**Launch Sites Locations Analysis with Folium**

Estimated time needed: **40** minutes

The launch success rate may depend on many factors such as payload mass, orbit type, and so on. It may also depend on the location and proximities of a launch site, i.e., the initial position of rocket trajectories. Finding an optimal location for building a launch site certainly involves many factors and hopefully we could discover some of the factors by analyzing the existing launch site locations.

In the previous exploratory data analysis labs, you have visualized the SpaceX launch dataset using matplotlib and seaborn and discovered some preliminary correlations between the launch site and success rates. In this lab, you will be performing more interactive visual analytics using Folium.

**Objectives**

This lab contains the following tasks:

* **TASK 1:** Mark all launch sites on a map
* **TASK 2:** Mark the success/failed launches for each site on the map
* **TASK 3:** Calculate the distances between a launch site to its proximities

After completed the above tasks, you should be able to find some geographical patterns about launch sites.

Let's first import required Python packages for this lab:

In [1]:

!pip3 install folium

!pip3 install wget

Collecting folium

Downloading folium-0.12.1.post1-py2.py3-none-any.whl (95 kB)

|████████████████████████████████| 95 kB 6.2 MB/s eta 0:00:01

Collecting branca>=0.3.0

Downloading branca-0.5.0-py3-none-any.whl (24 kB)

Requirement already satisfied: numpy in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium) (1.20.3)

Requirement already satisfied: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium) (2.26.0)

Requirement already satisfied: jinja2>=2.9 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium) (3.0.2)

Requirement already satisfied: MarkupSafe>=2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jinja2>=2.9->folium) (2.0.1)

Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium) (2.0.4)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium) (3.3)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium) (2022.5.18.1)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium) (1.26.7)

Installing collected packages: branca, folium

Successfully installed branca-0.5.0 folium-0.12.1.post1

Collecting wget

Downloading wget-3.2.zip (10 kB)

Building wheels for collected packages: wget

Building wheel for wget (setup.py) ... done

Created wheel for wget: filename=wget-3.2-py3-none-any.whl size=9672 sha256=4e37e94ebcc022778bafc6598e20120ce23d24f183fb10c794ff590d5ff8cc2d

Stored in directory: /tmp/wsuser/.cache/pip/wheels/04/5f/3e/46cc37c5d698415694d83f607f833f83f0149e49b3af9d0f38

Successfully built wget

Installing collected packages: wget

Successfully installed wget-3.2

In [2]:

**import** **folium**

**import** **wget**

**import** **pandas** **as** **pd**

!pip install folium==0.11.0

!pip install folium==0.12.1

Collecting folium==0.11.0

Downloading folium-0.11.0-py2.py3-none-any.whl (93 kB)

|████████████████████████████████| 93 kB 3.4 MB/s eta 0:00:01

Requirement already satisfied: numpy in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.11.0) (1.20.3)

Requirement already satisfied: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.11.0) (2.26.0)

Requirement already satisfied: branca>=0.3.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.11.0) (0.5.0)

Requirement already satisfied: jinja2>=2.9 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.11.0) (3.0.2)

Requirement already satisfied: MarkupSafe>=2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jinja2>=2.9->folium==0.11.0) (2.0.1)

Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.11.0) (2.0.4)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.11.0) (2022.5.18.1)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.11.0) (1.26.7)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.11.0) (3.3)

Installing collected packages: folium

Attempting uninstall: folium

Found existing installation: folium 0.12.1.post1

Uninstalling folium-0.12.1.post1:

Successfully uninstalled folium-0.12.1.post1

Successfully installed folium-0.11.0

Collecting folium==0.12.1

Downloading folium-0.12.1-py2.py3-none-any.whl (94 kB)

|████████████████████████████████| 94 kB 6.3 MB/s eta 0:00:01

Requirement already satisfied: numpy in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.12.1) (1.20.3)

Requirement already satisfied: jinja2>=2.9 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.12.1) (3.0.2)

Requirement already satisfied: branca>=0.3.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.12.1) (0.5.0)

Requirement already satisfied: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium==0.12.1) (2.26.0)

Requirement already satisfied: MarkupSafe>=2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jinja2>=2.9->folium==0.12.1) (2.0.1)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.12.1) (3.3)

Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.12.1) (2.0.4)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.12.1) (2022.5.18.1)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium==0.12.1) (1.26.7)

Installing collected packages: folium

Attempting uninstall: folium

Found existing installation: folium 0.11.0

Uninstalling folium-0.11.0:

Successfully uninstalled folium-0.11.0

Successfully installed folium-0.12.1

In [3]:

!pip install geemap

**import** **geemap**

**import** **json**

**import** **os**

**import** **requests**

**from** **geemap** **import** geojson\_to\_ee, ee\_to\_geojson

*#from iplyleaflet import GeoJson, Marker, MarkerCluster*

Collecting geemap

Downloading geemap-0.13.8-py2.py3-none-any.whl (2.0 MB)

|████████████████████████████████| 2.0 MB 18.8 MB/s eta 0:00:01

Collecting ffmpeg-python

Downloading ffmpeg\_python-0.2.0-py3-none-any.whl (25 kB)

Collecting gdown

Downloading gdown-4.4.0.tar.gz (14 kB)

