In [1]:

```
import matplotlib.backends.backend_tkagg
import matplotlib
matplotlib.use("Agg")  # or whichever backend you wish to use
%matplotlib notebook
%matplotlib inline

import matplotlib.pyplot as plt
import plotly.express as px
import plotly.graph_objects as go
from plotly.subplots import make_subplots


import os,re
import json
import glob
import pandas as pd
import time,pytz
import datetime
import math
import seaborn as sns
import numpy as np
import sklearn
from sklearn import linear_model
```

In [2]:

```
in_dir = r'C:\Users\u6037208\Box\Twitter\Tweets'
out_dir = r'C:\Users\u6037208\Box\Twitter\Analysis\Output'
twt_file = r'C:\Users\u6037208\Box\Twitter\Tweets\US_COVID_tweets.csv'
```

In [4]:
```
tweets = pd.read_csv(twt_file)
tweets.drop(columns =["user.time_zone", "_id","id","id_str","place.country_code","user.id","user.id_str","place.name","place.pl
tweets.head()
```

Out[4]:

	created_at	full_text	geo.coordinates	coordinates	place.full_name	user.location
0	Thu Mar 19 20:16:05 +0000 2020	Many ask us how they can support us during all...	[25.67931,-80.31869]	25.67931,-80.31869	Kendall, FL	9800 SW 77th Av Miami FL 33156
1	Thu Mar 19 20:39:55 +0000 2020	We wish that ceramic coating protected us from...	[41.07291,-111.99674]	41.07291,-111.99674	Layton, UT	Layton, UT
2	Thu Mar 19 20:28:50 +0000 2020	I HATE this Koon @Byrdgangshoota 🤦‍♂️😂 Nigga ...	[40.85,-73.8669]	40.85,-73.8669	Bronx, NY	New York, NY
3	Thu Mar 19 21:02:22 +0000 2020	Day 3.... Corona-0, QueRona-3! Workout complet...	[32.7774,-96.7977]	32.7774,-96.7977	Dallas, TX	Dallas
4	Thu Mar 19 21:05:44 +0000 2020	Staying busy. \n.\n.\n.\n.\n.\n.\n.\n.\n.\n.\n...	[34.1649,-118.3965]	34.1649,-118.3965	Los Angeles, CA	TX → LA

In [5]:
```
# df['Discounted_Price'] = df.apply(lambda row: row.Cost -
#                                   (row.Cost * 0.1), axis = 1)

tweets['create_time'] = tweets.apply(lambda row: datetime.datetime.strptime(row["created_at"],'%a %b %d %H:%M:%S +0000 %Y'),ax
tweets.head()
```

Out[5]:

	created_at	full_text	geo.coordinates	coordinates	place.full_name	user.location	create_time
0	Thu Mar 19 20:16:05 +0000 2020	Many ask us how they can support us during all...	[25.67931,-80.31869]	25.67931,-80.31869	Kendall, FL	9800 SW 77th Av Miami FL 33156	2020-03-19 20:16:05
1	Thu Mar 19 20:39:55 +0000 2020	We wish that ceramic coating protected us from...	[41.07291,-111.99674]	41.07291,-111.99674	Layton, UT	Layton, UT	2020-03-19 20:39:55
2	Thu Mar 19 20:28:50 +0000 2020	I HATE this Koon @Byrdgangshoota 🤦‍♂️ 😂 Nigga ...	[40.85,-73.8669]	40.85,-73.8669	Bronx, NY	New York, NY	2020-03-19 20:28:50
3	Thu Mar 19 21:02:22 +0000 2020	Day 3.... Corona-0, QueRona-3! Workout complet...	[32.7774,-96.7977]	32.7774,-96.7977	Dallas, TX	Dallas	2020-03-19 21:02:22
4	Thu Mar 19 21:05:44 +0000 2020	Staying busy. \n.\n.\n.\n.\n.\n.\n.\n.\n.\n.\n...	[34.1649,-118.3965]	34.1649,-118.3965	Los Angeles, CA	TX → LA	2020-03-19 21:05:44

In [6]:
```
tweets["create_time"][0]>tweets["create_time"][1]
type(tweets["create_time"][0])
```

Out[6]:
```
pandas._libs.tslibs.timestamps.Timestamp
```

In [7]:
```
# separate tweets into three waves, wave 1: March 1-May 31;wave 2: June 1-Aug 31; wave 3: Sep 1 - Dec 31, 2020
tweets.loc[tweets.create_time <='2020-05-31','Wave'] = "Wave 1"
tweets.loc[(tweets.create_time >'2020-05-31') & (tweets.create_time <='2020-08-31'),'Wave'] = "Wave 2"
tweets.loc[tweets.create_time > '2020-09-01','Wave'] = "Wave 3"


tweets.set_index('create_time', drop=False, append=False, inplace=True, verify_integrity=False)
tweets= tweets.sort_index(ascending=True)
tweets.head()
```

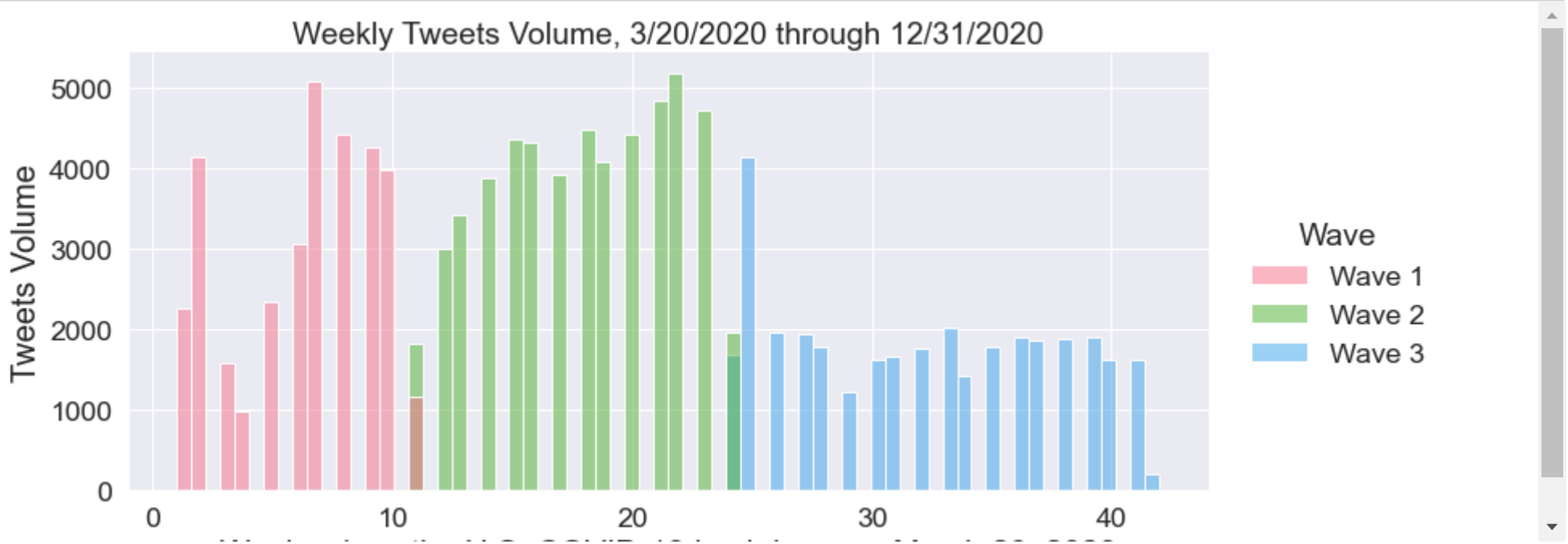
Out[7]:

create_time	created_at	full_text	geo.coordinates	coordinates	place.full_name	user.location	create_time	Wave
2020-03-19 19:53:17	Thu Mar 19 19:53:17 +0000 2020	#statewaterheaters #getitin #corona #keepingpe...	[39.8841,-82.759]	39.8841,-82.759	Pickerington, OH	ohio	2020-03-19 19:53:17	Wave 1
2020-03-19 19:53:46	Thu Mar 19 19:53:46 +0000 2020	"ain't no humans outside! (corona!)" 😂😂😂🤣 @ Cl...	[41.4996,-81.6937]	41.4996,-81.6937	Cleveland, OH	Simple Pleasures Lane	2020-03-19 19:53:46	Wave 1
2020-03-19 19:56:46	Thu Mar 19 19:56:46 +0000 2020	current weather in Corona: moderate rain, 56°F...	[33.88,-117.58]	33.88,-117.58	Corona, CA	Corona, CA	2020-03-19 19:56:46	Wave 1
2020-03-19 19:58:28	Thu Mar 19 19:58:28 +0000 2020	Quarantine 💭 training ! Adding some kicks 💥. \...	[34.0522,-118.243]	34.0522,-118.243	Los Angeles, CA	Los Angeles	2020-03-19 19:58:28	Wave 1
2020-03-19 20:05:01	Thu Mar 19 20:05:01 +0000 2020	#quarantine #stockpiling #food #sexylatino #la...	[34.1509,-118.355]	34.1509,-118.355	Los Angeles, CA	North Hollywood, Los Angeles	2020-03-19 20:05:01	Wave 1

