California Maps

This notebook contains maps of California paired with different wildfire plots. The notebook contains logic for generating maps of where fires occured, how large they were, and what caused them.

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
!ls
```

```
drive  sample_data
```

```
cleaned = pd.read_csv("/content/drive/Shareddrives/Data Science 303 Group Project/csv/cleaned_fires_data_with_four_closest_stations_nov21.csv")
cleaned = cleaned.replace([np.inf, -np.inf], np.nan)
cleaned = cleaned.dropna()
```

```
STATION_LIST = ["BODIE", "BROOKS", "COHASSET", "EEL_RIVER", "HELL_HOLE", "HERNANDEZ"]
STATION_LIST += ["HUNTER_MOUNTAIN", "JUANITA_LAKE", "LADDER_BUTTE", "LAS_TABLAS", "LA_HONDA", "OAK_CREEK"]
STATION_LIST += ["PANAMINT", "PILOT_HILL", "SCORPION", "SOLDIER_MOUNTAIN", "SQUAW_LAKE", "STAMPEDE", "VAN_BREMMER", "WOLVERTON"]
STATION_LIST = set(STATION_LIST)
```

Data Normalization: MinMax scaling latitude and longitude

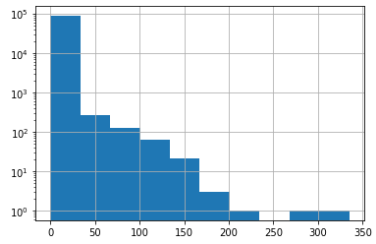
```
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()

lat = scaler.fit_transform(np.array(cleaned["LATITUDE"]).reshape(-1, 1))
long = scaler.fit_transform(np.array(cleaned["LONGITUDE"]).reshape(-1, 1))

# DROP ALL LATITUDE LONGITUDE COLUMNS, THEN READD THE SCALED LATITUDE AND LONGITUDE
drops = []
for col in cleaned.columns:
  if "LATITUDE" in col or "LONGITUDE" in col:
    drops.append(col)

for col in drops:
  del cleaned[col]

cleaned["S_LATITUDE"] = lat
cleaned["S_LONGITUDE"] = long

```

```
# Elevation for the primary station is redundant. Drop all elevation columns from the primary station, except for one
elevation = cleaned["PRIMARY_STATION_1_MONTHS_PRIOR_ELEVATION"]

drops = []
for col in cleaned.columns:
  if "PRIMARY_STATION" in col and "ELEVATION" in col:
    drops.append(col)

for col in drops:
  del cleaned[col]

cleaned["PRIMARY_STATION_ELEVATION"] = elevation

```

```
cleaned['DURATION'] = (cleaned['CONT_DOY']-cleaned['DISCOVERY_DOY'])%365
```

```
cleaned['DURATION'].max()
cleaned['DURATION'].hist(log=True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff9944e4190>
```




```
numerical = cleaned.select_dtypes(include="number")
numerical.head()
numerical.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 87106 entries, 0 to 87105
Columns: 292 entries, Unnamed: 0 to WOLVERTON
dtypes: float64(285), int64(7)
memory usage: 194.7 MB
```

```
cols = numerical.columns
```

```
closest = []

for col in cols:
  if (col[:16] == 'CLOSEST_STATION_' or col in STATION_LIST or col == "S_LATITUDE" or col == "S_LONGITUDE"):
    closest.append(col)
```

```
primary_station_data_cols = []
for col in cols:
  if ("PRIMARY_STATION" in col or col in STATION_LIST or col == "S_LATITUDE" or col == "S_LONGITUDE"):
    primary_station_data_cols.append(col)

primary_station_df = pd.DataFrame()
for col in primary_station_data_cols:
  primary_station_df[col] = numerical[col]

primary_station_df["FIRE_SIZE"] = numerical["FIRE_SIZE"]
primary_station_df["DURATION"] = numerical["DURATION"]

```

