Assignment 2 - Results Data - Covid Data

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Import all necessary packages and libararies

In [286…
```
import numpy as np
import pandas as pd
from scipy.stats import norm,t
import scipy
import matplotlib.pyplot as plt
import statsmodels.api as sm
from statsmodels.stats.proportion import proportion_confint
from pandas.api.types import CategoricalDtype
```

Part I - Results Data

In this part:

- Important observations/conclusions about the dataset.
- Compare between the probability of wins for the most three teams that played at home (non-neutral venues)
- Compare between the probability that Egypt would lose at home and away from all the matches it lost on only.
- Compare between the probability that the home teams would win in friendly vs official tournaments
- Graphs of confidence intervals for the probabilities.

Importing the dataset "results.csv" into python

In [139…
```
data = pd.read_csv('results.csv')
```

In [140…
```
data.head()
```

Out[140…

	date	home_team	away_team	home_score	away_score	tournament	city	country	neutral
0	1872-11-30	Scotland	England	0	0	Friendly	Glasgow	Scotland	False
1	1873-03-08	England	Scotland	4	2	Friendly	London	England	False
2	1874-03-07	Scotland	England	2	1	Friendly	Glasgow	Scotland	False

	date	home_team	away_team	home_score	away_score	tournament	city	country	neutral
3	1875-03-06	England	Scotland	2	2	Friendly	London	England	False
4	1876-03-04	Scotland	England	3	0	Friendly	Glasgow	Scotland	False

Here it is shown that the country that hosted the most number of matches is The United States

In [141…
```
data['country'].value_counts().head(1)
```

Out[141…
```
United States    1237
Name: country, dtype: int64
```

Comparing the probabilities of wins for the most three teams that played at home (non-neutral venues)

I will create a new column that shows whether a home team has won, lost, or drew in a match by finding the difference between the scores of home teams and scores of away teams

In [142…
```
diff_scores_home = data['home_score']-data['away_score']
```

If difference > 0, home team won

If difference < 0, home team lost

If difference = 0, home and away team tied

In [143…
```
conditions = [(diff_scores_home>0),(diff_scores_home<0),(diff_scores_home==0)]
labels = ['Win','Lose','Draw']
```

Here I assigned the conditions with their corresponding labels

In [144…
```
data['result'] = np.select(conditions,labels)
```

It is shown below that a new column called "result" has been added

In [145…
```
data.head()
```

Out[145…

	date	home_team	away_team	home_score	away_score	tournament	city	country	neutral	re
0	1872-11-30	Scotland	England	0	0	Friendly	Glasgow	Scotland	False	D
1	1873-03-08	England	Scotland	4	2	Friendly	London	England	False	
2	1874-03-07	Scotland	England	2	1	Friendly	Glasgow	Scotland	False	
3	1875-03-06	England	Scotland	2	2	Friendly	London	England	False	D

	date	home_team	away_team	home_score	away_score	tournament	city	country	neutral	re
4	1876-03-04	Scotland	England	3	0	Friendly	Glasgow	Scotland	False	

To find the estimated probabilities for a home team winning, losing, or drawing when playing at home, I will separate neutral and non-neutral venues, and choose non-neutral venues only.

In [146…
```
data_non_neutral = data[data['neutral']==False]
```

The code below displays the three most repeated home teams observed in the dataset : England, Sweden, & France

I am comparing these three teams because the number of times they showed up in the observations is relatively similar and this leads to a much better, unbiased comparison

In [147…
```
data_non_neutral['country'].value_counts().head(3)
```

Out[147…
```
England    499
Sweden     483
France     462
Name: country, dtype: int64
```

In [148…
```
# 1. England
```

Separate England from all the other home teams

In [149…
```
non_neutral_England_home = data_non_neutral[data_non_neutral['country']=='England']
```

When making sure variable 'home_team' includes 'England' only, I found other countries. This is a mistake in the dataset

In [150…
```
non_neutral_England_home['home_team'].value_counts()
```

Out[150…
```
England               464
Barawa                 11
Isle of Wight           9
Kernow                  8
Yorkshire               5
Sweden                  1
Parishes of Jersey      1
Name: home_team, dtype: int64
```

To fix the problem, I exculded from variable 'home_team' 'England' only

In [151…
```
non_neutral_England_home = non_neutral_England_home[non_neutral_England_home['home_team
```

In [152…
```
non_neutral_England_home['home_team'].value_counts()
```

Out[152…
```
England    464
Name: home_team, dtype: int64
```

In [153…
```
non_neutral_England_home.head()
```

Out[153…

	date	home_team	away_team	home_score	away_score	tournament	city	country	neutral	re
1	1873-03-08	England	Scotland	4	2	Friendly	London	England	False	
3	1875-03-06	England	Scotland	2	2	Friendly	London	England	False	D
6	1877-03-03	England	Scotland	1	3	Friendly	London	England	False	
10	1879-01-18	England	Wales	2	1	Friendly	London	England	False	
11	1879-04-05	England	Scotland	5	4	Friendly	London	England	False	

Here is the estimated probability that England would win when playing at home. Even though this probability is valid, we are not 100% sure this event will occur with probability 0.646552. A confidence interval that has the possible probabilities around 0.646552 is needed to establish more certainty.

In [154…
```
non_neutral_England_home['result'].value_counts(normalize = True).head(1)
```

Out[154…
```
Win    0.646552
Name: result, dtype: float64
```

Here is the number of times England won, lost, or drew when playing at home

In [155…
```
Eng = non_neutral_England_home['result'].value_counts()
Eng
```

Out[155…
```
Win     300
Draw    101
Lose     63
Name: result, dtype: int64
```

Below is the 95% confidence interval for the probability of England winning when playing at home

We can see that the estimated probability above (0.646552) lies between the interval below ((0.6030552883111224, 0.6900481599647397))

In [156…
```
Eng_win_prob = proportion_confint(count = Eng[0], nobs = Eng.sum(), alpha=(1-0.95), met
Eng_win_prob
```

Out[156…
```
(0.6030552883111224, 0.6900481599647397)
```

I repeated the same steps for the other home teams

In [157…
```
# 2. Sweden
```

In [158…
```
non_neutral_Sweden_home = data_non_neutral[data_non_neutral['country']=='Sweden']
```

In [159…
```
non_neutral_Sweden_home['home_team'].value_counts()
```

Out[159…
```
Sweden           460
Gotland            9
Sápmi              9
Åland Islands      5
Name: home_team, dtype: int64
```

In [160…
```
non_neutral_Sweden_home = non_neutral_Sweden_home[non_neutral_Sweden_home['home_team']=
```

In [161…
```
non_neutral_Sweden_home['home_team'].value_counts()
```

Out[161…
```
Sweden    460
Name: home_team, dtype: int64
```

In [162…
```
non_neutral_Sweden_home.head()
```

Out[162…

	date	home_team	away_team	home_score	away_score	tournament	city	country	n
224	7/12/1908	Sweden	Norway	11	3	Friendly	Gothenburg	Sweden	
296	6/18/1911	Sweden	Germany	2	4	Friendly	Solna	Sweden	
298	9/17/1911	Sweden	Norway	4	1	Friendly	Solna	Sweden	
328	6/20/1912	Sweden	Hungary	2	2	Friendly	Gothenburg	Sweden	
330	6/27/1912	Sweden	Finland	7	1	Friendly	Solna	Sweden	

In [163…
```
non_neutral_Sweden_home['result'].value_counts(normalize = True)
```

Out[163…
```
Win     0.600000
Draw    0.204348
Lose    0.195652
Name: result, dtype: float64
```

In [164…
```
Swed = non_neutral_Sweden_home['result'].value_counts()
Swed
```

Out[164…
```
Win     276
Draw     94
Lose     90
Name: result, dtype: int64
```

Below is the 95% confidence interval for the probability of Sweden winning when playing at home

In [165…
```
Swed_win_prob = proportion_confint(count = Swed[0], nobs = Swed.sum(), alpha=(1-0.95),
```

```
Swed_win_prob
```

Out[165…
```
(0.5552312677786161, 0.6447687322213839)
```

In [166…
```
# 3. France
```

In [167…
```
non_neutral_France_home = data_non_neutral[data_non_neutral['country']=='France']
```

