So let's split the data for domain wikipedia.org

```
df_wiki = df[df['Page'].str.contains('wikipedia.org_')]
df_wiki
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
0	2NE1_zh.wikipedia.org_all-access_spider	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	...	32.0	63.0	15.0	26.0	14.0	20.0	22.0	19.0	18.0	20.0
1	2PM_zh.wikipedia.org_all-access_spider	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	...	17.0	42.0	28.0	15.0	9.0	30.0	52.0	45.0	26.0	20.0
2	3C_zh.wikipedia.org_all-access_spider	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	...	3.0	1.0	1.0	7.0	4.0	4.0	6.0	3.0	4.0	17.0
3	4minute_zh.wikipedia.org_all-access_spider	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	...	32.0	10.0	26.0	27.0	16.0	11.0	17.0	19.0	10.0	11.0
4	52_Hz_I_Love_You_zh.wikipedia.org_all-access_s...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	48.0	9.0	25.0	13.0	3.0	11.0	27.0	13.0	36.0	10.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145058	Underworld_(serie_de_películas)_es.wikipedia.o...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	13.0	12.0	13.0	3.0	5.0	10.0
145059	Resident_Evil:_Capítulo_Final_es.wikipedia.org...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
145060	Enamorándome_de_Ramón_es.wikipedia.org_all-acc...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
145061	Hasta_el_último_hombre_es.wikipedia.org_all-ac...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
145062	Francisco_el_matemático_(serie_de_televisión_d...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

```
df_wiki[['pre', 'suf']] = df_wiki['Page'].str.split('.wikipedia.org_', expand = True)
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/965921108.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_wiki[['pre', 'suf']] = df_wiki['Page'].str.split('.wikipedia.org_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/965921108.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_wiki[['pre', 'suf']] = df_wiki['Page'].str.split('.wikipedia.org_', expand = True)
```

```
df_wiki
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	pre
0	2NE1_zh.wikipedia.org_all-access_spider	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	...	15.0	26.0	14.0	20.0	22.0	19.0	18.0	20.0	2NE1_zh
1	2PM_zh.wikipedia.org_all-access_spider	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	...	28.0	15.0	9.0	30.0	52.0	45.0	26.0	20.0	2PM_zh
2	3C_zh.wikipedia.org_all-access_spider	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	...	1.0	7.0	4.0	4.0	6.0	3.0	4.0	17.0	3C_zh
3	4minute_zh.wikipedia.org_all-access_spider	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	...	26.0	27.0	16.0	11.0	17.0	19.0	10.0	11.0	4minute_zh
4	52_Hz_I_Love_You_zh.wikipedia.org_all-access_s...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	25.0	13.0	3.0	11.0	27.0	13.0	36.0	10.0	52_Hz_I_Love_You_zh
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145058	Underworld_(serie_de_películas)_es.wikipedia.o...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	13.0	12.0	13.0	3.0	5.0	10.0	Underworld_(serie_de_películas)_es
145059	Resident_Evil:_Capítulo_Final_es.wikipedia.org...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Resident_Evil:_Capítulo_Final_es
145060	Enamorándome_de_Ramón_es.wikipedia.org_all-acc...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Enamorándome_de_Ramón_es
145061	Hasta_el_último_hombre_es.wikipedia.org_all-ac...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Hasta_el_último_hombre_es
145062	Francisco_el_matemático_(serie_de_televisión_d...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Francisco_el_matemático_(serie_de_televisión_d...

127208 rows × 553 columns

```
df_wiki['suf'].value_counts()
```

```
suf
all-access_all-agents    35099
mobile-web_all-agents    30923
all-access_spider        30614
desktop_all-agents       30572
Name: count, dtype: int64
```

```
df_wiki[['access_type', 'access_origin']] = df_wiki['suf'].str.split('_', expand = True)
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1254405575.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_wiki[['access_type', 'access_origin']] = df_wiki['suf'].str.split('_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1254405575.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_wiki[['access_type', 'access_origin']] = df_wiki['suf'].str.split('_', expand = True)
```

```
df_wiki[['access_type', 'access_origin']]
```

	access_type	access_origin
0	all-access	spider
1	all-access	spider
2	all-access	spider
3	all-access	spider
4	all-access	spider
...	...	...
145058	all-access	spider
145059	all-access	spider
145060	all-access	spider
145061	all-access	spider
145062	all-access	spider

```
df_wiki['name'] = df_wiki['pre'].str[:-3]
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/18284883.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_wiki['name'] = df_wiki['pre'].str[:-3]
```

```
df_wiki['name']
```

```
0                                                    2NE1
1                                                     2PM
2                                                      3C
3                                                 4minute
4                                        52_Hz_I_Love_You
                                ...
145058                       Underworld_(serie_de_películas)
145059                        Resident_Evil:_Capítulo_Final
145060                                Enamorándome_de_Ramón
145061                               Hasta_el_último_hombre
145062    Francisco_el_matemático_(serie_de_televisión_d...
Name: name, Length: 127208, dtype: object
```

```
df_wiki['lang'] = df_wiki['pre'].str[-2:]
df_wiki['lang']
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1874729731.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_wiki['lang'] = df_wiki['pre'].str[-2:]
0         zh
1         zh
2         zh
3         zh
4         zh
          ..
145058    es
145059    es
145060    es
145061    es
```

```
145062    es
Name: lang, Length: 127208, dtype: object
```

```
df_wiki.drop(columns = ['Page', 'pre', 'suf'], inplace = True)
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/914478054.py:1: 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
  df_wiki.drop(columns = ['Page', 'pre', 'suf'], inplace = True)
```

```
df_wiki
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	access_type	access_origin	name	lang
0	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	24.0	...	14.0	20.0	22.0	19.0	18.0	20.0	all-access	spider	2NE1	zh
1	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	4.0	...	9.0	30.0	52.0	45.0	26.0	20.0	all-access	spider	2PM	zh
2	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	4.0	...	4.0	4.0	6.0	3.0	4.0	17.0	all-access	spider	3C	zh
3	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	16.0	...	16.0	11.0	17.0	19.0	10.0	11.0	all-access	spider	4minute	zh
4	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	3.0	11.0	27.0	13.0	36.0	10.0	all-access	spider	52_Hz_I_Love_You	zh
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145058	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	13.0	12.0	13.0	3.0	5.0	10.0	all-access	spider	Underworld_(serie_de_películas)	es
145059	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	all-access	spider	Resident_Evil:_Capítulo_Final	es
145060	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	all-access	spider	Enamorándome_de_Ramón	es
145061	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	all-access	spider	Hasta_el_último_hombre	es
145062	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	all-access	spider	Francisco_el_matemático_(serie_de_televisión_d...	es

```
df_wiki['lang'].value_counts()
```

```
lang
en    24108
ja    20431
de    18547
fr    17802
zh    17229
ru    15022
es    14069
Name: count, dtype: int64
```

Let's do the same with the other set of rows which have a different domain name.

```
df_other.tail(20)
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
84715	Wikimedia_Engineering/2016-17_Q2_Goals_www.med...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	4.0	4.0	7.0	3.0	0.0	2.0	1.0	0.0	1.0	3.0
84716	Wikimedia_Engineering/2016-17_Q3_Goals_www.med...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	1.0	1.0	3.0	3.0	1.0	2.0	2.0	2.0	0.0	1.0
84717	Wikimedia_Engineering/Introducing_Victoria_Col...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	12.0	8.0	9.0	3.0	14.0	9.0	6.0	8.0	7.0	2.0
84718	Wikimedia_Hackathon_2016/Showcase_www.mediawik...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	1.0	2.0	1.0	0.0	NaN	0.0	1.0	0.0
84719	Wikimedia_Hackathon_2017/Participants_www.medi...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	4.0	1.0	2.0	NaN	1.0	1.0	0.0	1.0	1.0
84720	Wikimedia_Hackathon_2017/Register_and_Attend_w...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	5.0	2.0	2.0	NaN	1.0	1.0	1.0	0.0	NaN
84721	Wikimedia_Hackathon_Amrita_University_www.medi...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.0	3.0	7.0	8.0	2.0	3.0	2.0	4.0	0.0	1.0
84722	Wikimedia_Hackathon_BPHC_www.mediawiki.org_all...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	3.0	1.0	2.0	0.0	2.0	1.0	0.0	0.0	1.0	1.0
84723	Wikimedia_Language_engineering_www.mediawiki.o...	29.0	73.0	32.0	44.0	54.0	33.0	38.0	12.0	10.0	...	4.0	13.0	6.0	7.0	14.0	4.0	8.0	10.0	16.0	11.0
84724	Wikimedia_Product_www.mediawiki.org_all-access...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	3.0	13.0	23.0	7.0	9.0	8.0	32.0	34.0	5.0	6.0
84725	Wikimedia_Research_www.mediawiki.org_all-acces...	1.0	1.0	0.0	1.0	0.0	3.0	1.0	1.0	0.0	...	33.0	4.0	11.0	8.0	5.0	2.0	10.0	4.0	6.0	10.0
84726	Wikimedia_Research/Showcase_www.mediawiki.org_...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	5.0	7.0	8.0	2.0	4.0	7.0	3.0	3.0	4.0	8.0
84727	Wikipedia_Zero_www.mediawiki.org_all-access_sp...	11.0	12.0	14.0	7.0	9.0	13.0	9.0	6.0	13.0	...	4.0	9.0	7.0	7.0	5.0	11.0	7.0	5.0	12.0	7.0
84728	Wikispeech_www.mediawiki.org_all-access_spider	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	6.0	8.0	7.0	3.0	5.0	21.0	0.0	1.0	2.0	3.0
84729	Zürich_Hackathon_2014_www.mediawiki.org_all-ac...	3.0	19.0	19.0	30.0	21.0	24.0	17.0	178.0	40.0	...	6.0	7.0	4.0	8.0	2.0	4.0	9.0	4.0	11.0	12.0
84730	help:contents_www.mediawiki.org_all-access_spider	NaN	0.0	NaN	NaN	0.0	0.0	NaN	NaN	0.0	...	17.0	7.0	8.0	15.0	7.0	18.0	17.0	15.0	3.0	11.0
84731	how_to_contribute_www.mediawiki.org_all-access...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	183.0	37.0	4.0	18.0	2.0	172.0	19.0	29.0	2.0	178.0
84732	mediawiki_www.mediawiki.org_all-access_spider	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	30.0	48.0	13.0	24.0	11.0	12.0	51.0	23.0	3.0	48.0
84733	special:book_www.mediawiki.org_all-access_spider	0.0	0.0	0.0	0.0	0.0	NaN	0.0	0.0	0.0	...	180.0	40.0	3.0	53.0	300.0	3.0	44.0	6.0	0.0	154.0
84734	special:translate_www.mediawiki.org_all-access...	0.0	0.0	0.0	0.0	0.0	1.0	NaN	NaN	0.0	...	333.0	26.0	1.0	39.0	346.0	2.0	28.0	4.0	163.0	1.0

```
df_other.head(20)
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
13332	Accueil_commons.wikimedia.org_all-access_spider	55.0	48.0	44.0	35.0	46.0	41.0	32.0	43.0	40.0	...	69.0	74.0	34.0	62.0	88.0	57.0	74.0	61.0	51.0	60.0
13333	Atlas_of_Asia_commons.wikimedia.org_all-access...	5.0	3.0	4.0	6.0	3.0	1.0	5.0	6.0	6.0	...	49.0	43.0	44.0	38.0	31.0	29.0	37.0	32.0	29.0	34.0
13334	Atlas_of_Europe_commons.wikimedia.org_all-acce...	4.0	6.0	9.0	7.0	6.0	4.0	5.0	6.0	13.0	...	34.0	44.0	47.0	46.0	35.0	31.0	31.0	34.0	28.0	27.0
13335	Atlas_of_World_War_II_commons.wikimedia.org_al...	5.0	2.0	6.0	6.0	8.0	11.0	5.0	5.0	6.0	...	12.0	18.0	13.0	11.0	8.0	8.0	13.0	5.0	11.0	6.0
13336	Atlas_of_colonialism_commons.wikimedia.org_all...	8.0	6.0	15.0	5.0	5.0	9.0	10.0	3.0	9.0	...	46.0	32.0	40.0	38.0	29.0	19.0	30.0	29.0	26.0	26.0
13337	Atlas_of_the_United_Kingdom_commons.wikimedia....	5.0	7.0	6.0	10.0	7.0	8.0	6.0	3.0	8.0	...	16.0	12.0	18.0	10.0	9.0	21.0	13.0	27.0	12.0	8.0
13338	Atlas_of_the_United_States_commons.wikimedia.o...	10.0	14.0	13.0	20.0	9.0	18.0	10.0	9.0	19.0	...	11.0	22.0	18.0	13.0	11.0	49.0	10.0	14.0	17.0	12.0
13339	Bikini_commons.wikimedia.org_all-access_spider	4.0	5.0	2.0	2.0	2.0	1.0	5.0	5.0	5.0	...	4.0	9.0	5.0	7.0	4.0	4.0	5.0	7.0	8.0	4.0
13340	Campaign:OFBA2016_commons.wikimedia.org_all-ac...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	4.0	7.0	1.0	2.0	3.0	2.0	3.0	2.0	2.0	4.0
13341	Catalogue_of_Wilhelm_von_Gloeden's_pictures_co...	3.0	4.0	5.0	2.0	3.0	5.0	1.0	1.0	0.0	...	7.0	6.0	5.0	5.0	10.0	5.0	12.0	81.0	8.0	7.0
13342	Category:1920s_videos_of_ejaculation_commons.w...	0.0	0.0	0.0	0.0	0.0	1.0	2.0	0.0	5.0	...	1.0	1.0	3.0	1.0	1.0	1.0	1.0	0.0	1.0	3.0
13343	Category:1920s_videos_of_male_masturbation_com...	0.0	2.0	0.0	1.0	2.0	0.0	1.0	1.0	0.0	...	1.0	4.0	6.0	2.0	3.0	4.0	1.0	1.0	0.0	2.0
13344	Category:1930s_videos_of_ejaculation_commons.w...	1.0	0.0	0.0	1.0	0.0	0.0	4.0	1.0	0.0	...	1.0	2.0	0.0	1.0	0.0	3.0	1.0	1.0	1.0	0.0
13345	Category:2000s_ejaculation_(animated)_commons....	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.0	3.0	...	3.0	3.0	4.0	2.0	1.0	1.0	3.0	2.0	2.0	1.0
13346	Category:2000s_male_masturbation_(animated)_co...	3.0	1.0	1.0	0.0	0.0	1.0	0.0	1.0	2.0	...	1.0	1.0	2.0	1.0	3.0	2.0	2.0	3.0	3.0	3.0
13347	Category:2010s_male_masturbation_(animated)_co...	3.0	0.0	3.0	2.0	2.0	0.0	2.0	6.0	6.0	...	9.0	4.0	6.0	2.0	4.0	6.0	2.0	5.0	4.0	4.0
13348	Category:2010s_videos_of_ejaculation_commons.w...	4.0	1.0	3.0	6.0	4.0	2.0	7.0	5.0	3.0	...	12.0	6.0	11.0	8.0	15.0	5.0	5.0	6.0	13.0	3.0
13349	Category:2010s_videos_of_male_masturbation_com...	7.0	2.0	4.0	4.0	2.0	2.0	4.0	6.0	5.0	...	6.0	8.0	1.0	5.0	14.0	1.0	5.0	3.0	6.0	7.0
13350	Category:2013_commons.wikimedia.org_all-access...	8.0	4.0	7.0	8.0	2.0	4.0	2.0	13.0	5.0	...	17.0	22.0	11.0	7.0	10.0	17.0	1.0	12.0	27.0	7.0
13351	Category:2016_Berlin_Christmas_market_truck_at...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	61.0	26.0	18.0	1.0	7.0	6.0	1.0	2.0	3.0	5.0

```
df_other['Page'].str.split('.').str[-1].value_counts()
```

```
Page
org_mobile-web_all-agents    5016
org_all-access_all-agents    4303
org_all-access_spider        4299
org_desktop_all-agents       4237
Name: count, dtype: int64
```

```
df_other['Page'].str.contains('mediawiki').sum() + df_other['Page'].str.contains('wikimedia').sum()
```

```
17855
```

```
df_other.shape
```

```
(17855, 551)
```

Let's again split the data into two parts, one which has mediawiki and the other which has wikimedia.