Installing build dependencies ... done

Getting requirements to build wheel ... done

Preparing wheel metadata ... done

Collecting pycrs

Downloading PyCRS-1.0.2.tar.gz (36 kB)

Collecting ee-extra>=0.0.10

Downloading ee\_extra-0.0.13.tar.gz (187 kB)

|████████████████████████████████| 187 kB 55.8 MB/s eta 0:00:01

Collecting ipyleaflet>=0.14.0

Downloading ipyleaflet-0.16.0-py2.py3-none-any.whl (3.3 MB)

|████████████████████████████████| 3.3 MB 50.8 MB/s eta 0:00:01

Collecting pyshp>=2.1.3

Downloading pyshp-2.3.0-py2.py3-none-any.whl (46 kB)

|████████████████████████████████| 46 kB 8.9 MB/s eta 0:00:01

Collecting jupyterlab>=3

Downloading jupyterlab-3.4.2-py3-none-any.whl (8.8 MB)

|████████████████████████████████| 8.8 MB 59.1 MB/s eta 0:00:01

Requirement already satisfied: pillow in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from geemap) (9.0.1)

Collecting ipyevents

Downloading ipyevents-2.0.1-py2.py3-none-any.whl (130 kB)

|████████████████████████████████| 130 kB 62.7 MB/s eta 0:00:01

Requirement already satisfied: folium>=0.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from geemap) (0.12.1)

Collecting xyzservices

Downloading xyzservices-2022.4.0-py3-none-any.whl (36 kB)

Collecting geocoder

Downloading geocoder-1.38.1-py2.py3-none-any.whl (98 kB)

|████████████████████████████████| 98 kB 17.2 MB/s eta 0:00:01

Collecting colour

Downloading colour-0.1.5-py2.py3-none-any.whl (23 kB)

Collecting ipyfilechooser>=0.6.0

Downloading ipyfilechooser-0.6.0-py3-none-any.whl (11 kB)

Collecting earthengine-api>=0.1.304

Downloading earthengine-api-0.1.312.tar.gz (239 kB)

|████████████████████████████████| 239 kB 60.9 MB/s eta 0:00:01

Collecting sankee

Downloading sankee-0.0.7.tar.gz (29 kB)

Collecting bqplot

Downloading bqplot-0.12.33-py2.py3-none-any.whl (1.2 MB)

|████████████████████████████████| 1.2 MB 53.9 MB/s eta 0:00:01

Collecting whiteboxgui>=0.6.0

Downloading whiteboxgui-0.7.0-py2.py3-none-any.whl (99 kB)

|████████████████████████████████| 99 kB 18.0 MB/s eta 0:00:01

Collecting geeadd>=0.5.1

Downloading geeadd-0.5.5-py3-none-any.whl (30 kB)

Collecting geojson

Downloading geojson-2.5.0-py2.py3-none-any.whl (14 kB)

Collecting mapclassify>=2.4.0

Downloading mapclassify-2.4.3-py3-none-any.whl (38 kB)

Requirement already satisfied: matplotlib in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from geemap) (3.5.0)

Requirement already satisfied: pandas in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from geemap) (1.3.4)

Collecting ipytree

Downloading ipytree-0.2.1-py2.py3-none-any.whl (1.3 MB)

|████████████████████████████████| 1.3 MB 57.9 MB/s eta 0:00:01

Requirement already satisfied: numpy in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from geemap) (1.20.3)

Collecting python-box

Downloading python\_box-6.0.2-cp39-cp39-manylinux\_2\_17\_x86\_64.manylinux2014\_x86\_64.whl (3.3 MB)

|████████████████████████████████| 3.3 MB 50.1 MB/s eta 0:00:01

Requirement already satisfied: future in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from earthengine-api>=0.1.304->geemap) (0.18.2)

Collecting google-cloud-storage

Downloading google\_cloud\_storage-2.3.0-py2.py3-none-any.whl (107 kB)

|████████████████████████████████| 107 kB 63.0 MB/s eta 0:00:01

Collecting google-api-python-client<2,>=1.12.1

Downloading google\_api\_python\_client-1.12.11-py2.py3-none-any.whl (62 kB)

|████████████████████████████████| 62 kB 1.7 MB/s eta 0:00:01

Requirement already satisfied: google-auth>=1.4.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from earthengine-api>=0.1.304->geemap) (1.23.0)

Collecting google-auth-httplib2>=0.0.3

Downloading google\_auth\_httplib2-0.1.0-py2.py3-none-any.whl (9.3 kB)

Collecting httplib2<1dev,>=0.9.2

Downloading httplib2-0.20.4-py3-none-any.whl (96 kB)

|████████████████████████████████| 96 kB 11.5 MB/s eta 0:00:01

Collecting httplib2shim

Downloading httplib2shim-0.0.3.tar.gz (17 kB)

Requirement already satisfied: six in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from earthengine-api>=0.1.304->geemap) (1.15.0)

Requirement already satisfied: branca>=0.3.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium>=0.11.0->geemap) (0.5.0)

Requirement already satisfied: jinja2>=2.9 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium>=0.11.0->geemap) (3.0.2)

Requirement already satisfied: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from folium>=0.11.0->geemap) (2.26.0)

Requirement already satisfied: beautifulsoup4>=4.9.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from geeadd>=0.5.1->geemap) (4.10.0)