```
NUM_FEATURES_TO_KEEP = 30 + 2
correlation = primary_station_df.corr(method='pearson')
highest_correlation = (correlation.nlargest(NUM_FEATURES_TO_KEEP, 'FIRE_SIZE').index)

fire_size_prediction_df = primary_station_df[highest_correlation]
del fire_size_prediction_df["FIRE_SIZE"]
del fire_size_prediction_df["DURATION"]
```

```
TOP 32 FEATURES WITH HIGHEST CORRELATION TO FIRE SIZE
['FIRE_SIZE', 'DURATION', 'PRIMARY_STATION_13_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH', 'PRIMARY_STATION_1_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH', 'PRIMARY_
TOP 10 FEATURES WITH HIGHEST CORRELATION TO FIRE SIZE
Index(['PRIMARY_STATION_13_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH',
       'PRIMARY_STATION_1_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH',
       'PRIMARY_STATION_13_MONTHS_PRIOR_TEMPERATURE_MAX',
       'PRIMARY_STATION_1_MONTHS_PRIOR_TEMPERATURE_MAX',
       'PRIMARY_STATION_12_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_70_FAHRENHEIT',
       'PRIMARY_STATION_12_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_90_FAHRENHEIT',
       'PRIMARY_STATION_13_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_90_FAHRENHEIT',
       'PRIMARY_STATION_1_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_90_FAHRENHEIT',
       'PRIMARY_STATION_12_MONTHS_PRIOR_TEMPERATURE_MAX',
       'PRIMARY_STATION_12_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH'],
      dtype='object')
PRIMARY_STATION_13_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH             0.022363
PRIMARY_STATION_1_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH              0.022363
PRIMARY_STATION_13_MONTHS_PRIOR_TEMPERATURE_MAX                               0.020201
PRIMARY_STATION_1_MONTHS_PRIOR_TEMPERATURE_MAX                                0.020201
PRIMARY_STATION_12_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_70_FAHRENHEIT    0.019643
PRIMARY_STATION_12_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_90_FAHRENHEIT    0.019516
PRIMARY_STATION_13_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_90_FAHRENHEIT    0.019503
PRIMARY_STATION_1_MONTHS_PRIOR_NUM_DAYS_WITH_MAX_TEMP_ABOVE_90_FAHRENHEIT     0.019503
PRIMARY_STATION_12_MONTHS_PRIOR_TEMPERATURE_MAX                               0.019122
PRIMARY_STATION_12_MONTHS_PRIOR_EXTREME_MAXIMUM_TEMPERATURE_MONTH             0.018295
Name: FIRE_SIZE, dtype: float64
```

```
NUM_FEATURES_TO_KEEP = 30 + 2
correlation = primary_station_df.corr(method='pearson')
highest_correlation = (correlation.nlargest(NUM_FEATURES_TO_KEEP, 'DURATION').index)

fire_duration_prediction_df = primary_station_df[highest_correlation]
del fire_duration_prediction_df["FIRE_SIZE"]
del fire_duration_prediction_df["DURATION"]
```

```
TOP 32 FEATURES WITH HIGHEST CORRELATION TO FIRE DURATION
Index(['DURATION', 'FIRE_SIZE',
       'PRIMARY_STATION_6_MONTHS_PRIOR_NUM_DAYS_WHERE_AVG_TEMP_BELOW_65_FAHRENHEIT',
       'PRIMARY_STATION_6_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
       'PRIMARY_STATION_7_MONTHS_PRIOR_NUM_DAYS_WHERE_AVG_TEMP_BELOW_65_FAHRENHEIT',
       'PRIMARY_STATION_ELEVATION',
       'PRIMARY_STATION_5_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
       'PRIMARY_STATION_5_MONTHS_PRIOR_NUM_DAYS_WHERE_AVG_TEMP_BELOW_65_FAHRENHEIT',
       'PRIMARY_STATION_7_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
       'PRIMARY_STATION_16_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
       'PRIMARY_STATION_4_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
       'PRIMARY_STATION_15_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
       'PRIMARY_STATION_3_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
       'PRIMARY_STATION_16_MONTHS_PRIOR_HEATING_DEGREE_DAYS_TO_DATE',
```

```
closest_df = pd.DataFrame()

for col in closest:
  closest_df[col] = numerical[col]
```

```
       'PRIMARY_STATION_5_MONTHS_PRIOR_HEATING_DEGREE_DAYS_TO_DATE',
```

```
SUBSET = -1
```

```
       'PRIMARY_STATION_14_MONTHS_PRIOR_HEATING_DEGREE_DAYS_TO_DATE',
```

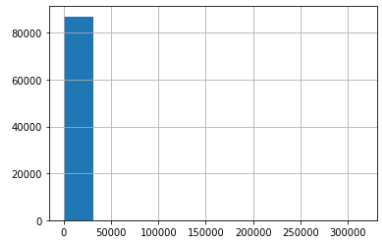
Fire Size Prediction using Linear Regression and Ridge Regression

Here, we predict the size of a fire using linear regression

```
       'PRIMARY_STATION_14_MONTHS_PRIOR_NUM_DAYS_WITH_MIN_TEMP_BELOW_32_FAHRENHEIT',
```

```
FIRE_SIZE = numerical["FIRE_SIZE"]
FIRE_SIZE.hist()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7ebd507410>
```




```
PRIMARY_STATION_ELEVATION                                    0.005009
```

```
log_fire_size = pd.DataFrame(np.log(FIRE_SIZE))
log_fire_size = log_fire_size.replace([np.inf, -np.inf], np.nan)
log_fire_size = log_fire_size.fillna(0)
log_fire_size = (log_fire_size - log_fire_size.mean()) / log_fire_size.std()
```

```
Name: DURATION, dtype: float64
```

Basic Neural Network Model

```
!pip install geopandas geoplot
```

```
import pandas as pd
import geopandas
import matplotlib.pyplot as plt
```

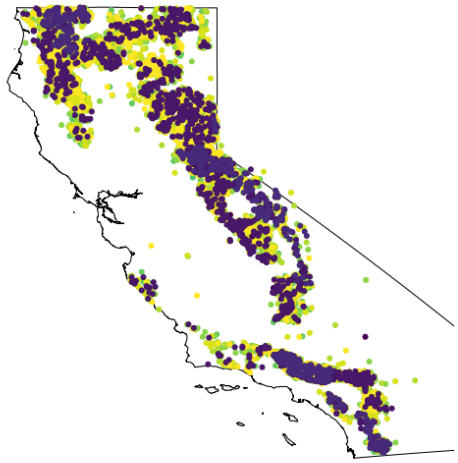
```
gdf = geopandas.GeoDataFrame(
    cleaned, geometry=geopandas.points_from_xy(cleaned.LONGITUDE, cleaned.LATITUDE))
world = geopandas.read_file("/content/drive/Shareddrives/Data Science 303 Group Project/shape_files/s_11au16/s_11au16.shp")
california_shape = world[world.STATE == "CA"]
```

```
ax = california_shape.plot(cleaned,
    color='white', edgecolor='black', figsize=(12, 12))
gdf.iloc[:40000].plot(ax=ax, color='red')
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/geopandas/plotting.py:645: UserWarning: Only specify one of 'column' or 'color'. Using 'color'.
  "Only specify one of 'column' or 'color'. Using 'color'.", UserWarning
```

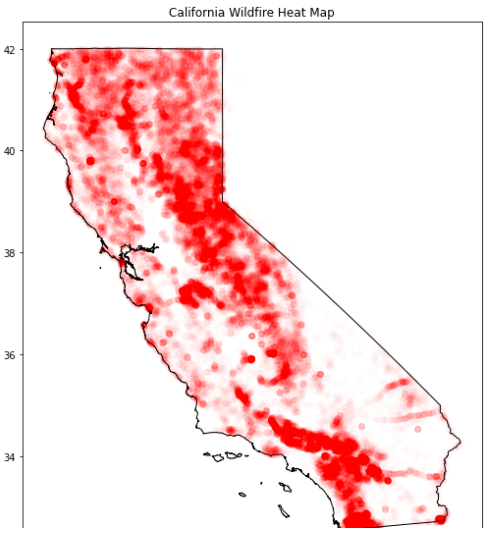

```
import geoplot
import geoplot.crs as gcrs
print(type(california_shape))
ax = california_shape.plot(cleaned, color='white', edgecolor='black', figsize=(10,10))
# legend=True, legend_kwargs={'orientation': 'vertical'}
geoplot.pointplot(gdf.iloc[:10000], hue='FIRE_YEAR', ax=ax)
plt.show()

```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
/usr/local/lib/python3.7/dist-packages/geopandas/plotting.py:645: UserWarning: Only specify one of 'column' or 'color'. Using 'color'.
  "Only specify one of 'column' or 'color'. Using 'color'.", UserWarning
```



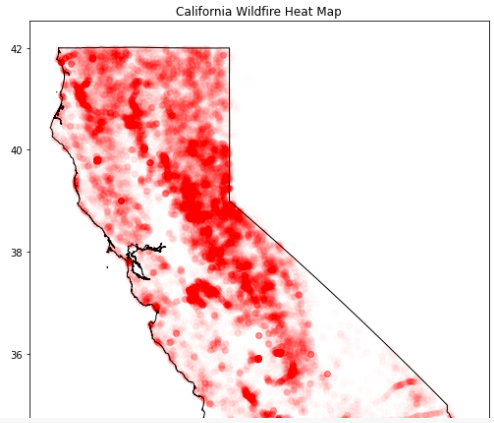
```
from mpl_toolkits.axes_grid1 import make_axes_locatable
# fig, ax = plt.subplots(1,1, figsize=(10,10))
fig = plt.figure()
ax = california_shape.plot(color='white', edgecolor='black', figsize=(10,10), legend=True)
ax.scatter(gdf.iloc[:-1].LONGITUDE, gdf.iloc[:-1].LATITUDE, alpha=.01, color="r")
ax.set_title("California Wildfire Heat Map")

```

```
Text(0.5, 1.0, 'California Wildfire Heat Map')
<Figure size 432x288 with 0 Axes>
```



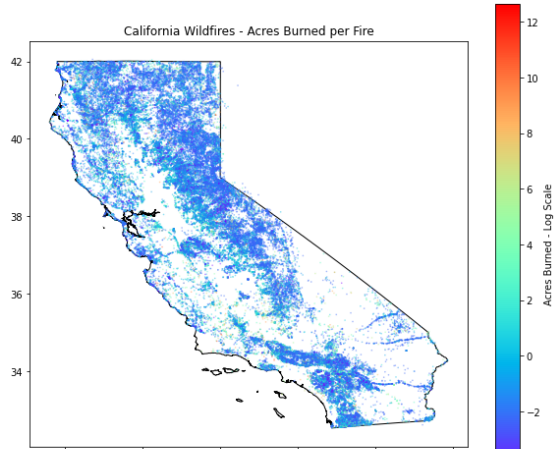

```
fig = plt.figure()
ax = california_shape.plot(color='white', edgecolor='black', figsize=(10,10), legend=True)
ax.scatter(gdf.iloc[:-1].LONGITUDE, gdf.iloc[:-1].LATITUDE, alpha=.01, color="r")
ax.set_title("California Wildfire Heat Map")
```

```
Text(0.5, 1.0, 'California Wildfire Heat Map')
<Figure size 432x288 with 0 Axes>
```

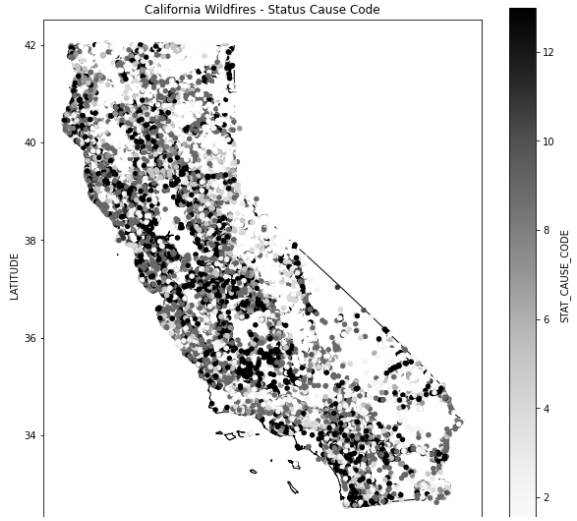



```
# https://towardsdatascience.com/plotting-maps-with-geopandas-428c97295a73
gdf["fire_size_log"] = np.log(gdf["FIRE_SIZE"])

fig, ax = plt.subplots(figsize=(10,10))
california_shape.plot(color='white', edgecolor='black', ax=ax)
gdf.plot(ax=ax, cmap="rainbow", column="fire_size_log", alpha=0.4, markersize=0.4, legend=True, legend_kwds={'shrink': 0.9, "label": "Acres Burned - Log Scale"})
ax.set_title("California Wildfires - Acres Burned per Fire")

```

```
Text(0.5, 1.0, 'California Wildfires - Acres Burned per Fire')
```



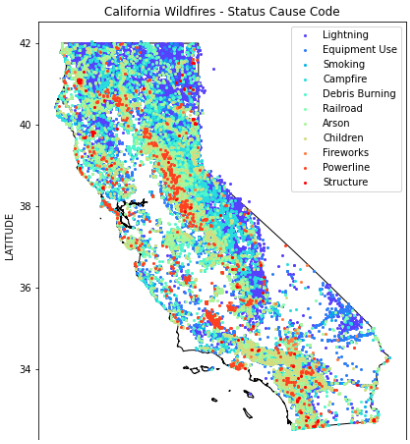

```
for i in range(1, 2):
  fig, ax = plt.subplots(figsize=(10,10))
  california_shape.plot(color='white', edgecolor='black', ax=ax)
  gdf.plot(kind="scatter", x="LONGITUDE", y="LATITUDE", ax=ax, lbe="STAT_CAUSE_CODE")
  # gdf[gdf["STAT_CAUSE_CODE"] == 4].plot(kind="scatter", ax=ax, column="STAT_CAUSE_CODE", alpha=1, markersize=0.2, label="3", legend=True)
  ax.set_title("California Wildfires - Status Cause Code")
```




```
import matplotlib.colors as colors
import matplotlib.cm as cmx
display(gdf.info())
```

```
# Source: https://stackoverflow.com/questions/28033046/matplotlib-scatter-color-by-categorical-factors

status_cause_codes = set(range(1, 13))
code_names = {9: 'Miscellaneous', 1: 'Lightning', 5: 'Debris Burning', 4: 'Campfire', 2: 'Equipment Use', 8: 'Children', 7: 'Arson', 3: 'Smoking', 6: 'Railroad', 10: 'Firework


hot = plt.get_cmap('rainbow')
cNorm  = colors.Normalize(vmin=0, vmax=len(status_cause_codes))
scalarMap = cmx.ScalarMappable(norm=cNorm, cmap=hot)

fig, ax = plt.subplots(figsize=(8,8))
california_shape.plot(color='white', edgecolor='black', ax=ax)
point_size = 4

for i in status_cause_codes:
  if i != 9:
    index = gdf["STAT_CAUSE_CODE"] == i
    gdf_p = gdf[index]
    gdf_p.plot(x="LONGITUDE", y="LATITUDE", kind="scatter", ax=ax, alpha=1, s=point_size, label=code_names[i], color=scalarMap.to_rgba(i))
ax.set_title("California Wildfires - Status Cause Code")

```

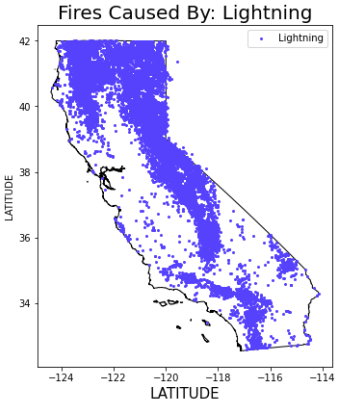
```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 87106 entries, 0 to 87105
Columns: 303 entries, Unnamed: 0 to fire_size_log
dtypes: float64(286), geometry(1), int64(7), object(9)
memory usage: 202.0+ MB
None
Text(0.5, 1.0, 'California Wildfires - Status Cause Code')
```



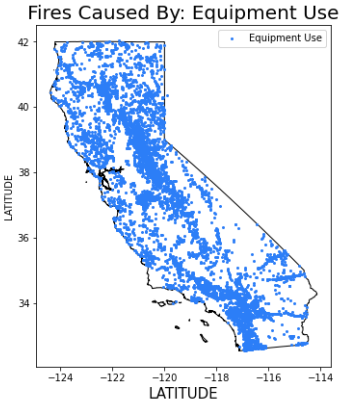

```
import matplotlib.colors as colors
import matplotlib.cm as cmx
display(gdf.info())
# Source: https://stackoverflow.com/questions/28033046/matplotlib-scatter-color-by-categorical-factors

status_cause_codes = set(range(1, 13))
code_names = {9: 'Miscellaneous', 1: 'Lightning', 5: 'Debris Burning', 4: 'Campfire', 2: 'Equipment Use', 8: 'Children', 7: 'Arson', 3: 'Smoking', 6: 'Railroad', 10: 'Firewo


hot = plt.get_cmap('rainbow')
cNorm  = colors.Normalize(vmin=0, vmax=len(status_cause_codes))
scalarMap = cmx.ScalarMappable(norm=cNorm, cmap=hot)

scale = 10
fig, ax = plt.subplots(4, 3)
plt.subplots_adjust(wspace=0, hspace=0.2)

point_size = 4

i = 1
for r in range(4):
  for c in range(3):
    california_shape.plot(color='white', edgecolor='black', ax=ax[r,c])
    index = gdf["STAT_CAUSE_CODE"] == i
    gdf_p = gdf[index]
    gdf_p.plot(x="LONGITUDE", y="LATITUDE", kind="scatter", ax=ax[r, c], alpha=1, s=point_size, label=code_names[i], color=scalarMap.to_rgba(i), figsize=(30,30))
    ax[r,c].set_title(f"Fires Caused By: { code_names[i] }", fontsize=20)
    ax[r,c].set_xlabel("LONGITUDE", fontsize=15)
    ax[r,c].set_xlabel("LATITUDE", fontsize=15)
    i += 1

# for i in status_cause_codes:
#     index = gdf["STAT_CAUSE_CODE"] == i
#     gdf_p = gdf[index]
#     gdf_p.plot(x="LONGITUDE", y="LATITUDE", kind="scatter", ax=ax, alpha=1, s=point_size, label=code_names[i], color=scalarMap.to_rgba(i))
# ax.set_title("California Wildfires - Status Cause Code")
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 87106 entries, 0 to 87105
Columns: 303 entries, Unnamed: 0 to fire_size_log
dtypes: float64(286), geometry(1), int64(7), object(9)
memory usage: 202.0+ MB
None
```

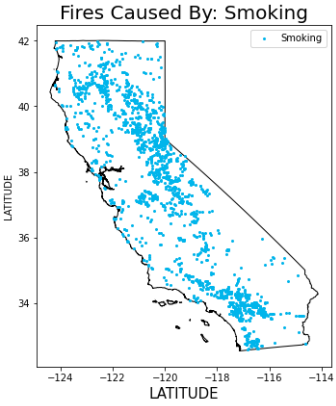
Fires Caused By: Lightning



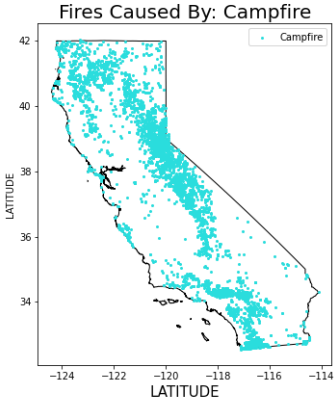
Fires Caused By: Equipment Use



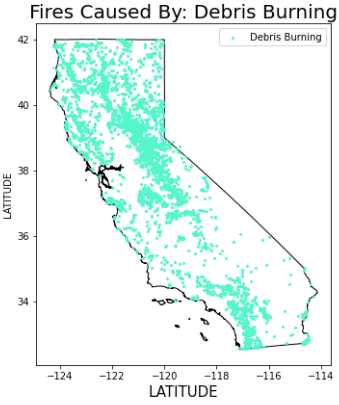
Fires Caused By: Smoking



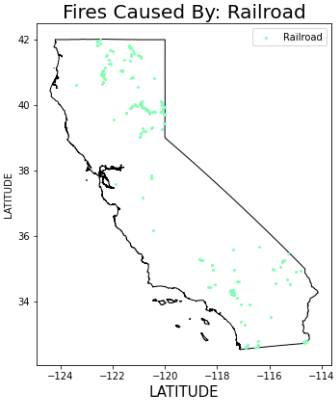
Fires Caused By: Campfire



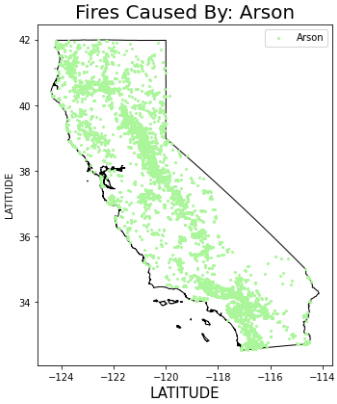
Fires Caused By: Debris Burning



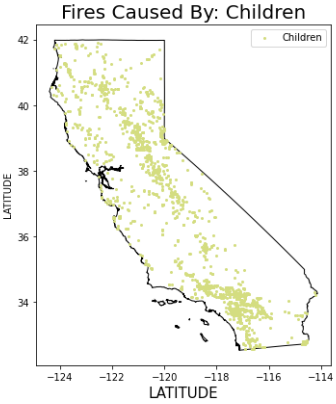
Fires Caused By: Railroad



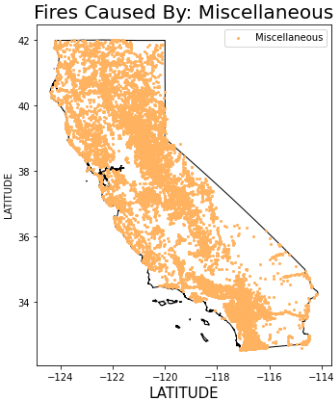
Fires Caused By: Arson



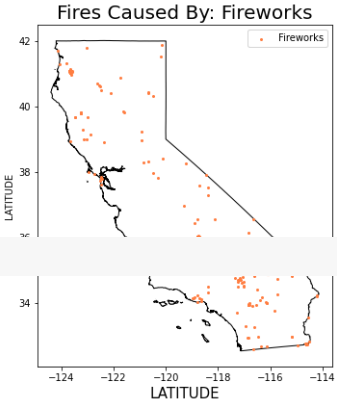
Fires Caused By: Children



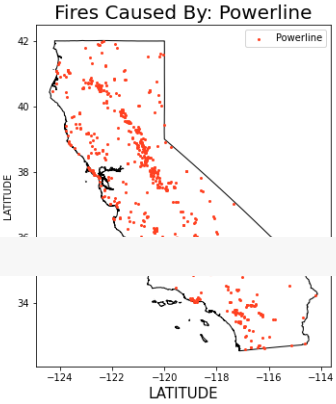
Fires Caused By: Miscellaneous



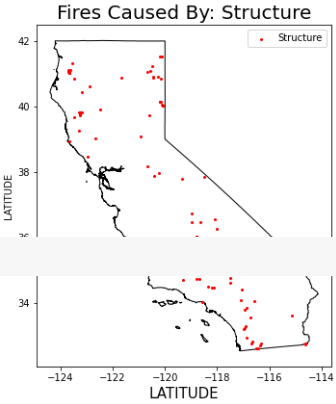
Fires Caused By: Fireworks



Fires Caused By: Powerline



Fires Caused By: Structure

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