```
import pandas as pd
import numpy as np


data = pd.read_csv("/content/time-series-19-covid-combined.csv")


data = data.sort_values("Date").reset_index()


## Data Cleaning
## Converting Date From string to Datetime

data['Date'] = pd.to_datetime(data['Date'])
print(data)
## replacing Null Values  0 for Numeric Columns
data.isna().sum()
data["Recovered"] = data["Recovered"].fillna(0)
data.isna().sum()
```

```
       index       Date         Country/Region  ... Confirmed  Recovered  Deaths
0          0 2020-01-22            Afghanistan  ...         0        0.0       0
1       3900 2020-01-22              Australia  ...         0        0.0       0
2      84175 2020-01-22         United Kingdom  ...         0        0.0       0
3      81250 2020-01-22   United Arab Emirates  ...         0        0.0       0
4       6825 2020-01-22               Barbados  ...         0        0.0       0
...      ...        ...                    ...  ...       ...        ...     ...
88070  68574 2020-12-11               Romania  ...    545567   443168.0   13116
88071  19499 2020-12-11                 China  ...       952      939.0       9
88072  71174 2020-12-11  Sao Tome and Principe  ...      1009      947.0      17
88073  74749 2020-12-11          South Africa  ...    845083   758373.0   22952
88074  88074 2020-12-11              Zimbabwe  ...     11162     9324.0     306

[88075 rows x 7 columns]
index                0
Date                 0
Country/Region       0
Province/State    61100
Confirmed            0
Recovered            0
Deaths               0
dtype: int64
```

3. **Merge the data for countries with multiple regions in order to provide a single time-series for each country.**

```
df_1 = data.groupby(['Date', 'Country/Region'])['Confirmed', 'Deaths', 'Recovered'].sum().reset_index()
df_1
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:1: FutureWarning: Indexing with multiple keys (implicitly converted to a tuple of keys) wil
  """Entry point for launching an IPython kernel.
```

	Date	Country/Region	Confirmed	Deaths	Recovered
0	2020-01-22	Afghanistan	0	0	0.0
1	2020-01-22	Albania	0	0	0.0
2	2020-01-22	Algeria	0	0	0.0
3	2020-01-22	Andorra	0	0	0.0
4	2020-01-22	Angola	0	0	0.0
...	...	...	...	...	...
62070	2020-12-11	Vietnam	1391	35	1238.0
62071	2020-12-11	West Bank and Gaza	106622	931	81166.0
62072	2020-12-11	Yemen	2082	606	1383.0
62073	2020-12-11	Zambia	18161	365	17329.0
62074	2020-12-11	Zimbabwe	11162	306	9324.0

4. Print the total number of confirmed cases and number of deaths in each country in the last reported day. What are the 10 countries with the highest number of confirmed COVID-19 cases? What are the 10 countries with the highest number of deaths?

Top 10 Countries with Highest Confirmed Cases

```
new_df = df_1[df_1.Date == "2020-12-11"]
df_2_1 = new_df.sort_values("Confirmed", ascending = False)[:20]
print(df_2_1[["Country/Region","Confirmed"]].head(10)) # 10 Countries with Highest Confirmed Cases
```

```
       Country/Region  Confirmed
62061              US   15842789
61963           India    9826775
61907          Brazil    6836227
62025          Russia    2574319
61946          France    2405210
62065  United Kingdom    1814395
61969           Italy    1805873
62060          Turkey    1780673
62045           Spain    1730575
61890       Argentina    1489328
```

Top 10 Countries with highest Deaths

```
df_2_2 = new_df.sort_values("Deaths", ascending = False)
df_ans = df_2_2[["Country/Region","Deaths"]][:10]
df_ans
```

	Country/Region	Deaths
62061	US	295450
61907	Brazil	180437
61963	India	142628
61998	Mexico	113019
62065	United Kingdom	63603
61969	Italy	63387
61946	France	57671
61965	Iran	51727
62045	Spain	47624
62025	Russia	45370

5. Plot a graph of the number of confirmed cases over time for each country. Which countries present exponential growth in the number of cases and which countries are already leaving exponential growth?

