In [ ]:
```
#Wania Urooj Suleman CMSID: 49178
!pip3 install folium
!pip3 install wget
```

In [3]:
```
import folium
import wget
import pandas as pd
from folium.plugins import MarkerCluster
from folium.plugins import MousePosition
from folium.features import DivIcon
```

In [4]:
```
spacex_csv_file = wget.download('https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBM-DS0321EN-SkillsNetwork/datasets/spacex_launch_geo.csv')
spacex_df=pd.read_csv(spacex_csv_file)
spacex_df.to_csv('spacex_launch_geo.csv')
```

```
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```

In [5]:
```
spacex_df = spacex_df[['Launch Site', 'Lat', 'Long', 'class']]
launch_sites_df = spacex_df.groupby(['Launch Site'], as_index=False).first()
launch_sites_df = launch_sites_df[['Launch Site', 'Lat', 'Long', 'class']]
launch_sites_df
```

Out[5]:

	Launch Site	Lat	Long	class
0	CCAFS LC-40	28.562302	-80.577356	0
1	CCAFS SLC-40	28.563197	-80.576820	1
2	KSC LC-39A	28.573255	-80.646895	1
3	VAFB SLC-4E	34.632834	-120.610745	0

In [6]:
```
nasa_coordinate = [29.559684888503615, -95.0830971930759]
site_map = folium.Map(location=nasa_coordinate, zoom_start=10)
circle = folium.Circle(nasa_coordinate, radius=1000, color='#d35400', fill=True).add_child(folium.Popup('NASA Johnson Space Center'))
marker = folium.map.Marker(
    nasa_coordinate,
    # Create an icon as a text label
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % 'NASA JSC',
        )
    )
site_map.add_child(circle)
site_map.add_child(marker)
```

Out[6]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [7]:
```
site_map = folium.Map(location=nasa_coordinate, zoom_start=5)
for lat, lng, label in zip(launch_sites_df['Lat'], launch_sites_df['Long'], launch_sites_df['Launch Site']):
    coordinate = [lat, lng]
    circle = folium.Circle(coordinate, radius=1000, color='#d35400', fill=True).add_child(folium.Popup(label))
    marker = folium.map.Marker(
        coordinate,
        icon=DivIcon(
            icon_size=(20,20),
            icon_anchor=(0,0),
            html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % label,
            )
        )
    site_map.add_child(circle)
    site_map.add_child(marker)

site_map
```

Out[7]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [8]:
```
spacex_df.tail(10)
```

Out[8]:

	Launch Site	Lat	Long	class
46	KSC LC-39A	28.573255	-80.646895	1
47	KSC LC-39A	28.573255	-80.646895	1
48	KSC LC-39A	28.573255	-80.646895	1
49	CCAFS SLC-40	28.563197	-80.576820	1
50	CCAFS SLC-40	28.563197	-80.576820	1
51	CCAFS SLC-40	28.563197	-80.576820	0
52	CCAFS SLC-40	28.563197	-80.576820	0
53	CCAFS SLC-40	28.563197	-80.576820	0
54	CCAFS SLC-40	28.563197	-80.576820	1
55	CCAFS SLC-40	28.563197	-80.576820	0

In [9]:
```
marker_cluster = MarkerCluster()
def assign_marker_color_LSDF(launch_class):
    if launch_class == 1:
        return 'green'
    else:
        return 'red'

launch_sites_df['marker_color'] = launch_sites_df['class'].apply(assign_marker_color_LSDF)
launch_sites_df
```

Out[9]:

	Launch Site	Lat	Long	class	marker_color
0	CCAFS LC-40	28.562302	-80.577356	0	red
1	CCAFS SLC-40	28.563197	-80.576820	1	green
2	KSC LC-39A	28.573255	-80.646895	1	green
3	VAFB SLC-4E	34.632834	-120.610745	0	red

In [10]:
```
def assign_marker_color(launch_outcome):
    if launch_outcome == 1:
        return 'green'
    else:
        return 'red'

