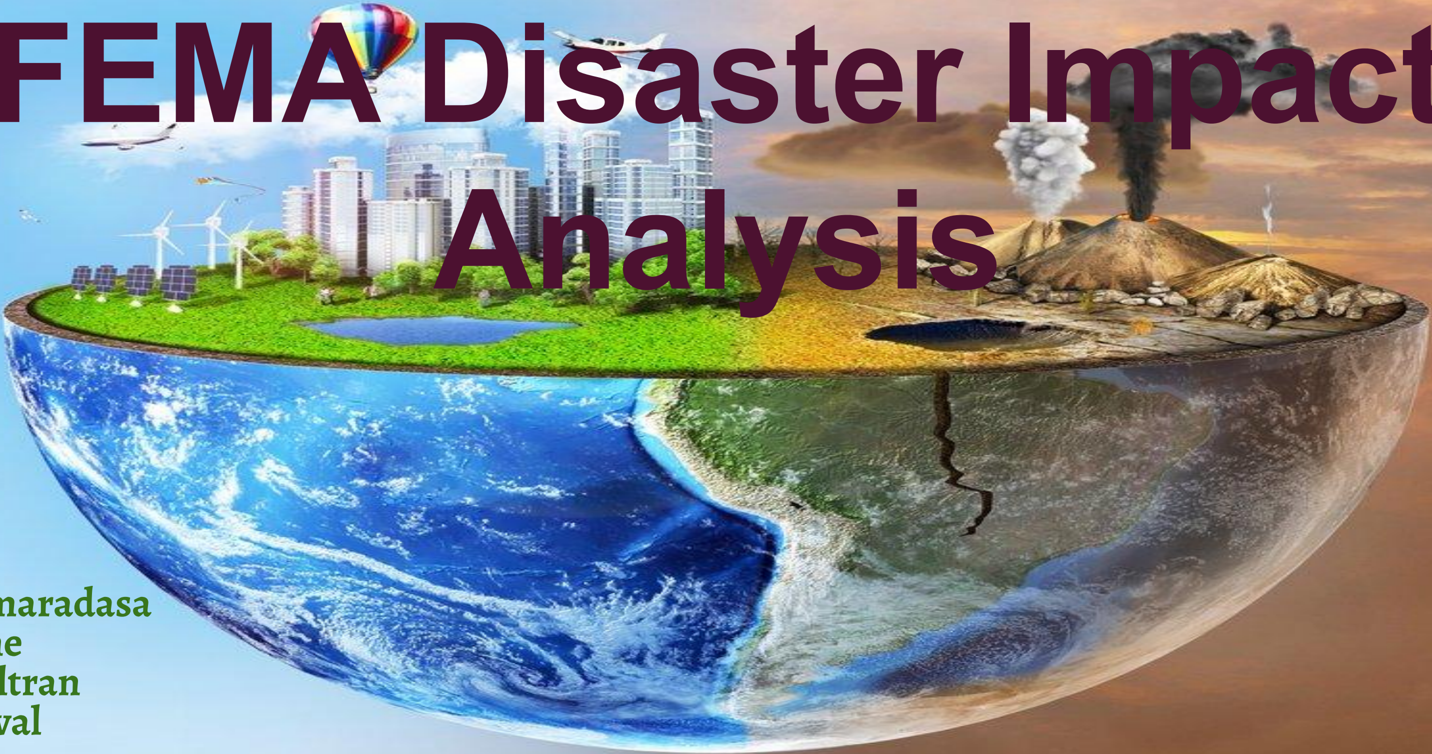
FEMA Disaster Impact Analysis



Group 01

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FEMA Disaster Declaration Raw Dataset

- **Dataset Name**: OpenFEMA Dataset: Disaster Declarations Summaries - v2
- **Dataset Size**: 28 columns and 67,361 rows
- **Data Origins**:
  - Older data manually entered or transferred from written spreadsheets
  - FEMA declarations date back to the 1950s
  - Labels and formats have evolved over decades
- **Challenges**:
  - Many columns were initially unreadable or lacked clarity
  - Abbreviated meanings and government-based definitions complicated comprehension

Declaration Type:
- FM = Fire Mgmt
- DR = Major Disasters
- EM = Emergency Disasters

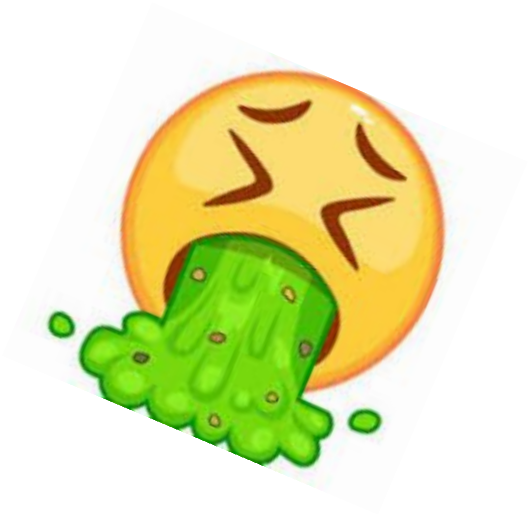
Fed. Relief Program:
- ih = Individuals & Households
- ia = Individual Assistance
- pa = Public Assistance
- hm = Hazard Mitigation