Assumptions : We will be using the Top 6 Countries[USA, INDIA, Brazil, Russia, France, UK] with Highest Confirmed Cases and observing there exponential Growth by plotting the graph of Total Confirmed Cases vs Month. We will also be Neglecting the December trend and the data for December month is not sufficient to observe the Trend

```
import matplotlib.pyplot as plt
country_li = []
df_new = pd.DataFrame(df_2_1["Country/Region"][:6])
df_new_reset = df_new.reset_index()
country_li = df_new_reset["Country/Region"].unique()
country_li
```

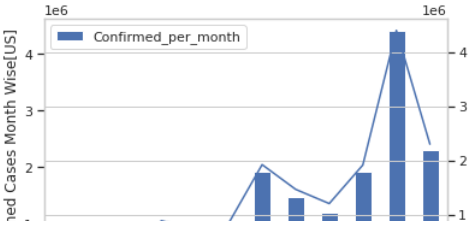
```
array(['US', 'India', 'Brazil', 'Russia', 'France', 'United Kingdom'],
      dtype=object)
```

```
df_5 = df_1[df_1["Country/Region"]=="US"][["Date","Country/Region","Confirmed"]]
x = df_5.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_5["Confirmed_per_month"] = new_li

df_5.Date = pd.to_datetime(df_5.Date)
df_5_new = df_5.groupby(pd.Grouper(key='Date', freq='1M')).agg({"Confirmed_per_month":'sum'}) # groupby each 1 month
df_5_new = df_5_new.reset_index()
df_5_new["Month"] = pd.to_datetime(df_5_new['Date']).dt.to_period('M')
df_5_new[['Month','Confirmed_per_month']].plot(kind='bar',xlabel = "Months" ,ylabel = "Confirmed Cases Month Wise[US]")
df_5_new['Confirmed_per_month'].plot(secondary_y=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f50a6d7abe0>
```



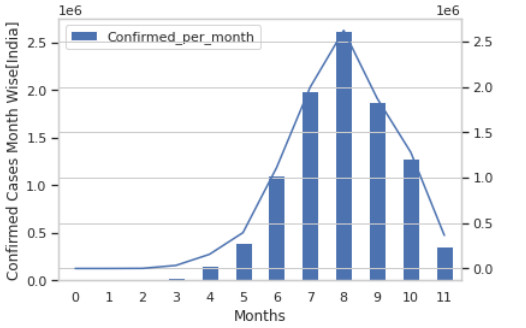
We can clearly observe that US Follows the Exponential Growth Trend

```
df_5 = df_1[df_1["Country/Region"]=="India"][["Date","Country/Region","Confirmed"]]
x = df_5.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_5["Confirmed_per_month"] = new_li

df_5.Date = pd.to_datetime(df_5.Date)
df_5_new = df_5.groupby(pd.Grouper(key='Date', freq='1M')).agg({"Confirmed_per_month":'sum'}) # groupby each 1 month
df_5_new = df_5_new.reset_index()
df_5_new["Month"] = pd.to_datetime(df_5_new['Date']).dt.to_period('M')
df_5_new[['Month','Confirmed_per_month']].plot(kind='bar',xlabel = "Months" ,ylabel = "Confirmed Cases Month Wise[India]")
df_5_new['Confirmed_per_month'].plot(secondary_y=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f50a6fcb940>
```



We can clearly observe that India is coming out of the the Exponential Growth Trend

```
df_5 = df_1[df_1["Country/Region"]=="Brazil"][["Date","Country/Region","Confirmed"]]
x = df_5.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_5["Confirmed_per_month"] = new_li

df_5.Date = pd.to_datetime(df_5.Date)
df_5_new = df_5.groupby(pd.Grouper(key='Date', freq='1M')).agg({"Confirmed_per_month":'sum'}) # groupby each 1 month
df_5_new = df_5_new.reset_index()
df_5_new["Month"] = pd.to_datetime(df_5_new['Date']).dt.to_period('M')
df_5_new[['Month','Confirmed_per_month']].plot(kind='bar',xlabel = "Months" ,ylabel = "Confirmed Cases Month Wise[Brazil]")
df_5_new['Confirmed_per_month'].plot(secondary_y=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f50a65b27b8>
```

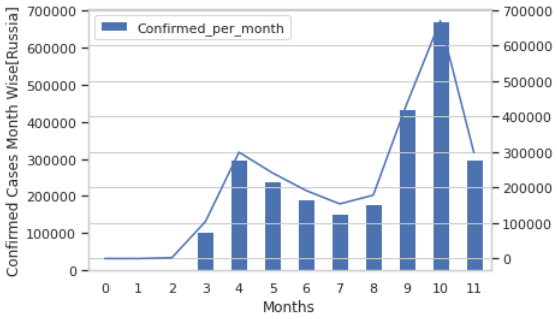
We can clearly observe that Brazil is coming out of the the Exponential Growth Trend

```
df_5 = df_1[df_1["Country/Region"]=="Russia"][["Date","Country/Region","Confirmed"]]
x = df_5.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_5["Confirmed_per_month"] = new_li

df_5.Date = pd.to_datetime(df_5.Date)
df_5_new = df_5.groupby(pd.Grouper(key='Date', freq='1M')).agg({"Confirmed_per_month":'sum'}) # groupby each 1 month
df_5_new = df_5_new.reset_index()
df_5_new["Month"] = pd.to_datetime(df_5_new['Date']).dt.to_period('M')
df_5_new[['Month','Confirmed_per_month']].plot(kind='bar',xlabel = "Months" ,ylabel = "Confirmed Cases Month Wise[Russia]")
df_5_new['Confirmed_per_month'].plot(secondary_y=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f50a6506240>
```



