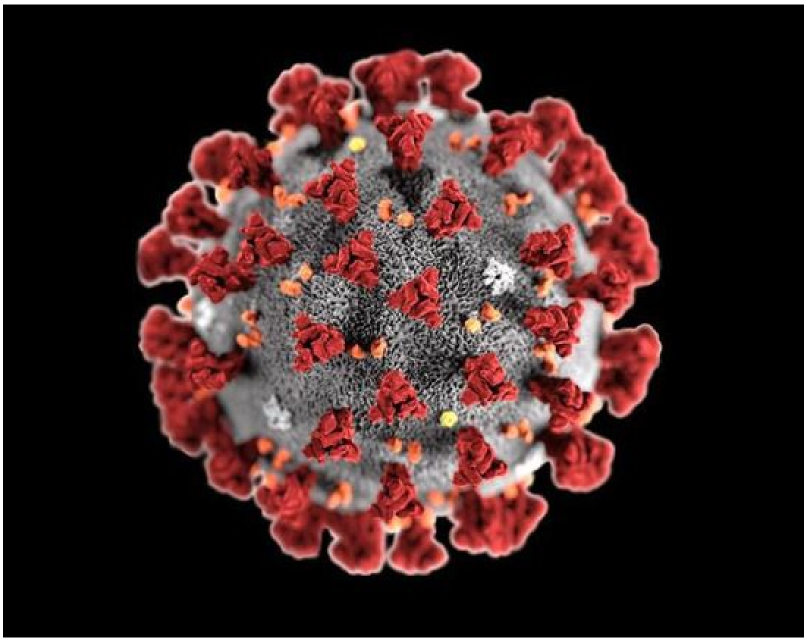


- In December 2019, COVID-19 coronavirus was first identified in the Wuhan region of China. By March 11, 2020, the World Health Organization (WHO) categorized the COVID-19 outbreak as a pandemic. A lot has happened in the months in between with major outbreaks in Iran, South Korea, and Italy. We know that COVID-19 spreads through respiratory droplets, such as through coughing, sneezing, or speaking.

Problem Statement

- predicting the cumulative number of confirmed cases and fatalities in various locations across the world.

Dataset basic Information

- Size of dataset:

```
- Rows : 25353

- Columns : 6
```

- Feature Description:

```
-  Id --->

-  Province_State --->

-  Country_Region --->

-  Date --->

-  ConfirmedCases --->

-  Fatalities --->
```

Importing Libraries

In [1]:

```
# Read Data
import numpy as np
import pandas as pd

# Visualization
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline

# style
plt.style.use("fivethirtyeight")
sns.set_style("darkgrid")
```

Read Data

In [2]:

```
# Import first 5 rows
train = pd.read_csv("train.csv", sep=",")
train.head()
```

Out[2]:

	Id	Province_State	Country_Region	Date	ConfirmedCases	Fatalities
0	1	NaN	Afghanistan	22-01-2020	0	0
1	2	NaN	Afghanistan	23-01-2020	0	0
2	3	NaN	Afghanistan	24-01-2020	0	0
3	4	NaN	Afghanistan	25-01-2020	0	0
4	5	NaN	Afghanistan	26-01-2020	0	0

In [3]:

```
train.shape   # Rows x Columns
```

Out[3]:

```
(25353, 6)
```

In [4]:

```
train.info()  # Shows Data types, Null Values for each variable
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 25353 entries, 0 to 25352
Data columns (total 6 columns):
 #   Column          Non-Null Count  Dtype 
---  ------          --------------  ----- 
 0   Id              25353 non-null  int64 
 1   Province_State  10773 non-null  object
 2   Country_Region  25353 non-null  object
 3   Date            25353 non-null  object
 4   ConfirmedCases  25353 non-null  int64 
 5   Fatalities      25353 non-null  int64 
dtypes: int64(3), object(3)
memory usage: 1.2+ MB
```

In [5]:

```
train.dtypes  # Gives data types of each variable
```

Out[5]:

```
Id                 int64
Province_State    object
Country_Region    object
Date              object
ConfirmedCases     int64
Fatalities         int64
dtype: object
```

In [6]:

```
train.count()  # Gives number of data points in each variable
```

Out[6]:

```
Id                25353
Province_State    10773
Country_Region    25353
Date              25353
ConfirmedCases    25353
Fatalities        25353
dtype: int64
```

In [7]:

```
train[["ConfirmedCases","Fatalities"]] = train[["ConfirmedCases","Fatalities"]].astype(int)
```

In [12]:

```
# convert format DD-MM-YYYY to YYYY-MM-DD
import datetime
train['Date'] = pd.to_datetime(train['Date'])
train['Date']
```

Out[12]:

```
0       2020-01-22
1       2020-01-23
2       2020-01-24
3       2020-01-25
4       2020-01-26
           ...
25348   2020-07-04
25349   2020-08-04
25350   2020-09-04
25351   2020-10-04
25352   2020-11-04
Name: Date, Length: 25353, dtype: datetime64[ns]
```

In [11]:

```
# Shows Starting date and Ending date
print(train['Date'].min())
print(train['Date'].max())
```

```
2020-01-02 00:00:00
2020-12-03 00:00:00
```

Summary and count for Numerical & categorical attribute

In [10]:

```
# Summary and count for Numerical attribute
df1 = train[['ConfirmedCases', 'Fatalities']]
df1.describe()
```

Out[10]:

	ConfirmedCases	Fatalities
count	25353.000000	25353.000000
mean	1003.824518	50.392853
std	7542.589521	592.843013
min	0.000000	0.000000
25%	0.000000	0.000000
50%	1.000000	0.000000
75%	93.000000	1.000000
max	181026.000000	19468.000000

In [11]:

```
# Summary and count for categorical attribute
df2 = train[['Province_State', 'Country_Region']]
df2.describe(include=["O"])
```

Out[11]:

	Province_State	Country_Region
count	10773	25353
unique	133	184
top	Tibet	US
freq	81	4374

In [12]:

```
df_Num = train[['ConfirmedCases', 'Fatalities']]
```

EDA (Exploratory Data Analysis)

Country_Region

In [13]:

```
train['Country_Region'].nunique()  # Number of uniques values in variable "Country_Region"
```

Out[13]:

```
184
```

In [14]:

```
train['Country_Region'].unique()  # List of uniques categories in variable "Country_Region'
```

Out[14]:

```
array(['Afghanistan', 'Albania', 'Algeria', 'Andorra', 'Angola',
       'Antigua and Barbuda', 'Argentina', 'Armenia', 'Australia',
       'Austria', 'Azerbaijan', 'Bahamas', 'Bahrain', 'Bangladesh',
       'Barbados', 'Belarus', 'Belgium', 'Belize', 'Benin', 'Bhutan',
       'Bolivia', 'Bosnia and Herzegovina', 'Botswana', 'Brazil',
       'Brunei', 'Bulgaria', 'Burkina Faso', 'Burma', 'Burundi',
       'Cabo Verde', 'Cambodia', 'Cameroon', 'Canada',
       'Central African Republic', 'Chad', 'Chile', 'China', 'Colombia',
       'Congo (Brazzaville)', 'Congo (Kinshasa)', 'Costa Rica',
       "Cote d'Ivoire", 'Croatia', 'Cuba', 'Cyprus', 'Czechia', 'Denmark',
       'Diamond Princess', 'Djibouti', 'Dominica', 'Dominican Republic',
       'Ecuador', 'Egypt', 'El Salvador', 'Equatorial Guinea', 'Eritrea',
       'Estonia', 'Eswatini', 'Ethiopia', 'Fiji', 'Finland', 'France',
       'Gabon', 'Gambia', 'Georgia', 'Germany', 'Ghana', 'Greece',
       'Grenada', 'Guatemala', 'Guinea', 'Guinea-Bissau', 'Guyana',
       'Haiti', 'Holy See', 'Honduras', 'Hungary', 'Iceland', 'India',
       'Indonesia', 'Iran', 'Iraq', 'Ireland', 'Israel', 'Italy',
       'Jamaica', 'Japan', 'Jordan', 'Kazakhstan', 'Kenya',
       'Korea, South', 'Kosovo', 'Kuwait', 'Kyrgyzstan', 'Laos', 'Latvia',
       'Lebanon', 'Liberia', 'Libya', 'Liechtenstein', 'Lithuania',
       'Luxembourg', 'MS Zaandam', 'Madagascar', 'Malawi', 'Malaysia',
       'Maldives', 'Mali', 'Malta', 'Mauritania', 'Mauritius', 'Mexico',
       'Moldova', 'Monaco', 'Mongolia', 'Montenegro', 'Morocco',
       'Mozambique', 'Namibia', 'Nepal', 'Netherlands', 'New Zealand',
       'Nicaragua', 'Niger', 'Nigeria', 'North Macedonia', 'Norway',
       'Oman', 'Pakistan', 'Panama', 'Papua New Guinea', 'Paraguay',
       'Peru', 'Philippines', 'Poland', 'Portugal', 'Qatar', 'Romania',
       'Russia', 'Rwanda', 'Saint Kitts and Nevis', 'Saint Lucia',
       'Saint Vincent and the Grenadines', 'San Marino',
       'Sao Tome and Principe', 'Saudi Arabia', 'Senegal', 'Serbia',
       'Seychelles', 'Sierra Leone', 'Singapore', 'Slovakia', 'Slovenia',
       'Somalia', 'South Africa', 'South Sudan', 'Spain', 'Sri Lanka',
       'Sudan', 'Suriname', 'Sweden', 'Switzerland', 'Syria', 'Taiwan*',
       'Tanzania', 'Thailand', 'Timor-Leste', 'Togo',
       'Trinidad and Tobago', 'Tunisia', 'Turkey', 'US', 'Uganda',
       'Ukraine', 'United Arab Emirates', 'United Kingdom', 'Uruguay',
       'Uzbekistan', 'Venezuela', 'Vietnam', 'West Bank and Gaza',
       'Western Sahara', 'Zambia', 'Zimbabwe'], dtype=object)
```