```
df_other1 = df_other.loc[df_other['Page'].str.contains('_www.mediawiki.org_')]
df_other1
```

	Page	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	...	2016-12-22	2016-12-23	2016-12-24	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31
19611	"Keep_me_logged_in"_extended_to_one_year_www.m...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	17.0	18.0	11.0	15.0	11.0	15.0	10.0	14.0	7.0	12.0
19612	2017_wikitext_editor_www.mediawiki.org_all-acc...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	91.0	50.0	47.0	40.0	31.0	61.0	52.0	43.0	100.0	73.0
19613	2017_wikitext_editor/Feedback_www.mediawiki.or...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	32.0	45.0	41.0	17.0	21.0	52.0	48.0	32.0	41.0	19.0
19614	API_www.mediawiki.org_all-access_all-agents	528.0	587.0	634.0	483.0	510.0	559.0	625.0	594.0	565.0	...	479.0	317.0	234.0	598.0	283.0	399.0	334.0	351.0	358.0	275.0
19615	API:Account_creation_www.mediawiki.org_all-acc...	37.0	38.0	46.0	41.0	79.0	91.0	100.0	54.0	43.0	...	55.0	37.0	23.0	387.0	35.0	38.0	38.0	28.0	45.0	41.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
84730	help:contents_www.mediawiki.org_all-access_spider	NaN	0.0	NaN	NaN	0.0	0.0	NaN	NaN	0.0	...	17.0	7.0	8.0	15.0	7.0	18.0	17.0	15.0	3.0	11.0
84731	how_to_contribute_www.mediawiki.org_all-access...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	183.0	37.0	4.0	18.0	2.0	172.0	19.0	29.0	2.0	178.0
84732	mediawiki_www.mediawiki.org_all-access_spider	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	30.0	48.0	13.0	24.0	11.0	12.0	51.0	23.0	3.0	48.0
84733	special:book_www.mediawiki.org_all-access_spider	0.0	0.0	0.0	0.0	0.0	NaN	0.0	0.0	0.0	...	180.0	40.0	3.0	53.0	300.0	3.0	44.0	6.0	0.0	154.0
84734	special:translate_www.mediawiki.org_all-access...	0.0	0.0	0.0	0.0	0.0	1.0	NaN	NaN	0.0	...	333.0	26.0	1.0	39.0	346.0	2.0	28.0	4.0	163.0	1.0

```
df_other1[['name','suf']] = df_other1['Page'].str.split('_www.mediawiki.org_', expand = True)
df_other1[['access_type','access_origin']] = df_other1['suf'].str.split('_', expand = True)
df_other1.drop(columns = ['suf', 'Page'], inplace = True)
df_other1
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/423571554.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other1[['name','suf']] = df_other1['Page'].str.split('_www.mediawiki.org_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/423571554.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other1[['name','suf']] = df_other1['Page'].str.split('_www.mediawiki.org_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/423571554.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other1[['access_type','access_origin']] = df_other1['suf'].str.split('_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/423571554.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other1[['access_type','access_origin']] = df_other1['suf'].str.split('_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/423571554.py:3: 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
  df_other1.drop(columns = ['suf', 'Page'], inplace = True)
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	name	access_type	access_origin
19611	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	15.0	11.0	15.0	10.0	14.0	7.0	12.0	"Keep_me_logged_in"_extended_to_one_year	all-access	all-agents
19612	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	40.0	31.0	61.0	52.0	43.0	100.0	73.0	2017_wikitext_editor	all-access	all-agents
19613	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	17.0	21.0	52.0	48.0	32.0	41.0	19.0	2017_wikitext_editor/Feedback	all-access	all-agents
19614	528.0	587.0	634.0	483.0	510.0	559.0	625.0	594.0	565.0	700.0	...	598.0	283.0	399.0	334.0	351.0	358.0	275.0	API	all-access	all-agents
19615	37.0	38.0	46.0	41.0	79.0	91.0	100.0	54.0	43.0	60.0	...	387.0	35.0	38.0	38.0	28.0	45.0	41.0	API:Account_creation	all-access	all-agents
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
84730	NaN	0.0	NaN	NaN	0.0	0.0	NaN	NaN	0.0	NaN	...	15.0	7.0	18.0	17.0	15.0	3.0	11.0	help:contents	all-access	spider
84731	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	18.0	2.0	172.0	19.0	29.0	2.0	178.0	how_to_contribute	all-access	spider
84732	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	24.0	11.0	12.0	51.0	23.0	3.0	48.0	mediawiki	all-access	spider
84733	0.0	0.0	0.0	0.0	0.0	NaN	0.0	0.0	0.0	0.0	...	53.0	300.0	3.0	44.0	6.0	0.0	154.0	special:book	all-access	spider
84734	0.0	0.0	0.0	0.0	0.0	1.0	NaN	NaN	0.0	0.0	...	39.0	346.0	2.0	28.0	4.0	163.0	1.0	special:translate	all-access	spider

```
df_other2 = df_other.loc[df_other['Page'].str.contains('_commons.wikimedia.org_')]
df_other2[['name','suf']] = df_other2['Page'].str.split('_commons.wikimedia.org_', expand = True)
df_other2[['access_type','access_origin']] = df_other2['suf'].str.split('_', expand = True)
df_other2.drop(columns = ['suf', 'Page'], inplace = True)
df_other2
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1812978925.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other2[['name','suf']] = df_other2['Page'].str.split('_commons.wikimedia.org_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1812978925.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other2[['name','suf']] = df_other2['Page'].str.split('_commons.wikimedia.org_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1812978925.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other2[['access_type','access_origin']] = df_other2['suf'].str.split('_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1812978925.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_other2[['access_type','access_origin']] = df_other2['suf'].str.split('_', expand = True)
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/1812978925.py:4: 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
  df_other2.drop(columns = ['suf', 'Page'], inplace = True)
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-25	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	name	access_type	access_origin
13332	55.0	48.0	44.0	35.0	46.0	41.0	32.0	43.0	40.0	38.0	...	62.0	88.0	57.0	74.0	61.0	51.0	60.0	Accueil	all-access	spider
13333	5.0	3.0	4.0	6.0	3.0	1.0	5.0	6.0	6.0	11.0	...	38.0	31.0	29.0	37.0	32.0	29.0	34.0	Atlas_of_Asia	all-access	spider
13334	4.0	6.0	9.0	7.0	6.0	4.0	5.0	6.0	13.0	10.0	...	46.0	35.0	31.0	31.0	34.0	28.0	27.0	Atlas_of_Europe	all-access	spider
13335	5.0	2.0	6.0	6.0	8.0	11.0	5.0	5.0	6.0	13.0	...	11.0	8.0	8.0	13.0	5.0	11.0	6.0	Atlas_of_World_War_II	all-access	spider
13336	8.0	6.0	15.0	5.0	5.0	9.0	10.0	3.0	9.0	6.0	...	38.0	29.0	19.0	30.0	29.0	26.0	26.0	Atlas_of_colonialism	all-access	spider
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82981	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	1.0	2.0	3.0	3.0	4.0	1.0	1.0	Commons:Уики_обича_паметниците_2016_България	desktop	all-agents
82982	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	51.0	45.0	31.0	27.0	31.0	26.0	27.0	File:Landgericht_Berlin,_Littenstraße,_Eingang...	desktop	all-agents
82983	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	File:Battle_of_Mosul_(2016–2017).svg	desktop	all-agents
82984	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	File:Ура!.ogv	desktop	all-agents
82985	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	NaN	File:関東地方居住者の自治体別四年制大学卒業率.png	desktop	all-agents

Joining both the data and also imputing the language column with 'Other' so that this table can again be joined with the 'wiki' table.

```
df_other = pd.concat([df_other1, df_other2], axis = 0)
df_other['lang'] = 'other'
```

```
df_other
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	name	access_type	access_origin	lang
19611	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	11.0	15.0	10.0	14.0	7.0	12.0	"Keep_me_logged_in"_extended_to_one_year	all-access	all-agents	other
19612	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	31.0	61.0	52.0	43.0	100.0	73.0	2017_wikitext_editor	all-access	all-agents	other
19613	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	21.0	52.0	48.0	32.0	41.0	19.0	2017_wikitext_editor/Feedback	all-access	all-agents	other
19614	528.0	587.0	634.0	483.0	510.0	559.0	625.0	594.0	565.0	700.0	...	283.0	399.0	334.0	351.0	358.0	275.0	API	all-access	all-agents	other
19615	37.0	38.0	46.0	41.0	79.0	91.0	100.0	54.0	43.0	60.0	...	35.0	38.0	38.0	28.0	45.0	41.0	API:Account_creation	all-access	all-agents	other
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82981	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.0	3.0	3.0	4.0	1.0	1.0	Commons:Уики_обича_паметниците_2016_България	desktop	all-agents	other
82982	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	45.0	31.0	27.0	31.0	26.0	27.0	File:Landgericht_Berlin,_Littenstraße,_Eingang...	desktop	all-agents	other
82983	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	File:Battle_of_Mosul_(2016–2017).svg	desktop	all-agents	other
82984	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	File:Ура!.ogv	desktop	all-agents	other
82985	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	File:関東地方居住者の自治体別四年制大学卒業率.png	desktop	all-agents	other

```
## Performing a union operation on the entire data set.
df = pd.concat([df_wiki, df_other], axis = 0)
```

```
df
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	access_type	access_origin	name	lang
0	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	24.0	...	14.0	20.0	22.0	19.0	18.0	20.0	all-access	spider	2NE1	zh
1	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	4.0	...	9.0	30.0	52.0	45.0	26.0	20.0	all-access	spider	2PM	zh
2	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	4.0	...	4.0	4.0	6.0	3.0	4.0	17.0	all-access	spider	3C	zh
3	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	16.0	...	16.0	11.0	17.0	19.0	10.0	11.0	all-access	spider	4minute	zh
4	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	3.0	11.0	27.0	13.0	36.0	10.0	all-access	spider	52_Hz_I_Love_You	zh
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82981	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	2.0	3.0	3.0	4.0	1.0	1.0	desktop	all-agents	Commons:Уики_обича_паметниците_2016_България	other
82982	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	45.0	31.0	27.0	31.0	26.0	27.0	desktop	all-agents	File:Landgericht_Berlin,_Littenstraße,_Eingang...	other
82983	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	desktop	all-agents	File:Battle_of_Mosul_(2016–2017).svg	other
82984	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	desktop	all-agents	File:Ура!.ogv	other
82985	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN	NaN	NaN	NaN	NaN	desktop	all-agents	File:関東地方居住者の自治体別四年制大学卒業率.png	other

```
# Dropping duplicate values
df.drop_duplicates(inplace = True)
```

```
df['null_count'] = df.isna().sum(axis = 1)
```

Dropping rows whose count of null values are more than 50.

```
df = df.loc[df.isna().sum(axis = 1)<50]
df
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	access_type	access_origin	name	lang	null_count
0	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	24.0	...	20.0	22.0	19.0	18.0	20.0	all-access	spider	2NE1	zh	0
1	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	4.0	...	30.0	52.0	45.0	26.0	20.0	all-access	spider	2PM	zh	0
2	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	4.0	...	4.0	6.0	3.0	4.0	17.0	all-access	spider	3C	zh	0
3	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	16.0	...	11.0	17.0	19.0	10.0	11.0	all-access	spider	4minute	zh	0
5	12.0	7.0	4.0	5.0	20.0	8.0	5.0	17.0	24.0	7.0	...	19.0	23.0	17.0	17.0	50.0	all-access	spider	5566	zh	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82911	71.0	61.0	60.0	56.0	50.0	60.0	72.0	73.0	57.0	73.0	...	47.0	62.0	68.0	52.0	55.0	desktop	all-agents	Commons:Portale_Comunità	other	0
82912	12.0	12.0	17.0	17.0	8.0	16.0	21.0	15.0	12.0	11.0	...	14.0	16.0	17.0	22.0	18.0	desktop	all-agents	Commons:Média_du_jour	other	0
82914	140.0	137.0	131.0	115.0	83.0	132.0	176.0	162.0	138.0	175.0	...	91.0	122.0	155.0	133.0	114.0	desktop	all-agents	Pàgina_principal	other	0
82917	NaN	1.0	2.0	NaN	1.0	NaN	3.0	1.0	3.0	1.0	...	7.0	1.0	4.0	5.0	2.0	desktop	all-agents	File:Le_pétomane_du_Moulin_Rouge_(1900).webm	other	13
82925	NaN	6.0	8.0	4.0	1.0	1.0	3.0	2.0	2.0	2.0	...	0.0	2.0	3.0	7.0	2.0	desktop	all-agents	File:Louis_Jean_Francois_Lagrenée_-_Amor_and_P...	other	39

```
df.drop(columns = 'null_count',inplace = True)
df
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/2624142291.py:1: 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
  df.drop(columns = 'null_count',inplace = True)
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	access_type	access_origin	name	lang
0	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	24.0	...	14.0	20.0	22.0	19.0	18.0	20.0	all-access	spider	2NE1	zh
1	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	4.0	...	9.0	30.0	52.0	45.0	26.0	20.0	all-access	spider	2PM	zh
2	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	4.0	...	4.0	4.0	6.0	3.0	4.0	17.0	all-access	spider	3C	zh
3	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	16.0	...	16.0	11.0	17.0	19.0	10.0	11.0	all-access	spider	4minute	zh
5	12.0	7.0	4.0	5.0	20.0	8.0	5.0	17.0	24.0	7.0	...	32.0	19.0	23.0	17.0	17.0	50.0	all-access	spider	5566	zh
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82911	71.0	61.0	60.0	56.0	50.0	60.0	72.0	73.0	57.0	73.0	...	50.0	47.0	62.0	68.0	52.0	55.0	desktop	all-agents	Commons:Portale_Comunità	other
82912	12.0	12.0	17.0	17.0	8.0	16.0	21.0	15.0	12.0	11.0	...	21.0	14.0	16.0	17.0	22.0	18.0	desktop	all-agents	Commons:Média_du_jour	other
82914	140.0	137.0	131.0	115.0	83.0	132.0	176.0	162.0	138.0	175.0	...	134.0	91.0	122.0	155.0	133.0	114.0	desktop	all-agents	Pàgina_principal	other
82917	NaN	1.0	2.0	NaN	1.0	NaN	3.0	1.0	3.0	1.0	...	5.0	7.0	1.0	4.0	5.0	2.0	desktop	all-agents	File:Le_pétomane_du_Moulin_Rouge_(1900).webm	other
82925	NaN	6.0	8.0	4.0	1.0	1.0	3.0	2.0	2.0	2.0	...	4.0	0.0	2.0	3.0	7.0	2.0	desktop	all-agents	File:Louis_Jean_Francois_Lagrenée_-_Amor_and_P...	other

Visualizing total views of each page across access_type, access_origin and language

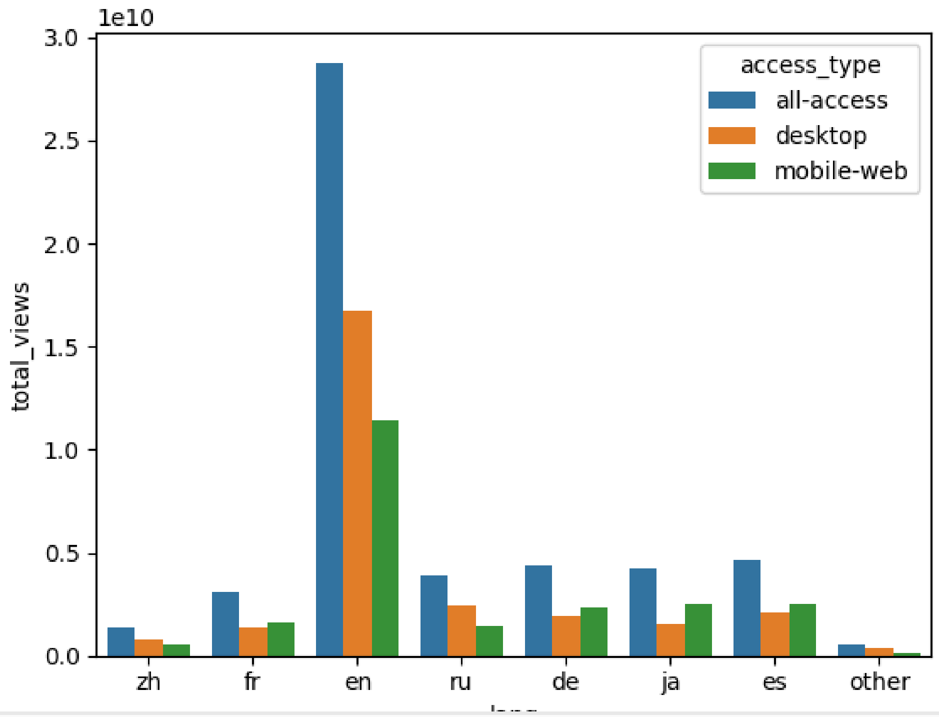
```
df['total_views'] = df.iloc[:,:-4].fillna(0).sum(axis = 1)
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/2128004960.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['total_views'] = df.iloc[:,:-4].fillna(0).sum(axis = 1)
```

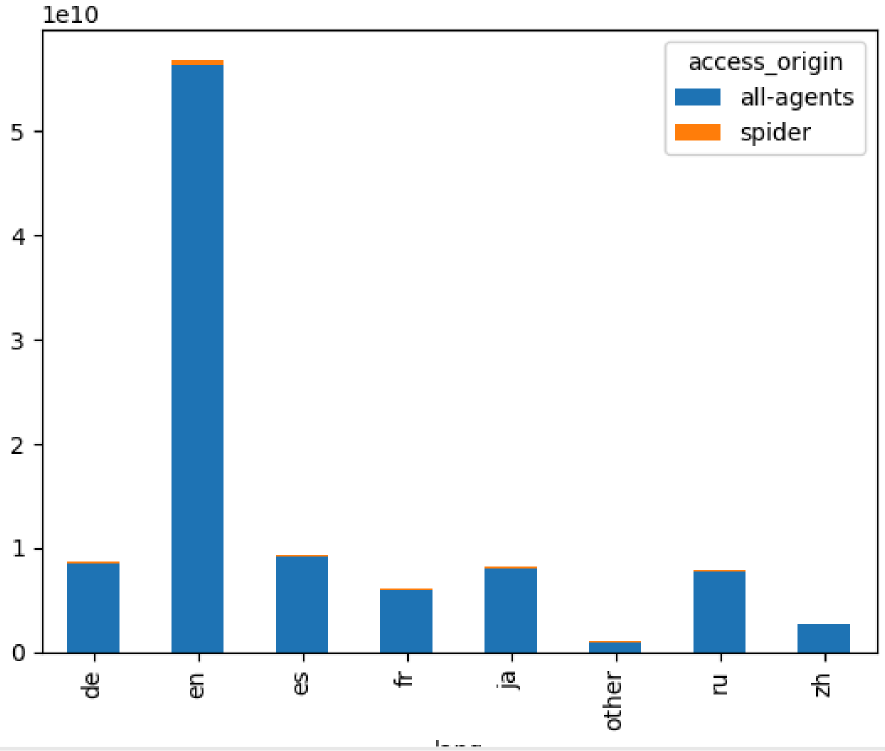
```
sns.barplot(df, x = 'lang', y ='total_views',estimator="sum",  hue= 'access_type', errorbar = None)
```

