In [20]:
```
import pandas as pd
from scipy.spatial import distance
import matplotlib.pyplot as plt
import numpy as np
import scipy
from scipy import stats
from numpy.linalg import norm
from matplotlib.pyplot import figure
import random
#https://www.google.com/covid19/mobility/
url = 'https://drive.google.com/file/d/18gyHbx6rfogq3yQ-GR9COjcGgyYlCnBZ/view?usp=sharing'
url2020 = 'https://drive.google.com/uc?id=' + url.split('/')[-2]
url = 'https://drive.google.com/file/d/1Eg8Lffm49bc-bGFkv_4ddrQw8U8WE6P4/view?usp=sharing'
url2021 = 'https://drive.google.com/uc?id=' + url.split('/')[-2]
df20 = pd.read_csv(url2020)
df20.info()
df21 = pd.read_csv(url2021)
df21.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 167657 entries, 0 to 167656
Data columns (total 15 columns):
 #   Column                                         Non-Null Count   Dtype  
---  ------                                         --------------   -----  
 0   country_region_code                            167657 non-null  object 
 1   country_region                                 167657 non-null  object 
 2   sub_region_1                                   167336 non-null  object 
 3   sub_region_2                                   141692 non-null  object 
 4   metro_area                                     0 non-null       float64
 5   iso_3166_2_code                                25644 non-null   object 
 6   census_fips_code                               0 non-null       float64
 7   place_id                                       167657 non-null  object 
 8   date                                           167657 non-null  object 
 9   retail_and_recreation_percent_change_from_baseline  101865 non-null  float64
 10  grocery_and_pharmacy_percent_change_from_baseline   106104 non-null  float64
 11  parks_percent_change_from_baseline             95186 non-null   float64
 12  transit_stations_percent_change_from_baseline  87723 non-null   float64
 13  workplaces_percent_change_from_baseline        158870 non-null  float64
 14  residential_percent_change_from_baseline       98651 non-null   float64
dtypes: float64(8), object(7)
```

```
memory usage: 19.2+ MB
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 158430 entries, 0 to 158429
Data columns (total 15 columns):
 #   Column                                                Non-Null Count   Dtype  
---  ------                                                --------------   -----  
 0   country_region_code                                   158430 non-null  object 
 1   country_region                                        158430 non-null  object 
 2   sub_region_1                                          158152 non-null  object 
 3   sub_region_2                                          135654 non-null  object 
 4   metro_area                                            0 non-null       float64
 5   iso_3166_2_code                                       22498 non-null   object 
 6   census_fips_code                                      0 non-null       float64
 7   place_id                                              158430 non-null  object 
 8   date                                                  158430 non-null  object 
 9   retail_and_recreation_percent_change_from_baseline    91170 non-null   float64
 10  grocery_and_pharmacy_percent_change_from_baseline     92489 non-null   float64
 11  parks_percent_change_from_baseline                    87099 non-null   float64
 12  transit_stations_percent_change_from_baseline         78809 non-null   float64
 13  workplaces_percent_change_from_baseline               154672 non-null  float64
 14  residential_percent_change_from_baseline              98407 non-null   float64
dtypes: float64(8), object(7)
memory usage: 18.1+ MB
```

In [21]:
```
df20
```

Out[21]:

	country_region_code	country_region	sub_region_1	sub_region_2	metro_area	iso_3166_2_code	census_fips_code	p
0	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
1	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
2	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
3	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
4	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
...	...	...	...	...	...	...	...	
167652	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
167653	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
167654	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
167655	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
167656	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u

167657 rows × 15 columns

In [22]:
```
df21
```

Out[22]:

	country_region_code	country_region	sub_region_1	sub_region_2	metro_area	iso_3166_2_code	census_fips_code	p
0	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
1	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
2	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
3	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
4	TR	Turkey	NaN	NaN	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iK
...	...	...	...	...	...	...	...	
158425	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
158426	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
158427	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
158428	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u
158429	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	NaN	NaN	ChIJ5RJc34yHnEAR6s60u

158430 rows × 15 columns

In [23]:
```
#Soru 1 Cevap (df20 için)
df20New=df20.dropna(axis=1,how='all')
df20New
```