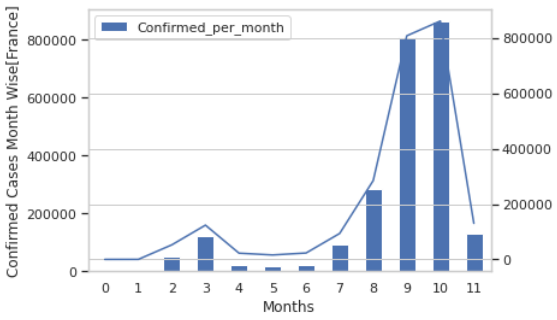
We can clearly observe that Russia is in the Exponential Growth Trend

```
df_5 = df_1[df_1["Country/Region"]=="France"][["Date","Country/Region","Confirmed"]]
x = df_5.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_5["Confirmed_per_month"] = new_li

df_5.Date = pd.to_datetime(df_5.Date)
df_5_new = df_5.groupby(pd.Grouper(key='Date', freq='1M')).agg({"Confirmed_per_month":'sum'}) # groupby each 1 month
df_5_new = df_5_new.reset_index()
df_5_new["Month"] = pd.to_datetime(df_5_new['Date']).dt.to_period('M')
df_5_new[['Month','Confirmed_per_month']].plot(kind='bar',xlabel = "Months" ,ylabel = "Confirmed Cases Month Wise[France]")
df_5_new['Confirmed_per_month'].plot(secondary_y=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f50a63de6d8>
```



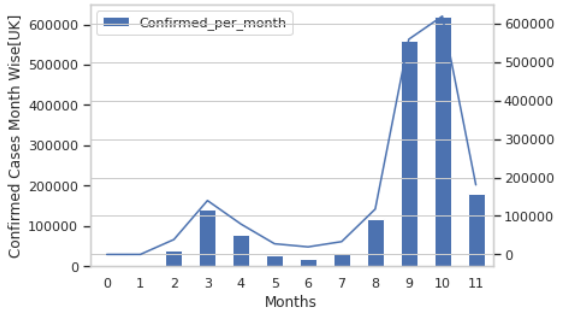
We can clearly observe that France is in the Exponential Growth Trend

```
df_5 = df_1[df_1["Country/Region"]=="United Kingdom"][["Date","Country/Region","Confirmed"]]
x = df_5.reset_index()
new_li = [1]
```

```
li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_5["Confirmed_per_month"] = new_li

df_5.Date = pd.to_datetime(df_5.Date)
df_5_new = df_5.groupby(pd.Grouper(key='Date', freq='1M')).agg({"Confirmed_per_month":'sum'}) # groupby each 1 month
df_5_new = df_5_new.reset_index()
df_5_new["Month"] = pd.to_datetime(df_5_new['Date']).dt.to_period('M')
df_5_new[['Month','Confirmed_per_month']].plot(kind='bar',xlabel = "Months" ,ylabel = "Confirmed Cases Month Wise[UK]")
df_5_new['Confirmed_per_month'].plot(secondary_y=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f50a6326ba8>
```



We can clearly observe that Uk is in the Exponential Growth Trend

6. Create a bar plot that shows the number of deaths per 100 confirmed cases (observed case-fatality ratio) for the 20 most a□ected countries.

```
df_2_1["Case_Fatality_Ratio"] = (df_2_1["Deaths"]/(df_2_1["Confirmed"]/100))
df_6 = df_2_1[["Country/Region", "Case_Fatality_Ratio"]].sort_values("Case_Fatality_Ratio",ascending = False)[:20]
```