```
<Axes: xlabel='lang', ylabel='total_views'>
```



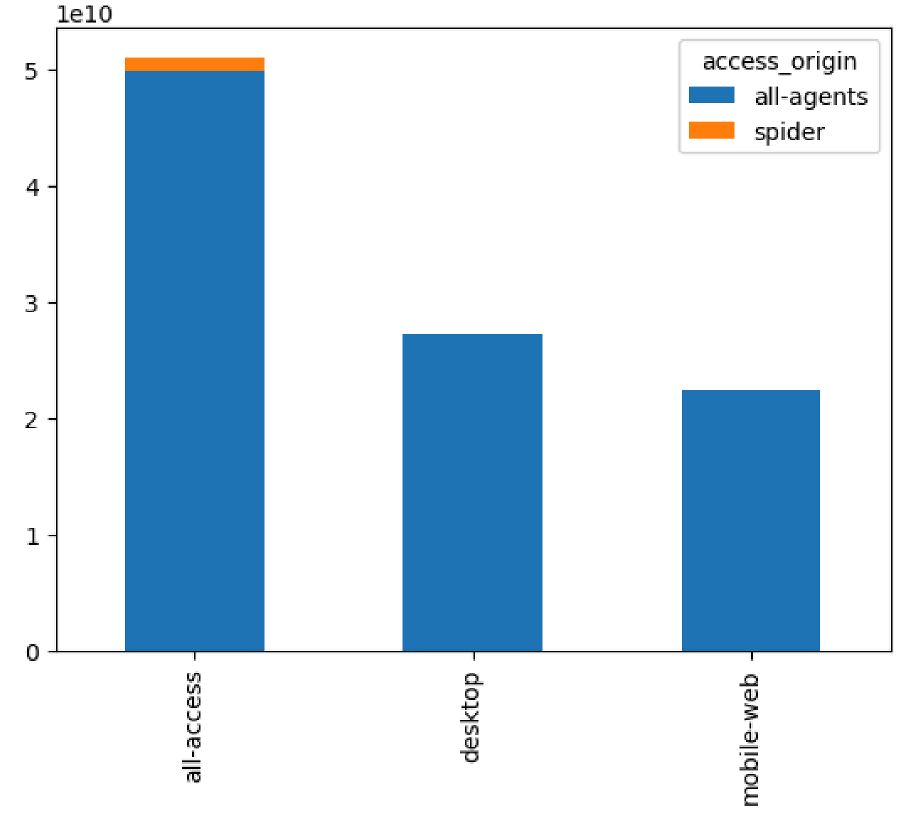
```
bar = df.groupby(['lang','access_origin'])['total_views'].sum().unstack('access_origin')
bar.plot(kind = 'bar', stacked = True)
```

```
<Axes: xlabel='lang'>
```



```
bar = df.groupby(['access_type','access_origin'])['total_views'].sum().unstack('access_origin').fillna(0)
bar.plot(kind = 'bar', stacked = True)
```

```
<Axes: xlabel='access_type'>
```



```
exog
```

	Exog
0	0
1	0
2	0
3	0
4	0
...	...
545	1
546	1
547	1
548	0
549	0

```
df.drop(columns = 'total_views', inplace = True)
```

```
/var/folders/tx/1rbx7xzs2xn_hvqwj21v8cth0000gn/T/ipykernel_5931/3382274676.py:1: 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
  df.drop(columns = 'total_views', inplace = True)
```

```
df
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	access_type	access_origin	name	lang
0	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	24.0	...	14.0	20.0	22.0	19.0	18.0	20.0	all-access	spider	2NE1	zh
1	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	4.0	...	9.0	30.0	52.0	45.0	26.0	20.0	all-access	spider	2PM	zh
2	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	4.0	...	4.0	4.0	6.0	3.0	4.0	17.0	all-access	spider	3C	zh
3	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	16.0	...	16.0	11.0	17.0	19.0	10.0	11.0	all-access	spider	4minute	zh
5	12.0	7.0	4.0	5.0	20.0	8.0	5.0	17.0	24.0	7.0	...	32.0	19.0	23.0	17.0	17.0	50.0	all-access	spider	5566	zh
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82911	71.0	61.0	60.0	56.0	50.0	60.0	72.0	73.0	57.0	73.0	...	50.0	47.0	62.0	68.0	52.0	55.0	desktop	all-agents	Commons:Portale_Comunità	other
82912	12.0	12.0	17.0	17.0	8.0	16.0	21.0	15.0	12.0	11.0	...	21.0	14.0	16.0	17.0	22.0	18.0	desktop	all-agents	Commons:Média_du_jour	other
82914	140.0	137.0	131.0	115.0	83.0	132.0	176.0	162.0	138.0	175.0	...	134.0	91.0	122.0	155.0	133.0	114.0	desktop	all-agents	Pàgina_principal	other
82917	NaN	1.0	2.0	NaN	1.0	NaN	3.0	1.0	3.0	1.0	...	5.0	7.0	1.0	4.0	5.0	2.0	desktop	all-agents	File:Le_pétomane_du_Moulin_Rouge_(1900).webm	other
82925	NaN	6.0	8.0	4.0	1.0	1.0	3.0	2.0	2.0	2.0	...	4.0	0.0	2.0	3.0	7.0	2.0	desktop	all-agents	File:Louis_Jean_Francois_Lagrenée_-_Amor_and_P...	other

```
df2 = df.copy()
```

Imputing null values using linear interpolation.

```
df2
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	access_type	access_origin	name	lang
0	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	24.0	...	14.0	20.0	22.0	19.0	18.0	20.0	all-access	spider	2NE1	zh
1	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	4.0	...	9.0	30.0	52.0	45.0	26.0	20.0	all-access	spider	2PM	zh
2	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	4.0	...	4.0	4.0	6.0	3.0	4.0	17.0	all-access	spider	3C	zh
3	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	16.0	...	16.0	11.0	17.0	19.0	10.0	11.0	all-access	spider	4minute	zh
5	12.0	7.0	4.0	5.0	20.0	8.0	5.0	17.0	24.0	7.0	...	32.0	19.0	23.0	17.0	17.0	50.0	all-access	spider	5566	zh
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82911	71.0	61.0	60.0	56.0	50.0	60.0	72.0	73.0	57.0	73.0	...	50.0	47.0	62.0	68.0	52.0	55.0	desktop	all-agents	Commons:Portale_Comunità	other
82912	12.0	12.0	17.0	17.0	8.0	16.0	21.0	15.0	12.0	11.0	...	21.0	14.0	16.0	17.0	22.0	18.0	desktop	all-agents	Commons:Média_du_jour	other
82914	140.0	137.0	131.0	115.0	83.0	132.0	176.0	162.0	138.0	175.0	...	134.0	91.0	122.0	155.0	133.0	114.0	desktop	all-agents	Pàgina_principal	other
82917	NaN	1.0	2.0	NaN	1.0	NaN	3.0	1.0	3.0	1.0	...	5.0	7.0	1.0	4.0	5.0	2.0	desktop	all-agents	File:Le_pétomane_du_Moulin_Rouge_(1900).webm	other
82925	NaN	6.0	8.0	4.0	1.0	1.0	3.0	2.0	2.0	2.0	...	4.0	0.0	2.0	3.0	7.0	2.0	desktop	all-agents	File:Louis_Jean_Francois_Lagrenée_-_Amor_and_P...	other

```
df2.iloc[:,:-4] = df2.iloc[:,:-4].interpolate(method = 'linear', axis = 1).fillna(0)
```

```
df2
```

	2015-07-01	2015-07-02	2015-07-03	2015-07-04	2015-07-05	2015-07-06	2015-07-07	2015-07-08	2015-07-09	2015-07-10	...	2016-12-26	2016-12-27	2016-12-28	2016-12-29	2016-12-30	2016-12-31	access_type	access_origin	name	lang
0	18.0	11.0	5.0	13.0	14.0	9.0	9.0	22.0	26.0	24.0	...	14.0	20.0	22.0	19.0	18.0	20.0	all-access	spider	2NE1	zh
1	11.0	14.0	15.0	18.0	11.0	13.0	22.0	11.0	10.0	4.0	...	9.0	30.0	52.0	45.0	26.0	20.0	all-access	spider	2PM	zh
2	1.0	0.0	1.0	1.0	0.0	4.0	0.0	3.0	4.0	4.0	...	4.0	4.0	6.0	3.0	4.0	17.0	all-access	spider	3C	zh
3	35.0	13.0	10.0	94.0	4.0	26.0	14.0	9.0	11.0	16.0	...	16.0	11.0	17.0	19.0	10.0	11.0	all-access	spider	4minute	zh
5	12.0	7.0	4.0	5.0	20.0	8.0	5.0	17.0	24.0	7.0	...	32.0	19.0	23.0	17.0	17.0	50.0	all-access	spider	5566	zh
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
82911	71.0	61.0	60.0	56.0	50.0	60.0	72.0	73.0	57.0	73.0	...	50.0	47.0	62.0	68.0	52.0	55.0	desktop	all-agents	Commons:Portale_Comunità	other
82912	12.0	12.0	17.0	17.0	8.0	16.0	21.0	15.0	12.0	11.0	...	21.0	14.0	16.0	17.0	22.0	18.0	desktop	all-agents	Commons:Média_du_jour	other
82914	140.0	137.0	131.0	115.0	83.0	132.0	176.0	162.0	138.0	175.0	...	134.0	91.0	122.0	155.0	133.0	114.0	desktop	all-agents	Pàgina_principal	other
82917	0.0	1.0	2.0	1.5	1.0	2.0	3.0	1.0	3.0	1.0	...	5.0	7.0	1.0	4.0	5.0	2.0	desktop	all-agents	File:Le_pétomane_du_Moulin_Rouge_(1900).webm	other
82925	0.0	6.0	8.0	4.0	1.0	1.0	3.0	2.0	2.0	2.0	...	4.0	0.0	2.0	3.0	7.0	2.0	desktop	all-agents	File:Louis_Jean_Francois_Lagrenée_-_Amor_and_P...	other

```
df2.drop(columns = ['access_type', 'access_origin', 'name'], inplace = True)
```

```
df3 = df2.groupby('lang').mean().T
df3
```

lang	de	en	es	fr	ja	other	ru	zh
2015-07-01	799.647328	4200.900811	1172.206002	521.973465	633.729585	129.850520	690.629757	300.854394
2015-07-02	788.763991	4188.774868	1120.260721	525.326916	727.754240	136.160375	702.591922	301.353872
2015-07-03	757.008443	3975.953755	1030.279301	505.128695	657.242768	128.716826	651.152326	299.338173
2015-07-04	694.663028	4147.187733	967.346374	539.936234	825.702545	109.856529	612.445536	302.212779
2015-07-05	807.571352	4284.875694	1051.982346	530.107138	792.187396	121.784986	652.219098	322.364472
...	...	...	...	...	...	...	...	...
2016-12-27	1137.956061	6858.752143	1089.732597	852.198550	810.105040	184.772165	1019.769264	366.570879
2016-12-28	1081.189712	6643.130524	1128.884642	780.368744	811.275919	214.349310	962.418012	372.836093
2016-12-29	1049.976794	7115.696049	1081.147901	764.657081	888.685015	178.955392	926.553429	343.531336
2016-12-30	1001.049729	5878.098277	822.373628	721.165597	982.269292	183.873276	828.873274	345.738780
2016-12-31	957.042938	5742.486097	793.234707	667.223882	1218.647606	159.885244	922.818567	354.046405

```
df3.iloc[:, -1] = exog['Exog']
```

```
df3
```

lang	de	en	es	fr	ja	other	ru	zh
2015-07-01	799.647328	4200.900811	1172.206002	521.973465	633.729585	129.850520	690.629757	0.0
2015-07-02	788.763991	4188.774868	1120.260721	525.326916	727.754240	136.160375	702.591922	0.0
2015-07-03	757.008443	3975.953755	1030.279301	505.128695	657.242768	128.716826	651.152326	0.0
2015-07-04	694.663028	4147.187733	967.346374	539.936234	825.702545	109.856529	612.445536	0.0
2015-07-05	807.571352	4284.875694	1051.982346	530.107138	792.187396	121.784986	652.219098	0.0
...	...	...	...	...	...	...	...	...
2016-12-27	1137.956061	6858.752143	1089.732597	852.198550	810.105040	184.772165	1019.769264	1.0
2016-12-28	1081.189712	6643.130524	1128.884642	780.368744	811.275919	214.349310	962.418012	1.0
2016-12-29	1049.976794	7115.696049	1081.147901	764.657081	888.685015	178.955392	926.553429	1.0
2016-12-30	1001.049729	5878.098277	822.373628	721.165597	982.269292	183.873276	828.873274	0.0
2016-12-31	957.042938	5742.486097	793.234707	667.223882	1218.647606	159.885244	922.818567	0.0

```
exog
```

	Exog
0	0
1	0
2	0
3	0
4	0
...	...
545	1
546	1
547	1
548	0
549	0

```
exog['Exog']
```

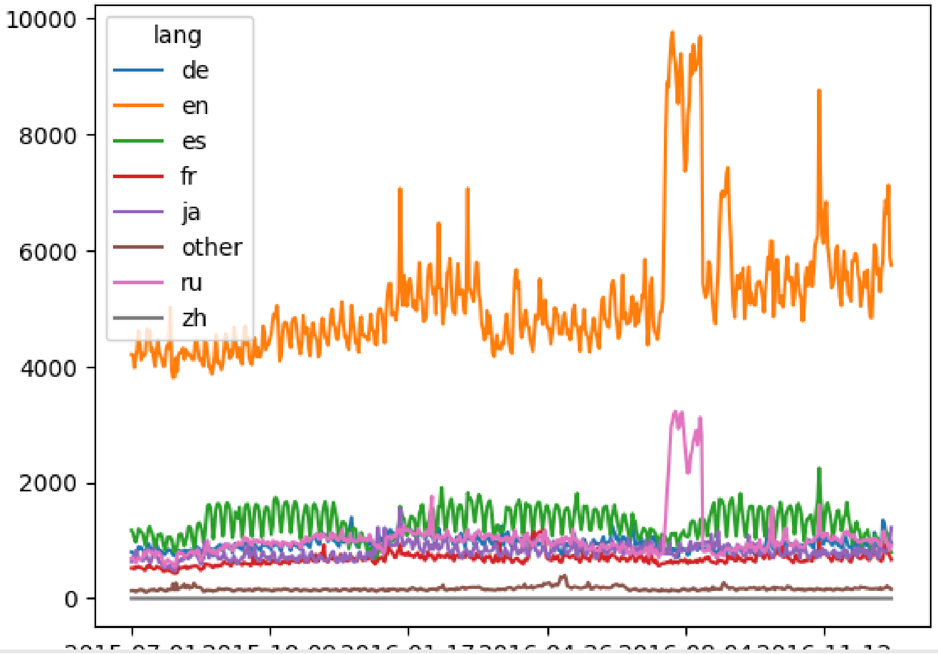
```
0      0
1      0
2      0
3      0
4      0
      ..
545    1
546    1
547    1
548    0
549    0
Name: Exog, Length: 550, dtype: int64
```

```
exog.shape
```

```
(550, 1)
```

```
df3.plot()
```

```
<Axes: >
```

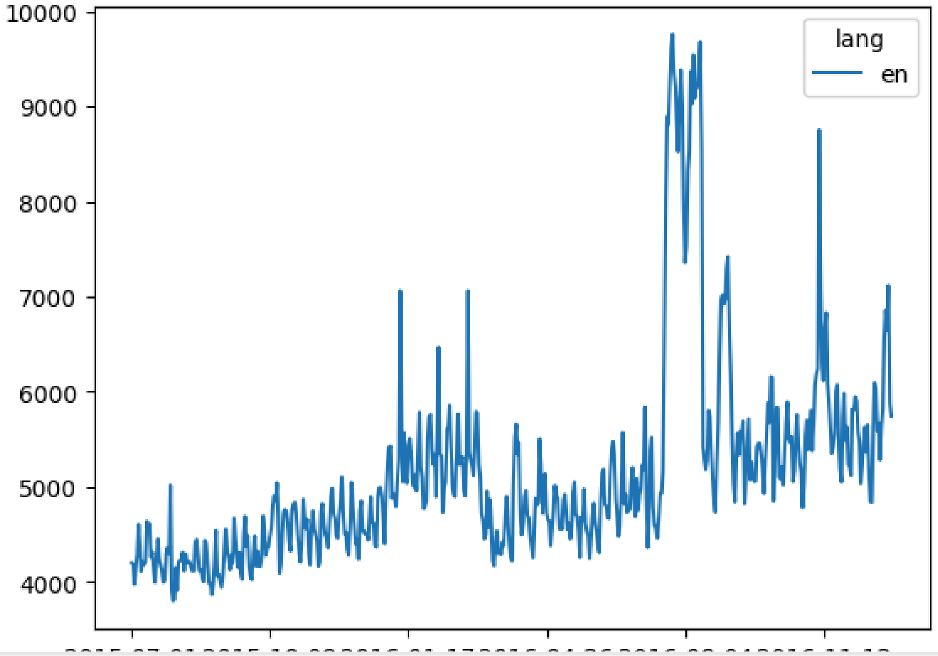


```
eng = df3.loc[:,['en']]
eng
```

lang	en
2015-07-01	4200.900811
2015-07-02	4188.774868
2015-07-03	3975.953755
2015-07-04	4147.187733
2015-07-05	4284.875694
...	...
2016-12-27	6858.752143
2016-12-28	6643.130524
2016-12-29	7115.696049
2016-12-30	5878.098277
2016-12-31	5742.486097

```
eng.plot()
```

```
<Axes: >
```



```
from statsmodels.tsa.stattools import adfuller
result = adfuller(eng, autolag='AIC')
result[1]
```

```
0.12267004620365096
```

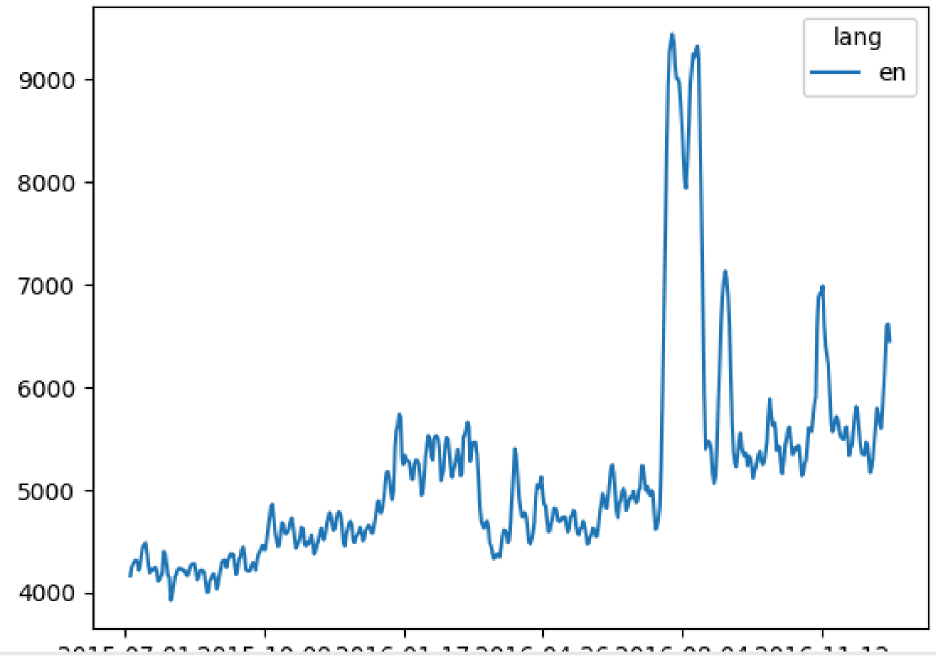
Null Hypothesis (H0): The series has a unit root (non-stationary).

Alternate Hypothesis (H1): The series has no unit root (stationary).

since p>0.05, we can confidently say that the data is non-stationary.

