comcast-customer-complaints

September 4, 2022

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

[2]:
```
df1 = pd.read_csv('Comcast_telecom_complaints_data.csv',index_col=0)
```

[3]:
```
df1.head()
```

[3]:

Ticket #	Customer Complaint	Date	Date_month_year	Time	Received Via	City	State	Zip code	Status	Filing on Behalf of Someone
250635	Comcast Cable Internet Speeds	22-04-15	22-Apr-15	3:53:50 PM	Customer Care Call	Abingdon	Maryland	21009	Closed	No
223441	Payment disappear - service got disconnected	04-08-15	04-Aug-15	10:22:56 AM	Internet	Acworth	Georgia	30102	Closed	No
242732	Speed and Service	18-04-15	18-Apr-15	9:55:47 AM	Internet	Acworth	Georgia	30101	Closed	Yes
277946	Comcast Imposed a New Usage Cap of 300GB that …	05-07-15	05-Jul-15	11:59:35 AM	Internet	Acworth	Georgia	30101	Open	Yes
307175	Comcast not working and no service to boot	26-05-15	26-May-15	1:25:26 PM	Internet	Acworth	Georgia	30101	Solved	No

[4]:
```
df1[df1.isnull()].count()
#No Nulls
```

[4]:
```
Customer Complaint             0
Date                           0
Date_month_year                0
Time                           0
Received Via                   0
City                           0
State                          0
Zip code                       0
Status                         0
Filing on Behalf of Someone    0
dtype: int64
```

[5]:
```
df1.describe(include='all')
```

[5]:

	Customer Complaint	Date	Date_month_year	Time	\
count	2224	2224	2224	2224	
unique	1841	91	91	2190	
top	Comcast	24-06-15	24-Jun-15	12:41:14 PM	
freq	83	218	218	2	
mean	NaN	NaN	NaN	NaN	
std	NaN	NaN	NaN	NaN	
min	NaN	NaN	NaN	NaN	
25%	NaN	NaN	NaN	NaN	
50%	NaN	NaN	NaN	NaN	
75%	NaN	NaN	NaN	NaN	
max	NaN	NaN	NaN	NaN	

	Received Via	City	State	Zip code	Status	\
count	2224	2224	2224	2224.000000	2224	
unique	2	928	43	NaN	4	
top	Customer Care Call	Atlanta	Georgia	NaN	Solved	
freq	1119	63	288	NaN	973	
mean	NaN	NaN	NaN	47994.393435	NaN	
std	NaN	NaN	NaN	28885.279427	NaN	
min	NaN	NaN	NaN	1075.000000	NaN	
25%	NaN	NaN	NaN	30056.500000	NaN	
50%	NaN	NaN	NaN	37211.000000	NaN	
75%	NaN	NaN	NaN	77058.750000	NaN	
max	NaN	NaN	NaN	99223.000000	NaN	

	Filing on Behalf of Someone
count	2224
unique	2
top	No
freq	2021
mean	NaN
std	NaN

```
min                             NaN
25%                             NaN
50%                             NaN
75%                             NaN
max                             NaN
```

0.0.1 EDA and Cleanup the data set

[6]:
```
df1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 2224 entries, 250635 to 363614
Data columns (total 10 columns):
 #   Column                        Non-Null Count  Dtype
---  ------                        --------------  -----
 0   Customer Complaint            2224 non-null   object
 1   Date                          2224 non-null   object
 2   Date_month_year               2224 non-null   object
 3   Time                          2224 non-null   object
 4   Received Via                  2224 non-null   object
 5   City                          2224 non-null   object
 6   State                         2224 non-null   object
 7   Zip code                      2224 non-null   int64
 8   Status                        2224 non-null   object
 9   Filing on Behalf of Someone   2224 non-null   object
dtypes: int64(1), object(9)
memory usage: 191.1+ KB
```

0.0.2 TASK 1 - Provide the trend chart for the number of complaints at monthly and daily granularity levels.

[7]:
```
df1['Date_month_year'] = pd.to_datetime(df1['Date_month_year'])
df1['Created_Month'] =  df1['Date_month_year'].apply(lambda x: x.month)
df1['Created_Day'] = df1['Date_month_year'].apply(lambda x: x.day)
df1['Created_Day of Week'] = df1['Date_month_year'].apply(lambda x: x.dayofweek)
```

[8]:
```
dmap = {0:'Mon',1:'Tue',2:'Wed',3:'Thur',4:'Fri',5:'Sat',6:'Sun'}
df1['Created_Day of Week']=df1['Created_Day of Week'].map(dmap)
df1.head(5)
```

[8]:

Ticket #	Customer Complaint	Date
250635	Comcast Cable Internet Speeds	22-04-15
223441	Payment disappear - service got disconnected	04-08-15
242732	Speed and Service	18-04-15
277946	Comcast Imposed a New Usage Cap of 300GB that …	05-07-15
307175	Comcast not working and no service to boot	26-05-15

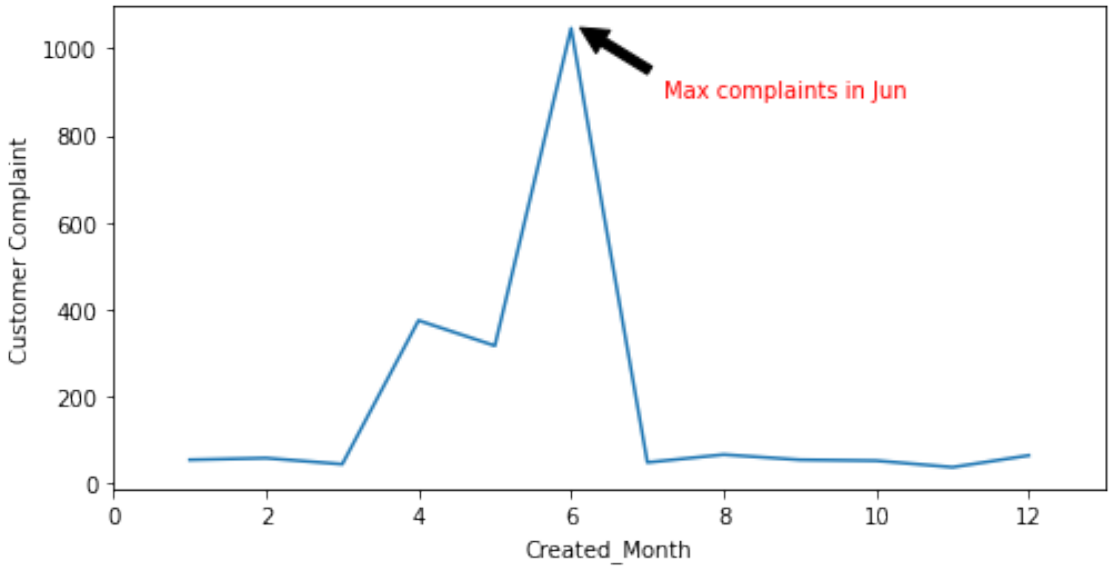
```
         Date_month_year         Time        Received Via      City     State  \
Ticket #
250635        2015-04-22   3:53:50 PM  Customer Care Call  Abingdon  Maryland
223441        2015-08-04  10:22:56 AM            Internet   Acworth   Georgia
242732        2015-04-18   9:55:47 AM            Internet   Acworth   Georgia
277946        2015-07-05  11:59:35 AM            Internet   Acworth   Georgia
307175        2015-05-26   1:25:26 PM            Internet   Acworth   Georgia

          Zip code  Status Filing on Behalf of Someone  Created_Month  \
Ticket #
250635       21009  Closed                          No              4
223441       30102  Closed                          No              8
242732       30101  Closed                         Yes              4
277946       30101    Open                         Yes              7
307175       30101  Solved                          No              5

          Created_Day Created_Day of Week
Ticket #
250635             22                 Wed
223441              4                 Tue
242732             18                 Sat
277946              5                 Sun
307175             26                 Tue
```

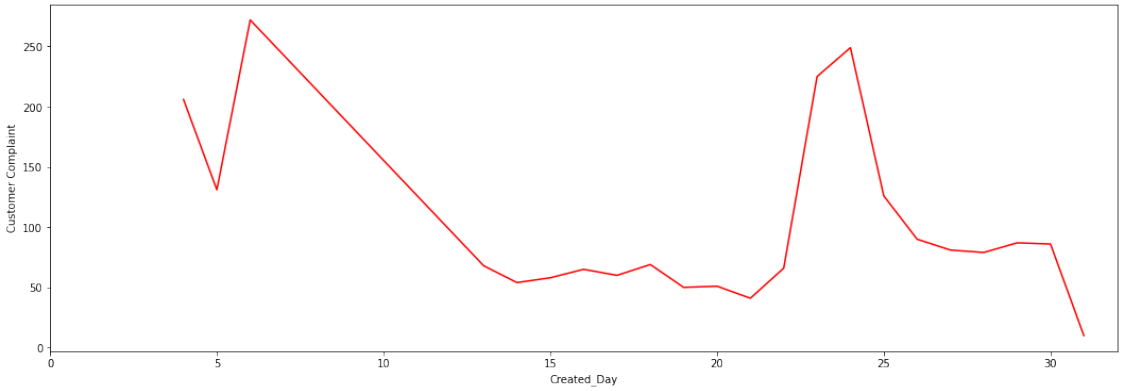
[9]:
```
#number of complaints monthly
plt.figure(figsize=(8,4))
bymonth = df1.groupby('Created_Month').count().reset_index()
lp = sns.lineplot(x='Created_Month', y= 'Customer Complaint', data = bymonth,␣
 ↪sort=False,markers = "o")
ax = lp.axes
ax.set_xlim(0,13)
ax.annotate('Max complaints in Jun', color='red',
            xy=(6, 1060), xycoords='data',
            xytext=(0.8, 0.85), textcoords='axes fraction',
            arrowprops=dict(facecolor='black', shrink=0.1),
            horizontalalignment='right', verticalalignment='top')
```

[9]:
```
Text(0.8, 0.85, 'Max complaints in Jun')
```



[10]:
```
#number of complaints Daily
plt.figure(figsize=(18,6))
byday = df1.groupby('Created_Day').count().reset_index()
lp = sns.lineplot(x='Created_Day', y= 'Customer Complaint', data = byday,␣
 ↪sort=False, color = 'red',markers = "o", )
ax = lp.axes
ax.set_xlim(0,32)
```

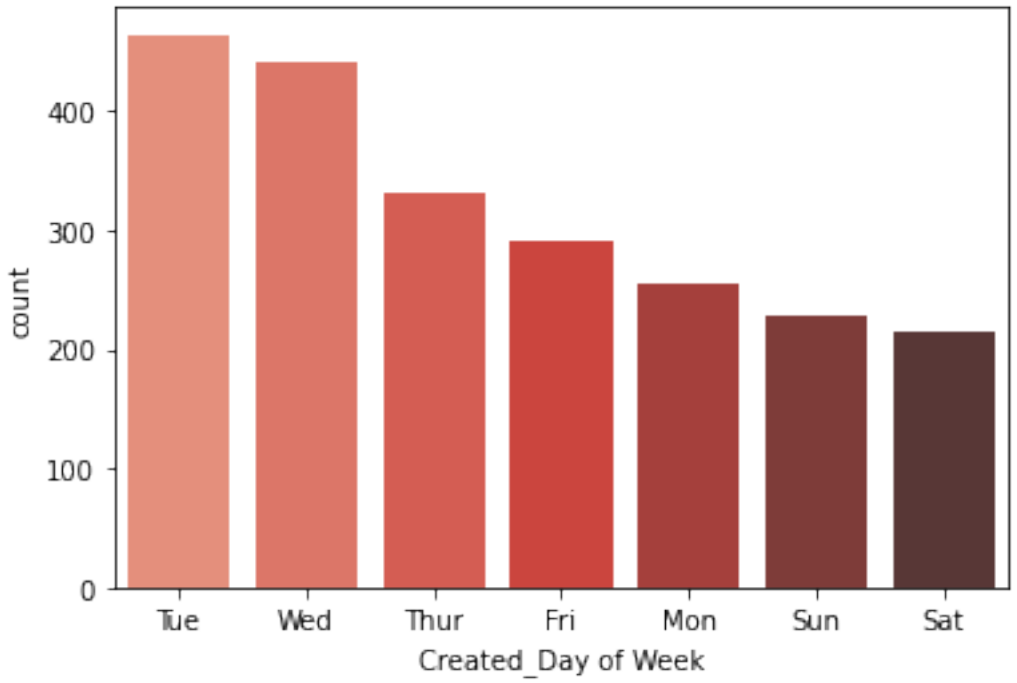
[10]: (0.0, 32.0)