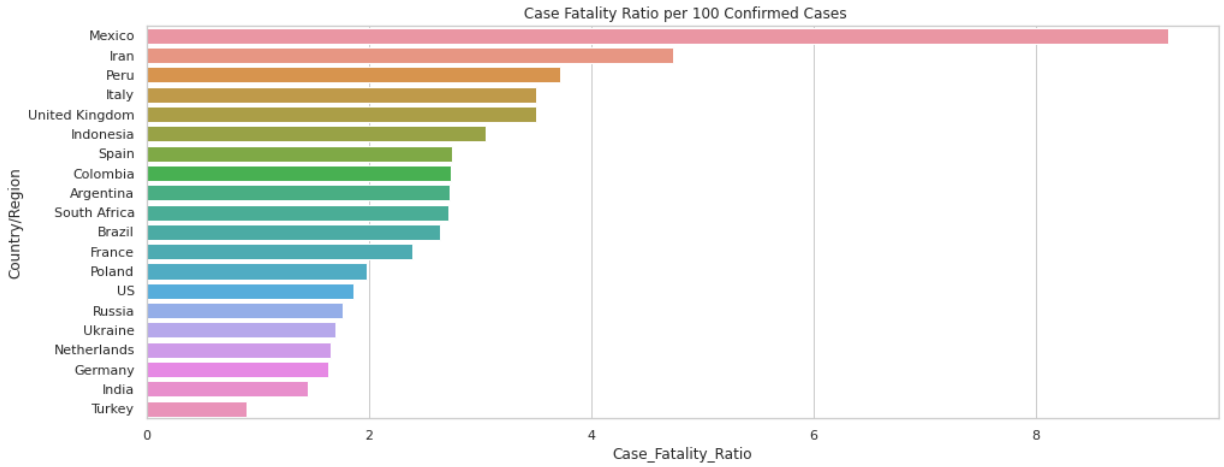
```
import seaborn as sns
import matplotlib.pyplot as plt

fig, ax = plt.subplots(figsize = (16,6))
sns.set_theme(style="whitegrid")

ax = sns.barplot(x="Case_Fatality_Ratio", y="Country/Region", data = df_6)

ax.set_title(" Case Fatality Ratio per 100 Confirmed Cases")
```

```
Text(0.5, 1.0, ' Case Fatality Ratio per 100 Confirmed Cases')
```



7. Compute the ratio between the total number of confirmed cases and the population size for each country. The file worldpopulation.json contains data on the population size of each country. What are the 10 countries with the highest number of confirmed COVID-19 cases per capita?

```
world_data = pd.read_json('/content/worldpopulation.json')
```

```
world_data = pd.read_json("/content/worldpopulation.json")

# Since US is withing top 20 confirmed cases country we are fixing its name in World Population so that when we merge it doesn't yield None

world_data = world_data.replace("U.S.","US")
world_data = world_data.replace("Czech Republic","Czechia")

df_7 =  world_data[["country","population"]]
df_7_merged = pd.merge(left=new_df, right = df_7, how='left', left_on='Country/Region', right_on = "country")
df_7_merged["Confirmed_cases_per_capita"] = df_7_merged["Confirmed"]/df_7_merged["population"]
df_7_merged
```

	Date	Country/Region	Confirmed	Deaths	Recovered	country	population	Confirmed_cases_per_capita
0	2020-12-11	Afghanistan	48116	1945	38141.0	Afghanistan	34169169.0	0.001408
1	2020-12-11	Albania	46863	977	24136.0	Albania	2911428.0	0.016096
2	2020-12-11	Algeria	91121	2575	59590.0	Algeria	41063753.0	0.002219
3	2020-12-11	Andorra	7236	78	6598.0	Andorra	68728.0	0.105285
4	2020-12-11	Angola	16061	365	8798.0	Angola	26655513.0	0.000603
...	...	...	...	...	...	...	...	...
186	2020-12-11	Vietnam	1391	35	1238.0	NaN	NaN	NaN
187	2020-12-11	West Bank and Gaza	106622	931	81166.0	NaN	NaN	NaN
188	2020-12-11	Yemen	2082	606	1383.0	Yemen	28119546.0	0.000074
189	2020-12-11	Zambia	18161	365	17329.0	Zambia	17237931.0	0.001054
190	2020-12-11	Zimbabwe	11162	306	9324.0	Zimbabwe	16337760.0	0.000683

10 countries with the highest number of confirmed COVID-19 cases per capita

```
countries = pd.DataFrame(df_7_merged.sort_values("Confirmed_cases_per_capita", ascending=False)[:10])
countries[["Country/Region", "Confirmed_cases_per_capita"]]
```

	Country/Region	Confirmed_cases_per_capita
3	Andorra	0.105285
103	Luxembourg	0.069774
118	Montenegro	0.064744
12	Bahrain	0.062598
139	Qatar	0.060169
147	San Marino	0.059432
46	Czechia	0.053927
16	Belgium	0.052465
177	US	0.048527
7	Armenia	0.048263

8. In this part we would like to test the hypothesis that the spread of the virus is slowed down by warm weather. Plot a graph of the monthly number of confirmed cases vs. the average monthly temperature for a few selected countries, and analyze the correlation between these two factors. You may use the file climate.json which contains monthly climate date from over 100 stations around the world, or you can use your own data sources.

