Sheet

# Assignment 2

by: Mohamed Hatem El-Badry 900211356

```
!pip install pandas
import pandas as pd
!pip install numpy
import numpy as np
```

```
Requirement already satisfied: pandas in /opt/python/envs/default/lib/python3.8/site-packages (1.3.5)
Requirement already satisfied: python-dateutil>=2.7.3 in /opt/python/envs/default/lib/python3.8/site-packages (from pandas) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in /opt/python/envs/default/lib/python3.8/site-packages (from pandas) (2022.1)
Requirement already satisfied: numpy>=1.17.3 in /opt/python/envs/default/lib/python3.8/site-packages (from pandas) (1.21.5)
Requirement already satisfied: six>=1.5 in /opt/python/envs/default/lib/python3.8/site-packages (from python-dateutil>=2.7.3->pandas
WARNING: You are using pip version 21.3.1; however, version 22.0.4 is available.
You should consider upgrading via the '/opt/python/envs/default/bin/python -m pip install --upgrade pip' command.
Requirement already satisfied: numpy in /opt/python/envs/default/lib/python3.8/site-packages (1.21.5)
WARNING: You are using pip version 21.3.1; however, version 22.0.4 is available.
You should consider upgrading via the '/opt/python/envs/default/bin/python -m pip install --upgrade pip' command.
```

## Part I:

```
df= pd.read_csv('results.csv' , encoding='latin-1')
df
```

| | 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 |
| 3 | 1875-03-06 | England | Scotland | 2 | 2 | Friendly | London | England | False |
| 4 | 1876-03-04 | Scotland | England | 3 | 0 | Friendly | Glasgow | Scotland | False |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 43183 | 2/1/2022 | Suriname | Guyana | 2 | 1 | Friendly | Paramaribo | Suriname | False |
| 43184 | 2/2/2022 | Burkina Faso | Senegal | 1 | 3 | African Cup of Nations | YaoundÃ© | Cameroon | True |
| 43185 | 2/3/2022 | Cameroon | Egypt | 0 | 0 | African Cup of Nations | YaoundÃ© | Cameroon | False |
| 43186 | 2/5/2022 | Cameroon | Burkina Faso | 3 | 3 | African Cup of Nations | YaoundÃ© | Cameroon | False |
| 43187 | 2/6/2022 | Senegal | Egypt | 0 | 0 | African Cup of Nations | YaoundÃ© | Cameroon | True |

43188 rows × 9 columns

```
x=df['home_score']-df['away_score']
```

```
conditions=[(x<0),(x>0), (x==0)]
```

```
values=['lose','win','draw']
```

```
df['result_home']=np.select(conditions,values)
```

```
df['result_home'].value_counts(normalize=True)
```

```
x=df['result_home'].value_counts()
x=np.array(x)
```

```
x.sum()
```

```
43188
```

```
df_noneutral=df[df['neutral']==False]
```

```
df_noneutral.shape
```

```
(32481, 10)
```

```
x=df_noneutral['result_home'].value_counts(normalize=True)
x
```

```
df_noneutralegy=df_noneutral[df_noneutral['country']=='Egypt'] #probability that egypt wins in it land
```

```
df_noneutralegyF=df_noneutralegy[df_noneutralegy['tournament']=='Friendly']
df_noneutralegyF  #probability of Egypt Winning in their land in friendly tournament
```

| | date | home_team | away_team | home_score | away_score | tournament | city | country | neutral | result_home |
|---|---|---|---|---|---|---|---|---|---|---|
| 1463 | 2/19/1932 | Egypt | Hungary | 0 | 0 | Friendly | Cairo | Egypt | False | draw |
| 1895 | 6/19/1936 | Egypt | Greece | 3 | 1 | Friendly | Cairo | Egypt | False | win |
| 2927 | 12/24/1948 | Egypt | Norway | 1 | 1 | Friendly | Cairo | Egypt | False | draw |
| 3080 | 2/17/1950 | Egypt | Greece | 2 | 0 | Friendly | Cairo | Egypt | False | win |
| 3425 | 1/16/1953 | Egypt | Yugoslavia | 1 | 3 | Friendly | Cairo | Egypt | False | lose |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 40925 | 6/13/2019 | Egypt | Tanzania | 1 | 0 | Friendly | Alexandria | Egypt | False | win |
| 40947 | 6/16/2019 | Egypt | Guinea | 3 | 1 | Friendly | Alexandria | Egypt | False | win |
| 41450 | 10/14/2019 | Egypt | Botswana | 1 | 0 | Friendly | Cairo | Egypt | False | win |
| 41514 | 11/7/2019 | Egypt | Liberia | 1 | 0 | Friendly | Alexandria | Egypt | False | win |
| 42758 | 9/30/2021 | Egypt | Liberia | 2 | 0 | Friendly | Alexandria | Egypt | False | win |