Collecting logzero>=1.5.0

Downloading logzero-1.7.0-py2.py3-none-any.whl (16 kB)

Requirement already satisfied: soupsieve>1.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from beautifulsoup4>=4.9.0->geeadd>=0.5.1->geemap) (2.3.1)

Collecting uritemplate<4dev,>=3.0.0

Downloading uritemplate-3.0.1-py2.py3-none-any.whl (15 kB)

Collecting google-api-core<3dev,>=1.21.0

Downloading google\_api\_core-2.8.1-py3-none-any.whl (114 kB)

|████████████████████████████████| 114 kB 57.7 MB/s eta 0:00:01

Requirement already satisfied: protobuf<4.0.0dev,>=3.15.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-api-core<3dev,>=1.21.0->google-api-python-client<2,>=1.12.1->earthengine-api>=0.1.304->geemap) (3.19.1)

Collecting google-auth>=1.4.1

Downloading google\_auth-2.6.6-py2.py3-none-any.whl (156 kB)

|████████████████████████████████| 156 kB 59.8 MB/s eta 0:00:01

Collecting googleapis-common-protos<2.0dev,>=1.56.2

Downloading googleapis\_common\_protos-1.56.2-py2.py3-none-any.whl (211 kB)

|████████████████████████████████| 211 kB 64.2 MB/s eta 0:00:01

Requirement already satisfied: rsa<5,>=3.1.4 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth>=1.4.1->earthengine-api>=0.1.304->geemap) (4.7.2)

Requirement already satisfied: pyasn1-modules>=0.2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth>=1.4.1->earthengine-api>=0.1.304->geemap) (0.2.8)

Requirement already satisfied: cachetools<6.0,>=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth>=1.4.1->earthengine-api>=0.1.304->geemap) (4.2.2)

Requirement already satisfied: pyparsing!=3.0.0,!=3.0.1,!=3.0.2,!=3.0.3,<4,>=2.4.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from httplib2<1dev,>=0.9.2->earthengine-api>=0.1.304->geemap) (3.0.4)

Requirement already satisfied: ipywidgets in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipyfilechooser>=0.6.0->geemap) (7.6.5)

Collecting traittypes<3,>=0.2.1

Downloading traittypes-0.2.1-py2.py3-none-any.whl (8.6 kB)

Requirement already satisfied: ipython>=4.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipywidgets->ipyfilechooser>=0.6.0->geemap) (7.29.0)

Requirement already satisfied: traitlets>=4.3.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipywidgets->ipyfilechooser>=0.6.0->geemap) (5.1.1)

Requirement already satisfied: jupyterlab-widgets>=1.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipywidgets->ipyfilechooser>=0.6.0->geemap) (1.0.0)

Requirement already satisfied: nbformat>=4.2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipywidgets->ipyfilechooser>=0.6.0->geemap) (5.1.3)

Requirement already satisfied: ipykernel>=4.5.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipywidgets->ipyfilechooser>=0.6.0->geemap) (6.4.1)

Requirement already satisfied: ipython-genutils~=0.2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.2.0)

Requirement already satisfied: widgetsnbextension~=3.5.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipywidgets->ipyfilechooser>=0.6.0->geemap) (3.5.1)

Requirement already satisfied: tornado<7.0,>=4.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (6.1)

Requirement already satisfied: debugpy<2.0,>=1.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (1.5.1)

Requirement already satisfied: jupyter-client<8.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (7.0.6)

Requirement already satisfied: matplotlib-inline<0.2.0,>=0.1.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.1.2)

Requirement already satisfied: pexpect>4.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (4.8.0)

Requirement already satisfied: decorator in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (5.1.0)

Requirement already satisfied: pickleshare in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.7.5)

Requirement already satisfied: jedi>=0.16 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.18.0)

Requirement already satisfied: setuptools>=18.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (58.0.4)

Requirement already satisfied: prompt-toolkit!=3.0.0,!=3.0.1,<3.1.0,>=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (3.0.20)

Requirement already satisfied: pygments in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (2.10.0)

Requirement already satisfied: backcall in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.2.0)

Requirement already satisfied: parso<0.9.0,>=0.8.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jedi>=0.16->ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.8.3)

Requirement already satisfied: MarkupSafe>=2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jinja2>=2.9->folium>=0.11.0->geemap) (2.0.1)

Requirement already satisfied: entrypoints in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-client<8.0->ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.3)

Requirement already satisfied: pyzmq>=13 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-client<8.0->ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (22.3.0)

Requirement already satisfied: python-dateutil>=2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-client<8.0->ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (2.8.2)

Requirement already satisfied: jupyter-core>=4.6.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-client<8.0->ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (4.9.1)

Requirement already satisfied: nest-asyncio>=1.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-client<8.0->ipykernel>=4.5.1->ipywidgets->ipyfilechooser>=0.6.0->geemap) (1.5.1)

Collecting jupyter-server~=1.16

Downloading jupyter\_server-1.17.0-py3-none-any.whl (342 kB)

|████████████████████████████████| 342 kB 60.2 MB/s eta 0:00:01

Collecting jupyterlab-server~=2.10

Downloading jupyterlab\_server-2.14.0-py3-none-any.whl (54 kB)

|████████████████████████████████| 54 kB 6.6 MB/s eta 0:00:01

Requirement already satisfied: packaging in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyterlab>=3->geemap) (21.3)