In [15]:

```
train['Country_Region'].value_counts()  # Number of data points in variable "Country_Regior
```

Out[15]:

```
US                  4374
China               2673
Canada               972
United Kingdom       891
France               891
                    ... 
Ethiopia              81
Taiwan*               81
Benin                 81
Morocco               81
Dominica              81
Name: Country_Region, Length: 184, dtype: int64
```

ConfirmedCases

In [16]:

```
train['ConfirmedCases'].nunique()  # Number of uniques values in variable "ConfirmedCases"
```

Out[16]:

```
2494
```

In [17]:

```
train['ConfirmedCases'].unique()  # List of uniques categories in variable "Country_Region'
```

Out[17]:

```
array([    0,     1,     4, ..., 73758, 78991,   406])
```

In [18]:

```
train['ConfirmedCases'].value_counts()  # Number of data points in variable "Country_Regior
```

Out[18]:

```
0       12475
1        1015
2         445
3         435
4         282
        ...  
1784        1
3849        1
7979        1
3897        1
2031        1
Name: ConfirmedCases, Length: 2494, dtype: int64
```

Fatalities

In [19]:

```
# In Fatalities, listed no of unique categories
train['Fatalities'].nunique()
```

Out[19]:

```
629
```

In [20]:

```
train['Fatalities'].value_counts()  # Number of data points in variable "Country_Region"
```

Out[20]:

```
0       18566
1        1586
2         810
3         570
6         423
        ...
617         1
649         1
2808        1
793         1
3174        1
Name: Fatalities, Length: 629, dtype: int64
```

In [21]:

```
# Listed Sum of "Canada" Confirmed Cases & Fatalities
train[train['Country_Region']=='Canada'].groupby(by='Country_Region').sum()
```

Out[21]:

	Id	ConfirmedCases	Fatalities
Country_Region			
Canada	4970808	233554	4282

In [22]:

```
# Showing data of China
train.loc[train['Country_Region'] == 'China', :].head(10)
```

Out[22]:

	Id	Province_State	Country_Region	Date	ConfirmedCases	Fatalities
4374	6157	Anhui	China	2020-01-22	1	0
4375	6158	Anhui	China	2020-01-23	9	0
4376	6159	Anhui	China	2020-01-24	15	0
4377	6160	Anhui	China	2020-01-25	39	0
4378	6161	Anhui	China	2020-01-26	60	0
4379	6162	Anhui	China	2020-01-27	70	0
4380	6163	Anhui	China	2020-01-28	106	0
4381	6164	Anhui	China	2020-01-29	152	0
4382	6165	Anhui	China	2020-01-30	200	0
4383	6166	Anhui	China	2020-01-31	237	0

In [23]:

```
# Listing first 20 rows of Confirmed cases in US
Confirmed_US = train[train['Country_Region'] == 'US'].groupby(['Date']).sum().ConfirmedCase
Confirmed_US
```

Out[23]:

```
Date
2020-01-02         0
2020-01-03         0
2020-01-04    213214
2020-01-22         0
2020-01-23         0
2020-01-24         0
2020-01-25         0
2020-01-26         0
2020-01-27         0
2020-01-28         0
2020-01-29         0
2020-01-30         0
2020-01-31         0
2020-02-02         0
2020-02-03         0
2020-02-04    243441
2020-02-13         0
2020-02-14         0
2020-02-15         0
2020-02-16         0
Name: ConfirmedCases, dtype: int32
```

Missing Values

In [24]:

```
# Listing Number of missing values by feature column wise.
train.isnull().sum()
```

Out[24]:

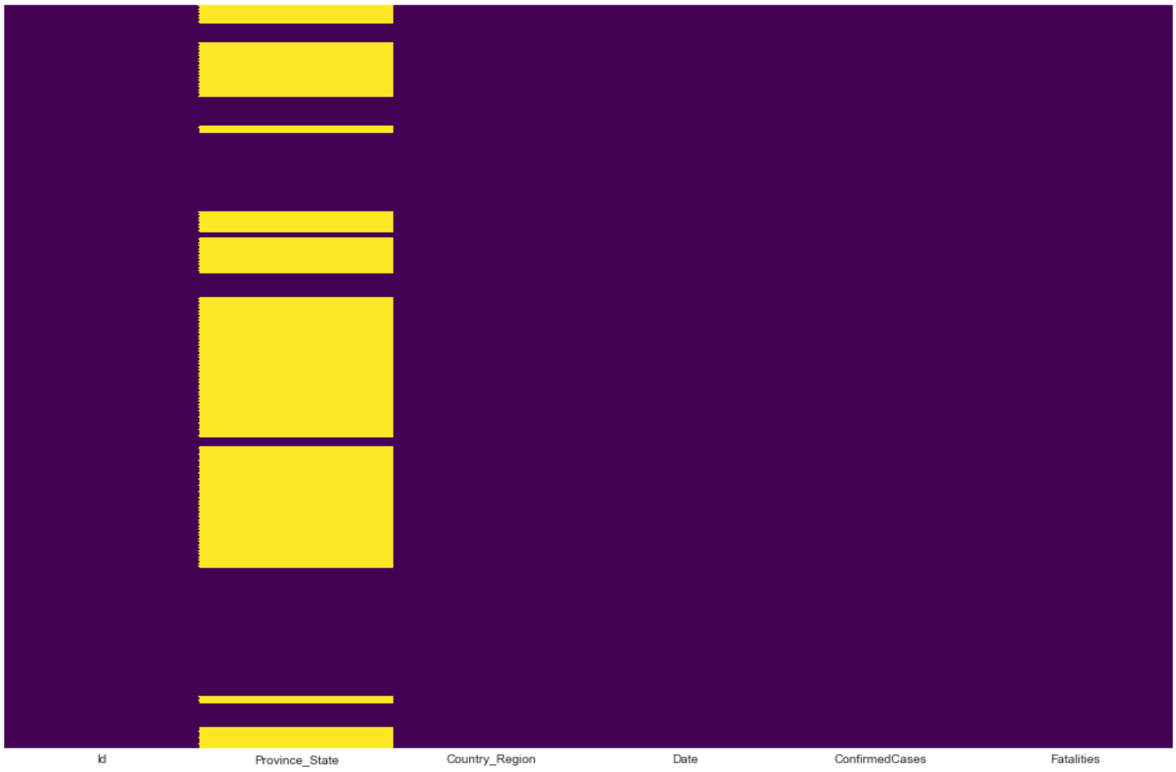
```
Id                    0
Province_State    14580
Country_Region        0
Date                  0
ConfirmedCases        0
Fatalities            0
dtype: int64
```

In [25]:

```
# Missing value representation by Heatmap
plt.figure(figsize=(15,11))
sns.heatmap(train.isnull(), yticklabels=False, cbar=False, cmap='viridis')
```

Out[25]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1df1fdd02e8>
```



- From graph understood that "Province_State" has missing values

Data Visualization

- Used below **visualisation libraries**

1. Matplotlib

2. Seaborn (statistical data visualization)

1. Univariate Analysis

- Univariate Analysis : data consists of **only one variable**.

1. Bar Charts

2. Histograms

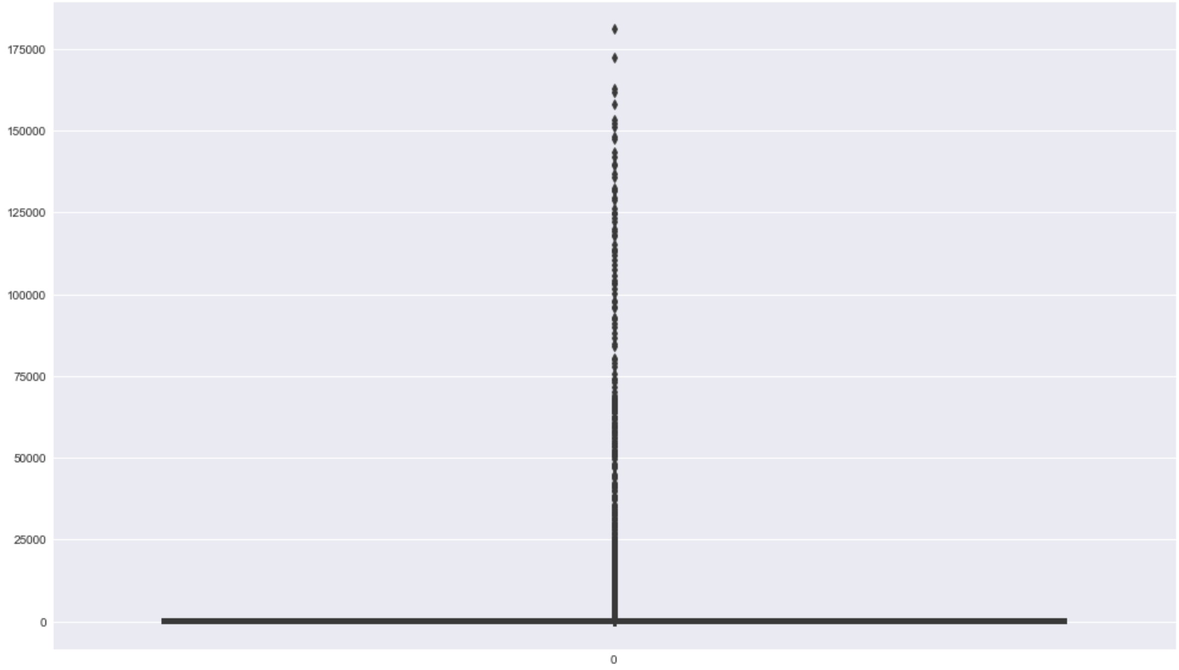
3. Pie Charts

In [26]:

```
# Box Plot used to find out the outliers in feature column of "ConfirmedCases"
plt.figure(figsize=(15,10))
sns.boxplot(data=train['ConfirmedCases'], palette='winter')
```

Out[26]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1df1fe4ed30>
```

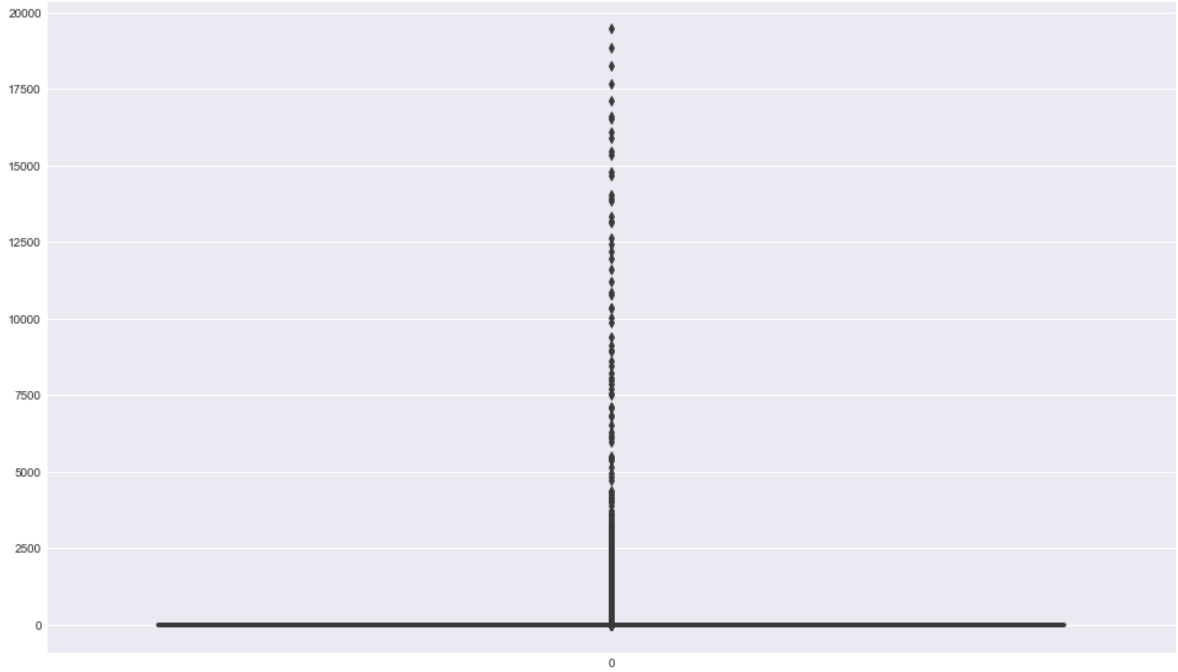


In [27]:

```
# Box Plot used to find out the outliers in feature column of "Fatalities"
plt.figure(figsize=(15,10))
sns.boxplot(data=train['Fatalities'], palette='winter')
```

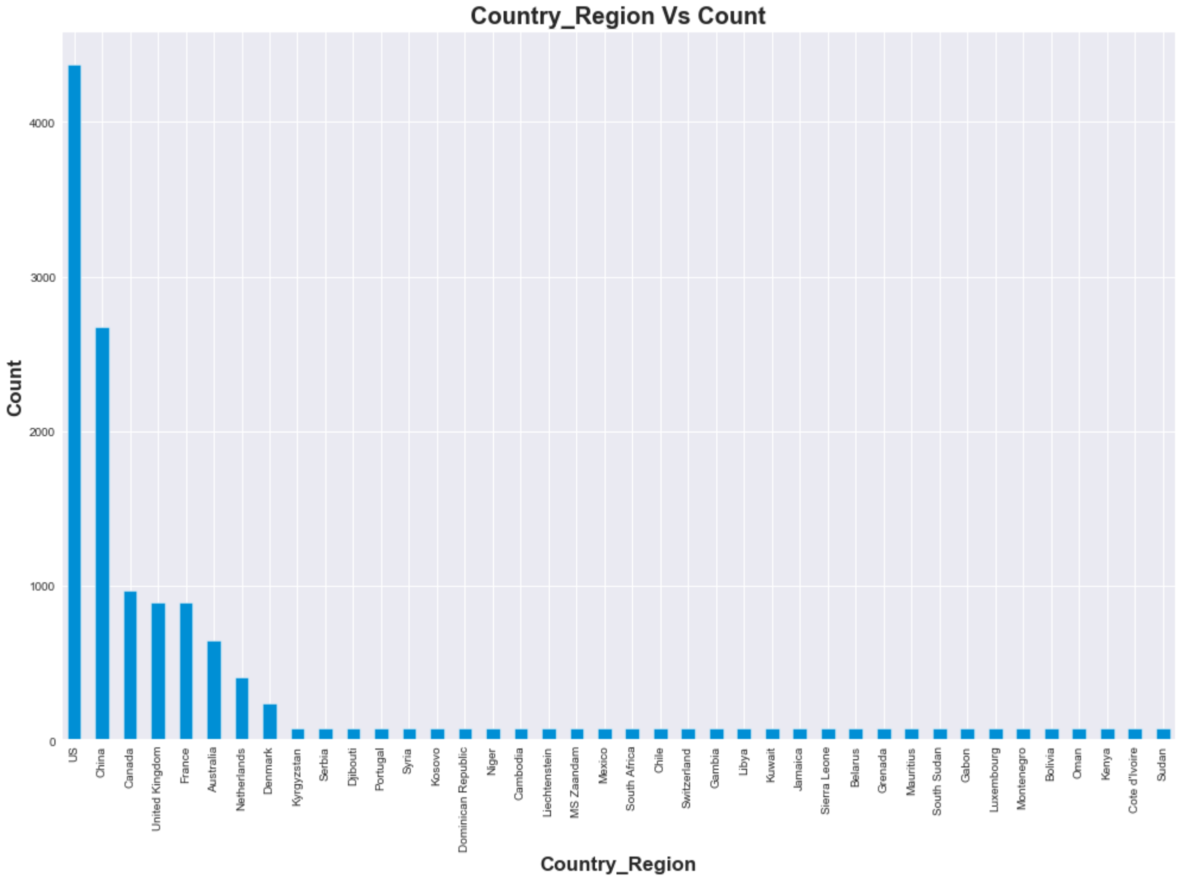
Out[27]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1df1ff4fa20>
```



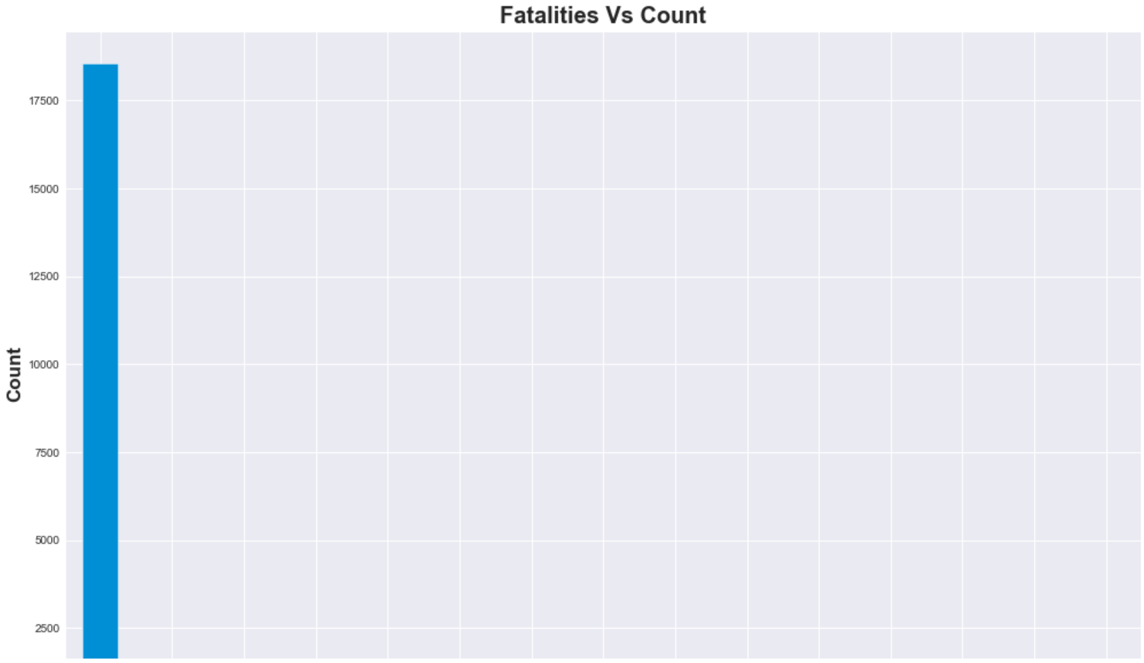
In [28]:

```
# Bar Chart for showing count of County/Region wise
plt.figure(figsize=(15,11))

train['Country_Region'].value_counts()[0:40].plot(kind='bar')

plt.xlabel('Country_Region', fontsize=17, fontweight = 'bold')
plt.ylabel('Count', fontsize=17, fontweight = 'bold')

plt.title('Country_Region Vs Count', fontsize=20, fontweight = 'bold')

plt.show()
```



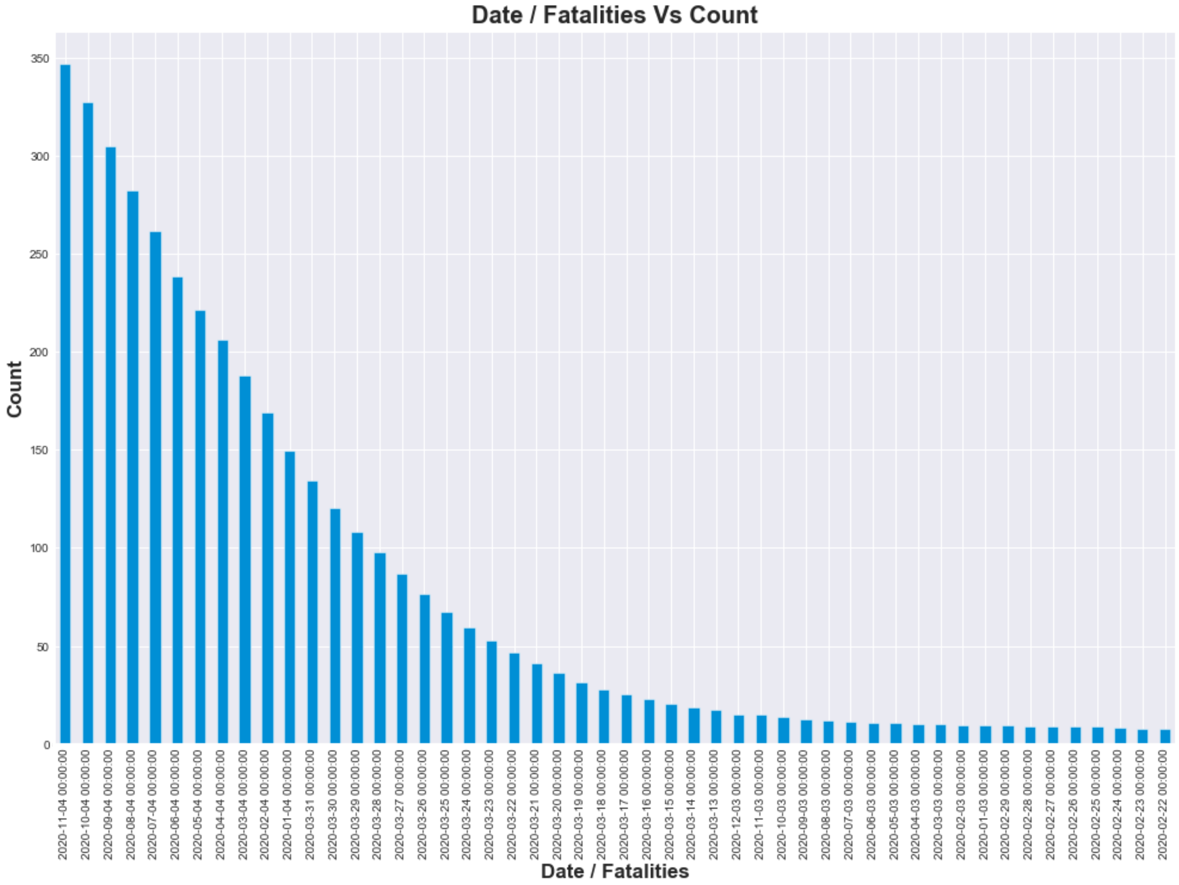
```
In [29]:
```

```
# Bar Chart for showing count of Fatalities
plt.figure(figsize=(15,11))

train['Fatalities'].value_counts()[0:15].plot(kind='bar')

plt.xlabel('Fatalities', fontsize=17, fontweight = 'bold')
plt.ylabel('Count', fontsize=17, fontweight = 'bold')

plt.title('Fatalities Vs Count', fontsize=20, fontweight = 'bold')

plt.show()
```



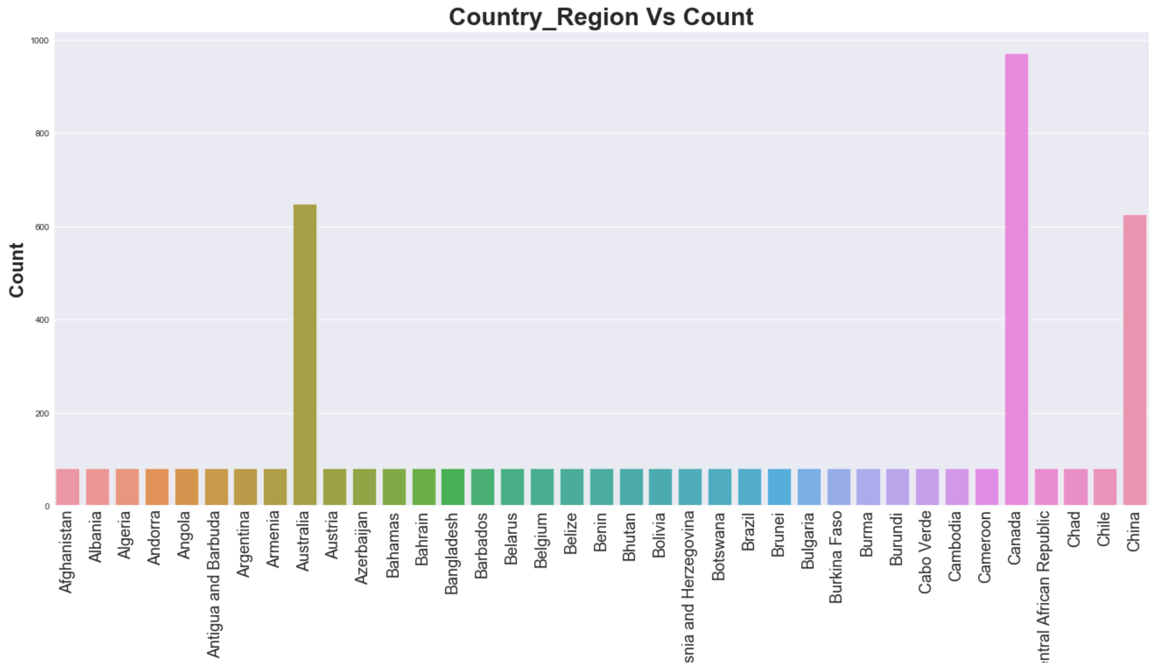
In [30]:

```
# Bar Chart for showing count of Date wise Fatalities
plt.figure(figsize=(15,11))

train.groupby('Date').mean().sort_values(by='Fatalities', ascending=False)['Fatalities'][0:

plt.xlabel('Date / Fatalities', fontsize=17, fontweight = 'bold')
plt.ylabel('Count', fontsize=17, fontweight = 'bold')

plt.title('Date / Fatalities Vs Count', fontsize=20, fontweight = 'bold')

plt.show()
```



In [31]:

```
# Count map by using Seaborn
# Showing Count for Each Country from first 5000 rows
plt.figure(figsize=(20,10))
sns.countplot(train['Country_Region'].head(5000))

plt.xlabel('Country_Region', fontsize=22, fontweight = 'bold')
plt.ylabel('Count', fontsize=22, fontweight = 'bold')

plt.title('Country_Region Vs Count', fontsize=28, fontweight = 'bold')

plt.xticks(rotation = 90, fontsize=18)

plt.show()
```



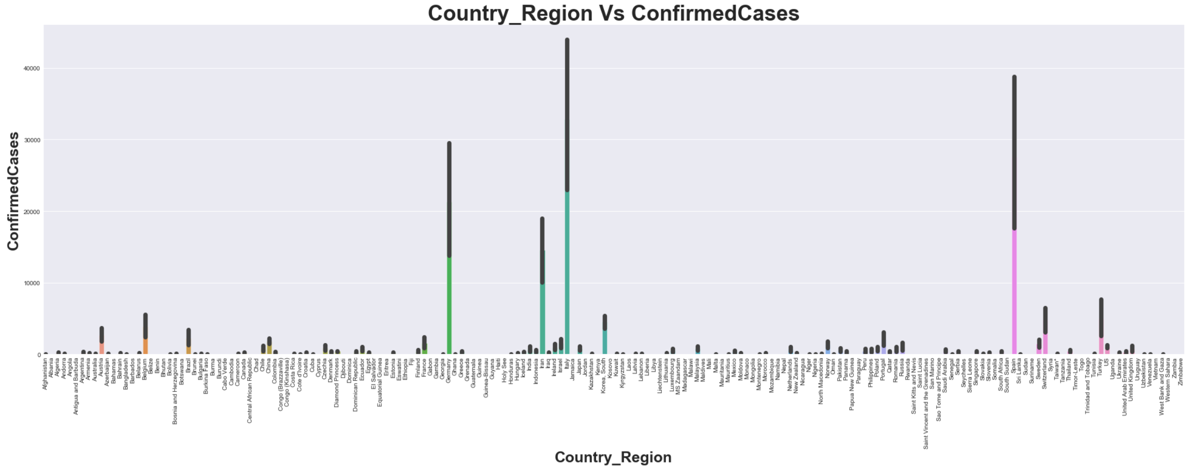
2. Bivariate Analysis

- Bivariate Analysis : data involves **two different variables**.
- There are three types of bivariate analysis

```
1. Numerical & Numerical

2. Categorical & Categorical

3. Numerical & Categorical
```

In [32]:

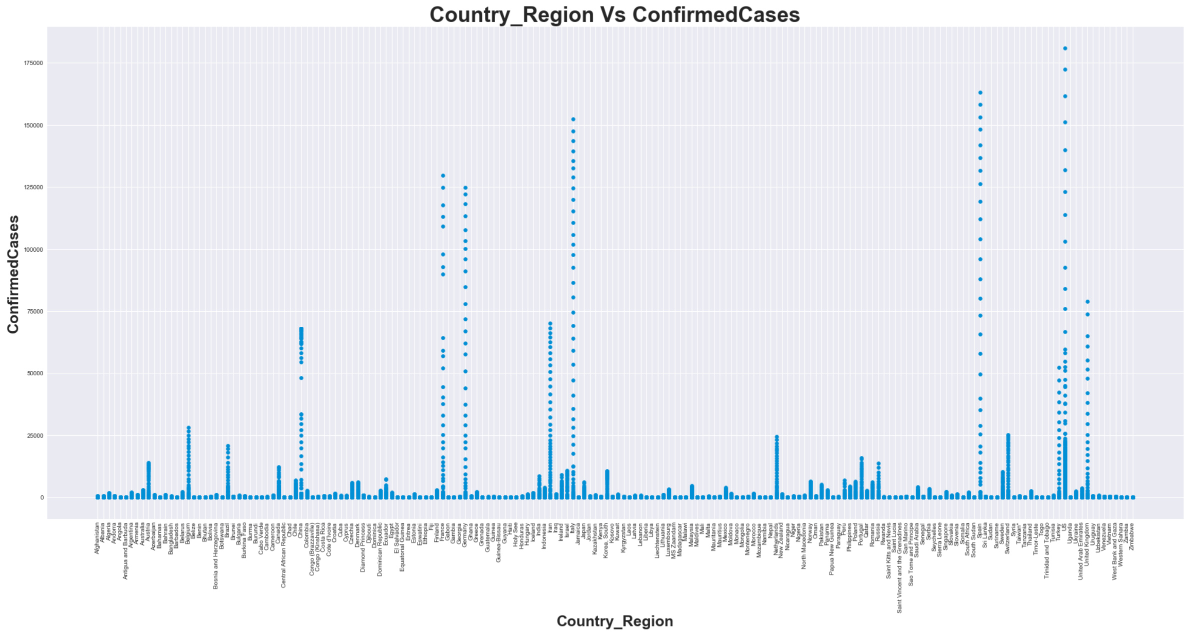
```
# Bar plot between "Country_Region" & "ConfirmedCases"
plt.figure(figsize=(30,10))
sns.barplot(x='Country_Region', y='ConfirmedCases', data=train)

plt.xlabel('Country_Region', fontsize=25, fontweight='bold')
plt.ylabel('ConfirmedCases', fontsize=25, fontweight='bold')

plt.title('Country_Region Vs ConfirmedCases', fontsize=35, fontweight='bold')

plt.xticks(rotation=90)

plt.show()
```



- graph shows number of **Confirmed Cases** by **Country** wise and can find which country have max / min cases.

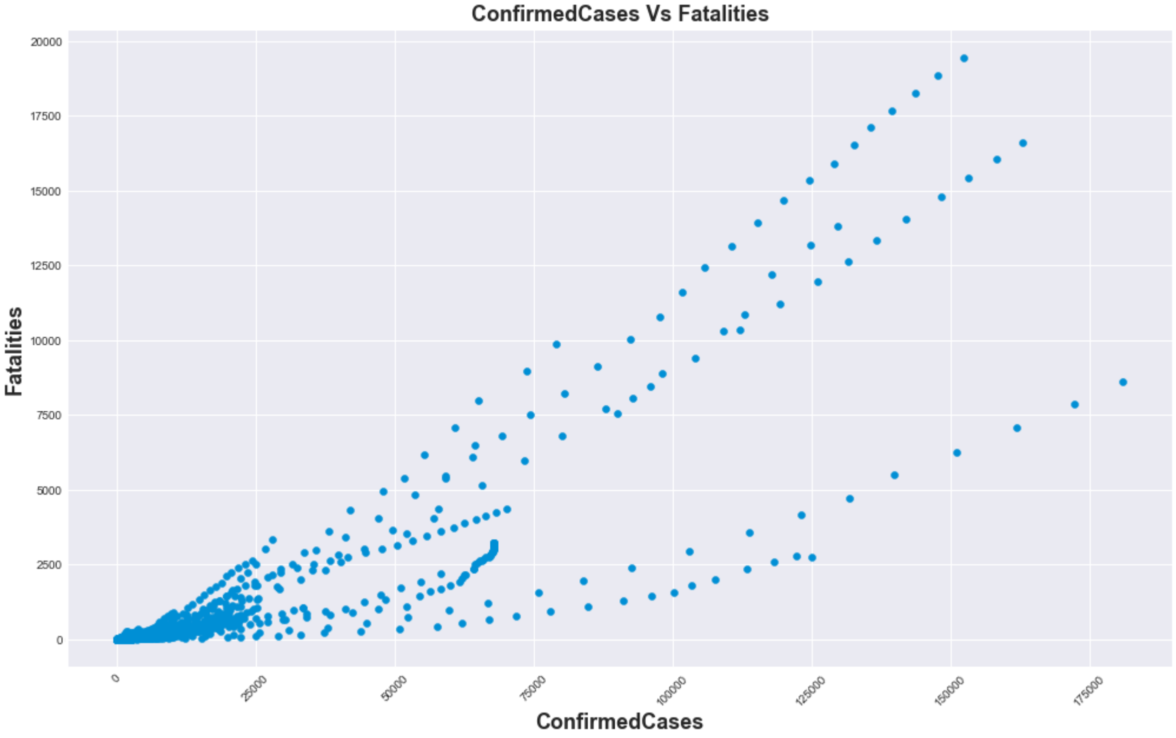
In [35]:

```
# Scatter plot between "Country_Region" & "ConfirmedCases"
plt.figure(figsize=(30,15))
plt.scatter(train['Country_Region'], train['ConfirmedCases'])

plt.xlabel('Country_Region', fontsize=25, fontweight='bold')
plt.ylabel('ConfirmedCases', fontsize=25, fontweight='bold')

plt.title('Country_Region Vs ConfirmedCases', fontsize=35, fontweight='bold')
plt.xticks(rotation = 90)

plt.show()
```



In [36]:

```
# Scatter plot between "ConfirmedCases" & "Fatalities"
plt.figure(figsize=(15,10))
plt.scatter(train['ConfirmedCases'], train['Fatalities'])

plt.xlabel('ConfirmedCases', fontsize=18, fontweight='bold')
plt.ylabel('Fatalities', fontsize=18, fontweight='bold')

plt.title('ConfirmedCases Vs Fatalities', fontsize=18, fontweight='bold')
plt.xticks(rotation = 45)

plt.show()
```



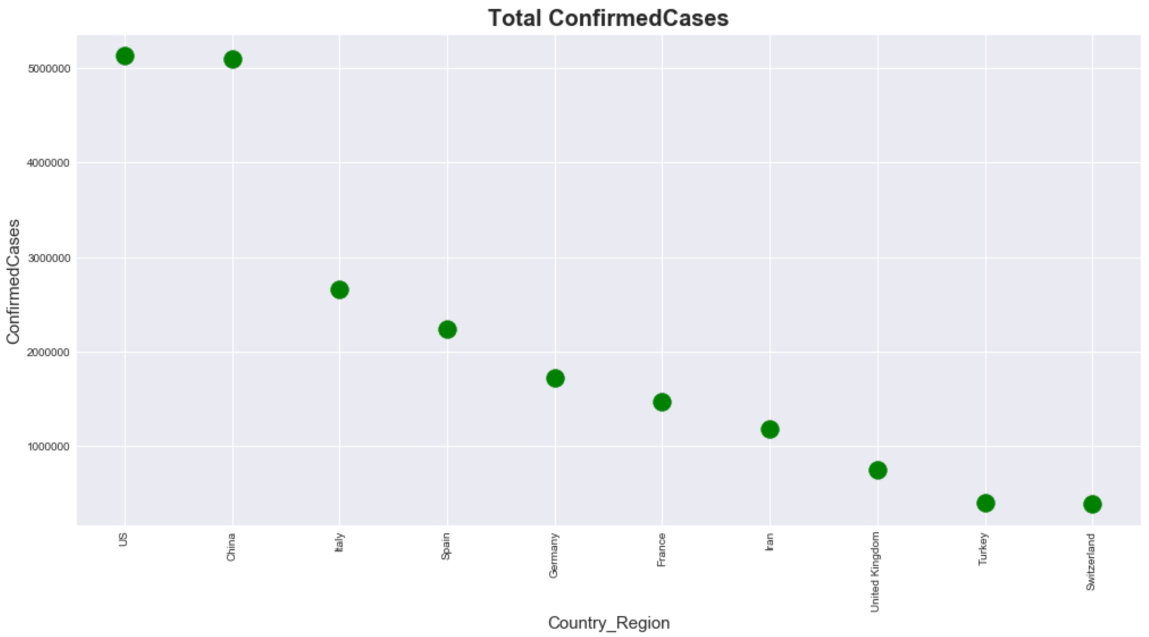
- By **Scatter Plots** can find **Outliers** and **relation between features**

In [40]:

```
df_Cases = Country[Country['ConfirmedCases'] != 0].sort_values(by='ConfirmedCases',ascendir
```

In [87]:

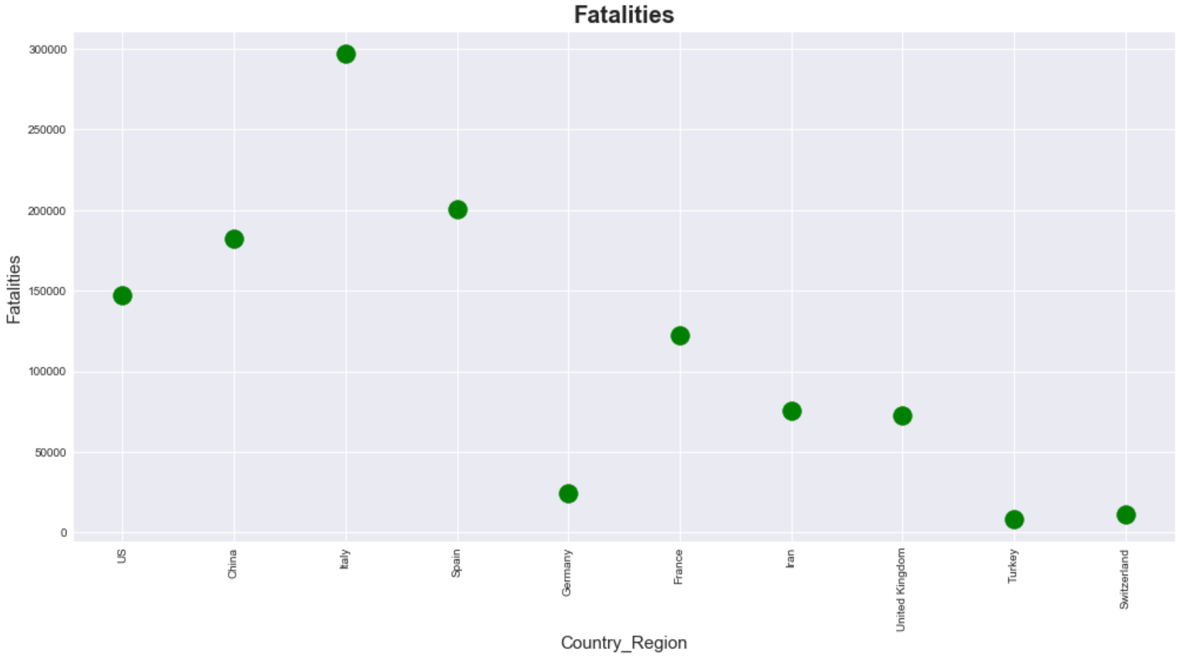
```
# Scatter Plot For Country VS ConfirmedCases
plt.figure(figsize=(15,8))
plt.scatter(df_Cases['Country_Region'], df_Cases['ConfirmedCases'], c='green', s=250)

plt.xlabel('Country_Region', fontsize = 15)
plt.ylabel('ConfirmedCases', fontsize = 15)

plt.title("Total ConfirmedCases", fontsize = 20, fontweight='bold')

plt.xticks(rotation=90)

plt.show()
```



- Highest & Lowest Number of ConfirmedCases in US & Switzerland

In [88]:

```
# Scatter Plot For Country VS ConfirmedCases
plt.figure(figsize=(15,8))
plt.scatter(df_Cases['Country_Region'], df_Cases['Fatalities'], c='green', s=250)

plt.xlabel('Country_Region', fontsize = 15)
plt.ylabel('Fatalities', fontsize = 15)

plt.title("Fatalities", fontsize = 20, fontweight='bold')

plt.xticks(rotation=90)

plt.show()
```



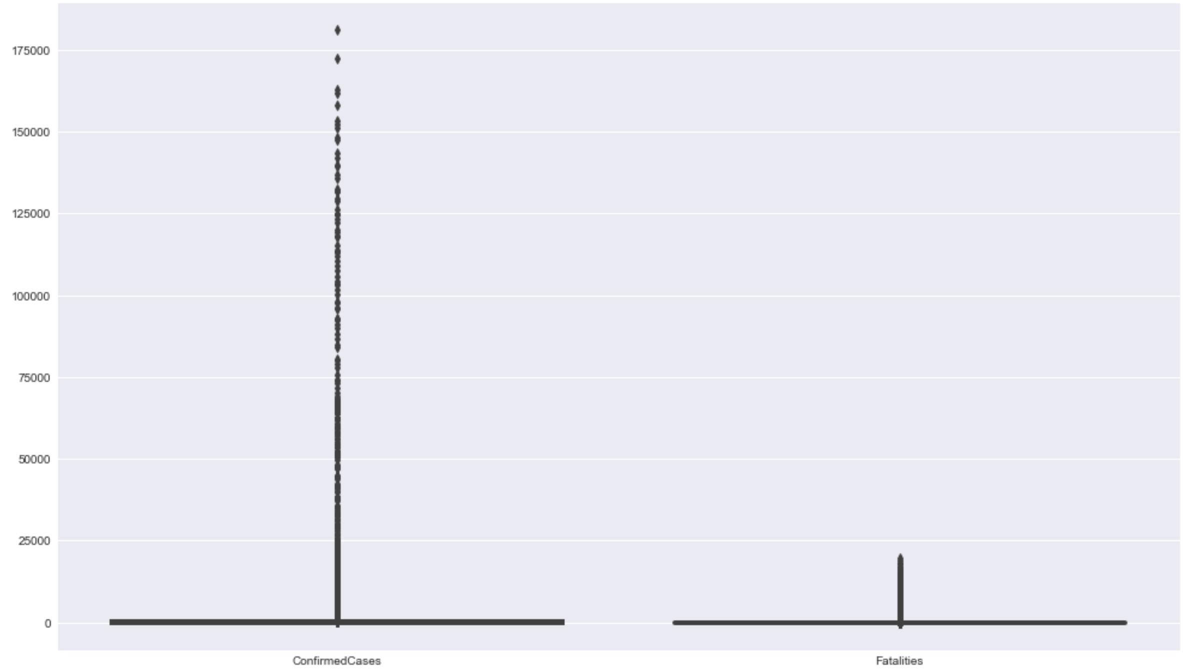
- Highest & Lowest Number of Fatalities in Italy & Turkey

In [37]:

```
# Box plot created for feature columns of "ConfirmedCases" & "Fatalities"
plt.figure(figsize=(15,10))
sns.boxplot(data=train[['ConfirmedCases','Fatalities']])
```

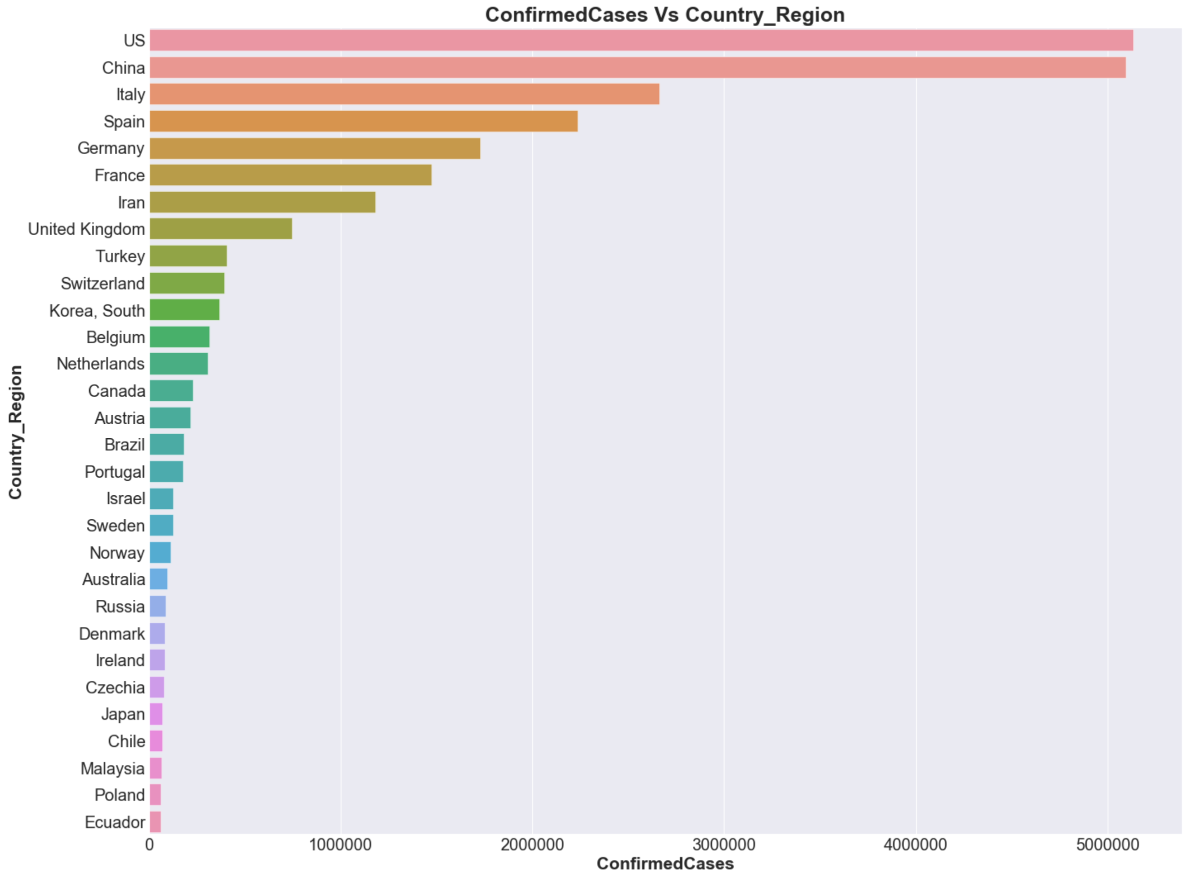
Out[37]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1df20434fd0>
```



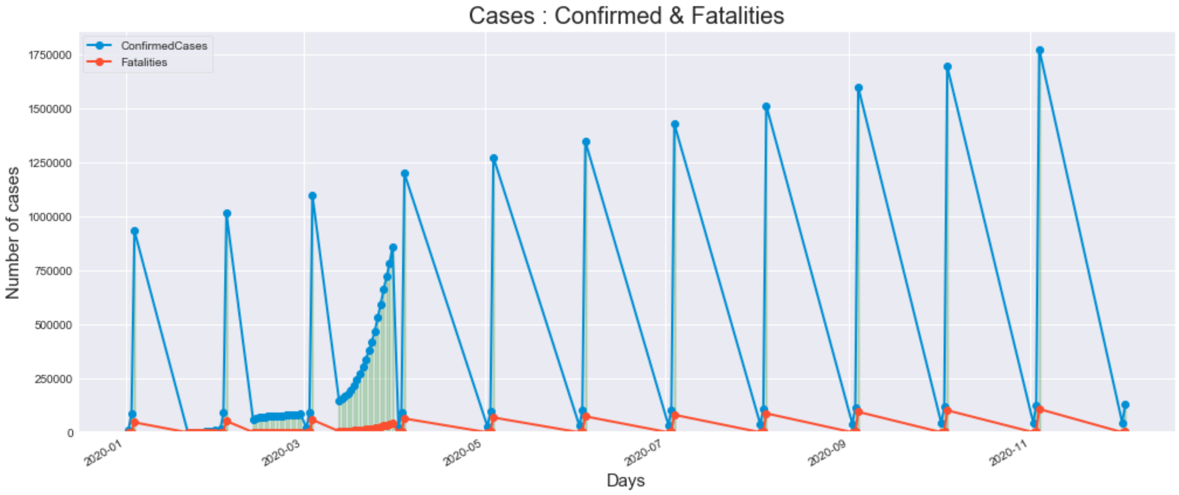
In [38]:

```
# bar plot showing Confirmed Cases as per Country / Region wise
plt.figure(figsize=(20,18))
Country = train.groupby(by='Country_Region')[['ConfirmedCases','Fatalities']].sum().reset_i

sns.barplot(x='ConfirmedCases', y='Country_Region', data = Country[Country['ConfirmedCases'

plt.xlabel('ConfirmedCases', fontsize=21, fontweight = 'bold')
plt.ylabel('Country_Region', fontsize=21, fontweight = 'bold')

plt.xticks(fontsize=20)
plt.yticks(fontsize=20)

plt.title('ConfirmedCases Vs Country_Region', fontsize=25, fontweight = 'bold')

plt.show()
```



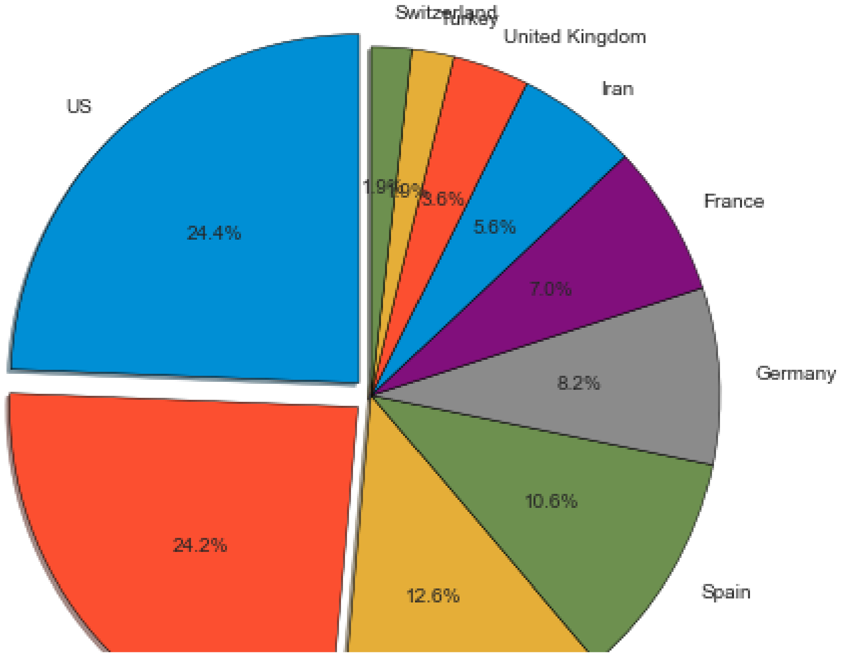
In [39]:

```
# Group dataset by 'Date' with sum parameter and analyse the 'Confirmed','Deaths' values.
#plt.figure(figsize=(15,12))
Date = train.groupby('Date').sum()[['ConfirmedCases', 'Fatalities']]
Date.plot(kind='line', figsize = (15,7), marker='o', linewidth=2)
plt.bar(Date.index, Date['ConfirmedCases'], alpha=0.3, color='g')

plt.xlabel('Days', fontsize=15)
plt.ylabel('Number of cases', fontsize=15)

plt.title('Cases : Confirmed & Fatalities', fontsize=20)

plt.legend()

plt.show()
```