Out[23]:

	country_region_code	country_region	sub_region_1	sub_region_2	iso_3166_2_code	place_id	date	retail_and_recrea
0	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2020-02-15	
1	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2020-02-16	
2	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2020-02-17	
3	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2020-02-18	
4	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2020-02-19	
...	...	...	...	...	...	...	...	
167652	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2020-12-27	
167653	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2020-12-28	
167654	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2020-12-29	
167655	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2020-12-30	
167656	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2020-12-31	

167657 rows × 13 columns

In [24]:
```
#Soru 1 Cevap (df21 için)
df21New=df21.dropna(axis=1,how='all')
df21New
```

Out[24]:

	country_region_code	country_region	sub_region_1	sub_region_2	iso_3166_2_code	place_id	date	retail_and_rec
0	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2021-01-01	
1	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2021-01-02	
2	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2021-01-03	
3	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2021-01-04	
4	TR	Turkey	NaN	NaN	NaN	ChIJcSZPllwVsBQRKl9iKtTb2UA	2021-01-05	
...	...	...	...	...	...	...	...	
158425	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2021-10-01	
158426	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2021-10-02	
158427	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2021-10-03	
158428	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2021-10-04	
158429	TR	Turkey	Zonguldak	Zonguldak Merkez	NaN	ChIJ5RJc34yHnEAR6s60uOmblJc	2021-10-05	

158430 rows × 13 columns

In [25]:
```
#Soru 2 Cevap (df20 için)
# mahalanobis için baktığım site: https://www.statology.org/mahalanobis-distance-python/

monthGroup20=df20New.groupby(pd.DatetimeIndex(df20New['date']).month).mean()
def mahalanobis(x=None, data=None, cov=None):

    x_mu = x - np.mean(data)
    if not cov:
        cov = np.cov(data.values.T)
    inv_covmat = np.linalg.inv(cov)
    left = np.dot(x_mu, inv_covmat)
    mahal = np.dot(left, x_mu.T)
    return mahal.diagonal()

monthGroup20 ['mahalanobis'] = mahalanobis(x=monthGroup20, data=monthGroup20[['retail_and_recreation_percent_change_from_
monthGroup20
```

Out[25]:

eline	transit_stations_percent_change_from_baseline	workplaces_percent_change_from_baseline	residential_percent_change_from_baseline	mahalanobis
9374	-6.643751	9.353484	-0.698443	6.799677
3226	-22.896115	-12.652553	6.332819	2.515010
7354	-64.418867	-47.539997	20.742720	8.602830
7900	-58.020520	-41.539711	17.455508	8.229767
2002	-17.117761	-10.425022	4.339668	7.663963
0799	-1.882360	-10.858957	-0.082189	3.050788
7582	1.375155	-16.412747	-0.669343	6.643364
7984	-11.851192	-11.053215	2.389219	1.514244
7698	-10.521094	-8.295500	3.886670	5.844341
3678	-25.197093	-14.877225	8.382888	2.320447
5514	-39.558470	-30.277044	15.067144	6.815570

In [26]:
```
#Soru 2 Cevap (df21 için)
monthGroup21=df21New.groupby(pd.DatetimeIndex(df21New['date']).month).mean()
def mahalanobis(x=None, data=None, cov=None):

    x_mu = x - np.mean(data)
    if not cov:
        cov = np.cov(data.values.T)
    inv_covmat = np.linalg.inv(cov)
    left = np.dot(x_mu, inv_covmat)
    mahal = np.dot(left, x_mu.T)
    return mahal.diagonal()

monthGroup21 ['mahalanobis'] = mahalanobis(x=monthGroup21, data=monthGroup21[['retail_and_recreation_percent_change_from_
monthGroup21
```

Out[26]:

eline	transit_stations_percent_change_from_baseline	workplaces_percent_change_from_baseline	residential_percent_change_from_baseline	mahalanobis
0820	-40.967841	-31.960336	13.586489	6.529720
7913	-31.025378	-25.911408	9.778199	5.917862
9031	-20.468370	-13.891509	6.377278	2.885326
3790	-27.611852	-23.792819	11.048254	6.946990
7062	-31.783479	-33.632010	12.395152	6.527793
5513	8.431063	-10.437586	0.311459	5.306735
3643	40.417973	-17.413158	-2.827990	6.314734
1242	34.897984	-8.252919	-2.106539	5.860010
1012	25.758633	-0.748786	-1.655904	3.008164
5628	22.198843	1.826553	-0.911099	4.702667