145 rows × 10 columns

```
x=df_noneutralegyF['result_home'].value_counts(normalize=True)
x
```

```
import statsmodels.api as sm
from statsmodels.stats.proportion import proportion_confint
```

```
x=df_noneutralegyF['result_home'].value_counts()
x=np.array(x)
x
```

```
N=x.sum()
```

```
CI_egy=proportion_confint(count=x[0], nobs=N, alpha=(1-.95))
CI_egy
```

```
(0.47077769679111225, 0.6326705790709567)
```

```
df_noneutralgre=df_noneutral[df_noneutral['country']=='Greece']
```

```
df_noneutralgreF=df_noneutralgre[df_noneutralgre['tournament']=='Friendly']
```

```
df_noneutralgreF.shape
```

```
(126, 10)
```

```
df_noneutralgreF['result_home'].value_counts(normalize=True)
```

```
x=df_noneutralgreF['result_home'].value_counts()
x=np.array(x)
N=x.sum()
CI_gre=proportion_confint(count=x[0], nobs=N, alpha=(1-.95))
CI_gre
```

```
(0.3114005769651982, 0.4822502166855954)
```

```
df_noneutralwal=df_noneutral[df_noneutral['country']=='Wales']
df_noneutralwalF=df_noneutralwal[df_noneutralwal['tournament']=='Friendly']
df_noneutralwalF['result_home'].value_counts(normalize=True)
```

```
x=df_noneutralwalF['result_home'].value_counts()
x=np.array(x)
N=x.sum()
CI_wal=proportion_confint(count=x[0], nobs=N, alpha=(1-.95))
CI_wal
```

```
(0.2541364398001451, 0.478257926397038)
```

```
df_noneutralscot=df_noneutral[df_noneutral['country']=='Scotland']
df_noneutralscotF=df_noneutralscot[df_noneutralscot['tournament']=='Friendly']
df_noneutralscotF['result_home'].value_counts(normalize=True)
```

```
x=df_noneutralscotF['result_home'].value_counts()
x=np.array(x)
N=x.sum()
CI_scot=proportion_confint(count=x[0], nobs=N, alpha=(1-.95))
CI_scot
```

```
(0.4048157345543417, 0.5951842654456583)
```

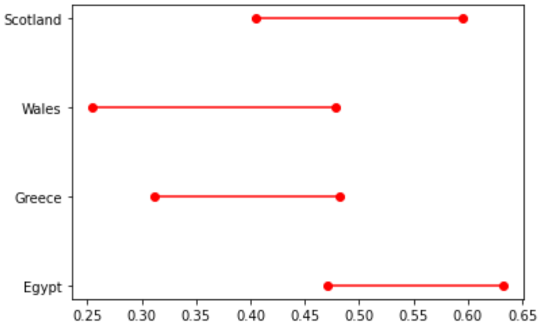
```
import matplotlib.pyplot as plt
```

```
ci_friendly = {}
ci_friendly['country'] = ['Egypt','Greece','Wales', 'Scotland']
ci_friendly['lb'] = [CI_egy[0],CI_gre[0],CI_wal[0], CI_scot[0]]
ci_friendly['ub'] = [CI_egy[1],CI_gre[1],CI_wal[1], CI_scot[1]]
df_ci= pd.DataFrame(ci_friendly)
df_ci
```

| | country | lb | ub |
|---|---|---|---|
| 0 | Egypt | 0.470778 | 0.632671 |
| 1 | Greece | 0.311401 | 0.482250 |
| 2 | Wales | 0.254136 | 0.478258 |
| 3 | Scotland | 0.404816 | 0.595184 |

```
for lb,ub,y in zip(df_ci['lb'],df_ci['ub'],range(len(df_ci))):

    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['country'])) #a graph for the confidence interval of 4 different countries' winning chance in
```

```
([<matplotlib.axis.YTick at 0x7f8f5bef0520>,
  <matplotlib.axis.YTick at 0x7f8f5bef0b50>,
  <matplotlib.axis.YTick at 0x7f8f5bf44f40>,
  <matplotlib.axis.YTick at 0x7f8f5bebf700>],
 [Text(0, 0, 'Egypt'),
  Text(0, 1, 'Greece'),
  Text(0, 2, 'Wales'),
  Text(0, 3, 'Scotland')])
```



this can make us determine that Egypt has the higher chance of winning a friendly tournament done on their homeland among the 4 countries

```
x=df['home_score']-df['away_score']
conditions=[(x<0),(x>0), (x==0)]
values=['win','lose','draw']
df['result_away']=np.select(conditions,values)
df
```

| | date | home_team | away_team | home_score | away_score | tournament | city | country | neutral | result_home | result_away |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1872-11-30 | Scotland | England | 0 | 0 | Friendly | Glasgow | Scotland | False | draw | draw |
| 1 | 1873-03-08 | England | Scotland | 4 | 2 | Friendly | London | England | False | win | lose |
| 2 | 1874-03-07 | Scotland | England | 2 | 1 | Friendly | Glasgow | Scotland | False | win | lose |
| 3 | 1875-03-06 | England | Scotland | 2 | 2 | Friendly | London | England | False | draw | draw |
| 4 | 1876-03-04 | Scotland | England | 3 | 0 | Friendly | Glasgow | Scotland | False | win | lose |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 43183 | 2/1/2022 | Suriname | Guyana | 2 | 1 | Friendly | Paramaribo | Suriname | False | win | lose |
| 43184 | 2/2/2022 | Burkina Faso | Senegal | 1 | 3 | African Cup of Nations | YaoundÃ© | Cameroon | True | lose | win |
| 43185 | 2/3/2022 | Cameroon | Egypt | 0 | 0 | African Cup of Nations | YaoundÃ© | Cameroon | False | draw | draw |
| 43186 | 2/5/2022 | Cameroon | Burkina Faso | 3 | 3 | African Cup of Nations | YaoundÃ© | Cameroon | False | draw | draw |
| 43187 | 2/6/2022 | Senegal | Egypt | 0 | 0 | African Cup of Nations | YaoundÃ© | Cameroon | True | draw | draw |