[11]:
```
#number of complaints based on created day of the week
sns.countplot(x='Created_Day of Week', data = df1, order=df1['Created_Day of␣
 ↪Week'].value_counts().index, palette ="Reds_d")
```

```
#More number of complaints on Tuesday and wednesday
```

[11]: <AxesSubplot:xlabel='Created_Day of Week', ylabel='count'>



0.0.3 TASK 2 - Provide a table with the frequency of complaint types.

[12]:
```
df1['Customer Complaint'] = df1['Customer Complaint'].str.title()
CT_freq = df1['Customer Complaint'].value_counts()
CT_freq
```

[12]:
```
Comcast                                                              102
Comcast Data Cap                                                      30
Comcast Internet                                                      29
Comcast Data Caps                                                     21
Comcast Billing                                                       18
                                                                     ...
Monthly Data Caps                                                      1
Comcast/Xfinity Poor Service, Fraudulent Billing And Collection        1
Lost Emails/Billing                                                    1
Improper Billing And Non Resolution Of Issues                          1
Comcast, Ypsilanti Mi Internet Speed                                   1
Name: Customer Complaint, Length: 1740, dtype: int64
```

[25]:
```
import nltk
nltk.download('omw-1.4')
%pip install wordcloud
```

```
[nltk_data] Downloading package omw-1.4 to
[nltk_data]     /Users/shubhamarundekatey/nltk_data…
DEPRECATION: Configuring installation scheme with distutils config files is
deprecated and will no longer work in the near future. If you are using a
Homebrew or Linuxbrew Python, please see discussion at
https://github.com/Homebrew/homebrew-core/issues/76621
Requirement already satisfied: wordcloud in /usr/local/lib/python3.9/site-
packages (1.8.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.9/site-
packages (from wordcloud) (3.5.1)
Requirement already satisfied: pillow in /usr/local/lib/python3.9/site-packages
(from wordcloud) (8.4.0)
Requirement already satisfied: numpy>=1.6.1 in /usr/local/lib/python3.9/site-
packages (from wordcloud) (1.21.4)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.9/site-
packages (from matplotlib->wordcloud) (0.11.0)
Requirement already satisfied: python-dateutil>=2.7 in
/usr/local/lib/python3.9/site-packages (from matplotlib->wordcloud) (2.8.2)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.9/site-packages (from matplotlib->wordcloud) (1.3.2)
Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.9/site-packages (from matplotlib->wordcloud) (4.29.1)
Requirement already satisfied: pyparsing>=2.2.1 in
/usr/local/lib/python3.9/site-packages (from matplotlib->wordcloud) (3.0.6)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.9/site-
packages (from matplotlib->wordcloud) (21.3)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.9/site-
packages (from python-dateutil>=2.7->matplotlib->wordcloud) (1.16.0)
DEPRECATION: Configuring installation scheme with distutils config files is
deprecated and will no longer work in the near future. If you are using a
Homebrew or Linuxbrew Python, please see discussion at
https://github.com/Homebrew/homebrew-core/issues/76621
WARNING: You are using pip version 22.0.4; however, version 22.2.2 is
available.
You should consider upgrading via the '/usr/local/opt/python@3.9/bin/python3.9
-m pip install --upgrade pip' command.
Note: you may need to restart the kernel to use updated packages.
```

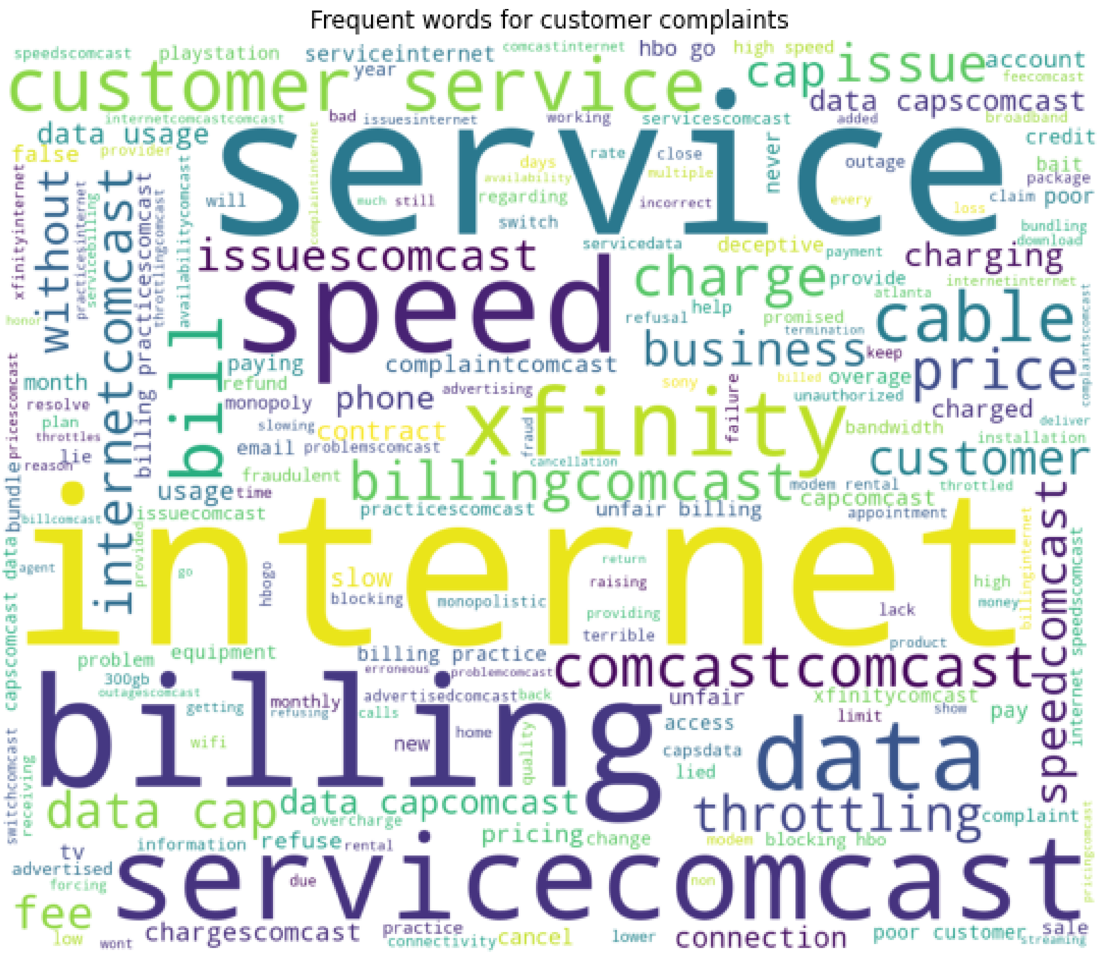
[14]:
```
from wordcloud import WordCloud, STOPWORDS
common_complaints = df1['Customer Complaint'].dropna().tolist()
common_complaints ='' .join(common_complaints).lower()

list_stops =␣
 ↪('Comcast','Now','Company','Day','Someone','Thing','Also','Got','Way','Call','Called','One'

for word in list_stops:
    STOPWORDS.add(word)
```

[15]:
```
wordcloud = WordCloud(stopwords=STOPWORDS,
                      background_color='white',
                      width=1200,
                      height=1000).generate(common_complaints)
```

[16]:
```
plt.figure( figsize=(10,12) )
plt.imshow(wordcloud)
plt.title('Frequent words for customer complaints')
plt.axis('off')
plt.show()
#Internet complaints are Maximum
```




```
[17]: from nltk.corpus import stopwords
      from nltk.stem.wordnet import WordNetLemmatizer
      import string

      stop = set(stopwords.words('english'))
      exclude = set(string.punctuation)
      lemma = WordNetLemmatizer()
```

```
[18]: nltk.download('wordnet')
```

```
[nltk_data] Downloading package wordnet to
[nltk_data]     /Users/shubhamarundekatey/nltk_data…
```

```
[18]: True
```

```
[19]: def clean(doc):
          stop_free = " ".join([i for i in doc.lower().split() if i not in stop])
```

```
    punc_free = "".join([ch for ch in stop_free if ch not in exclude])
    normalized = " ".join(lemma.lemmatize(word) for word in punc_free.split())
    return normalized
```

[26]:
```
doc_complete = df1['Customer Complaint'].tolist()
doc_clean = [clean(doc).split() for doc in doc_complete]
```

[34]:
```
import gensim
from gensim import corpora
```

[35]:
```
dictionary = corpora.Dictionary(doc_clean)
dictionary
```

[35]:
```
<gensim.corpora.dictionary.Dictionary at 0x147047400>
```

[36]:
```
doc_term_matrix = [dictionary.doc2bow(doc) for doc in doc_clean]
doc_term_matrix
```