```
eng.rolling(window = 5, center = False).mean().plot()
```

```
<Axes: >
```

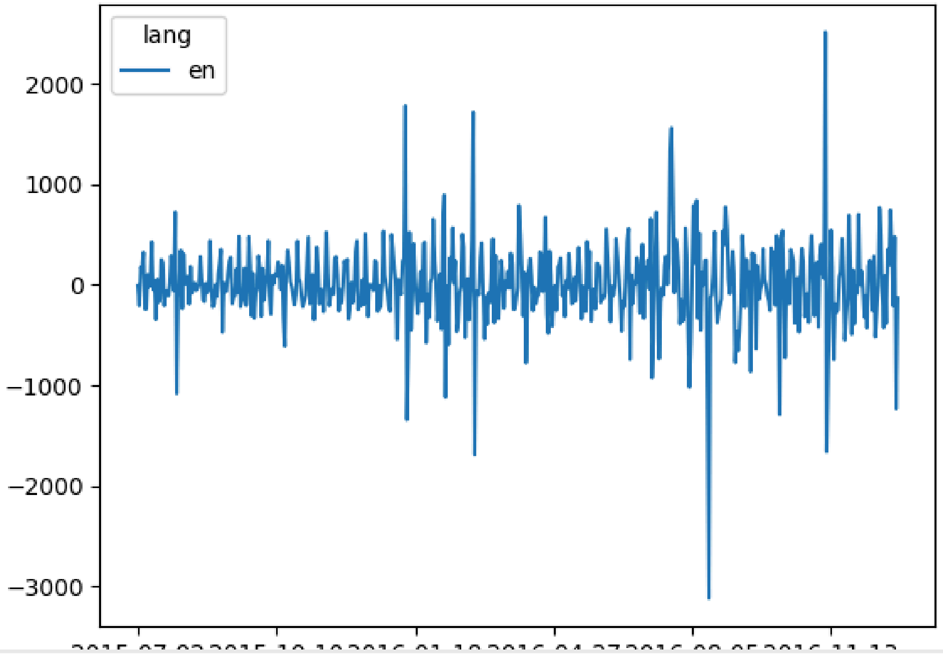


```
eng_dif = eng[1:] - eng.shift(1)[1:]
eng_dif
```

```
      lang           en
2015-07-02   -12.125943
2015-07-03  -212.821113
2015-07-04   171.233978
2015-07-05   137.687961
2015-07-06   319.356004
   ...              ...
2016-12-27   297.790164
2016-12-28  -215.621619
2016-12-29   472.565525
2016-12-30 -1237.597771
2016-12-31  -135.612181
```

```
eng_dif.plot()
```

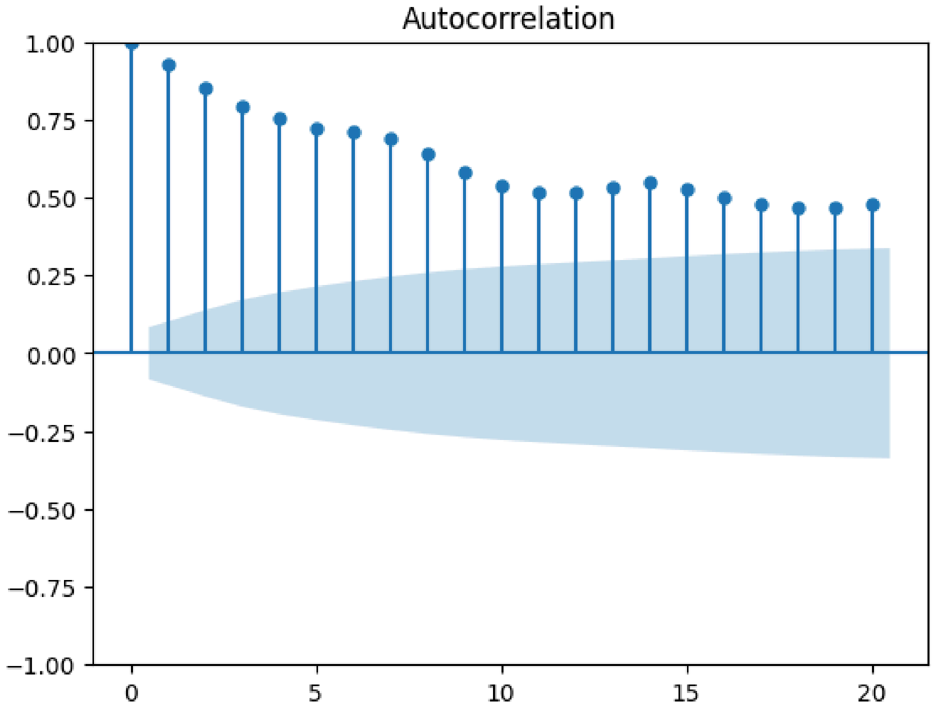
```
<Axes: >
```

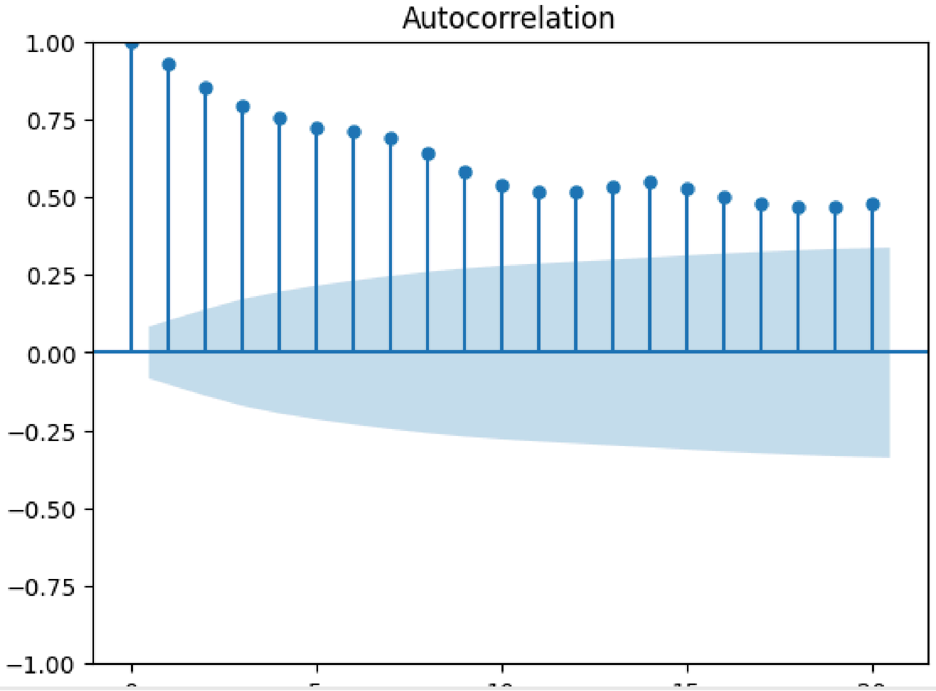


```
result = adfuller(eng_dif, autolag='AIC')
result[1]
```

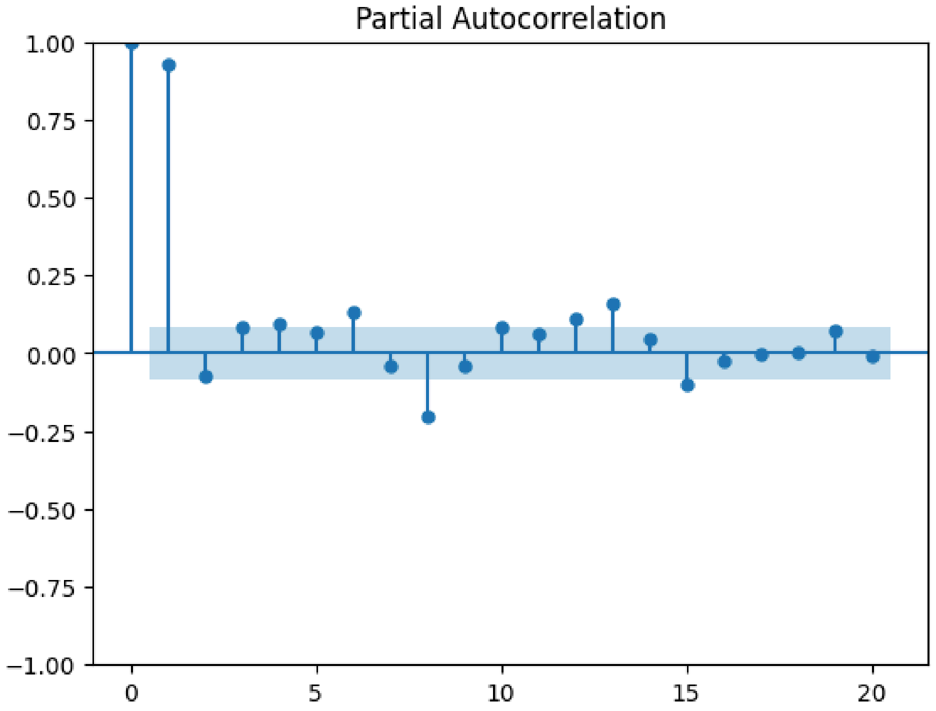
```
5.065700666316545e-13
```

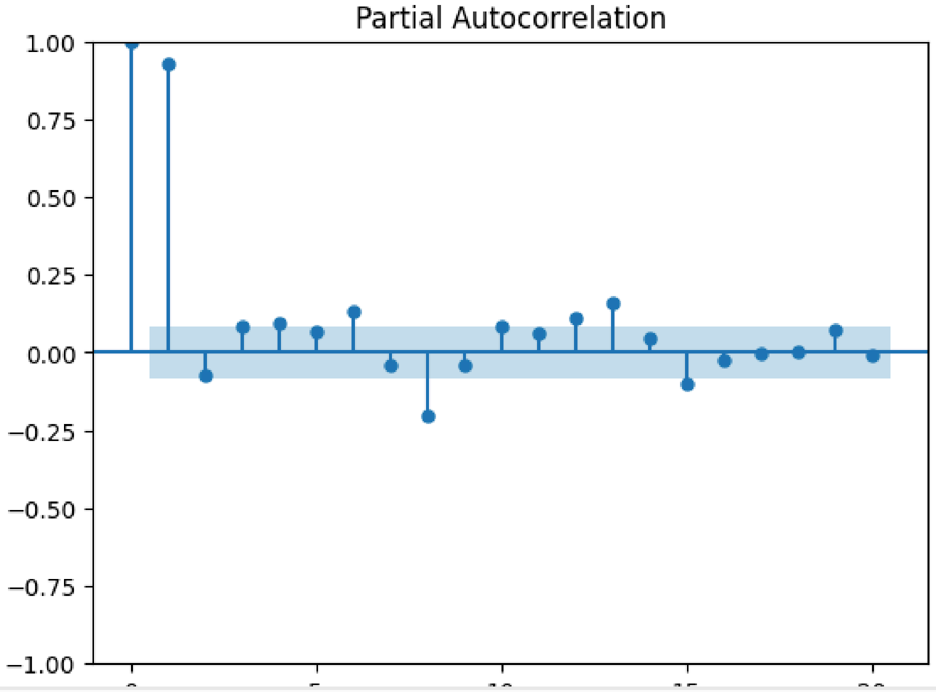
```
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
plot_acf(eng, lags = 20)
```



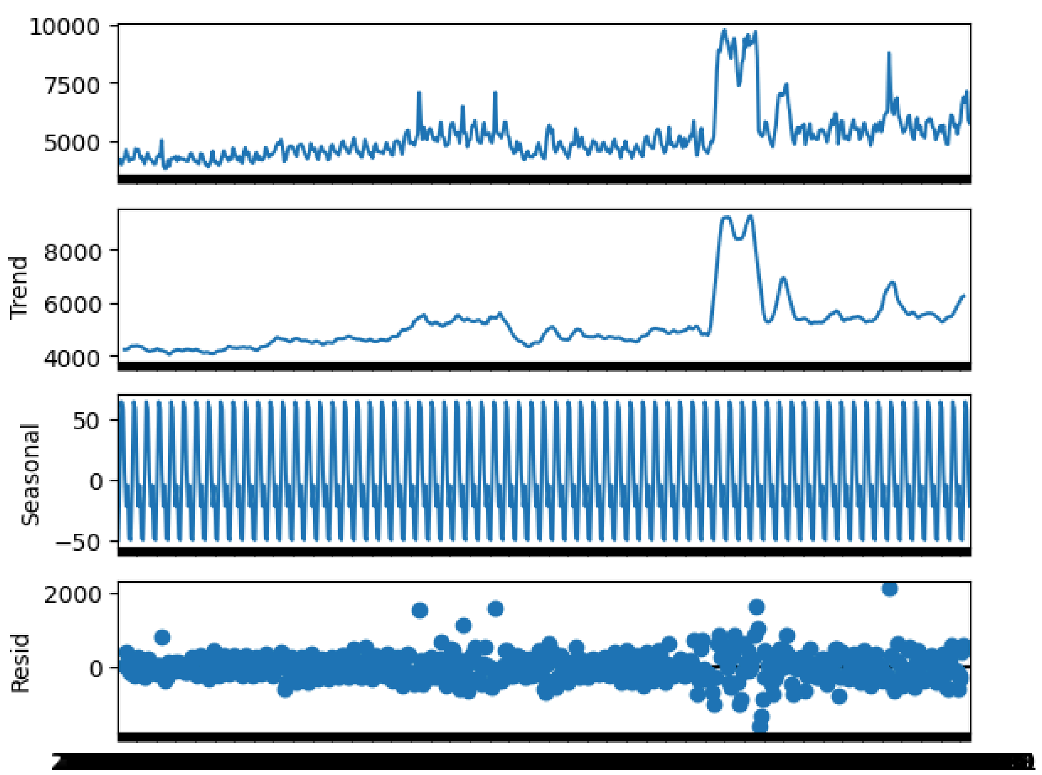


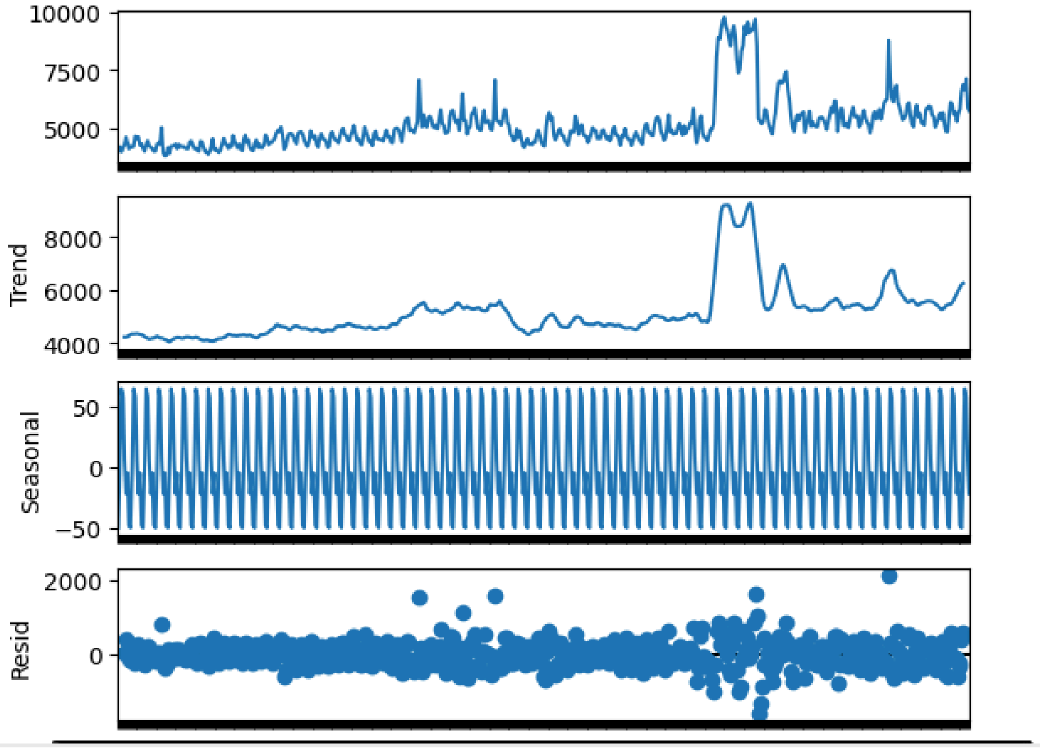
```
plot_pacf(eng, lags = 20)
```