43188 rows × 11 columns

```
df_noneutral=df[df['neutral']==False]
```

```
df_noneutralegy=df_noneutral[df_noneutral['away_team']=='Egypt']
df_noneutralegyF=df_noneutralegy[df_noneutralegy['tournament']=='Friendly']
x=df_noneutralegyF['result_away'].value_counts()
x=np.array(x)
x
N=x.sum()
CI_egy=proportion_confint(count=x[1], nobs=N, alpha=(1-.95))
CI_egy
```

```
(0.24715478691048412, 0.43284521308951596)
```

```
df_noneutralgre=df_noneutral[df_noneutral['away_team']=='Greece']
df_noneutralgreF=df_noneutralgre[df_noneutralgre['tournament']=='Friendly']
x=df_noneutralgreF['result_away'].value_counts()
x=np.array(x)
x
N=x.sum()
CI_gre=proportion_confint(count=x[1], nobs=N, alpha=(1-.95))
CI_gre
```

```
(0.22828832246685596, 0.39779863405488325)
```

```
df_noneutralwal=df_noneutral[df_noneutral['away_team']=='Wales']
df_noneutralwalF=df_noneutralwal[df_noneutralwal['tournament']=='Friendly']
x=df_noneutralwalF['result_away'].value_counts()
x=np.array(x)
x
N=x.sum()
CI_wal=proportion_confint(count=x[1], nobs=N, alpha=(1-.95))
CI_wal
```

```
(0.18082080408154663, 0.37339606338833287)
```

```
df_noneutralscot=df_noneutral[df_noneutral['away_team']=='Scotland']
df_noneutralscotF=df_noneutralscot[df_noneutralscot['tournament']=='Friendly']
x=df_noneutralscotF['result_away'].value_counts()
x=np.array(x)
x
N=x.sum()
CI_scot=proportion_confint(count=x[1], nobs=N, alpha=(1-.95))
CI_scot
```

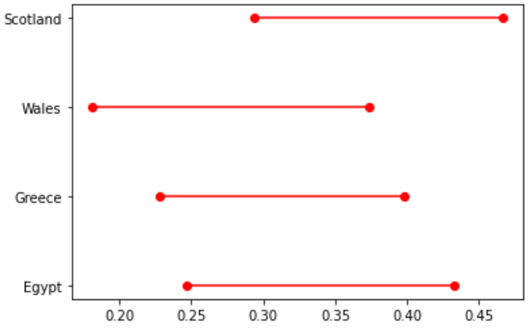
```
(0.2936725636434827, 0.466658014868914)
```

```
ci_friendlyL = {}
ci_friendlyL['country'] = ['Egypt','Greece','Wales', 'Scotland']
ci_friendlyL['lb'] = [CI_egy[0],CI_gre[0],CI_wal[0], CI_scot[0]]
ci_friendlyL['ub'] = [CI_egy[1],CI_gre[1],CI_wal[1], CI_scot[1]]
df_ci= pd.DataFrame(ci_friendlyL)
df_ci
```

| | country | lb | ub |
|---|---|---|---|
| 0 | Egypt | 0.247155 | 0.432845 |
| 1 | Greece | 0.228288 | 0.397799 |
| 2 | Wales | 0.180821 | 0.373396 |
| 3 | Scotland | 0.293673 | 0.466658 |

```
for lb,ub,y in zip(df_ci['lb'],df_ci['ub'],range(len(df_ci))):

    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['country']))
```

```
([<matplotlib.axis.YTick at 0x7f8f56a6d7c0>,
  <matplotlib.axis.YTick at 0x7f8f56a6d040>,
  <matplotlib.axis.YTick at 0x7f8f593a0460>,
  <matplotlib.axis.YTick at 0x7f8f56d109a0>],
 [Text(0, 0, 'Egypt'),
  Text(0, 1, 'Greece'),
  Text(0, 2, 'Wales'),
  Text(0, 3, 'Scotland')])
```