[36]:
```
[[(0, 1), (1, 1), (2, 1), (3, 1)],
 [(4, 1), (5, 1), (6, 1), (7, 1), (8, 1)],
 [(3, 1), (8, 1)],
 [(1, 1), (9, 1), (10, 1), (11, 1), (12, 1), (13, 1), (14, 1), (15, 1)],
 [(1, 1), (8, 1), (16, 1), (17, 1)],
 [(18, 1), (19, 1), (20, 1), (21, 1), (22, 1), (23, 1), (24, 1)],
 [(8, 1), (10, 1), (20, 1), (25, 1), (26, 1)],
 [(1, 1), (8, 1), (27, 1), (28, 1), (29, 1), (30, 1)],
 [(1, 1), (31, 1), (32, 1)],
 [(1, 1), (33, 1), (34, 1), (35, 1), (36, 1)],
 [(5, 1), (8, 1), (37, 1), (38, 1)],
 [(39, 1), (40, 1), (41, 1), (42, 1), (43, 1), (44, 1)],
 [(1, 1),
  (2, 1),
  (45, 1),
  (46, 1),
  (47, 1),
  (48, 1),
  (49, 1),
  (50, 1),
  (51, 1),
  (52, 1),
  (53, 1)],
 [(2, 1), (3, 1)],
 [(2, 1), (54, 1), (55, 1), (56, 1)],
 [(2, 1), (57, 1)],
 [(2, 1), (3, 1), (58, 1)],
 [(1, 1), (59, 1), (60, 1), (61, 1), (62, 1), (63, 1), (64, 1), (65, 1)],
 [(2, 1), (8, 1), (66, 1)],
```

```
[(8, 1), (40, 1), (67, 1), (68, 1), (69, 1)],
[(2, 1), (70, 1), (71, 1)],
[(0, 1), (8, 2), (66, 1), (72, 1)],
[(3, 1)],
[(1, 1), (70, 1), (73, 1), (74, 1)],
[(1, 1)],
[(75, 1), (76, 1)],
[(1, 1), (8, 1), (72, 1)],
[(1, 1), (77, 1), (78, 1), (79, 1), (80, 1)],
[(1, 1), (2, 1), (38, 1), (81, 1), (82, 1), (83, 1), (84, 1)],
[(2, 1), (17, 1), (85, 1), (86, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (2, 1), (10, 1), (20, 1)],
[(87, 1), (88, 1), (89, 1), (90, 1)],
[(1, 1), (2, 1), (15, 1), (20, 1)],
[(1, 1), (91, 1), (92, 1)],
[(1, 1)],
[(8, 1)],
[(1, 1)],
[(2, 1), (38, 1), (82, 1), (93, 1)],
[(1, 1), (46, 1), (94, 1), (95, 1)],
[(96, 1)],
[(2, 1), (3, 1), (97, 1)],
[(2, 1), (98, 1), (99, 1)],
[(1, 1), (55, 1), (100, 1), (101, 1), (102, 1), (103, 1), (104, 1), (105, 1)],
[(3, 1), (22, 1), (106, 1)],
[(38, 1), (107, 1), (108, 1), (109, 1), (110, 1), (111, 1)],
[(1, 1), (38, 1), (112, 1)],
[(1, 1)],
[(1, 1), (8, 1), (38, 1), (82, 1)],
[(0, 1), (35, 1), (113, 1)],
[(8, 1), (82, 1)],
[(48, 1), (49, 1), (114, 1), (115, 1)],
[(2, 1), (116, 1)],
[(39, 1), (82, 1)],
[(70, 1)],
[(57, 1), (117, 1)],
[(1, 1), (91, 1), (118, 1), (119, 1), (120, 1)],
[(1, 1), (121, 1), (122, 1)],
[(1, 1), (46, 1), (123, 1), (124, 1), (125, 1)],
[(1, 1), (82, 1)],
[(1, 1), (8, 1), (29, 1), (126, 1), (127, 1), (128, 1)],
[(1, 1)],
[(129, 1)],
[(1, 1), (8, 1), (40, 1), (69, 1), (78, 1), (130, 1), (131, 1)],
[(1, 1), (8, 1), (132, 1)],
[(8, 1), (133, 1), (134, 1), (135, 1), (136, 1)],
```

```
[(82, 1), (117, 1)],
[(0, 1), (2, 1), (45, 1), (137, 1), (138, 1)],
[(139, 1)],
[(3, 1), (82, 1)],
[(140, 1)],
[(60, 1), (141, 1), (142, 1), (143, 1), (144, 1)],
[(1, 1),
 (10, 1),
 (20, 1),
 (145, 1),
 (146, 1),
 (147, 1),
 (148, 1),
 (149, 1),
 (150, 1)],
[(1, 1), (10, 1), (20, 1)],
[(3, 1), (8, 1)],
[(20, 1), (74, 1), (151, 1), (152, 1), (153, 1)],
[(1, 1), (10, 1), (20, 1), (154, 1)],
[(1, 1), (38, 1), (155, 1)],
[(1, 1), (62, 1), (156, 1)],
[(1, 1), (82, 1), (157, 1)],
[(158, 1), (159, 1)],
[(10, 1), (20, 1), (160, 1)],
[(10, 1), (20, 1)],
[(1, 1), (8, 1), (161, 1), (162, 1)],
[(1, 1), (24, 1), (163, 1), (164, 1)],
[(0, 1), (8, 1), (165, 1), (166, 1), (167, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (8, 1), (168, 1)],
[(10, 1), (20, 1)],
[(1, 1), (8, 1), (169, 1), (170, 1), (171, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1)],
[(172, 1), (173, 1)],
[(1, 1), (2, 1), (8, 1), (74, 1), (102, 1), (174, 1), (175, 1), (176, 1)],
[(8, 1), (102, 1), (152, 1), (177, 1), (178, 1)],
[(8, 1),
 (146, 1),
 (179, 1),
 (180, 1),
 (181, 1),
 (182, 1),
 (183, 1),
 (184, 1),
 (185, 1),
 (186, 1),
```

```
 (187, 1),
 (188, 1),
 (189, 1),
 (190, 1)],
[(1, 1), (8, 1), (82, 1), (191, 1)],
[(1, 1), (8, 1), (72, 1)],
[(1, 1)],
[(1, 1), (10, 1), (20, 1), (101, 1), (192, 1), (193, 1)],
[(1, 1), (19, 1), (137, 1), (194, 1), (195, 1)],
[(1, 1), (10, 1), (196, 1)],
[(1, 1), (8, 1), (66, 1), (72, 1)],
[(10, 1), (20, 1)],
[(8, 1), (72, 1), (197, 1)],
[(8, 1), (198, 1)],
[(1, 1), (15, 1), (20, 1), (199, 1)],
[(1, 1), (8, 1), (29, 1), (200, 1)],
[(1, 1), (8, 1), (158, 1), (201, 1), (202, 1), (203, 1)],
[(1, 1), (38, 1), (204, 1)],
[(1, 1), (205, 1), (206, 1)],
[(8, 1), (207, 1), (208, 1)],
[(1, 1), (38, 1)],
[(1, 1), (2, 1)],
[(1, 1), (3, 1), (209, 1)],
[(10, 1), (20, 1)],
[(1, 1), (10, 1), (20, 1), (192, 1)],
[(1, 1), (10, 1), (20, 1), (192, 1)],
[(1, 1), (8, 1), (72, 1), (210, 1)],
[(1, 1), (9, 1), (20, 1), (24, 1), (211, 1)],
[(1, 1), (158, 1)],
[(1, 1), (10, 1), (20, 1)],
[(38, 1), (74, 1), (212, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (2, 1), (213, 1), (214, 1), (215, 1)],
[(3, 1)],
[(2, 1), (199, 1), (216, 1), (217, 1)],
[(0, 1), (1, 1), (2, 1), (8, 1)],
[(1, 1), (24, 1), (109, 1), (199, 1), (218, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (90, 1), (219, 1)],
[(1, 1), (69, 1), (84, 1), (187, 1), (220, 1), (221, 1)],
[(1, 1), (15, 1), (20, 1), (23, 1)],
[(137, 1), (195, 1), (199, 1), (222, 1), (223, 1)],
[(90, 1), (224, 1)],
[(1, 1), (70, 1)],
[(2, 1), (3, 1), (196, 1), (225, 1), (226, 1)],
[(2, 1), (58, 1)],
[(1, 1), (3, 1), (25, 1), (227, 1), (228, 1)],
```

```
[(1, 1), (57, 1)],
[(1, 1)],
[(1, 1), (38, 1), (74, 1), (90, 1), (153, 1)],
[(2, 1), (25, 1)],
[(15, 1), (20, 1), (24, 1)],
[(8, 1), (38, 1), (108, 1), (229, 1)],
[(10, 1), (101, 1), (230, 1), (231, 1)],
[(1, 1), (20, 1), (23, 1)],
[(84, 1), (90, 1), (168, 1), (232, 1), (233, 1)],
[(1, 1), (234, 1), (235, 1), (236, 1), (237, 1)],
[(71, 1), (178, 1), (238, 1)],
[(12, 1), (35, 1), (72, 1), (159, 1)],
[(1, 1), (2, 1), (25, 1)],
[(2, 1), (224, 1)],
[(199, 1), (239, 1)],
[(10, 1), (20, 1), (240, 1)],
[(1, 1), (2, 1), (241, 1)],
[(25, 1)],
[(2, 1), (8, 1), (73, 1), (242, 1), (243, 1)],
[(1, 1), (2, 1)],
[(8, 1), (40, 1), (244, 1)],
[(1, 1), (48, 1), (49, 1), (245, 1), (246, 1)],
[(8, 1), (130, 1), (152, 1), (247, 1), (248, 1), (249, 1), (250, 1)],
[(214, 1)],
[(21, 1), (249, 1)],
[(1, 1), (251, 1)],
[(0, 1), (158, 1), (199, 1), (229, 1)],
[(1, 1), (38, 1), (82, 1), (223, 1)],
[(1, 1), (235, 1), (252, 1), (253, 1)],
[(8, 1), (57, 1), (254, 1), (255, 1)],
[(1, 1),
 (2, 1),
 (3, 1),
 (99, 1),
 (158, 1),
 (256, 1),
 (257, 1),
 (258, 1),
 (259, 1)],
[(2, 1), (3, 1), (158, 1), (260, 1)],
[(2, 1), (3, 1), (261, 1)],
[(8, 1), (262, 1)],
[(1, 1), (38, 1), (74, 1)],
[(70, 1)],
[(2, 1), (3, 1), (97, 1), (263, 1), (264, 1)],
[(1, 1),
 (2, 1),
```

```
 (3, 1),
 (8, 1),
 (97, 1),
 (98, 1),
 (99, 1),
 (263, 1),
 (265, 1)],
[(1, 1), (8, 1), (70, 1), (147, 1), (266, 1), (267, 1)],
[(2, 1), (21, 1), (225, 1), (268, 1), (269, 1)],
[(1, 1), (2, 1), (3, 1), (70, 1), (265, 1)],
[(0, 1), (1, 1), (270, 1)],
[(8, 1), (38, 1), (72, 1), (112, 1), (210, 1)],
[(1, 1), (78, 1), (108, 1)],
[(1, 1), (241, 1)],
[(45, 1), (86, 1), (90, 1)],
[(0, 1), (2, 1)],
[(2, 1), (8, 1), (97, 1), (262, 1)],
[(1, 1), (179, 1)],
[(1, 1), (3, 1), (28, 1), (82, 1), (271, 1), (272, 1)],
[(10, 1), (15, 1), (20, 1), (273, 1)],
[(74, 1), (102, 1), (152, 1), (274, 1)],
[(0, 1), (1, 1)],
[(1, 1), (224, 1)],
[(1, 1), (57, 1)],
[(0, 1)],
[(1, 1), (199, 1)],
[(1, 1)],
[(2, 1), (275, 1)],
[(74, 1), (109, 1)],
[(1, 1), (204, 1)],
[(1, 1), (17, 1), (57, 1), (155, 1), (176, 1), (208, 1), (276, 1), (277, 1)],
[(1, 1)],
[(278, 1)],
[(3, 1), (99, 1), (196, 1), (279, 1), (280, 1), (281, 1), (282, 1)],
[(1, 1), (38, 1), (283, 1)],
[(1, 1), (2, 1), (221, 1), (284, 1)],
[(1, 1), (46, 1), (246, 1), (285, 1)],
[(10, 1), (20, 1), (286, 1), (287, 1)],
[(1, 1)],
[(136, 1), (199, 1), (247, 1), (288, 1), (289, 1)],
[(1, 1), (2, 1), (290, 1), (291, 1), (292, 1)],
[(1, 1), (2, 1), (290, 1), (291, 1), (292, 1)],
[(1, 1), (8, 2), (72, 1), (203, 1)],
[(2, 1), (12, 1), (137, 1), (210, 1), (225, 1), (293, 1), (294, 1), (295, 1)],
[(1, 1), (38, 1)],
[(21, 1), (181, 1), (296, 1), (297, 1)],
[(1, 1), (199, 1), (212, 1)],
```

```
[(38, 1), (298, 1)],
[(38, 1), (155, 1)],
[(3, 1), (8, 1), (130, 1), (299, 1), (300, 1)],
[(1, 1),
 (57, 1),
 (71, 1),
 (72, 1),
 (82, 1),
 (301, 1),
 (302, 1),
 (303, 1),
 (304, 1)],
[(8, 1), (305, 1)],
[(199, 1), (306, 1)],
[(1, 1),
 (12, 1),
 (55, 1),
 (71, 1),
 (158, 1),
 (188, 1),
 (307, 1),
 (308, 1),
 (309, 1)],
[(310, 1), (311, 1), (312, 1), (313, 1), (314, 1), (315, 1)],
[(1, 1), (2, 1)],
[(1, 1), (8, 1), (38, 1), (191, 1)],
[(1, 1), (57, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (82, 1)],
[(1, 1), (19, 1), (21, 1), (136, 1), (316, 1)],
[(158, 1), (288, 1)],
[(159, 1), (199, 1), (317, 1), (318, 1)],
[(25, 1), (319, 1)],
[(2, 1), (8, 1), (320, 1), (321, 1)],
[(1, 1), (38, 1), (74, 1), (212, 1)],
[(1, 1), (8, 1), (38, 1), (159, 1)],
[(1, 1), (2, 1), (3, 1), (322, 1)],
[(21, 1), (98, 1), (137, 1), (195, 1), (309, 1), (323, 1), (324, 1)],
[(139, 1), (325, 1)],
[(38, 1)],
[(38, 1)],
[(8, 1), (326, 1)],
[(1, 1), (74, 1), (197, 1)],
[(38, 1), (61, 1), (327, 1)],
[(1, 1), (3, 1), (82, 1)],
[(221, 1), (284, 1)],
[(2, 1), (8, 1), (40, 1), (328, 1), (329, 1)],
```

```
[(1, 1), (5, 1), (136, 1), (179, 1), (188, 1), (247, 1)],