```
from statsmodels.tsa.seasonal import seasonal_decompose
seasonal_decompose(eng, period = 8, model='additive').plot()
```



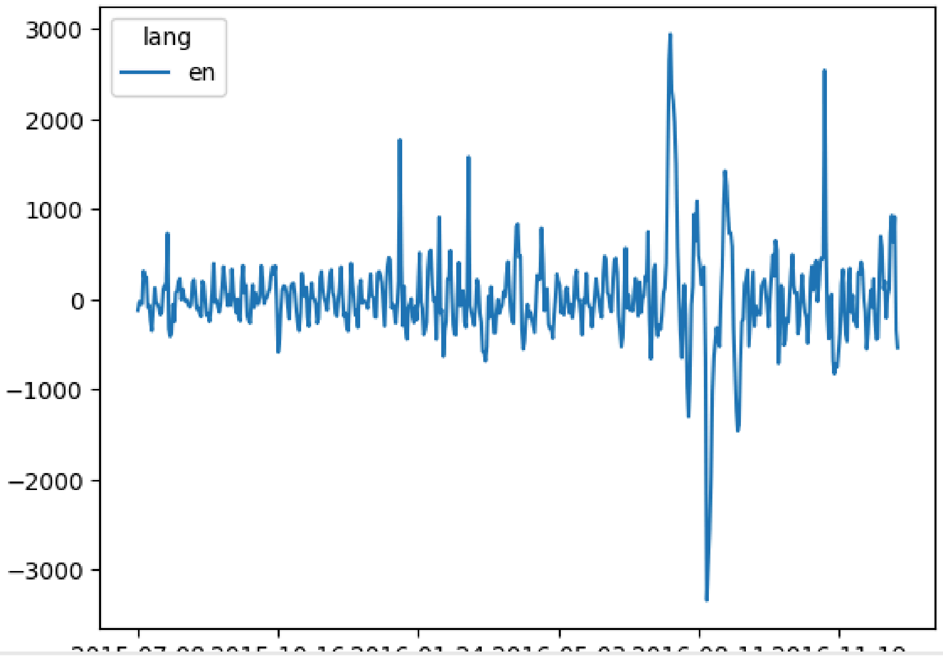


```
type(eng)
```

```
pandas.core.frame.DataFrame
```

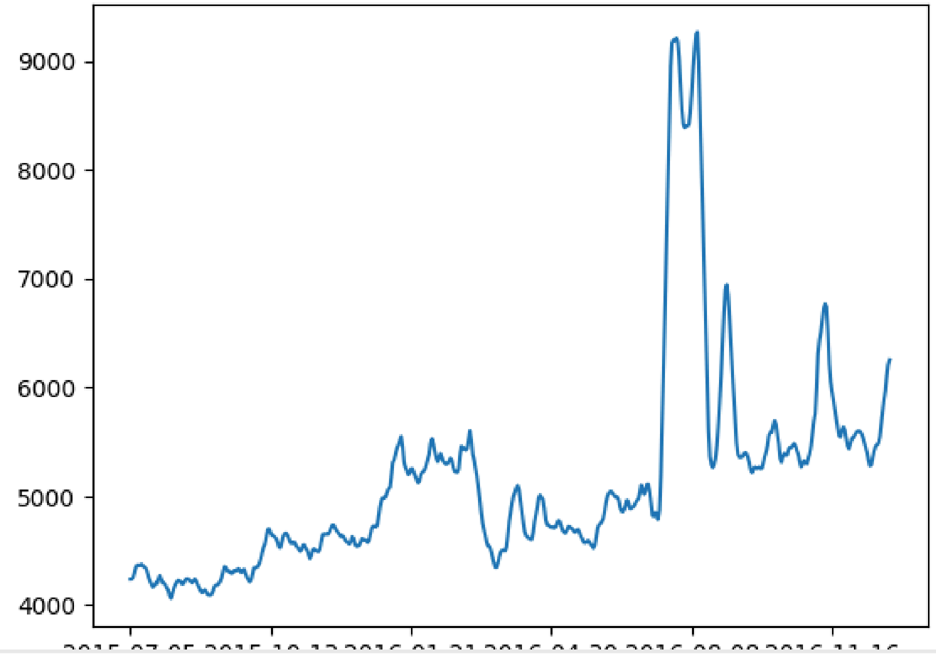
```
detrend = eng[7:] - eng.rolling(window = 8).mean()[7:]
detrend.plot()
```

```
<Axes: >
```



```
decompose = seasonal_decompose(eng, period = 8, model='additive')
decompose.trend[4:-4].plot()
```

```
<Axes: >
```

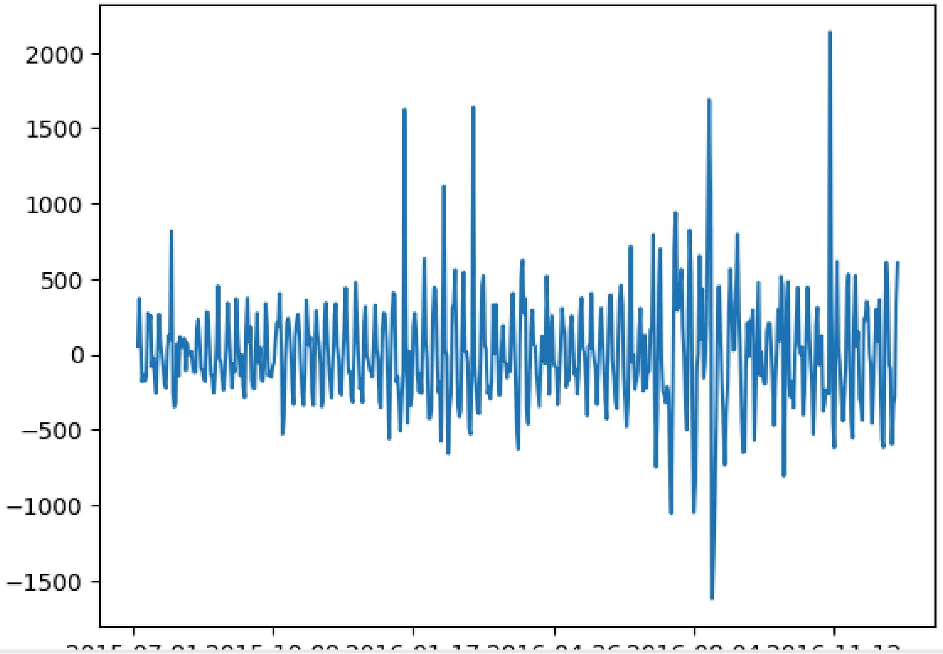


```
eng.iloc[4:-4,:] - pd.DataFrame(decompose.trend[4:-4], index = eng.index[4:-4])
```

	en	trend
2015-07-05	NaN	NaN
2015-07-06	NaN	NaN
2015-07-07	NaN	NaN
2015-07-08	NaN	NaN
2015-07-09	NaN	NaN
...	...	...
2016-12-23	NaN	NaN
2016-12-24	NaN	NaN
2016-12-25	NaN	NaN
2016-12-26	NaN	NaN
2016-12-27	NaN	NaN

```
detrend = eng['en']-decompose.trend
detrend.plot()
```

```
<Axes: >
```



```
detrend
```

```
2015-07-01           NaN
2015-07-02           NaN
2015-07-03           NaN
2015-07-04           NaN
2015-07-05     50.629794
                 ...
2016-12-27    606.299365
2016-12-28           NaN
2016-12-29           NaN
2016-12-30           NaN
2016-12-31           NaN
Length: 550, dtype: float64
```

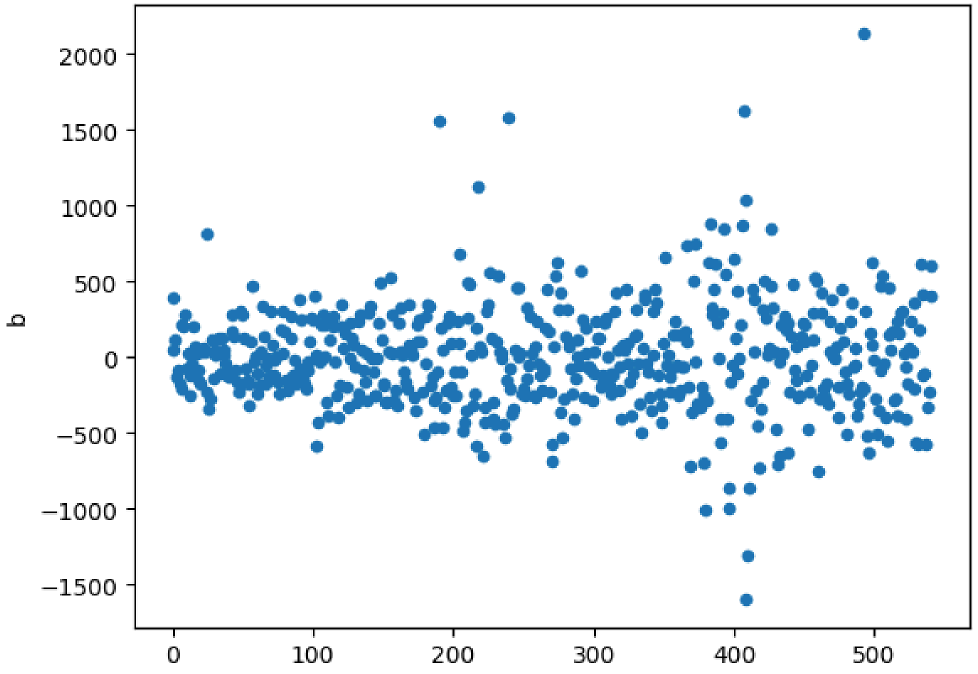
```
decompose.seasonal
```

```
2015-07-01   -50.404382
2015-07-02    -1.920385
2015-07-03    64.262228
2015-07-04    58.030591
2015-07-05     5.659501
                ...
2016-12-27    -1.920385
2016-12-28    64.262228
2016-12-29    58.030591
2016-12-30     5.659501
2016-12-31   -22.294375
Name: seasonal, Length: 550, dtype: float64
```

```
noise = eng['en']-decompose.seasonal - decompose.trend
```

```
noise = pd.DataFrame(noise[4:-4]).reset_index().drop(columns = 'index').reset_index().rename(columns = {'index': 'a', 0:'b'})
noise.plot(x = 'a', y = 'b', kind = 'scatter')
```

```
<Axes: xlabel='a', ylabel='b'>
```



```
from statsmodels.tsa.arima.model import ARIMA
```

```
model = ARIMA(eng[:-50], order = (1,1,20))
model_fit = model.fit()
```

```
/Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: No frequency information was provided, so inferred frequency D will be u
  self._init_dates(dates, freq)
/Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: No frequency information was provided, so inferred frequency D will be u
  self._init_dates(dates, freq)
/Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: No frequency information was provided, so inferred frequency D will be u
  self._init_dates(dates, freq)
/Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages/statsmodels/base/model.py:607: ConvergenceWarning: Maximum Likelihood optimization failed to converge. Check mle_retvals
  warnings.warn("Maximum Likelihood optimization failed to "
```

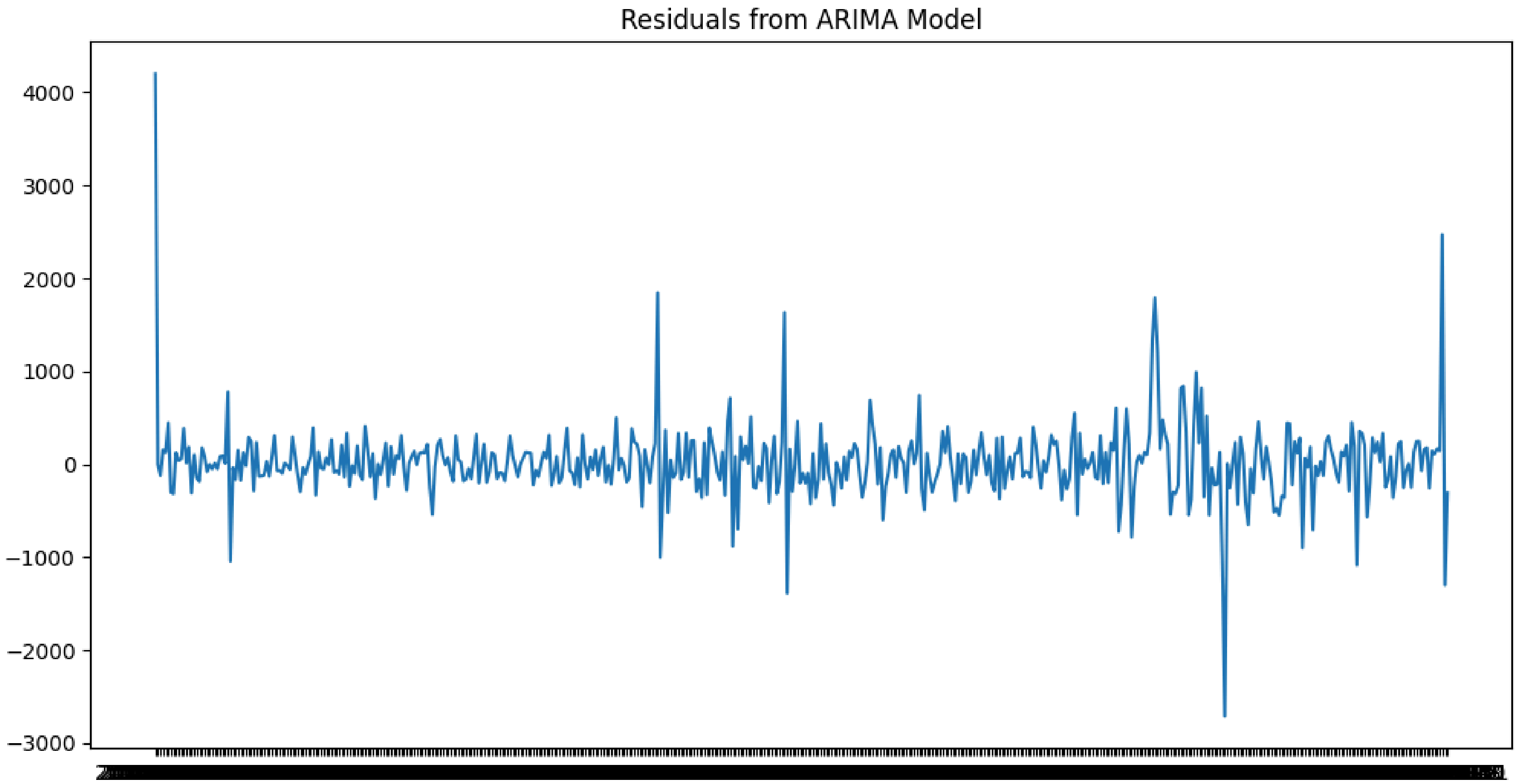
```
model_fit.summary()
```

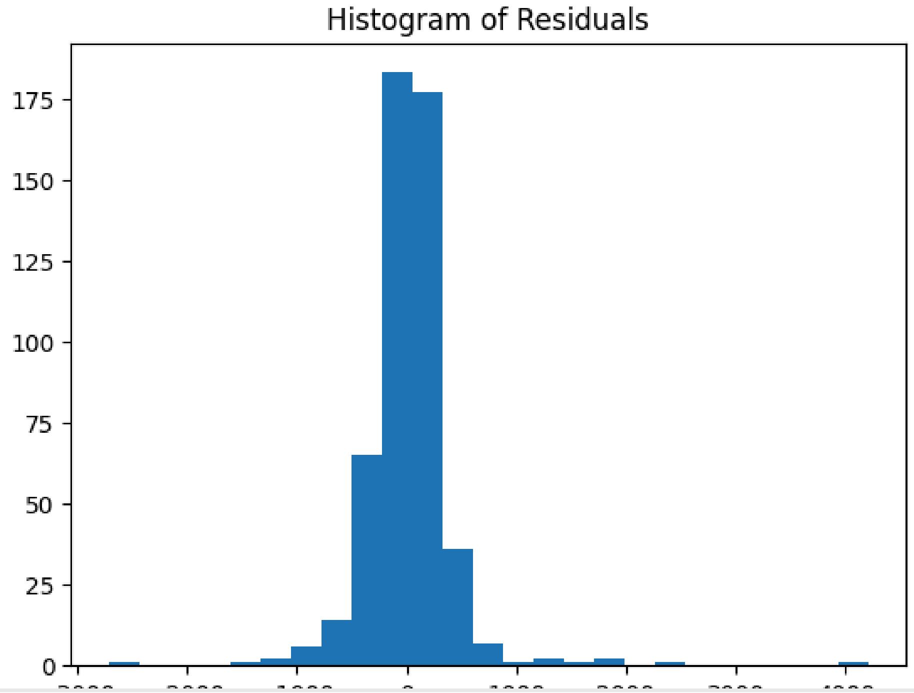
```
                        SARIMAX Results
    Dep. Variable:  en                   No. Observations: 500
        Model:      ARIMA(1, 1, 20)      Log Likelihood    -3658.183
        Date:       Sun, 22 Sep 2024          AIC          7360.365
        Time:       18:48:16                  BIC          7453.043
       Sample:      07-01-2015               HQIC          7396.735
                    - 11-11-2016
  Covariance Type: opg
             coef      std err    z      P>|z|   [0.025     0.975]
   ar.L1  0.4463      0.246     1.811   0.070 -0.037     0.929
   ma.L1  -0.5153     0.250     -2.058  0.040 -1.006     -0.024
   ma.L2  -0.1095     0.061     -1.805  0.071 -0.228     0.009
   ma.L3  0.0525      0.078     0.677   0.499 -0.100     0.205
   ma.L4  0.0182      0.061     0.297   0.767 -0.102     0.138
   ma.L5  -0.1118     0.060     -1.849  0.064 -0.230     0.007
   ma.L6  0.1715      0.068     2.525   0.012 0.038      0.305
   ma.L7  0.1060      0.080     1.318   0.187 -0.052     0.264
   ma.L8  -0.1265     0.074     -1.711  0.087 -0.271     0.018
   ma.L9  -0.1197     0.060     -2.006  0.045 -0.237     -0.003
  ma.L10 0.0348       0.066     0.527   0.599 -0.095     0.165
  ma.L11 -0.1174      0.063     -1.863  0.063 -0.241     0.006
  ma.L12 -0.1037      0.079     -1.313  0.189 -0.259     0.051
  ma.L13 0.0761       0.074     1.025   0.305 -0.069     0.222
  ma.L14 0.0908       0.059     1.531   0.126 -0.025     0.207
  ma.L15 -0.1753      0.062     -2.829  0.005 -0.297     -0.054
  ma.L16 0.0572       0.067     0.859   0.390 -0.073     0.188
  ma.L17 -0.0306      0.062     -0.492  0.623 -0.153     0.091
  ma.L18 -0.1372      0.065     -2.126  0.033 -0.264     -0.011
  ma.L19 0.1413       0.065     2.158   0.031 0.013      0.270
  ma.L20 0.1160       0.069     1.685   0.092 -0.019     0.251
  sigma2 1.355e+05 4635.499 29.225 0.000 1.26e+05 1.45e+05
     Ljung-Box (L1) (Q):      0.04 Jarque-Bera (JB): 3435.91
           Prob(Q):           0.85      Prob(JB):     0.00
  Heteroskedasticity (H): 6.05        Skew:          0.21
    Prob(H) (two-sided):      0.00      Kurtosis:     15.85