this is the probability of losing of 4 different countries in a friendly tournament, playing as the away team. This shows that scotland has the higher probability of losing in a friendly tournament away from their home

```
y=list(df['tournament'].value_counts().index)
y
```

```
['Friendly',
 'FIFA World Cup qualification',
 'UEFA Euro qualification',
 'African Cup of Nations qualification',
 'FIFA World Cup',
 'Copa AmÃ©rica',
 'African Cup of Nations',
 'AFC Asian Cup qualification',
 'CECAFA Cup',
 'CFU Caribbean Cup qualification',
 'Merdeka Tournament',
 'British Championship',
 'Gulf Cup',
 'AFC Asian Cup',
 'Gold Cup',
 'Island Games',
 'UEFA Euro',
 'COSAFA Cup',
 'UEFA Nations League',
 'AFF Championship',
 'Nordic Championship',
 'African Nations Championship',
 'CFU Caribbean Cup',
 'AmÃ\xadlcar Cabral Cup',
 "King's Cup",
 'South Pacific Games',
 'UNCAF Cup',
 'Korea Cup',
 'SAFF Cup',
 'Arab Cup',
 'Confederations Cup',
 'International Cup',
 'CCCF Championship',
 'EAFF Championship',
 'CONCACAF Nations League',
 'Windward Islands Tournament',
 'CONIFA World Football Cup',
 'Oceania Nations Cup',
 'AFC Challenge Cup',
 'WAFF Championship',
 'Baltic Cup',
 'AFC Challenge Cup qualification',
 'Nehru Cup',
 'Balkan Cup',
 'Indonesia Tournament',
 'Oceania Nations Cup qualification',
 'Cyprus International Tournament',
 'Kirin Cup',
 'CONCACAF Nations League qualification',
 'Gold Cup qualification',
 'UDEAC Cup',
 'African Nations Championship qualification',
 'Vietnam Independence Cup',
 'Palestine Cup',
 'Viva World Cup',
 'West African Cup',
 'Malta International Tournament',
 'Pacific Games',
 'CONIFA European Football Cup',
 'CONCACAF Championship',
 'Pan American Championship',
 'Brazil Independence Cup',
 'USA Cup',
 'United Arab Emirates Friendship Tournament',
 'Copa Chevallier Boutell',
 'Dynasty Cup',
 'Copa Lipton',
 'COSAFA Cup qualification',
 'Copa Newton',
 'Lunar New Year Cup',
 'Merlion Cup',
 'Arab Cup qualification',
 'Copa Paz del Chaco',
 'Copa Roca',
 "Prime Minister's Cup",
 'CONCACAF Championship qualification',
 'ABCS Tournament',
 'Inter Games Football Tournament',
 'Copa del PacÃ\xadfico',
 'Copa Rio Branco',
 'Simba Tournament',
 'Copa Carlos Dittborn',
 'Copa Juan Pinto DurÃ¡n',
 'Copa Oswaldo Cruz',
 'ELF Cup',
 'UNIFFAC Cup',
 'Millennium Cup',
 'Copa Premio Honor Uruguayo',
 'Dunhill Cup',
 'GaNEFo',
 'Nile Basin Tournament',
 'Intercontinental Cup',
 'Copa Artigas',
 'Jordan International Tournament',
 'King Hassan II Tournament',
 'Copa Premio Honor Argentino',
 'SKN Football Festival',
 'Rous Cup',
 'Atlantic Cup',
 'FIFI Wild Cup',
 "Copa Bernardo O'Higgins",
 'Tournoi de France',
 'Bolivarian Games',
 'Beijing International Friendship Tournament',
 'VFF Cup',
 'Mahinda Rajapaksa Cup',
 'Mundialito',
 'NAFU Championship',
 'Nations Cup',
 'Copa RamÃ³n Castilla',
 'Copa FÃ©lix Bogado',
 'World Unity Cup',
 'Guangzhou International Friendship Tournament',
 'Afro-Asian Games',
 'Dragon Cup',
 'Matthews Cup',
 'Dakar Tournament',
 'OSN Cup',
 'Great Wall Cup',
 'Three Nations Cup',
 'Copa AmÃ©rica qualification',
 'AFF Championship qualification',
 'Atlantic Heritage Cup',
 'Cup of Ancient Civilizations',
 'FIFA 75th Anniversary Cup',
 'TIFOCO Tournament']
```

```
df_noneutralegy=df_noneutral[df_noneutral['away_team']=='Egypt']
df_noneutralegyF=df_noneutralegy[df_noneutralegy['tournament']=='Friendly']
x=df_noneutralegyF['result_away'].value_counts()
x=np.array(x)
x
N=x.sum()
CI_egyF=proportion_confint(count=x[0], nobs=N, alpha=(1-.95))
CI_egyF
```

```
(0.28486600512143223, 0.4751339948785678)
```

```
df_noneutralegy=df_noneutral[df_noneutral['away_team']=='Egypt']
df_noneutralegyF=df_noneutralegy[df_noneutralegy['tournament']=='FIFA World Cup qualification']
x=df_noneutralegyF['result_away'].value_counts()
x=np.array(x)
x
N=x.sum()
CI_egyFIFA=proportion_confint(count=x[0], nobs=N, alpha=(1-.95))
CI_egyFIFA
```

```
(0.24249192186541954, 0.5302353508618531)
```

```
df_noneutralegy=df_noneutral[df_noneutral['away_team']=='Egypt']
df_noneutralegyF=df_noneutralegy[df_noneutralegy['tournament']=='African Cup of Nations qualification']
x=df_noneutralegyF['result_away'].value_counts()
x=np.array(x)
x
N=x.sum()
CI_egyAFRI=proportion_confint(count=x[0], nobs=N, alpha=(1-.95))
CI_egyAFRI
```

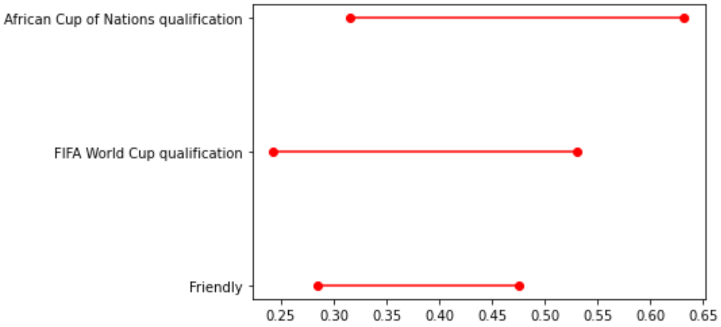
```
(0.3149304774470007, 0.6324379436056309)
```

```
ci_tour = {}
ci_tour['tournament'] = ['Friendly','FIFA World Cup qualification','African Cup of Nations qualification']
ci_tour['lb'] = [CI_egyF[0],CI_egyFIFA[0],CI_egyAFRI[0]]
ci_tour['ub'] = [CI_egyF[1],CI_egyFIFA[1],CI_egyAFRI[1]]
df_ci= pd.DataFrame(ci_tour)
df_ci
```