In [168…
```
non_neutral_France_home['home_team'].value_counts()
```

Out[168…
```
France       443
Brittany       9
Corsica        8
Occitania      2
Name: home_team, dtype: int64
```

In [169…
```
non_neutral_France_home = non_neutral_France_home[non_neutral_France_home['home_team']=
```

In [170…
```
non_neutral_France_home['home_team'].value_counts()
```

Out[170…
```
France    443
Name: home_team, dtype: int64
```

In [171…
```
non_neutral_France_home.head()
```

Out[171…

	date	home_team	away_team	home_score	away_score	tournament	city	country	neu
166	2/12/1905	France	Switzerland	1	0	Friendly	Paris	France	F
185	4/22/1906	France	Belgium	0	5	Friendly	Saint-Cloud	France	F
215	4/12/1908	France	Belgium	1	2	Friendly	Colombes	France	F
257	4/3/1910	France	Belgium	0	4	Friendly	Gentilly	France	F
277	1/1/1911	France	Hungary	0	3	Friendly	Maisons-Alfort	France	F

In [172…
```
non_neutral_France_home['result'].value_counts(normalize = True)
```

Out[172…
```
Win     0.586907
Lose    0.212190
Draw    0.200903
Name: result, dtype: float64
```

In [173…
```
Fran = non_neutral_France_home['result'].value_counts()
Fran
```

Out[173…
```
Win     260
Lose     94
Draw     89
Name: result, dtype: int64
```

Below is the 95% confidence interval for the probability of France winning when playing at home

In [174…
```
Fran_win_prob = proportion_confint(count = 260, nobs = Fran.sum(), alpha=(1-0.95), meth
Fran_win_prob
```

Out[174…
```
(0.541055825404375, 0.6327590730154896)
```

Here is the process to display a graph that shows the three different 95% confidence intervals for the three different teams: England, Sweden, & France

In [175…
```
ci_home_win = {}
```

In [176…
```
ci_home_win['country'] = ['England','Sweden','France']
```

In [177…
```
ci_home_win['lb'] = [Eng_win_prob[0],Swed_win_prob[0],Fran_win_prob[0]]
```

In [178…
```
ci_home_win['ub'] = [Eng_win_prob[1],Swed_win_prob[1],Fran_win_prob[1]]
```

Create a table that has the lower bounds (lb) and upper bounds (ub) for the probabilities of winning for England, Sweden, & France

In [179…
```
ci_home_win = pd.DataFrame(ci_home_win)
ci_home_win
```

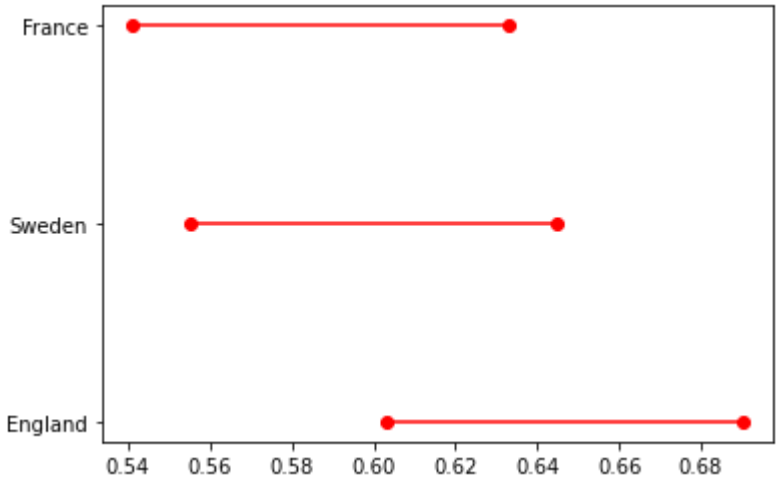
Out[179…

	country	lb	ub
0	England	0.603055	0.690048
1	Sweden	0.555231	0.644769
2	France	0.541056	0.632759

The graph below shows that the 95% confidence intervals for the three countries are relatively similar in length and that England is the most probable to win at home. However, the three intervals intersect in many parts; for instance, Sweden and England intersect from around 0.60 till 0.65.

The 95% confidence intervals of Sweden and France include almost the same probability ranges when comparing them with England's 95% confidence interval

In [180…
```
for lb,ub,y in zip (ci_home_win['lb'],ci_home_win['ub'], range(len(ci_home_win))):
    plt.plot((lb,ub),(y,y),'ro-')
    plt.yticks(range(len(ci_home_win)), list(ci_home_win['country']))
```



Comparing between the probability that Egypt would lose at home and away from all the matches it lost on only

Separate Egypt from all other countries

In [181…

```
non_neutral_Egy_home = data_non_neutral[data_non_neutral['country']=='Egypt']
non_neutral_Egy_home
```

Out[181…

	date	home_team	away_team	home_score	away_score	tournament	city	country
1463	2/19/1932	Egypt	Hungary	0	0	Friendly	Cairo	Egypt
1661	3/16/1934	Egypt	Israel	7	1	FIFA World Cup qualification	Cairo	Egypt
1895	6/19/1936	Egypt	Greece	3	1	Friendly	Cairo	Egypt
2927	12/24/1948	Egypt	Norway	1	1	Friendly	Cairo	Egypt
3080	2/17/1950	Egypt	Greece	2	0	Friendly	Cairo	Egypt
...	...	...	...	...	...	...	...	...
42165	3/29/2021	Egypt	Comoros	4	0	African Cup of Nations qualification	Cairo	Egypt
42590	9/1/2021	Egypt	Angola	1	0	FIFA World Cup qualification	Cairo	Egypt
42758	9/30/2021	Egypt	Liberia	2	0	Friendly	Alexandria	Egypt
42812	10/8/2021	Egypt	Libya	1	0	FIFA World Cup qualification	Alexandria	Egypt
43040	11/16/2021	Egypt	Gabon	2	1	FIFA World Cup qualification	Alexandria	Egypt

258 rows × 10 columns

In [182…
```
non_neutral_Egy_home['home_team'].value_counts()
```

Out[182…
```
Egypt    258
Name: home_team, dtype: int64
```

Below are all the teams Egypt has played against when it played at home

In [183…
```
non_neutral_Egy_home['away_team'].unique()
```

Out[183…
```
array(['Hungary', 'Israel', 'Greece', 'Norway', 'Yugoslavia', 'Italy',
       'Bulgaria', 'Portugal', 'Czechoslovakia', 'Austria', 'Brazil',
       'Algeria', 'Sudan', 'German DR', 'Libya', 'Tunisia', 'Uganda',
       'Zambia', 'Ivory Coast', 'DR Congo', 'Congo', 'Ethiopia', 'Kenya',
       'Nigeria', 'Morocco', 'Cameroon', 'Turkey', 'Iraq', 'Zimbabwe',
       'Canada', 'Madagascar', 'Mexico', 'England', 'Romania', 'Senegal',
       'Mozambique', 'Switzerland', 'Liberia', 'Finland', 'Chile',
       'Malawi', 'Denmark', 'South Korea', 'Colombia', 'Chad', 'Mali',
       'Poland', 'Angola', 'Kuwait', 'Togo', 'Ghana', 'Tanzania',
       'Namibia', 'Belarus', 'Mauritius', 'United Arab Emirates',
       'North Korea', 'Estonia', 'Burkina Faso', 'Qatar', 'South Africa',
       'Sweden', 'Rwanda', 'Trinidad and Tobago', 'Gabon', 'Belgium',
       'Benin', 'Uruguay', 'Burundi', 'Mauritania', 'Botswana',
       'Argentina', 'Djibouti', 'Guinea', 'Sierra Leone', 'Australia',
       'Niger', 'Central African Republic', 'Eswatini',
       'Equatorial Guinea', 'Jordan', 'Comoros'], dtype=object)
```

I separated the matches that Egypt has lost on when it played at home

In [184…
```
Egy_lose_home = non_neutral_Egy_home[non_neutral_Egy_home['result']=='Lose']
Egy_lose_home.head()
```