In [8]:
```
# returns the # of weeks after Mar 1, 2020. i.e., Mar 8, 2020 will be the 2nd week.
def find_weeks(time):
    start = datetime.datetime.strptime("Thu Mar 19 19:53:17 +0000 2020",'%a %b %d %H:%M:%S +0000 %Y')
    time1 = datetime.datetime.strptime(time,'%a %b %d %H:%M:%S +0000 %Y')
    tt = math.floor((time1-start).days/7)+1
    return tt
```

In [9]:
```
tweets['Week'] = tweets["created_at"].apply(find_weeks)
#tweets.head(10)
```

In [10]:
```
### tweets.groupby(["week"]).size().plot(kind = "bar",figsize =(10,10),color )
# use unstack()
#data.groupby(['date','type']).count()['amount'].unstack().plot(ax=ax)
sns.set(font_scale=1.6)
g = sns.displot(data = tweets, x= "Week",kde = False, hue = "Wave",palette =sns.color_palette("husl", 3), height=5, aspect=2.2)
g.set_axis_labels("Weeks since the U.S. COVID-19 Lockdown on March 20, 2020", "Tweets Volume", fontsize = 20)
g.set_titles("Weekly Tweets Volume between March 1-December 31, 2020")
plt.title("Weekly Tweets Volume, 3/20/2020 through 12/31/2020")
plt.show()
```



In [11]:
```
# add 4 cols: Asain(138), Black(2278), Latino(478), Whites (1156)
tweets.loc[tweets['full_text'].str.lower().str.contains('asia'), 'Asian'] = 1
tweets.loc[tweets['full_text'].str.lower().str.contains('black'), 'Black'] = 1
tweets.loc[tweets['full_text'].str.lower().str.contains('latin'), 'Latino'] = 1
tweets.loc[tweets['full_text'].str.lower().str.contains('hispanic'), 'Latino'] = 1
tweets.loc[tweets['full_text'].str.lower().str.contains('white'), 'White'] = 1
```

In [12]:
```
tweets[tweets['Latino']==1].head()
```

Out[12]:

create_time	created_at	full_text	geo.coordinates	coordinates	place.full_name	user.location	create_time	Wave	Week	Asia
2020-03-19 20:05:01	Thu Mar 19 20:05:01 +0000 2020	#quarantine #stockpiling #food #sexylatino #la...	[34.1509,-118.355]	34.1509,-118.355	Los Angeles, CA	North Hollywood, Los Angeles	2020-03-19 20:05:01	Wave 1	1	Nal
2020-03-20 09:19:43	Fri Mar 20 09:19:43 +0000 2020	Thanks for sharing 33.666.9999\n#drdrew\n\nRep...	[25.7752,-80.192]	25.7752,-80.192	Miami, FL	Allapattah, U.S.A.	2020-03-20 09:19:43	Wave 1	1	Nal
2020-03-21 17:51:32	Sat Mar 21 17:51:32 +0000 2020	Lesbian social isolating. #corona😷 @ New York,...	[40.7142,-74.0064]	40.7142,-74.0064	Manhattan, NY	London, England	2020-03-21 17:51:32	Wave 1	1	Nal
2020-03-23 12:00:54	Mon Mar 23 12:00:54 +0000 2020	Would have been here now #stayhomesavelives #s...	[27.37691,-82.63402]	27.37691,-82.63402	Longboat Key, FL	Halifax, Nova Scotia, Canada	2020-03-23 12:00:54	Wave 1	1	Nal
2020-03-24 00:44:01	Tue Mar 24 00:44:01 +0000 2020	Tonight's corona special. L51&L52 \n#princ...	[40.6215,-74.2452]	40.6215,-74.2452	Linden, NJ	NaN	2020-03-24 00:44:01	Wave 1	1	Nal

In [13]:
```
tweets.to_csv(r'C:\Users\u6037208\Box\Twitter\Tweets\US_COVID_tweets_10152020.csv')
```

In [14]:
```
#tweets.drop(columns =["wave","week"], inplace = True)

# most rows in "place.full_name" use format "city name, state name" format, str[-2:] takes the last 2 characters (state abbrevi
# and save it to a new field "State".
tweets["State"] = tweets["place.full_name"].str[-2:]
tweets["State"]
```

Out[14]:
```
create_time
2020-03-19 19:53:17    OH
2020-03-19 19:53:46    OH
2020-03-19 19:56:46    CA
2020-03-19 19:58:28    CA
2020-03-19 20:05:01    CA
                       ..
2021-01-01 04:15:06    NY
2021-01-01 04:15:34    TX
2021-01-01 04:19:14    GA
2021-01-01 04:23:45    SA
2021-01-01 04:24:39    NY
Name: State, Length: 122120, dtype: object
```

In [15]:
```
# There are 12252 rows with a state abbreviation of "SA", which means the last 2 characters are not state abbr but "USA"
# need to identify those rows and assign correct state abbrs in "State" field
state_name = tweets["State"].value_counts().to_frame()
state_name.to_csv("State_name_check.csv")
```

In [16]:
```
state_name = []
state_name =list(set(list(tweets["State"])))
len(state_name)
state_name.sort(reverse=True)
# after sort alphabetically, the first 23 are lower case ones, which are made up state names, so will be skipped
#state_name[23:]
```

In [19]:

```
# st_name contains the names and abbrivations of 50 US states and DC.
st_name =pd.read_csv(r'C:\Users\u6037208\Box\Twitter\Tweets\US_States_full name_vs_Abbr.csv', names=('State', 'ST'))

# 12252 rows in column "place.full_name" use "state name, USA" format,
# while the rest use "city name, state abbrivation" format. This step look for those 12252 rows, and replace
# the full state with state abbreviations to be consistent with other rows

for index, row in tweets.iterrows():
    if 'SA' in row["State"]:
        for index2,row2 in st_name.iterrows():
            tweets[row["place.full_name"][:-5] in row2["State"],'State'] = row2["ST"]

print (tweets.head())
# tweets[tweets["State"]=="SA"]
```

```
                                  created_at  \
create_time
2020-03-19 19:53:17  Thu Mar 19 19:53:17 +0000 2020
2020-03-19 19:53:46  Thu Mar 19 19:53:46 +0000 2020
2020-03-19 19:56:46  Thu Mar 19 19:56:46 +0000 2020
2020-03-19 19:58:28  Thu Mar 19 19:58:28 +0000 2020
2020-03-19 20:05:01  Thu Mar 19 20:05:01 +0000 2020

                                                    full_text  \
create_time
2020-03-19 19:53:17  #statewaterheaters #getitin #corona #keepingpe...
2020-03-19 19:53:46  "ain't no humans outside! (corona!)" 😂😂😂🤣 @ Cl...
2020-03-19 19:56:46  current weather in Corona: moderate rain, 56°F...
2020-03-19 19:58:28  Quarantine 💭 training ! Adding some kicks 💥. \...
2020-03-19 20:05:01  #quarantine #stockpiling #food #sexylatino #la...

                        geo.coordinates       coordinates   place.full_name  \
create_time
2020-03-19 19:53:17   [39.8841,-82.759]   39.8841,-82.759  Pickerington, OH
2020-03-19 19:53:46  [41.4996,-81.6937]  41.4996,-81.6937     Cleveland, OH
2020-03-19 19:56:46     [33.88,-117.58]     33.88,-117.58        Corona, CA
2020-03-19 19:58:28  [34.0522,-118.243]  34.0522,-118.243   Los Angeles, CA
2020-03-19 20:05:01  [34.1509,-118.355]  34.1509,-118.355   Los Angeles, CA

                                  user.location         create_time    Wave  \
create_time
2020-03-19 19:53:17                        ohio 2020-03-19 19:53:17  Wave 1
2020-03-19 19:53:46        Simple Pleasures Lane 2020-03-19 19:53:46  Wave 1
```

```
2020-03-19 19:56:46                   Corona, CA 2020-03-19 19:56:46  Wave 1
2020-03-19 19:58:28                  Los Angeles 2020-03-19 19:58:28  Wave 1
2020-03-19 20:05:01  North Hollywood, Los Angeles 2020-03-19 20:05:01  Wave 1

                     Week  Asian  Black  Latino  White State (False, State)  \
create_time
2020-03-19 19:53:17     1    NaN    NaN     NaN    NaN    OH             WY
2020-03-19 19:53:46     1    NaN    NaN     NaN    NaN    OH             WY
2020-03-19 19:56:46     1    NaN    NaN     NaN    NaN    CA             WY
2020-03-19 19:58:28     1    NaN    NaN     NaN    NaN    CA             WY
2020-03-19 20:05:01     1    NaN    NaN     1.0    NaN    CA             WY

                    (True, State)
create_time
2020-03-19 19:53:17            MO
2020-03-19 19:53:46            MO
2020-03-19 19:56:46            MO
2020-03-19 19:58:28            MO
2020-03-19 20:05:01            MO
```

In [20]:

```
# The "place.full_name" field for many rows ends with "San Francisco", so the Stata abbreviation were "co", change "co" to "CA
# co= tweets[tweets['State']=='co']
# co.to_csv("co.csv")

tweets.loc[tweets.State =='co','State'] = "CA"
tweets[tweets['State']=='co']
```