|   | tournament | lb | ub |
|---|---|---|---|
| 0 | Friendly | 0.284866 | 0.475134 |
| 1 | FIFA World Cup qualification | 0.242492 | 0.530235 |
| 2 | African Cup of Nations qualification | 0.314930 | 0.632438 |

```
for lb,ub,y in zip(df_ci['lb'],df_ci['ub'],range(len(df_ci))):

    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['tournament']))
```

```
([<matplotlib.axis.YTick at 0x7f8f57ba4880>,
  <matplotlib.axis.YTick at 0x7f8f57ba4100>,
  <matplotlib.axis.YTick at 0x7f8f57b97100>],
 [Text(0, 0, 'Friendly'),
  Text(0, 1, 'FIFA World Cup qualification'),
  Text(0, 2, 'African Cup of Nations qualification')])
```



the graph above shows the confidence interval of Egypt winning in 3 different tournaments as the away team

## Part II:

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

|   | date | iso3c | country | income | region | continent | dcases | ddeaths | population | weekdays | month |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2020-02-24 | AFG | Afghanistan | Low income | South Asia | Asia | 5 | 0 | 38041754 | Mon | Feb |
| 1 | 2020-02-25 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Tue | Feb |
| 2 | 2020-02-26 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Wed | Feb |
| 3 | 2020-02-27 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Thu | Feb |
| 4 | 2020-02-28 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Fri | Feb |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 122838 | 2021-12-27 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 1098 | 17 | 14645468 | Mon | Dec |
| 122839 | 2021-12-28 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 2099 | 32 | 14645468 | Tue | Dec |
| 122840 | 2021-12-29 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 0 | 0 | 14645468 | Wed | Dec |
| 122841 | 2021-12-30 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 4180 | 57 | 14645468 | Thu | Dec |
| 122842 | 2021-12-31 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 1530 | 7 | 14645468 | Fri | Dec |

122843 rows × 11 columns

```
from pandas.api.types import CategoricalDtype
cats=['Fri', 'Sat' , 'Sun', 'Mon', 'Tue' , 'Wed', 'Thu']
cat_type= CategoricalDtype(categories=cats, ordered=True)
df['weekdays']=df['weekdays'].astype(cat_type)
```

```
dfegy=df[df['country']=='Egypt']
```

```
stats=dfegy.groupby("weekdays").agg({"dcases": [np.mean, np.std, np.size]})
```

```
stats
```

| | dcases | | |
|---|---|---|---|
| | mean | std | size |
| weekdays | | | |
| Fri | 567.161616 | 428.533849 | 99 |
| Sat | 558.806122 | 421.803605 | 98 |
| Sun | 545.520408 | 422.358748 | 98 |
| Mon | 561.846939 | 442.137949 | 98 |
| Tue | 566.153061 | 419.125460 | 98 |
| Wed | 561.479592 | 406.337812 | 98 |
| Thu | 567.683673 | 410.020004 | 98 |

```
ci95_h = []
ci95_l = []
```

```
import scipy.stats
```

```
stats.index
```

```
CategoricalIndex(['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], categories=['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], or
```

```
for i in stats.index:
 m, s, n = stats.loc[i]
 x=scipy.stats.t.interval(.95, n-1, m,s/np.sqrt(n-1))
 ci95_h.append(x[1])
 ci95_l.append(x[0])
```

```
ci95_h
```

```
[653.0661477518557,
 643.8071867945697,
 630.633343760431,
 650.9457415593621,
 650.614430845941,
 643.3640186561778,
 650.3101288341297]
```

```
ci95_l
```

```
[481.2570845713766,
 473.80505810338957,
 460.4074725660996,
 472.74813599165833,
 481.6916916030385,
 479.5951650172916,
 485.0572181046457]
```

```
stats['ci95_hi'] = ci95_h
stats['ci95_lo'] = ci95_l
print(stats)
```

```
              dcases                       ci95_hi     ci95_lo
                mean         std size
weekdays
Fri       567.161616  428.533849   99  653.066148  481.257085
Sat       558.806122  421.803605   98  643.807187  473.805058
Sun       545.520408  422.358748   98  630.633344  460.407473
Mon       561.846939  442.137949   98  650.945742  472.748136
Tue       566.153061  419.125460   98  650.614431  481.691692
Wed       561.479592  406.337812   98  643.364019  479.595165
Thu       567.683673  410.020004   98  650.310129  485.057218
```