Let's observed the Trend for top 10 Countries with most Confirmed Cases

```
df_2_1 # DataFrame which holds the countries with Most COnfirmed Cases Top 20
# pd.merge(left= df_2_1, right = climate_data , how='left', left_on='Country/Region', right_on = "country")
```

	Date	Country/Region	Confirmed	Deaths	Recovered	Case_Fatality_Ratio
62061	2020-12-11	US	15842789	295450	6135314.0	1.864886
61963	2020-12-11	India	9826775	142628	9324328.0	1.451422
61907	2020-12-11	Brazil	6836227	180437	6078287.0	2.639424
62025	2020-12-11	Russia	2574319	45370	2041006.0	1.762408
61946	2020-12-11	France	2405210	57671	181581.0	2.397753
62065	2020-12-11	United Kingdom	1814395	63603	3799.0	3.505466
61969	2020-12-11	Italy	1805873	63387	1052163.0	3.510047
62060	2020-12-11	Turkey	1780673	15977	458109.0	0.897245
62045	2020-12-11	Spain	1730575	47624	150376.0	2.751918
61890	2020-12-11	Argentina	1489328	40606	1324792.0	2.726465
61921	2020-12-11	Colombia	1408909	38669	1304299.0	2.744606
61950	2020-12-11	Germany	1314309	21567	966238.0	1.640938

```
climate_data = pd.read_json('/content/climate.json')
climate_data
```

	id	city	country	monthlyAvg
0	1	Amsterdam	Netherlands	[{'high': 7, 'low': 3, 'dryDays': 19, 'snowDay...
1	2	Athens	Greece	[{'high': 12, 'low': 7, 'dryDays': 21, 'snowDa...
2	3	Atlanta GA	United States	[{'high': 12, 'low': 2, 'dryDays': 18, 'snowDa...
3	4	Auckland	New Zealand	[{'high': 23, 'low': 16, 'dryDays': 24, 'snowD...
4	5	Austin TX	United States	[{'high': 18, 'low': 6, 'dryDays': 15, 'snowDa...
...	...	...	...	...
100	101	Albuquerque NM	United States	[{'high': 10, 'low': -4, 'dryDays': 24, 'snowD...
101	102	Vermont IL	United States	[{'high': 3, 'low': -8, 'dryDays': 18, 'snowDa...
102	103	Nashville TE	United States	[{'high': 9, 'low': -1, 'dryDays': 18, 'snowDa...
103	104	St. Louis MO	United States	[{'high': 7, 'low': -4, 'dryDays': 16, 'snowDa...
104	105	Minneapolis MN	United States	[{'high': -3, 'low': -13, 'dryDays': 20, 'snow...

```
li = climate_data['monthlyAvg'].values.tolist()
```

```
import simplejson as json
from pandas.io.json import json_normalize
with open('/content/climate.json','r') as f:
    data = json.loads(f.read())

temp_data =json_normalize(data, record_path =['monthlyAvg'], meta =['id','city','country'])
temp_data.replace("United States","US")
temp_data[['high','country','city']]
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:6: FutureWarning: pandas.io.json.json_normalize is deprecated, use pandas.json_normalize ir
```

	high	country	city
0	7	Netherlands	Amsterdam
1	6	Netherlands	Amsterdam
2	10	Netherlands	Amsterdam
3	11	Netherlands	Amsterdam
4	16	Netherlands	Amsterdam
...	...	...	...
1255	28	United States	Minneapolis MN
1256	24	United States	Minneapolis MN
1257	16	United States	Minneapolis MN
1258	6	United States	Minneapolis MN
1259	-1	United States	Minneapolis MN

Finding the Confirmed Cases for US by Month

```
df_US = df_1[df_1["Country/Region"]=="US"][["Date","Country/Region","Confirmed"]]

x = df_US.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_US["New_Confirmed_per_day"] = new_li

df_US.Date = pd.to_datetime(df_US.Date)
US_Data = df_US.groupby(pd.Grouper(key='Date', freq='1M')).agg({"New_Confirmed_per_day":'sum'}) # groupby each 1 month
US_Data["Country"] = "US"

us_data = US_Data.reset_index()
us_data["Month"] = pd.to_datetime(us_data['Date']).dt.to_period('M')
us_data
```