Out[20]:

	created_at	full_text	geo.coordinates	coordinates	place.full_name	user.location	create_time	Wave	Week	Asian	Black	Latino	White	State

create_time

In [21]:
```
# create a new dataframe sumarizing tweets volume for each race by wave and state
TW_Wave_State = tweets.groupby(["Wave","State"]).sum()

TW_Wave_State.columns = ['Week', 'Asian','Black','Latino', 'White']
# reset index to get grouped columns back
TW_Wave_State = TW_Wave_State.reset_index()
TW_Wave_State.head()
TW_Wave_State.to_csv('tweet_summary_by_wave_state.csv')
# in the "tweet_summary_by_wave_state_process.csv", deleted the rows without a valid state name, also  because
# those records hardly contain any race name word
```

Out[21]:

	Wave	State	Week	Asian	Black	Latino	White
0	Wave 1	AK	92	0.0	0.0	0.0	0.0
1	Wave 1	AL	1095	0.0	2.0	0.0	0.0
2	Wave 1	AR	384	0.0	1.0	0.0	0.0
3	Wave 1	AZ	1882	2.0	5.0	0.0	2.0
4	Wave 1	CA	38379	9.0	77.0	23.0	38.0

In [22]:
```
#import the file with COVID cases and deaths by each race
COVID_file = r'C:\Users\u6037208\Box\Twitter\COVID_data\COVID_case_death_state_race_process.csv'
covid = pd.read_csv(COVID_file)
covid.head()
```

Out[22]:

	Time	State	Cases_White	Cases_Black	Cases_Latinx	Cases_Asian	Deaths_White	Deaths_Black	Deaths_Latinx	Deaths_Asian
0	20201230	AK	14623.0	1245.0	NaN	1864.0	74.0	8.0	NaN	20.0
1	20201230	AL	111969.0	59617.0	NaN	1378.0	2404.0	1352.0	NaN	15.0
2	20201230	AR	140576.0	37146.0	NaN	2002.0	2550.0	540.0	NaN	22.0
3	20201230	AZ	162683.0	14804.0	147562.0	6281.0	3960.0	243.0	2503.0	87.0
4	20201230	CA	319136.0	64518.0	887580.0	100569.0	7679.0	1697.0	11575.0	2818.0

In [23]:
```
covid['create_time'] = covid.apply(lambda row: datetime.datetime.strptime(str(row["Time"]),'%Y%m%d'),axis =1)
covid.head()
```

Out[23]:

	Time	State	Cases_White	Cases_Black	Cases_Latinx	Cases_Asian	Deaths_White	Deaths_Black	Deaths_Latinx	Deaths_Asian	create_time
0	20201230	AK	14623.0	1245.0	NaN	1864.0	74.0	8.0	NaN	20.0	2020-12-30
1	20201230	AL	111969.0	59617.0	NaN	1378.0	2404.0	1352.0	NaN	15.0	2020-12-30
2	20201230	AR	140576.0	37146.0	NaN	2002.0	2550.0	540.0	NaN	22.0	2020-12-30
3	20201230	AZ	162683.0	14804.0	147562.0	6281.0	3960.0	243.0	2503.0	87.0	2020-12-30
4	20201230	CA	319136.0	64518.0	887580.0	100569.0	7679.0	1697.0	11575.0	2818.0	2020-12-30

In [24]:
```
# separate covid cases and deaths into three waves, wave 1: March 1-May 31;wave 2: June 1-Aug 31; wave 3: Sep 1 - Dec 31, 2020
#
covid.loc[covid.create_time <='2020-05-31','Wave'] = "Wave 1"
covid.loc[(covid.create_time >'2020-05-31') & (covid.create_time <='2020-08-31'),'Wave'] = "Wave 2"
covid.loc[covid.create_time > '2020-09-01','Wave'] = "Wave 3"


covid.set_index('create_time', drop=False, append=False, inplace=True, verify_integrity=False)
covid= covid.sort_index(ascending=True)
covid.head(4)
```

Out[24]:

	Time	State	Cases_White	Cases_Black	Cases_Latinx	Cases_Asian	Deaths_White	Deaths_Black	Deaths_Latinx	Deaths_Asian	create_tim
create_time											
2020-04-12	20200412	WY	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1
2020-04-12	20200412	ME	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1
2020-04-12	20200412	MD	2300.0	3200.0	NaN	190.0	83.0	104.0	NaN	8.0	2020-04-1
2020-04-12	20200412	MA	4271.0	1358.0	1885.0	331.0	199.0	20.0	28.0	13.0	2020-04-1

In [25]:
```
# returns the # of weeks after Mar 20, 2020. i.e., Mar 8, 2020 will be the 2nd week.
def find_weeks_covid(time):
    start = datetime.datetime.strptime("20200320",'%Y%m%d')
    time1 = datetime.datetime.strptime(str(time),'%Y%m%d')
    week_no = math.floor((time1-start).days/7)+1
    return  week_no
```

In [26]:
```
covid['Week'] = covid["Time"].apply(find_weeks_covid)
covid.tail(5)
```

Out[26]:

create_time	Time	State	Cases_White	Cases_Black	Cases_Latinx	Cases_Asian	Deaths_White	Deaths_Black	Deaths_Latinx	Deaths_Asian	create_tim
2020-12-30	20201230	NE	87234.0	4464.0	NaN	2429.0	1105.0	58.0	NaN	23.0	2020-12-3
2020-12-30	20201230	ND	49538.0	2678.0	NaN	1255.0	NaN	NaN	NaN	NaN	2020-12-3
2020-12-30	20201230	NC	271212.0	91016.0	NaN	7989.0	4140.0	1692.0	NaN	80.0	2020-12-3
2020-12-30	20201230	MS	97054.0	72243.0	4770.0	871.0	2416.0	1957.0	50.0	15.0	2020-12-3
2020-12-30	20201230	AK	14623.0	1245.0	NaN	1864.0	74.0	8.0	NaN	20.0	2020-12-3

In [27]:
```
covid['Total_Cases'] = covid["Cases_White"] + covid["Cases_Black"] + covid["Cases_Latinx"] + covid["Cases_Asian"]
covid['Total_Deaths'] = covid["Deaths_White"] + covid["Deaths_Black"] + covid["Deaths_Latinx"] + covid["Deaths_Asian"]
covid.head()
```

Out[27]:

create_time	Time	State	Cases_White	Cases_Black	Cases_Latinx	Cases_Asian	Deaths_White	Deaths_Black	Deaths_Latinx	Deaths_Asian	create_tim
2020-04-12	20200412	WY	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1
2020-04-12	20200412	ME	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1
2020-04-12	20200412	MD	2300.0	3200.0	NaN	190.0	83.0	104.0	NaN	8.0	2020-04-1
2020-04-12	20200412	MA	4271.0	1358.0	1885.0	331.0	199.0	20.0	28.0	13.0	2020-04-1
2020-04-12	20200412	LA	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1

In [28]:

```
covid.columns

covid_case_death_by_state = covid[['State', 'Wave', 'Week', 'Total_Cases','Total_Deaths']]
# covid_case_death_by_state.to_csv('COVID_case_death_by_wave_week_state.csv')

# covid_case_death dataframe keeps "create_time"(date),'Wave', 'Week' fields, and sum the data across all states

covid_case_death = covid[['State', 'Wave', 'Week', 'Total_Cases','Total_Deaths']].groupby(["create_time",'Wave', 'Week']).agg(
# # rename columns
covid_case_death.columns = ['Total_Cases','Total_Deaths']
# # # reset index to get grouped columns back
covid_case_death = covid_case_death.reset_index()
covid_case_death.head()

# covid_case_death.to_csv('COVID_case_death_by_wave_week_all_races_all_states.csv')

# covid_case_death = covid.groupby(["Week","Wave"]).agg({"Total_Cases":['max'],"Total_Deaths":['max']})
# covid_case_death
```

Out[28]:

	create_time	Wave	Week	Total_Cases	Total_Deaths
0	2020-04-12	Wave 1	4	51481.0	2350.0
1	2020-04-15	Wave 1	4	78892.0	11537.0
2	2020-04-19	Wave 1	5	92132.0	16975.0
3	2020-04-22	Wave 1	5	127286.0	14309.0
4	2020-04-26	Wave 1	6	149384.0	16703.0

In [29]:
```
# The data was collected every 3 days, so there are two dates within each week.
# Cases and deaths were cumulative, to get the increased cases/deaths within the week, use the data on 2nd date minus 1st date
covid_case_death.tail()
```

Out[29]:

	create_time	Wave	Week	Total_Cases	Total_Deaths
71	2020-12-16	Wave 3	39	4656860.0	169101.0
72	2020-12-20	Wave 3	40	4943921.0	175062.0
73	2020-12-23	Wave 3	40	5116795.0	178054.0
74	2020-12-27	Wave 3	41	5249850.0	181857.0
75	2020-12-30	Wave 3	41	5514207.0	186270.0