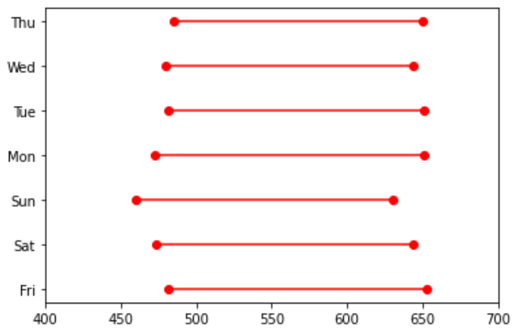
```
df_ci= pd.DataFrame(stats)
df_ci['weekdays']=df_ci.index
```

```
df_ci
```

| | dcases | | | ci95_hi | ci95_lo | weekdays |
|---|---|---|---|---|---|---|
| | mean | std | size | | | |
| weekdays | | | | | | |
| Fri | 567.161616 | 428.533849 | 99 | 653.066148 | 481.257085 | Fri |
| Sat | 558.806122 | 421.803605 | 98 | 643.807187 | 473.805058 | Sat |
| Sun | 545.520408 | 422.358748 | 98 | 630.633344 | 460.407473 | Sun |
| Mon | 561.846939 | 442.137949 | 98 | 650.945742 | 472.748136 | Mon |
| Tue | 566.153061 | 419.125460 | 98 | 650.614431 | 481.691692 | Tue |
| Wed | 561.479592 | 406.337812 | 98 | 643.364019 | 479.595165 | Wed |
| Thu | 567.683673 | 410.020004 | 98 | 650.310129 | 485.057218 | Thu |

```
for lb,ub,y in zip(df_ci['ci95_lo'],df_ci['ci95_hi'],range(len(df_ci))):
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['weekdays']))
plt.xlim([400, 700])
```

```
(400.0, 700.0)
```



```
fatality= df['ddeaths']/df['dcases']
df['fatality'] = fatality
df['fatality'] = df['fatality'].fillna(0)
df
```

| | date | iso3c | country | income | region | continent | dcases | ddeaths | population | weekdays | month | fatality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2020-02-24 | AFG | Afghanistan | Low income | South Asia | Asia | 5 | 0 | 38041754 | Mon | Feb | 0.000000 |
| 1 | 2020-02-25 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Tue | Feb | 0.000000 |
| 2 | 2020-02-26 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Wed | Feb | 0.000000 |
| 3 | 2020-02-27 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Thu | Feb | 0.000000 |
| 4 | 2020-02-28 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Fri | Feb | 0.000000 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 122838 | 2021-12-27 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 1098 | 17 | 14645468 | Mon | Dec | 0.015483 |
| 122839 | 2021-12-28 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 2099 | 32 | 14645468 | Tue | Dec | 0.015245 |
| 122840 | 2021-12-29 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 0 | 0 | 14645468 | Wed | Dec | 0.000000 |
| 122841 | 2021-12-30 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 4180 | 57 | 14645468 | Thu | Dec | 0.013636 |
| 122842 | 2021-12-31 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 1530 | 7 | 14645468 | Fri | Dec | 0.004575 |

122843 rows × 12 columns

```
mask = (df['date'] > '2019-12-31') & (df['date'] <= '2020-12-31')
df2020=df.loc[mask]
df2020
```

| | date | iso3c | country | income | region | continent | dcases | ddeaths | population | weekdays | month | fatality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2020-02-24 | AFG | Afghanistan | Low income | South Asia | Asia | 5 | 0 | 38041754 | Mon | Feb | 0.000000 |
| 1 | 2020-02-25 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Tue | Feb | 0.000000 |
| 2 | 2020-02-26 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Wed | Feb | 0.000000 |
| 3 | 2020-02-27 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Thu | Feb | 0.000000 |
| 4 | 2020-02-28 | AFG | Afghanistan | Low income | South Asia | Asia | 0 | 0 | 38041754 | Fri | Feb | 0.000000 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 122473 | 2020-12-27 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 114 | 8 | 14645468 | Sun | Dec | 0.070175 |
| 122474 | 2020-12-28 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 71 | 5 | 14645468 | Mon | Dec | 0.070423 |
| 122475 | 2020-12-29 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 177 | 5 | 14645468 | Tue | Dec | 0.028249 |
| 122476 | 2020-12-30 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 300 | 1 | 14645468 | Wed | Dec | 0.003333 |
| 122477 | 2020-12-31 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 242 | 3 | 14645468 | Thu | Dec | 0.012397 |

54958 rows × 12 columns

```
mask = (df['date'] > '2020-12-31') & (df['date'] <= '2021-12-31')
df2021=df.loc[mask]
df2021
```

| | date | iso3c | country | income | region | continent | dcases | ddeaths | population | weekdays | month | fatality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 312 | 2021-01-01 | AFG | Afghanistan | Low income | South Asia | Asia | 183 | 12 | 38041754 | Fri | Jan | 0.065574 |
| 313 | 2021-01-02 | AFG | Afghanistan | Low income | South Asia | Asia | 73 | 10 | 38041754 | Sat | Jan | 0.136986 |
| 314 | 2021-01-03 | AFG | Afghanistan | Low income | South Asia | Asia | 123 | 10 | 38041754 | Sun | Jan | 0.081301 |
| 315 | 2021-01-04 | AFG | Afghanistan | Low income | South Asia | Asia | 200 | 9 | 38041754 | Mon | Jan | 0.045000 |
| 316 | 2021-01-05 | AFG | Afghanistan | Low income | South Asia | Asia | 102 | 7 | 38041754 | Tue | Jan | 0.068627 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 122838 | 2021-12-27 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 1098 | 17 | 14645468 | Mon | Dec | 0.015483 |
| 122839 | 2021-12-28 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 2099 | 32 | 14645468 | Tue | Dec | 0.015245 |
| 122840 | 2021-12-29 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 0 | 0 | 14645468 | Wed | Dec | 0.000000 |
| 122841 | 2021-12-30 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 4180 | 57 | 14645468 | Thu | Dec | 0.013636 |
| 122842 | 2021-12-31 | ZWE | Zimbabwe | Lower middle income | Sub-Saharan Africa | Africa | 1530 | 7 | 14645468 | Fri | Dec | 0.004575 |