	Date	New_Confirmed_per_day	Country	Month
0	2020-01-31	8	US	2020-01
1	2020-02-29	17	US	2020-02
2	2020-03-31	192152	US	2020-03
3	2020-04-30	884047	US	2020-04
4	2020-05-31	718241	US	2020-05
5	2020-06-30	834359	US	2020-06
6	2020-07-31	1922730	US	2020-07
7	2020-08-31	1464676	US	2020-08
8	2020-09-30	1201822	US	2020-09
9	2020-10-31	1915046	US	2020-10
10	2020-11-30	4408087	US	2020-11

```
## Filtering temperature data for 12 Months For New York City In United States

temp_data_1 = temp_data[temp_data['city'] == "New York City NY"]
# new_temp_data = temp_data.reset_index()
new_data = temp_data_1.replace("United States","US")
final_temp_data = new_data.reset_index()
final_temp_data["Month"] = us_data.Month
final_temp_data["Confirmed_Cases"] = us_data["New_Confirmed_per_day"]
final_temp_data
```

	index	high	low	dryDays	snowDays	rainfall	id	city	country	Month	Confirmed_Cases
0	672	6	-3	16	8.0	85.4	57	New York City NY	US	2020-01	8
1	673	7	-3	15	6.0	57.0	57	New York City NY	US	2020-02	17
2	674	10	0	16	5.0	98.6	57	New York City NY	US	2020-03	192152
3	675	16	6	13	1.0	95.9	57	New York City NY	US	2020-04	884047
4	676	21	11	14	0.0	102.7	57	New York City NY	US	2020-05	718241
5	677	27	17	15	0.0	98.1	57	New York City NY	US	2020-06	834359
6	678	29	20	17	0.0	101.4	57	New York City NY	US	2020-07	1922730
7	679	29	19	18	0.0	113.6	57	New York City NY	US	2020-08	1464676
8	680	25	16	18	0.0	108.2	57	New York City NY	US	2020-09	1201822
9	681	19	10	19	0.0	96.9	57	New York City NY	US	2020-10	1915046
10	682	13	4	16	1.0	85.4	57	New York City NY	US	2020-11	4408087

Finding the Confirmed Cases for India by Month

```
df_ind = df_1[df_1["Country/Region"]=="US"][["Date","Country/Region","Confirmed"]]
x = df_ind.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_ind["New_Confirmed_per_day"] = new_li

df_ind.Date = pd.to_datetime(df_ind.Date)
```

```
df_ind.Date = pd.to_datetime(df_ind.Date)
Ind_Data = df_ind.groupby(pd.Grouper(key='Date', freq='1M')).agg({"New_Confirmed_per_day":'sum'}) # groupby each 1 month
Ind_Data["Country"] = "India"

Ind_data = Ind_Data.reset_index()
Ind_data["Month"] = pd.to_datetime(Ind_data['Date']).dt.to_period('M')
Ind_data
```

	Date	New_Confirmed_per_day	Country	Month
0	2020-01-31	8	India	2020-01
1	2020-02-29	17	India	2020-02
2	2020-03-31	192152	India	2020-03
3	2020-04-30	884047	India	2020-04
4	2020-05-31	718241	India	2020-05
5	2020-06-30	834359	India	2020-06
6	2020-07-31	1922730	India	2020-07
7	2020-08-31	1464676	India	2020-08
8	2020-09-30	1201822	India	2020-09
9	2020-10-31	1915046	India	2020-10
10	2020-11-30	4408087	India	2020-11

```
temp_data_ind = temp_data[temp_data['city'] == "Mumbai"]
final_temp_Ind = temp_data_ind.reset_index()
final_temp_Ind["Month"] = Ind_data.Month
final_temp_Ind["Confirmed_Cases"] = Ind_data["New_Confirmed_per_day"]
final_temp_Ind
```

	index	high	low	dryDays	snowDays	rainfall	id	city	country	Month	Confirmed_Cases
0	636	31	17	29	0.0	1.3	54	Mumbai	India	2020-01	8
1	637	32	18	28	0.0	0.4	54	Mumbai	India	2020-02	17
2	638	33	21	31	0.0	6.2	54	Mumbai	India	2020-03	192152
3	639	33	24	30	0.0	7.0	54	Mumbai	India	2020-04	884047
4	640	34	27	27	0.0	26.6	54	Mumbai	India	2020-05	718241
5	641	32	26	8	0.0	494.6	54	Mumbai	India	2020-06	834359
6	642	31	26	2	0.0	735.8	54	Mumbai	India	2020-07	1922730
7	643	30	25	2	0.0	530.7	54	Mumbai	India	2020-08	1464676
8	644	31	25	8	0.0	348.0	54	Mumbai	India	2020-09	1201822
9	645	34	24	24	0.0	90.5	54	Mumbai	India	2020-10	1915046
10	646	34	21	29	0.0	5.0	54	Mumbai	India	2020-11	4408087