[(197, 1), (221, 1), (330, 1), (331, 1)],
[(21, 1), (137, 1), (195, 1)],
[(1, 1), (82, 1), (332, 1)],
[(153, 1), (333, 1)],
[(75, 1), (76, 1), (224, 1)],
[(1, 1), (48, 1), (49, 1)],
[(1, 1), (2, 1), (97, 1)],
[(2, 1), (3, 1), (97, 1)],
[(1, 1), (38, 1), (334, 1)],
[(1, 1), (161, 1), (199, 1), (269, 1), (335, 1), (336, 1)],
[(1, 1), (38, 1), (74, 1), (212, 1)],
[(48, 1), (49, 1), (337, 1), (338, 1), (339, 1), (340, 1)],
[(1, 1), (8, 1), (341, 1), (342, 1)],
[(1, 1), (343, 1)],
[(78, 1), (121, 1), (344, 1)],
[(3, 1), (28, 1), (292, 1), (345, 1)],
[(1, 1), (3, 1), (25, 1), (196, 1)],
[(286, 1), (346, 1)],
[(2, 1), (3, 1), (292, 1)],
[(38, 1), (159, 1)],
[(1, 1), (347, 1), (348, 1)],
[(1, 1),
 (8, 1),
 (38, 1),
 (69, 1),
 (84, 1),
 (349, 1),
 (350, 1),
 (351, 1),
 (352, 1)],
[(1, 1), (48, 1), (49, 1), (246, 1), (353, 1)],
[(1, 1), (15, 1), (20, 1), (199, 1)],
[(1, 1), (38, 1), (82, 1), (101, 1)],
[(1, 1), (2, 1), (3, 1)],
[(1, 1), (2, 1), (8, 1), (97, 1)],
[(1, 1), (2, 1), (97, 1)],
[(1, 1), (2, 1), (354, 1)],
[(1, 1), (71, 1), (179, 1), (211, 1), (355, 1), (356, 1), (357, 1)],
[(1, 1), (8, 1), (358, 1)],
[(1, 1)],
[(1, 1)],
[(8, 1), (32, 1), (91, 1), (359, 1)],
[(38, 1), (252, 1)],
[(38, 1), (360, 1)],
[(361, 1)],
[(1, 1), (2, 1), (25, 1)],
```

```
[(1, 1), (38, 1), (229, 1)],
[(38, 1), (199, 1)],
[(2, 1)],
[(360, 1), (362, 1)],
[(232, 1), (233, 1), (363, 1)],
[(8, 1), (208, 1), (364, 1), (365, 1)],
[(2, 1), (158, 1), (265, 1)],
[(1, 1), (8, 1), (99, 1)],
[(8, 1), (21, 1), (261, 1), (366, 1)],
[(1, 1), (8, 1)],
[(8, 1), (72, 1), (210, 1)],
[(8, 1), (63, 1), (67, 1), (119, 1)],
[(1, 1)],
[(2, 1), (8, 1), (367, 1)],
[(1, 1), (3, 1), (38, 1), (82, 1)],
[(8, 1), (299, 1), (368, 1), (369, 1), (370, 1)],
[(1, 1), (164, 1)],
[(2, 1), (25, 1)],
[(38, 1), (74, 1), (212, 1)],
[(38, 1), (82, 1), (371, 1)],
[(1, 1), (8, 1), (372, 1)],
[(20, 1), (23, 1)],
[(224, 1), (373, 1)],
[(1, 1), (38, 1), (374, 1)],
[(1, 1)],
[(2, 1), (97, 1)],
[(2, 1), (8, 1)],
[(90, 1), (121, 1), (375, 1)],
[(1, 1),
 (3, 1),
 (38, 1),
 (57, 1),
 (283, 1),
 (292, 1),
 (376, 1),
 (377, 1),
 (378, 1)],
[(1, 1), (52, 1), (285, 1), (313, 1), (379, 1)],
[(1, 1), (63, 1), (155, 1), (380, 1)],
[(3, 1), (97, 1), (225, 1), (381, 1)],
[(1, 1), (2, 1), (25, 1), (382, 1)],
[(1, 1), (383, 1)],
[(1, 1), (8, 1), (38, 1), (82, 1), (110, 1), (384, 1)],
[(38, 1), (385, 1)],
[(8, 1), (168, 1), (386, 1), (387, 1)],
[(1, 1), (388, 1)],
[(1, 1), (36, 1), (158, 1), (185, 1), (368, 1), (389, 1)],
```

```
[(2, 1), (390, 1)],
[(1, 1), (35, 1)],
[(1, 1), (2, 1), (8, 1), (391, 1), (392, 1), (393, 1)],
[(21, 1), (269, 1), (294, 1), (313, 1)],
[(1, 1), (155, 1), (364, 1), (394, 1), (395, 1)],
[(57, 1), (121, 1), (139, 1), (187, 1), (396, 1), (397, 1)],
[(1, 1), (2, 1)],
[(1, 1), (2, 1)],
[(8, 1), (82, 1)],
[(1, 1), (90, 1), (199, 1), (398, 1)],
[(2, 1), (58, 1)],
[(1, 1), (10, 1), (15, 1)],
[(1, 1), (10, 1), (15, 1), (20, 1)],
[(1, 1), (10, 1), (20, 1), (399, 1), (400, 1)],
[(2, 1), (8, 1)],
[(8, 1)],
[(8, 1), (38, 1), (249, 1), (401, 1), (402, 1)],
[(15, 1), (20, 1), (38, 1)],
[(75, 1), (76, 1), (403, 1), (404, 1)],
[(2, 1), (3, 1)],
[(1, 1), (199, 1), (296, 1), (405, 1)],
[(1, 1), (2, 1), (406, 1)],
[(1, 1), (22, 1), (35, 1), (407, 1), (408, 1)],
[(1, 1), (57, 1)],
[(1, 1), (2, 1), (3, 1)],
[(1, 1), (57, 1)],
[(10, 1), (20, 1)],
[(1, 1), (15, 1), (20, 1), (82, 1), (352, 1), (409, 1)],
[(1, 1), (15, 1), (20, 1), (82, 1), (352, 1), (409, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (15, 1), (20, 1), (410, 1)],
[(1, 1), (2, 1), (10, 1), (20, 1), (411, 1)],
[(1, 1), (21, 2), (105, 1), (324, 1), (395, 1), (412, 1), (413, 1), (414, 1)],
[(0, 1), (1, 1), (225, 1), (265, 1), (415, 1), (416, 1), (417, 1)],
[(1, 1), (8, 1), (82, 1), (418, 1), (419, 1)],
[(1, 1), (29, 1), (78, 1), (120, 1), (364, 1), (420, 1), (421, 1)],
[(1, 1), (2, 2), (102, 1), (148, 1), (232, 1), (422, 1)],
[(1, 1), (2, 1), (10, 1), (15, 1)],
[(1, 1), (8, 1), (210, 1)],
[(1, 1), (10, 1), (20, 1), (423, 1)],
[(1, 1), (2, 1), (8, 1), (25, 1)],
[(82, 1), (424, 1)],
[(199, 1), (425, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (158, 1), (426, 1), (427, 1), (428, 1), (429, 1), (430, 1)],
[(1, 1), (2, 1)],
[(1, 1), (9, 1), (10, 1), (20, 1)],
```

```
[(2, 1), (3, 1), (264, 1)],
[(8, 1), (35, 1), (73, 1), (431, 1), (432, 1), (433, 1), (434, 1), (435, 1)],
[(1, 1), (2, 1), (3, 1), (35, 1)],
[(1, 1), (436, 1)],
[(63, 1), (437, 1), (438, 1), (439, 1)],
[(2, 1), (82, 1), (320, 1)],
[(90, 1)],
[(117, 1)],
[(1, 1), (440, 1), (441, 1)],
[(1, 1), (95, 1), (442, 1)],
[(1, 1), (443, 1)],
[(8, 1), (72, 1), (178, 1), (444, 1)],
[(1, 1), (48, 1), (49, 1), (246, 1)],
[(445, 1), (446, 1)],
[(1, 1), (8, 2), (72, 1), (82, 1)],
[(1, 1), (224, 1), (314, 1)],
[(1, 1), (54, 1)],
[(1, 1), (3, 1), (10, 1), (20, 1), (25, 1)],
[(259, 1), (447, 1), (448, 1), (449, 1)],
[(1, 1), (155, 1)],
[(199, 1), (252, 1), (432, 1), (450, 1), (451, 1)],
[(1, 1), (57, 1), (384, 1)],
[(1, 1), (2, 1), (225, 1), (452, 1)],
[(95, 1), (103, 1), (225, 1), (453, 1), (454, 1)],
[(1, 1), (455, 1), (456, 1), (457, 1), (458, 1), (459, 1)],
[(38, 1), (112, 1)],
[(1, 1), (57, 1)],
[(1, 1)],
[(2, 1), (3, 1), (299, 1)],
[(1, 1), (52, 1), (115, 1), (460, 1)],
[(1, 1), (82, 1), (86, 1)],
[(1, 1), (2, 1)],
[(1, 1)],
[(1, 1), (8, 1), (72, 1), (210, 1), (461, 1), (462, 1)],
[(1, 1), (463, 1), (464, 1)],
[(1, 1), (2, 1)],
[(8, 1), (66, 1), (199, 1), (465, 1), (466, 1), (467, 1)],
[(2, 1), (8, 1), (38, 1), (57, 1), (72, 1), (97, 1), (210, 1)],
[(8, 1)],
[(1, 1), (32, 1)],
[(1, 1), (2, 1), (3, 1), (225, 1)],
[(0, 1), (1, 1), (2, 1)],
[(1, 1), (8, 1), (395, 1), (468, 1)],
[(1, 1)],
[(1, 1), (120, 1), (199, 1), (469, 1)],
[(1, 1), (8, 1), (19, 1), (470, 1)],
[(1, 1), (35, 1), (70, 1), (171, 1), (471, 1)],
```

```
[(2, 1), (8, 1), (55, 1), (199, 1), (229, 1), (395, 1)],
[(38, 1), (74, 1), (212, 1)],
[(1, 1), (472, 1)],
[(473, 1), (474, 1)],
[(1, 1), (74, 1), (102, 1), (212, 1)],
[(2, 1), (3, 1), (97, 1)],
[(8, 1), (121, 1), (375, 1), (475, 1)],
[(1, 1),
 (7, 1),
 (19, 1),
 (21, 1),
 (61, 1),
 (158, 1),
 (476, 1),
 (477, 1),
 (478, 1),
 (479, 1)],
[(8, 1), (139, 1), (407, 1)],
[(3, 1), (8, 1), (480, 1), (481, 1)],
[(1, 1), (8, 1), (38, 1)],
[(38, 1), (74, 1), (212, 1)],
[(35, 1), (90, 1), (99, 1), (482, 1), (483, 1)],
[(90, 1), (234, 1), (484, 1)],
[(1, 1), (2, 1), (50, 1), (51, 1), (53, 1)],
[(8, 1), (485, 1)],
[(1, 1), (38, 1), (91, 1), (229, 1), (486, 1), (487, 1)],
[(1, 1), (2, 1), (3, 1)],
[(1, 1), (411, 1), (488, 1)],
[(1, 1), (38, 1)],
[(0, 1), (1, 1), (2, 1), (176, 1), (489, 1)],
[(2, 1), (32, 1), (225, 1)],
[(1, 1), (2, 1), (3, 1), (25, 1)],
[(1, 1), (24, 1), (90, 1), (199, 1), (490, 1)],
[(1, 1), (8, 1), (32, 1)],
[(1, 1), (38, 1)],
[(199, 1), (491, 1)],
[(139, 1)],
[(2, 1), (371, 1)],
[(139, 1)],
[(117, 1), (225, 1), (492, 1)],
[(1, 1), (50, 1), (90, 1), (357, 1), (448, 1), (493, 1), (494, 1)],
[(8, 1), (82, 1)],
[(1, 1), (2, 1), (32, 1)],
[(1, 1)],
[(15, 1), (217, 1), (495, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (38, 1), (74, 1)],
```

```
[(8, 1), (72, 1), (210, 1)],
[(2, 1), (3, 1)],
[(1, 1), (60, 1), (142, 1), (496, 1), (497, 1)],
[(1, 1), (498, 1), (499, 1), (500, 1), (501, 1), (502, 1), (503, 1)],
[(8, 1), (108, 1), (168, 1), (443, 1), (504, 1)],
[(25, 1), (90, 1), (340, 1), (505, 1), (506, 1)],
[(1, 1), (21, 1), (249, 1)],
[(82, 1), (507, 1)],
[(35, 1), (508, 1), (509, 1)],
[(1, 1), (38, 1), (212, 1)],
[(1, 1), (129, 1), (436, 1)],
[(1, 1), (8, 1), (57, 1)],
[(158, 1), (199, 1), (510, 1)],
[(38, 1)],
[(2, 1), (176, 1), (224, 1)],
[(3, 1), (8, 1), (38, 1), (156, 1), (511, 1), (512, 1)],
[(1, 1), (8, 1), (513, 1)],
[(61, 1), (324, 1)],
[(1, 1), (8, 1), (324, 1), (514, 1), (515, 1), (516, 1), (517, 1), (518, 1)],
[(1, 1), (90, 1)],
[(1, 1), (8, 1), (244, 1)],
[(1, 1), (2, 1), (3, 1), (97, 1)],
[(1, 1), (8, 1)],
[(2, 1), (158, 1), (519, 1), (520, 1)],
[(1, 1), (8, 1), (38, 1)],
[(1, 1), (521, 1)],
[(1, 1), (74, 1), (522, 1), (523, 1)],
[(3, 1), (264, 1)],
[(8, 1), (524, 1)],
[(1, 1), (8, 1), (81, 1), (443, 1), (474, 1)],
[(8, 1), (72, 1), (203, 1), (214, 1), (443, 1), (525, 1)],
[(1, 1), (8, 1), (526, 1), (527, 1)],
[(38, 1), (528, 1)],
[(2, 1), (139, 1)],
[(58, 1), (358, 1)],
[(1, 1), (155, 1), (158, 1)],
[(38, 1), (74, 1), (212, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (2, 1), (97, 1), (529, 1)],
[(1, 1), (21, 1), (29, 1), (195, 1), (283, 1), (296, 1), (530, 1)],
[(1, 1)],
[(0, 1), (2, 1), (35, 1), (82, 1), (212, 1), (531, 1)],
[(1, 1), (2, 1), (3, 1), (532, 1)],
[(0, 1), (2, 1)],
[(9, 1), (10, 1), (20, 1), (70, 1), (533, 1)],
[(1, 1), (8, 1), (90, 1), (232, 1), (233, 1)],
[(1, 1), (75, 1), (76, 1)],
```

```
[(1, 1), (10, 1), (20, 1), (192, 1), (193, 1)],
[(10, 1), (15, 1), (20, 1)],
[(10, 1), (20, 1)],
[(15, 1), (20, 1)],
[(78, 1), (534, 1), (535, 1), (536, 1)],