67885 rows × 12 columns

```
df2020['dcases'].sum()
```

```
83839670
```

```
df2020['ddeaths'].sum()
```

```
1883714
```

```
df['region'].unique()
```

```
from pandas.api.types import CategoricalDtype
cats=['South Asia', 'Sub-Saharan Africa', 'Europe & Central Asia','Middle East & North Africa','Latin America & Caribbean','East Asia 
cat_type = CategoricalDtype(categories=cats, ordered=True)
df['region'] = df['region'].astype(cat_type)
```

```
stats=df2020.groupby("region").agg({"ddeaths": [np.mean, np.std, np.size]})
```

```
stats
```

| | ddeaths | | |
|---|---|---|---|
| | mean | std | size |
| region | | | |
| East Asia & Pacific | 7.110776 | 27.950752 | 6301 |
| Europe & Central Asia | 36.913612 | 111.023170 | 15743 |
| Latin America & Caribbean | 57.772410 | 181.529167 | 9750 |
| Middle East & North Africa | 17.696025 | 47.867778 | 6415 |
| North America(region) | 534.744557 | 759.732535 | 689 |
| South Asia | 67.306966 | 204.340594 | 2541 |
| Sub-Saharan Africa | 3.070567 | 20.413941 | 13519 |

```
ci95_hi = []
ci95_lo = []
```

```
for i in stats.index:
    m, s, n = stats.loc[i]
    x=scipy.stats.t.interval(.95, n-1, m,s/np.sqrt(n-1))
    ci95_hi.append(x[1])
    ci95_lo.append(x[0])
```

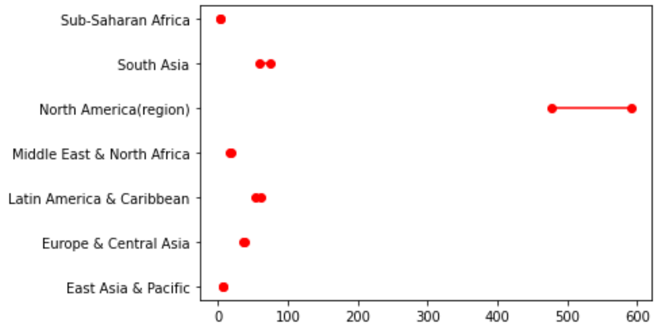
```
stats['ci95_hi'] = ci95_hi
stats['ci95_lo'] = ci95_lo
print(stats)
```

```
                              ddeaths                          ci95_hi  \
                                 mean         std   size
region
East Asia & Pacific           7.110776   27.950752   6301    7.801103
Europe & Central Asia        36.913612  111.023170  15743   38.648076
Latin America & Caribbean    57.772410  181.529167   9750   61.376274
Middle East & North Africa   17.696025   47.867778   6415   18.867704
North America(region)       534.744557  759.732535    689  591.614040
South Asia                   67.306966  204.340594   2541   75.257437
Sub-Saharan Africa            3.070567   20.413941  13519    3.414725

                              ci95_lo

region
East Asia & Pacific           6.420449
Europe & Central Asia        35.179149
Latin America & Caribbean    54.168546
Middle East & North Africa   16.524345
North America(region)       477.875074
South Asia                   59.356494
Sub-Saharan Africa            2.726410
```

```
df_ci= pd.DataFrame(stats)
df_ci['region']=df_ci.index
```

```
for lb,ub,y in zip(df_ci['ci95_lo'],df_ci['ci95_hi'],range(len(df_ci))):
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['region']))
```

```
([<matplotlib.axis.YTick at 0x7f8f51076880>,
  <matplotlib.axis.YTick at 0x7f8f510213a0>,
  <matplotlib.axis.YTick at 0x7f8f5265c1f0>,
  <matplotlib.axis.YTick at 0x7f8f57f06760>,
  <matplotlib.axis.YTick at 0x7f8f57f10040>,
  <matplotlib.axis.YTick at 0x7f8f57f10640>,
  <matplotlib.axis.YTick at 0x7f8f57f10d90>],
 [Text(0, 0, 'East Asia & Pacific'),
  Text(0, 1, 'Europe & Central Asia'),
  Text(0, 2, 'Latin America & Caribbean'),
  Text(0, 3, 'Middle East & North Africa'),
  Text(0, 4, 'North America(region)'),
  Text(0, 5, 'South Asia'),
  Text(0, 6, 'Sub-Saharan Africa')])
```



this shows that north america had the highest probability of number of deaths between the regions in 2020

```
df['income'].unique()
```

```
from pandas.api.types import CategoricalDtype
cats=['Low income', 'Lower middle income', 'Upper middle income','High income']
cat_type = CategoricalDtype(categories=cats, ordered=True)
df['income'] = df['income'].astype(cat_type)
```

```
stats=df2021.groupby("income").agg({"dcases": [np.mean, np.std, np.size]})
stats
ci95_hi = []
ci95_lo = []
```