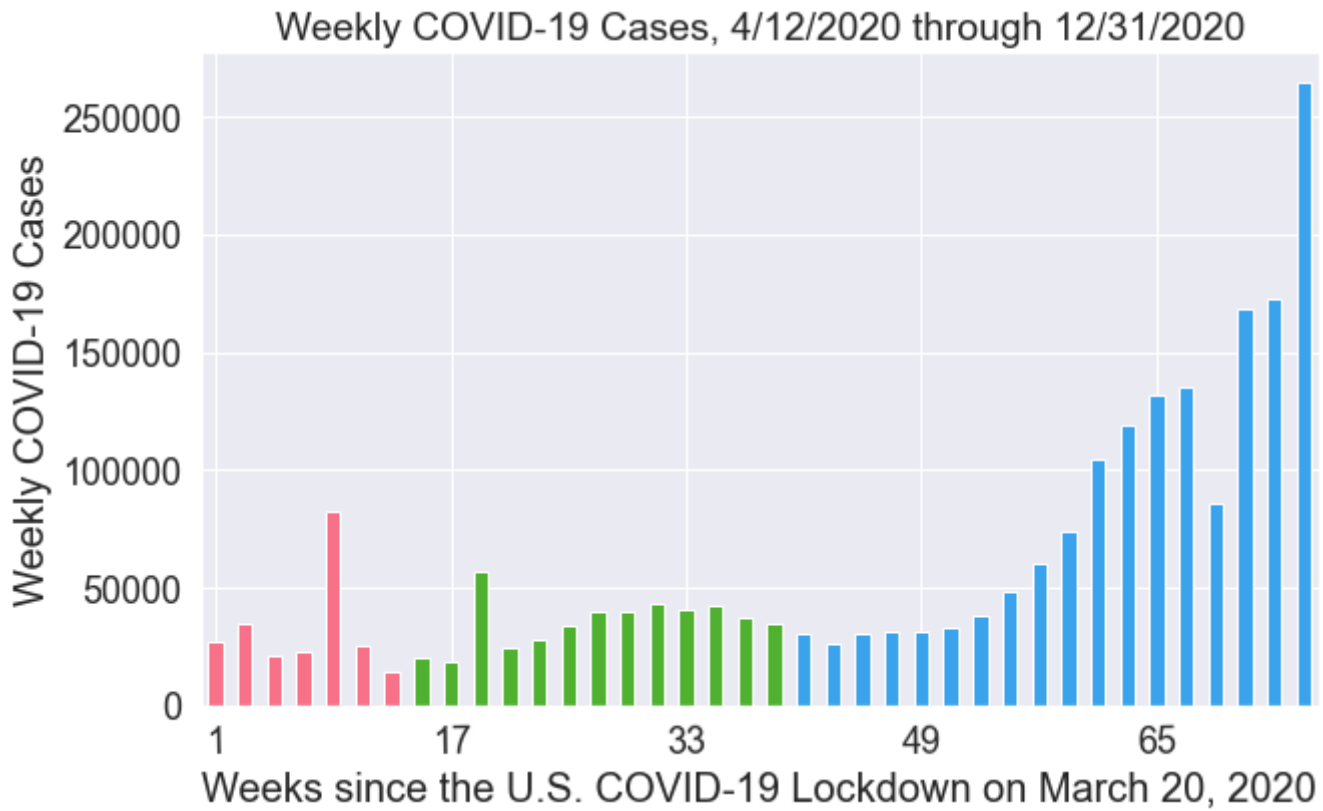
In [35]:
```
# The data was collected every 3 days, so there are two dates within each week.
# Cases and deaths were cumulative, to get the increased cases/deaths within the week, use the data on 2nd date minus 1st date
covid_wk_case_death =covid_case_death
covid_wk_case_death['Cases_Diff'] = covid_case_death['Total_Cases'].diff() # use diff() to get the diff btw data of 2 dates wi
covid_wk_case_death['Deaths_Diff'] = covid_case_death['Total_Deaths'].diff()
covid_wk_case_death_2 = covid_wk_case_death[1::2] # select the odd numbered rows, which are the increased cases & deaths
covid_wk_case_death_2.head()
```

Out[35]:

	create_time	Wave	Week	Total_Cases	Total_Deaths	Cases_Diff	Deaths_Diff
1	2020-04-15	Wave 1	4	78892.0	11537.0	27411.0	9187.0
3	2020-04-22	Wave 1	5	127286.0	14309.0	35154.0	-2666.0
5	2020-04-29	Wave 1	6	170955.0	25989.0	21571.0	9286.0
7	2020-05-06	Wave 1	7	242666.0	34173.0	22815.0	2057.0
9	2020-05-13	Wave 1	8	352543.0	41236.0	82117.0	3093.0

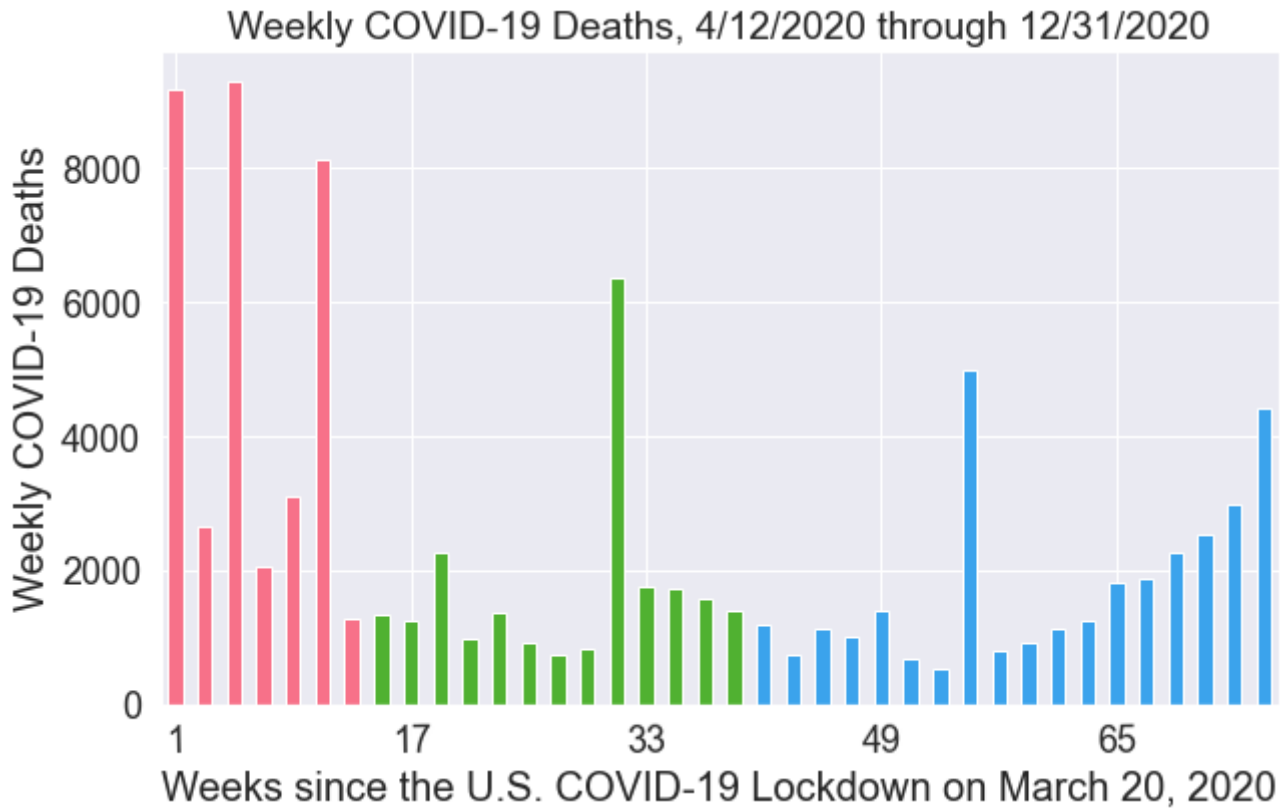
In [36]:

```
# plot the weekly cases

# covid_wk_case_death_2 = covid_wk_case_death_2.set_index("Week")
colours = {"Wave 1": "#F77189", "Wave 2": "#50B131", "Wave 3": "#3BA3EC"}

ax =covid_wk_case_death_2.Cases_Diff.plot(kind = 'bar', figsize=(10,6),fontsize=18, color=covid_wk_case_death_2['Wave'].replace
# ax.set_xtick(['0','10','20','30','40'])
plt.xticks(rotation=1, horizontalalignment="center")
plt.locator_params(axis="x", nbins=5) # change the number of x-axis ticks
plt.xlabel('Weeks since the U.S. COVID-19 Lockdown on March 20, 2020', fontsize=20)
plt.ylabel('Weekly COVID-19 Cases', fontsize=20)
plt.savefig(out_dir + "\Weekly COVID-19 Cases.jpg",dpi=300)
# ax.legend(['Wave 1', 'Wave 2'])
```