Out[184…

	date	home_team	away_team	home_score	away_score	tournament	city	country	ne
3425	1/16/1953	Egypt	Yugoslavia	1	3	Friendly	Cairo	Egypt	
3587	11/13/1953	Egypt	Italy	1	2	FIFA World Cup qualification	Cairo	Egypt	
3605	2/12/1954	Egypt	Hungary	0	3	Friendly	Cairo	Egypt	
3898	12/23/1955	Egypt	Portugal	0	4	Friendly	Cairo	Egypt	
4309	12/13/1957	Egypt	Czechoslovakia	1	2	Friendly	Cairo	Egypt	

Below is the number of times Egypt lost at home (43 times)

In [185…
```
nloses_home = Egy_lose_home['result'].value_counts()
nloses_home
```

Out[185…
```
Lose    43
Name: result, dtype: int64
```

In [186…
```
nloses_home = 43
```

To find Egypt's loses when playing away, I found the difference in the perspective of the away scores

In [187...
```
diff_scores_away = data['away_score']-data['home_score']
conditions = [(diff_scores_away>0),(diff_scores_away<0),(diff_scores_away==0)]
labels = ['Win_away','Lose_away','Draw_away']
data['result'] = np.select(conditions,labels)
```

In [188...
```
Egy_away = data[data['away_team']=='Egypt']
Egy_away.head()
```

Out[188...

	date	home_team	away_team	home_score	away_score	tournament	city	country
819	6/22/1924	Austria	Egypt	3	1	Friendly	Vienna	Austria
824	6/29/1924	Sweden	Egypt	5	0	Friendly	Stockholm	Sweden
1144	6/14/1928	Netherlands	Egypt	1	2	Friendly	Rotterdam	Netherlands
1146	6/28/1928	Luxembourg	Egypt	1	1	Friendly	Esch-sur-Alzette	Luxembourg
1670	4/6/1934	Israel	Egypt	1	4	FIFA World Cup qualification	Tel Aviv	Palestine

Separating all Egypt's losses when playing away

In [119...
```
Egy_lose_away = Egy_away[Egy_away['result']=='Lose_away']
Egy_lose_away
```

Out[119...

	date	home_team	away_team	home_score	away_score	tournament	city	countr
819	6/22/1924	Austria	Egypt	3	1	Friendly	Vienna	Austri
824	6/29/1924	Sweden	Egypt	5	0	Friendly	Stockholm	Swede
3299	11/25/1951	Greece	Egypt	1	0	Friendly	Athens	Greec
3410	11/2/1952	Yugoslavia	Egypt	5	0	Friendly	Belgrade	Yugoslavi
3604	1/24/1954	Italy	Egypt	5	1	FIFA World Cup qualification	Milan	Ita
...	...	...	...	...	...	...	...	
40043	6/19/2018	Russia	Egypt	3	1	FIFA World Cup	Saint Petersburg	Russi
40060	6/25/2018	Saudi Arabia	Egypt	2	1	FIFA World Cup	Volgograd	Russi
40740	3/26/2019	Nigeria	Egypt	1	0	Friendly	Asaba	Nigeri
43099	12/15/2021	Tunisia	Egypt	1	0	Arab Cup	Doha	Qata

	date	home_team	away_team	home_score	away_score	tournament	city	countr
43119	1/11/2022	Nigeria	Egypt	1	0	African Cup of Nations	Garoua	Cameroo

95 rows × 10 columns

Below is the number of times Egypt lost playing away (95 times)

In [120…
```
nloses_away = Egy_lose_away['result'].value_counts()
nloses_away
```

Out[120…
```
Lose_away    95
Name: result, dtype: int64
```

In [121…
```
nloses_away =  95
```

Below is the sum of all Egypt's losses (the losses at home and losses away)

In [122…
```
x = nloses_away + nloses_home
x
```

Out[122…
```
138
```

Compute the 95% confidence interval for Egypt's loss at home

In [123…
```
CI_Egy_home = proportion_confint(count = nloses_home, nobs = x, alpha=(1-0.95), method
CI_Egy_home
```

Out[123…
```
(0.23432160884031095, 0.3888667969567905)
```

Compute the 95% confidence interval Egypt's loss away

In [124…
```
CI_Egy_away = proportion_confint(count = nloses_away, nobs = x, alpha=(1-0.95), method
CI_Egy_away
```

Out[124…
```
(0.6111332030432094, 0.765678391159689)
```

Here is a graph that compares the 95% confidence intervals for the probability of Egypt's losses when playing at home or away from all the matches it lost on

In [125…
```
CI_Egy = {}
```

In [132…
```
CI_Egy['result'] = ['Lose_home','Lose_away']
```

In [133…
```
CI_Egy['lb'] = [CI_Egy_home[0],CI_Egy_away[0]]
```

In [134…
```
CI_Egy['ub'] = [CI_Egy_home[1],CI_Egy_away[1]]
```

In [135…
```
CI_Egypt = pd.DataFrame(CI_Egy)
```

In [136…
```
CI_Egypt
```

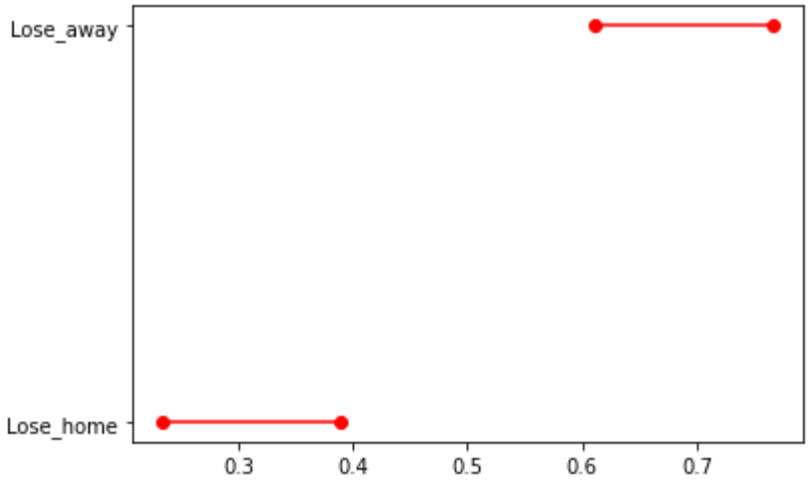
Out[136…

	result	lb	ub
0	Lose_home	0.234322	0.388867
1	Lose_away	0.611133	0.765678

The graph below shows that the confidence intervals for both probabilities of playing at home and away are similar in length. However, the probability for Egypt to lose when playing away is much greater than the probability for the team to lose when playing at home. This demonstrates the effect of fans on the players' motivation.

In [137…
```
import matplotlib.pyplot as plt
for lb,ub,y in zip(CI_Egypt['lb'],CI_Egypt['ub'],range(len(CI_Egypt))):
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(CI_Egypt)),list(CI_Egypt['result']))
```

Out[137…
```
([<matplotlib.axis.YTick at 0x19ca5ad3d30>,
  <matplotlib.axis.YTick at 0x19ca5ad35b0>],
 [Text(0, 0, 'Lose_home'), Text(0, 1, 'Lose_away')])
```



Comparing between the probabilities that the home teams would win in friendly vs official tournaments

Below I created a column "result" that shows whether a home team won, lost, or drew in a match

In [195…
```
diff_scores_home = data['home_score']-data['away_score']
conditions = [(diff_scores_home>0),(diff_scores_home<0),(diff_scores_home==0)]
labels = ['Win','Lose','Draw']
data['result'] = np.select(conditions,labels)
```

Below I created a column "typematch" that indicates whether a match is friendly or official

In [196…
```
conditions = [(data['tournament']=='Friendly'),(data['tournament']!='Friendly')]
values = ['Friendly','Official']
data['typematch'] = np.select(conditions, values)
```

In [191…
```
data['typematch'].value_counts()
```

Out[191…
```
Official    25912
Friendly    17276
Name: typematch, dtype: int64
```

We can see that a new column "typematch" has been added

In [197…
```
data.head()
```

Out[197…

	date	home_team	away_team	home_score	away_score	tournament	city	country	neutral	re
0	1872-11-30	Scotland	England	0	0	Friendly	Glasgow	Scotland	False	D
1	1873-03-08	England	Scotland	4	2	Friendly	London	England	False	
2	1874-03-07	Scotland	England	2	1	Friendly	Glasgow	Scotland	False	
3	1875-03-06	England	Scotland	2	2	Friendly	London	England	False	D
4	1876-03-04	Scotland	England	3	0	Friendly	Glasgow	Scotland	False	