[(1, 1), (10, 1), (20, 1), (537, 1), (538, 1)],
[(1, 1), (10, 1), (15, 1)],
[(1, 1), (2, 1), (8, 1), (197, 1), (462, 1)],
[(539, 1), (540, 1), (541, 1), (542, 1)],
[(1, 1), (57, 1)],
[(1, 1), (2, 1), (38, 1), (82, 1), (176, 1)],
[(1, 1), (19, 1), (21, 1), (90, 1), (137, 1), (195, 1), (312, 1), (543, 1)],
[(38, 1), (544, 1)],
[(1, 1), (2, 2), (10, 1), (90, 1), (436, 1)],
[(1, 1), (10, 1), (20, 1), (147, 1), (150, 1), (545, 1)],
[(1, 1), (2, 1), (8, 1), (546, 1)],
[(1, 1), (143, 1), (199, 1)],
[(1, 1), (10, 1), (20, 1), (547, 1)],
[(38, 1), (91, 1), (199, 1)],
[(1, 1),
 (10, 1),
 (20, 1),
 (23, 1),
 (38, 1),
 (74, 1),
 (102, 1),
 (156, 1),
 (358, 1),
 (548, 1)],
[(38, 1), (74, 1), (109, 1)],
[(38, 1), (57, 1)],
[(1, 1), (38, 1), (74, 1), (212, 1)],
[(1, 1), (45, 1), (549, 1), (550, 1), (551, 1)],
[(2, 1), (3, 1)],
[(38, 1), (74, 1), (552, 1), (553, 1)],
[(60, 1), (554, 1)],
[(1, 1), (90, 1), (246, 1), (285, 1)],
[(1, 1), (40, 1), (555, 1), (556, 1), (557, 1)],
[(340, 1), (558, 1), (559, 1), (560, 1)],
[(2, 1), (3, 1), (35, 1), (368, 1)],
[(1, 1), (2, 1), (199, 1), (523, 1), (561, 1)],
[(1, 1), (2, 2), (3, 1), (25, 1), (546, 1), (562, 1)],
[(3, 1), (97, 1)],
[(38, 1), (563, 1)],
[(1, 1), (2, 1), (224, 1)],
[(10, 1), (20, 1), (82, 1), (564, 1), (565, 1)],
[(1, 1), (20, 1), (38, 1)],
```

```
[(10, 1), (20, 1)],
[(1, 1)],
[(1, 1)],
[(1, 1)],
[(2, 1), (32, 1), (566, 1), (567, 1), (568, 1)],
[(1, 1), (2, 1)],
[(1, 1), (38, 1), (569, 1)],
[(109, 1), (111, 1), (570, 1)],
[(571, 1), (572, 1)],
[(35, 2), (204, 1), (468, 1), (573, 1), (574, 1), (575, 1), (576, 1)],
[(555, 1), (577, 1)],
[(1, 1), (28, 1), (81, 1), (578, 1)],
[(21, 1)],
[(0, 1), (1, 1), (579, 1), (580, 1)],
[(218, 1), (577, 1)],
[(1, 1)],
[(1, 1), (38, 1), (74, 1), (212, 1), (384, 1)],
[(1, 1), (158, 1), (212, 1)],
[(1, 1), (8, 1)],
[(1, 1), (2, 1), (3, 1), (97, 1), (345, 1)],
[(1, 1), (2, 1), (8, 1), (38, 1), (155, 1)],
[(1, 1), (3, 1), (38, 1)],
[(1, 1), (8, 1), (60, 1), (78, 1), (121, 1), (130, 1), (168, 1)],
[(1, 1), (8, 1), (178, 1), (581, 1)],
[(2, 1), (3, 1), (66, 1), (97, 1), (221, 1), (345, 1)],
[(267, 1), (582, 1), (583, 1)],
[(48, 1), (49, 1), (115, 1), (584, 1)],
[(1, 1),
 (8, 1),
 (36, 1),
 (63, 1),
 (158, 1),
 (585, 1),
 (586, 1),
 (587, 1),
 (588, 1)],
[(21, 1), (413, 1), (443, 1), (589, 1)],
[(2, 1), (97, 1)],
[(2, 1), (3, 1), (95, 1), (103, 1), (590, 1)],
[(1, 1), (8, 1), (67, 1), (72, 1), (591, 1), (592, 1), (593, 1)],
[(1, 1), (57, 1)],
[(67, 1), (594, 1)],
[(2, 1), (35, 1), (595, 1)],
[(1, 1), (3, 1), (14, 1), (25, 1), (449, 1)],
[(2, 1), (3, 1), (97, 1), (263, 1)],
[(2, 1), (3, 1), (134, 1), (596, 1), (597, 1)],
[(8, 1), (67, 1), (136, 1)],
```

```
[(2, 1), (97, 1)],
[(1, 1),
 (29, 1),
 (67, 1),
 (120, 1),
 (137, 1),
 (195, 1),
 (296, 1),
 (598, 1),
 (599, 1),
 (600, 1)],
[(187, 1), (577, 1), (601, 1)],
[(21, 1), (78, 1), (108, 1), (118, 1), (252, 1)],
[(2, 1), (8, 2), (602, 1)],
[(2, 1), (8, 1), (602, 1)],
[(8, 1), (199, 1), (212, 1), (603, 1)],
[(1, 1), (7, 1), (476, 1)],
[(32, 1), (74, 1), (212, 1)],
[(334, 1), (604, 1)],
[(1, 1), (8, 1)],
[(1, 1), (38, 1), (74, 1)],
[(1, 1)],
[(1, 1), (605, 1)],
[(3, 1), (86, 1), (97, 1), (225, 1)],
[(1, 1), (3, 1), (198, 1), (292, 1), (606, 1)],
[(1, 1), (8, 1)],
[(174, 1), (296, 1), (607, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (38, 1), (212, 1)],
[(1, 1)],
[(8, 1), (97, 1)],
[(1, 1), (2, 1)],
[(1, 1)],
[(2, 1), (82, 1)],
[(8, 1), (102, 1), (608, 1)],
[(609, 1), (610, 1), (611, 1)],
[(143, 1), (179, 1)],
[(1, 1), (2, 1), (8, 1), (57, 1)],
[(38, 1), (82, 1)],
[(1, 1), (8, 1), (25, 1), (210, 1)],
[(1, 1),
 (10, 1),
 (15, 1),
 (20, 1),
 (29, 1),
 (38, 1),
 (317, 1),
```

```
 (612, 1),
 (613, 1),
 (614, 1),
 (615, 1),
 (616, 1)],
[(8, 1), (286, 1), (327, 1)],
[(1, 1), (8, 1), (210, 1)],
[(10, 1), (617, 1), (618, 1)],
[(1, 1), (10, 1), (20, 1)],
[(3, 1), (8, 1), (97, 1), (210, 1)],
[(8, 1), (38, 1)],
[(1, 1), (619, 1)],
[(1, 1),
 (2, 1),
 (10, 1),
 (15, 1),
 (154, 1),
 (395, 1),
 (617, 1),
 (618, 1),
 (620, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (10, 1), (20, 1), (621, 1), (622, 1)],
[(1, 1), (424, 1)],
[(21, 1), (623, 1), (624, 1)],
[(1, 1), (2, 1), (155, 1)],
[(1, 1), (2, 1), (38, 1)],
[(1, 1), (90, 1), (625, 1), (626, 1)],
[(1, 1), (38, 1), (82, 1)],
[(1, 1), (2, 1)],
[(1, 1), (32, 1), (514, 1), (627, 1)],
[(1, 1), (57, 1), (628, 1), (629, 1), (630, 1)],
[(1, 1), (8, 1), (178, 1)],
[(1, 1), (8, 1), (57, 1), (197, 1), (631, 1)],
[(10, 1), (20, 1)],
[(2, 1), (3, 1), (8, 1)],
[(1, 1), (35, 1), (90, 1), (632, 1), (633, 1)],
[(38, 1), (571, 1)],
[(28, 1),
 (320, 1),
 (335, 1),
 (409, 1),
 (411, 1),
 (567, 1),
 (634, 1),
 (635, 1),
 (636, 1),
```

```
 (637, 1),
 (638, 1),
 (639, 1)],
[(1, 1), (411, 1), (640, 1)],
[(1, 1), (2, 1), (8, 1)],
[(1, 1), (78, 1), (158, 1), (395, 1), (641, 1), (642, 1), (643, 1)],
[(38, 1), (74, 1), (212, 1)],
[(199, 1), (294, 1)],
[(1, 1), (19, 1), (368, 1), (644, 1)],
[(20, 1), (139, 1), (645, 1)],
[(224, 1)],
[(179, 1), (208, 1), (412, 1), (596, 1)],
[(1, 1), (38, 1), (143, 1)],
[(1, 1), (12, 1), (76, 1), (615, 1), (646, 1), (647, 1), (648, 2), (649, 1)],
[(1, 1), (82, 1), (219, 1)],
[(10, 1), (101, 1), (286, 1), (650, 1), (651, 1)],
[(1, 1), (2, 1), (3, 1), (241, 1), (652, 1)],
[(224, 1), (653, 1)],
[(2, 1), (224, 1), (654, 1), (655, 1), (656, 1), (657, 1), (658, 1)],
[(8, 1), (292, 1), (462, 1), (659, 1)],
[(8, 1), (513, 1)],
[(1, 1), (8, 1), (38, 1), (57, 1), (72, 1)],
[(1, 1), (25, 1)],
[(8, 2), (57, 1), (358, 1), (660, 1)],
[(8, 2), (57, 1), (358, 1), (660, 1)],
[(1, 1), (2, 1), (38, 1), (661, 1), (662, 1)],
[(8, 1), (120, 1), (663, 1), (664, 1), (665, 1)],
[(1, 1), (2, 1), (21, 1), (136, 1), (509, 1), (666, 1)],
[(54, 1), (667, 1)],
[(38, 1), (82, 1)],
[(1, 1), (38, 1), (74, 1), (212, 1)],
[(1, 1),
 (8, 1),
 (38, 1),
 (57, 1),
 (109, 1),
 (315, 1),
 (358, 1),
 (668, 1),
 (669, 1)],
[(1, 1), (2, 1), (3, 1), (57, 1)],
[(1, 1), (38, 1), (82, 1)],
[(1, 1), (670, 1), (671, 1)],
[(1, 1), (2, 1), (208, 1), (350, 1), (672, 1), (673, 1)],
[(1, 1), (35, 1), (632, 1)],
[(84, 1), (200, 1), (674, 1), (675, 1)],
[(1, 1)],
```

```
[(1, 1)],
[(1, 1), (82, 1)],
[(1, 1), (8, 1), (232, 1)],
[(139, 1)],
[(1, 1), (8, 1), (38, 1), (82, 1)],
[(8, 1), (210, 1)],
[(10, 1), (20, 1)],
[(1, 1)],
[(2, 1), (38, 1)],
[(1, 1), (35, 1), (676, 1)],
[(1, 1), (8, 1), (82, 1), (271, 1), (677, 1), (678, 1), (679, 1)],
[(38, 1), (82, 1), (680, 1), (681, 1)],
[(1, 1), (38, 1), (682, 1)],
[(1, 1), (8, 1)],
[(2, 1), (422, 1), (561, 1)],
[(8, 1), (324, 1), (327, 1)],
[(17, 1), (86, 1), (99, 1)],
[(10, 1), (20, 1), (22, 1)],
[(2, 1), (3, 1), (82, 1), (225, 1)],
[(1, 1), (2, 1)],
[(0, 1), (1, 1), (69, 1), (136, 1), (259, 1), (683, 1), (684, 1)],
[(2, 1), (10, 1)],
[(358, 1), (596, 1), (685, 1), (686, 1), (687, 1)],
[(1, 1), (3, 1), (25, 1)],
[(1, 1)],
[(1, 1), (2, 1), (25, 1)],
[(12, 1), (39, 1), (45, 1), (200, 2), (688, 1), (689, 1), (690, 1)],
[(1, 1), (2, 1), (3, 1), (82, 2), (340, 1), (691, 1), (692, 1), (693, 1)],
[(1, 1), (40, 1), (694, 1)],
[(139, 1)],
[(1, 1), (2, 1), (358, 1), (555, 1), (567, 1)],
[(38, 1), (82, 1)],
[(1, 1), (67, 1), (695, 1)],
[(1, 1), (8, 1), (696, 1)],
[(1, 1), (360, 1)],
[(109, 1), (697, 1)],
[(1, 1), (7, 1), (118, 1), (698, 1)],
[(2, 1)],
[(90, 1), (122, 1), (134, 1), (617, 1), (699, 1)],
[(1, 1), (82, 1)],
[(2, 1), (20, 1), (546, 1), (700, 1)],
[(0, 1), (1, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1)],
[(1, 1), (10, 1), (20, 1)],
[(3, 1), (32, 1), (63, 1), (105, 1), (701, 1)],
```

```
[(1, 1),
 (102, 1),
 (208, 1),
 (309, 1),
 (387, 1),
 (702, 1),
 (703, 1),
 (704, 1),
 (705, 1)],
[(0, 1), (1, 1), (579, 1)],
[(1, 1), (38, 1)],
[(48, 1), (49, 1), (52, 1), (58, 1), (90, 1), (358, 1), (460, 1), (706, 1)],
[(100, 1), (395, 2), (707, 1), (708, 1), (709, 1), (710, 1)],
[(36, 1), (214, 1)],
[(1, 1), (38, 1), (212, 1)],
[(1, 1), (78, 1), (369, 1), (711, 1), (712, 1), (713, 1)],
[(1, 1), (19, 1), (199, 1), (714, 1)],
[(199, 1), (715, 1)],
[(1, 1), (57, 1)],
[(18, 1), (35, 1), (508, 1)],
[(1, 1), (38, 1), (57, 1)],
[(2, 1), (3, 1), (716, 1)],
[(2, 1), (3, 1), (225, 1), (454, 1)],
[(2, 1)],
[(2, 1), (262, 1)],
[(109, 1), (697, 1)],
[(38, 1), (82, 1), (569, 1), (635, 1), (717, 1)],
[(718, 1), (719, 1)],
[(8, 1), (38, 1), (139, 1), (142, 1), (143, 1), (210, 1)],
[(10, 1), (20, 1), (289, 1)],
[(1, 1), (20, 1), (199, 1)],
[(1, 1), (2, 1), (45, 1), (140, 1), (369, 1), (634, 1)],
[(63, 1), (99, 1), (474, 1), (720, 1), (721, 1)],
[(1, 1), (2, 1), (35, 1), (82, 1), (158, 1), (722, 1)],
[(3, 1), (299, 1), (723, 1)],
[(2, 1), (3, 1), (90, 1)],
[(1, 1), (38, 1)],
[(8, 1), (724, 1), (725, 1)],
[(97, 1), (726, 1)],
[(1, 1), (8, 1), (200, 1), (405, 1)],
[(8, 1), (39, 1), (45, 1), (727, 1)],
[(8, 1), (117, 1)],
[(164, 1), (728, 1)],
[(10, 1), (20, 1), (729, 1)],
[(3, 1), (8, 1), (99, 1), (139, 1), (265, 1)],