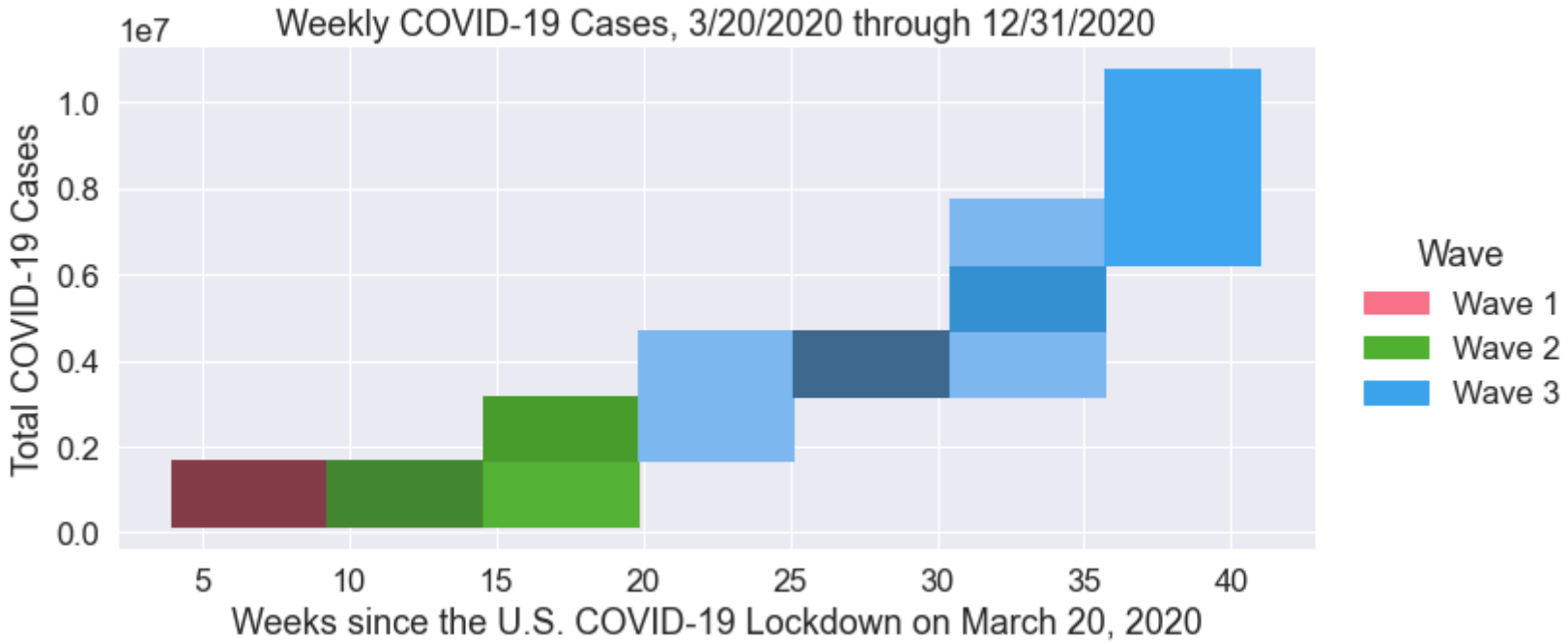
In [38]:
```
# change the value of a minus death value to a positive number
covid_wk_case_death_2.at[3,"Deaths_Diff"] = 2666
```

In [39]:
```
plot the weekly deaths
olours = {"Wave 1": "#F77189", "Wave 2": "#50B131", "Wave 3": "#3BA3EC"}
 =covid_wk_case_death_2.Deaths_Diff.plot(kind = 'bar', figsize=(10,6),fontsize=18, color=covid_wk_case_death_2['Wave'].replace(
ax.set_xtick(['0','10','20','30','40'])
t.xticks(rotation=1, horizontalalignment="center")
t.locator_params(axis="x", nbins=5) # change the number of x-axis ticks
t.xlabel('Weeks since the U.S. COVID-19 Lockdown on March 20, 2020', fontsize=20)
t.ylabel('Weekly COVID-19 Deaths', fontsize=20)
t.savefig(out_dir + "\Weekly COVID-19 Deaths.jpg",dpi=300)
ax.legend(['Wave 1', 'Wave 2'])
```



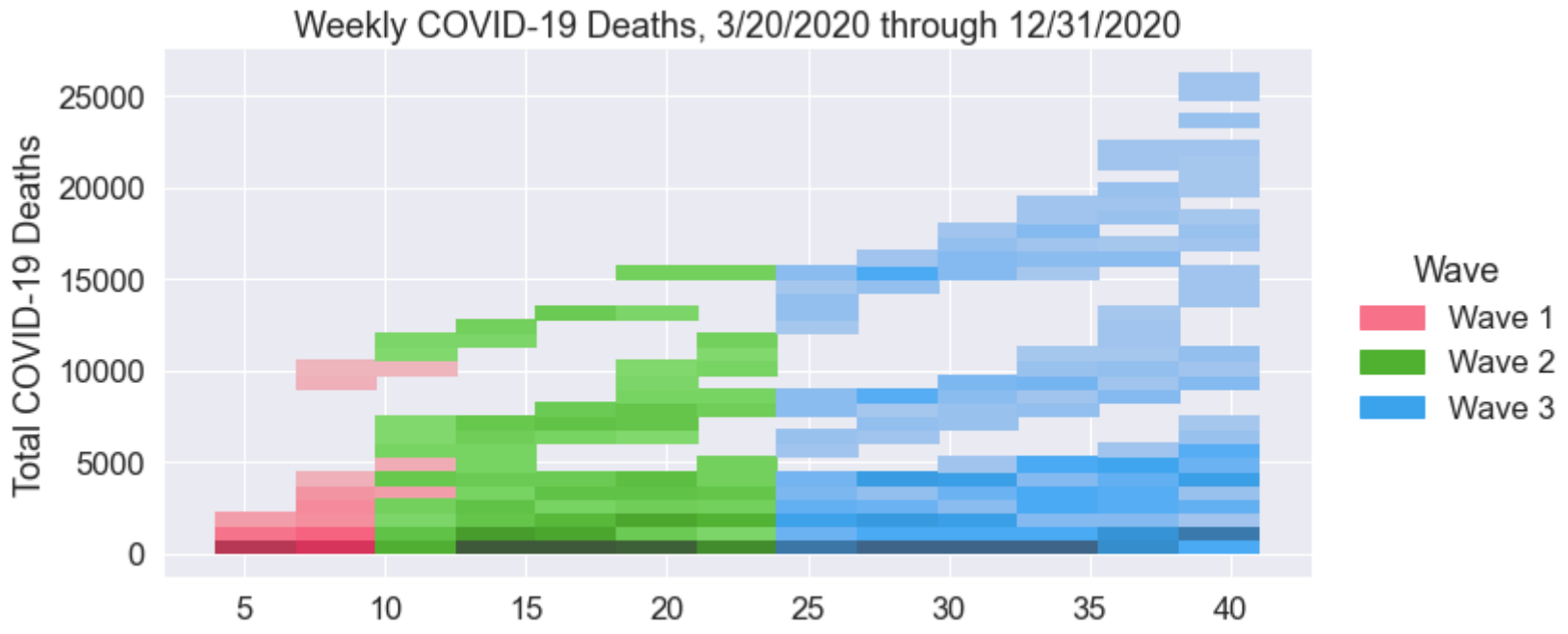
In [535]:

```
#data.groupby(['date','type']).count()['amount'].unstack().plot(ax=ax)
sns.set(font_scale=1.5)
# covid_na =covid[~np.isnan(covid)] # remove the NaNs
g = sns.displot(data = covid_case_death, x= "Week", y ="Total_Cases_sum",  hue = "Wave",palette =sns.color_palette("husl", 3),
g.set_axis_labels("Weeks since the U.S. COVID-19 Lockdown on March 20, 2020", "Total COVID-19 Cases")
plt.title("Weekly COVID-19 Cases, 3/20/2020 through 12/31/2020")

plt.savefig(out_dir + "\Weekly COVID-19 Cases_Old_legend.jpg",dpi=300)
plt.show()
```