Here I created a contingency table for the draws, losses, and wins according to the type of match (friendly or official)

In [198…
```
x = pd.crosstab(data['typematch'],data['result'],margins=True)
x
```

Out[198…

result	Draw	Lose	Win	All
typematch				
Friendly	4329	4806	8141	17276
Official	5626	7418	12868	25912
All	9955	12224	21009	43188

Turn the contingency table into an array assigned to "x"

In [200…
```
x = np.array(x)
x
```

Out[200…
```
array([[ 4329,  4806,  8141, 17276],
       [ 5626,  7418, 12868, 25912],
```

```
       [ 9955, 12224, 21009, 43188]], dtype=int64)
```

To find the 95% confidence interval for the probabilities of home teams winning in an Offical vs Friendly match

In [203…
```
CI_Friendly = proportion_confint(count=x[0,2],nobs=x[2,2],alpha=(1-0.95))
CI_Friendly
```

Out[203…
```
(0.3809128857381539, 0.394088304228051)
```

In [204…
```
CI_Official = proportion_confint(count=x[1,2],nobs=x[2,2],alpha=(1-0.95))
CI_Official
```

Out[204…
```
(0.6059116957719489, 0.619087114261846)
```

To draw the corresponding confidence intervals graphs

In [205…
```
CI_matchtype = {}
CI_matchtype['matchtype'] = ['Offical','Friendly']
CI_matchtype['lb'] = [CI_Friendly[0],CI_Official[0]]
CI_matchtype['ub'] = [CI_Friendly[1],CI_Official[1]]
CI_matchtype_win = pd.DataFrame(CI_matchtype)
CI_matchtype_win
```

Out[205…

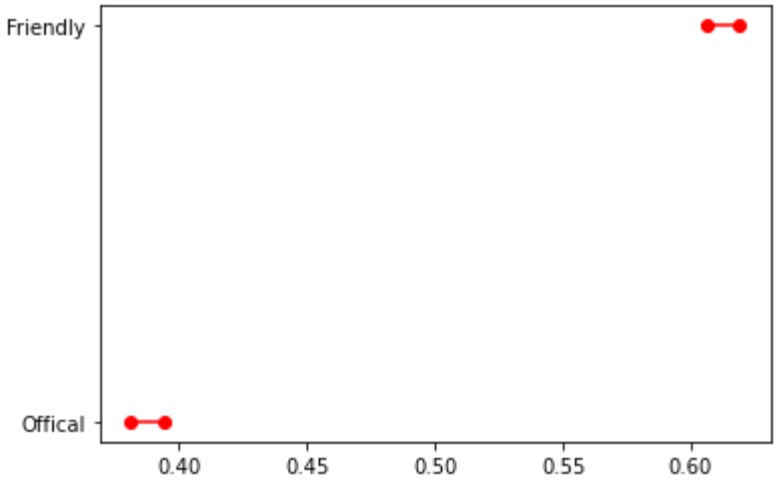
	matchtype	lb	ub
0	Offical	0.380913	0.394088
1	Friendly	0.605912	0.619087

The graph below shows that the probability for home teams to win on friendly matches is higher than the probability to win on official matches.

Maybe because on friendly matches the players do not feel as stressed as they would when playing in an offical match, so they would win more

In [206…
```
import matplotlib.pyplot as plt
for lb,ub,y in zip(CI_matchtype_win['lb'],CI_matchtype_win['ub'],range(len(CI_matchtype
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(CI_matchtype_win)),list(CI_matchtype_win['matchtype']))
```

Out[206…
```
([<matplotlib.axis.YTick at 0x19ca568ab50>,
  <matplotlib.axis.YTick at 0x19ca568a3d0>],
 [Text(0, 0, 'Offical'), Text(0, 1, 'Friendly')])
```



Part II - Covid Data

In this part:

- Important observations/conclusions about the dataset.
- Compare the 95% confidence intervals for the daily average deaths between Asia and Africa.
- Compare the 95% confidence intervals for the daily average deaths and the ratio between deaths and confirmed cases according to income (High income vs Low income).
- Compare the 95% confidence intervals for the average cases by month for India in 2020 and 2021.
- Graphs of confidence intervals for the probabilities.

Import the data "covid_data" into python

In [207…
```
df = pd.read_csv('covid_data.csv', encoding ='latin-1')
```

In [208…
```
df.head()
```

Out[208…

	date	iso3c	country	income	region	continent	dcases	ddeaths	population	weekdays	mont
0	2020-02-24	AFG	Afghanistan	Low income	South Asia	Asia	5	0	38041754	Mon	Fe
1	2020-02-25	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Tue	Fe
2	2020-02-26	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Wed	Fe
3	2020-02-27	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Thu	Fe
4	2020-02-28	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Fri	Fe

Below is a summary for the data of Covid. Some important things to take note of from here is that

the maximum number of daily cases in all of the observations, regardless of income, population size, or country is 823225 and that the maximum number of deaths reached in a day was 8786. Also, the mean of daiy cases is 2353.722996 and the mean of daily deaths is 44.293024.

In [210…
```
df.describe()
```

Out[210…

	dcases	ddeaths	population
count	122843.000000	122843.000000	1.228430e+05
mean	2353.722996	44.293024	4.258179e+07
std	12256.414469	197.945108	1.521859e+08
min	0.000000	0.000000	1.800800e+04
25%	3.000000	0.000000	2.347706e+06
50%	98.000000	1.000000	9.746117e+06
75%	860.000000	13.000000	3.041786e+07
max	823225.000000	8786.000000	1.397715e+09

Below is the sum of the daily reported cases in 2020 and 2021

In [211…
```
c = df['dcases'].sum()
c
```

Out[211… 289138394

Below is the sum of the daily reported deaths in 2020 and 2021

In [214…
```
d = df['ddeaths'].sum()
d
```

Out[214… 5441088

Below is the ratio between deaths and confirmed cases in the whole dataset

Here the ratio is small and this means that the number of deaths is insignificant when compared to the number of cases

In [215…
```
d/c
```

Out[215… 0.01881828256955733

Compare the 95% confidence intervals for the daily average deaths between Asia and Africa

The reason why I am comparing between Asia and Africa is because they are the two largest continents in terms of population and area

In [224…
```
#1. Asia
```

Below I separated the continent 'Asia' from all the other continents

In [217…
```
Asia = df[df['continent']=='Asia']
Asia.head()
```

Out[217…

	date	iso3c	country	income	region	continent	dcases	ddeaths	population	weekdays	mont
0	2020-02-24	AFG	Afghanistan	Low income	South Asia	Asia	5	0	38041754	Mon	Fe
1	2020-02-25	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Tue	Fe
2	2020-02-26	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Wed	Fe
3	2020-02-27	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Thu	Fe
4	2020-02-28	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Fri	Fe

The standard deviation of the daily deaths for Asia

In [218…
```
std_Asia = Asia['ddeaths'].std()
std_Asia
```

Out[218…
```
192.1301580956554
```

The estimated average (mean) of the daily deaths for Asia

In [220…
```
mean_Asia = Asia['ddeaths'].mean()
mean_Asia
```

Out[220…
```
40.51686332508118
```

The size/length of the variable "ddeaths" for Asia

In [222…
```
len_Asia = np.size(Asia['ddeaths'])
len_Asia
```

Out[222…
```
31103
```

95% confidence interval for the average daily deaths in both 2020 and 2021 for Asia

Since I am trying to find the confidence interval of the average and we have an unknown variance, I used the t interval

In [226…
```
CI_ddeaths_Asia = scipy.stats.t.interval(0.95, len_Asia - 1, mean_Asia, std_Asia/np.sqr
CI_ddeaths_Asia
```

Out[226…
```
(38.381526577905404, 42.65220007225696)
```

In [227…
```
#2. Africa
```

Below I separated the continent 'Africa' from all the other continents

In [228…
```
Africa = df[df['continent']=='Africa']
Africa.head()
```

Out[228…

	date	iso3c	country	income	region	continent	dcases	ddeaths	population	weekdays	mont
677	2020-03-20	AGO	Angola	Lower middle income	Sub-Saharan Africa	Africa	1	0	31825295	Fri	Ma
678	2020-03-21	AGO	Angola	Lower middle income	Sub-Saharan Africa	Africa	1	0	31825295	Sat	Ma
679	2020-03-22	AGO	Angola	Lower middle income	Sub-Saharan Africa	Africa	0	0	31825295	Sun	Ma
680	2020-03-23	AGO	Angola	Lower middle income	Sub-Saharan Africa	Africa	1	0	31825295	Mon	Ma
681	2020-03-24	AGO	Angola	Lower middle income	Sub-Saharan Africa	Africa	0	0	31825295	Tue	Ma