spacex_df['marker_color'] = spacex_df['class'].apply(assign_marker_color)
spacex_df.tail(10)
```

Out[10]:

	Launch Site	Lat	Long	class	marker_color
46	KSC LC-39A	28.573255	-80.646895	1	green
47	KSC LC-39A	28.573255	-80.646895	1	green
48	KSC LC-39A	28.573255	-80.646895	1	green
49	CCAFS SLC-40	28.563197	-80.576820	1	green
50	CCAFS SLC-40	28.563197	-80.576820	1	green
51	CCAFS SLC-40	28.563197	-80.576820	0	red
52	CCAFS SLC-40	28.563197	-80.576820	0	red
53	CCAFS SLC-40	28.563197	-80.576820	0	red
54	CCAFS SLC-40	28.563197	-80.576820	1	green
55	CCAFS SLC-40	28.563197	-80.576820	0	red

In [11]:
```
site_map.add_child(marker_cluster)
for lat, lng, label, color in zip(spacex_df['Lat'], spacex_df['Long'], spacex_df['Launch Site'], spacex_df['marker_color']):
    coordinate = [lat, lng]
    marker = folium.Marker(
        coordinate,
        icon=folium.Icon(color='white', icon_color=color),
        popup=label
    )
    marker_cluster.add_child(marker)

site_map
```

Out[11]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [12]:
```
formatter = "function(num) {return L.Util.formatNum(num, 5);};"
mouse_position = MousePosition(
    position='topright',
    separator=' Long: ',
    empty_string='NaN',
    lng_first=False,
    num_digits=20,
    prefix='Lat:',
    lat_formatter=formatter,
    lng_formatter=formatter,
)

site_map.add_child(mouse_position)
site_map
```

Out[12]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [13]:
```
from math import sin, cos, sqrt, atan2, radians

def calculate_distance(lat1, lon1, lat2, lon2):
    # approximate radius of earth in km
    R = 6373.0

    lat1 = radians(lat1)
    lon1 = radians(lon1)
    lat2 = radians(lat2)
    lon2 = radians(lon2)

    dlon = lon2 - lon1
    dlat = lat2 - lat1

    a = sin(dlat / 2)**2 + cos(lat1) * cos(lat2) * sin(dlon / 2)**2
    c = 2 * atan2(sqrt(a), sqrt(1 - a))

    distance = R * c
    return distance
coastline_lat = 28.56222
coastline_lon = -80.56809
launch_site_lat = 28.56321
launch_site_lon = -80.57683
distance_coastline = calculate_distance(launch_site_lat, launch_site_lon, coastline_lat, coastline_lon)
coast_coordinates = [coastline_lat, coastline_lon]
distance_marker = folium.Marker(
    coast_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_coastline),
        )
    )
distance_marker.add_to(site_map)
site_map
```

Out[13]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [14]:
```
launch_site_coordinates = [launch_site_lat, launch_site_lon]
lines=folium.PolyLine(locations=[coast_coordinates, launch_site_coordinates], weight=1)
site_map.add_child(lines)
```

Out[14]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [15]:
```
city_lat = 28.61208
city_lon = -80.80764
distance_city = calculate_distance(launch_site_lat, launch_site_lon, city_lat, city_lon)

city_coordinates = [city_lat, city_lon]
distance_marker = folium.Marker(
    city_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_city),
        )
    )
distance_marker.add_to(site_map)

launch_site_coordinates = [launch_site_lat, launch_site_lon]
lines=folium.PolyLine(locations=[city_coordinates, launch_site_coordinates], weight=1)
site_map.add_child(lines)
site_map
```

Out[15]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [16]:
```
railway_lat = 28.57208
railway_lon = -80.58527
distance_railway = calculate_distance(launch_site_lat, launch_site_lon, railway_lat, railway_lon)