  Warnings:
```

```
residuals = model_fit.resid
plt.figure(figsize=(12, 6))
plt.plot(residuals)
plt.title('Residuals from ARIMA Model')
plt.show()

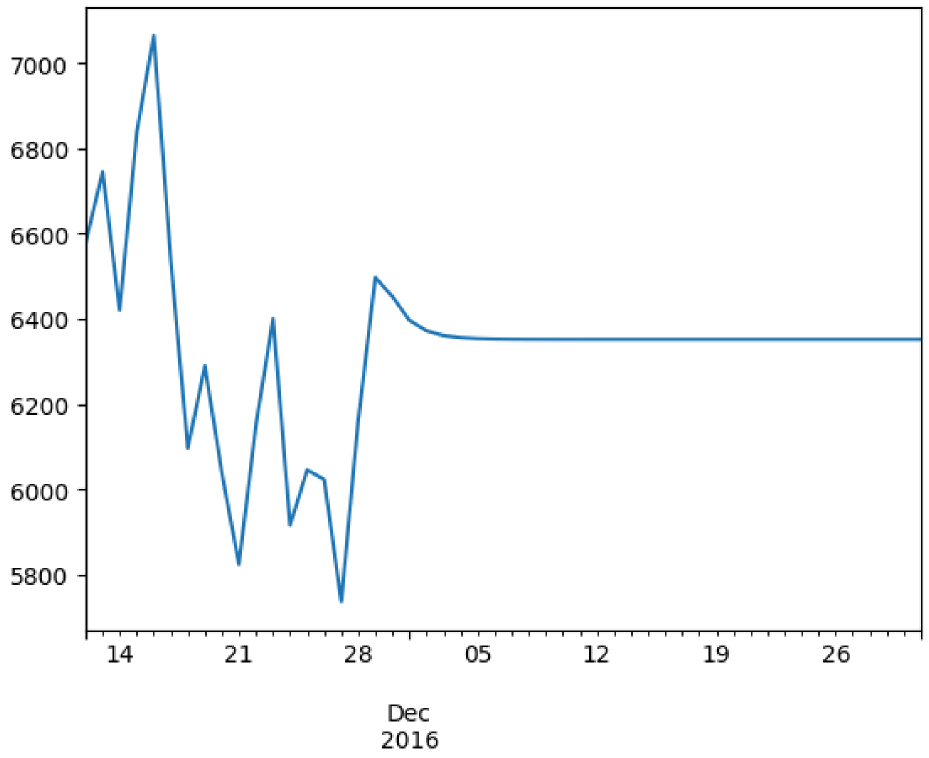
# Additionally, you can plot the histogram of the residuals
plt.hist(residuals, bins=25)
plt.title('Histogram of Residuals')
plt.show()
```

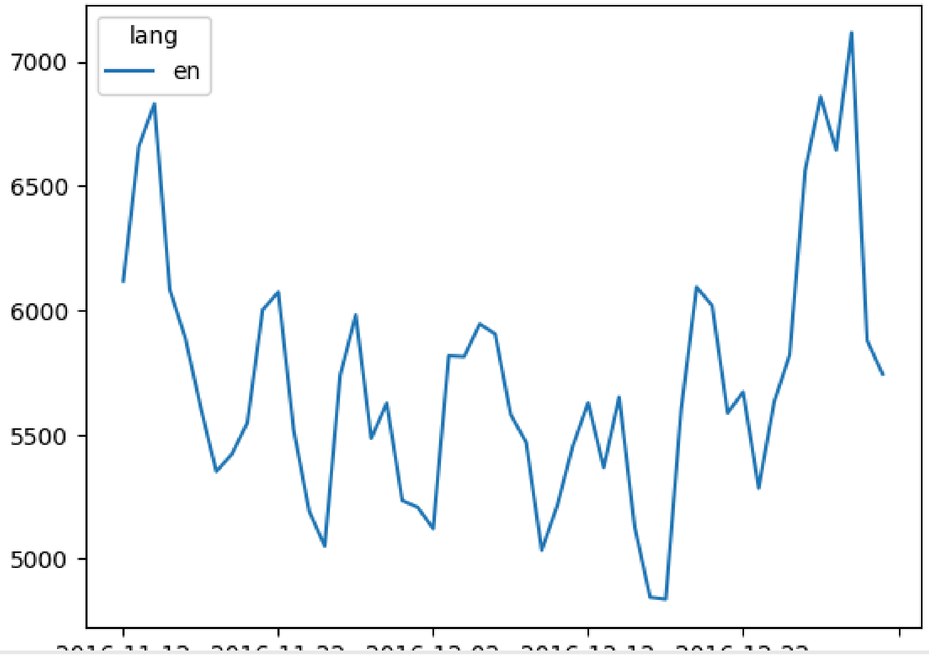




```
model_fit.forecast(steps = 50).plot()
eng[-50:].plot()
plt.plot()
```

```
[]
```





```
plt.plot(eng[-50:]['en'])
plt.plot(model_fit.forecast(steps = 50))

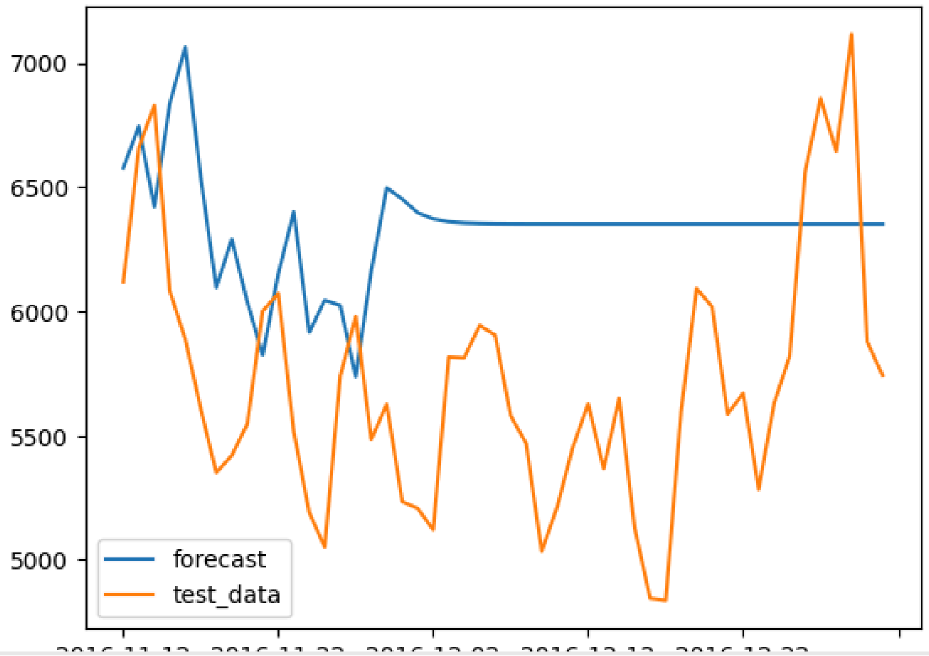

result = pd.DataFrame({'forecast':model_fit.forecast(steps = 50).values, 'test_data': eng[-50:]['en'].values}, index = eng[-50:]['en'].index)
result
```

	forecast	test_data
2016-11-12	6576.928907	6116.910660
2016-11-13	6745.161559	6657.517676
2016-11-14	6420.520468	6829.377274
2016-11-15	6836.053313	6082.436394
2016-11-16	7064.360814	5887.411804
2016-11-17	6537.765921	5606.946011
2016-11-18	6096.264727	5350.859814
2016-11-19	6289.690352	5419.887853
2016-11-20	6038.102638	5546.449398
2016-11-21	5823.930148	6001.560364
2016-11-22	6151.531263	6072.268430
2016-11-23	6400.453339	5516.919017
2016-11-24	5915.751393	5189.955247
2016-11-25	6045.128217	5050.970676
2016-11-26	6023.262427	5739.386269
2016-11-27	5736.731890	5980.170758
2016-11-28	6162.163260	5484.593394
2016-11-29	6496.952941	5626.363491
2016-11-30	6452.213665	5234.401947
2016-12-01	6396.578995	5206.698793
2016-12-02	6371.750338	5120.669867
2016-12-03	6360.669798	5816.332720
2016-12-04	6355.724771	5812.945149
2016-12-05	6353.517903	5944.109262
2016-12-06	6352.533021	5903.722993
2016-12-07	6352.093487	5579.527442
2016-12-08	6351.897332	5467.509567
2016-12-09	6351.809792	5033.982474
2016-12-10	6351.770725	5212.522584
2016-12-11	6351.753290	5452.008473
2016-12-12	6351.745509	5627.218467
2016-12-13	6351.742036	5367.159064
2016-12-14	6351.740487	5649.926802
2016-12-15	6351.739795	5127.462004
2016-12-16	6351.739486	4844.878526
2016-12-17	6351.739349	4836.821445
2016-12-18	6351.739287	5599.354649
2016-12-19	6351.739260	6092.571183
2016-12-20	6351.739248	6017.943988

2016-12-20	6351.739248	6017.943988
2016-12-21	6351.739242	5586.057504
2016-12-22	6351.739240	5670.727760
2016-12-23	6351.739239	5283.516507
2016-12-24	6351.739238	5629.874161
2016-12-25	6351.739238	5820.107795
2016-12-26	6351.739238	6560.961979
2016-12-27	6351.739238	6858.752143
2016-12-28	6351.739238	6643.130524
2016-12-29	6351.739238	7115.696049
2016-12-30	6351.739238	5878.098277
2016-12-31	6351.739238	5740.488087

```
result.plot()
```

```
<Axes: >
```



```
from sklearn.metrics import mean_absolute_percentage_error
```

```
mean_absolute_percentage_error(result['test_data'], result['forecast'])
```

```
0.13143532871553995
```

```
def arima_(p,d,q):
    model = ARIMA(eng[:-50], order = (p,d,q))
    model_fit = model.fit()
    result = pd.DataFrame({'forecast':model_fit.forecast(steps = 50).values, 'test_data': eng[-50:]['en'].values}, index = eng[-50:]['en'].index)
    result.plot()
    mean_absolute_percentage_error(result['test_data'], result['forecast'])
```

```
import warnings
warnings.filterwarnings('ignore')
```

```
for p in np.arange(1,11):
    for q in [1,6,8,13,15]:
        model = ARIMA(eng[:-50], order = (p,1,q))
        model_fit = model.fit()
        result = pd.DataFrame({'forecast':model_fit.forecast(steps = 50).values, 'test_data': eng[-50:]['en'].values}, index = eng[-50:]['en'].index)
        mape = mean_absolute_percentage_error(result['test_data'], result['forecast'])
        result.plot(legend = mape)
```

```
for p in np.arange(1,11):
    for q in [1,6,8,13,15]:
        model = ARIMA(eng[:-50], order = (p,1,q))
        model_fit = model.fit()
        result = pd.DataFrame({'forecast':model_fit.forecast(steps = 50).values, 'test_data': eng[-50:]['en'].values}, index = eng[-50:]['en'].index)
        plt.figure(figsize=(10, 6))
        plt.plot(result.index, result['forecast'], label='forecast', marker='o')
        plt.plot(result.index, result['test_data'], label='test_data', marker='x')
        plt.title('Forecast vs Actual Data')
        for label in plt.gca().get_xticklabels():
            label.set_visible(False)
        plt.ylabel('Values')
        plt.legend()
        plt.grid(True)
        plt.show()

        mape = 100*mean_absolute_percentage_error(result['test_data'], result['forecast'])
        print(f"MAPE: {mape:.2f}%")
        print("p:",p, " q:",q)
```

Start coding or generate with AI.

Start coding or generate with AI.

Best parameters we got is p: 7, q: 6 with a mape of 8.26% and p: 1, q: 1 with a mape of 8.1%

```
from statsmodels.tsa.statespace.sarimax import SARIMAX
```

```
eng['Exog'] = exog['Exog']
```

```
def sarimax_(p, q, P, D, Q, S, endog, exog):
    model = SARIMAX(endog = endog[:-50], exog = exog[:-50], order=(p, 1, q), seasonal_order=(P, D, Q, S))
    model_fit = model.fit(disp = False)
    result = pd.DataFrame({'forecast':model_fit.get_forecast(steps = 50, exog = exog[-50:]).predicted_mean, 'test_data': endog[-50:].values}, index = endog[-50:].index)
    mape = 100*mean_absolute_percentage_error(result['test_data'], result['forecast'])
    return (result, mape)
```

```
def forecast_plot(result, mape, p, q, P, D, Q, S):
    plt.figure(figsize=(10, 6))
    plt.plot(result.index, result['forecast'], label='forecast', marker='o')
    plt.plot(result.index, result['test_data'], label='test_data', marker='x')
    plt.title('Forecast vs Actual Data')
    for label in plt.gca().get_xticklabels():
        label.set_visible(False)
    plt.ylabel('Values')
    plt.legend()
    plt.grid(True)
    plt.show()
    print(f"MAPE: {mape:.2f}%")
    print("p:",p, " q:",q, " P:",P, " D:",D, " Q",Q, " S",S )
```

Start coding or generate with AI.

```
optimal_param = []
MAPE = []
for p in [1, 4]:
    for q in np.arange(1,4):
        for P in np.arange(1,3):
            for Q in np.arange(1,3):
                for S in [6, 8, 13, 15]:
                    for D in [0,1]:
                        result, mape = sarimax_(p, q, P, D, Q, S, eng['en'], eng['Exog'])
                        MAPE.append(mape)
                        optimal_param.append((p,q,P,D,Q,S))
optimum = optimal_param[np.argmin(MAPE)]
p0, q0, P0, D0, Q0, S0 = optimum

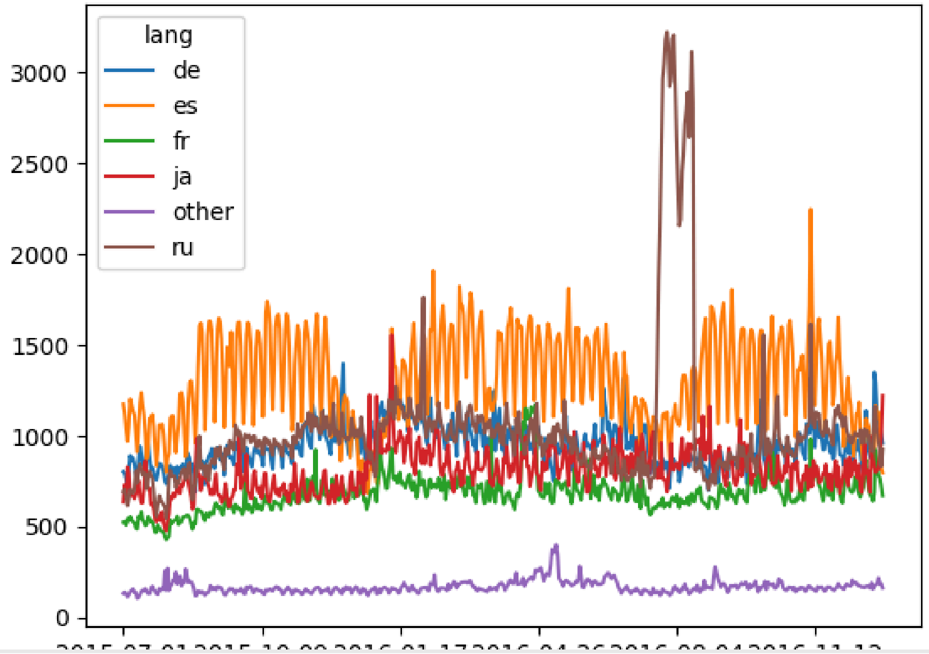
result, mape = sarimax_(p0, q0, P0, D0, Q0, S0, eng['en'], eng['Exog'])
forecast_plot(result, mape, p0, q0, P0, D0, Q0, S0)
```