The standard deviation of the daily deaths for Africa

In [229…
```
std_Africa = Africa['ddeaths'].std()
std_Africa
```

Out[229…
```
31.04342390551242
```

The estimated average (mean) of the daily deaths for Africa

In [230…
```
mean_Africa = Africa['ddeaths'].mean()
mean_Africa
```

Out[230…
```
6.588286183925945
```

The size/length of the variable "ddeaths" for Africa

In [231…
```
len_Africa = np.size(Africa['ddeaths'])
len_Africa
```

Out[231…
```
34677
```

95% confidence interval for the average daily deaths in both 2020 and 2021 for Africa

In [232…
```
CI_ddeaths_Africa = scipy.stats.t.interval(0.95, len_Africa - 1, mean_Africa, std_Afric
CI_ddeaths_Africa
```

Out[232…
```
(6.2615340981609915, 6.915038269690898)
```

Compare between the 95% confidence intervals of the average daily deaths for Asia and Africa in a graph

In [233…
```
ddeaths_cont = {}
ddeaths_cont['continent'] = ['Asia','Africa']
ddeaths_cont['lb'] = [CI_ddeaths_Asia[0],CI_ddeaths_Africa[0]]
ddeaths_cont['ub'] = [CI_ddeaths_Asia[1],CI_ddeaths_Africa[1]]
CI_ddeaths_cont = pd.DataFrame(ddeaths_cont)
CI_ddeaths_cont
```

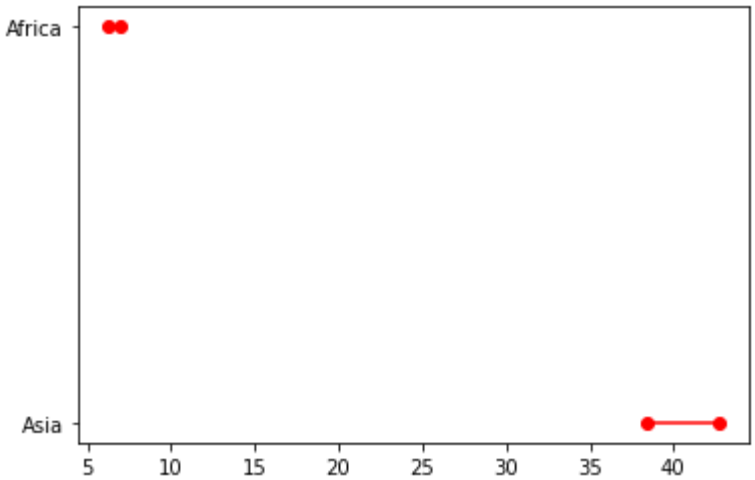
Out[233…

	continent	lb	ub
0	Asia	38.381527	42.652200
1	Africa	6.261534	6.915038

Below is the graph showing the 95% confidence intervals for the daily average deaths in Asia and Africa during 2020 and 2021 combined. We see that the average daily deaths for Africa is much less than the average daily deaths for Asia. Also, the confidence interval for Asia is wider than that of Africa. The reason behind this can be because the sample size in Africa is larger or because of a smaller margin of error.

In [234…
```
for lb,ub,y in zip(CI_ddeaths_cont['lb'],CI_ddeaths_cont['ub'],range(len(CI_ddeaths_con
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(CI_ddeaths_cont)),list(CI_ddeaths_cont['continent']))
```

Out[234…
```
([<matplotlib.axis.YTick at 0x19ca6f66520>,
  <matplotlib.axis.YTick at 0x19ca6f61d60>],
 [Text(0, 0, 'Asia'), Text(0, 1, 'Africa')])
```



Compare the 95% confidence intervals for the daily average deaths and the ratio between deaths and confirmed cases according to income (High income vs Low income)

In [246…
```
# Low Income
```

Separate "Low income" from all other incomes

In [235…
```
L_income = df[df['income']=='Low income']
L_income.head()
```

Out[235…

	date	iso3c	country	income	region	continent	dcases	ddeaths	population	weekdays	mont
0	2020-02-24	AFG	Afghanistan	Low income	South Asia	Asia	5	0	38041754	Mon	Fe
1	2020-02-25	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Tue	Fe
2	2020-02-26	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Wed	Fe
3	2020-02-27	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Thu	Fe
4	2020-02-28	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Fri	Fe

The countries associated with a low income

In [236…
```
L_income['country'].value_counts()
```

Out[236…
```
Nepal                      707
Afghanistan                677
Togo                       666
Burkina Faso               662
Congo - Kinshasa           661
Ethiopia                   659
Guinea                     659
Rwanda                     658
Central African Republic   657
Benin                      656
Somalia                    656
Tanzania                   656
Gambia                     655
Liberia                    655
Chad                       653
Niger                      652
Haiti                      652
Madagascar                 652
Uganda                     651
Syria                      650
Mozambique                 650
Mali                       647
Guinea-Bissau              647
Sierra Leone               641
Burundi                    641
Malawi                     639
South Sudan                636
Yemen                      631
```

```
Tajikistan                  610
Name: country, dtype: int64
```

Sum of reported daily cases for countries with low income

In [238…
```
cl = L_income['dcases'].sum()
cl
```

Out[238…
```
2429562
```

Sum of daily deaths for countries with low income

In [241…
```
dl = L_income['ddeaths'].sum()
dl
```

Out[241…
```
48431
```

Ratio between the daily deaths and the daily cases for countries with low income

In [242…
```
dl/cl
```

Out[242…
```
0.01993404572511424
```

The standard deviation of the daily deaths for countries with low income

In [248…
```
std_L = L_income['ddeaths'].std()
std_L
```

Out[248…
```
12.912590584822501
```

The average (mean) daily deaths for countries with low income

In [249…
```
mean_L = L_income['ddeaths'].mean()
mean_L
```

Out[249…
```
2.557615124630334
```

The size/length of variable "ddeaths" for countries with low income

In [250…
```
len_L = np.size(L_income['ddeaths'])
len_L
```

Out[250…
```
18936
```

Below is the 95% confidence interval of the average daily deaths for the countries with low income

In [251…
```
CI_ddeaths_L = scipy.stats.t.interval(0.95, len_L - 1, mean_L , std_L/np.sqrt(len_L - 1
CI_ddeaths_L
```

Out[251…
```
(2.373683426953564, 2.741546822307104)
```

In [247…
```
# High Income
```

Separate "High income" from all other incomes

In [252…
```
H_income = df[df['income']=='High income']
H_income.head()
```

Out[252…

	date	iso3c	country	income	region	continent	dcases	ddeaths	population	weekdays	mont
1992	2020-03-02	AND	Andorra	High income	Europe & Central Asia	Europe	1	0	77142	Mon	Ma
1993	2020-03-03	AND	Andorra	High income	Europe & Central Asia	Europe	0	0	77142	Tue	Ma
1994	2020-03-04	AND	Andorra	High income	Europe & Central Asia	Europe	0	0	77142	Wed	Ma
1995	2020-03-05	AND	Andorra	High income	Europe & Central Asia	Europe	0	0	77142	Thu	Ma
1996	2020-03-06	AND	Andorra	High income	Europe & Central Asia	Europe	0	0	77142	Fri	Ma