Collecting nbclassic~=0.2

Downloading nbclassic-0.3.7-py3-none-any.whl (13 kB)

Requirement already satisfied: prometheus-client in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-server~=1.16->jupyterlab>=3->geemap) (0.12.0)

Requirement already satisfied: Send2Trash in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-server~=1.16->jupyterlab>=3->geemap) (1.8.0)

Collecting anyio<4,>=3.1.0

Downloading anyio-3.6.1-py3-none-any.whl (80 kB)

|████████████████████████████████| 80 kB 19.6 MB/s eta 0:00:01

Requirement already satisfied: argon2-cffi in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-server~=1.16->jupyterlab>=3->geemap) (20.1.0)

Collecting nbformat>=4.2.0

Downloading nbformat-5.4.0-py3-none-any.whl (73 kB)

|████████████████████████████████| 73 kB 4.7 MB/s eta 0:00:01

Requirement already satisfied: terminado>=0.8.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyter-server~=1.16->jupyterlab>=3->geemap) (0.9.4)

Collecting nbconvert>=6.4.4

Downloading nbconvert-6.5.0-py3-none-any.whl (561 kB)

|████████████████████████████████| 561 kB 53.9 MB/s eta 0:00:01

Collecting websocket-client

Downloading websocket\_client-1.3.2-py3-none-any.whl (54 kB)

|████████████████████████████████| 54 kB 6.7 MB/s eta 0:00:01

Requirement already satisfied: idna>=2.8 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from anyio<4,>=3.1.0->jupyter-server~=1.16->jupyterlab>=3->geemap) (3.3)

Collecting sniffio>=1.1

Downloading sniffio-1.2.0-py3-none-any.whl (10 kB)

Collecting json5

Downloading json5-0.9.8.tar.gz (22 kB)

Collecting babel

Downloading Babel-2.10.1-py3-none-any.whl (9.5 MB)

|████████████████████████████████| 9.5 MB 46.9 MB/s eta 0:00:01 eta 0:00:01

Requirement already satisfied: jsonschema>=3.0.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyterlab-server~=2.10->jupyterlab>=3->geemap) (3.2.0)

Collecting jinja2>=2.9

Downloading Jinja2-3.1.2-py3-none-any.whl (133 kB)

|████████████████████████████████| 133 kB 58.3 MB/s eta 0:00:01

Requirement already satisfied: importlib-metadata>=3.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jupyterlab-server~=2.10->jupyterlab>=3->geemap) (4.8.2)

Requirement already satisfied: zipp>=0.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from importlib-metadata>=3.6->jupyterlab-server~=2.10->jupyterlab>=3->geemap) (3.6.0)

Requirement already satisfied: attrs>=17.4.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jsonschema>=3.0.1->jupyterlab-server~=2.10->jupyterlab>=3->geemap) (21.2.0)

Requirement already satisfied: pyrsistent>=0.14.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from jsonschema>=3.0.1->jupyterlab-server~=2.10->jupyterlab>=3->geemap) (0.18.0)

Requirement already satisfied: networkx in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from mapclassify>=2.4.0->geemap) (2.6.3)

Requirement already satisfied: scikit-learn in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from mapclassify>=2.4.0->geemap) (1.0.2)

Requirement already satisfied: scipy>=1.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from mapclassify>=2.4.0->geemap) (1.7.3)

Collecting notebook-shim>=0.1.0

Downloading notebook\_shim-0.1.0-py3-none-any.whl (13 kB)

Requirement already satisfied: notebook<7 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbclassic~=0.2->jupyterlab>=3->geemap) (6.4.6)

Requirement already satisfied: pandocfilters>=1.4.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (1.4.3)

Requirement already satisfied: jupyterlab-pygments in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (0.1.2)

Requirement already satisfied: nbclient>=0.5.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (0.5.3)

Collecting tinycss2

Downloading tinycss2-1.1.1-py3-none-any.whl (21 kB)

Requirement already satisfied: defusedxml in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (0.7.1)

Requirement already satisfied: bleach in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (4.0.0)

Requirement already satisfied: mistune<2,>=0.8.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (0.8.4)

Requirement already satisfied: async-generator in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from nbclient>=0.5.0->nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (1.10)

Collecting fastjsonschema

Downloading fastjsonschema-2.15.3-py3-none-any.whl (22 kB)

Requirement already satisfied: pytz>=2017.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pandas->geemap) (2021.3)

Requirement already satisfied: ptyprocess>=0.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pexpect>4.3->ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.7.0)

Requirement already satisfied: wcwidth in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from prompt-toolkit!=3.0.0,!=3.0.1,<3.1.0,>=2.0.0->ipython>=4.0.0->ipywidgets->ipyfilechooser>=0.6.0->geemap) (0.2.5)

Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pyasn1-modules>=0.2.1->google-auth>=1.4.1->earthengine-api>=0.1.304->geemap) (0.4.8)

Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium>=0.11.0->geemap) (2.0.4)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium>=0.11.0->geemap) (1.26.7)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium>=0.11.0->geemap) (2022.5.18.1)