[(3, 1), (8, 1), (99, 1), (139, 1), (265, 1)],
[(24, 1), (199, 1)],
```

```
[(0, 1), (1, 1), (2, 1), (730, 1)],
[(1, 1), (38, 1), (368, 1)],
[(1, 1), (2, 1), (8, 1), (35, 1), (731, 1)],
[(2, 1), (340, 1), (513, 1)],
[(2, 1), (732, 1), (733, 1)],
[(1, 1), (27, 1), (155, 1), (734, 1), (735, 1), (736, 1), (737, 1)],
[(10, 1), (20, 1)],
[(672, 1), (738, 1), (739, 1)],
[(38, 1), (74, 1), (212, 1)],
[(1, 1), (35, 1), (368, 1)],
[(38, 1), (223, 1), (295, 1), (298, 1), (740, 1), (741, 1)],
[(1, 1), (21, 1), (324, 1), (405, 1), (742, 1), (743, 1), (744, 1)],
[(8, 1), (139, 1)],
[(1, 1), (513, 1)],
[(176, 1), (660, 1), (745, 1), (746, 1)],
[(10, 1), (20, 1), (24, 1)],
[(1, 1), (2, 1), (314, 1), (616, 1), (747, 1), (748, 1)],
[(2, 1), (225, 1), (262, 1)],
[(158, 1),
 (300, 1),
 (318, 1),
 (343, 1),
 (395, 1),
 (486, 1),
 (639, 1),
 (749, 1),
 (750, 1),
 (751, 1)],
[(1, 1)],
[(1, 1), (2, 1)],
[(1, 1)],
[(1, 1), (2, 1), (8, 1), (72, 1), (82, 1), (171, 1), (539, 1)],
[(3, 1), (264, 1)],
[(2, 1), (290, 1), (291, 1), (292, 1), (752, 1)],
[(314, 1), (753, 1), (754, 1), (755, 1)],
[(1, 1)],
[(1, 1)],
[(1, 1), (2, 1), (8, 1)],
[(1, 1), (368, 1)],
[(1, 1), (204, 1)],
[(1, 1), (199, 1), (508, 1), (756, 1)],
[(2, 1), (155, 1)],
[(1, 1), (295, 1), (757, 1), (758, 1), (759, 1), (760, 1)],
[(177, 1), (708, 1)],
[(3, 1), (69, 1), (324, 1)],
[(1, 1), (488, 1)],
[(1, 1), (3, 1), (97, 1), (761, 1)],
```

```
[(10, 1), (20, 1)],
[(1, 1), (38, 1), (57, 1)],
[(667, 1), (724, 1)],
[(1, 1), (129, 1)],
[(25, 1), (139, 1)],
[(1, 1),
 (2, 1),
 (100, 2),
 (114, 1),
 (176, 1),
 (208, 1),
 (350, 1),
 (660, 1),
 (762, 1),
 (763, 1),
 (764, 1)],
[(1, 1), (765, 1)],
[(3, 1), (119, 1), (299, 1)],
[(1, 1), (3, 1), (25, 1)],
[(1, 1), (38, 1)],
[(1, 1), (38, 1), (143, 1)],
[(1, 1), (25, 1)],
[(1, 1), (2, 1), (3, 1), (45, 1), (241, 1)],
[(1, 1), (2, 1), (8, 1), (120, 1), (360, 1), (468, 1)],
[(1, 1), (8, 1), (208, 1), (296, 1), (723, 1), (766, 1)],
[(74, 1), (109, 1), (212, 1), (697, 1)],
[(1, 1), (2, 1), (15, 1), (158, 1)],
[(1, 1), (10, 1), (20, 1)],
[(38, 1), (82, 1)],
[(1, 1), (38, 1), (74, 1)],
[(7, 1), (265, 1)],
[(1, 1), (221, 1)],
[(1, 1), (176, 1), (251, 1), (578, 1), (767, 1)],
[(1, 1), (15, 1), (20, 1), (211, 1)],
[(1, 1), (15, 1), (20, 1), (768, 1)],
[(0, 1)],
[(199, 1)],
[(1, 1), (10, 1), (20, 1)],
[(1, 1), (10, 1), (15, 1), (20, 1)],
[(1, 1), (2, 1), (19, 1), (23, 1), (309, 1), (769, 1), (770, 1)],
[(20, 1), (24, 1), (199, 1)],
[(2, 1)],
[(8, 1), (102, 1), (539, 1), (724, 1), (771, 1), (772, 1)],
[(1, 1), (8, 1), (46, 1)],
[(199, 1), (773, 1)],
[(38, 1), (82, 1), (774, 1)],
[(1, 1), (19, 1), (21, 1), (136, 1), (509, 1)],
```

```
[(1, 1), (8, 1), (775, 1)],
[(78, 1), (468, 1), (776, 1)],
[(1, 1), (143, 1), (199, 1)],
[(1, 1), (10, 1), (20, 1), (199, 1), (777, 1)],
[(0, 1), (1, 1), (199, 1), (252, 1)],
[(0, 1), (1, 1), (199, 1), (252, 1)],
[(1, 1), (74, 1), (143, 1), (224, 1)],
[(1, 1), (156, 1)],
[(778, 1)],
[(3, 1), (25, 1)],
[(264, 1), (324, 1), (779, 1)],
[(1, 1), (214, 1), (780, 1)],
[(2, 1), (3, 1)],
[(1, 1), (90, 1)],
[(0, 1), (2, 1), (558, 1)],
[(0, 1), (2, 1), (176, 1), (558, 1)],
[(1, 1), (2, 1), (8, 1), (176, 1), (360, 1)],
[(2, 1), (38, 1), (225, 1)],
[(1, 1), (2, 1), (35, 1), (265, 1)],
[(1, 1)],
[(1, 1), (8, 1), (29, 1), (200, 1)],
[(360, 1), (781, 1), (782, 1)],
[(158, 1), (411, 1), (575, 1), (783, 1), (784, 1)],
[(411, 1), (488, 1)],
[(1, 1), (29, 1), (296, 1), (572, 1), (785, 1), (786, 1), (787, 1)],
[(1, 1), (10, 1), (20, 1)],
[(10, 1), (20, 1)],
[(1, 1), (78, 1), (155, 1)],
[(8, 1), (262, 1)],
[(788, 1)],
[(1, 1)],
[(158, 1), (289, 1)],
[(8, 1), (74, 1), (102, 1), (109, 1), (211, 1), (789, 1)],
[(38, 1), (283, 1)],
[(8, 1), (665, 1)],
[(38, 1), (790, 1)],
[(2, 1), (3, 1), (66, 1), (134, 1)],
[(1, 1), (8, 1), (40, 1)],
[(38, 1), (791, 1), (792, 1)],
[(2, 1), (532, 1), (615, 1)],
[(158, 1), (475, 1), (793, 1)],
[(1, 1), (199, 1), (794, 1)],
[(1, 1), (25, 1)],
[(2, 1), (8, 1), (63, 1), (67, 1), (366, 1)],
[(12, 1), (38, 1), (82, 1), (179, 1)],
[(1, 1), (3, 1), (25, 1), (35, 1), (265, 1)],
[(0, 1), (1, 1), (185, 1), (224, 1), (795, 1), (796, 1)],
```

```
[(1, 1), (38, 1)],
[(797, 1)],
[(1, 1), (2, 1), (97, 1)],
[(2, 1), (8, 1), (158, 1), (289, 1), (422, 1), (798, 1)],
[(25, 1)],
[(1, 1), (2, 1), (8, 1), (57, 1)],
[(5, 1),
 (6, 1),
 (7, 1),
 (8, 1),
 (54, 1),
 (71, 1),
 (169, 1),
 (177, 1),
 (198, 1),
 (210, 1),
 (462, 1),
 (530, 1),
 (681, 2),
 (799, 1)],
[(1, 1)],
[(1, 1), (90, 1), (443, 1), (588, 1), (800, 1)],
[(2, 1), (34, 1), (225, 1)],
[(1, 1), (8, 1), (82, 1)],
[(1, 1), (8, 1), (199, 1), (368, 1), (801, 1), (802, 1)],
[(1, 1), (8, 1), (244, 1), (299, 1), (647, 1)],
[(1, 1), (158, 1), (213, 1), (405, 1), (432, 1), (575, 1), (586, 1)],
[(2, 1),
 (3, 1),
 (8, 1),
 (35, 1),
 (72, 1),
 (178, 1),
 (210, 1),
 (265, 1),
 (803, 1)],
[(1, 1), (75, 1), (76, 1), (368, 1), (525, 1)],
[(1, 1),
 (2, 1),
 (8, 1),
 (38, 1),
 (468, 1),
 (508, 1),
 (569, 1),
 (804, 1),
 (805, 1),
 (806, 1)],
```

```
[(1, 1), (2, 1), (807, 1), (808, 1)],
[(809, 1), (810, 1)],
[(1, 1), (811, 1)],
[(1, 1), (2, 1), (3, 1), (57, 1), (90, 1), (292, 1), (812, 1), (813, 1)],
[(38, 1), (121, 1), (218, 1)],
[(1, 1), (8, 1), (19, 1), (21, 1), (82, 1), (613, 1), (814, 1)],
[(1, 1)],
[(8, 1), (84, 1), (168, 1), (369, 1), (815, 1), (816, 1), (817, 1)],
[(10, 1), (20, 1), (152, 1), (818, 1)],
[(246, 1), (285, 1)],
[(3, 1), (264, 1), (763, 1), (819, 1)],
[(8, 1), (21, 1), (72, 1), (443, 1), (820, 1)],
[(10, 1), (20, 1), (90, 1)],
[(1, 1), (8, 1)],
[(63, 1), (275, 1), (324, 1), (821, 1), (822, 1), (823, 1), (824, 1)],
[(8, 1), (21, 1), (136, 1), (643, 1), (825, 1), (826, 1), (827, 1)],
[(78, 1), (136, 1), (828, 1), (829, 1), (830, 1)],
[(82, 2), (158, 1), (394, 1), (831, 1), (832, 1)],
[(1, 1)],
[(1, 1), (8, 1), (40, 1), (69, 1), (833, 1)],
[(21, 1), (834, 1), (835, 1), (836, 1)],
[(8, 1), (84, 1), (158, 1), (265, 1), (518, 1), (837, 1)],
[(1, 1)],
[(1, 1), (314, 1), (838, 1)],
[(1, 1), (38, 1)],
[(1, 1), (72, 1), (839, 1), (840, 1)],
[(1, 1), (72, 1), (839, 1), (840, 1)],
[(2, 1), (8, 1)],
[(49, 1), (71, 1), (841, 1)],
[(1, 1), (8, 1), (72, 1), (76, 1), (81, 1), (411, 1), (842, 1)],
[(1, 1), (8, 1), (38, 1), (155, 1), (843, 1)],
[(2, 1), (139, 1), (632, 1)],
[(122, 1), (155, 1), (224, 1), (762, 1)],
[(1, 1), (102, 1), (179, 1), (844, 1)],
[(98, 1),
 (137, 1),
 (195, 1),
 (309, 1),
 (324, 1),
 (395, 1),
 (845, 1),
 (846, 1),
 (847, 1)],
[(1, 1), (38, 1)],
[(1, 1),
 (2, 1),
 (8, 1),
```

```
 (61, 1),
 (65, 1),
 (323, 1),
 (546, 1),
 (848, 1),
 (849, 1)],
[(1, 1), (8, 1)],
[(25, 1)],
[(1, 1), (660, 1), (850, 1)],
[(294, 1)],
[(139, 1)],
[(1, 1), (2, 1), (264, 1)],
[(8, 2),
 (38, 1),
 (74, 1),
 (82, 1),
 (197, 1),
 (212, 1),
 (225, 1),
 (288, 1),
 (697, 1)],
[(1, 1), (8, 1), (295, 1), (851, 1), (852, 1), (853, 1)],
[(38, 1), (137, 1), (384, 1), (678, 1), (854, 1)],
[(1, 1), (15, 1), (20, 1), (760, 1), (855, 1)],
[(121, 1), (218, 1), (436, 1)],
[(2, 1), (90, 1)],
[(158, 1), (856, 1)],
[(2, 1), (204, 1)],
[(1, 1), (2, 1), (580, 1), (857, 1)],
[(1, 2), (2, 1), (8, 1), (102, 1), (108, 1), (858, 1)],
[(45, 1),
 (134, 1),
 (136, 1),
 (158, 1),
 (179, 2),
 (356, 1),
 (727, 1),
 (859, 1),
 (860, 1),
 (861, 1)],
[(82, 1), (850, 1)],
[(2, 1), (730, 1)],
[(1, 1), (8, 1), (72, 1)],
[(1, 1), (8, 1), (38, 1)],
[(1, 1), (3, 1), (82, 1), (104, 1)],
[(1, 1), (91, 1), (465, 1), (596, 1), (862, 1)],
[(1, 1), (57, 1)],
```

```
[(70, 1), (143, 1), (286, 1), (863, 1), (864, 1)],
[(1, 1), (29, 1), (200, 1), (865, 1)],
[(8, 1), (72, 1), (866, 1)],
[(550, 1), (867, 1), (868, 1)],
[(1, 1), (8, 1), (17, 1), (635, 1)],
[(2, 1), (8, 1), (82, 1)],
[(0, 1), (1, 1), (340, 1)],
[(1, 1), (57, 1)],
[(1, 1)],
[(1, 1), (230, 1), (869, 1)],
[(1, 1)],
[(204, 1)],
[(1, 1), (8, 1), (72, 1)],
[(1, 1), (2, 1), (8, 2), (66, 1), (72, 1)],
[(2, 1), (225, 1), (539, 1)],
[(752, 1), (870, 1)],
[(8, 1), (122, 1), (358, 1), (577, 1)],
[(1, 1), (8, 1)],
[(1, 1), (2, 1), (57, 1)],
[(1, 1), (8, 1), (17, 1)],
[(1, 1), (19, 1), (35, 1), (715, 1)],
[(1, 1), (2, 1), (8, 1)],
[(1, 1), (2, 1), (408, 1)],
[(1, 1),
 (2, 2),
 (8, 1),
 (72, 1),
 (203, 1),
 (279, 1),
 (281, 2),
 (369, 1),
 (584, 1),
 (660, 1),
 (747, 1),
 (871, 1),
 (872, 1)],
[(8, 1),
 (38, 1),
 (72, 1),
 (82, 1),
 (271, 1),
 (572, 1),
 (873, 1),
 (874, 1),
 (875, 1),
 (876, 1)],
[(1, 1), (38, 1), (159, 1), (877, 1)],
```

```
 [(10, 1), (20, 1), (35, 1), (289, 1)],
 [(12, 1), (193, 1), (294, 1), (393, 1), (878, 1), (879, 1)],
 [(1, 1), (880, 1)],
 [(1, 1), (8, 1), (71, 1), (72, 1), (283, 1), (411, 1), (559, 1), (881, 1)],
 [(1, 1), (8, 1), (71, 1), (72, 1), (283, 1), (411, 1), (559, 1), (881, 1)],
 [(1, 1), (8, 1), (72, 1), (197, 1), (875, 1)],
 [(38, 1), (112, 1)],
 [(0, 1), (1, 1)],
 [(258, 1), (443, 1), (539, 1), (588, 1), (882, 1)],
 [(883, 1), (884, 1)],
 [(1, 1), (8, 1)],
 [(1, 1), (102, 1)],
 …]
```