```
df4 = df3.drop(columns = ['en', 'zh'])
df4
```

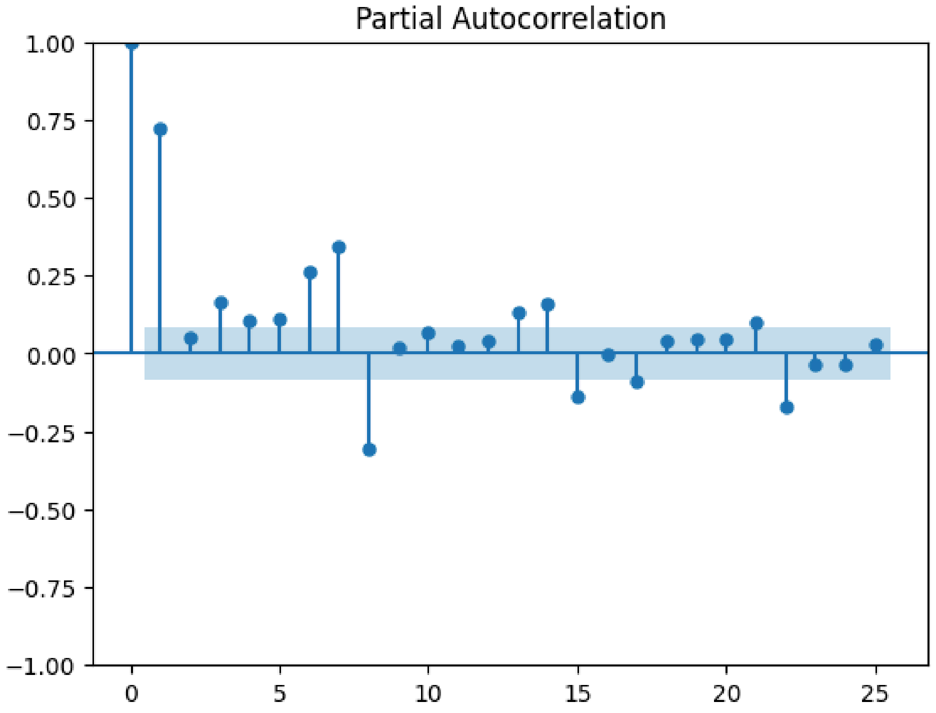
lang	de	es	fr	ja	other	ru
2015-07-01	799.647328	1172.206002	521.973465	633.729585	129.850520	690.629757
2015-07-02	788.763991	1120.260721	525.326916	727.754240	136.160375	702.591922
2015-07-03	757.008443	1030.279301	505.128695	657.242768	128.716826	651.152326
2015-07-04	694.663028	967.346374	539.936234	825.702545	109.856529	612.445536
2015-07-05	807.571352	1051.982346	530.107138	792.187396	121.784986	652.219098
...	...	...	...	...	...	...
2016-12-27	1137.956061	1089.732597	852.198550	810.105040	184.772165	1019.769264
2016-12-28	1081.189712	1128.884642	780.368744	811.275919	214.349310	962.418012
2016-12-29	1049.976794	1081.147901	764.657081	888.685015	178.955392	926.553429
2016-12-30	1001.049729	822.373628	721.165597	982.269292	183.873276	828.873274
2016-12-31	957.042938	793.234707	667.223882	1218.647606	159.885244	922.818567

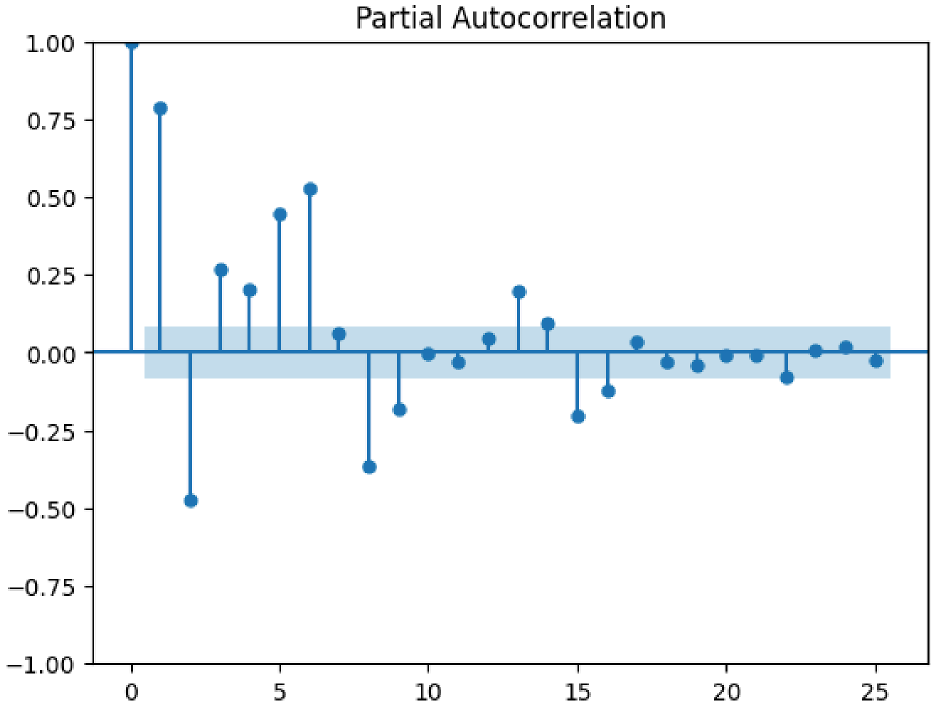
```
df4.plot()
```

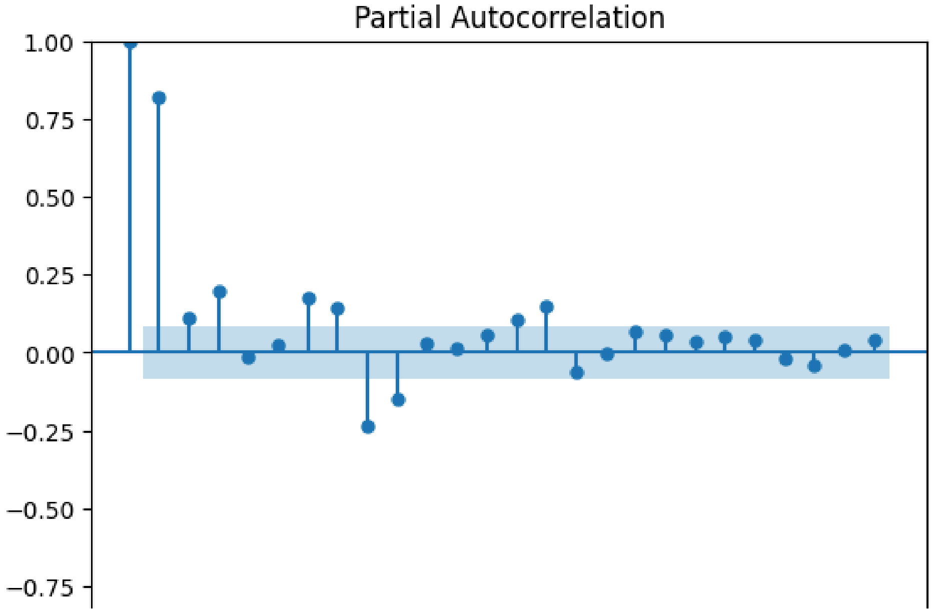
```
<Axes: >
```

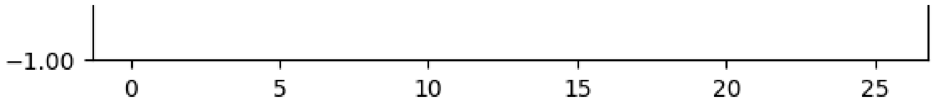


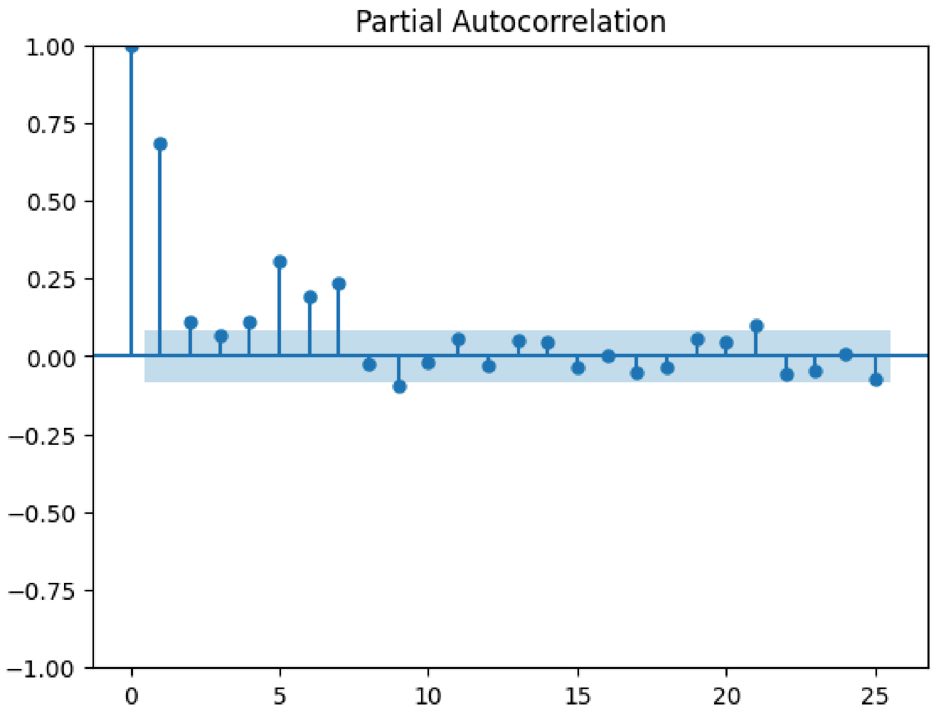
```
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
for lang in df4.columns:
    plot_pacf(df4[lang], lags = 25)
```

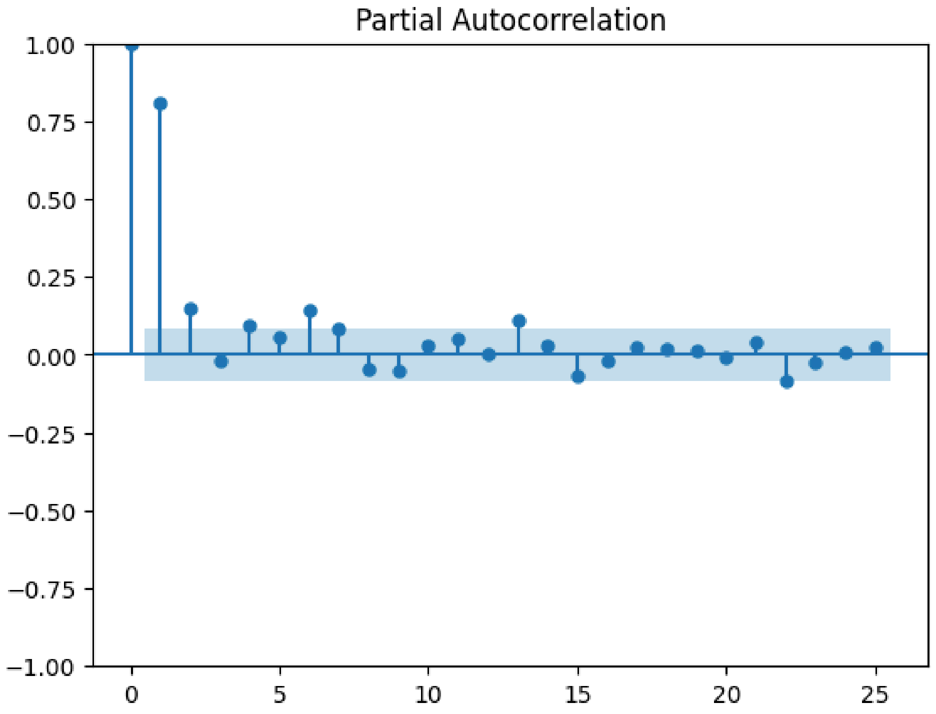

Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25

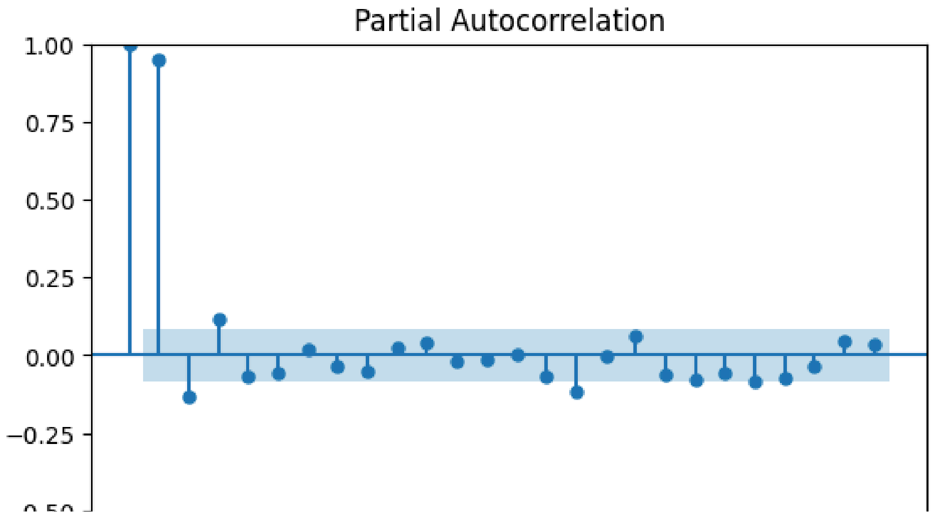

Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25

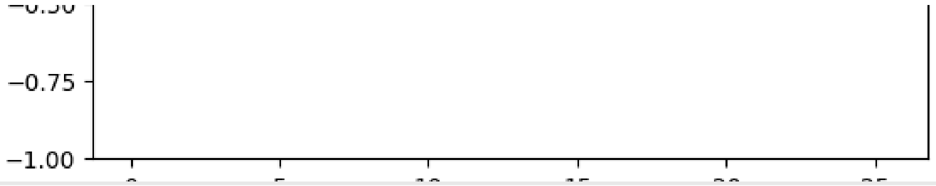

Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75


−1.00
0
5
10
15
20
25


Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25


Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20
25


Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25


−0.50
−0.75
−1.00

```
df4.columns
```

```
Index(['de', 'es', 'fr', 'ja', 'other', 'ru'], dtype='object', name='lang')
```

```
def sarima_(p, q, P, D, Q, S, endog):
    model = SARIMAX(endog = endog[:-50], order=(p, 1, q), seasonal_order=(P, D, Q, S))
    model_fit = model.fit(disp = False)
    result = pd.DataFrame({'forecast':model_fit.get_forecast(steps = 50).predicted_mean, 'test_data': endog[-50:].values}, index = endog[-50:].index)
    mape = 100*mean_absolute_percentage_error(result['test_data'], result['forecast'])
    return (result, mape)
```

```
for lang in df4.columns:
    print("language: ", lang)
    optimal_param = []
    MAPE = []
    for p in np.arange(1,4):
        for q in np.arange(1,4):
            for P in np.arange(1,2):
                for Q in np.arange(1,2):
                    for S in [7,8,14]:
                        for D in [0,1]:
                            result, mape = sarima_(p, q, P, D, Q, S, df4[lang])
                            MAPE.append(mape)
                            optimal_param.append((p,q,P,D,Q,S))
    optimum = optimal_param[np.argmin(MAPE)]
    p0, q0, P0, D0, Q0, S0 = optimum

    result, mape = sarima_(p0, q0, P0, D0, Q0, S0, df4[lang])
    forecast_plot(result, mape, p0, q0, P0, D0, Q0, S0)
```

Show hidden output

```
pip install pystan==2.19.1.1
```

```
Collecting pystan==2.19.1.1
  Using cached pystan-2.19.1.1.tar.gz (16.2 MB)
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Preparing metadata (pyproject.toml) ... error
  error: subprocess-exited-with-error

  × Preparing metadata (pyproject.toml) did not run successfully.
  │ exit code: 1
  ╰─> [2 lines of output]
      <string>:61: DeprecationWarning: Attribute s is deprecated and will be removed in Python 3.14; use value instead
      Cython>=0.22 and NumPy are required.
      [end of output]

  note: This error originates from a subprocess, and is likely not a problem with pip.
error: metadata-generation-failed

× Encountered error while generating package metadata.
╰─> See above for output.

note: This is an issue with the package mentioned above, not pip.
hint: See above for details.
Note: you may need to restart the kernel to use updated packages.
```

```
pip install prophet
```

```
Requirement already satisfied: prophet in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (1.1.5)
Requirement already satisfied: cmdstanpy>=1.0.4 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from prophet) (1.2.4)
Requirement already satisfied: numpy>=1.15.4 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from prophet) (1.26.1)
Requirement already satisfied: matplotlib>=2.0.0 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from prophet) (3.8.1)
Requirement already satisfied: pandas>=1.0.4 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from prophet) (2.1.2)
Requirement already satisfied: holidays>=0.25 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from prophet) (0.55)
Requirement already satisfied: tqdm>=4.36.1 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from prophet) (4.66.2)
Requirement already satisfied: importlib-resources in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from prophet) (6.4.4)
Requirement already satisfied: stanio<2.0.0,>=0.4.0 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from cmdstanpy>=1.0.4->prophet) (0.5.1)
Requirement already satisfied: python-dateutil in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from holidays>=0.25->prophet) (2.8.2)
Requirement already satisfied: contourpy>=1.0.1 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from matplotlib>=2.0.0->prophet) (1.2.0)
Requirement already satisfied: cycler>=0.10 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from matplotlib>=2.0.0->prophet) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from matplotlib>=2.0.0->prophet) (4.44.0)
Requirement already satisfied: kiwisolver>=1.3.1 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from matplotlib>=2.0.0->prophet) (1.4.5)
Requirement already satisfied: packaging>=20.0 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from matplotlib>=2.0.0->prophet) (23.2)
Requirement already satisfied: pillow>=8 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from matplotlib>=2.0.0->prophet) (10.1.0)
Requirement already satisfied: pyparsing>=2.3.1 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from matplotlib>=2.0.0->prophet) (3.1.1)
Requirement already satisfied: pytz>=2020.1 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from pandas>=1.0.4->prophet) (2023.3.post1)
Requirement already satisfied: tzdata>=2022.1 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from pandas>=1.0.4->prophet) (2023.3)
Requirement already satisfied: six>=1.5 in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (from python-dateutil->holidays>=0.25->prophet) (1.16.0)
Note: you may need to restart the kernel to use updated packages.
```

```
eng.index
```

```
Index(['2015-07-01', '2015-07-02', '2015-07-03', '2015-07-04', '2015-07-05',
       '2015-07-06', '2015-07-07', '2015-07-08', '2015-07-09', '2015-07-10',
       ...
       '2016-12-22', '2016-12-23', '2016-12-24', '2016-12-25', '2016-12-26',
       '2016-12-27', '2016-12-28', '2016-12-29', '2016-12-30', '2016-12-31'],
      dtype='object', length=550)
```

