In [1]:

```
# Using K-Means clustering to cluster Covid-19 cases in US counties

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
```

In [2]:

```
# Covid-19 cases in US
# link to data: https://github.com/nytimes/covid-19-data
data = pd.read_csv('us-counties.csv')
data
```

Out[2]:

	date	county	state	fips	cases	deaths
0	2020-01-21	Snohomish	Washington	53061.0	1	0
1	2020-01-22	Snohomish	Washington	53061.0	1	0
2	2020-01-23	Snohomish	Washington	53061.0	1	0
3	2020-01-24	Cook	Illinois	17031.0	1	0
4	2020-01-24	Snohomish	Washington	53061.0	1	0
...	...	...	...	...	...	...
115452	2020-05-04	Sublette	Wyoming	56035.0	1	0
115453	2020-05-04	Sweetwater	Wyoming	56037.0	11	0
115454	2020-05-04	Teton	Wyoming	56039.0	67	1
115455	2020-05-04	Uinta	Wyoming	56041.0	6	0
115456	2020-05-04	Washakie	Wyoming	56043.0	4	0

115457 rows × 6 columns

In [3]:

```
# Since the original data doesn't have longitudes and latitudes of the counties, I have to use this to merge the longitudes and latitudes
# Link to data: https://en.wikipedia.org/wiki/User:Michael_J/County_table
fips = pd.read_csv('fips.csv')
fips
```

Out[3]:

	State	FIPS	County	Latitude	Longitude
0	AL	1001	Autauga	32.536382	-86.644490
1	AL	1003	Baldwin	30.659218	-87.746067
2	AL	1005	Barbour	31.870670	-85.405456
3	AL	1007	Bibb	33.015893	-87.127148
4	AL	1009	Blount	33.977448	-86.567246
...	...	...	...	...	...
3138	WY	56037	Sweetwater	41.660339	-108.875676
3139	WY	56039	Teton	44.049321	-110.588102
3140	WY	56041	Uinta	41.284726	-110.558947
3141	WY	56043	Washakie	43.878831	-107.669052
3142	WY	56045	Weston	43.846213	-104.570020

3143 rows × 5 columns

In [4]:
```
# Merge based on same fips (counties) so each row in data has a longitude and
 latitude of the county
data = data.merge(fips, left_on='fips', right_on='FIPS')
data
```

Out[4]:

	date	county	state	fips	cases	deaths	State	FIPS	County	Latitu
0	2020-01-21	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
1	2020-01-22	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
2	2020-01-23	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
3	2020-01-24	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
4	2020-01-25	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
...	...	...	...	...	...	...	...	...	...	
114106	2020-05-04	Boone	Nebraska	31011.0	1	0	NE	31011	Boone	41.7054
114107	2020-05-04	McPherson	Nebraska	31117.0	1	0	NE	31117	McPherson	41.5964
114108	2020-05-04	De Baca	New Mexico	35011.0	1	0	NM	35011	De Baca	34.3514
114109	2020-05-04	Blaine	Oklahoma	40011.0	1	0	OK	40011	Blaine	35.8777
114110	2020-05-04	Refugio	Texas	48391.0	1	0	TX	48391	Refugio	28.3124

114111 rows × 11 columns

In [6]:

```python
# drop unwanted columns
cleandata = data.drop(['date', 'fips', 'FIPS', 'deaths', 'cases', 'State', 'County', 'county', 'state'], axis=1)
cleandata
```

Out[6]:

	Latitude	Longitude
0	48.054913	-121.766412
1	48.054913	-121.766412
2	48.054913	-121.766412
3	48.054913	-121.766412
4	48.054913	-121.766412
...	...	...
114106	41.705400	-98.066794
114107	41.596473	-101.060237
114108	34.351429	-104.401527
114109	35.877782	-98.428934
114110	28.312496	-97.160479