[37]:
```
from gensim.models import LdaModel
```

[38]:
```
num_topic = 9
ldamodel = LdaModel(doc_term_matrix,num_topics=num_topic,id2word =␣
↪dictionary,passes=10)
```

[39]:
```
topics = ldamodel.show_topics()
for topic in topics:
    print(topic)
    print()
```

```
(0, '0.086*"comcast" + 0.061*"pricing" + 0.058*"bill" + 0.036*"monopolistic" +
0.035*"comcastxfinity" + 0.025*"cramming" + 0.024*"unfair" + 0.022*"bandwidth" +
0.019*"high" + 0.018*"back"')

(1, '0.114*"comcast" + 0.100*"service" + 0.057*"internet" + 0.040*"charge" +
0.025*"problem" + 0.019*"outage" + 0.019*"monopoly" + 0.018*"without" +
0.018*"help" + 0.014*"broadband"')

(2, '0.142*"comcast" + 0.138*"billing" + 0.066*"practice" + 0.037*"unfair" +
0.022*"cable" + 0.019*"charge" + 0.018*"fraudulent" + 0.016*"account" +
0.014*"service" + 0.013*"month"')

(3, '0.088*"comcast" + 0.073*"fee" + 0.045*"bill" + 0.029*"lack" +
0.027*"without" + 0.027*"charge" + 0.026*"charging" + 0.024*"refund" +
0.024*"monthly" + 0.021*"increased"')

(4, '0.120*"issue" + 0.082*"comcast" + 0.063*"billing" + 0.045*"price" +
0.036*"contract" + 0.024*"business" + 0.023*"switch" + 0.021*"year" +
0.017*"modem" + 0.016*"xfinitycomcast"')

(5, '0.244*"service" + 0.102*"internet" + 0.080*"comcast" + 0.046*"customer" +
0.029*"poor" + 0.022*"connection" + 0.018*"terrible" + 0.015*"promised" +
0.014*"failure" + 0.013*"show"')
```

```
(6, '0.123*"comcast" + 0.106*"complaint" + 0.049*"service" + 0.039*"billing" +
0.030*"charged" + 0.025*"false" + 0.024*"pay" + 0.020*"credit" +
0.020*"deceptive" + 0.019*"bill"')

(7, '0.207*"comcast" + 0.167*"data" + 0.134*"cap" + 0.031*"usage" +
0.026*"internet" + 0.013*"limit" + 0.011*"xfinity" + 0.009*"said" +
0.009*"shitty" + 0.009*"access"')

(8, '0.224*"internet" + 0.146*"speed" + 0.112*"comcast" + 0.045*"slow" +
0.042*"throttling" + 0.036*"xfinity" + 0.016*"connectivity" + 0.015*"paying" +
0.010*"mb" + 0.010*"low"')
```