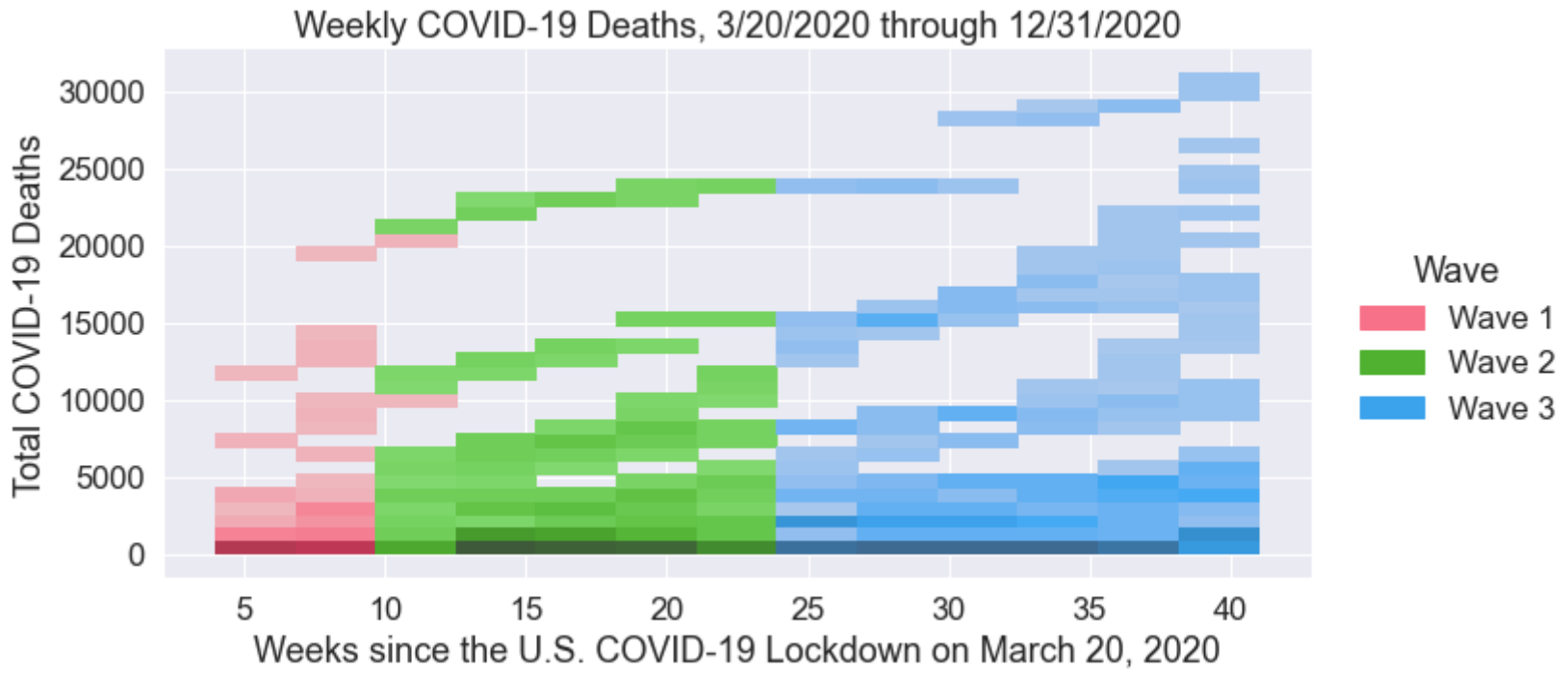
In [404]:

```
#data.groupby(['date','type']).count()['amount'].unstack().plot(ax=ax)
sns.set(font_scale=1.5)
# covid_na =covid[~np.isnan(covid)] # remove the NaNs
g = sns.displot(data = covid_na, x= "Week", y ="Total_Deaths",  hue = "Wave",palette =sns.color_palette("husl", 3), height=5, a
g.set_axis_labels("Weeks since the U.S. COVID-19 Lockdown on March 20, 2020", "Total COVID-19 Deaths")
plt.title("Weekly COVID-19 Deaths, 3/20/2020 through 12/31/2020")
plt.show()
```



In [405]:

```
#data.groupby(['date','type']).count()['amount'].unstack().plot(ax=ax)
sns.set(font_scale=1.5)
# covid_na =covid[~np.isnan(covid)] # remove the NaNs
g = sns.displot(data = covid, x= "Week", y ="Total_Deaths",  hue = "Wave",palette =sns.color_palette("husl", 3), height=5, aspe
g.set_axis_labels("Weeks since the U.S. COVID-19 Lockdown on March 20, 2020", "Total COVID-19 Deaths")
plt.title("Weekly COVID-19 Deaths, 3/20/2020 through 12/31/2020")
plt.show()
```



In [537]:
```
covid_na =covid[~pd.isnull(covid.Total_Cases)] # remove the NaNs from "Total_Cases" column
covid_na.head()
```

Out[537]:

create_time	Time	State	Cases_White	Cases_Black	Cases_Latinx	Cases_Asian	Deaths_White	Deaths_Black	Deaths_Latinx	Deaths_Asian	create_tim
2020-04-12	20200412	MA	4271.0	1358.0	1885.0	331.0	199.0	20.0	28.0	13.0	2020-04-1
2020-04-12	20200412	IL	5214.0	5458.0	2513.0	691.0	259.0	308.0	70.0	27.0	2020-04-1
2020-04-12	20200412	CT	3030.0	993.0	1277.0	124.0	343.0	65.0	45.0	6.0	2020-04-1
2020-04-12	20200412	CA	4323.0	945.0	4729.0	1756.0	224.0	54.0	147.0	92.0	2020-04-1
2020-04-12	20200412	AZ	661.0	65.0	286.0	61.0	28.0	2.0	8.0	3.0	2020-04-1

In [591]:
```
covid.head()
```

Out[591]:

create_time	Time	State	Cases_White	Cases_Black	Cases_Latinx	Cases_Asian	Deaths_White	Deaths_Black	Deaths_Latinx	Deaths_Asian	create_tim
2020-04-12	20200412	WY	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1
2020-04-12	20200412	ME	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1
2020-04-12	20200412	MD	2300.0	3200.0	NaN	190.0	83.0	104.0	NaN	8.0	2020-04-1
2020-04-12	20200412	MA	4271.0	1358.0	1885.0	331.0	199.0	20.0	28.0	13.0	2020-04-1
2020-04-12	20200412	LA	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	2020-04-1

In [40]:
```
# import the csv with both covid per 100k and tweet volume by state abbreviation
CovTw = pd.read_csv("tweet_COVID_per100k_summary_by_wave_state_Final.csv")
CovTw.head()
```

Out[40]:

	Wave	State	A_Case_Per100K	B_Case_Per100K	L_Case_Per100K	W_Case_Per100K	A_Death_Per100K	B_Death_Per100K	L_Death_Per100K	W_Death_Pe
0	Wave 1	AK	100.660385	53.446818	0.000000	57.545383	4.376538	0.000000	0.000000	1.(
1	Wave 1	AL	125.975025	580.842005	0.000000	206.611430	4.394478	21.432715	0.000000	9.5
2	Wave 1	AR	164.478985	516.884145	0.000000	150.531394	2.222689	10.023892	0.000000	3.3
3	Wave 1	AZ	88.971082	231.038271	213.663247	91.349523	5.157744	9.140668	6.434821	8.1
4	Wave 1	CA	126.560121	181.571376	279.996223	67.554292	10.375507	17.424181	10.084485	5.6

In [41]:
```
CovTw.columns
```

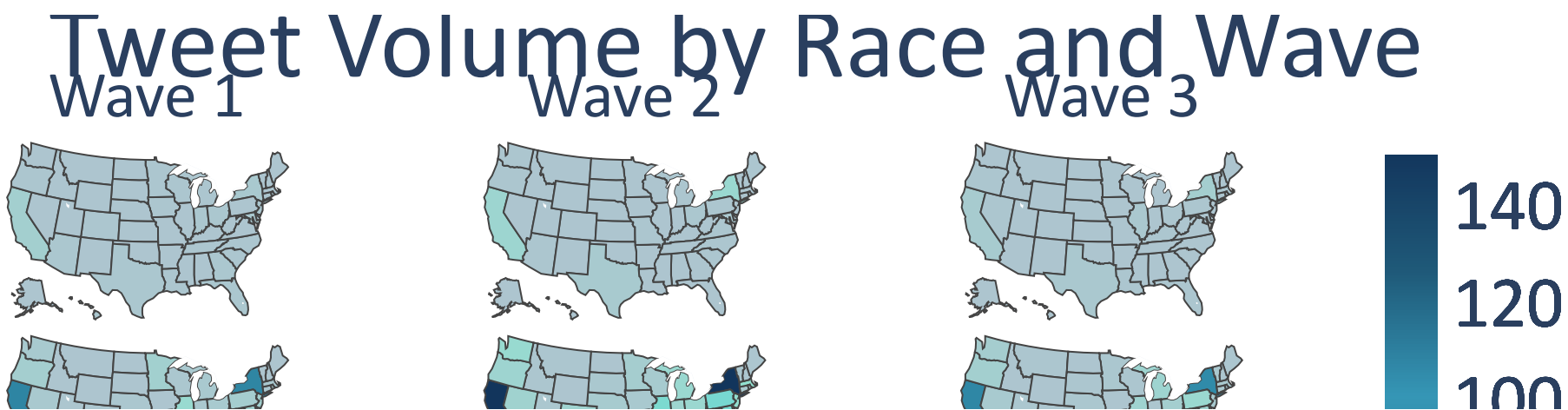
Out[41]:
```
Index(['Wave', 'State', 'A_Case_Per100K', 'B_Case_Per100K', 'L_Case_Per100K',
       'W_Case_Per100K', 'A_Death_Per100K', 'B_Death_Per100K',
       'L_Death_Per100K', 'W_Death_Per100K', 'Twt_Asian', 'Twt_Black',
       'Twt_Latino', 'Twt_White'],
      dtype='object')
```