In [27]:
```
#Soru 3 Cevap (Euclid)

x=[]
columnList = ["retail_and_recreation_percent_change_from_baseline", "grocery_and_pharmacy_percent_change_from_baseline",
for j in range(2,11):
    for i in range(0,6):
        x.append( norm(monthGroup20[columnList[i]][j] - monthGroup21[columnList[i]][j]))

x
```

Out[27]:
```
[43.207825818808956,
 7.592034245398164,
 27.297287094425233,
 24.381626220786572,
 35.26489176923577,
 10.476641731895878,
 3.1502127574245193,
 29.115696954058627,
 1.8658053354168986,
 2.4277455372172483,
 1.2389558785279942,
 0.04445848339650649,
 27.646830241643677,
 47.97642364746609,
 28.25356438655215,
 36.80701474441706,
 23.747178236130694,
 9.694466892201735,
 14.371224699442166,
 28.86948706130481,
 16.87083840633429,
 26.237040901859228,
 7.907700788249528,
 5.060356685804187,
 20.007944299127626,
 35.57008532049699,
 7.423510509135063,
 25.54882440219258,
 0.012564074024165706,
```

```
4.028209522246186,
33.84326252960485,
46.449366884219195,
31.232843856080272,
42.30033220309397,
6.55420048588525,
2.745800753540859,
35.72344663820422,
49.19005584791403,
12.953659826079992,
33.52282876292102,
8.159828217556855,
1.437196293268553,
37.98492588996848,
52.58494215228433,
13.173028510227013,
37.60982549714655,
10.3044286302139,
4.045123118575571,
36.5055323607675,
41.49468857448193,
11.477929826220233,
32.71993710424438,
10.122053078649754,
4.797768206914869]
```

In [28]:
```
#Soru 3 Cevap (Minkowski)
x=[]
columnList = ["retail_and_recreation_percent_change_from_baseline", "grocery_and_pharmacy_percent_change_from_baseline",
for j in range(2,11):
    for i in range(0,6):
        x.append( distance.minkowski(monthGroup20[columnList[i]][j], monthGroup21[columnList[i]][j],1))

x
```