The countries associated with a high income

In [253…
```
H_income['country'].value_counts()
```

Out[253…
```
Japan                  710
South Korea            710
United States          710
Singapore              709
Canada                 709
France                 708
Australia              706
Germany                705
United Arab Emirates   703
Finland                703
Italy                  701
United Kingdom         701
Spain                  700
Sweden                 700
Belgium                697
Israel                 680
Chile                  678
Oman                   677
```

```
Kuwait                677
Bahrain               677
Croatia               676
Switzerland           676
Austria               676
Norway                675
Greece                675
Netherlands           674
Estonia               674
Denmark               674
Iceland               673
New Zealand           673
Qatar                 672
San Marino            672
Lithuania             672
Luxembourg            672
Monaco                672
Ireland               672
Czechia               671
Saudi Arabia          670
Portugal              670
Andorra               670
Latvia                670
Hungary               668
Liechtenstein         668
Poland                668
Slovenia              667
Slovakia              666
Malta                 665
Brunei                663
Cyprus                662
Panama                662
Antigua & Barbuda     659
Uruguay               659
Trinidad & Tobago     658
Seychelles            657
Bahamas               656
Barbados              655
St. Kitts & Nevis     647
Palau                 132
Name: country, dtype: int64
```

Sum of reported daily cases for countries with high income

In [257…

```
ch = H_income['dcases'].sum()
ch
```

Out[257…

```
136132124
```

Sum of daily deaths for countries with high income

In [258…

```
dh = H_income['ddeaths'].sum()
dh
```

Out[258…

```
1952834
```

Ratio between the daily deaths and the daily cases for countries with high income

In [256…
```
dh/ch
```

Out[256…
```
0.014345137228594186
```

The standard deviation of the daily deaths for countries with high income

In [261…
```
std_H = H_income['ddeaths'].std()
std_H
```

Out[261…
```
222.3114694475608
```

The average (mean) daily deaths for countries with high income

In [262…
```
mean_H = H_income['ddeaths'].mean()
mean_H
```

Out[262…
```
50.32817895984743
```

The size/length of variable "ddeaths" for countries with high income

In [263…
```
len_H = np.size(H_income['ddeaths'])
len_H
```

Out[263…
```
38802
```

Below is the 95% confidence interval of the average daily deaths for the countries with high income

In [264…
```
CI_ddeaths_H = scipy.stats.t.interval(0.95, len_H - 1, mean_H , std_H/np.sqrt(len_H - 1
CI_ddeaths_H
```

Out[264…
```
(48.11609274841139, 52.540265171283465)
```

Graph the 95% confidence intervals for the average daily deaths according to income (high income vs low income)

In [265…
```
ddeaths_income = {}
ddeaths_income['income'] = ['Low Income','High Income']
ddeaths_income['lb'] = [CI_ddeaths_L[0],CI_ddeaths_H[0]]
ddeaths_income['ub'] = [CI_ddeaths_L[1],CI_ddeaths_H[1]]
CI_ddeaths_inc = pd.DataFrame(ddeaths_income)
CI_ddeaths_inc
```

Out[265…

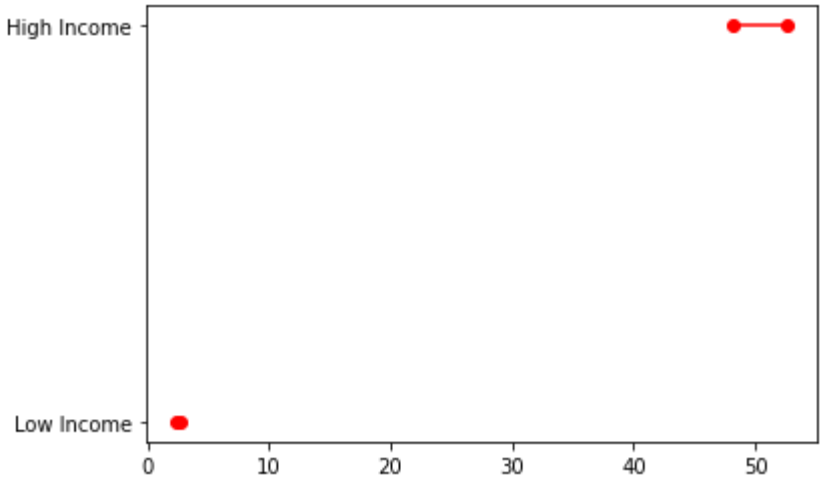
	income	lb	ub
0	Low Income	2.373683	2.741547
1	High Income	48.116093	52.540265

I thought that countries with higher income would have a lower daily death average, but surprisingly countries with low income had a much lower daily death average when comparing to

countries with high income. Also, the confidence interval for countries associated with high income is wider than the interval for countries with low income

In [267…
```
for lb,ub,y in zip(CI_ddeaths_inc['lb'],CI_ddeaths_inc['ub'],range(len(CI_ddeaths_inc))
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(CI_ddeaths_inc)),list(CI_ddeaths_inc['income']))
```

Out[267…
```
([<matplotlib.axis.YTick at 0x19ca732f7f0>,
  <matplotlib.axis.YTick at 0x19ca732dfa0>],
 [Text(0, 0, 'Low Income'), Text(0, 1, 'High Income')])
```



Find and compare between the 95% confidence intervals for the average cases by month for India in 2020 and 2021

Indicating that the months are ordered in the order of "cats"

In [289…
```
cats = ['Jan', 'Feb', 'Mar','Apr','May','Jun','Jul','Aug','Sep','Oct','Nov','Dec']
cat_type = CategoricalDtype(categories=cats, ordered=True)
df['month'] = df['month'].astype(cat_type)
```

Separate India from all the other countries

In [291…
```
India = df[df['country'] == 'India']
```

For each month, find the mean, standard deviation, and length/size of the daily cases

In [292…
```
stats = India.groupby("month").agg({"dcases": [np.mean, np.std, np.size]})
```

In [298…
```
stats = pd.DataFrame(stats)
stats
```

Out[298…

month	mean	std	size
Jan	14269.757576	6482.719062	33
Feb	6221.631579	6589.542141	57

month	mean	std	size
Mar	17916.419355	22066.831712	62
Apr	116279.500000	137715.333493	60
May	147835.822581	156159.070842	62
Jun	43857.700000	37231.180478	60
Jul	37978.983871	8960.893487	62
Aug	50809.661290	15576.946155	62
Sep	59621.333333	28873.530060	60
Oct	38558.145161	23693.595216	62
Nov	26494.816667	16729.044007	60
Dec	17559.725806	10467.380049	62

In [299…
```
stats.columns = ['mean','std','size']
```

Create a function that evaluates the lowerbound of the 95% confidence interval for the average daily cases

In [300…
```
def get_ci_lb(x, alpha=0.05):
    sample_s = np.std(x)
    sample_mean = np.mean(x)
    sample_size = len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean - margin_of_error
```

Create a function that evaluates the upperbound of the 95% confidence interval for the average daily cases

In [301…
```
def get_ci_ub(x, alpha=0.05):
    sample_s = np.std(x)
    sample_mean = np.mean(x)
    sample_size = len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean + margin_of_error
```

In [302…
```
x = India['dcases']
```

Lowerbound of the confidence interval

In [305…
```
get_ci_lb(x)
```

Out[305…
```
44032.38633467612
```

Upperbound of the confidence interval

In [307…
```
get_ci_ub(x)
```

Out[307…
```
55288.351557061775
```

Two new columns were added showing the lowerbound and upperbound for the average daily cases in India

In [309…
```
CI_dcases = statsm = India.groupby("month").agg({"dcases": [np.mean, np.std, np.size,ge
statsm
```

Out[309…

	dcases				
	mean	std	size	get_ci_lb	get_ci_ub
month					
Jan	14269.757576	6482.719062	33	11971.085348	16568.429803
Feb	6221.631579	6589.542141	57	4473.190704	7970.072454
Mar	17916.419355	22066.831712	62	12312.493397	23520.345313
Apr	116279.500000	137715.333493	60	80703.857009	151855.142991
May	147835.822581	156159.070842	62	108178.844086	187492.801076
Jun	43857.700000	37231.180478	60	34239.866232	53475.533768
Jul	37978.983871	8960.893487	62	35703.343024	40254.624718
Aug	50809.661290	15576.946155	62	46853.857664	54765.464916
Sep	59621.333333	28873.530060	60	52162.509604	67080.157062
Oct	38558.145161	23693.595216	62	32541.098627	44575.191695
Nov	26494.816667	16729.044007	60	22173.246352	30816.386982
Dec	17559.725806	10467.380049	62	14901.509007	20217.942606

In [310…
```
statsm.index
```

Out[310…
```
CategoricalIndex(['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun', 'Jul', 'Aug',
                  'Sep', 'Oct', 'Nov', 'Dec'],
                 categories=['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun', 'Jul', 'Aug',
...], ordered=True, dtype='category', name='month')
```