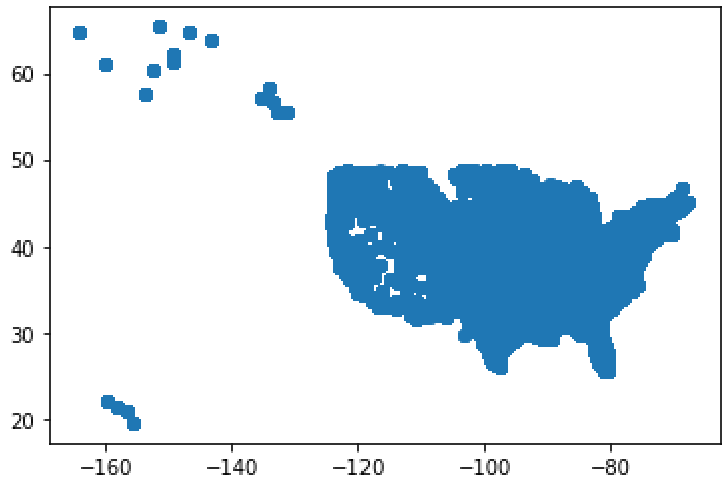
114111 rows × 2 columns

In [7]:

```python
# This is what the plot of cleandata on XY graph looks like
# As you can see, covid-19 cases have been reported in most of the counties in the US
plt.scatter(cleandata['Longitude'], cleandata['Latitude'])
```

Out[7]:

```
<matplotlib.collections.PathCollection at 0x1c5fdd32108>
```



In [8]:
```
# Assign k=200
km = KMeans(n_clusters=200)
km
```

Out[8]:
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=200, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

In [9]:
```
# Perform k-means clustering
clusters = km.fit_predict(cleandata[['Longitude', 'Latitude']])
clusters
```

Out[9]:
```
array([103, 103, 103, ...,  17,  12, 161])
```

In [10]:
```
# Assign the cluster numbers to the data points
cleandata['Cluster'] = clusters
data['Cluster'] = clusters
data
```

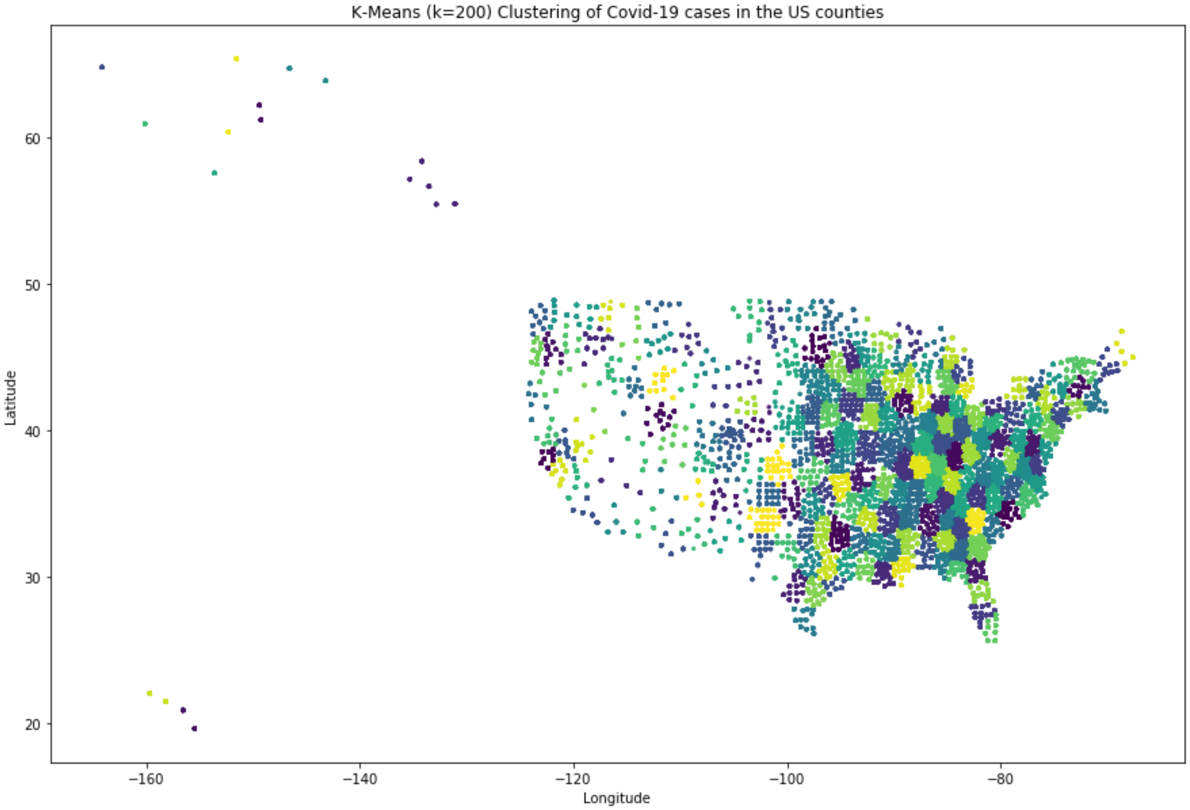
Out[10]:

	date	county	state	fips	cases	deaths	State	FIPS	County	Latitu
0	2020-01-21	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
1	2020-01-22	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
2	2020-01-23	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
3	2020-01-24	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
4	2020-01-25	Snohomish	Washington	53061.0	1	0	WA	53061	Snohomish	48.0549
...	...	...	...	...	...	...	...	...	...	
114106	2020-05-04	Boone	Nebraska	31011.0	1	0	NE	31011	Boone	41.7054
114107	2020-05-04	McPherson	Nebraska	31117.0	1	0	NE	31117	McPherson	41.5964
114108	2020-05-04	De Baca	New Mexico	35011.0	1	0	NM	35011	De Baca	34.3514
114109	2020-05-04	Blaine	Oklahoma	40011.0	1	0	OK	40011	Blaine	35.8777
114110	2020-05-04	Refugio	Texas	48391.0	1	0	TX	48391	Refugio	28.3124

114111 rows × 12 columns

In [11]:
```
# Create a map of the datapoints and clusters
fig = plt.figure(figsize=[15, 10])
ax = fig.add_subplot(111)
scatter = ax.scatter(cleandata['Longitude'],cleandata['Latitude'], c=clusters,
s=5)
ax.set_title('K-Means (k=200) Clustering of Covid-19 cases in the US counties'
)
ax.set_xlabel('Longitude')
ax.set_ylabel('Latitude')
```

Out[11]:
```
Text(0, 0.5, 'Latitude')
```



Summary & Results:

I used K-Means clustering on the counties in this data but it didn't have longitudes and latitudes so I found another dataset who contained US counties, county fips number and the longitudes and latitudes of the counties. So now I can merge the two datasets based on the fips on the counties since both datasets have fips column. So I got about 114,000 data points each with date, county, longitude, latitude, cases... etc. I needed to decide on a k value and I tried couple different k values but decided to go with k=200. Since most the US poplation live is urban areas my assumption was that most of the cases will be in counties in urban areas. So, it seemed right for the clusters to cover different metropolitan areas in the US. Since there are 50 states, I predicted that on average most states will have about four main metorpolitan areas which is why I went with 200 clusters. Once the clusters were computed I assigned them to the data by appending the cluster cloumn.

Next, I created a scatter plot of the longitude and latitude of the datapoints and the cluster they belonged to. As I expected, the graph ended up looking like the shape of US. You can clearly see the discrepancy in the amount of counties that have Covid-19 cases in different parts of the US. Each dot on the map represents a county. The northeast, southeast and midwest regions have a lot more counties with Covid-19 cases then northwest and southwest regions of the country. This was expected since the eastern region of the country is more populated then the western part. You can see from the graph that florida has 5 clusters. There is a cluster in dark blue where Miami is located. There are two clusters in shades of green in central Florida and two more clusters in northern Florida. There is a cluster in blue where New York City is located and then below that is another cluster in green in New Jersy. In the west coast there is cluster in green where San Francisco is located. And if you look south of that there is a cluster in yellow near LA.