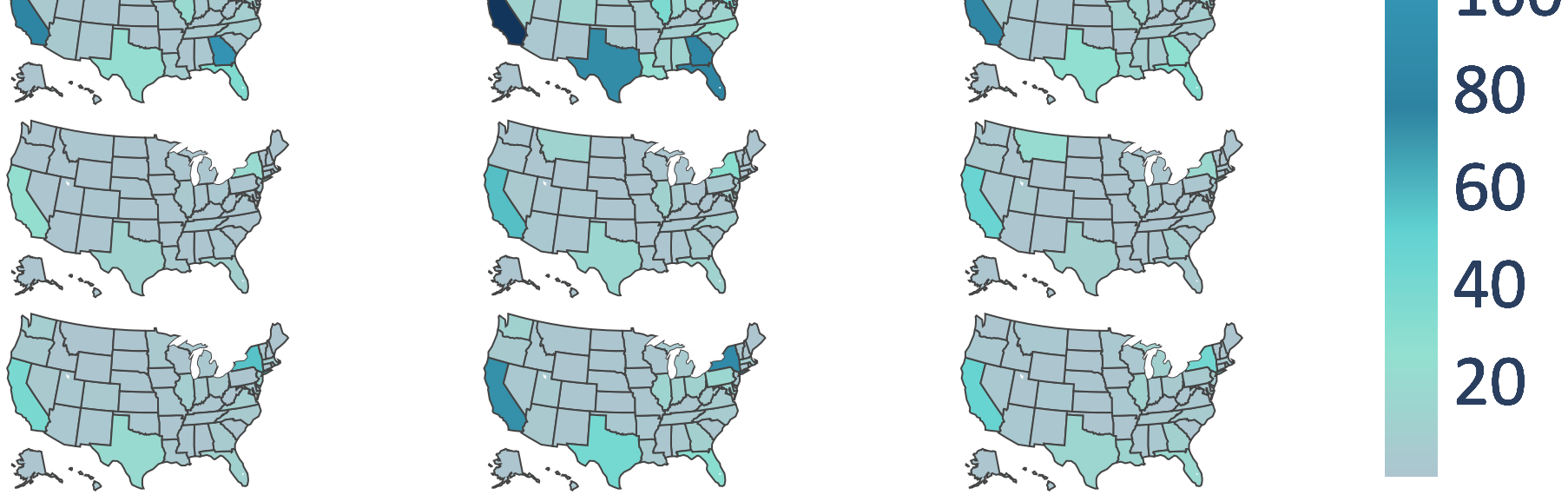
In [42]:
```
CovTw[['Twt_Asian', 'Twt_Black','Twt_Latino', 'Twt_White' ]].max()
```

Out[42]:
```
Twt_Asian      18
Twt_Black     227
Twt_Latino     56
Twt_White      84
dtype: int64
```

In [43]:

```
waves = (CovTw['Wave'].sort_values(ascending=True).unique()).tolist()

cscale = ['#ADC5CF','#92E0D0','#61D2D1','#2D83A1','#3596B5','#1F5A79','#12355C',]

# cscale = [[0, 'rgb(0,0,255)'], [1, 'rgb(0,50,255)']]
rows = 4
cols = 3
fig = make_subplots(rows=rows, cols=cols,
    specs = [[{'type': 'choropleth'} for c in np.arange(cols)] for r in np.arange(rows)],
    subplot_titles = waves, vertical_spacing=0.01, horizontal_spacing=0)
fig.update_annotations(font_size=38)

for i, y in enumerate(waves):
    fig.add_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.Twt_Asian[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=150, colorscale=cscale), row = 1, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.Twt_Black[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=150, colorscale=cscale), row = 2, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.Twt_Latino[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=150, colorscale=cscale), row = 3, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.Twt_White[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=150, colorscale=cscale), row = 4, col = i+1)

fig.update_layout(title={'text':'Tweet Volume by Race and Wave', 'xanchor': 'center','x':0.5,},
    **{'geo' + str(i) + '_scope': 'usa' for i in [''] + np.arange(2,rows*cols+1).tolist()},
    coloraxis_showscale=True, margin={"r":0,"t":70,"l":1,"b":15}, font=dict(family="Calibri",size=42))

fig.update_traces(showscale=True)
fig.show()
# fig.write_image(out_dir + "\Map Tweet Volume by Race and Wave.jpg",width=2500, height=2000, scale=1, engine="kaleido")
```





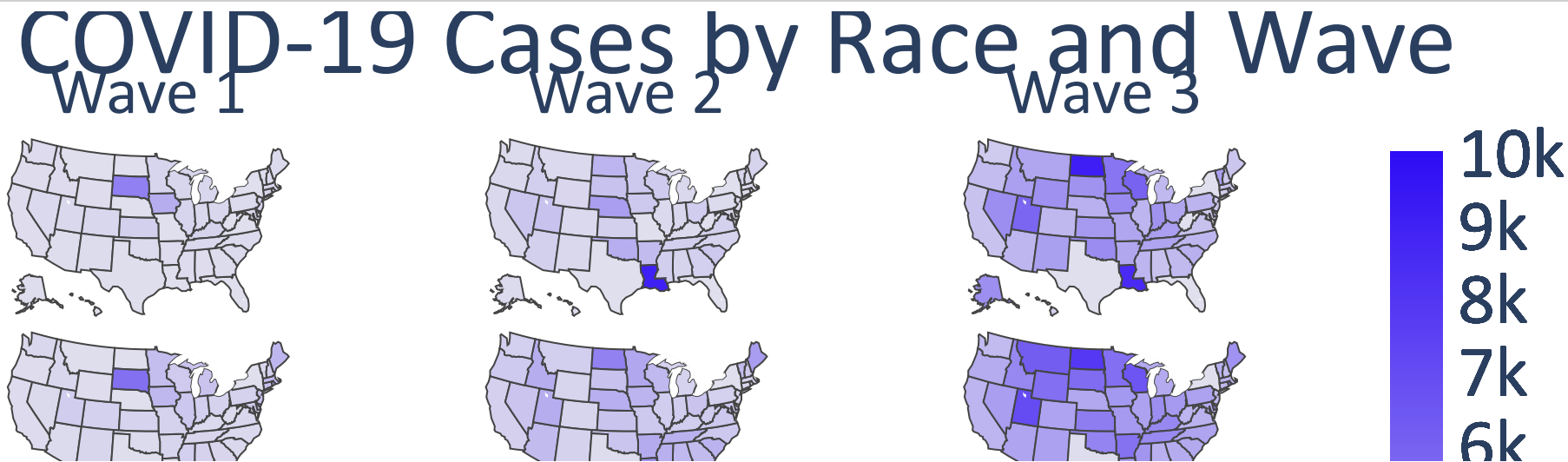
In [44]:
```
CovTw[['A_Case_Per100K', 'B_Case_Per100K', 'L_Case_Per100K','W_Case_Per100K' ]].max()
```

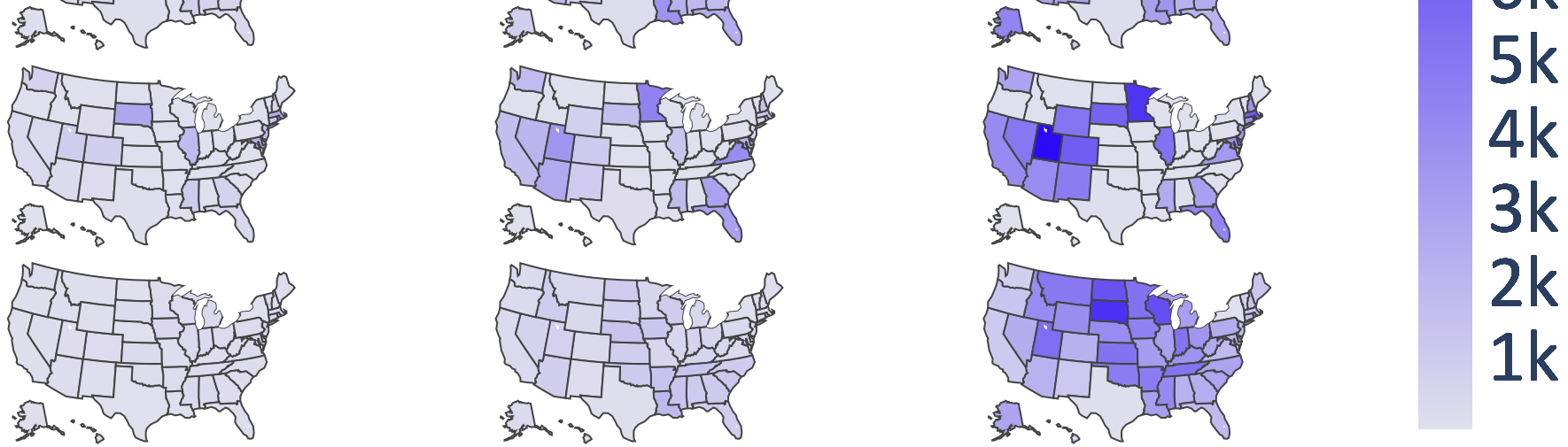
Out[44]:
```
A_Case_Per100K    9083.096235
B_Case_Per100K    7819.622632
L_Case_Per100K    9995.185889
W_Case_Per100K    8225.652724
dtype: float64
```

In [ ]:
```
["E0DFED","#CCC7EE","#B8B0EF","#A498F0","#9080F1","#7D69F1","#6951F2","#5539F3","#4122F4","#2D0AF5"]
```

In [45]:

```
waves = (CovTw['Wave'].sort_values(ascending=True).unique()).tolist()

cscale = ["#E0DFED","#CCC7EE","#B8B0EF","#A498F0","#9080F1","#7D69F1","#6951F2","#5539F3","#4122F4","#2D0AF5"]

# cscale = [[0, 'rgb(0,0,255)'], [1, 'rgb(0,50,255)']]
rows = 4
cols = 3
fig = make_subplots(rows=rows, cols=cols,
    specs = [[{'type': 'choropleth'} for c in np.arange(cols)] for r in np.arange(rows)],
    subplot_titles = waves, vertical_spacing=0.01, horizontal_spacing=0)
fig.update_annotations(font_size=38)

for i, y in enumerate(waves):
    fig.add_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.A_Case_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=10000, colorscale=cscale), row = 1, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.B_Case_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=10000, colorscale=cscale), row = 2, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.L_Case_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=10000, colorscale=cscale), row = 3, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.W_Case_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=10000, colorscale=cscale), row = 4, col = i+1)

fig.update_layout(title={'text':'COVID-19 Cases by Race and Wave', 'xanchor': 'center','x':0.5,},
    **{'geo' + str(i) + '_scope': 'usa' for i in ['']} + np.arange(2,rows*cols+1).tolist()},
    coloraxis_showscale=True, margin={"r":0,"t":70,"l":1,"b":15}, font=dict(family="Calibri",size=42))

fig.update_traces(showscale=True)
fig.show()
fig.write_image(out_dir + "\Map COVID-19 Cases by Race and Wave.jpg",width=2500, height=2000, scale=1, engine="kaleido")
```