Collecting whitebox

Downloading whitebox-2.1.2-py2.py3-none-any.whl (75 kB)

|████████████████████████████████| 75 kB 9.1 MB/s eta 0:00:01

Requirement already satisfied: cffi>=1.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from argon2-cffi->jupyter-server~=1.16->jupyterlab>=3->geemap) (1.14.6)

Requirement already satisfied: pycparser in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from cffi>=1.0.0->argon2-cffi->jupyter-server~=1.16->jupyterlab>=3->geemap) (2.21)

Requirement already satisfied: webencodings in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from bleach->nbconvert>=6.4.4->jupyter-server~=1.16->jupyterlab>=3->geemap) (0.5.1)

Collecting filelock

Downloading filelock-3.7.1-py3-none-any.whl (10 kB)

Requirement already satisfied: tqdm in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from gdown->geemap) (4.62.3)

Requirement already satisfied: click in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from geocoder->geemap) (8.0.3)

Collecting ratelim

Downloading ratelim-0.1.6-py2.py3-none-any.whl (4.0 kB)

Collecting google-resumable-media>=2.3.2

Downloading google\_resumable\_media-2.3.3-py2.py3-none-any.whl (76 kB)

|████████████████████████████████| 76 kB 12.0 MB/s eta 0:00:01

Collecting google-cloud-core<3.0dev,>=2.3.0

Downloading google\_cloud\_core-2.3.0-py2.py3-none-any.whl (29 kB)

Collecting google-crc32c<2.0dev,>=1.0

Downloading google\_crc32c-1.3.0-cp39-cp39-manylinux\_2\_12\_x86\_64.manylinux2010\_x86\_64.whl (36 kB)

Requirement already satisfied: cycler>=0.10 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from matplotlib->geemap) (0.11.0)

Requirement already satisfied: fonttools>=4.22.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from matplotlib->geemap) (4.25.0)

Requirement already satisfied: kiwisolver>=1.0.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from matplotlib->geemap) (1.3.1)

Requirement already satisfied: PySocks!=1.5.7,>=1.5.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->folium>=0.11.0->geemap) (1.7.1)

Collecting plotly>=5.2.2

Downloading plotly-5.8.0-py2.py3-none-any.whl (15.2 MB)

|████████████████████████████████| 15.2 MB 51.8 MB/s eta 0:00:01

Requirement already satisfied: tenacity>=6.2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from plotly>=5.2.2->sankee->geemap) (8.0.1)

Requirement already satisfied: joblib>=0.11 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from scikit-learn->mapclassify>=2.4.0->geemap) (0.17.0)

Requirement already satisfied: threadpoolctl>=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from scikit-learn->mapclassify>=2.4.0->geemap) (2.2.0)

Building wheels for collected packages: earthengine-api, ee-extra, gdown, httplib2shim, json5, pycrs, sankee

Building wheel for earthengine-api (setup.py) ... done

Created wheel for earthengine-api: filename=earthengine\_api-0.1.312-py3-none-any.whl size=268583 sha256=480747805e65effe8326093e8d1c7d08870d136ac95061cab3e9a4b3b72451d8

Stored in directory: /tmp/wsuser/.cache/pip/wheels/c9/60/69/40143710d9f5758911f2dc532c978a540cc75b6ca3911bc3f6

Building wheel for ee-extra (setup.py) ... done

Created wheel for ee-extra: filename=ee\_extra-0.0.13-py3-none-any.whl size=198406 sha256=cb3037ee50add687a2dfc00328da57a1fa53daecede016e7a22754bc90433dff

Stored in directory: /tmp/wsuser/.cache/pip/wheels/a7/bf/16/b672866aae85ccd76c15853a8f3311d87eb679a0f0d38fe01d

Building wheel for gdown (PEP 517) ... done

Created wheel for gdown: filename=gdown-4.4.0-py3-none-any.whl size=14759 sha256=88ac099ab0aac9fdb1d02537678440f7d4446c7d5153584c8f1e6e161db478a6

Stored in directory: /tmp/wsuser/.cache/pip/wheels/7d/37/b6/b2a79c75e898c0b8e46ff255102602d7159a10d9af0d80641a

Building wheel for httplib2shim (setup.py) ... done

Created wheel for httplib2shim: filename=httplib2shim-0.0.3-py2.py3-none-any.whl size=18058 sha256=1c416892c5d4b7e20b0f9e9a0d80c1ce2f5d602438b896e6e140a6b6272f13e4

Stored in directory: /tmp/wsuser/.cache/pip/wheels/cc/e7/8f/8a433809ef32e27c1f24d80effef7dde1212f72fec13df73aa

Building wheel for json5 (setup.py) ... done

Created wheel for json5: filename=json5-0.9.8-py2.py3-none-any.whl size=18606 sha256=7ffca8db0c2d1af32e161eeb2a1213993266cd1ef436c7f529c7c8836147a00f

Stored in directory: /tmp/wsuser/.cache/pip/wheels/33/13/22/d6429949983cbc014ae883a13af8b3ce949adcc4cf9196a4b9

Building wheel for pycrs (setup.py) ... done

Created wheel for pycrs: filename=PyCRS-1.0.2-py3-none-any.whl size=32704 sha256=7f8dcb908efd6cc97bcfbe6cc1e23cb51f47348e104a644d82c9459b6fe26766