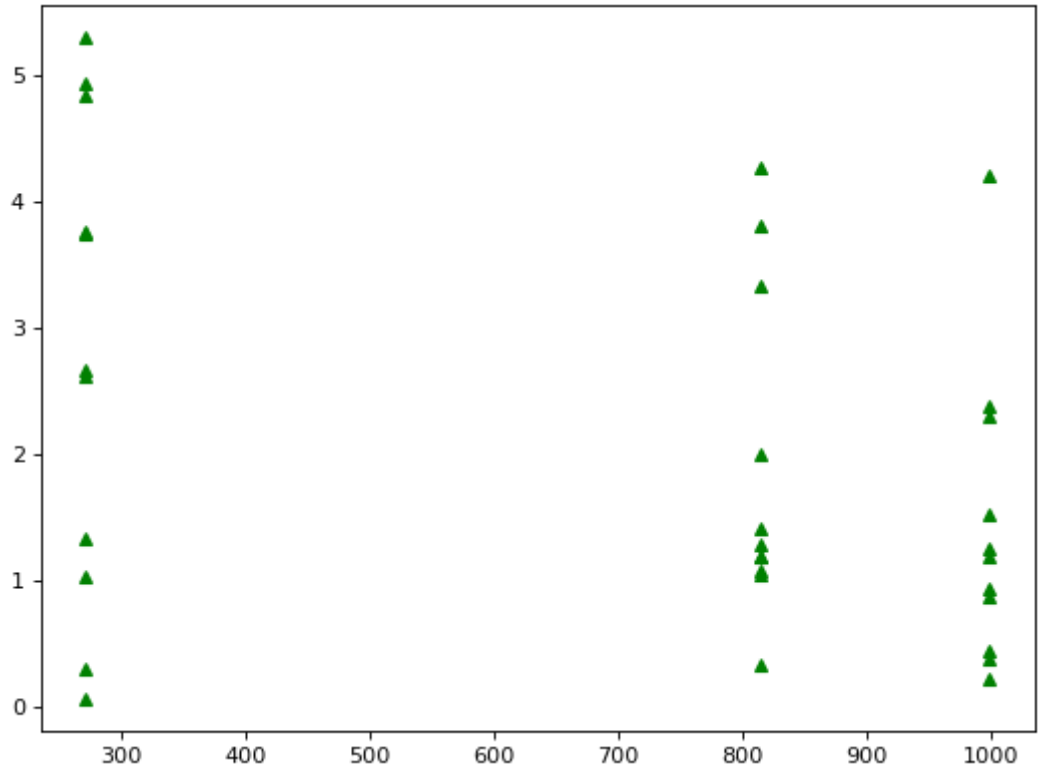
Out[28]:
```
[43.207825818808956,
 7.592034245398164,
 27.297287094425233,
 24.381626220786572,
 35.26489176923577,
 10.476641731895878,
 3.1502127574245193,
 29.115696954058627,
 1.8658053354168986,
 2.4277455372172483,
 1.2389558785279942,
 0.04445848339650649,
 27.646830241643677,
 47.97642364746609,
 28.25356438655215,
 36.80701474441706,
 23.747178236130694,
 9.694466892201735,
 14.371224699442166,
 28.86948706130481,
 16.87083840633429,
 26.237040901859228,
 7.907700788249528,
 5.060356685804187,
 20.007944299127626,
 35.57008532049699,
 7.423510509135063,
 25.54882440219258,
 0.012564074024165706,
```

```
4.028209522246186,
33.84326252960485,
46.449366884219195,
31.232843856080272,
42.30033220309397,
6.55420048588525,
2.745800753540859,
35.72344663820422,
49.19005584791403,
12.953659826079992,
33.52282876292102,
8.159828217556855,
1.437196293268553,
37.98492588996848,
52.58494215228433,
13.173028510227013,
37.60982549714655,
10.3044286302139,
4.045123118575571,
36.5055323607675,
41.49468857448193,
11.477929826220233,
32.71993710424438,
10.122053078649754,
4.797768206914869]
```

In [101]:
```
#Soru 4 Cevap
monthGroup20=df20New.groupby(pd.DatetimeIndex(df20New['date']).month).mean()
x=[]
y=[]
t=[]
n= random.randint(50,1000)
r= random.randint(50,1000)
z= random.randint(50,1000)
sampleDf1=df20.sample(n)
sampleDf2=df20.sample(r)
sampleDf3=df20.sample(z)
monthSample1=sampleDf1.groupby(pd.DatetimeIndex(sampleDf1['date']).month).mean()
monthSample2=sampleDf2.groupby(pd.DatetimeIndex(sampleDf2['date']).month).mean()
monthSample3=sampleDf3.groupby(pd.DatetimeIndex(sampleDf3['date']).month).mean()

a=[]
b=[]
c=[]
for j in range(2,13):
        x.append(n)
        y.append(r)
        t.append(z)
        a.append(abs(monthGroup20.loc[j].mean()-monthSample1.loc[j].mean()))
        b.append(abs(monthGroup20.loc[j].mean()-monthSample2.loc[j].mean()))
        c.append(abs(monthGroup20.loc[j].mean()-monthSample3.loc[j].mean()))
figure(figsize=(8, 6), dpi=80)
plt.plot(x,a,"g^")
plt.plot(y,b,"g^")
plt.plot(t,c,"g^")
```

Out[101]:
```
[<matplotlib.lines.Line2D at 0x1c757eaa160>]
```


5
4
3
2
1
0
300
400
500
600
700
800
900
1000

In [106]:
```
#Soru 5 Cevap
n= random.randint(50,1000)
monthGroup20=df20.groupby(pd.DatetimeIndex(df20['date']).month)
sampleDf1=monthGroup20.apply(lambda s: s.sample(n))
df20Groupby=df20New.groupby(pd.DatetimeIndex(df20New['date']).month).mean()
x=[]
y=[]
for j in range(2,13):
    x.append(n)
    y.append(abs(df20Groupby.loc[j].mean()-sampleDf1.loc[j].mean().mean()))
figure(figsize=(8, 6), dpi=80)
plt.plot(x,y,"g^")
```

Out[106]:
```
[<matplotlib.lines.Line2D at 0x1c75c0778e0>]
```