Finding the Confirmed Cases for Russia by Month

```
df_rus = df_1[df_1["Country/Region"]=="Russia"][["Date","Country/Region","Confirmed"]]
x = df_rus.reset_index()
new_li = [1]

li = x["Confirmed"]
for i in range(1,x.shape[0]):
    temp = abs(li[i] - li[i-1])
    new_li.append(temp)
df_rus["New_Confirmed_per_day"] = new_li

df_rus.Date = pd.to_datetime(df_rus.Date)
Rus_Data = df_rus.groupby(pd.Grouper(key='Date', freq='1M')).agg({"New_Confirmed_per_day":'sum'}) # groupby each 1 month
Rus_Data["Country"] = "Russia"

Rus_data = Rus_Data.reset_index()
Rus_data["Month"] = pd.to_datetime(Rus_data['Date']).dt.to_period('M')
Rus_data
```

	Date	New_Confirmed_per_day	Country	Month
0	2020-01-31	3	Russia	2020-01
1	2020-02-29	0	Russia	2020-02
2	2020-03-31	2335	Russia	2020-03
3	2020-04-30	104161	Russia	2020-04
4	2020-05-31	299345	Russia	2020-05
5	2020-06-30	241086	Russia	2020-06
6	2020-07-31	191532	Russia	2020-07

```
temp_data_rus = temp_data[temp_data['city'] == "Moscow"]
final_temp_rus = temp_data_rus.reset_index()
final_temp_rus["Month"] = Rus_data.Month
final_temp_rus["Confirmed_Cases"] = Rus_data["New_Confirmed_per_day"]
final_temp_rus
```

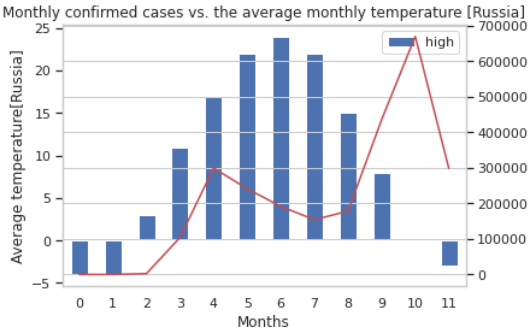
	index	high	low	dryDays	snowDays	rainfall	id	city	country	Month	Confirmed_Cases
0	624	-4	-9	10	23.0	44.7	53	Moscow	Russia	2020-01	3
1	625	-4	-11	12	20.0	45.1	53	Moscow	Russia	2020-02	0
2	626	3	-6	16	14.0	32.5	53	Moscow	Russia	2020-03	2335
3	627	11	1	18	4.0	31.4	53	Moscow	Russia	2020-04	104161
4	628	17	6	15	1.0	57.9	53	Moscow	Russia	2020-05	299345
5	629	22	11	15	0.0	73.4	53	Moscow	Russia	2020-06	241086
6	630	24	13	17	0.0	78.8	53	Moscow	Russia	2020-07	191532
7	631	22	11	16	0.0	75.0	53	Moscow	Russia	2020-08	153941
8	632	15	6	15	0.0	62.3	53	Moscow	Russia	2020-09	178397
9	633	8	2	14	4.0	77.2	53	Moscow	Russia	2020-10	435468
10	634	0	-5	12	15.0	45.3	53	Moscow	Russia	2020-11	669669

Explantation Problem 8 -- Graph which represets Total Monthly Confirmed zCases vs Average Monthly Temperature month wise. The line here represents the "Confirmed Cases" , the Y-axis Represents the Average Temperature and X-axis represents the Month. Here, we observe that as the avg temperature increases we see a downward slope in the line whereas as the temp decreases the slop of line is positive. WHich clearly indicates that there is a negative Coorelation between the Total Number of Confirmed Cases and Monthly Average Temperature

```
g_3 = final_temp_rus[["high","Confirmed_Cases","Month"]]
g_3[['Month','high']].plot(kind='bar',xlabel = "Months" ,ylabel = "Average temperature[Russia]")

g_3['Confirmed_Cases'].plot(secondary_y=True, color = "r")
plt.title("Monthly confirmed cases vs. the average monthly temperature [Russia]")
```

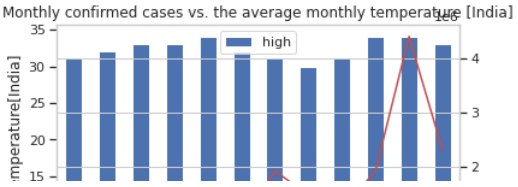
```
Text(0.5, 1.0, 'Monthly confirmed cases vs. the average monthly temperature [Russia]')
```




```
g_2 = final_temp_Ind[["high","Confirmed_Cases","Month"]]
g_2[['Month','high']].plot(kind='bar',xlabel = "Months" ,ylabel = "Average temperature[India]")

g_2['Confirmed_Cases'].plot(secondary_y=True, color = "r")
plt.title("Monthly confirmed cases vs. the average monthly temperature [India]")
```