In [311…
```
statsm.columns = ['mean','std','size','lb','ub']
```

Here I turned the identifying index to be the months

In [314…
```
statsm['month'] = statsm.index
```

In [315…
```
statsm.head()
```

Out[315…

month	mean	std	size	lb	ub	month
Jan	14269.757576	6482.719062	33	11971.085348	16568.429803	Jan
Feb	6221.631579	6589.542141	57	4473.190704	7970.072454	Feb
Mar	17916.419355	22066.831712	62	12312.493397	23520.345313	Mar
Apr	116279.500000	137715.333493	60	80703.857009	151855.142991	Apr
May	147835.822581	156159.070842	62	108178.844086	187492.801076	May

To find the confidence intervals for 2020 and 2021 separately, I indicated that the variable "date" in the dataset is actually a date because in python it is an object

In [329…
```
df['date'] = pd. to_datetime(df['date'],format='%Y-%m-%d')
```

In [330…
```
df['year'] = pd. DatetimeIndex(df['date']). year
```

I compute now, by country, by year, by month the following statistics on the daily Covid cases: mean, std, size, CI(95%) LB, and UB

In [331…
```
statsdcases = df.groupby(['country','year','month']).agg({"dcases": [np.mean, np.std, n
```

In [332…
```
statsdcases.head(24)
```

Out[332…

			dcases				
			mean	std	size	get_ci_lb	get_ci_ub
country	year	month					
Afghanistan	**2020**	**Jan**	NaN	NaN	NaN	NaN	NaN
		Feb	0.833333	2.041241	6.0	-1.308818	2.975485
		Mar	5.258065	10.871883	31.0	1.270225	9.245904
		Apr	55.366667	40.385627	30.0	40.286426	70.446908
		May	430.741935	266.692078	31.0	332.918491	528.565379
		Jun	542.166667	278.939504	30.0	438.008944	646.324389
		Jul	167.193548	124.566560	31.0	121.502165	212.884932
		Aug	52.258065	54.725355	31.0	32.184642	72.331487
		Sep	36.866667	28.389815	30.0	26.265735	47.467598
		Oct	63.870968	32.698361	31.0	51.877112	75.864823
		Nov	162.700000	79.090149	30.0	133.167253	192.232747
		Dec	197.258065	74.022955	31.0	170.106225	224.409904

			dcases				
			mean	std	size	get_ci_lb	get_ci_ub
country	year	month					
	2021	Jan	86.870968	40.486822	31.0	72.020281	101.721654
		Feb	24.678571	16.537395	28.0	18.266039	31.091104
		Mar	23.870968	17.589281	31.0	17.419167	30.322768
		Apr	109.700000	57.199680	30.0	88.341288	131.058712
		May	390.096774	261.671086	31.0	294.115045	486.078503
		Jun	1560.700000	539.104887	30.0	1359.394927	1762.005073
		Jul	919.193548	468.370325	31.0	747.393926	1090.993171
		Aug	195.677419	158.879281	31.0	137.400029	253.954810
		Sep	65.133333	46.887049	30.0	47.625421	82.641245
		Oct	34.709677	24.771211	31.0	25.623524	43.795831
		Nov	34.633333	28.842597	30.0	23.863331	45.403336
		Dec	25.645161	16.706383	31.0	19.517211	31.773112

Transform the data index to columns

In [333…
```
statsdcases = statsdcases.reset_index()
```

Now, filter the of India data in 2021

In [334…
```
statsInd = statsdcases[(statsdcases['country']=='India') & (statsdcases['year']==2021)]
statsInd
```

Out[334…

	country	year	month	dcases				
				mean	std	size	get_ci_lb	get_ci_ub
1812	India	2021	Jan	15190.354839	5511.578065	31.0	13168.691683	17212.017995
1813	India	2021	Feb	12665.392857	2329.287053	28.0	11762.189628	13568.596086
1814	India	2021	Mar	35787.870968	18167.230223	31.0	29124.077123	42451.664813
1815	India	2021	Apr	231443.466667	105568.028204	30.0	192023.717090	270863.216243
1816	India	2021	May	290647.580645	86201.026855	31.0	259028.788725	322266.372566
1817	India	2021	Jun	74553.000000	29283.040341	30.0	63618.533034	85487.466966
1818	India	2021	Jul	40135.161290	4175.353072	31.0	38603.629419	41666.693162
1819	India	2021	Aug	37258.741935	6253.440232	31.0	34964.961540	39552.522331
1820	India	2021	Sep	31862.066667	7294.804140	30.0	29138.142034	34585.991299
1821	India	2021	Oct	16745.387097	3248.474839	31.0	15553.836906	17936.937287

	country	year	month	dcases				
				mean	std	size	get_ci_lb	get_ci_ub
1822	India	2021	Nov	10365.400000	1619.731280	30.0	9760.582400	10970.217600
1823	India	2021	Dec	8542.032258	4446.852621	31.0	6910.913548	10173.150968

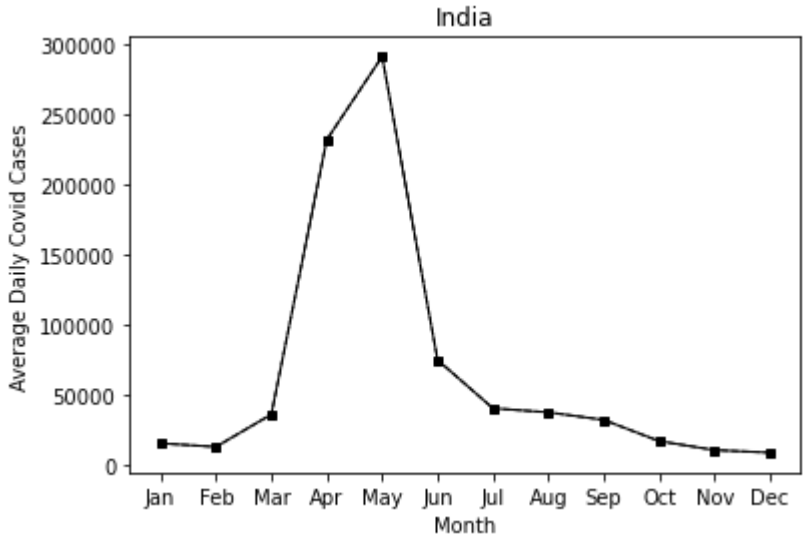
In [335…
```
statsInd.columns
```

Out[335…
```
MultiIndex([('country',          ''),
            (   'year',          ''),
            (  'month',          ''),
            ( 'dcases',      'mean'),
            ( 'dcases',       'std'),
            ( 'dcases',      'size'),
            ( 'dcases', 'get_ci_lb'),
            ( 'dcases', 'get_ci_ub')],
           )
```

In [336…
```
statsInd.columns = ['country','year','month','mean','std','size','lb','ub']
```

Below is the graph for the average daily cases for India in 2021 by month

In [338…
```
plt.plot( 'month', 'mean', data=statsInd, marker='s', color='black', markersize=4,
plt.plot( 'month', 'mean', data=statsInd, marker='o', color='black',  markersize=4, lin
plt.xlabel("Month")
plt.ylabel("Average Daily Covid Cases")
plt.title("India")
plt.show()
```



Upperbounds and lowerbounds for each month in the graph above

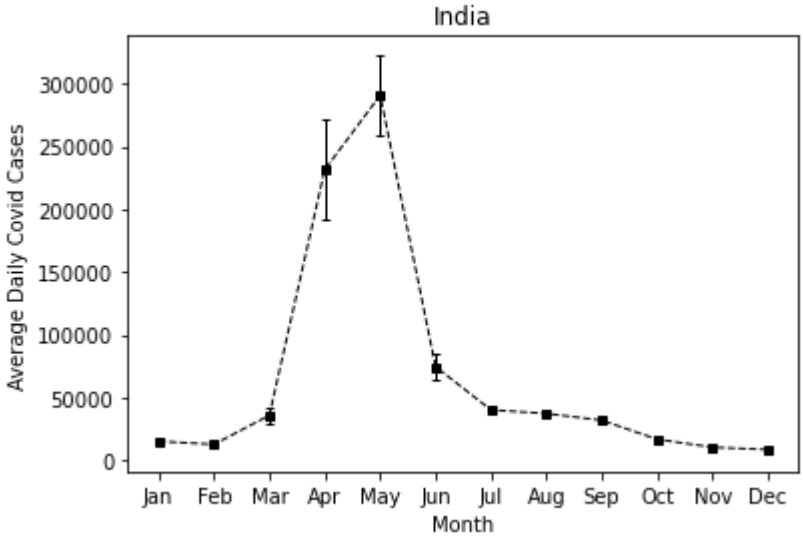
In [339…
```
ci_lb_ub = [statsInd['lb'],statsInd['ub']]
```