Stored in directory: /tmp/wsuser/.cache/pip/wheels/94/01/24/bc7bff66667ef317615144a15e04593a08d9bb322f2c427d6c

Building wheel for sankee (setup.py) ... done

Created wheel for sankee: filename=sankee-0.0.7-py3-none-any.whl size=27640 sha256=a6f094b5cf9c4ee80e36a4137443b439bb82f769d590502935073792e977f644

Stored in directory: /tmp/wsuser/.cache/pip/wheels/8c/8b/5f/9064446073c3836eedbf134410e8453587df0fab4833ebaba0

Successfully built earthengine-api ee-extra gdown httplib2shim json5 pycrs sankee

Installing collected packages: fastjsonschema, nbformat, tinycss2, jinja2, sniffio, nbconvert, googleapis-common-protos, google-auth, websocket-client, httplib2, google-crc32c, google-api-core, anyio, uritemplate, jupyter-server, google-resumable-media, google-cloud-core, google-auth-httplib2, notebook-shim, json5, httplib2shim, google-cloud-storage, google-api-python-client, babel, xyzservices, whitebox, traittypes, ratelim, plotly, nbclassic, logzero, jupyterlab-server, ipytree, ipyfilechooser, filelock, earthengine-api, whiteboxgui, sankee, python-box, pyshp, pycrs, mapclassify, jupyterlab, ipyleaflet, ipyevents, geojson, geocoder, geeadd, gdown, ffmpeg-python, ee-extra, colour, bqplot, geemap

Attempting uninstall: nbformat

Found existing installation: nbformat 5.1.3

Uninstalling nbformat-5.1.3:

Successfully uninstalled nbformat-5.1.3

Attempting uninstall: jinja2

Found existing installation: Jinja2 3.0.2

Uninstalling Jinja2-3.0.2:

Successfully uninstalled Jinja2-3.0.2

Attempting uninstall: nbconvert

Found existing installation: nbconvert 6.1.0

Uninstalling nbconvert-6.1.0:

Successfully uninstalled nbconvert-6.1.0

Attempting uninstall: googleapis-common-protos

Found existing installation: googleapis-common-protos 1.52.0

Uninstalling googleapis-common-protos-1.52.0:

Successfully uninstalled googleapis-common-protos-1.52.0

Attempting uninstall: google-auth

Found existing installation: google-auth 1.23.0

Uninstalling google-auth-1.23.0:

Successfully uninstalled google-auth-1.23.0

Attempting uninstall: plotly

Found existing installation: plotly 5.1.0

Uninstalling plotly-5.1.0:

Successfully uninstalled plotly-5.1.0

Successfully installed anyio-3.6.1 babel-2.10.1 bqplot-0.12.33 colour-0.1.5 earthengine-api-0.1.312 ee-extra-0.0.13 fastjsonschema-2.15.3 ffmpeg-python-0.2.0 filelock-3.7.1 gdown-4.4.0 geeadd-0.5.5 geemap-0.13.8 geocoder-1.38.1 geojson-2.5.0 google-api-core-2.8.1 google-api-python-client-1.12.11 google-auth-2.6.6 google-auth-httplib2-0.1.0 google-cloud-core-2.3.0 google-cloud-storage-2.3.0 google-crc32c-1.3.0 google-resumable-media-2.3.3 googleapis-common-protos-1.56.2 httplib2-0.20.4 httplib2shim-0.0.3 ipyevents-2.0.1 ipyfilechooser-0.6.0 ipyleaflet-0.16.0 ipytree-0.2.1 jinja2-3.1.2 json5-0.9.8 jupyter-server-1.17.0 jupyterlab-3.4.2 jupyterlab-server-2.14.0 logzero-1.7.0 mapclassify-2.4.3 nbclassic-0.3.7 nbconvert-6.5.0 nbformat-5.4.0 notebook-shim-0.1.0 plotly-5.8.0 pycrs-1.0.2 pyshp-2.3.0 python-box-6.0.2 ratelim-0.1.6 sankee-0.0.7 sniffio-1.2.0 tinycss2-1.1.1 traittypes-0.2.1 uritemplate-3.0.1 websocket-client-1.3.2 whitebox-2.1.2 whiteboxgui-0.7.0 xyzservices-2022.4.0

In [4]:

*# Import folium MarkerCluster plugin*

**import** **folium**

**from** **folium.plugins** **import** MarkerCluster

*#from folium.plugins import MarkerCluster*

*# Import folium MousePosition plugin*

**from** **folium.plugins** **import** MousePosition

*# Import folium DivIcon plugin*

**from** **folium.features** **import** DivIcon

If you need to refresh your memory about folium, you may download and refer to this previous folium lab:

[Generating Maps with Python](https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBM-DS0321EN-SkillsNetwork/labs/module/_3/DV0101EN-3-5-1-Generating-Maps-in-Python-py-v2.0.ipynb)

**Task 1: Mark all launch sites on a map**

First, let's try to add each site's location on a map using site's latitude and longitude coordinates

The following dataset with the name spacex\_launch\_geo.csv is an augmented dataset with latitude and longitude added for each site.

In [5]:

*# Download and read the `spacex\_launch\_geo.csv`*

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)

Now, you can take a look at what are the coordinates for each site.