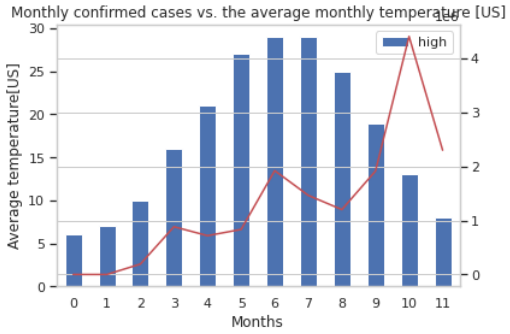
```
Text(0.5, 1.0, 'Monthly confirmed cases vs. the average monthly temperature [India]')
```




```
g = final_temp_data[["high","Confirmed_Cases","Month"]]
g[['Month','high']].plot(kind='bar',xlabel = "Months" ,ylabel = "Average temperature[US]")

g['Confirmed_Cases'].plot(secondary_y=True, color = "r")
plt.title("Monthly confirmed cases vs. the average monthly temperature [US]")
```

```
Text(0.5, 1.0, 'Monthly confirmed cases vs. the average monthly temperature [US]')
```



Thus looking at all these graphs we can say that the Hypothesis stands True i.e the spread of coronavirus slows down as the temperature increases.

9. Articulate your own research question related to COVID-19 and try to provide an answer to it using the given data set.

What are the 10 countries with the highest number of Deaths COVID-19 cases per capita?

```
world_data = world_data.replace("U.S.","US")
world_data = world_data.replace("Czech Republic","Czechia")

df_9 =  world_data[["country","population"]]
df_9_merged = pd.merge(left=new_df, right = df_9, how='left', left_on='Country/Region', right_on = "country")
df_9_merged["Death_cases_per_capita"] = df_9_merged["Deaths"]/df_9_merged["population"]
df_9_merged
```

	Date	Country/Region	Confirmed	Deaths	Recovered	country	population	Death_cases_per_capita
0	2020-12-11	Afghanistan	48116	1945	38141.0	Afghanistan	34169169.0	0.000057
1	2020-12-11	Albania	46863	977	24136.0	Albania	2911428.0	0.000336
2	2020-12-11	Algeria	91121	2575	59590.0	Algeria	41063753.0	0.000063
3	2020-12-11	Andorra	7236	78	6598.0	Andorra	68728.0	0.001135
4	2020-12-11	Angola	16061	365	8798.0	Angola	26655513.0	0.000014
...	...	...	...	...	...	...	...	...
186	2020-12-11	Vietnam	1391	35	1238.0	NaN	NaN	NaN
187	2020-12-11	West Bank and Gaza	106622	931	81166.0	NaN	NaN	NaN
188	2020-12-11	Yemen	2082	606	1383.0	Yemen	28119546.0	0.000022
189	2020-12-11	Zambia	18161	365	17329.0	Zambia	17237931.0	0.000021
190	2020-12-11	Zimbabwe	11162	306	9324.0	Zimbabwe	16337760.0	0.000019

```
countries = pd.DataFrame(df_9_merged.sort_values("Death_cases_per_capita", ascending=False)[:20])
final_df_9 = countries[["Country/Region", "Death_cases_per_capita"]].reset_index()
final_df_9[["Country/Region","Death_cases_per_capita"]]
```

	Country/Region	Death_cases_per_capita
0	San Marino	0.001557
1	Belgium	0.001546
2	Andorra	0.001135
3	Peru	0.001135
4	Italy	0.001060
5	Spain	0.001034
6	Slovenia	0.000965
7	Argentina	0.000917
8	Montenegro	0.000909
9	US	0.000905
10	France	0.000888
11	Czechia	0.000885
12	Mexico	0.000868
13	Chile	0.000862
14	Bosnia and Herzegovina	0.000857
15	Brazil	0.000854

```
import seaborn as sns
import matplotlib.pyplot as plt

fig, ax = plt.subplots(figsize = (16,6))
sns.set_theme(style="whitegrid")

ax = sns.barplot(x="Death_cases_per_capita", y="Country/Region", data = final_df_9)

ax.set_title("Highest NUmber of Covid Cases-19 cases per capita")
```

```
Text(0.5, 1.0, 'Highest NUmber of Covid Cases-19 cases per capita')
```