```
from prophet import Prophet
```

```
exog.index = eng.index
eng['Exog'] = exog['Exog']
eng
```

lang	en	Exog
2015-07-01	4200.900811	0
2015-07-02	4188.774868	0
2015-07-03	3975.953755	0
2015-07-04	4147.187733	0
2015-07-05	4284.875694	0
...	...	...
2016-12-27	6858.752143	1
2016-12-28	6643.130524	1
2016-12-29	7115.696049	1
2016-12-30	5878.098277	0
2016-12-31	5742.486097	0

```
pr = pd.DataFrame({'ds': eng.index, 'y': eng['en'], 'exo': eng['Exog']})
pr
```

	ds	y	exo
2015-07-01	2015-07-01	4200.900811	0
2015-07-02	2015-07-02	4188.774868	0
2015-07-03	2015-07-03	3975.953755	0
2015-07-04	2015-07-04	4147.187733	0
2015-07-05	2015-07-05	4284.875694	0
...	...	...	...
2016-12-27	2016-12-27	6858.752143	1
2016-12-28	2016-12-28	6643.130524	1
2016-12-29	2016-12-29	7115.696049	1
2016-12-30	2016-12-30	5878.098277	0
2016-12-31	2016-12-31	5742.486097	0

```
model = Prophet()
model.add_regressor('exo')
model.fit(pr[:-50])
```

```
21:00:32 - cmdstanpy - INFO - Chain [1] start processing
21:00:32 - cmdstanpy - INFO - Chain [1] done processing
<prophet.forecaster.Prophet at 0x12e8e2540>
```

```
exog = pd.read_csv('Exog_Campaign_eng')
exog
```

	Exog
0	0
1	0
2	0
3	0
4	0
...	...
545	1
546	1
547	1
548	0
549	0

```
future = model.make_future_dataframe(periods = 50)
future['exo'] = exog['Exog']
future
```

	ds	exo
0	2015-07-01	0
1	2015-07-02	0
2	2015-07-03	0
3	2015-07-04	0
4	2015-07-05	0
...	...	...
545	2016-12-27	1
546	2016-12-28	1
547	2016-12-29	1
548	2016-12-30	0
549	2016-12-31	0

```
forecast = model.predict(future)
forecast
```

	ds	trend	yhat_lower	yhat_upper	trend_lower	trend_upper	additive_terms	additive_terms_lower	additive_terms_upper	exo	...	extra_regressors_additive	extra_regressors_additive_lower
0	2015-07-01	4057.749958	3391.638765	4795.400891	4057.749958	4057.749958	-29.537691	-29.537691	-29.537691	0.000000	...	0.000000	0.000000
1	2015-07-02	4061.783759	3219.381127	4612.199077	4061.783759	4061.783759	-122.678441	-122.678441	-122.678441	0.000000	...	0.000000	0.000000
2	2015-07-03	4065.817561	3181.263451	4529.851793	4065.817561	4065.817561	-233.129944	-233.129944	-233.129944	0.000000	...	0.000000	0.000000
3	2015-07-04	4069.851363	3233.094440	4570.140232	4069.851363	4069.851363	-146.039815	-146.039815	-146.039815	0.000000	...	0.000000	0.000000
4	2015-07-05	4073.885164	3568.297937	4951.982323	4073.885164	4073.885164	183.933255	183.933255	183.933255	0.000000	...	0.000000	0.000000
...	...	...	...	...	...	...	...	...	...	...	...	...	...
545	2016-12-27	5638.215917	7716.941961	8994.104876	5620.636527	5654.232735	2676.135299	2676.135299	2676.135299	2609.824482	...	2609.824482	2609.824482
546	2016-12-28	5641.425507	7571.647192	8892.918783	5623.252296	5657.961312	2580.286791	2580.286791	2580.286791	2609.824482	...	2609.824482	2609.824482
547	2016-12-29	5644.635096	7448.233181	8809.605741	5625.862312	5661.689890	2487.146040	2487.146040	2487.146040	2609.824482	...	2609.824482	2609.824482
548	2016-12-30	5647.844686	4704.631503	6085.841580	5628.589703	5665.604851	-233.129944	-233.129944	-233.129944	0.000000	...	0.000000	0.000000
549	2016-12-31	5651.054276	4845.167275	6176.218334	5631.111570	5669.390479	-146.039815	-146.039815	-146.039815	0.000000	...	0.000000	0.000000

550 rows × 22 columns

```
forecast['yhat']
```

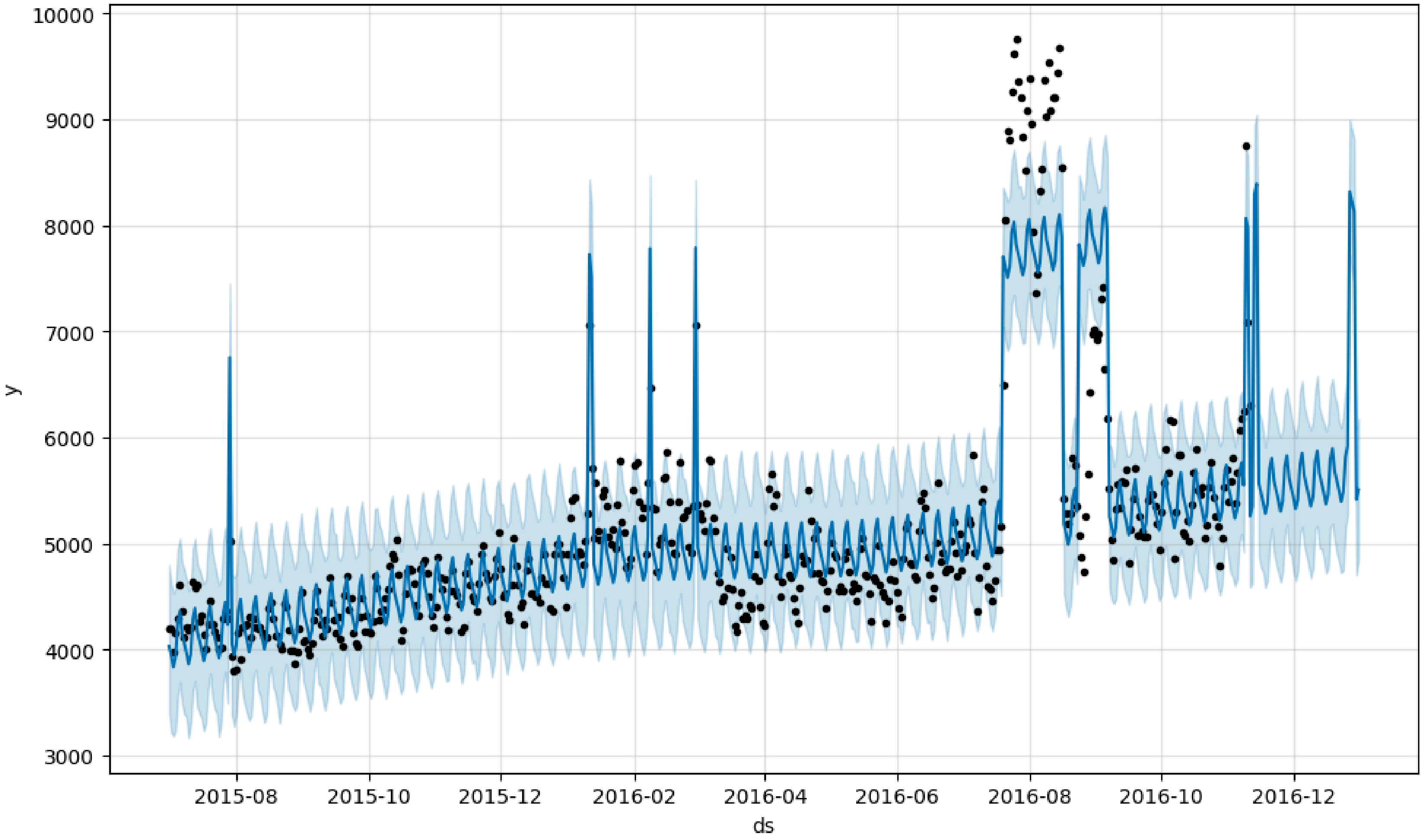
```
0       4028.212267
1       3939.105318
2       3832.687617
3       3923.811547
```

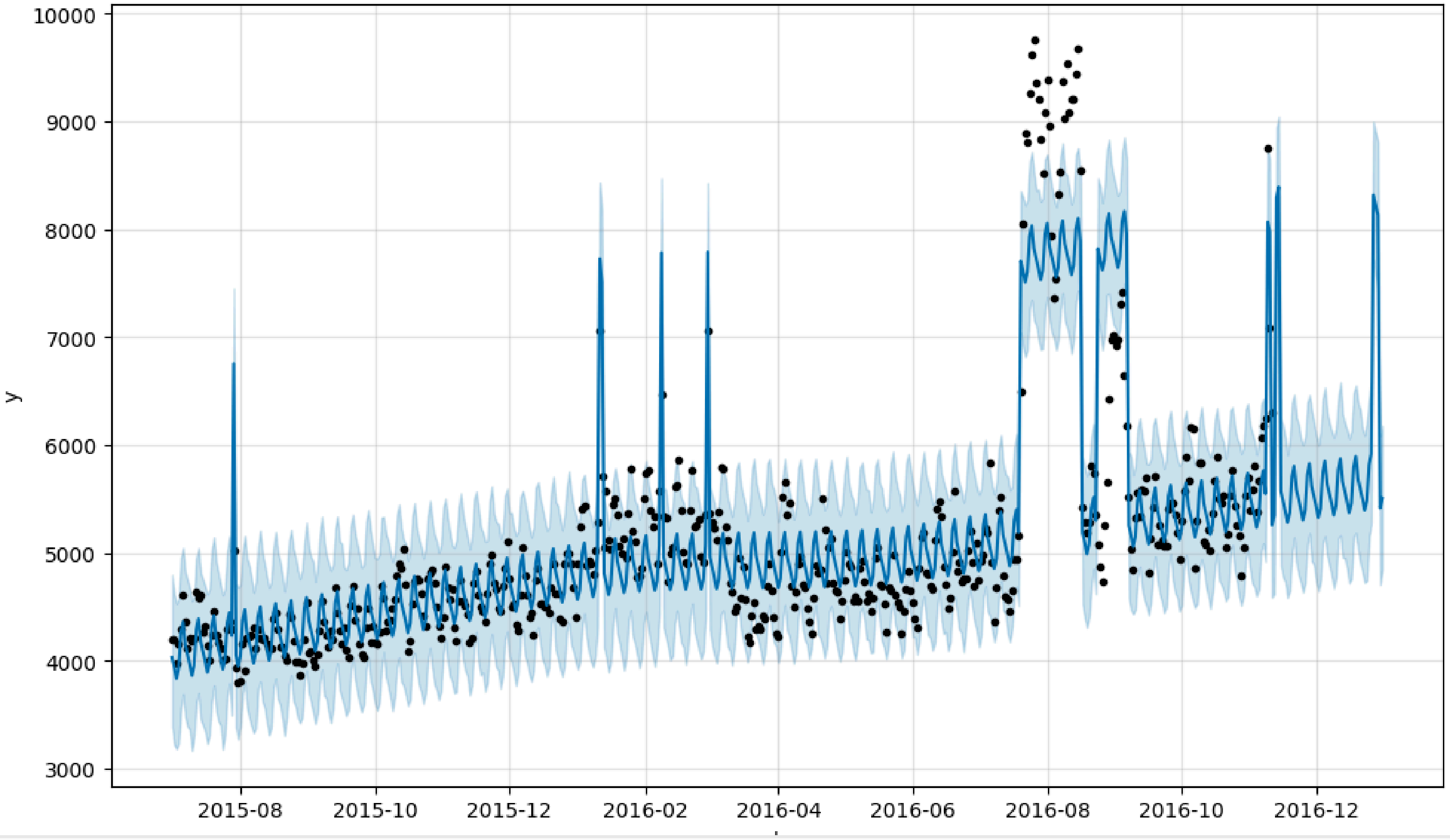
```
4      4257.818420
          ...
545    8314.351216
546    8221.712297
547    8131.781137
548    5414.714743
549    5505.014461
Name: yhat, Length: 550, dtype: float64
```

```
mape = 100*mean_absolute_percentage_error(pr['y'][-50:], model.predict(future)['yhat'][-50:])
mape
```

```
6.201175822246687
```

```
model.plot(forecast)
```

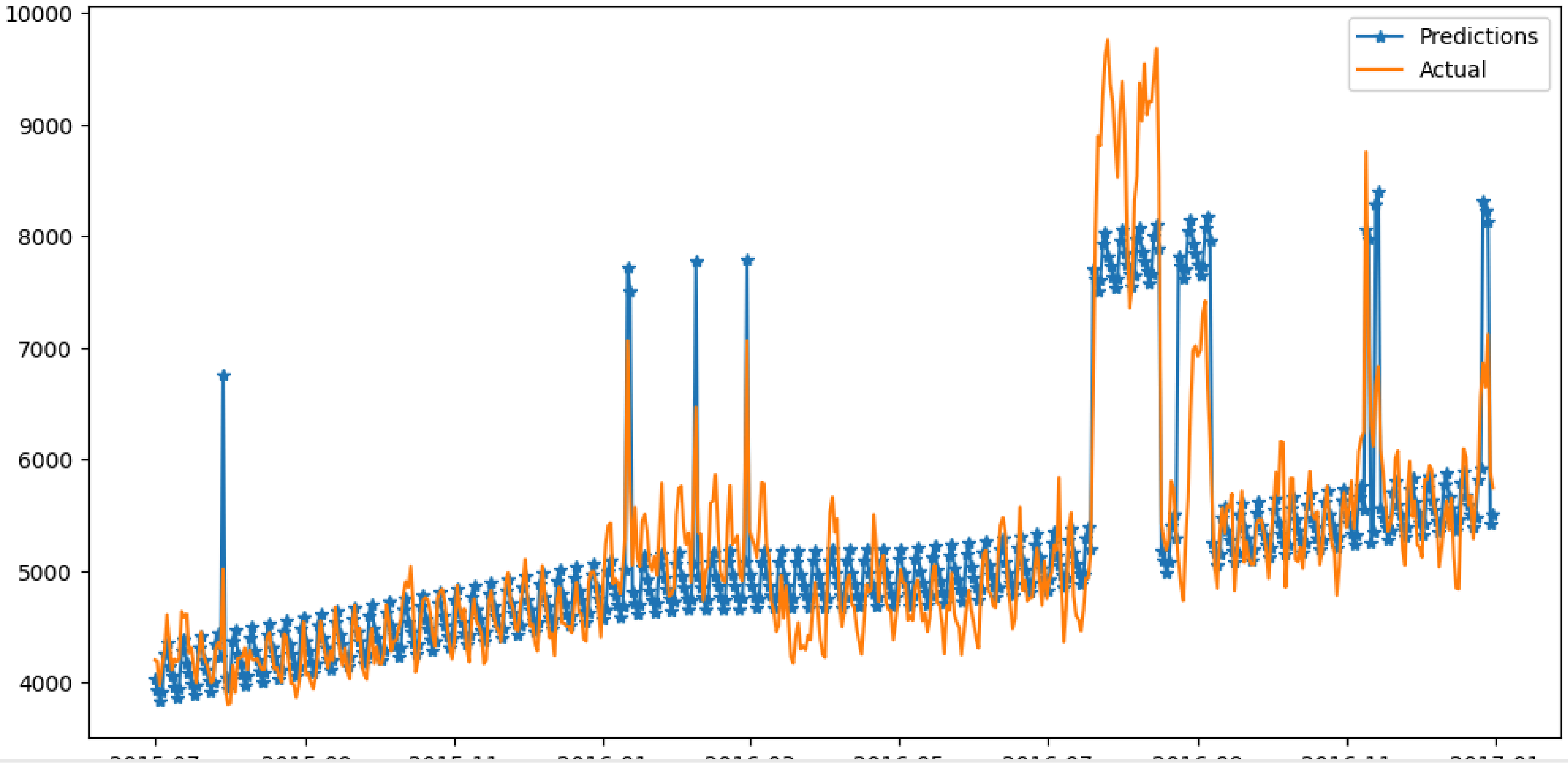




```
plt.figure(figsize = (12,6))
plt.plot(forecast['ds'], forecast['yhat'],'-*', label = 'Predictions')
plt.plot(forecast['ds'], forecast['yhat'], '-*', label = 'Predictions')
plt.plot(pd.to_datetime(pr['ds']), pr['y'], label = 'Actual')

plt.legend()
```

```
<matplotlib.legend.Legend at 0x12c6a9fd0>
```



Qustionnaire

2. Three Inferences from data visualizations:

1. Most of the views to the webpages come from English language sites. Each language follows a different pattern in the timeseries charts

2. All agents had most views (>95%) compared to spider.

3. All access has most views compared to desktop or mobile web pages.

3. Decomposition of the series will give us Trend, seasonality and noise. We can use statsmodels library to directly separate the time series.

4. Just differencing at level 1 gave us a stationary time series. The reason being that the data is linearly increasing, if it was increasing exponentially or quadratically then we would need to increase the level of differencing. We have proved the stationarity of the data using the dickery-fuller test.

5. We have implemented all three models - ARIMA, SARIMA and SARIMAX. We saw that ARIMA gave us good mape value due to a simplistic model. Whereas SARIMAX gave us the best result with english data as it contained exogenous data. The difference between the three is that ARIMA doesn't consider the seasonality factor of the time series. SARIMA considers seasonality and SARIMAX contains both seasonality as well as exogenous variables like holiday.

```
df3.mean(axis = 0)
```

```
lang
de        944.606066
en       5145.041788
es       1295.522886
fr        678.671975
ja        802.097377
other     165.845057
ru       1036.113919
zh          0.098182
dtype: float64
```

6. The average number of views is highest in english language, second highest in espaniol and lowest in zh.

```
Start coding or generate with AI.
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Start coding or generate with AI.
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Start coding or generate with AI.

Start coding or generate with AI.

Start coding or generate with AI.

Start coding or generate with AI.