railway_coordinates = [railway_lat, railway_lon]
distance_marker = folium.Marker(
    railway_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_railway),
        )
    )
distance_marker.add_to(site_map)

launch_site_coordinates = [launch_site_lat, launch_site_lon]
lines=folium.PolyLine(locations=[railway_coordinates, launch_site_coordinates], weight=1)
site_map.add_child(lines)
site_map
```

Out[16]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [17]:
```
highway_lat = 28.56478
highway_lon = -80.57103
distance_highway = calculate_distance(launch_site_lat, launch_site_lon, highway_lat, highway_lon)

highway_coordinates = [highway_lat, highway_lon]
distance_marker = folium.Marker(
    highway_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_highway),
        )
    )
distance_marker.add_to(site_map)

launch_site_coordinates = [launch_site_lat, launch_site_lon]
lines=folium.PolyLine(locations=[highway_coordinates, launch_site_coordinates], weight=1)
site_map.add_child(lines)
site_map
```

Out[17]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [18]:
```
# Draw a line between the closest city(Cape Canaveral) to the launch site
city_2_lat = 28.40159
city_2_lon = -80.6042
distance_city_2 = calculate_distance(launch_site_lat, launch_site_lon, city_2_lat, city_2_lon)

city_2_coordinates = [city_2_lat, city_2_lon]
distance_marker = folium.Marker(
    city_2_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_city_2),
        )
    )
distance_marker.add_to(site_map)

launch_site_coordinates = [launch_site_lat, launch_site_lon]
lines=folium.PolyLine(locations=[city_2_coordinates, launch_site_coordinates], weight=1)
site_map.add_child(lines)
site_map
```

Out[18]: Make this Notebook Trusted to load map: File -> Trust Notebook

In [19]:
```
launch_site_4_lat = 34.63286
launch_site_4_lon = -120.61074
launch_site_4_coordinates = [launch_site_4_lat, launch_site_4_lon]

city_Lompoc_lat = 34.63879
city_Lompoc_lon = -120.45788
distance_city_Lompoc = calculate_distance(launch_site_4_lat, launch_site_4_lon, city_Lompoc_lat, city_Lompoc_lon)

city_Lompoc_coordinates = [city_Lompoc_lat, city_Lompoc_lon]

distance_marker = folium.Marker(
    city_Lompoc_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_city_Lompoc),
        )
    )
distance_marker.add_to(site_map)

lines=folium.PolyLine(locations=[city_Lompoc_coordinates, launch_site_4_coordinates], weight=1)
site_map.add_child(lines)
west_coast_lat = 34.63698
west_coast_lon = -120.6245
distance_west_coast = calculate_distance(launch_site_4_lat, launch_site_4_lon, west_coast_lat, west_coast_lon)

west_coast_coordinates = [west_coast_lat, west_coast_lon]

distance_marker = folium.Marker(
    west_coast_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_west_coast),
        )
    )
distance_marker.add_to(site_map)

lines=folium.PolyLine(locations=[west_coast_coordinates, launch_site_4_coordinates], weight=1)
site_map.add_child(lines)

# Draw a line between the closest railway to the launch site(Space Launch Complex 4)
railway_4_lat = 34.63677
railway_4_lon = -120.6236
distance_railway_4 = calculate_distance(launch_site_4_lat, launch_site_4_lon, railway_4_lat, railway_4_lon)

railway_4_coordinates = [railway_4_lat, railway_4_lon]

distance_marker = folium.Marker(
    railway_4_coordinates,
    icon=DivIcon(
        icon_size=(20,20),
         icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % "{:10.2f} KM".format(distance_railway_4),
        )
    )
distance_marker.add_to(site_map)

lines=folium.PolyLine(locations=[railway_4_coordinates, launch_site_4_coordinates], weight=1)
site_map.add_child(lines)
```

```
site_map
```

Out[19]: Make this Notebook Trusted to load map: File -> Trust Notebook