In [340…
```
n = np.abs(ci_lb_ub - statsInd['mean'].to_numpy())
```

Below I added the 95% confidence intervals for the average daily cases per month

In [344…

```
plt.errorbar('month', 'mean',  yerr = n, data = statsInd,marker = 's', capsize = 2,
             color = 'black', markersize = 4, linewidth = 1, linestyle = '--')
plt.xlabel("Month")
plt.ylabel("Average Daily Covid Cases")
plt.title("India")
plt.show()
```



To compare between 2020 and 2021

In [345…

```
statsInd_21 = statsdcases[(statsdcases['country']=='India')
                          & (statsdcases['year']==2021)]
statsInd_21
```

Out[345…

	country	year	month	dcases				
				mean	std	size	get_ci_lb	get_ci_ub
1812	India	2021	Jan	15190.354839	5511.578065	31.0	13168.691683	17212.017995
1813	India	2021	Feb	12665.392857	2329.287053	28.0	11762.189628	13568.596086
1814	India	2021	Mar	35787.870968	18167.230223	31.0	29124.077123	42451.664813
1815	India	2021	Apr	231443.466667	105568.028204	30.0	192023.717090	270863.216243
1816	India	2021	May	290647.580645	86201.026855	31.0	259028.788725	322266.372566
1817	India	2021	Jun	74553.000000	29283.040341	30.0	63618.533034	85487.466966
1818	India	2021	Jul	40135.161290	4175.353072	31.0	38603.629419	41666.693162
1819	India	2021	Aug	37258.741935	6253.440232	31.0	34964.961540	39552.522331
1820	India	2021	Sep	31862.066667	7294.804140	30.0	29138.142034	34585.991299
1821	India	2021	Oct	16745.387097	3248.474839	31.0	15553.836906	17936.937287
1822	India	2021	Nov	10365.400000	1619.731280	30.0	9760.582400	10970.217600
1823	India	2021	Dec	8542.032258	4446.852621	31.0	6910.913548	10173.150968

In [346...
```
statsInd_20 = statsdcases[(statsdcases['country']=='India')
                          & (statsdcases['year']==2020)]
statsInd_20
```

Out[346...

	country	year	month	dcases				
				mean	std	size	get_ci_lb	get_ci_ub
1800	India	2020	Jan	0.500000	0.707107	2.0	-5.853102	6.853102
1801	India	2020	Feb	0.068966	0.257881	29.0	-0.029127	0.167058
1802	India	2020	Mar	44.967742	56.751202	31.0	24.151233	65.784251
1803	India	2020	Apr	1115.533333	500.681724	30.0	928.575705	1302.490962
1804	India	2020	May	5024.064516	1863.490219	31.0	4340.530785	5707.598247
1805	India	2020	Jun	13162.400000	3638.887501	30.0	11803.617076	14521.182924
1806	India	2020	Jul	35822.806452	11671.764895	31.0	31541.568524	40104.044379
1807	India	2020	Aug	64360.580645	8646.870624	31.0	61188.882894	67532.278396
1808	India	2020	Sep	87380.600000	6971.220497	30.0	84777.503486	89983.696514
1809	India	2020	Oct	60370.903226	12149.922297	31.0	55914.275747	64827.530704
1810	India	2020	Nov	42624.233333	5337.656128	30.0	40631.119779	44617.346888
1811	India	2020	Dec	26577.419355	5911.932548	31.0	24408.904989	28745.933721

In [347...
```
statsInd_20.columns = ['country','year','month','mean','std','size','lb','ub']
statsInd_21.columns = ['country','year','month','mean','std','size','lb','ub']
```

The x axis will display the name of the months

In [348...
```
x = statsInd_20['month']
x
```

Out[348...
```
1800    Jan
1801    Feb
1802    Mar
1803    Apr
1804    May
1805    Jun
1806    Jul
1807    Aug
1808    Sep
1809    Oct
1810    Nov
1811    Dec
Name: month, dtype: category
Categories (12, object): ['Jan' < 'Feb' < 'Mar' < 'Apr' ... 'Sep' < 'Oct' < 'Nov' < 'De
c']
```

In [349...
```
y1 = statsInd_20['mean']
y1
```

Out[349…
```
1800        0.500000
1801        0.068966
1802       44.967742
1803     1115.533333
1804     5024.064516
1805    13162.400000
1806    35822.806452
1807    64360.580645
1808    87380.600000
1809    60370.903226
1810    42624.233333
1811    26577.419355
Name: mean, dtype: float64
```

In [350…
```
y2 = statsInd_21['mean']
y2
```

Out[350…
```
1812     15190.354839
1813     12665.392857
1814     35787.870968
1815    231443.466667
1816    290647.580645
1817     74553.000000
1818     40135.161290
1819     37258.741935
1820     31862.066667
1821     16745.387097
1822     10365.400000
1823      8542.032258
Name: mean, dtype: float64
```

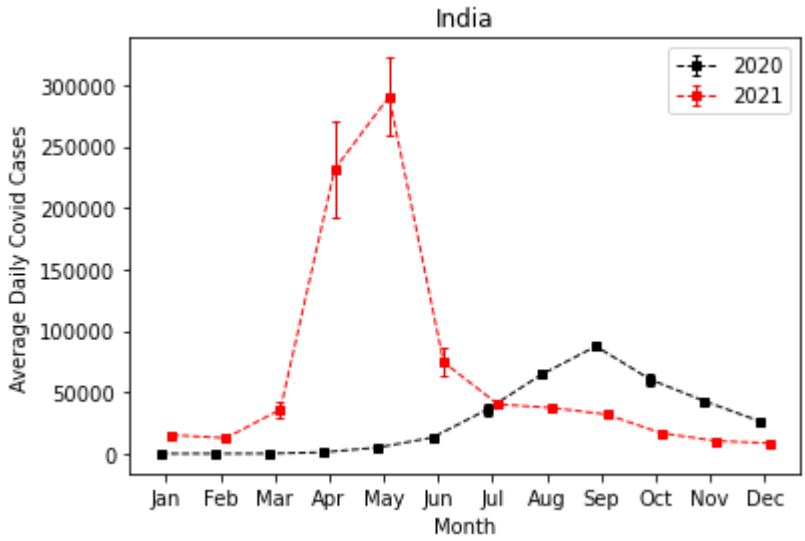
In [351…
```
ci_20 = [statsInd_20['lb'], statsInd_20['ub']]
err20 = np.abs(ci_20 - statsInd_20['mean'].to_numpy())
```

In [352…
```
ci_21 = [statsInd_21['lb'], statsInd_21['ub']]
err21 = np.abs(ci_21 - statsInd_21['mean'].to_numpy())
```

Below is the graph for the average daily cases by month in both 2020 (black) and 2021 (red) with the confidence interval of the average in each month

In [354…
```
from matplotlib.transforms import Affine2D
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=err20, data=statsInd_20,marker='s', capsize=2,
             color='black', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=err21, data=statsInd_21,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily Covid Cases")
plt.title("India")
plt.show()
```



In 2020, India experienced a mean that is steadily increasing from Jan till Sep. The highest average daily cases happened in Sep. Then, a steady decrease occured after Sep till Dec. The confidence intervals for the average daily cases in each month is narrow.

In 2021, India experienced in the beginning almost no cases, but then from Mar till Jun an intense increase of cases occured. The highest average daily cases occured in May. Afterwards, an intense decrease happened around mid May till Jun and then with a steady decrease from Jun till Dec. The confidence intervals in April and May are much more wider than those in any other month.

Around July, India experienced almost the same average daily cases. Overall, the difference between the average daily cases for the two years is not significantly different except from Mar till Jun.