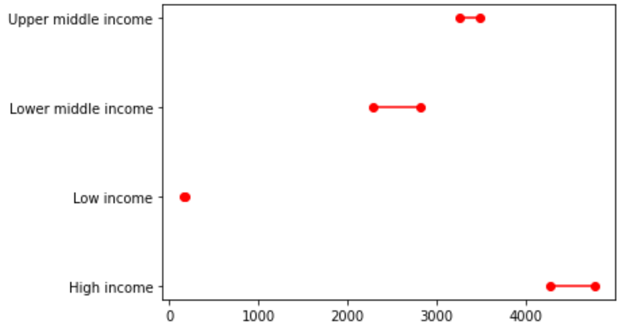
```
ci95_hi = []
ci95_lo = []
for i in stats.index:
    m, s, n = stats.loc[i]
    x=scipy.stats.t.interval(.95, n-1, m,s/np.sqrt(n-1))
    ci95_hi.append(x[1])
    ci95_lo.append(x[0])
stats['ci95_hi'] = ci95_hi
stats['ci95_lo'] = ci95_lo
print(stats)
```

```
                          dcases                          ci95_hi  \
                            mean           std   size
income
High income          4520.954339  18317.784729  20937  4769.095778
Low income            168.681058    657.105911  10585   181.201170
Lower middle income  2550.449589  17762.604302  16653  2820.256518
Upper middle income  3368.106393   8585.182602  19710  3487.971286

                         ci95_lo

income
High income          4272.812901
Low income            156.160946
Lower middle income  2280.642659
Upper middle income  3248.241499
```

```
df_ci= pd.DataFrame(stats)
df_ci['income']=df_ci.index
```

```
for lb,ub,y in zip(df_ci['ci95_lo'],df_ci['ci95_hi'],range(len(df_ci))):
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['income']))
```

```
([<matplotlib.axis.YTick at 0x7f8f51022400>,
  <matplotlib.axis.YTick at 0x7f8f553d1c10>,
  <matplotlib.axis.YTick at 0x7f8f5bef0910>,
  <matplotlib.axis.YTick at 0x7f8f5101c6a0>],
 [Text(0, 0, 'High income'),
  Text(0, 1, 'Low income'),
  Text(0, 2, 'Lower middle income'),
  Text(0, 3, 'Upper middle income')])
```



shows that the higher the income, the higher the probability of cases in 2021

```
df['continent'].unique()
```

```
from pandas.api.types import CategoricalDtype
cats=['Asia', 'Africa', 'Europe','South America', 'North America', 'Oceania']
cat_type = CategoricalDtype(categories=cats, ordered=True)
df['continent'] = df['continent'].astype(cat_type)
```

```
stats=df.groupby("continent").agg({"ddeaths": [np.mean, np.std, np.size]})
stats
```

| | ddeaths | | |
|---|---|---|---|
| | mean | std | size |
| continent | | | |
| Asia | 40.516863 | 192.130158 | 31103.0 |
| Africa | 6.588286 | 31.043424 | 34677.0 |
| Europe | 52.627530 | 140.575791 | 29103.0 |
| South America | NaN | NaN | NaN |
| North America | NaN | NaN | NaN |
| Oceania | 0.758323 | 3.094773 | 4746.0 |

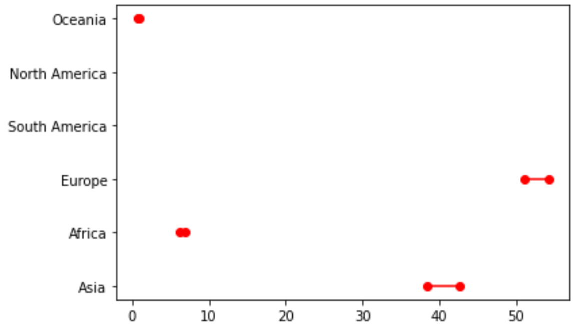
```
ci95_hi = []
ci95_lo = []
for i in stats.index:
    m, s, n = stats.loc[i]
    x=scipy.stats.t.interval(.95, n-1, m,s/np.sqrt(n-1))
    ci95_hi.append(x[1])
    ci95_lo.append(x[0])
stats['ci95_hi'] = ci95_hi
stats['ci95_lo'] = ci95_lo
print(stats)
```

```
                 ddeaths                            ci95_hi    ci95_lo
                    mean         std      size                        
continent                                                             
Asia           40.516863  192.130158   31103.0  42.652200  38.381527
Africa          6.588286   31.043424   34677.0   6.915038   6.261534
Europe         52.627530  140.575791   29103.0  54.242689  51.012371
South America        NaN         NaN       NaN        NaN        NaN
North America        NaN         NaN       NaN        NaN        NaN
Oceania         0.758323    3.094773    4746.0   0.846401   0.670244
```

```
df_ci= pd.DataFrame(stats)
df_ci['continent']=df_ci.index
```

```
for lb,ub,y in zip(df_ci['ci95_lo'],df_ci['ci95_hi'],range(len(df_ci))):
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['continent']))
```

```
([<matplotlib.axis.YTick at 0x7f8f557ebe80>,
  <matplotlib.axis.YTick at 0x7f8f557eb700>,
  <matplotlib.axis.YTick at 0x7f8f557e8670>,
  <matplotlib.axis.YTick at 0x7f8f56422730>,
  <matplotlib.axis.YTick at 0x7f8f56419040>,
  <matplotlib.axis.YTick at 0x7f8f56422b20>],
 [Text(0, 0, 'Asia'),
  Text(0, 1, 'Africa'),
  Text(0, 2, 'Europe'),
  Text(0, 3, 'South America'),
  Text(0, 4, 'North America'),
  Text(0, 5, 'Oceania')])
```



Europe had the highest probability of deaths