[40]:
```
word_dict = {}
for i in range(num_topic):
    words = ldamodel.show_topic(i,topn = 20)
    word_dict['Topic '+"{}".format(i)]=[i[0] for i in words]
```

[41]:
```
pd.DataFrame(word_dict)
```

[41]:

	Topic 0	Topic 1	Topic 2	Topic 3	Topic 4	\
0	comcast	comcast	comcast	comcast	issue	
1	pricing	service	billing	fee	comcast	
2	bill	internet	practice	bill	billing	
3	monopolistic	charge	unfair	lack	price	
4	comcastxfinity	problem	cable	without	contract	
5	cramming	outage	charge	charge	business	
6	unfair	monopoly	fraudulent	charging	switch	
7	bandwidth	without	account	refund	year	
8	high	help	service	monthly	modem	
9	back	broadband	month	increased	xfinitycomcast	
10	hbo	billed	day	equipment	xfinity	
11	ps4	signal	several	overcharge	bait	
12	scam	please	email	contract	equipment	
13	throttle	12	unauthorized	notice	false	
14	go	home	loss	installation	information	
15	hbogo	lied	time	isp	3	
16	agreement	overage	10	consumer	cable	
17	competition	refusal	regarding	consent	returned	
18	device	provided	extremely	violation	getting	
19	inconsistent	system	week	capping	get	

	Topic 5	Topic 6	Topic 7	Topic 8
0	service	comcast	comcast	internet
1	internet	complaint	data	speed
2	comcast	service	cap	comcast

```
3       customer      billing     usage               slow
4           poor      charged  internet         throttling
5     connection        false     limit            xfinity
6       terrible          pay   xfinity       connectivity
7       promised       credit      said             paying
8        failure    deceptive    shitty                 mb
9           show         bill    access                low
10           day  advertising      sale               rate
11  intermittent      payment      plan          throttled
12    misleading      provide     300gb      disconnection
13    unreliable        phone   overage         advertised
14        option       change     cable      communication
15           bad        price   atlanta           download
16      horrible    incorrect        tv  misrepresentation
17  availability       charge     trial          streaming
18       quality     improper     offer       consistently
19           one  appointment   attempt            ordered
```

[46]:
```python
# import pyLDAvis.gensim
import pyLDAvis
import pyLDAvis.gensim_models as gensimvis
pyLDAvis.enable_notebook()
```

[48]:
```python
Lda_display = gensimvis.
 ↪prepare(ldamodel,doc_term_matrix,dictionary,sort_topics=False)
pyLDAvis.display(Lda_display)
```

```
/usr/local/lib/python3.9/site-packages/pyLDAvis/_prepare.py:246: FutureWarning:
In a future version of pandas all arguments of DataFrame.drop except for the
argument 'labels' will be keyword-only
  default_term_info = default_term_info.sort_values(
/usr/local/lib/python3.9/site-packages/past/builtins/misc.py:45:
DeprecationWarning: the imp module is deprecated in favour of importlib; see the
module's documentation for alternative uses
  from imp import reload
/usr/local/lib/python3.9/site-packages/past/builtins/misc.py:45:
DeprecationWarning: the imp module is deprecated in favour of importlib; see the
module's documentation for alternative uses
  from imp import reload
/usr/local/lib/python3.9/site-packages/past/builtins/misc.py:45:
DeprecationWarning: the imp module is deprecated in favour of importlib; see the
module's documentation for alternative uses
  from imp import reload
/usr/local/lib/python3.9/site-packages/past/builtins/misc.py:45:
DeprecationWarning: the imp module is deprecated in favour of importlib; see the
module's documentation for alternative uses
  from imp import reload
/usr/local/lib/python3.9/site-packages/past/builtins/misc.py:45:
```

```
DeprecationWarning: the imp module is deprecated in favour of importlib; see the
module's documentation for alternative uses
  from imp import reload
/usr/local/lib/python3.9/site-packages/past/builtins/misc.py:45:
DeprecationWarning: the imp module is deprecated in favour of importlib; see the
module's documentation for alternative uses
  from imp import reload
```

[48]: <IPython.core.display.HTML object>

0.0.4 TASK 3 - Create a new categorical variable with value as Open and Closed. Open & Pending is to be categorized as Open and Closed & Solved is to be categorized as Closed.

[49]:
```
df1['Highlevel_Status'] = ["Open" if Status=="Open" or Status=="Pending" else␣
↪"Closed" for Status in df1["Status"]]
```

[50]:
```
df1['Highlevel_Status'].unique()
```

[50]:
```
array(['Closed', 'Open'], dtype=object)
```

0.0.5 TASK 4 - Provide state wise status of complaints in a stacked bar chart. Use the categorized variable from Q3.

[51]:
```
df1['State'] = df1['State'].str.title()
st_cmp = df1.groupby(['State','Highlevel_Status']).size().unstack().fillna(0)
```

[52]:
```
st_cmp
```

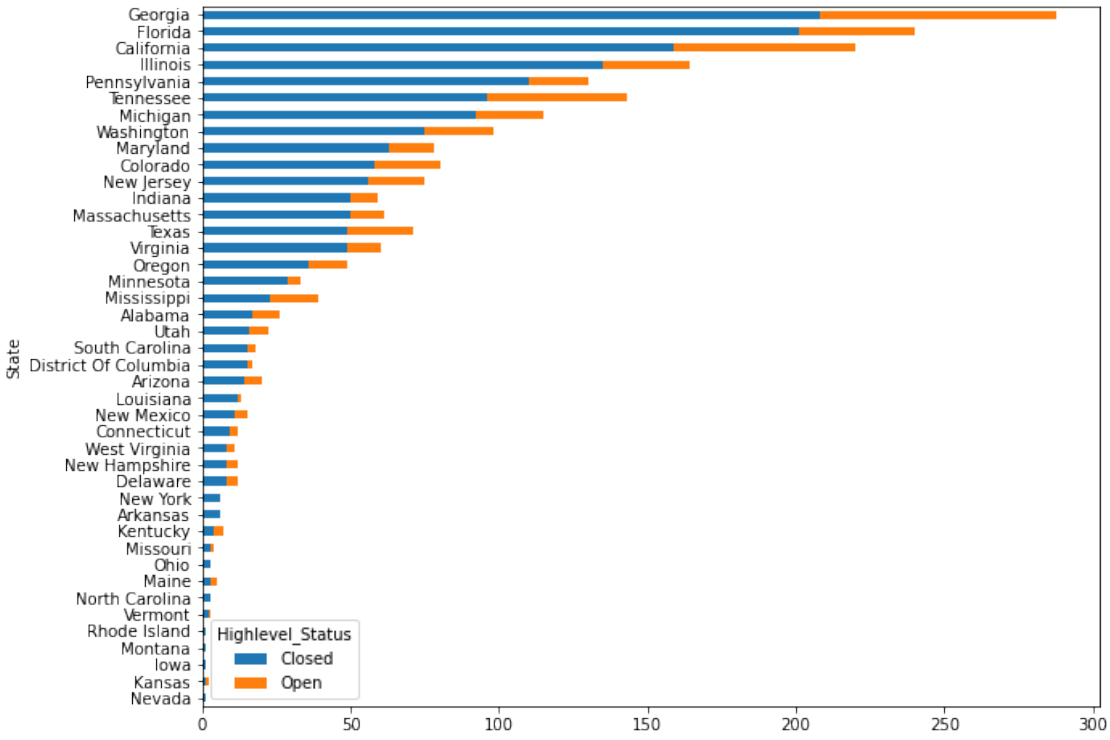
[52]:

Highlevel_Status	Closed	Open
State		
Alabama	17.0	9.0
Arizona	14.0	6.0
Arkansas	6.0	0.0
California	159.0	61.0
Colorado	58.0	22.0
Connecticut	9.0	3.0
Delaware	8.0	4.0
District Of Columbia	15.0	2.0
Florida	201.0	39.0
Georgia	208.0	80.0
Illinois	135.0	29.0
Indiana	50.0	9.0
Iowa	1.0	0.0
Kansas	1.0	1.0
Kentucky	4.0	3.0
Louisiana	12.0	1.0
Maine	3.0	2.0

```
Maryland                63.0  15.0
Massachusetts           50.0  11.0
Michigan                92.0  23.0
Minnesota               29.0   4.0
Mississippi             23.0  16.0
Missouri                 3.0   1.0
Montana                  1.0   0.0
Nevada                   1.0   0.0
New Hampshire            8.0   4.0
New Jersey              56.0  19.0
New Mexico              11.0   4.0
New York                 6.0   0.0
North Carolina           3.0   0.0
Ohio                     3.0   0.0
Oregon                  36.0  13.0
Pennsylvania           110.0  20.0
Rhode Island             1.0   0.0
South Carolina          15.0   3.0
Tennessee               96.0  47.0
Texas                   49.0  22.0
Utah                    16.0   6.0
Vermont                  2.0   1.0
Virginia                49.0  11.0
Washington              75.0  23.0
West Virginia            8.0   3.0
```

[53]:
```
st_cmp.sort_values('Closed',axis = 0,ascending=True).plot(kind="barh",␣
↪figsize=(10,8), stacked=True)
```

[53]:
```
<AxesSubplot:ylabel='State'>
```



0.0.6 TASK 5 - Which state has the maximum complaints Which state has the highest percentage of unresolved complaints

[54]:
```
df1.groupby(["State"]).size().sort_values(ascending=False).to_frame().rename({0:
↪ "Complaint count"}, axis=1)[:1]
#Georgia has highest complaints
```

[54]:

State	Complaint count
Georgia	288

[55]:
```
CT = df1.groupby(["State","Highlevel_Status"]).size().unstack().fillna(0)
CT.sort_values('Closed',axis = 0,ascending=False)[:1]
```

[55]:

State	Highlevel_Status	Closed	Open
Georgia		208.0	80.0

[56]:
```
#highest percentage of unresolved complaints
CT['Resolved_cmp_prct'] = CT['Closed']/CT['Closed'].sum()*100
CT['Unresolved_cmp_prct'] = CT['Open']/CT['Open'].sum()*100
```

[57]:
```
CT.sort_values('Unresolved_cmp_prct',axis = 0,ascending=False)[:1]
#Georgia state has highest Unresolved complaints when compared to other states
```

[57]:
```
Highlevel_Status  Closed  Open  Resolved_cmp_prct  Unresolved_cmp_prct
State
Georgia            208.0  80.0           12.18512            15.473888
```

0.0.7 TASK 6 — Provide the percentage of complaints resolved till date, which were received through the Internet and customer care calls.

[58]:
```
cr = df1.groupby(['Received Via','Highlevel_Status']).size().unstack().fillna(0)
cr['resolved'] = cr['Closed']/cr['Closed'].sum()*100
cr['resolved']
```

[58]:
```
Received Via
Customer Care Call    50.615114
Internet              49.384886
Name: resolved, dtype: float64
```

[59]:

[ ]:

[ ]: