# Timeline Analysis Covid 19

### Create a EDA showing spread of Covid-19 cases in your country.

### Identify interesting patterns and possible reasons helping Covid-19 spreadwith basic as well as advanced charts.

**Dataset: Daily updated .csv file on [https://bit.ly/30d2gdi](https://bit.ly/30d2gdi)**

Coronavirus is a family of viruses that can cause illness, which can vary from common cold and cough to sometimes more severe disease. Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV) were such severe cases with the world already has faced.

SARS-CoV-2 (n-coronavirus) is the new virus of the coronavirus family, which first discovered in 2019, which has not been identified in humans before. It is a contiguous virus which started from Wuhan in December 2019. Which later declared as Pandemic by WHO due to high rate spreads throughout the world. Currently (on date 08 October 2020), this leads to a total of 3M+ cases across the globe, including 100K+ deaths around the globe.

Pandemic is spreading all over the world; it becomes more important to understand about this spread. This NoteBook is an effort to analyze the cumulative data of confirmed, deaths, and recovered cases over time. In this notebook, the main focus is to analyze the spread trend of this virus all over the world.

## Downloding and Installing Prerequisite

### Install:

pip install pycountry_convert

pip install folium

In [1]:

```
# Install pycountry_convert
!pip install pycountry_convert
!pip install folium
#!pip install tensorflow`
!wget https://raw.githubusercontent.com/tarunk04/COVID-19-CaseStudy-and-
Predictions/master/models/model_deaths.h5
!wget https://raw.githubusercontent.com/tarunk04/COVID-19-CaseStudy-and-
Predictions/master/models/model_confirmed.h5
!wget https://raw.githubusercontent.com/tarunk04/COVID-19-CaseStudy-and-
Predictions/master/models/model_usa_c.h5
```

```
Requirement already satisfied: pycountry_convert in c:\users\hp\anaconda3\lib\site-packages
(0.7.2)
Requirement already satisfied: pprintpp>=0.3.0 in c:\users\hp\anaconda3\lib\site-packages (from
pycountry_convert) (0.4.0)
Requirement already satisfied: pytest-cov>=2.5.1 in c:\users\hp\anaconda3\lib\site-packages (from
pycountry_convert) (2.10.1)
Requirement already satisfied: repoze.lru>=0.7 in c:\users\hp\anaconda3\lib\site-packages (from
pycountry_convert) (0.7)
Requirement already satisfied: pytest-mock>=1.6.3 in c:\users\hp\anaconda3\lib\site-packages (from
pycountry_convert) (3.3.1)
Requirement already satisfied: pycountry>=16.11.27.1 in c:\users\hp\anaconda3\lib\site-packages (f
rom pycountry_convert) (20.7.3)
Requirement already satisfied: wheel>=0.30.0 in c:\users\hp\anaconda3\lib\site-packages (from
pycountry_convert) (0.34.2)
Requirement already satisfied: pytest>=3.4.0 in c:\users\hp\anaconda3\lib\site-packages (from
pycountry_convert) (5.3.5)
Requirement already satisfied: coverage>=4.4 in c:\users\hp\anaconda3\lib\site-packages (from
pytest-cov>=2.5.1->pycountry_convert) (5.3)
Requirement already satisfied: py>=1.5.0 in c:\users\hp\anaconda3\lib\site-packages (from
pytest>=3.4.0->pycountry_convert) (1.8.1)
Requirement already satisfied: packaging in c:\users\hp\anaconda3\lib\site-packages (from
pytest>=3.4.0->pycountry_convert) (19.0)
```

```
Requirement already satisfied: attrs>=17.4.0 in c:\users\hp\anaconda3\lib\site-packages (from
pytest>=3.4.0->pycountry_convert) (19.3.0)
Requirement already satisfied: more-itertools>=4.0.0 in c:\users\hp\anaconda3\lib\site-packages
(from pytest>=3.4.0->pycountry_convert) (8.2.0)
Requirement already satisfied: pluggy<1.0,>=0.12 in c:\users\hp\anaconda3\lib\site-packages (from
pytest>=3.4.0->pycountry_convert) (0.13.1)
Requirement already satisfied: wcwidth in c:\users\hp\anaconda3\lib\site-packages (from
pytest>=3.4.0->pycountry_convert) (0.1.8)
Requirement already satisfied: importlib-metadata>=0.12 in c:\users\hp\anaconda3\lib\site-packages
(from pytest>=3.4.0->pycountry_convert) (1.5.0)
Requirement already satisfied: atomicwrites>=1.0 in c:\users\hp\anaconda3\lib\site-packages (from
pytest>=3.4.0->pycountry_convert) (1.3.0)
Requirement already satisfied: colorama in c:\users\hp\anaconda3\lib\site-packages (from
pytest>=3.4.0->pycountry_convert) (0.4.3)
Requirement already satisfied: pyparsing>=2.0.2 in c:\users\hp\anaconda3\lib\site-packages (from p
ackaging->pytest>=3.4.0->pycountry_convert) (2.4.6)
Requirement already satisfied: six in c:\users\hp\anaconda3\lib\site-packages (from packaging-
>pytest>=3.4.0->pycountry_convert) (1.14.0)
Requirement already satisfied: zipp>=0.5 in c:\users\hp\anaconda3\lib\site-packages (from
importlib-metadata>=0.12->pytest>=3.4.0->pycountry_convert) (2.2.0)
Requirement already satisfied: folium in c:\users\hp\anaconda3\lib\site-packages (0.11.0)
Requirement already satisfied: numpy in c:\users\hp\anaconda3\lib\site-packages (from folium)
(1.18.1)
Requirement already satisfied: branca>=0.3.0 in c:\users\hp\anaconda3\lib\site-packages (from
folium) (0.4.1)
Requirement already satisfied: jinja2>=2.9 in c:\users\hp\anaconda3\lib\site-packages (from
folium) (2.11.1)
Requirement already satisfied: requests in c:\users\hp\anaconda3\lib\site-packages (from folium) (
2.24.0)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\hp\anaconda3\lib\site-packages (from j
inja2>=2.9->folium) (1.1.1)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
c:\users\hp\anaconda3\lib\site-packages (from requests->folium) (1.24.3)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\hp\anaconda3\lib\site-packages (from
requests->folium) (2019.11.28)
Requirement already satisfied: idna<3,>=2.5 in c:\users\hp\anaconda3\lib\site-packages (from
requests->folium) (2.8)
Requirement already satisfied: chardet<4,>=3.0.2 in c:\users\hp\anaconda3\lib\site-packages (from
requests->folium) (3.0.4)
```

```
--2020-10-19 09:05:48--  https://raw.githubusercontent.com/tarunk04/COVID-19-CaseStudy-and-
Predictions/master/models/model_deaths.h5
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 199.232.20.133
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|199.232.20.133|:443...
connected.
HTTP request sent, awaiting response... 200 OK
Length: 111008 (108K) [application/octet-stream]
Saving to: 'model_deaths.h5.4'

     0K .......... .......... .......... .......... .......... 46%  133K 0s
    50K .......... .......... .......... .......... .......... 92%  202K 0s
   100K ........                                               100%  180K=0.7s

2020-10-19 09:06:21 (162 KB/s) - 'model_deaths.h5.4' saved [111008/111008]

--2020-10-19 09:06:21--  https://raw.githubusercontent.com/tarunk04/COVID-19-CaseStudy-and-
Predictions/master/models/model_confirmed.h5
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 199.232.20.133
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|199.232.20.133|:443...
connected.
HTTP request sent, awaiting response... 200 OK
Length: 111008 (108K) [application/octet-stream]
Saving to: 'model_confirmed.h5.4'

     0K .......... .......... .......... .......... .......... 46%  271K 0s
    50K .......... .......... .......... .......... .......... 92%  307K 0s
   100K ........                                               100%  363K=0.4s

2020-10-19 09:06:25 (293 KB/s) - 'model_confirmed.h5.4' saved [111008/111008]

--2020-10-19 09:06:25--  https://raw.githubusercontent.com/tarunk04/COVID-19-CaseStudy-and-
Predictions/master/models/model_usa_c.h5
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 199.232.20.133
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|199.232.20.133|:443...
connected.
HTTP request sent, awaiting response... 200 OK
```

```
Length: 111008 (108K) [application/octet-stream]
Saving to: 'model_usa_c.h5.4'

     0K .......... .......... .......... .......... .......... 46% 52.7K 1s
    50K .......... .......... .......... .......... .......... 92%  119K 0s
   100K ........                                               100%  122K=1.4s

2020-10-19 09:06:31 (75.4 KB/s) - 'model_usa_c.h5.4' saved [111008/111008]
```

## Imports and Datasets

Pandas - for dataset handeling

Numpy - Support for Pandas and calculations

Matplotlib - for visualization (Platting graphas)

pycountry_convert - Library for getting continent (name) to from their country names

folium - Library for Map

keras - Prediction Models

plotly - for interative plots

In [2]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import ticker
import pycountry_convert as pc
import folium
import branca
from datetime import datetime, timedelta,date
from scipy.interpolate import make_interp_spline, BSpline
import plotly.express as px
import json, requests

#from keras.layers import Input, Dense, Activation, LeakyReLU
#from keras import models
#from keras.optimizers import RMSprop, Adam

%matplotlib inline
```

In [3]:

```
df_confirmed = pd.read_csv('https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_confirmed_global.csv')
df_deaths = pd.read_csv('https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_deaths_global.csv')

# Depricated
# df_recovered = pd.read_csv('https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_19-covid-Recovered.csv')
df_covid19 = pd.read_csv("https://raw.githubusercontent.com/CSSEGISandData/COVID-19/web-data/data/cases_country.csv")
df_table = pd.read_csv("https://raw.githubusercontent.com/CSSEGISandData/COVID-19/web-data/data/cases_time.csv",parse_dates=['Last_Update'])
```

```
C:\Users\hp\anaconda3\lib\site-packages\IPython\core\interactiveshell.py:3063: DtypeWarning: 
Columns (11) have mixed types.Specify dtype option on import or set low_memory=False.
  interactivity=interactivity, compiler=compiler, result=result)
```

In [4]:

```
# new dataset
df_covid19.head(2)
```

Out[4]:

| | Country_Region | Last_Update | Lat | Long_ | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_H |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Afghanistan | 2020-10-19 03:24:46 | 33.93911 | 67.709953 | 40200.0 | 1492.0 | 33614.0 | 5094.0 | 103.266666 | NaN | |
| 1 | Albania | 2020-10-19 03:24:46 | 41.15330 | 20.168300 | 17055.0 | 451.0 | 10071.0 | 6533.0 | 592.640211 | NaN | |

In [5]:

```
df_confirmed.head(2)
```

Out[5]:

| | Province/State | Country/Region | Lat | Long | 1/22/20 | 1/23/20 | 1/24/20 | 1/25/20 | 1/26/20 | 1/27/20 | ... | 10/8/20 | 10/9/20 | 10/10/2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | NaN | Afghanistan | 33.93911 | 67.709953 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 39616 | 39693 | 3970 |
| 1 | NaN | Albania | 41.15330 | 20.168300 | 0 | 0 | 0 | 0 | 0 | 0 | ... | 14899 | 15066 | 1523 |

2 rows × 274 columns

## Preprocessing

In [6]:

```
df_confirmed = df_confirmed.rename(columns={"Province/State":"state","Country/Region": "country"})
df_deaths = df_deaths.rename(columns={"Province/State":"state","Country/Region": "country"})
df_covid19 = df_covid19.rename(columns={"Country_Region": "country"})
df_covid19["Active"] = df_covid19["Confirmed"]-df_covid19["Recovered"]-df_covid19["Deaths"]
# df_recovered = df_recovered.rename(columns={"Province/State":"state","Country/Region":
"country"})
```

In [7]:

```
# Changing the conuntry names as required by pycountry_convert Lib
df_confirmed.loc[df_confirmed['country'] == "US", "country"] = "USA"
df_deaths.loc[df_deaths['country'] == "US", "country"] = "USA"
df_covid19.loc[df_covid19['country'] == "US", "country"] = "USA"
df_table.loc[df_table['Country_Region'] == "US", "Country_Region"] = "USA"
# df_recovered.loc[df_recovered['country'] == "US", "country"] = "USA"


df_confirmed.loc[df_confirmed['country'] == 'Korea, South', "country"] = 'South Korea'
df_deaths.loc[df_deaths['country'] == 'Korea, South', "country"] = 'South Korea'
df_covid19.loc[df_covid19['country'] == "Korea, South", "country"] = "South Korea"
df_table.loc[df_table['Country_Region'] == "Korea, South", "Country_Region"] = "South Korea"
# df_recovered.loc[df_recovered['country'] == 'Korea, South', "country"] = 'South Korea'

df_confirmed.loc[df_confirmed['country'] == 'Taiwan*', "country"] = 'Taiwan'
df_deaths.loc[df_deaths['country'] == 'Taiwan*', "country"] = 'Taiwan'
df_covid19.loc[df_covid19['country'] == "Taiwan*", "country"] = "Taiwan"
df_table.loc[df_table['Country_Region'] == "Taiwan*", "Country_Region"] = "Taiwan"
# df_recovered.loc[df_recovered['country'] == 'Taiwan*', "country"] = 'Taiwan'

df_confirmed.loc[df_confirmed['country'] == 'Congo (Kinshasa)', "country"] = 'Democratic Republic
of the Congo'
df_deaths.loc[df_deaths['country'] == 'Congo (Kinshasa)', "country"] = 'Democratic Republic of the
Congo'
df_covid19.loc[df_covid19['country'] == "Congo (Kinshasa)", "country"] = "Democratic Republic of
the Congo"
df_table.loc[df_table['Country_Region'] == "Congo (Kinshasa)", "Country_Region"] = "Democratic Repu
blic of the Congo"
# df_recovered.loc[df_recovered['country'] == 'Congo (Kinshasa)', "country"] = 'Democratic Republi
c of the Congo'

df_confirmed.loc[df_confirmed['country'] == "Cote d'Ivoire", "country"] = "Côte d'Ivoire"
df_deaths.loc[df_deaths['country'] == "Cote d'Ivoire", "country"] = "Côte d'Ivoire"
df_covid19.loc[df_covid19['country'] == "Cote d'Ivoire", "country"] = "Côte d'Ivoire"
df_table.loc[df_table['Country_Region'] == "Cote d'Ivoire", "Country_Region"] = "Côte d'Ivoire"
# df_recovered.loc[df_recovered['country'] == "Cote d'Ivoire", "country"] = "Côte d'Ivoire"
```

```
df_confirmed.loc[df_confirmed['country'] == "Reunion", "country"] = "Réunion"
df_deaths.loc[df_deaths['country'] == "Reunion", "country"] = "Réunion"
df_covid19.loc[df_covid19['country'] == "Reunion", "country"] = "Réunion"
df_table.loc[df_table['Country_Region'] == "Reunion", "Country_Region"] = "Réunion"
# df_recovered.loc[df_recovered['country'] == "Reunion", "country"] = "Réunion"

df_confirmed.loc[df_confirmed['country'] == 'Congo (Brazzaville)', "country"] = 'Republic of the C
ongo'
df_deaths.loc[df_deaths['country'] == 'Congo (Brazzaville)', "country"] = 'Republic of the Congo'
df_covid19.loc[df_covid19['country'] == "Congo (Brazzaville)", "country"] = "Republic of the
Congo"
df_table.loc[df_table['Country_Region'] == "Congo (Brazzaville)", "Country_Region"] = "Republic of
the Congo"
# df_recovered.loc[df_recovered['country'] == 'Congo (Brazzaville)', "country"] = 'Republic of the
Congo'

df_confirmed.loc[df_confirmed['country'] == 'Bahamas, The', "country"] = 'Bahamas'
df_deaths.loc[df_deaths['country'] == 'Bahamas, The', "country"] = 'Bahamas'
df_covid19.loc[df_covid19['country'] == "Bahamas, The", "country"] = "Bahamas"
df_table.loc[df_table['Country_Region'] == "Bahamas, The", "Country_Region"] = "Bahamas"
# df_recovered.loc[df_recovered['country'] == 'Bahamas, The', "country"] = 'Bahamas'

df_confirmed.loc[df_confirmed['country'] == 'Gambia, The', "country"] = 'Gambia'
df_deaths.loc[df_deaths['country'] == 'Gambia, The', "country"] = 'Gambia'
df_covid19.loc[df_covid19['country'] == "Gambia, The", "country"] = "Gambia"
df_table.loc[df_table['Country_Region'] == "Gambia", "Country_Region"] = "Gambia"
# df_recovered.loc[df_recovered['country'] == 'Gambia, The', "country"] = 'Gambia'

# getting all countries
countries = np.asarray(df_confirmed["country"])
countries1 = np.asarray(df_covid19["country"])
# Continent_code to Continent_names
continents = {
    'NA': 'North America',
    'SA': 'South America',
    'AS': 'Asia',
    'OC': 'Australia',
    'AF': 'Africa',
    'EU' : 'Europe',
    'na' : 'Others'
}

# Defininng Function for getting continent code for country.
def country_to_continent_code(country):
    try:
        return pc.country_alpha2_to_continent_code(pc.country_name_to_country_alpha2(country))
    except :
        return 'na'

#Collecting Continent Information
df_confirmed.insert(2,"continent", [continents[country_to_continent_code(country)] for country in c
ountries[:]])
df_deaths.insert(2,"continent",  [continents[country_to_continent_code(country)] for country in cou
ntries[:]])
df_covid19.insert(1,"continent",  [continents[country_to_continent_code(country)] for country in co
untries1[:]])
df_table.insert(1,"continent",  [continents[country_to_continent_code(country)] for country in df_t
able["Country_Region"].values])
# df_recovered.insert(2,"continent",  [continents[country_to_continent_code(country)] for country
in countries[:]] )
```

In [8]:

```
df_table = df_table[df_table["continent"] != "Others"]
```

In [9]:

```
df_deaths[df_deaths["continent" ]== 'Others']
```

Out[9]:

| | state | country | continent | Lat | Long | 1/22/20 | 1/23/20 | 1/24/20 | 1/25/20 | 1/26/20 | ... | 10/8/20 | 10/9/20 | 10/10/20 | 10/11/2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **34** | NaN | Burma | Others | 21.916200 | 95.956000 | 0 | 0 | 0 | 0 | 0 | ... | 535 | 566 | 598 | 64 |

| | state | country | continent | Lat | Long | 1/22/20 | 1/23/20 | 1/24/20 | 1/25/20 | 1/26/20 | ... | 10/8/20 | 10/9/20 | 10/10/20 | 10/11/2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **102** | NaN | Diamond Princess | Others | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0 | ... | 13 | 13 | 13 | |
| **139** | NaN | Holy See | Others | 41.902900 | 12.453400 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | |
| **156** | NaN | Kosovo | Others | 42.602636 | 20.902977 | 0 | 0 | 0 | 0 | 0 | ... | 638 | 638 | 645 | 64 |
| **168** | NaN | MS Zaandam | Others | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0 | ... | 2 | 2 | 2 | |
| **238** | NaN | Timor-Leste | Others | -8.874217 | 125.727539 | 0 | 0 | 0 | 0 | 0 | ... | 0 | 0 | 0 | |
| **262** | NaN | West Bank and Gaza | Others | 31.952200 | 35.233200 | 0 | 0 | 0 | 0 | 0 | ... | 359 | 367 | 378 | 38 |
| **263** | NaN | Western Sahara | Others | 24.215500 | -12.885800 | 0 | 0 | 0 | 0 | 0 | ... | 1 | 1 | 1 | |

8 rows × 275 columns

In [10]:

```
#df_active = df_confirmed.copy()
#df_active.iloc[:,5:] = df_active.iloc[:,5:] - df_recovered.iloc[:,5:] - df_deaths.iloc[:,5:]
#df_active.head(5)
```

In [11]:

```
df_confirmed = df_confirmed.replace(np.nan, '', regex=True)
df_deaths = df_deaths.replace(np.nan, '', regex=True)
# df_recovered = df_recovered.replace(np.nan, '', regex=True)
# df_active = df_active.replace(np.nan, '', regex=True)
```

## Defining Functions

plot_params()

visualize_covid_cases()

get_mortality_rate()

In [12]:

```
def plot_params(ax,axis_label= None, plt_title = None,label_size=15, axis_fsize = 15, title_fsize =
20, scale = 'linear' ):
    # Tick-Parameters
    ax.xaxis.set_minor_locator(ticker.AutoMinorLocator())
    ax.yaxis.set_minor_locator(ticker.AutoMinorLocator())
    ax.tick_params(which='both', width=1,labelsize=label_size)
    ax.tick_params(which='major', length=6)
    ax.tick_params(which='minor', length=3, color='0.8')

    # Grid
    plt.grid(lw = 1, ls = '-', c = "0.7", which = 'major')
    plt.grid(lw = 1, ls = '-', c = "0.9", which = 'minor')

    # Plot Title
    plt.title( plt_title,{'fontsize':title_fsize})

    # Yaxis sacle
    plt.yscale(scale)
    plt.minorticks_on()
    # Plot Axes Labels
    xl = plt.xlabel(axis_label[0],fontsize = axis_fsize)
    yl = plt.ylabel(axis_label[1],fontsize = axis_fsize)

def visualize_covid_cases(confirmed, deaths, continent=None , country = None , state = None, period
= None, figure = None, scale = "linear"):
    x = 0
    if figure == None:
        f = plt.figure(figsize=(10,10))
        # Sub plot
        ax = f.add_subplot(111)
```

```
    else :
        f = figure[0]
        # Sub plot
        ax = f.add_subplot(figure[1],figure[2],figure[3])

    plt.tight_layout(pad=10, w_pad=5, h_pad=5)

    stats = [confirmed, deaths]
    label = ["Confirmed", "Deaths"]

    if continent != None:
        params = ["continent",continent]
    elif country != None:
        params = ["country",country]
    else:
        params = ["All", "All"]
    color = ["darkcyan","crimson"]
    marker_style = dict(linewidth=3, linestyle='-', marker='o',markersize=4, markerfacecolor='#ffff
ff')
    for i,stat in enumerate(stats):
        if params[1] == "All" :
            cases = np.sum(np.asarray(stat.iloc[:,5:]),axis = 0)[x:]
        else :
            cases = np.sum(np.asarray(stat[stat[params[0]] == params[1]].iloc[:,5:]),axis = 0)[x:]
        date = np.arange(1,cases.shape[0]+1)[x:]
        plt.plot(date,cases,label = label[i]+" (Total : "+str(cases[-1])+")",color=color[i],**marke
r_style)

    if params[1] == "All" :
        Total_confirmed = np.sum(np.asarray(stats[0].iloc[:,5:]),axis = 0)[x:]
        Total_deaths = np.sum(np.asarray(stats[1].iloc[:,5:]),axis = 0)[x:]
    else :
        Total_confirmed =  np.sum(np.asarray(stats[0][stat[params[0]] == params[1]].iloc[:,5:]),axi
s = 0)[x:]
        Total_deaths = np.sum(np.asarray(stats[1][stat[params[0]] == params[1]].iloc[:,5:]),axis =
0)[x:]

    text = "From "+stats[0].columns[5]+" to "+stats[0].columns[-1]+"\n"
    text += "Mortality rate : "+ str(int(Total_deaths[-1]/(Total_confirmed[-1])*10000)/100)+"\n"
    text += "Last 5 Days:\n"
    text += "Confirmed : " + str(Total_confirmed[-1] - Total_confirmed[-6])+"\n"
    text += "Deaths : " + str(Total_deaths[-1] - Total_deaths[-6])+"\n"
    text += "Last 24 Hours:\n"
    text += "Confirmed : " + str(Total_confirmed[-1] - Total_confirmed[-2])+"\n"
    text += "Deaths : " + str(Total_deaths[-1] - Total_deaths[-2])+"\n"

    plt.text(0.02, 0.78, text, fontsize=15, horizontalalignment='left', verticalalignment='top', tr
ansform=ax.transAxes,bbox=dict(facecolor='white', alpha=0.4))

    # Plot Axes Labels
    axis_label = ["Days ("+df_confirmed.columns[5]+" - "+df_confirmed.columns[-1]+")","No of Cases"
]

    # Plot Parameters
    plot_params(ax,axis_label,scale = scale)

    # Plot Title
    if params[1] == "All" :
        plt.title("COVID-19 Cases World",{'fontsize':25})
    else:
        plt.title("COVID-19 Cases for "+params[1] ,{'fontsize':25})

    # Legend Location
    l = plt.legend(loc= "best",fontsize = 15)

    if figure == None:
        plt.show()

def get_total_cases(cases, country = "All"):
    if(country == "All") :
        return np.sum(np.asarray(cases.iloc[:,5:]),axis = 0)[-1]
    else :
        return np.sum(np.asarray(cases[cases["country"] == country].iloc[:,5:]),axis = 0)[-1]

def get_mortality_rate(confirmed,deaths, continent = None, country = None):
    if continent != None:
        params = ["continent",continent]
```

```
    elif country != None:
        params = ["country",country]
    else :
        params = ["All", "All"]

    if params[1] == "All" :
        Total_confirmed = np.sum(np.asarray(confirmed.iloc[:,5:]),axis = 0)
        Total_deaths = np.sum(np.asarray(deaths.iloc[:,5:]),axis = 0)
        mortality_rate = np.round((Total_deaths/Total_confirmed)*100,2)
    else :
        Total_confirmed =  np.sum(np.asarray(confirmed[confirmed[params[0]] == params[1]].iloc[:,5:
]),axis = 0)
        Total_deaths = np.sum(np.asarray(deaths[deaths[params[0]] == params[1]].iloc[:,5:]),axis =
0)
        mortality_rate = np.round((Total_deaths/Total_confirmed)*100,2)

    return np.nan_to_num(mortality_rate)
def dd(date1,date2):
    return (datetime.strptime(date1,'%m/%d/%y') - datetime.strptime(date2,'%m/%d/%y')).days


out = ""+"output/"
```

# General Analysis of Data

Getting country wise and continent wise data.

In [13]:

```
df_countries_cases = df_covid19.copy().drop(['Lat','Long_','continent','Last_Update'],axis =1)
df_countries_cases.index = df_countries_cases["country"]
df_countries_cases = df_countries_cases.drop(['country'],axis=1)

df_continents_cases = df_covid19.copy().drop(['Lat','Long_','country','Last_Update'],axis =1)
df_continents_cases = df_continents_cases.groupby(["continent"]).sum()
```

## Global Reported Cases till Date

Total number of confirmed cases, deaths reported, revoveries and active cases all across the world

In [14]:

```
pd.DataFrame(df_countries_cases.sum()).transpose().style.background_gradient(cmap='Wistia',axis=1)
```

Out[14]:

| | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mortality_ |
|---|---|---|---|---|---|---|---|---|
| 0 | 39898689.000000 | 1112588.000000 | 27420679.000000 | 11232746.000000 | 122521.770540 | 0.000000 | 0.000000 | 465.22 |

## Coninent Wise Reported Cases

Coninent Wise reported confirmed cases, recovered cases, deaths, active cases

In [15]:

```
df_continents_cases.style.background_gradient(cmap='Wistia')
```

Out[15]:

| continent | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Morta |
|---|---|---|---|---|---|---|---|---|
| Africa | 1646268.000000 | 39746.000000 | 1354438.000000 | 252084.000000 | 9519.943977 | 0.000000 | 0.000000 | 1 |
| Asia | 12379254.000000 | 222138.000000 | 10770245.000000 | 1386871.000000 | 33300.342191 | 0.000000 | 0.000000 | 9 |
| Australia | 29901.000000 | 939.000000 | 27502.000000 | 1457.000000 | 157.250603 | 0.000000 | 0.000000 | 1 |

| continent | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mort |
|---|---|---|---|---|---|---|---|---|
| Europe | 6954084.000000 | 238929.000000 | 2839114.000000 | 3743375.000000 | 43081.847670 | 0.000000 | 0.000000 | 1 |
| North America | 9811606.000000 | 329569.000000 | 4565349.000000 | 4916688.000000 | 14906.866313 | 0.000000 | 0.000000 | 5 |
| Others | 100838.000000 | 1957.000000 | 72945.000000 | 25929.000000 | 5264.512742 | 0.000000 | 0.000000 | 4 |
| South America | 8976738.000000 | 279310.000000 | 7791086.000000 | 906342.000000 | 16291.237045 | 0.000000 | 0.000000 | 3 |

## Country Wise Reported Cases

Country Wise reported confirmed cases, recovered cases, deaths, active cases

In [16]:

```
df_countries_cases.sort_values('Confirmed', ascending= False).style.background_gradient(cmap='Wistia')
```

```
C:\Users\hp\anaconda3\lib\site-packages\matplotlib\colors.py:527: RuntimeWarning: invalid value
encountered in less
  xa[xa < 0] = -1
C:\Users\hp\anaconda3\lib\site-packages\pandas\io\formats\style.py:1089: RuntimeWarning: All-NaN s
lice encountered
  smin = np.nanmin(s.to_numpy()) if vmin is None else vmin
C:\Users\hp\anaconda3\lib\site-packages\pandas\io\formats\style.py:1090: RuntimeWarning: All-NaN s
lice encountered
  smax = np.nanmax(s.to_numpy()) if vmax is None else vmax
```

Out[16]:

| country | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mor |
|---|---|---|---|---|---|---|---|---|
| USA | 8154206.000000 | 219672.000000 | 3234138.000000 | 4700396.000000 | 2474.974351 | nan | nan | |
| India | 7494551.000000 | 114031.000000 | 6597209.000000 | 783311.000000 | 543.081680 | nan | nan | |
| Brazil | 5224362.000000 | 153675.000000 | 4526393.000000 | 544294.000000 | 2457.836153 | nan | nan | |
| Russia | 1390824.000000 | 24039.000000 | 1065608.000000 | 301177.000000 | 953.047005 | nan | nan | |
| Argentina | 989680.000000 | 26267.000000 | 803965.000000 | 159448.000000 | 2189.762110 | nan | nan | |
| Colombia | 959572.000000 | 28970.000000 | 858294.000000 | 72308.000000 | 1885.844364 | nan | nan | |
| Spain | 936560.000000 | 33775.000000 | 150376.000000 | 752409.000000 | 2003.131958 | nan | nan | |
| France | 876342.000000 | 33325.000000 | 108014.000000 | 735003.000000 | 1342.569096 | nan | nan | |
| Peru | 865549.000000 | 33702.000000 | 774356.000000 | 57491.000000 | 2625.115379 | nan | nan | |
| Mexico | 851227.000000 | 86167.000000 | 720973.000000 | 44087.000000 | 666.102021 | nan | nan | |
| United Kingdom | 725292.000000 | 43736.000000 | 2589.000000 | 678967.000000 | 1068.396956 | nan | nan | |
| South Africa | 703793.000000 | 18471.000000 | 634543.000000 | 50779.000000 | 1186.660842 | nan | nan | |
| Iran | 530380.000000 | 30375.000000 | 427400.000000 | 72605.000000 | 631.457737 | nan | nan | |
| Chile | 491760.000000 | 13635.000000 | 463943.000000 | 14182.000000 | 2572.476583 | nan | nan | |
| Iraq | 426634.000000 | 10254.000000 | 360477.000000 | 55903.000000 | 1060.684861 | nan | nan | |
| Italy | 414241.000000 | 36543.000000 | 251461.000000 | 126237.000000 | 685.128144 | nan | nan | |
| Bangladesh | 388569.000000 | 5660.000000 | 303972.000000 | 78937.000000 | 235.940528 | nan | nan | |
| Germany | 368671.000000 | 9794.000000 | 293220.000000 | 65657.000000 | 440.025831 | nan | nan | |
| Indonesia | 361867.000000 | 12511.000000 | 285324.000000 | 64032.000000 | 132.298263 | nan | nan | |
| Philippines | 356618.000000 | 6652.000000 | 310158.000000 | 39808.000000 | 325.437552 | nan | nan | |
| Turkey | 347493.000000 | 9296.000000 | 304003.000000 | 34194.000000 | 412.019023 | nan | nan | |
| Saudi Arabia | 342202.000000 | 5185.000000 | 328538.000000 | 8479.000000 | 982.947399 | nan | nan | |
| Pakistan | 323452.000000 | 6659.000000 | 307409.000000 | 9384.000000 | 146.429710 | nan | nan | |
| Ukraine | 307301.000000 | 5762.000000 | 130338.000000 | 171201.000000 | 702.663130 | nan | nan | |
| Israel | 303109.000000 | 2209.000000 | 268093.000000 | 32807.000000 | 3501.907044 | nan | nan | |
| Netherlands | 234203.000000 | 6811.000000 | 5206.000000 | 222186.000000 | 1366.820752 | nan | nan | |

| country | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mor |
|---|---|---|---|---|---|---|---|---|
| Belgium | 222253.000000 | 10413.000000 | 21157.000000 | 190683.000000 | 1917.690802 | nan | nan | |
| Canada | 200804.000000 | 9816.000000 | 169751.000000 | 21237.000000 | 530.445849 | nan | nan | |
| Romania | 180388.000000 | 5872.000000 | 130894.000000 | 43622.000000 | 937.680538 | nan | nan | |
| Poland | 175766.000000 | 3573.000000 | 92651.000000 | 79542.000000 | 464.416822 | nan | nan | |
| Czechia | 173885.000000 | 1422.000000 | 72134.000000 | 100329.000000 | 1623.730435 | nan | nan | |
| Morocco | 173632.000000 | 2928.000000 | 143972.000000 | 26732.000000 | 470.412829 | nan | nan | |
| Ecuador | 153289.000000 | 12387.000000 | 134187.000000 | 6715.000000 | 868.834545 | nan | nan | |
| Bolivia | 139771.000000 | 8481.000000 | 104483.000000 | 26807.000000 | 1197.384158 | nan | nan | |
| Nepal | 132246.000000 | 739.000000 | 92166.000000 | 39341.000000 | 453.879505 | nan | nan | |
| Qatar | 129431.000000 | 224.000000 | 126406.000000 | 2801.000000 | 4492.478463 | nan | nan | |
| Panama | 124745.000000 | 2564.000000 | 101041.000000 | 21140.000000 | 2891.117205 | nan | nan | |
| Dominican Republic | 121347.000000 | 2199.000000 | 98207.000000 | 20941.000000 | 1118.621625 | nan | nan | |
| Kuwait | 116146.000000 | 701.000000 | 107860.000000 | 7585.000000 | 2719.688247 | nan | nan | |
| United Arab Emirates | 115602.000000 | 463.000000 | 107516.000000 | 7623.000000 | 1168.830381 | nan | nan | |
| Oman | 109953.000000 | 1101.000000 | 95624.000000 | 13228.000000 | 2153.145465 | nan | nan | |
| Kazakhstan | 109508.000000 | 1768.000000 | 105001.000000 | 2739.000000 | 583.211955 | nan | nan | |
| Egypt | 105424.000000 | 6120.000000 | 98247.000000 | 1057.000000 | 103.019119 | nan | nan | |
| Sweden | 103200.000000 | 5918.000000 | nan | nan | 1021.856035 | nan | nan | |
| Guatemala | 101360.000000 | 3530.000000 | 90610.000000 | 7220.000000 | 565.764957 | nan | nan | |
| Portugal | 99911.000000 | 2181.000000 | 59000.000000 | 38730.000000 | 979.835941 | nan | nan | |
| Costa Rica | 95514.000000 | 1183.000000 | 58816.000000 | 35515.000000 | 1874.987486 | nan | nan | |
| Japan | 93098.000000 | 1672.000000 | 84461.000000 | 6965.000000 | 73.608956 | nan | nan | |
| China | 90972.000000 | 4739.000000 | 85819.000000 | 414.000000 | 6.476367 | nan | nan | |
| Ethiopia | 89137.000000 | 1352.000000 | 42649.000000 | 45136.000000 | 77.534988 | nan | nan | |
| Belarus | 87698.000000 | 929.000000 | 79757.000000 | 7012.000000 | 928.087849 | nan | nan | |
| Honduras | 87594.000000 | 2563.000000 | 34662.000000 | 50369.000000 | 884.376242 | nan | nan | |
| Venezuela | 86636.000000 | 736.000000 | 79694.000000 | 6206.000000 | 304.670747 | nan | nan | |
| Bahrain | 77902.000000 | 300.000000 | 74320.000000 | 3282.000000 | 4578.207469 | nan | nan | |
| Switzerland | 74422.000000 | 2123.000000 | 50600.000000 | 21699.000000 | 859.910859 | nan | nan | |
| Moldova | 67050.000000 | 1584.000000 | 47842.000000 | 17624.000000 | 1662.137208 | nan | nan | |
| Austria | 64806.000000 | 893.000000 | 49561.000000 | 14352.000000 | 719.554983 | nan | nan | |
| Armenia | 64694.000000 | 1081.000000 | 48104.000000 | 15509.000000 | 2183.222790 | nan | nan | |
| Uzbekistan | 63124.000000 | 525.000000 | 60080.000000 | 2519.000000 | 188.603259 | nan | nan | |
| Lebanon | 62286.000000 | 520.000000 | 28062.000000 | 33704.000000 | 912.556286 | nan | nan | |
| Nigeria | 61440.000000 | 1125.000000 | 56611.000000 | 3704.000000 | 29.805047 | nan | nan | |
| Singapore | 57911.000000 | 28.000000 | 57807.000000 | 76.000000 | 989.873585 | nan | nan | |
| Paraguay | 54724.000000 | 1188.000000 | 36068.000000 | 17468.000000 | 767.245283 | nan | nan | |
| Algeria | 54402.000000 | 1856.000000 | 38088.000000 | 14458.000000 | 124.060903 | nan | nan | |
| Kyrgyzstan | 52044.000000 | 1111.000000 | 45736.000000 | 5197.000000 | 797.708099 | nan | nan | |
| Ireland | 49962.000000 | 1852.000000 | 23364.000000 | 24746.000000 | 1011.827949 | nan | nan | |
| Libya | 48790.000000 | 725.000000 | 26889.000000 | 21176.000000 | 710.056209 | nan | nan | |
| Ghana | 47310.000000 | 310.000000 | 46618.000000 | 382.000000 | 152.254638 | nan | nan | |
| West Bank and Gaza | 47135.000000 | 408.000000 | 40498.000000 | 6229.000000 | 923.959152 | nan | nan | |
| Hungary | 46290.000000 | 1142.000000 | 14088.000000 | 31060.000000 | 479.175185 | nan | nan | |
| Azerbaijan | 44964.000000 | 626.000000 | 40037.000000 | 4301.000000 | 443.468034 | nan | nan | |
| Kenya | 44881.000000 | 832.000000 | 31857.000000 | 12192.000000 | 83.466459 | nan | nan | |
| Tunisia | 40542.000000 | 626.000000 | 5032.000000 | 34884.000000 | 343.035032 | nan | nan | |
| Afghanistan | 40200.000000 | 1492.000000 | 33614.000000 | 5094.000000 | 103.266666 | nan | nan | |

| country | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mor |
|---|---|---|---|---|---|---|---|---|
| Jordan | 37573.000000 | 345.000000 | 6912.000000 | 30316.000000 | 368.249382 | nan | nan | |
| Serbia | 36160.000000 | 776.000000 | nan | nan | 413.854512 | nan | nan | |
| Burma | 36025.000000 | 880.000000 | 17076.000000 | 18069.000000 | 66.210506 | nan | nan | |
| Denmark | 35893.000000 | 680.000000 | 29741.000000 | 5472.000000 | 619.677867 | nan | nan | |
| Bosnia and Herzegovina | 34112.000000 | 984.000000 | 24995.000000 | 8133.000000 | 1039.741650 | nan | nan | |
| El Salvador | 31666.000000 | 922.000000 | 27000.000000 | 3744.000000 | 488.205654 | nan | nan | |
| Slovakia | 29835.000000 | 88.000000 | 7359.000000 | 22388.000000 | 546.464302 | nan | nan | |
| Bulgaria | 29503.000000 | 986.000000 | 16943.000000 | 11574.000000 | 424.598597 | nan | nan | |
| Australia | 27399.000000 | 905.000000 | 25108.000000 | 1386.000000 | 107.617136 | nan | nan | |
| Croatia | 25580.000000 | 363.000000 | 20053.000000 | 5164.000000 | 623.101829 | nan | nan | |
| Greece | 25370.000000 | 509.000000 | 1347.000000 | 23514.000000 | 243.402703 | nan | nan | |
| South Korea | 25275.000000 | 444.000000 | 23368.000000 | 1463.000000 | 49.298621 | nan | nan | |
| North Macedonia | 23628.000000 | 834.000000 | 17239.000000 | 5555.000000 | 1134.118596 | nan | nan | |
| Cameroon | 21441.000000 | 423.000000 | 20117.000000 | 901.000000 | 80.769645 | nan | nan | |
| Malaysia | 20498.000000 | 187.000000 | 13262.000000 | 7049.000000 | 63.331895 | nan | nan | |
| Côte d'Ivoire | 20323.000000 | 121.000000 | 20021.000000 | 181.000000 | 77.044462 | nan | nan | |
| Georgia | 17477.000000 | 136.000000 | 8060.000000 | 9281.000000 | 438.110637 | nan | nan | |
| Albania | 17055.000000 | 451.000000 | 10071.000000 | 6533.000000 | 592.640211 | nan | nan | |
| Kosovo | 16891.000000 | 653.000000 | 14661.000000 | 1577.000000 | 933.015755 | nan | nan | |
| Madagascar | 16810.000000 | 238.000000 | 16215.000000 | 357.000000 | 60.705603 | nan | nan | |
| Norway | 16457.000000 | 278.000000 | 11863.000000 | 4316.000000 | 303.565124 | nan | nan | |
| Zambia | 15853.000000 | 346.000000 | 15005.000000 | 502.000000 | 86.232800 | nan | nan | |
| Montenegro | 15615.000000 | 236.000000 | 10994.000000 | 4385.000000 | 2486.219513 | nan | nan | |
| Senegal | 15418.000000 | 317.000000 | 13814.000000 | 1287.000000 | 92.081130 | nan | nan | |
| Sudan | 13697.000000 | 836.000000 | 6764.000000 | 6097.000000 | 31.236553 | nan | nan | |
| Finland | 13424.000000 | 351.000000 | 9100.000000 | 3973.000000 | 242.279069 | nan | nan | |
| Slovenia | 13142.000000 | 188.000000 | 6313.000000 | 6641.000000 | 632.151509 | nan | nan | |
| Namibia | 12293.000000 | 131.000000 | 10422.000000 | 1740.000000 | 483.801905 | nan | nan | |
| Guinea | 11518.000000 | 70.000000 | 10427.000000 | 1021.000000 | 87.704123 | nan | nan | |
| Maldives | 11210.000000 | 37.000000 | 10164.000000 | 1009.000000 | 2073.844401 | nan | nan | |
| Democratic Republic of the Congo | 11006.000000 | 302.000000 | 10356.000000 | 348.000000 | 12.288776 | nan | nan | |
| Luxembourg | 10888.000000 | 133.000000 | 8468.000000 | 2287.000000 | 1739.363809 | nan | nan | |
| Mozambique | 10866.000000 | 75.000000 | 8513.000000 | 2278.000000 | 34.765154 | nan | nan | |
| Uganda | 10590.000000 | 97.000000 | 6992.000000 | 3501.000000 | 23.152095 | nan | nan | |
| Tajikistan | 10493.000000 | 80.000000 | 9511.000000 | 902.000000 | 110.016711 | nan | nan | |
| Haiti | 8964.000000 | 231.000000 | 7213.000000 | 1520.000000 | 78.614111 | nan | nan | |
| Gabon | 8881.000000 | 54.000000 | 8430.000000 | 397.000000 | 399.015513 | nan | nan | |
| Jamaica | 8274.000000 | 171.000000 | 3859.000000 | 4244.000000 | 279.417431 | nan | nan | |
| Zimbabwe | 8147.000000 | 231.000000 | 7678.000000 | 238.000000 | 54.814237 | nan | nan | |
| Cabo Verde | 7752.000000 | 86.000000 | 6526.000000 | 1140.000000 | 1394.274697 | nan | nan | |
| Angola | 7622.000000 | 247.000000 | 3030.000000 | 4345.000000 | 23.190951 | nan | nan | |
| Mauritania | 7608.000000 | 163.000000 | 7347.000000 | 98.000000 | 163.624867 | nan | nan | |
| Lithuania | 7521.000000 | 113.000000 | 3097.000000 | 4311.000000 | 276.274652 | nan | nan | |
| Cuba | 6220.000000 | 125.000000 | 5768.000000 | 327.000000 | 54.914901 | nan | nan | |
| Malawi | 5857.000000 | 181.000000 | 4742.000000 | 934.000000 | 30.616904 | nan | nan | |
| Eswatini | 5780.000000 | 116.000000 | 5415.000000 | 249.000000 | 498.205426 | nan | nan | |
| Bahamas | 5703.000000 | 122.000000 | 3300.000000 | 2281.000000 | 1450.229880 | nan | nan | |
| Sri Lanka | 5538.000000 | 13.000000 | 3403.000000 | 2122.000000 | 25.862492 | nan | nan | |
| Djibouti | 5459.000000 | 61.000000 | 5375.000000 | 23.000000 | 553.539240 | nan | nan | |

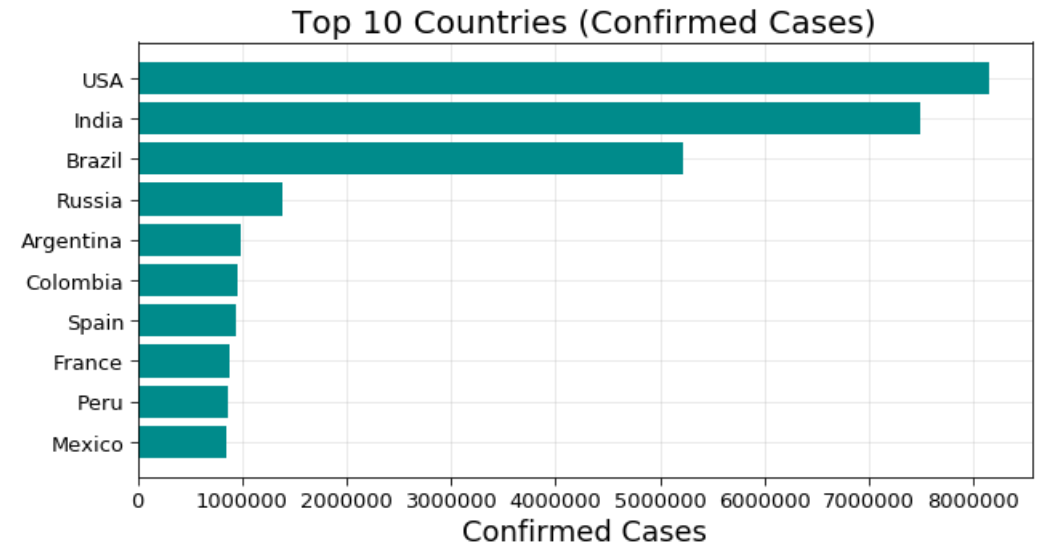
| country | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mor |
|---|---|---|---|---|---|---|---|---|
| Djibouti | 5459.000000 | 61.000000 | 5375.000000 | 23.000000 | 552.529246 | nan | nan | |
| Nicaragua | 5353.000000 | 154.000000 | 4225.000000 | 974.000000 | 80.805440 | nan | nan | |
| Trinidad and Tobago | 5297.000000 | 96.000000 | 3652.000000 | 1549.000000 | 378.494753 | nan | nan | |
| Botswana | 5242.000000 | 20.000000 | 905.000000 | 4317.000000 | 222.909690 | nan | nan | |
| Republic of the Congo | 5156.000000 | 92.000000 | 3887.000000 | 1177.000000 | 93.438094 | nan | nan | |
| Suriname | 5130.000000 | 109.000000 | 4944.000000 | 77.000000 | 874.480511 | nan | nan | |
| Syria | 5077.000000 | 248.000000 | 1528.000000 | 3301.000000 | 29.010339 | nan | nan | |
| Equatorial Guinea | 5070.000000 | 83.000000 | 4954.000000 | 33.000000 | 361.372360 | nan | nan | |
| Rwanda | 4974.000000 | 34.000000 | 4783.000000 | 157.000000 | 38.402716 | nan | nan | |
| Central African Republic | 4855.000000 | 62.000000 | 1924.000000 | 2869.000000 | 100.522510 | nan | nan | |
| Malta | 4628.000000 | 45.000000 | 3236.000000 | 1347.000000 | 1048.152032 | nan | nan | |
| Estonia | 4078.000000 | 68.000000 | 3211.000000 | 799.000000 | 307.416518 | nan | nan | |
| Iceland | 4055.000000 | 11.000000 | 2804.000000 | 1240.000000 | 1188.278388 | nan | nan | |
| Somalia | 3864.000000 | 99.000000 | 3089.000000 | 676.000000 | 24.312255 | nan | nan | |
| Guyana | 3734.000000 | 109.000000 | 2654.000000 | 971.000000 | 474.725990 | nan | nan | |
| Thailand | 3686.000000 | 59.000000 | 3481.000000 | 146.000000 | 5.280804 | nan | nan | |
| Gambia | 3649.000000 | 118.000000 | 2649.000000 | 882.000000 | 150.993270 | nan | nan | |
| Latvia | 3450.000000 | 44.000000 | 1329.000000 | 2077.000000 | 182.907239 | nan | nan | |
| Mali | 3388.000000 | 132.000000 | 2586.000000 | 670.000000 | 16.730175 | nan | nan | |
| Andorra | 3377.000000 | 59.000000 | 2057.000000 | 1261.000000 | 4370.672361 | nan | nan | |
| South Sudan | 2842.000000 | 55.000000 | 1290.000000 | 1497.000000 | 25.389216 | nan | nan | |
| Belize | 2813.000000 | 44.000000 | 1670.000000 | 1099.000000 | 707.457604 | nan | nan | |
| Cyprus | 2644.000000 | 25.000000 | 1444.000000 | 1175.000000 | 218.990012 | nan | nan | |
| Uruguay | 2531.000000 | 51.000000 | 2105.000000 | 375.000000 | 72.861224 | nan | nan | |
| Benin | 2496.000000 | 41.000000 | 2330.000000 | 125.000000 | 20.588627 | nan | nan | |
| Guinea-Bissau | 2389.000000 | 41.000000 | 1782.000000 | 566.000000 | 121.392400 | nan | nan | |
| Burkina Faso | 2381.000000 | 65.000000 | 1774.000000 | 542.000000 | 11.390558 | nan | nan | |
| Sierra Leone | 2330.000000 | 73.000000 | 1760.000000 | 497.000000 | 29.209031 | nan | nan | |
| Togo | 2057.000000 | 51.000000 | 1531.000000 | 475.000000 | 24.846785 | nan | nan | |
| Yemen | 2056.000000 | 597.000000 | 1338.000000 | 121.000000 | 6.893322 | nan | nan | |
| New Zealand | 1886.000000 | 25.000000 | 1824.000000 | 37.000000 | 39.110512 | nan | nan | |
| Lesotho | 1833.000000 | 42.000000 | 961.000000 | 830.000000 | 85.564163 | nan | nan | |
| Chad | 1379.000000 | 93.000000 | 1181.000000 | 105.000000 | 8.395299 | nan | nan | |
| Liberia | 1377.000000 | 82.000000 | 1268.000000 | 27.000000 | 27.225938 | nan | nan | |
| Niger | 1210.000000 | 69.000000 | 1126.000000 | 15.000000 | 4.998629 | nan | nan | |
| Vietnam | 1134.000000 | 35.000000 | 1031.000000 | 68.000000 | 1.165006 | nan | nan | |
| Sao Tome and Principe | 933.000000 | 15.000000 | 898.000000 | 20.000000 | 425.714429 | nan | nan | |
| San Marino | 759.000000 | 42.000000 | 685.000000 | 32.000000 | 2236.431139 | nan | nan | |
| Diamond Princess | 712.000000 | 13.000000 | 659.000000 | 40.000000 | nan | nan | nan | |
| Papua New Guinea | 581.000000 | 7.000000 | 540.000000 | 34.000000 | 6.493777 | nan | nan | |
| Burundi | 542.000000 | 1.000000 | 497.000000 | 44.000000 | 4.558153 | nan | nan | |
| Taiwan | 535.000000 | 7.000000 | 491.000000 | 37.000000 | 2.246316 | nan | nan | |
| Tanzania | 509.000000 | 21.000000 | 183.000000 | 305.000000 | 0.852108 | nan | nan | |
| Comoros | 502.000000 | 7.000000 | 485.000000 | 10.000000 | 57.728023 | nan | nan | |
| Eritrea | 452.000000 | 0.000000 | 388.000000 | 64.000000 | 12.745222 | nan | nan | |
| Mauritius | 417.000000 | 10.000000 | 364.000000 | 43.000000 | 32.789025 | nan | nan | |

| country | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mor |
|---|---|---|---|---|---|---|---|---|
| Bhutan | 329.000000 | 0.000000 | 299.000000 | 26.000000 | 42.715515 | nan | nan | |
| Mongolia | 324.000000 | 0.000000 | 312.000000 | 12.000000 | 9.883195 | nan | nan | |
| Cambodia | 283.000000 | 0.000000 | 280.000000 | 3.000000 | 1.692688 | nan | nan | |
| Monaco | 265.000000 | 2.000000 | 217.000000 | 46.000000 | 675.262461 | nan | nan | |
| Liechtenstein | 224.000000 | 1.000000 | 132.000000 | 91.000000 | 587.356111 | nan | nan | |
| Barbados | 221.000000 | 7.000000 | 200.000000 | 14.000000 | 76.904072 | nan | nan | |
| Seychelles | 149.000000 | 0.000000 | 148.000000 | 1.000000 | 151.515152 | nan | nan | |
| Brunei | 147.000000 | 3.000000 | 143.000000 | 1.000000 | 33.601306 | nan | nan | |
| Antigua and Barbuda | 119.000000 | 3.000000 | 101.000000 | 15.000000 | 121.517850 | nan | nan | |
| Saint Vincent and the Grenadines | 67.000000 | 0.000000 | 64.000000 | 3.000000 | 60.389195 | nan | nan | |
| Dominica | 33.000000 | 0.000000 | 29.000000 | 4.000000 | 45.839063 | nan | nan | |
| Saint Lucia | 33.000000 | 0.000000 | 27.000000 | 6.000000 | 17.971018 | nan | nan | |
| Fiji | 32.000000 | 2.000000 | 30.000000 | 0.000000 | 3.569660 | nan | nan | |
| Timor-Leste | 29.000000 | 0.000000 | 28.000000 | 1.000000 | 2.199566 | nan | nan | |
| Holy See | 27.000000 | 0.000000 | 15.000000 | 12.000000 | 3337.453646 | nan | nan | |
| Grenada | 27.000000 | 0.000000 | 24.000000 | 3.000000 | 23.995947 | nan | nan | |
| Laos | 23.000000 | 0.000000 | 22.000000 | 1.000000 | 0.316127 | nan | nan | |
| Saint Kitts and Nevis | 19.000000 | 0.000000 | 19.000000 | 0.000000 | 35.719657 | nan | nan | |
| Western Sahara | 10.000000 | 1.000000 | 8.000000 | 1.000000 | 1.674116 | nan | nan | |
| MS Zaandam | 9.000000 | 2.000000 | nan | nan | nan | nan | nan | |
| Solomon Islands | 3.000000 | 0.000000 | nan | nan | 0.459518 | nan | nan | |

## Top 10 countries (Confirmed Cases and Deaths)

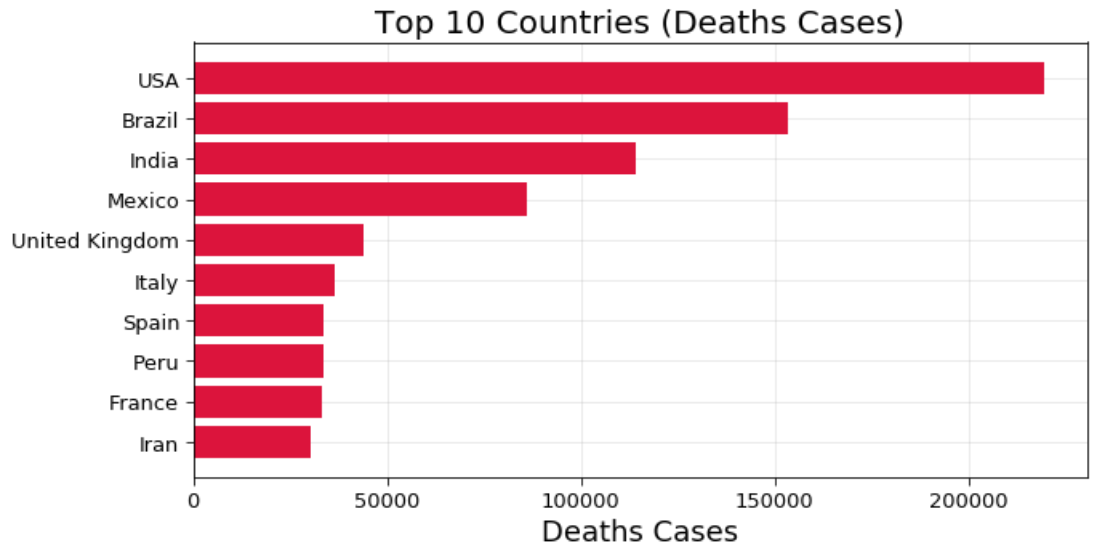
In [17]:

```
f = plt.figure(figsize=(10,5))
f.add_subplot(111)

plt.axes(axisbelow=True)
plt.barh(df_countries_cases.sort_values('Confirmed')["Confirmed"].index[-10:],df_countries_cases.so
rt_values('Confirmed')["Confirmed"].values[-10:],color="darkcyan")
plt.tick_params(size=5,labelsize = 13)
plt.xlabel("Confirmed Cases",fontsize=18)
plt.title("Top 10 Countries (Confirmed Cases)",fontsize=20)
plt.grid(alpha=0.3)
```



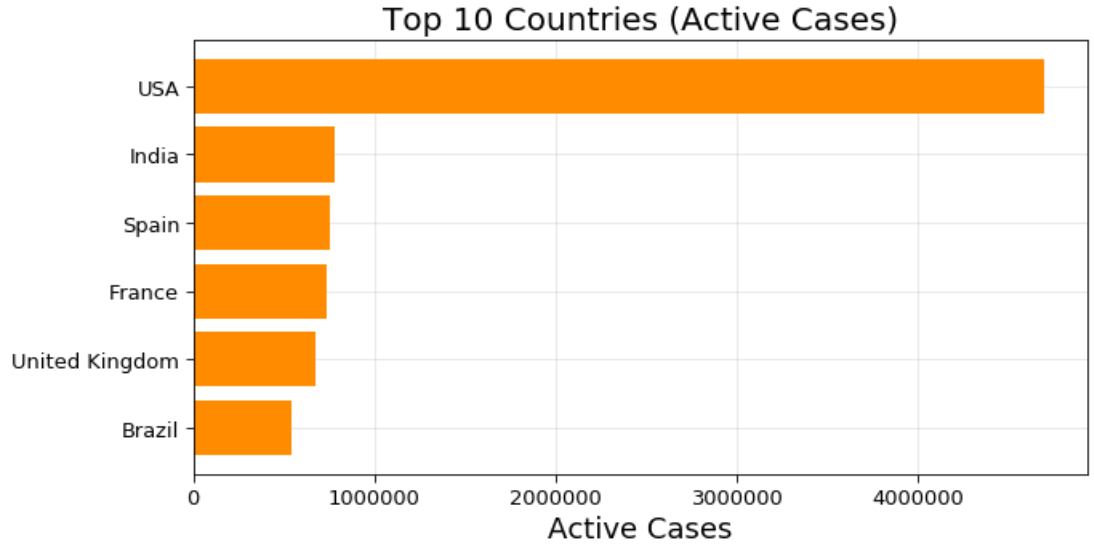
In [18]:

```
f = plt.figure(figsize=(10,5))
f.add_subplot(111)

plt.axes(axisbelow=True)
plt.barh(df_countries_cases.sort_values('Deaths')["Deaths"].index[-10:],df_countries_cases.sort_val
ues('Deaths')["Deaths"].values[-10:],color="crimson")
plt.tick_params(size=5,labelsize = 13)
plt.xlabel("Deaths Cases",fontsize=18)
plt.title("Top 10 Countries (Deaths Cases)",fontsize=20)
plt.grid(alpha=0.3,which='both')
```




In [19]:

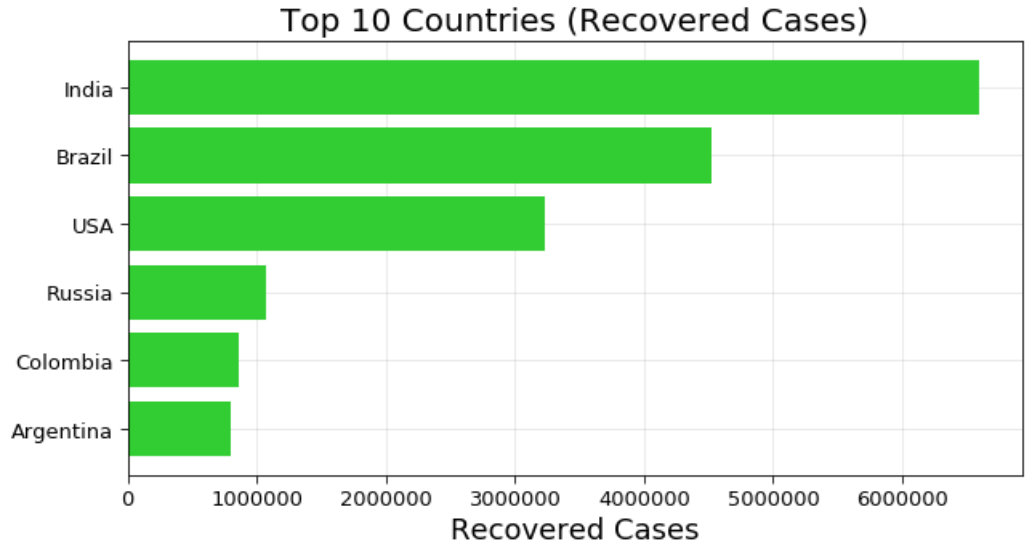
```
f = plt.figure(figsize=(10,5))
f.add_subplot(111)

plt.axes(axisbelow=True)
plt.barh(df_countries_cases.sort_values('Active')["Active"].index[-10:],df_countries_cases.sort_val
ues('Active')["Active"].values[-10:],color="darkorange")
plt.tick_params(size=5,labelsize = 13)
plt.xlabel("Active Cases",fontsize=18)
plt.title("Top 10 Countries (Active Cases)",fontsize=20)
plt.grid(alpha=0.3,which='both')
```




In [20]:

```
f = plt.figure(figsize=(10,5))
```

```
f.add_subplot(111)

plt.axes(axisbelow=True)
plt.barh(df_countries_cases.sort_values('Recovered')["Recovered"].index[-10:],df_countries_cases.so
rt_values('Recovered')["Recovered"].values[-10:],color="limegreen")
plt.tick_params(size=5,labelsize = 13)
plt.xlabel("Recovered Cases",fontsize=18)
plt.title("Top 10 Countries (Recovered Cases)",fontsize=20)
plt.grid(alpha=0.3,which='both')
```




## Correlation Analysis

Plotting Heat map of correlation of confirmed cases, recovered cases, deaths and active cases.

### Country wise Correlation

In [21]:

```
df_countries_cases.corr().style.background_gradient(cmap='Reds')
```

Out[21]:

| | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mortality_Rate | |
|---|---|---|---|---|---|---|---|---|---|
| **Confirmed** | 1.000000 | 0.933599 | 0.935600 | 0.786954 | 0.230247 | nan | nan | 0.025499 | 0.0 |
| **Deaths** | 0.933599 | 1.000000 | 0.821802 | 0.818133 | 0.256028 | nan | nan | 0.116305 | 0.0 |
| **Recovered** | 0.935600 | 0.821802 | 1.000000 | 0.518555 | 0.196777 | nan | nan | 0.025971 | 0.0 |
| **Active** | 0.786954 | 0.818133 | 0.518555 | 1.000000 | 0.210659 | nan | nan | 0.040722 | 0.0 |
| **Incident_Rate** | 0.230247 | 0.256028 | 0.196777 | 0.210659 | 1.000000 | nan | nan | -0.065401 | 0.0 |
| **People_Tested** | nan | nan | nan | nan | nan | nan | nan | nan | |
| **People_Hospitalized** | nan | nan | nan | nan | nan | nan | nan | nan | |
| **Mortality_Rate** | 0.025499 | 0.116305 | 0.025971 | 0.040722 | -0.065401 | nan | nan | 1.000000 | 0.3 |
| **UID** | -0.013810 | -0.014221 | -0.022375 | 0.030262 | -0.094630 | nan | nan | 0.323996 | 1.0 |

### Continent Wise Correlation

In [22]:

```
df_continents_cases.corr().style.background_gradient(cmap='Reds')
```

Out[22]:

| | Confirmed | Deaths | Recovered | Active | Incident_Rate | People_Tested | People_Hospitalized | Mortality_Rate | |
|---|---|---|---|---|---|---|---|---|---|
| **Confirmed** | 1.000000 | 0.910790 | 0.917187 | 0.605240 | 0.687956 | nan | nan | 0.273001 | 0.1 |
| **Deaths** | 0.910790 | 1.000000 | 0.712899 | 0.790698 | 0.622446 | nan | nan | 0.171968 | 0.2 |
| **Recovered** | 0.917187 | 0.712899 | 1.000000 | 0.238127 | 0.554049 | nan | nan | 0.214225 | 0.0 |
| **Active** | 0.605240 | 0.790698 | 0.238127 | 1.000000 | 0.560402 | nan | nan | 0.235580 | 0.0 |
| **Incident_Rate** | 0.687956 | 0.622446 | 0.554049 | 0.560402 | 1.000000 | nan | nan | 0.642148 | 0.3 |
| **People_Tested** | nan | nan | nan | nan | nan | nan | nan | nan | |
| **People_Hospitalized** | nan | nan | nan | nan | nan | nan | nan | nan | |
| **Mortality_Rate** | 0.273001 | 0.171968 | 0.214225 | 0.235580 | 0.642148 | nan | nan | 1.000000 | 0.7 |
| **UID** | -0.118890 | -0.252957 | -0.096877 | -0.093093 | 0.304452 | nan | nan | 0.781978 | 1.0 |

## Visualization on Map

In [23]:

```
world_map = folium.Map(location=[10,0], tiles="cartodbpositron", zoom_start=2,max_zoom=6,min_zoom=2
)
for i in range(0,len(df_confirmed)):
    folium.Circle(
        location=[df_confirmed.iloc[i]['Lat'], df_confirmed.iloc[i]['Long']],
        tooltip = "<h5 style='text-align:center;font-weight: bold'>"+df_confirmed.iloc[i]['country'
]+"</h5>"+
                  "<div style='text-align:center;'>"+str(np.nan_to_num(df_confirmed.iloc[i]
['state']))+"</div>"+
                  "<hr style='margin:10px;'>"+
                  "<ul style='color: #444;list-style-type:circle;align-item:left;padding-
left:20px;padding-right:20px'>"+
        "<li>Confirmed: "+str(df_confirmed.iloc[i,-1])+"</li>"+
        "<li>Deaths:   "+str(df_deaths.iloc[i,-1])+"</li>"+
        "<li>Mortality Rate:   "+str(np.round(df_deaths.iloc[i,-1]/(df_confirmed.iloc[i,-1]+1.00001
)*100,2))+"</li>"+
        "</ul>"
        ,
        radius=(int((np.log(df_confirmed.iloc[i,-1]+1.00001)))+0.2)*50000,
        color='#ff6600',
        fill_color='#ff8533',
        fill=True).add_to(world_map)

world_map
```

Out[23]:

Make this Notebook Trusted to load map: File -> Trust Notebook

## Global Confirmed Cases Heat Map

In [24]:

```
temp_df = pd.DataFrame(df_countries_cases['Confirmed'])
temp_df = temp_df.reset_index()
fig = px.choropleth(temp_df, locations="country",
                    color=np.log10(temp_df.iloc[:,-1]), # lifeExp is a column of gapminder
                    hover_name="country", # column to add to hover information
                    hover_data=["Confirmed"],
                    color_continuous_scale=px.colors.sequential.Plasma,locationmode="country names"
)
fig.update_geos(fitbounds="locations", visible=False)
fig.update_layout(title_text="Confirmed Cases Heat Map (Log Scale)")
fig.update_coloraxes(colorbar_title="Confirmed Cases(Log Scale)",colorscale="Reds")
# fig.to_image("Global Heat Map confirmed.png")
fig.show()
```

## COVID-19 Spread Analysis

Spread Analysis is in two sections

Spread Across Globe

Spread Trends in the World, Continents and few most affected Countries

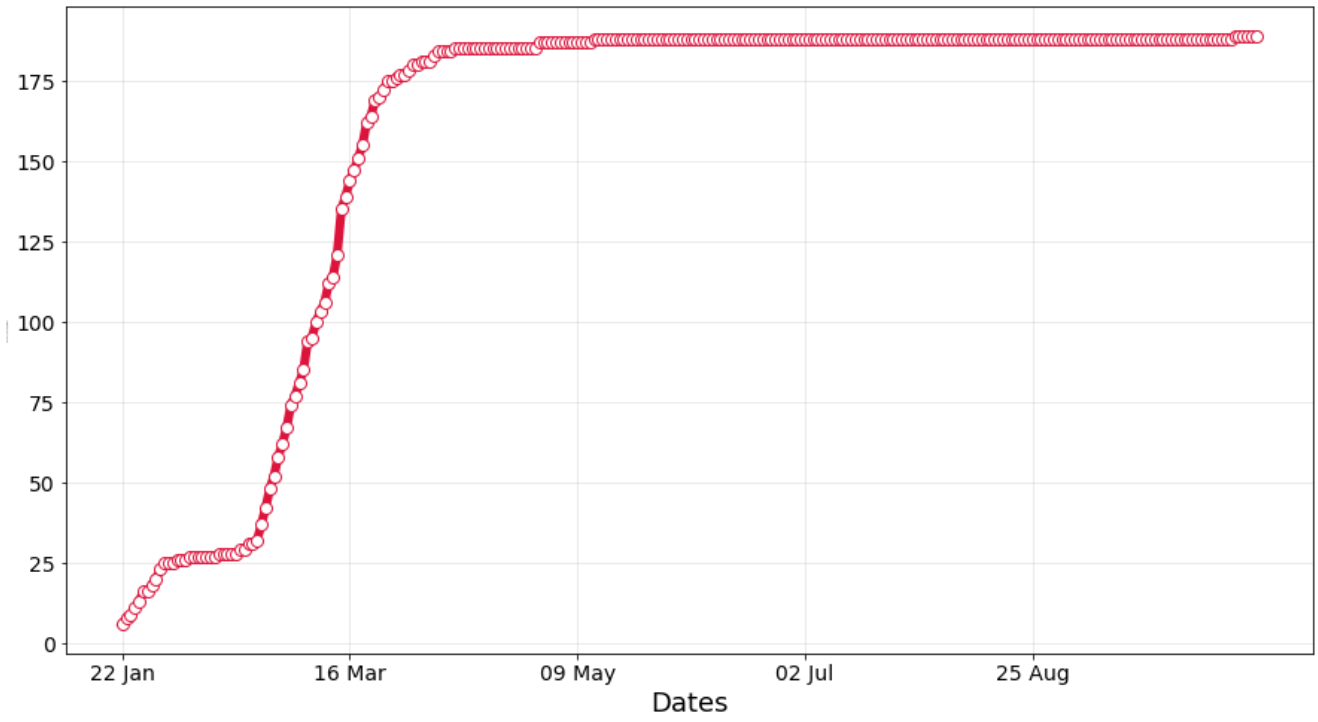
## 1. Spread Across Globe

### Number of countries affected over the time

### Number of countries affected over the time

In [25]:

```
case_nums_country = df_confirmed.groupby("country").sum().drop(['Lat','Long'],axis
=1).apply(lambda x: x[x > 0].count(), axis =0)
d = [datetime.strptime(date,'%m/%d/%y').strftime("%d %b") for date in case_nums_country.index]

f = plt.figure(figsize=(15,8))
f.add_subplot(111)
marker_style = dict(c="crimson",linewidth=6, linestyle='-', marker='o',markersize=8, markerfacecolo
r='#ffffff')
plt.plot(d, case_nums_country,**marker_style)
plt.tick_params(labelsize = 14)
plt.xticks(list(np.arange(0,len(d),int(len(d)/5))),d[:-1:int(len(d)/5)]+[d[-1]])

#labels
plt.xlabel("Dates",fontsize=18)
plt.ylabel("Number of Countries/Regions",fontsize=1)
plt.grid(alpha = 0.3)


plt.show()
plt.close()
```




## 2. Spread Trends in the World, Continents and few most affected Countries

COVID-19 Global Spread Trends

COVID-19 Spread Trends in Different Continents

COVID-19 Spread Trends in Few Most Affected Countries

COVID-19 Spread Comparison of few most affected countries

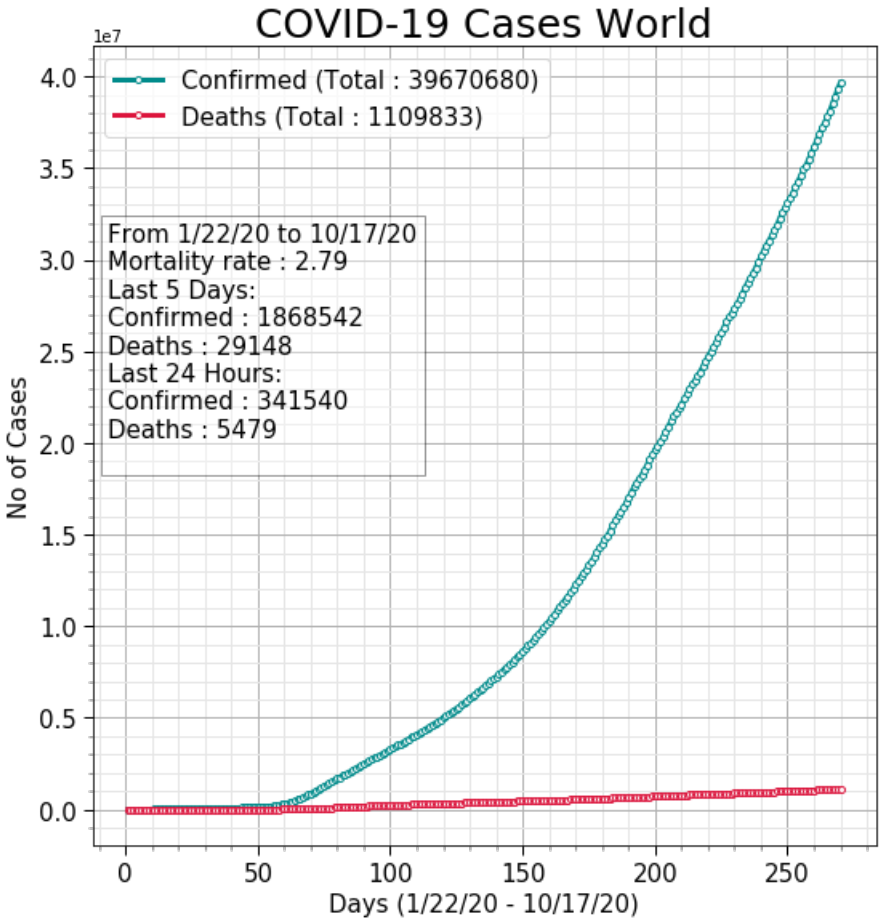
COVID-19 Spread Comparison of in different continents

## 1. COVID-19 Global Spread Trends

In [26]:

```
cols = 1
rows = 1
f = plt.figure(figsize=(10,10*rows))
visualize_covid_cases(df_confirmed, df_deaths,continent = "All",figure = [f,rows,cols, 1])
```

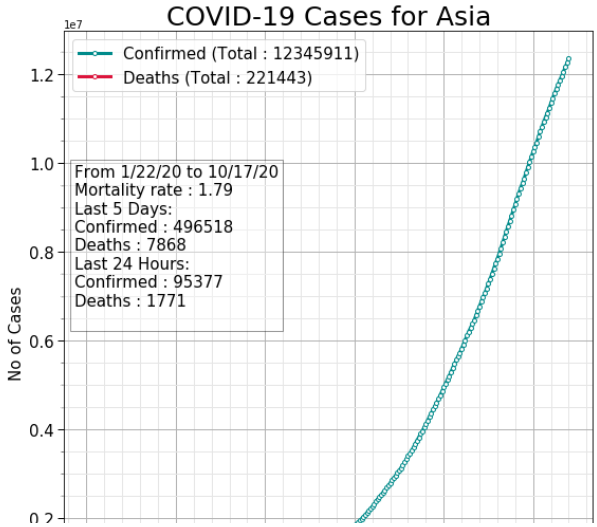
```
#plt.savefig(out+'COIVD-19-World.png')
plt.show()
```

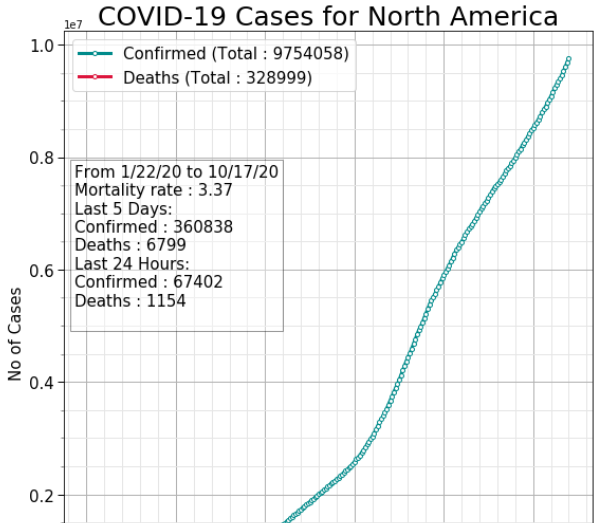


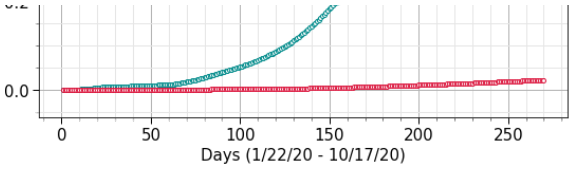

## 2 . COVID-19 Spread Trends in Different Continents

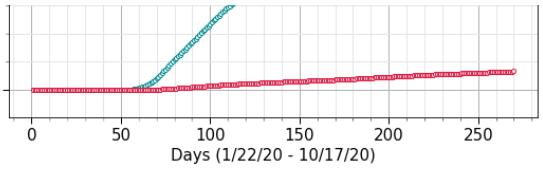
In [27]:

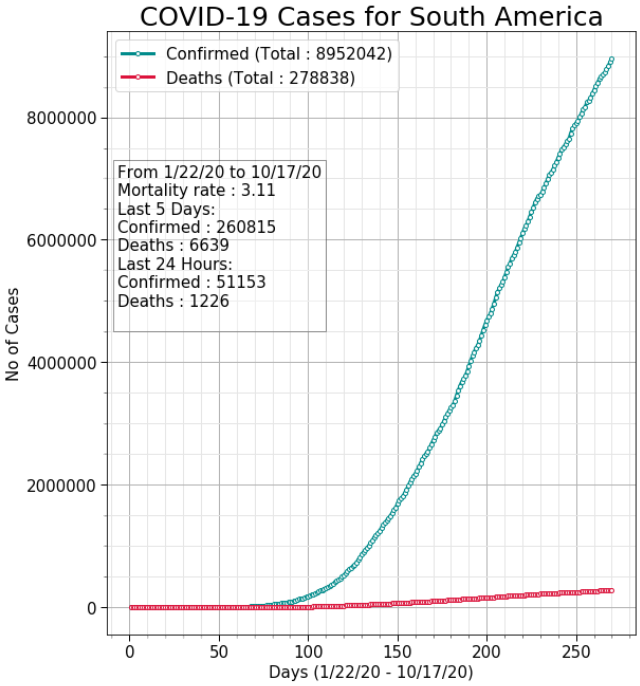
```
df_continents= df_confirmed.groupby(["continent"]).sum()
continents = df_continents.sort_values(df_continents.columns[-1],ascending = False).index

cols =2
rows = int(np.ceil(continents.shape[0]/cols))
f = plt.figure(figsize=(20,10*rows))
for i,continent in enumerate(continents):
    visualize_covid_cases(df_confirmed, df_deaths, continent = continent,figure = [f,rows,cols, i+1
])

plt.show()
```

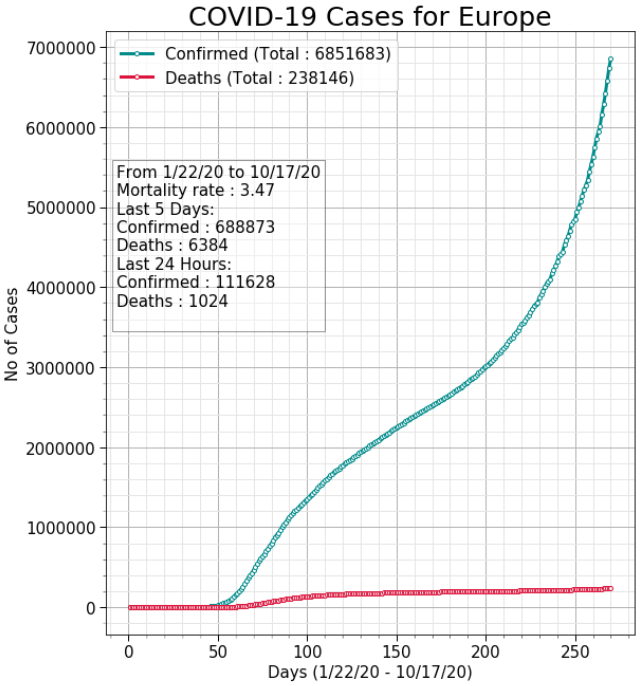


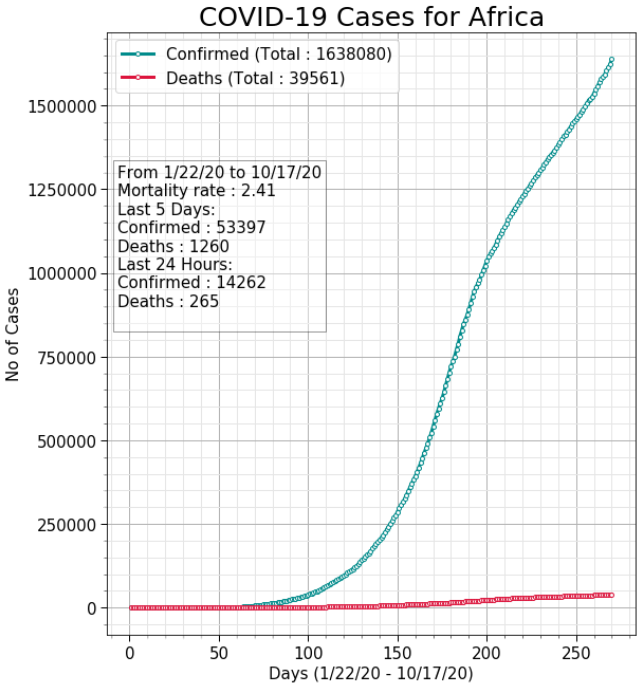



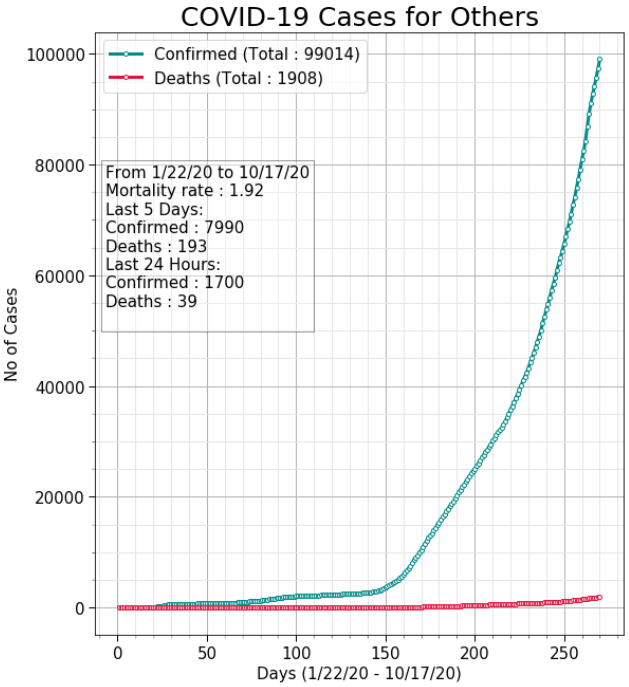

0.0
0
50
100
150
200
250
Days (1/22/20 - 10/17/20)

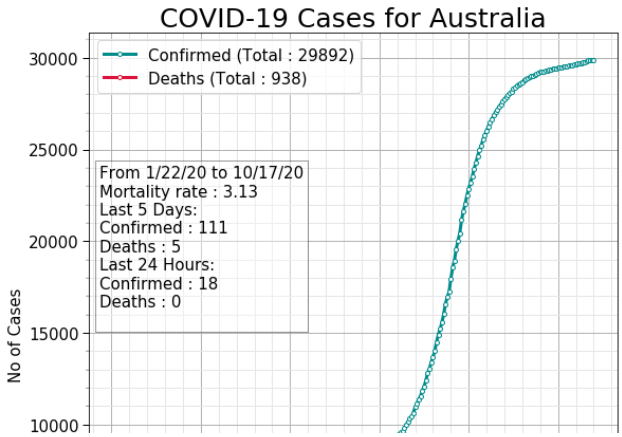

0.0
0
50
100
150
200
250
Days (1/22/20 - 10/17/20)

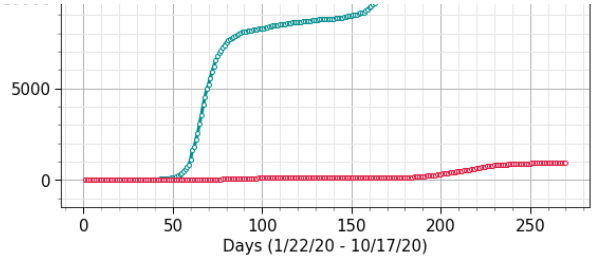

COVID-19 Cases for South America
Confirmed (Total : 8952042)
Deaths (Total : 278838)
From 1/22/20 to 10/17/20
Mortality rate : 3.11
Last 5 Days:
Confirmed : 260815
Deaths : 6639
Last 24 Hours:
Confirmed : 51153
Deaths : 1226
No of Cases
8000000
6000000
4000000
2000000
0
0
50
100
150
200
250
Days (1/22/20 - 10/17/20)


COVID-19 Cases for Europe
Confirmed (Total : 6851683)
Deaths (Total : 238146)
From 1/22/20 to 10/17/20
Mortality rate : 3.47
Last 5 Days:
Confirmed : 688873
Deaths : 6384
Last 24 Hours:
Confirmed : 111628
Deaths : 1024
No of Cases
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
0
50
100
150
200
250
Days (1/22/20 - 10/17/20)


COVID-19 Cases for Africa
Confirmed (Total : 1638080)
Deaths (Total : 39561)
From 1/22/20 to 10/17/20
Mortality rate : 2.41
Last 5 Days:
Confirmed : 53397
Deaths : 1260
Last 24 Hours:
Confirmed : 14262
Deaths : 265
No of Cases
1500000
1250000
1000000
750000
500000
250000
0
0
50
100
150
200
250
Days (1/22/20 - 10/17/20)


COVID-19 Cases for Others
Confirmed (Total : 99014)
Deaths (Total : 1908)
From 1/22/20 to 10/17/20
Mortality rate : 1.92
Last 5 Days:
Confirmed : 7990
Deaths : 193
Last 24 Hours:
Confirmed : 1700
Deaths : 39
No of Cases
100000
80000
60000
40000
20000
0
0
50
100
150
200
250
Days (1/22/20 - 10/17/20)


COVID-19 Cases for Australia
Confirmed (Total : 29892)
Deaths (Total : 938)
From 1/22/20 to 10/17/20
Mortality rate : 3.13
Last 5 Days:
Confirmed : 111
Deaths : 5
Last 24 Hours:
Confirmed : 18
Deaths : 0
No of Cases
30000
25000
20000
15000
10000

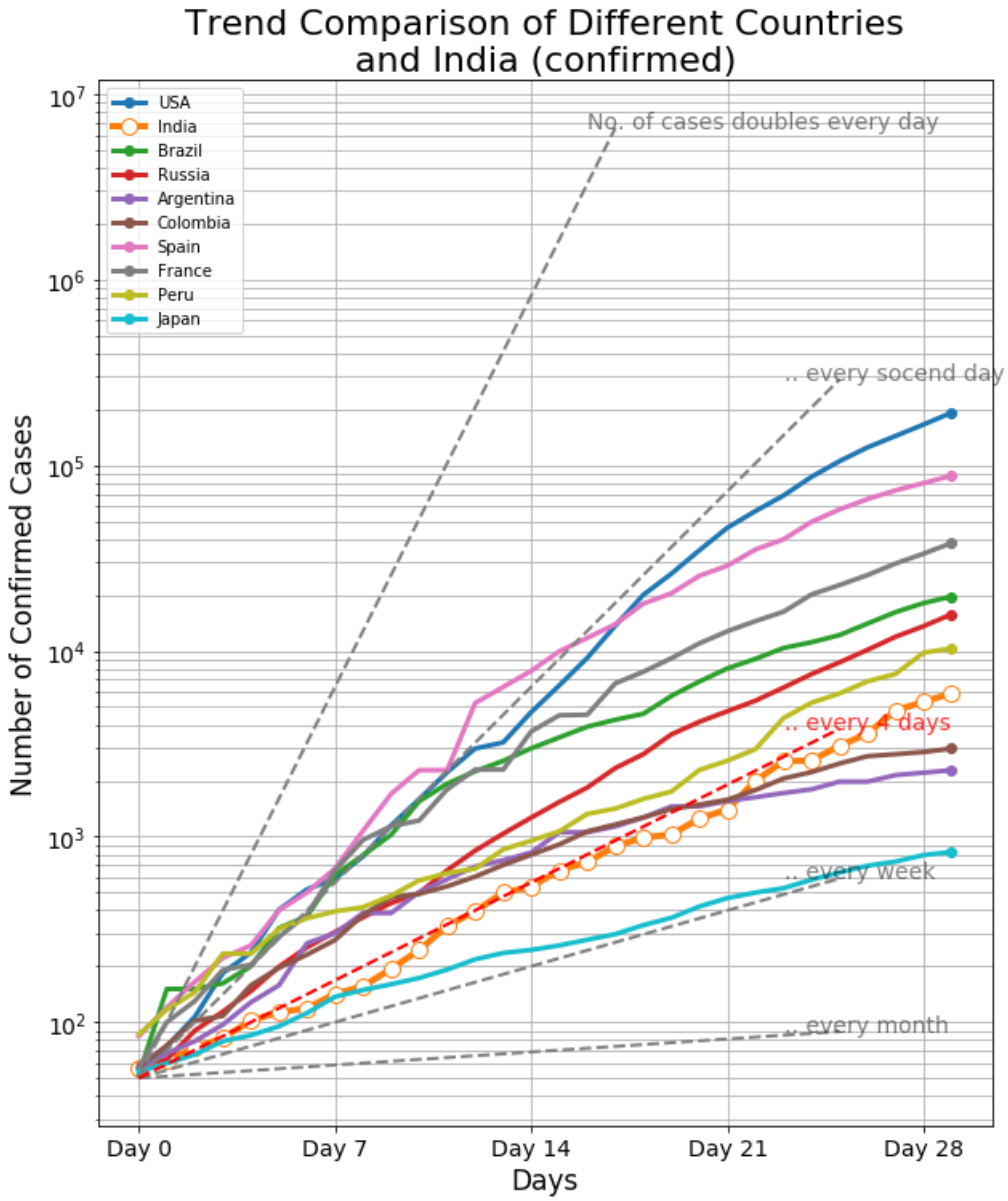



### 4. COVID-19 Spread Comparison of few most affected countries and INDIA

In [28]:

```
temp = df_confirmed.groupby('country').sum().drop(["Lat","Long"],axis =1).sort_values(df_confirmed
.columns[-1], ascending= False)

threshold = 50
f = plt.figure(figsize=(10,12))
ax = f.add_subplot(111)
for i,country in enumerate(temp.index):
    if i >= 9:
        if country != "India" and country != "Japan" :
            continue
    x = 30
    t = temp.loc[temp.index== country].values[0]
    t = t[t>threshold][:x]

    date = np.arange(0,len(t[:x]))
    xnew = np.linspace(date.min(), date.max(), 30)
    spl = make_interp_spline(date, t, k=1)  # type: BSpline
    power_smooth = spl(xnew)
    if country != "India":
        plt.plot(xnew,power_smooth,'-o',label = country,linewidth =3, markevery=[-1])
    else:
        marker_style = dict(linewidth=4, linestyle='-', marker='o',markersize=10, markerfacecolor='
#ffffff')
        plt.plot(date,t,"-.",label = country,**marker_style)

plt.tick_params(labelsize = 14)
plt.xticks(np.arange(0,30,7),[ "Day "+str(i) for i in range(30)][::7])

# Reference lines
x = np.arange(0,18)
y = 2**(x+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate("No. of cases doubles every day",(x[-2],y[-1]),xycoords="data",fontsize=14,alpha = 0.5
)

x = np.arange(0,26)
y = 2**(x/2+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every socend day",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)

x = np.arange(0,26)
y = 2**(x/7+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every week",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)

x = np.arange(0,26)
y = 2**(x/30+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every month",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)


# India is following trend similar to doulbe the cases in 4 days but it may increase the rate
x = np.arange(0,26)
y = 2**(x/4+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "Red")
plt.annotate(".. every 4 days",(x[-3],y[-1]),color="Red",xycoords="data",fontsize=14,alpha = 0.8)

# plot Params
plt.xlabel("Days",fontsize=17)
plt.ylabel("Number of Confirmed Cases",fontsize=17)
```

```
plt.title("Trend Comparison of Different Countries\n and India (confirmed) ",fontsize=22)
plt.legend(loc = "upper left")
plt.yscale("log")
plt.grid(which="both")
#plt.savefig(out+'Trend Comparison with India (confirmed).png')
plt.show()
```

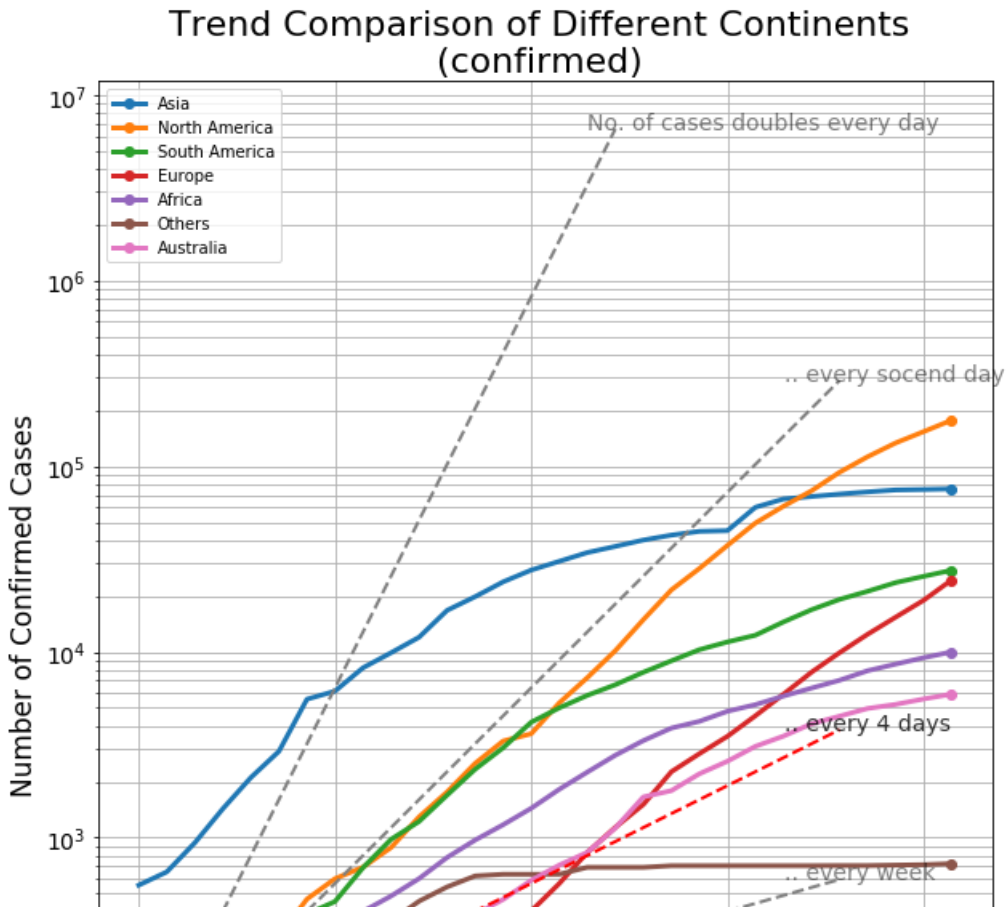


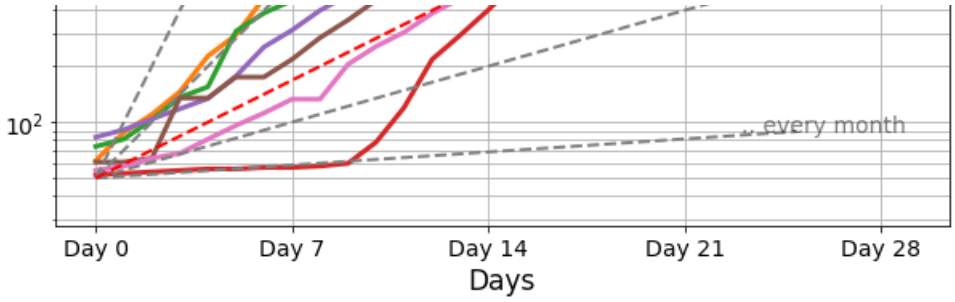

### 5. COVID-19 Spread Comparison of in different continents

In [29]:

```
temp = df_confirmed.groupby('continent').sum().drop(["Lat","Long"],axis =1).sort_values(df_confirme
d.columns[-1], ascending= False)

threshold = 50
f = plt.figure(figsize=(10,12))
ax = f.add_subplot(111)
for i,country in enumerate(temp.index):
    if i > 10:
        break
    x = 30
    t = temp.loc[temp.index== country].values[0]
    t = t[t>threshold][:x]

    date = np.arange(0,len(t[:x]))
    xnew = np.linspace(date.min(), date.max(), 30)
    spl = make_interp_spline(date, t, k=1)  # type: BSpline
    power_smooth = spl(xnew)
    plt.plot(xnew,power_smooth,'-o',label = country,linewidth =3, markevery=[-1])
```

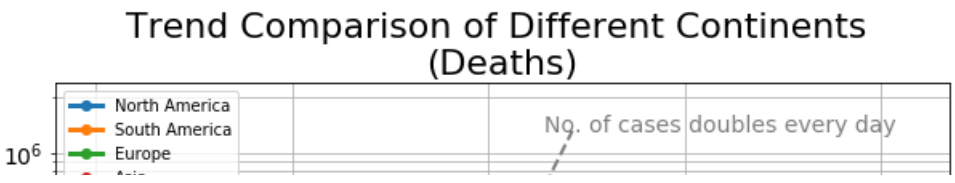
```
plt.tick_params(labelsize = 14)
plt.xticks(np.arange(0,30,7),[ "Day "+str(i) for i in range(30)][::7])

# Reference lines
x = np.arange(0,18)
y = 2**(x+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate("No. of cases doubles every day",(x[-2],y[-1]),xycoords="data",fontsize=14,alpha = 0.5
)

x = np.arange(0,26)
y = 2**(x/2+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every socend day",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)

x = np.arange(0,26)
y = 2**(x/7+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every week",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)

x = np.arange(0,26)
y = 2**(x/30+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every month",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)


# India is following trend similar to doulbe the cases in 4 days but it may increase the rate
x = np.arange(0,26)
y = 2**(x/4+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "Red")
plt.annotate(".. every 4 days",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.8)

# plot Params
plt.xlabel("Days",fontsize=17)
plt.ylabel("Number of Confirmed Cases",fontsize=17)
plt.title("Trend Comparison of Different Continents \n(confirmed) ",fontsize=22)
plt.legend(loc = "upper left")
plt.yscale("log")
plt.grid(which="both")
#plt.savefig(out+'Trend Comparison of continents (Confirmed).png')
plt.show()
```

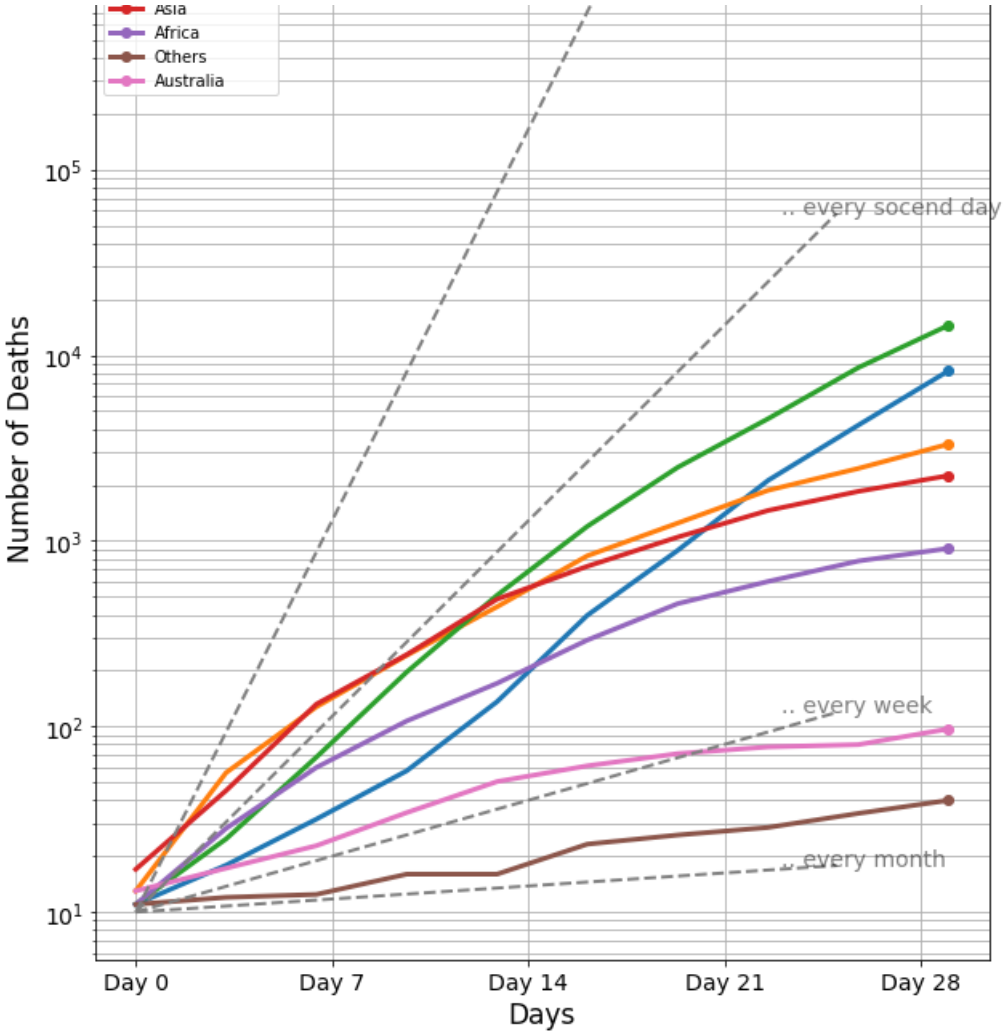





In [30]:

```
temp = df_deaths.groupby('continent').sum().drop(["Lat","Long"],axis
=1).sort_values(df_deaths.columns[-1], ascending= False)

threshold = 10
f = plt.figure(figsize=(10,12))
ax = f.add_subplot(111)
for i,country in enumerate(temp.index):
    if i > 10:
        break
    x = 30
    t = temp.loc[temp.index== country].values[0]
    t = t[t>threshold][:x]

    date = np.arange(0,len(t[:x]))
    xnew = np.linspace(date.min(), date.max(), 10)
    spl = make_interp_spline(date, t, k=1)  # type: BSpline
    power_smooth = spl(xnew)
    plt.plot(xnew,power_smooth,'-o',label = country,linewidth =3, markevery=[-1])


plt.tick_params(labelsize = 14)
plt.xticks(np.arange(0,30,7),[ "Day "+str(i) for i in range(30)][::7])

# Reference lines
x = np.arange(0,18)
y = 2**(x+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate("No. of cases doubles every day",(x[-2],y[-1]),xycoords="data",fontsize=14,alpha = 0.5
)

x = np.arange(0,26)
y = 2**(x/2+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every socend day",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)

x = np.arange(0,26)
y = 2**(x/7+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every week",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)

x = np.arange(0,26)
y = 2**(x/30+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. every month",(x[-3],y[-1]),xycoords="data",fontsize=14,alpha = 0.5)

# plot Params
plt.xlabel("Days",fontsize=17)
plt.ylabel("Number of Deaths",fontsize=17)
plt.title("Trend Comparison of Different Continents \n(Deaths)",fontsize=22)
plt.legend(loc = "upper left")
plt.yscale("log")
plt.grid(which="both")
#plt.savefig(out+'Trend Comparison continents (deaths).png')
plt.show()
```






## Global Prediction

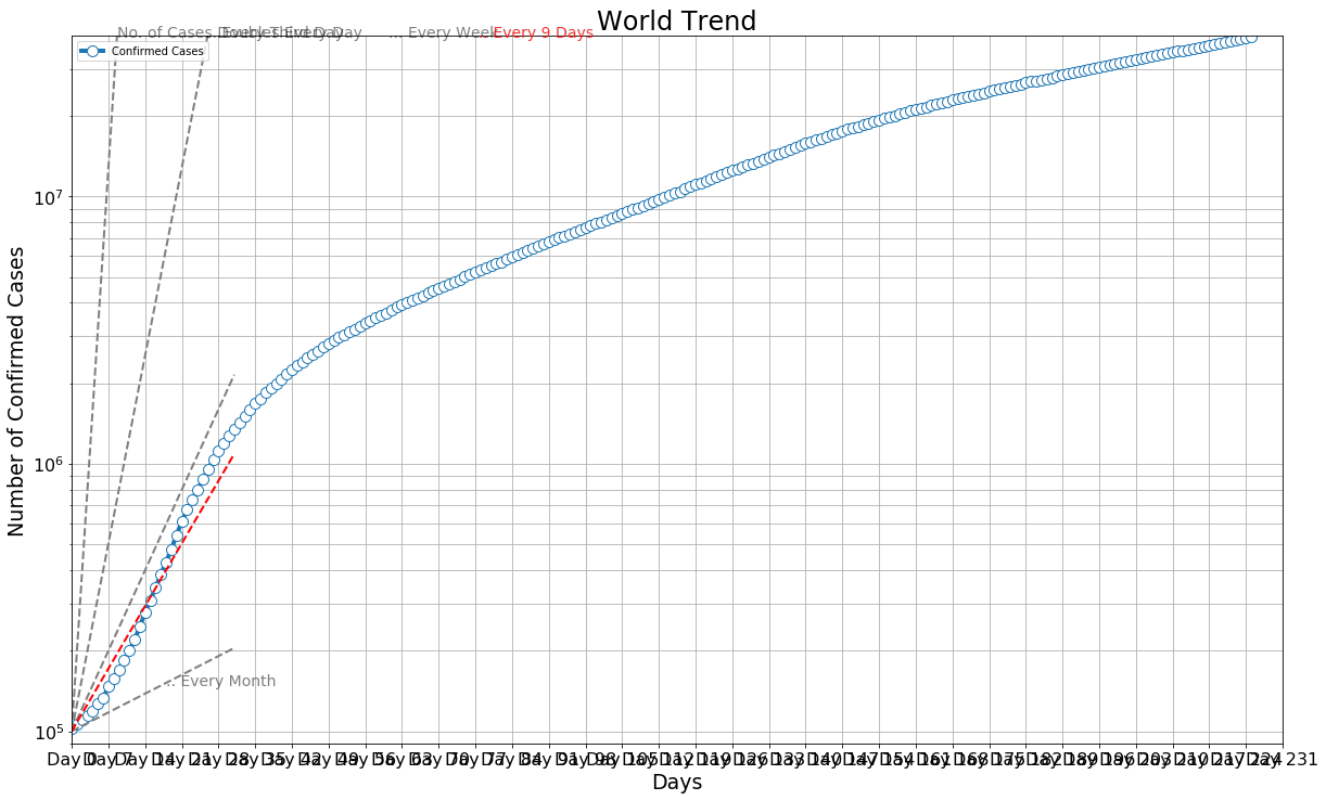
### Global Trend:

It is useful to understand the global trend of an increase in the number of cases over time. There is always a pattern in any data, but the concern is how strongly data follows a pattern. COVID-19 spreads exponentially, positive cases of COVID-19 takes 67 days to reach 1 Lakhs while it takes only 11 days to reach 2 Lakhs, 4 days to reach 3 Lakhs, and just 2 days to reach 5 Lakhs. This trend shows how fast it spreads.

In [31]:

```
temp_data = df_confirmed.iloc[:,5:].sum(axis =0)
f = plt.figure(figsize=(20,12))
f.add_subplot(111)

threshold = 100000

t = temp_data.values
t = t[t >threshold]

date = np.arange(0,len(t[:]))
xnew = np.linspace(date.min(), date.max(), 10)
spl = make_interp_spline(date, t, k=1)  # type: BSpline
power_smooth = spl(xnew)

marker_style = dict(linewidth=4, linestyle='-', marker='o',markersize=10, markerfacecolor='#ffffff'
)
plt.plot(date,t,"-.",label="Confirmed Cases",**marker_style)


# Reference lines
x = np.arange(0,32)
y = 2**(x+np.log2(threshold))
plt.plot(x,y,"--",linewidth=2,color="gray")
```

```
plt.plot(x,y,    ,linewidth =2,color = "gray")
plt.annotate("No. of Cases Doubles Every Day",
(np.log2((t.max()-threshold)/threshold),t.max()-threshold/2),xycoords="data",fontsize=14,alpha = 0.
5)

x = np.arange(0,32)
y = 2**(x/3+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate("...Every Third Day",
(np.log2((t.max()-threshold)/threshold)*3,t.max()-threshold),xycoords="data",fontsize=14,alpha = 0.
5)

x = np.arange(0,32)
y = 2**(x/7+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate("... Every Week",(np.log2((t.max()-threshold)/threshold)*7,t.max()-threshold),xycoords
="data",fontsize=14,alpha = 0.5)

x = np.arange(0,32)
y = 2**(x/30+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "gray")
plt.annotate(".. Every Month",(18,2**(17/30+np.log2(threshold))),xycoords="data",fontsize=14,alpha
= 0.5)

x = np.arange(0,32)
y = 2**(x/9+np.log2(threshold))
plt.plot(x,y,"--",linewidth =2,color = "Red")
plt.annotate(".. Every 9 Days",(np.log2((t.max()-threshold)/threshold)*9,t.max()-threshold),color="
Red",xycoords="data",fontsize=14,alpha = 0.8)


plt.xlim(date[0],date[-1])
plt.ylim(threshold - threshold/10,t.max()+threshold)
# plot Params
# plt.tight_layout()
plt.tick_params(labelsize = 16)
plt.xticks(np.arange(0,len(t[:])+7,7),[ "Day "+str(i) for i in range(len(t[:])+7)][::7])
plt.xlabel("Days",fontsize=19)
plt.ylabel("Number of Confirmed Cases",fontsize=19)
plt.title("World Trend",fontsize=24)
plt.legend(loc = "upper left")
plt.yscale("log")
plt.grid(which="both")
#plt.savefig(out+"World Trend Confirmed cases.png")
plt.show()
```



## Prediction Curve for Global Death Cases

Buliding Model

In [32]:

```
# Dense_l1 = Dense(80,name="Dense_l1")(Visible)
# LRelu_l1 = LeakyReLU(name = "LRelu_l1")(Dense_l1)
# Dense_l2 = Dense(80,name = "Dense_l2")(LRelu_l1)
# LRelu_l2 = LeakyReLU(name = "LRelu_l2")(Dense_l2)
# Dense_l3 = Dense(1,name="Dense_l3")(LRelu_l2)
# LRelu_l3 = LeakyReLU(name = "Output")(Dense_l3)
# model2 = models.Model(inputs=Visible, outputs=LRelu_l3)
# model2.compile(optimizer=Adam(lr=0.0001),
#                loss='mean_squared_error',
#                metrics=['accuracy'])
# model2.summary()
```

In [33]:

```
data_y = np.log10(np.asarray(df_confirmed.sum()[5:]).astype("float32"))
data_x = np.arange(1,len(data_y)+1)
```

In [ ]:

In [ ]:

## COVID-19 Mortality Rate Variation Over Period of Time

For any epidemic the one of the most important evaluation is Mortality Rate. It is the measure of number of deaths in a particular population during a specific interval.

1st curve shows how the mortality rate varies from 22 JAN 2020 to till date all over the world.

2nd Curve shows the variation of mortality rate in different continents over time.

In [41]:

```
df_continents= df_confirmed.groupby(["continent"]).sum()
continents = df_continents.sort_values(df_continents.columns[-1],ascending = False).index
continents = ["All"]+list(continents)

cols =1
rows = 2
axis_label = ["Days ("+df_confirmed.columns[5]+" - "+df_confirmed.columns[-1]+")","Mortality Rate (
of 100)"]

f = plt.figure(figsize=(15,10*rows))

#SubPlot 1
ax = f.add_subplot(211)
mortality_rate = get_mortality_rate(df_confirmed,df_deaths,continent=continents[0])
plt.plot(np.arange(1,mortality_rate.shape[0]+1),mortality_rate,label = "World : Current Mortality R
ate "+str(mortality_rate[-1]))

plt_title = "COVID-19: World Mortality Rate Curve"
plot_params(ax,axis_label,plt_title)
# Legend Location
l = plt.legend(loc= "best")


#SubPlot 2
ax = f.add_subplot(212)
for i, continent in enumerate(continents[1:]):
    mortality_rate = get_mortality_rate(df_confirmed,df_deaths,continent=continent)
```

```
    plt.plot(np.arange(1+mortality_rate[mortality_rate == 0].shape[0],mortality_rate[mortality_rate
== 0].shape[0]+mortality_rate[mortality_rate > 0].shape[0]+1),mortality_rate[mortality_rate > 0],la
bel = continents[i+1]+" "+str(mortality_rate[-1]))

plt_title = "COVID-19: Mortality Rate Curve for all Continents"
plot_params(ax,axis_label,plt_title)

# Legend Location
l = plt.legend(loc= "best")

plt.minorticks_on()
#plt.savefig(out+'Mortality rate.png')
plt.show()
```

```
C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:112: RuntimeWarning:

invalid value encountered in true_divide

C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:112: RuntimeWarning:

invalid value encountered in true_divide

C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:112: RuntimeWarning:

invalid value encountered in true_divide

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invalid value encountered in true_divide

C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:112: RuntimeWarning:

invalid value encountered in true_divide
```
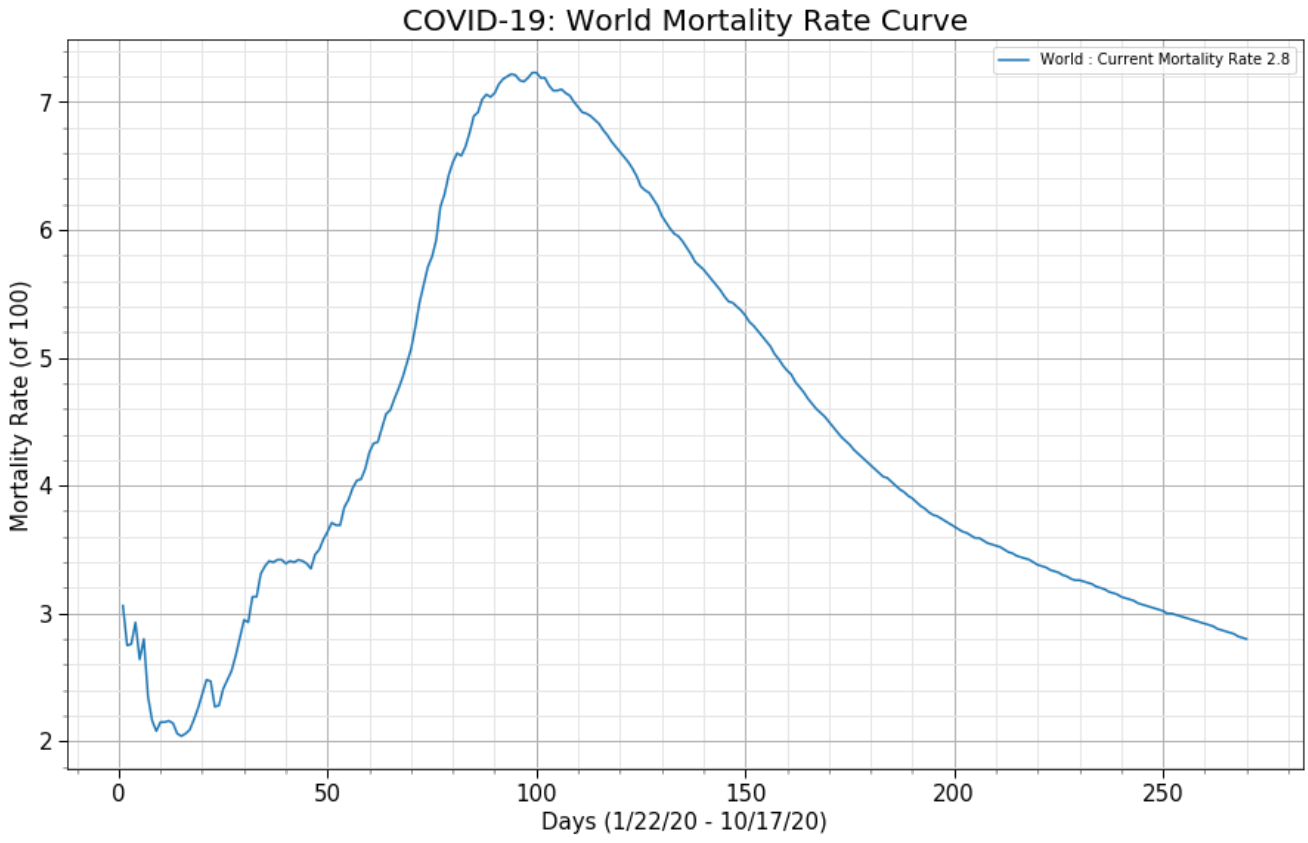
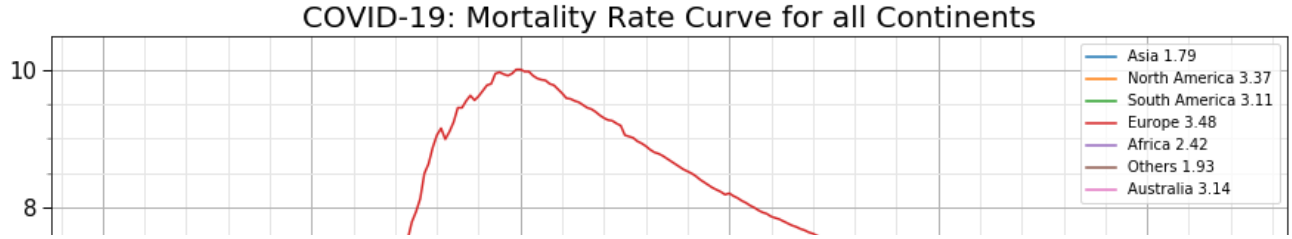
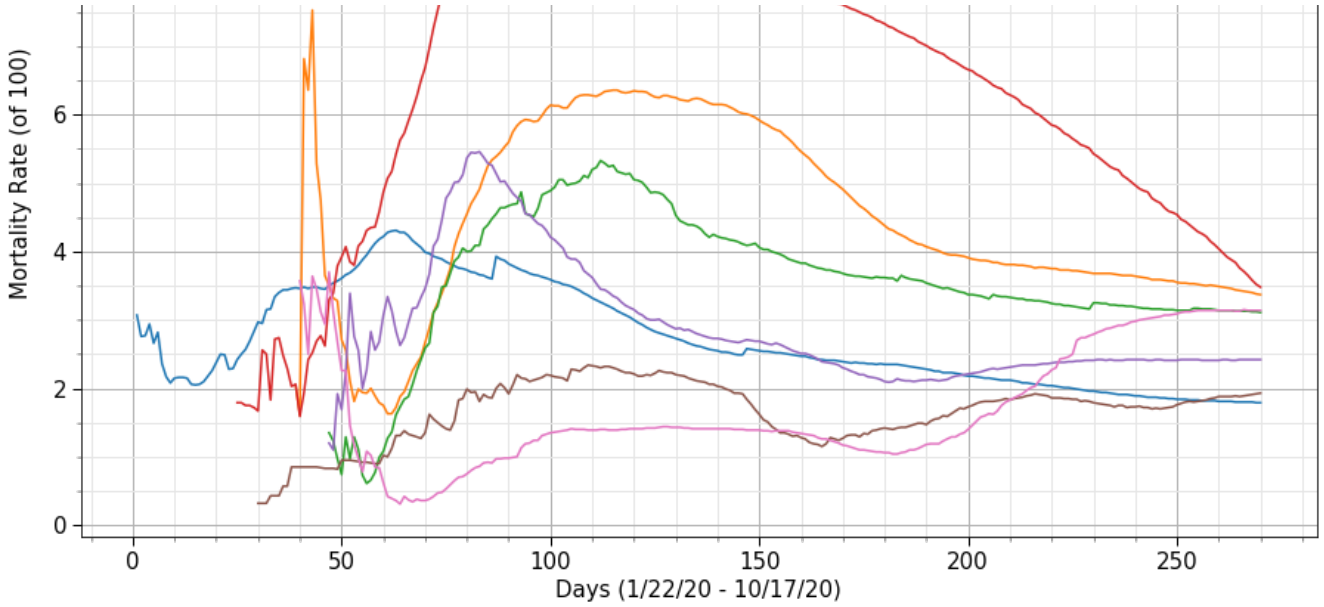






### COVID-19: Change in Mortality Rate of Each Countries Over Time

In [42]:

```
df_data = df_table.groupby(['Last_Update', 'Country_Region'])['Confirmed', 'Deaths','continent'].ma
x().reset_index()
df_data["Last_Update"] = pd.to_datetime( df_data["Last_Update"]).dt.strftime('%m/%d/%Y')

fig = px.scatter(df_data, y=100*df_data["Deaths"]/(df_data["Confirmed"]+1),
                 x= df_data["Confirmed"]+1,
                 range_y = [-1,18],
                 range_x = [1,df_data["Confirmed"].max()+10000],
                 color= "continent", hover_name="Country_Region",
                 hover_data=["Confirmed","Deaths"],
                 range_color= [0, max(np.power(df_data["Confirmed"],0.3))],
                 animation_frame="Last_Update",
                 animation_group="Country_Region",
                 color_continuous_scale=px.colors.sequential.Plasma,
                 title='COVID-19: Change in Mortality Rate of Each Countries Over Time',
                 size = np.power(df_data["Confirmed"]+1,0.3)-0.5,
                 size_max = 30,
                 log_x=True,
                 height =700,
                 )
fig.update_coloraxes(colorscale="hot")
fig.update(layout_coloraxis_showscale=False)
fig.update_xaxes(title_text="Confirmed Cases (Log Scale)")
fig.update_yaxes(title_text="Mortality Rate (%)")
fig.show()
```

```
C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:1: FutureWarning:

Indexing with multiple keys (implicitly converted to a tuple of keys) will be deprecated, use a li
st instead.
```

## Cumulative Confirmed Cases and Cumulative Recovery Vs Cumulative Deaths Analysis

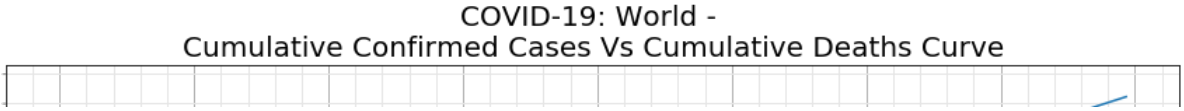
The variation of Cumulative Confirmed Cases and Cumulative Recovery with Cumulative Deaths can show a trend. These 2 curves depict the same. Also, these curves should be a straight line as shown in the 1st curve, but the 2nd curve is not showing that trend, and as the number of recovered cases is increasing, death is increasing at a faster rate.

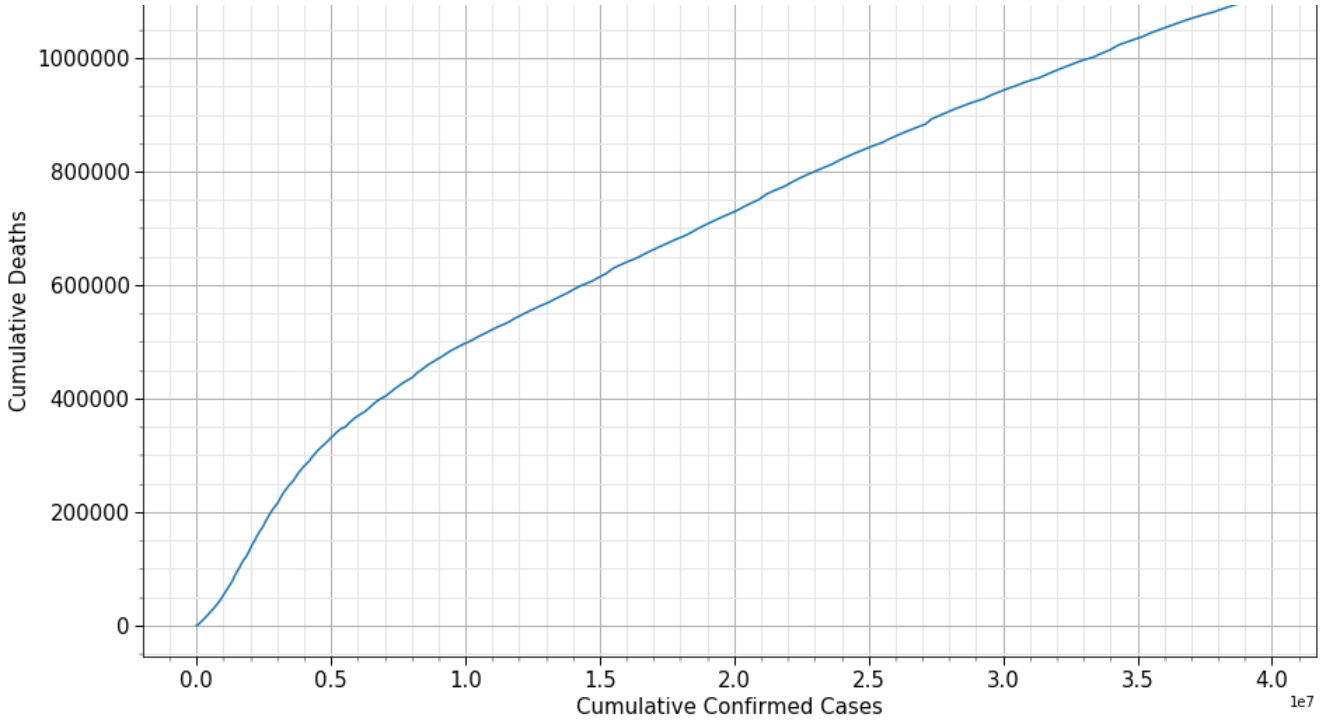
1st curve: Cumulative Confirmed Cases VS Cumulative Deaths

2nd curve: Cululative Recovery VS Cumulative Deaths

In [43]:

```
cols =1
rows = 2

f = plt.figure(figsize=(15,10*rows))

# SubPlot 1
ax = f.add_subplot(211)
plt.plot(np.sum(np.asarray(df_confirmed.iloc[:,5:]),axis = 0),np.sum(np.asarray(df_deaths.iloc[:,5
:]),axis = 0))

axis_label = ["Cumulative Confirmed Cases","Cumulative Deaths"]
plt_title = "COVID-19: World - \nCumulative Confirmed Cases Vs Cumulative Deaths Curve"
plot_params(ax,axis_label,plt_title)


# # SubPlot 2
# ax = f.add_subplot(212)
# mortality_rate = get_mortality_rate(df_confirmed,df_deaths,continent=continents[0])
# plt.plot(np.sum(np.asarray(df_recovered.iloc[:,5:]),axis =
0),np.sum(np.asarray(df_deaths.iloc[:,5:]),axis = 0))

# axis_label = ["Cumulative Recoveries","Cumulative Deaths"]
# plt_title = "COVID-19: World - Cumulative Recovery Vs Cumulative Deaths Curve"

# plot_params(ax,axis_label,plt_title)
plt.minorticks_on()
#plt.savefig(out+'Cumulative Confirmed Cases Vs Cumulative Deaths Curve.png')
plt.show()
```






### Variation of Deaths vs Confirmed cases of different cuntries over time

In [44]:

```
df_data = df_table.groupby(['Last_Update', 'Country_Region'])['Confirmed', 'Deaths','continent'].ma
x().reset_index()
df_data["Last_Update"] = pd.to_datetime( df_data["Last_Update"]).dt.strftime('%m/%d/%Y')

fig = px.scatter(df_data, y=df_data["Deaths"],
                    x= df_data["Confirmed"]+1,
                    range_y = [1,df_data["Deaths"].max()+1000],
                    range_x = [1,df_data["Confirmed"].max()+10000],
                    color= "continent", hover_name="Country_Region",
                    hover_data=["Confirmed","Deaths"],
                    range_color= [0, max(np.power(df_data["Confirmed"],0.3))],
                    animation_frame="Last_Update",
                    animation_group="Country_Region",
                    color_continuous_scale=px.colors.sequential.Plasma,
                    title='COVID-19: Change Deaths vs Cofirmed of Each Countries Over Time',
                    size = np.power(df_data["Confirmed"]+1,0.3)-0.5,
                    size_max = 30,
                    log_x=True,
                    log_y=True,
                    height =700,
                    )
fig.update_coloraxes(colorscale="hot")
fig.update(layout_coloraxis_showscale=False)
fig.update_xaxes(title_text="Confirmed Cases (Log Scale)")
fig.update_yaxes(title_text="Deaths Rate (Log Scale)")
fig.show()
```

```
C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:1: FutureWarning:

Indexing with multiple keys (implicitly converted to a tuple of keys) will be deprecated, use a li
st instead.
```

# COVID-19 : INDIA

**Few basic visualization related to India. I will be updating with more visualization in further commits. i am also working on Paitent Data Insights. Adding Soon**

Dataset: This dataset is provided by https://api.rootnet.in/

## Analysis of Tests done in India

In [45]:

```
#For runing this command connect to your internet
df_india_test = pd.io.json.json_normalize(requests.get('https://api.rootnet.in/covid19-
in/stats/testing/history').json()['data']).rename(columns =
{"totalIndividualsTested":"c_individualtest","totalPositiveCases":"c_positive","totalSamplesTested"
:"c_tests"})
```

```
C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:2: FutureWarning:

pandas.io.json.json_normalize is deprecated, use pandas.json_normalize instead
```

In [46]:

```
df_india_test["p2t_ratio"]= np.round(100*df_india_test["c_positive"]/df_india_test["c_tests"],2)
df_india_test["positive"] = df_india_test["c_positive"].diff()
df_india_test["tests"] = df_india_test["c_tests"].diff()
df_india_test["p2t_ratio"]= np.round(100*df_india_test["positive"]/df_india_test["tests"],2)
```

### Total tests done till date (30 March 2020) in India

In [47]:

```
df_india_test["c_tests"][-1:].values[0]
```

Out[47]:

```
94224190.0
```

### Test Conducted per Million People

In [48]:

```
np.round(1000000*df_india_test["c_tests"][-1:].values[0]/1300000000,2)
```

Out[48]:

```
72480.15
```

## COVID19 Cases in India

In [49]:

```
india_data_json = requests.get('https://api.rootnet.in/covid19-
in/unofficial/covid19india.org/statewise').json()
df_india = pd.io.json.json_normalize(india_data_json['data']['statewise'])
df_india = df_india.set_index("state")
```

```
C:\Users\hp\anaconda3\lib\site-packages\ipykernel_launcher.py:2: FutureWarning:

pandas.io.json.json_normalize is deprecated, use pandas.json_normalize instead
```

In [50]:

```
total = df_india.sum()
total.name = "Total"
pd.DataFrame(total).transpose().style.background_gradient(cmap='Wistia',axis=1)
```

Out[50]:

| | confirmed | recovered | deaths | active |
|---|---|---|---|---|
| **Total** | 7549247 | 6660817 | 114646 | 772558 |

In [51]:

```
df_india.style.background_gradient(cmap='Wistia')
```

Out[51]:

| state | confirmed | recovered | deaths | active |
|---|---|---|---|---|
| **Maharashtra** | 1595381 | 1369810 | 42115 | 182973 |
| **Andhra Pradesh** | 783132 | 740229 | 6429 | 36474 |
| **Karnataka** | 765586 | 645825 | 10478 | 109264 |
| **Tamil Nadu** | 687400 | 637637 | 10642 | 39121 |
| **Uttar Pradesh** | 455146 | 415592 | 6658 | 32896 |
| **Delhi** | 331017 | 301716 | 6009 | 23292 |
| **Kerala** | 341860 | 245399 | 1162 | 95203 |
| **West Bengal** | 321036 | 281053 | 6056 | 33927 |
| **Odisha** | 268364 | 246837 | 1188 | 20339 |
| **Telangana** | 222111 | 198790 | 1271 | 22050 |
| **Bihar** | 204212 | 192594 | 996 | 10621 |
| **Assam** | 200709 | 171680 | 868 | 28158 |
| **Rajasthan** | 173266 | 150379 | 1747 | 21140 |

| state | confirmed | recovered | deaths | active |
|---|---|---|---|---|
| Gujarat | 159726 | 141752 | 3638 | 14336 |
| Madhya Pradesh | 160188 | 144134 | 2773 | 13281 |
| Chhattisgarh | 160396 | 132168 | 1478 | 26750 |
| Haryana | 150033 | 138351 | 1640 | 10042 |
| Punjab | 127630 | 117883 | 4012 | 5735 |
| Jharkhand | 96352 | 89011 | 839 | 6502 |
| Jammu and Kashmir | 87942 | 77886 | 1379 | 8677 |
| Uttarakhand | 58024 | 50982 | 927 | 5728 |
| Goa | 40587 | 36395 | 544 | 3648 |
| Puducherry | 33141 | 28290 | 574 | 4277 |
| Tripura | 29465 | 26199 | 326 | 2917 |
| Himachal Pradesh | 18967 | 16037 | 263 | 2630 |
| Manipur | 15463 | 11741 | 116 | 3606 |
| Chandigarh | 13646 | 12554 | 208 | 884 |
| Arunachal Pradesh | 13406 | 10552 | 30 | 2824 |
| Meghalaya | 8508 | 6282 | 75 | 2151 |
| Nagaland | 7816 | 6142 | 21 | 1582 |
| Ladakh | 5598 | 4615 | 66 | 917 |
| Andaman and Nicobar Islands | 4108 | 3868 | 56 | 184 |
| Sikkim | 3597 | 3184 | 60 | 272 |
| Dadra and Nagar Haveli and Daman and Diu | 3181 | 3102 | 2 | 52 |
| Mizoram | 2253 | 2148 | 0 | 105 |
| State Unassigned | 0 | 0 | 0 | 0 |
| Lakshadweep | 0 | 0 | 0 | 0 |

## States with Reported Deaths

In [52]:

```
df_india[df_india['deaths'] > 0].style.background_gradient(cmap='Wistia')
```

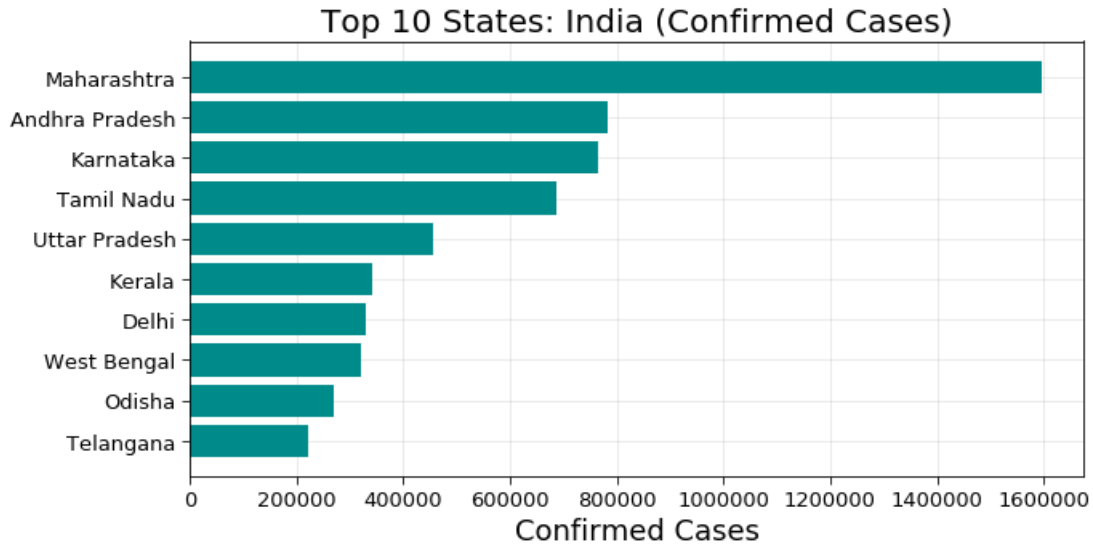
Out[52]:

| state | confirmed | recovered | deaths | active |
|---|---|---|---|---|
| Maharashtra | 1595381 | 1369810 | 42115 | 182973 |
| Andhra Pradesh | 783132 | 740229 | 6429 | 36474 |
| Karnataka | 765586 | 645825 | 10478 | 109264 |
| Tamil Nadu | 687400 | 637637 | 10642 | 39121 |
| Uttar Pradesh | 455146 | 415592 | 6658 | 32896 |
| Delhi | 331017 | 301716 | 6009 | 23292 |
| Kerala | 341860 | 245399 | 1162 | 95203 |
| West Bengal | 321036 | 281053 | 6056 | 33927 |
| Odisha | 268364 | 246837 | 1188 | 20339 |
| Telangana | 222111 | 198790 | 1271 | 22050 |
| Bihar | 204212 | 192594 | 996 | 10621 |
| Assam | 200709 | 171680 | 868 | 28158 |
| Rajasthan | 173266 | 150379 | 1747 | 21140 |
| Gujarat | 159726 | 141752 | 3638 | 14336 |
| Madhya Pradesh | 160188 | 144134 | 2773 | 13281 |
| Chhattisgarh | 160396 | 132168 | 1478 | 26750 |

| state | confirmed | recovered | deaths | active |
|---|---|---|---|---|
| Haryana | 150033 | 138351 | 1640 | 10042 |
| Punjab | 127630 | 117883 | 4012 | 5735 |
| Jharkhand | 96352 | 89011 | 839 | 6502 |
| Jammu and Kashmir | 87942 | 77886 | 1379 | 8677 |
| Uttarakhand | 58024 | 50982 | 927 | 5728 |
| Goa | 40587 | 36395 | 544 | 3648 |
| Puducherry | 33141 | 28290 | 574 | 4277 |
| Tripura | 29465 | 26199 | 326 | 2917 |
| Himachal Pradesh | 18967 | 16037 | 263 | 2630 |
| Manipur | 15463 | 11741 | 116 | 3606 |
| Chandigarh | 13646 | 12554 | 208 | 884 |
| Arunachal Pradesh | 13406 | 10552 | 30 | 2824 |
| Meghalaya | 8508 | 6282 | 75 | 2151 |
| Nagaland | 7816 | 6142 | 21 | 1582 |
| Ladakh | 5598 | 4615 | 66 | 917 |
| Andaman and Nicobar Islands | 4108 | 3868 | 56 | 184 |
| Sikkim | 3597 | 3184 | 60 | 272 |
| Dadra and Nagar Haveli and Daman and Diu | 3181 | 3102 | 2 | 52 |

In [53]:

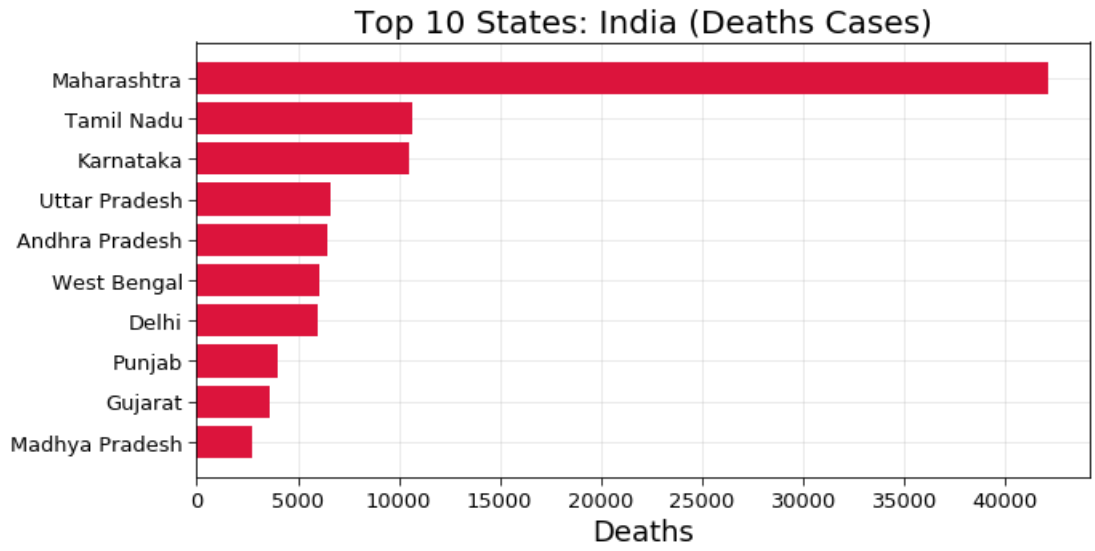
```
f = plt.figure(figsize=(10,5))
f.add_subplot(111)

plt.axes(axisbelow=True)
plt.barh(df_india.sort_values('confirmed')["confirmed"].index[-10:],df_india.sort_values('confirmed
')["confirmed"].values[-10:],color="darkcyan")
plt.tick_params(size=5,labelsize = 13)
plt.xlabel("Confirmed Cases",fontsize=18)
plt.title("Top 10 States: India (Confirmed Cases)",fontsize=20)
plt.grid(alpha=0.3)
#plt.savefig(out+'Top 10 States_India (Confirmed Cases).png')
```




In [54]:

```
f = plt.figure(figsize=(10,5))
f.add_subplot(111)

plt.axes(axisbelow=True)
plt.barh(df_india.sort_values('deaths')["deaths"].index[-10:],df_india.sort_values('deaths')["death
s"].values[-10:],color="crimson")
plt.tick_params(size=5,labelsize = 13)
```

```
plt.xlabel("Deaths",fontsize=18)
plt.title("Top 10 States: India (Deaths Cases)",fontsize=20)
plt.grid(alpha=0.3)
#plt.savefig(out+'Top 10 States_India (Deaths Cases).png')
```




### Correlation

In [55]:

```
df_india.corr().style.background_gradient(cmap='Reds')
```

Out[55]:

| | confirmed | recovered | deaths | active |
|---|---|---|---|---|
| **confirmed** | 1.000000 | 0.998287 | 0.921107 | 0.905507 |
| **recovered** | 0.998287 | 1.000000 | 0.911909 | 0.879502 |
| **deaths** | 0.921107 | 0.911909 | 1.000000 | 0.861551 |
| **active** | 0.905507 | 0.879502 | 0.861551 | 1.000000 |

## Conclusion

There are hundreds of coronaviruses, most of which circulate in animals. Only seven of these viruses infect humans and four of them cause symptoms of the common cold. But, three times in the last 20 years, a coronavirus has jumped from animals to humans to cause severe disease.

SARS, a beta coronavirus emerged in 2002 and was controlled mainly by aggressive public health measures. There have been no new cases since 2004. MERS emerged in 2012, still exists in camels, and can infect people who have close contact with them.

COVID-19, a new and sometimes deadly respiratory illness that is believed to have originated in a live animal market in China, has spread rapidly throughout that country and the world.

The new coronavirus was first detected in Wuhan, China in December 2019. Tens of thousands of people were infected in China, with the virus spreading easily from person-to-person in many parts of that country.

The novel coronavirus infections were at first associated with travel from Wuhan, but the virus has now established itself in 177 countries and territories around the world in a rapidly expanding pandemic. Health officials in the United States and around the world are working to contain the spread of the virus through public health measures such as social distancing, contact tracing, testing, quarantines and travel restrictions. Scientists are working to find medications to treat the disease and to develop a vaccine.

The World Health Organization declared the novel coronavirus outbreak “a public health emergency of international concern” on January 30. On March 11, 2020 after sustained spread of the disease outside of China, the World Health Organization declared the COVID-19 epidemic a pandemic. Public health measures like ones implemented in China and now around the world, will hopefully blunt the spread of the virus while treatments and a vaccine are developed to stop it.

In [ ]:

```
```