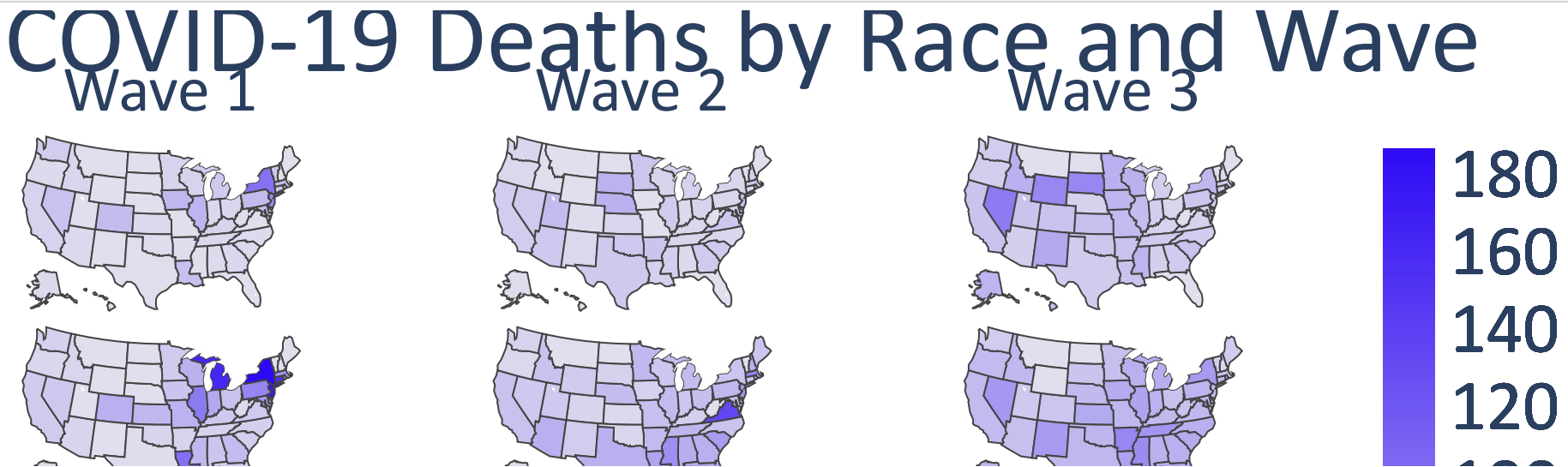


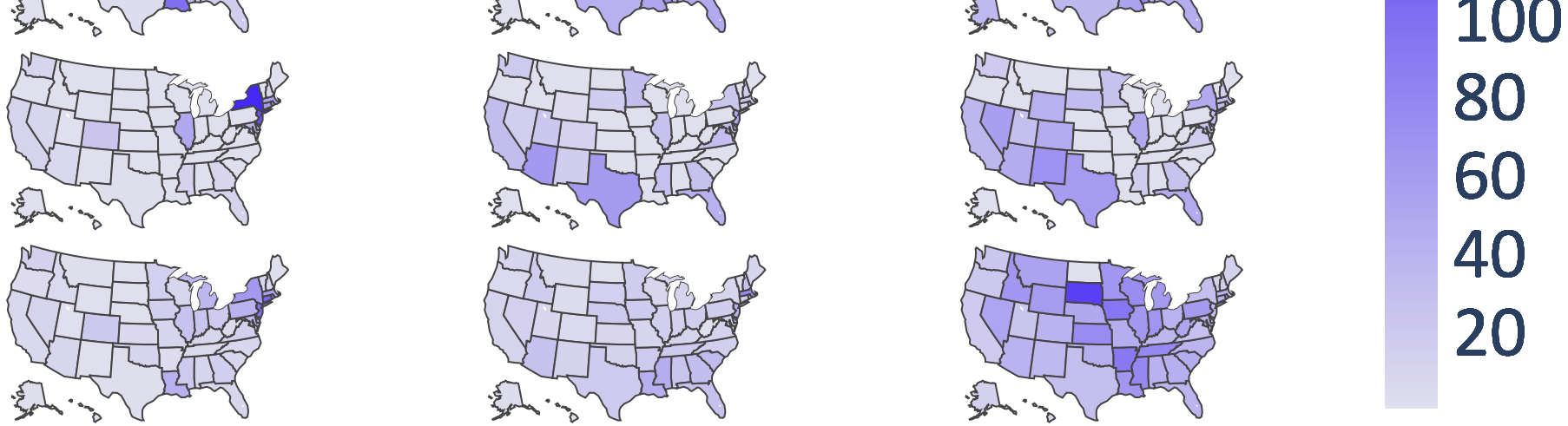
In [65]:
```
CovTw[['A_Death_Per100K', 'B_Death_Per100K','L_Death_Per100K', 'W_Death_Per100K' ]].max()
```

Out[65]:
```
A_Death_Per100K     95.190316
B_Death_Per100K    186.243793
L_Death_Per100K    160.215531
W_Death_Per100K    139.383203
dtype: float64
```

In [46]:

```
waves = (CovTw['Wave'].sort_values(ascending=True).unique()).tolist()

cscale = ["#E0DFED","#CCC7EE","#B8B0EF","#A498F0","#9080F1","#7D69F1","#6951F2","#5539F3","#4122F4","#2D0AF5"]

# cscale = [[0, 'rgb(0,0,255)'], [1, 'rgb(0,50,255)']]
rows = 4
cols = 3
fig = make_subplots(rows=rows, cols=cols,
    specs = [[{'type': 'choropleth'} for c in np.arange(cols)] for r in np.arange(rows)],
    subplot_titles = waves, vertical_spacing=0.01, horizontal_spacing=0)
fig.update_annotations(font_size=38)

for i, y in enumerate(waves):
    fig.add_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.A_Death_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=186, colorscale=cscale), row = 1, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.B_Death_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=186, colorscale=cscale), row = 2, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.L_Death_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=186, colorscale=cscale), row = 3, col = i+1)
    fig.append_trace(go.Choropleth(locations=CovTw.State[CovTw['Wave']==y],z = CovTw.W_Death_Per100K[CovTw['Wave']==y],
              locationmode = 'USA-states', zmin=0, zmax=186, colorscale=cscale), row = 4, col = i+1)

fig.update_layout(title={'text':'COVID-19 Deaths by Race and Wave', 'xanchor': 'center','x':0.5,},
    **{'geo' + str(i) + '_scope': 'usa' for i in ['']} + np.arange(2,rows*cols+1).tolist()},
    coloraxis_showscale=True, margin={"r":0,"t":70,"l":1,"b":15}, font=dict(family="Calibri",size=42))

fig.update_traces(showscale=True)
fig.show()
# fig.write_image(out_dir + "\Map COVID-19 Deaths by Race and Wave.jpg",width=2500, height=2000, scale=1, engine="kaleido")
```





In [183]:
```
CovTwPop = pd.read_csv("tweet_COVID_Pop_summary_by_wave_state_final.csv")
CovTwPop.head()
```

Out[183]:

	Wave	State	Cases_Asian	Cases_Black	Cases_Latinx	Cases_White	Deaths_Asian	Deaths_Black	Deaths_Latinx	Deaths_White	Asian_Pop	Black_Po
0	Wave 1	AK	46.0	13.0	NaN	274.0	2.0	0.0	NaN	5.0	45698.216	24323.24
1	Wave 1	AL	86.0	7534.0	NaN	6861.0	3.0	278.0	NaN	318.0	68267.500	1297082.5(
2	Wave 1	AR	74.0	2372.0	NaN	3463.0	1.0	46.0	NaN	76.0	44990.550	458903.6
3	Wave 1	AZ	207.0	733.0	4715.0	4972.0	12.0	29.0	142.0	444.0	232659.867	317263.4
4	Wave 1	CA	7209.0	4137.0	42897.0	15843.0	591.0	397.0	1545.0	1333.0	5696107.065	2278442.8

In [193]:

```
regression_model = sklearn.linear_model.LinearRegression()

training_data_1 = CovTwPop.loc[CovTwPop['Wave']=='Wave 1',['Asian_Pop','Twt_Asian']]
target_values_1 = CovTwPop.loc[CovTwPop['Wave']=='Wave 1',["Cases_Asian"]].fillna(0)

regression_model.fit(training_data_1, target_values_1)

estimates = regression_model.coef_
print(estimates)
```

```
[[ 1.34790575e-03 -1.05768644e+02]]
```