In [6]:

*# Select relevant sub-columns: `Launch Site`, `Lat(Latitude)`, `Long(Longitude)`, `class`*

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']]

launch\_sites\_df

Out[6]:

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

Above coordinates are just plain numbers that can not give you any intuitive insights about where are those launch sites. If you are very good at geography, you can interpret those numbers directly in your mind. If not, that's fine too. Let's visualize those locations by pinning them on a map.

We first need to create a folium Map object, with an initial center location to be NASA Johnson Space Center at Houston, Texas.

In [7]:

*# Start location is NASA Johnson Space Center*

nasa\_coordinate = [29.559684888503615, -95.0830971930759]

site\_map = folium.Map(location=nasa\_coordinate, zoom\_start=10)

We could use folium.Circle to add a highlighted circle area with a text label on a specific coordinate. For example,

In [8]:

*# Create a blue circle at NASA Johnson Space Center's coordinate with a popup label showing its name*

circle = folium.Circle(nasa\_coordinate, radius=1000, color='#d35400', fill=**True**).add\_child(folium.Popup('NASA Johnson Space Center'))

*# Create a blue circle at NASA Johnson Space Center's coordinate with a icon showing its name*

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[8]:

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

and you should find a small yellow circle near the city of Houston and you can zoom-in to see a larger circle.

Now, let's add a circle for each launch site in data frame launch\_sites

*TODO:* Create and add folium.Circle and folium.Marker for each launch site on the site map

An example of folium.Circle:

folium.Circle(coordinate, radius=1000, color='#000000', fill=True).add\_child(folium.Popup(...))

An example of folium.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', ))

In [9]:

*# Initial the map*

site\_map = folium.Map(location=nasa\_coordinate, zoom\_start=5)

*# For each launch site, add a Circle object based on its coordinate (Lat, Long) values. In addition, add Launch site name as a popup label*

**for** index, row **in** launch\_sites\_df.iterrows():

coordinate = [row['Lat'], row['Long']]

folium.Circle(coordinate, radius=1000, color='#000000', fill=**True**).add\_child(folium.Popup(row['Launch Site'])).add\_to(site\_map)

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>' % row['Launch Site'], )).add\_to(site\_map)

site\_map

Out[9]:

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

The generated map with marked launch sites should look similar to the following:

Map

Description automatically generated

Now, you can explore the map by zoom-in/out the marked areas , and try to answer the following questions:

* Are all launch sites in proximity to the Equator line?
* Are all launch sites in very close proximity to the coast?

Also please try to explain your findings.

**Task 2: Mark the success/failed launches for each site on the map**

Next, let's try to enhance the map by adding the launch outcomes for each site, and see which sites have high success rates. Recall that data frame spacex\_df has detailed launch records, and the class column indicates if this launch was successful or not

In [10]:

spacex\_df.tail(10)

Out[10]:

|  | **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 |

Next, let's create markers for all launch records. If a launch was successful (class=1), then we use a green marker and if a launch was failed, we use a red marker (class=0)

Note that a launch only happens in one of the four launch sites, which means many launch records will have the exact same coordinate. Marker clusters can be a good way to simplify a map containing many markers having the same coordinate.

Let's first create a MarkerCluster object

In [11]:

marker\_cluster = MarkerCluster()

*TODO:* Create a new column in launch\_sites dataframe called marker\_color to store the marker colors based on the class value

In [ ]:

*# Apply a function to check the value of `class` column*

*# If class=1, marker\_color value will be green*

*# If class=0, marker\_color value will be red*

In [12]:

*# Function to assign color to launch outcome*

**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[12]:

|  | **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 |

*TODO:* For each launch result in spacex\_df data frame, add a folium.Marker to marker\_cluster

In [13]:

*# Add marker\_cluster to current site\_map*

site\_map.add\_child(marker\_cluster)

*# for each row in spacex\_df data frame*

*# create a Marker object with its coordinate*

*# and customize the Marker's icon property to indicate if this launch was successed or failed,*

*# e.g., icon=folium.Icon(color='white', icon\_color=row['marker\_color']*

**for** index, row **in** spacex\_df.iterrows():

*# create and add a Marker cluster to the site map*

coordinate = [row['Lat'], row['Long']]

folium.map.Marker(coordinate, icon=folium.Icon(color='white',icon\_color=row['marker\_color'])).add\_to(marker\_cluster)

site\_map

Out[13]:

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Your updated map may look like the following screenshots:

Map

Description automatically generated

Diagram

Description automatically generated

From the color-labeled markers in marker clusters, you should be able to easily identify which launch sites have relatively high success rates.

**TASK 3: Calculate the distances between a launch site to its proximities**

Next, we need to explore and analyze the proximities of launch sites.

Let's first add a MousePosition on the map to get coordinate for a mouse over a point on the map. As such, while you are exploring the map, you can easily find the coordinates of any points of interests (such as railway)

In [14]:

*# Add Mouse Position to get the coordinate (Lat, Long) for a mouse over on the map*

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[14]:

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

Now zoom in to a launch site and explore its proximity to see if you can easily find any railway, highway, coastline, etc. Move your mouse to these points and mark down their coordinates (shown on the top-left) in order to the distance to the launch site.

You can calculate the distance between two points on the map based on their Lat and Long values using the following method:

In [15]:

**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

*TODO:* Mark down a point on the closest coastline using MousePosition and calculate the distance between the coastline point and the launch site.

In [22]:

*# find coordinate of the closet coastline*

*# e.g.,: Lat: 28.56367 Lon: -80.57163*

*# distance\_coastline = calculate\_distance(launch\_site\_lat, launch\_site\_lon, coastline\_lat, coastline\_lon)*

launch\_site\_lat = 28.563197

launch\_site\_lon = -80.576820

coastline\_lat = 28.56334

coastline\_lon = -80.56799

distance\_coastline = calculate\_distance(launch\_site\_lat, launch\_site\_lon, coastline\_lat, coastline\_lon)

print(distance\_coastline,' km')

0.8627671182499878 km

*TODO:* After obtained its coordinate, create a folium.Marker to show the distance

In [24]:

*# Create and add a folium.Marker on your selected closest coastline point on the map*

*# Display the distance between coastline point and launch site using the icon property*

*# for example*

*# distance\_marker = folium.Marker(*

*# coordinate,*

*# 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),*

*# )*

*# )*

distance\_marker = folium.Marker(

[coastline\_lat, coastline\_lon],

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),

)

)

site\_map.add\_child(distance\_marker)

Out[24]:

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

*TODO:* Draw a PolyLine between a launch site to the selected coastline point

In [25]:

*# Create a `folium.PolyLine` object using the coastline coordinates and launch site coordinate*

*# lines=folium.PolyLine(locations=coordinates, weight=1)*

coordinates = [[launch\_site\_lat,launch\_site\_lon],[coastline\_lat,coastline\_lon]]

lines=folium.PolyLine(locations=coordinates, weight=1)

site\_map.add\_child(lines)

Out[25]:

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

Your updated map with distance line should look like the following screenshot:

Chart

Description automatically generated with low confidence

*TODO:* Similarly, you can draw a line betwee a launch site to its closest city, railway, highway, etc. You need to use MousePosition to find the their coordinates on the map first

A railway map symbol may look like this:

A picture containing text

Description automatically generated

A highway map symbol may look like this:

Text

Description automatically generated with medium confidence

A city map symbol may look like this:

Map

Description automatically generated

In [27]:

*# Create a marker with distance to a closest city, railway, highway, etc.*

*# Draw a line between the marker to the launch site*

closest\_highway = 28.56335, -80.57085

closest\_railroad = 28.57206, -80.58525

closest\_city = 28.10473, -80.64531

In [28]:

distance\_highway = calculate\_distance(launch\_site\_lat, launch\_site\_lon, closest\_highway[0], closest\_highway[1])

print('distance\_highway =',distance\_highway, ' km')

distance\_railroad = calculate\_distance(launch\_site\_lat, launch\_site\_lon, closest\_railroad[0], closest\_railroad[1])

print('distance\_railroad =',distance\_railroad, ' km')

distance\_city = calculate\_distance(launch\_site\_lat, launch\_site\_lon, closest\_city[0], closest\_city[1])

print('distance\_city =',distance\_city, ' km')

distance\_highway = 0.5834695366934144 km

distance\_railroad = 1.2845344718142522 km

distance\_city = 51.43416999517233 km

In [29]:

distance\_marker = folium.Marker(

closest\_highway,

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),

)

)

site\_map.add\_child(distance\_marker)

*# closest highway line*

coordinates = [[launch\_site\_lat,launch\_site\_lon],closest\_highway]

lines=folium.PolyLine(locations=coordinates, weight=1)

site\_map.add\_child(lines)

*# closest railroad marker*

distance\_marker = folium.Marker(

closest\_railroad,

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\_railroad),

)

)

site\_map.add\_child(distance\_marker)

*# closest railroad line*

coordinates = [[launch\_site\_lat,launch\_site\_lon],closest\_railroad]

lines=folium.PolyLine(locations=coordinates, weight=1)

site\_map.add\_child(lines)

*# closest city marker*

distance\_marker = folium.Marker(

closest\_city,

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),

)

)

site\_map.add\_child(distance\_marker)

*# closest city line*

coordinates = [[launch\_site\_lat,launch\_site\_lon],closest\_city]

lines=folium.PolyLine(locations=coordinates, weight=1)

site\_map.add\_child(lines)

Out[29]:

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

In [ ]:

After you plot distance lines to the proximities, you can answer the following questions easily:

Are launch sites **in** close proximity to railways?

Are launch sites **in** close proximity to highways?

Are launch sites **in** close proximity to coastline?

Do launch sites keep certain distance away **from** **cities**?

Also please **try** to explain your findings.

In [ ]:

Yes, the launch sites are **in** close proximity to coastline so they can fly over the ocean during launch

Yes, the launch sites are **in** close proximity to highways making them asseable to the workers

Yes, launch sites are **in** close proximity to railways making them assesable to part that can help **in** assembly

Yes, launch sites are **not** **in** close proximity to cities which **is** good. This keeps people safe

**Next Steps:**

Now you have discovered many interesting insights related to the launch sites' location using folium, in a very interactive way. Next, you will need to build a dashboard using Ploty Dash on detailed launch records.

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**Change Log**

| **Date (YYYY-MM-DD)** | **Version** | **Changed By** | **Change Description** |
| --- | --- | --- | --- |
| 2021-05-26 | 1.0 | Yan | Created the initial version |

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