In [72]:

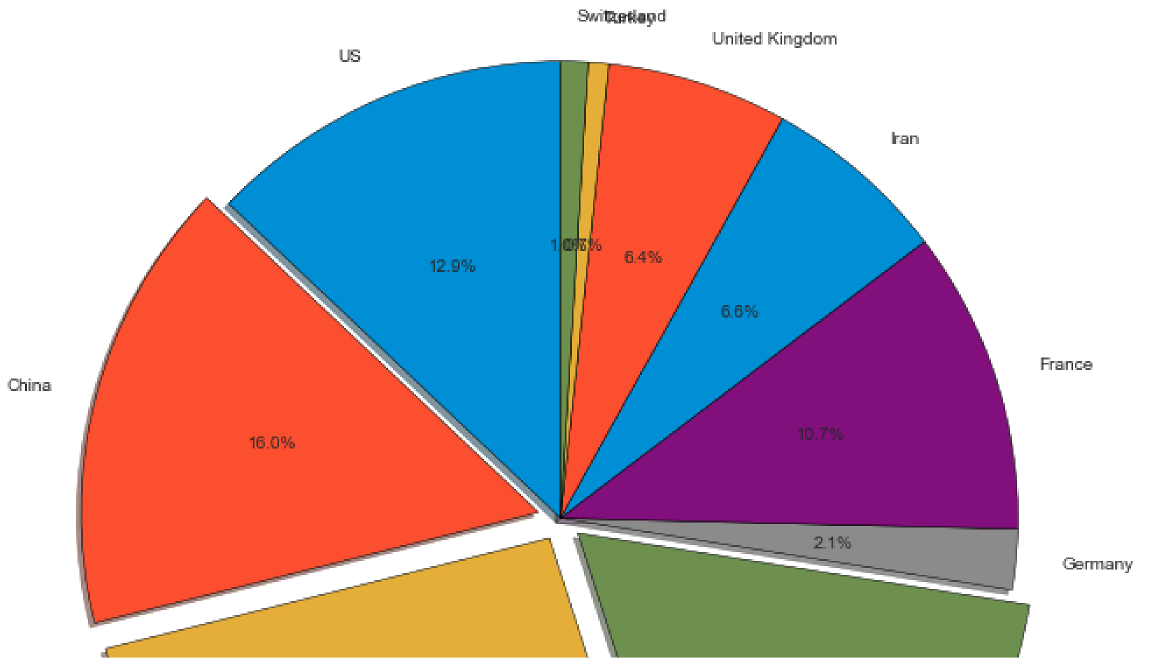
```
# Pie chart for Confirmed Cases

# Pie chart, where the slices will be ordered and plotted counter-clockwise:
# autopct : formatting how the percentages appear on the pie chart

plt.figure(figsize=(5,4))
explode =(0.1,0.1,0,0,0,0,0,0,0,0)

plt.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a circle.

plt.pie(df_Cases['ConfirmedCases'], labels=df_Cases['Country_Region'], radius=2, autopct='%
        shadow=True, startangle=90, explode = explode, wedgeprops={'edgecolor': 'black'})



plt.show()
```



- Highest number of Confirmed Cases in US as 24.4%
- Lowest number of Confirmed Cases in Switzerland & Turkey as 1.9%

In [73]:

```
# Pie chart for Fatalities(Death)

plt.figure(figsize=(7,6))

plt.axis('equal')

explode =(0,0.1,0.1,0.1,0,0,0,0,0,0)

plt.pie(df_Cases['Fatalities'], labels=df_Cases['Country_Region'], radius=2, autopct='%0.1f
        shadow=True, startangle=90, explode = explode, center=(0, 0), wedgeprops={'edgecolo

plt.show()
```



- Highest death rate in Italy : 26%
- Lowest death rate in Switzerland : 1%

In [88]:

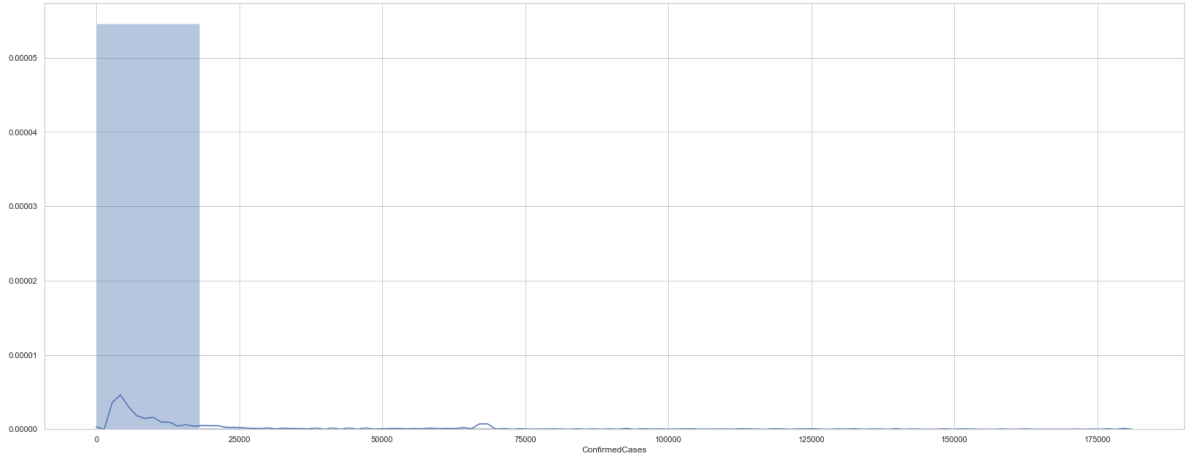
```
# Pairplot used to show features on Country/Region basis
df = train[['ConfirmedCases', 'Fatalities', 'Country_Region']]
sns.pairplot(df, hue='Country_Region')
```

Out[88]:

```
<seaborn.axisgrid.PairGrid at 0x1fff6c9e390>
```

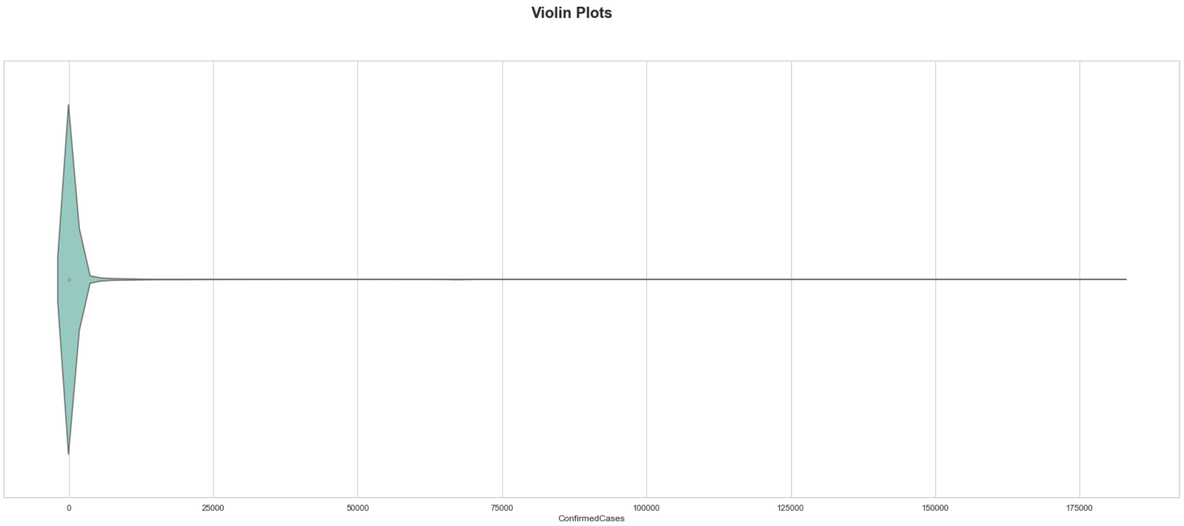
In [151]:

```
# Dist Plot
plt.figure(figsize=(25,10))
sns.distplot(train['ConfirmedCases'], bins=10)
plt.show()
```



In [152]:

```
# Violin Plot
plt.figure(figsize=(25,10))
plt.suptitle('Violin Plots', fontsize=20, fontweight = 'bold')
sns.violinplot(x='ConfirmedCases', data=train, palette='Set3')
plt.show()
```


Violin Plots
ConfirmedCases