FIPS Codes:
- Federal Information Processing System (States and Counties)
- Uniquely identify geographic areas

https://www.fema.gov/openfema-data-page/disaster-declarations-summaries-v2

Original DataFrame

This is not readable - shown here for emphasis on raw format and necessary transformations



	femaDeclarationString	disasterNumber	state	declarationType	declarationDate	fyDeclared	incidentType	declarationTitle
0	FM-5530-NV	5530	NV	FM	2024-08-12T00:00:00.000Z	2024	Fire	GOLD RANCH FIRE
1	FM-5529-OR	5529	OR	FM	2024-08-09T00:00:00.000Z	2024	Fire	LEE FALLS FIRE
2	FM-5528-OR	5528	OR	FM	2024-08-06T00:00:00.000Z	2024	Fire	ELK LANE FIRE
3	FM-5527-OR	5527	OR	FM	2024-08-02T00:00:00.000Z	2024	Fire	MILE MARKER 132 FIRE
4	FM-5522-CA	5522	CA	FM	2024-07-27T00:00:00.000Z	2024	Fire	BOREL FIRE
...	...	...	...	...	...	...	...	...
67351	DR-9-TX	9	TX	DR	1953-06-19T00:00:00.000Z	1953	Flood	FLOOD
67352	DR-8-IA	8	IA	DR	1953-06-11T00:00:00.000Z	1953	Flood	FLOOD
67353	DR-7-MA	7	MA	DR	1953-06-11T00:00:00.000Z	1953	Tornado	TORNADO
67354	DR-2-TX	2	TX	DR	1953-05-15T00:00:00.000Z	1953	Tornado	TORNADO & HEAVY RAINFALL
67355	DR-1-GA	1	GA	DR	1953-05-02T00:00:00.000Z	1953	Tornado	TORNADO

	ihProgramDeclared	iaProgramDeclared	paProgramDeclared	hmProgramDeclared	incidentBeginDate	incidentEndDate	disasterCloseoutDate	tribalRequest
0	0	0	1	1	2024-08-11T00:00:00.000Z	NaN	NaN	0
1	0	0	1	1	2024-08-08T00:00:00.000Z	NaN	NaN	0
2	0	0	1	1	2024-08-04T00:00:00.000Z	NaN	NaN	0
3	0	0	1	1	2024-08-02T00:00:00.000Z	NaN	NaN	0
4	0	0	1	1	2024-07-25T00:00:00.000Z	NaN	NaN	0
...	...	...	...	...	...	...	...	...
67351	0	1	1	1	1953-06-19T00:00:00.000Z	1953-06-19T00:00:00.000Z	1958-01-01T00:00:00.000Z	0
67352	0	1	1	1	1953-06-11T00:00:00.000Z	1953-06-11T00:00:00.000Z	1955-11-01T00:00:00.000Z	0
67353	0	1	1	1	1953-06-11T00:00:00.000Z	1953-06-11T00:00:00.000Z	1956-06-01T00:00:00.000Z	0
67354	0	1	1	1	1953-05-15T00:00:00.000Z	1953-05-15T00:00:00.000Z	1958-01-01T00:00:00.000Z	0
67355	0	1	1	1	1953-05-02T00:00:00.000Z	1953-05-02T00:00:00.000Z	1954-06-01T00:00:00.000Z	0

	fipsStateCode	fipsCountyCode	placeCode	designatedArea	declarationRequestNumber	lastIAFilingDate	incidentId	region
0	32	31	99031	Washoe (County)	24123	NaN	2024081201	9
1	41	67	99067	Washington (County)	24122	NaN	2024081001	10
2	41	31	99031	Jefferson (County)	24116	NaN	2024080701	10
3	41	17	99017	Deschutes (County)	24111	NaN	2024080301	10
4	6	29	99029	Kern (County)	24102	NaN	2024072701	9
...	...	...	...	...	...	...	...	...
67351	48	0	0	Statewide	53010	NaN	53010	6
67352	19	0	0	Statewide	53008	NaN	53008	7
67353	25	0	0	Statewide	53009	NaN	53009	1
67354	48	0	0	Statewide	53003	NaN	53003	6
67355	13	0	0	Statewide	53013	NaN	53013	4

	designatedIncidentTypes	lastRefresh	hash	id
0	R	2024-08-27T18:22:14.800Z	5d07e7c51bb300bfbec94a699a1e1ab1d61a97cd	f15a7a79-f1c3-41bb-8a5c-c05fbaa34423
1	R	2024-08-27T18:22:14.800Z	ae87cf3c6ed795015b714af7166c7c295b2b67c7	09e3f81a-5e16-4b72-b317-1c64a0cfa69c
2	R	2024-08-27T18:22:14.800Z	432cf0995c47e3895cea996ade5621b810460501	59983f89-30bf-4888-b21b-62a8d57d9aac
3	R	2024-08-27T18:22:14.800Z	2f21d90cb6bc64b0d4121aa3f18d852bbb4b11fa	8d13ecf0-bc2f-496b-8c9f-b2e73da832a0
4	R	2024-08-27T18:22:14.800Z	51ec819011c936f387ecf10b9d5839b35419ca96	9b73e19b-d326-4992-8da1-7e658d97607c
...	...	...	...	...
67351	NaN	2024-08-27T18:22:14.800Z	2488a86cd6660a72865c1e6da2b16eac37753a33	6ef58fa5-6899-466b-9e3b-ee4c06da0876
67352	NaN	2024-08-27T18:22:14.800Z	a051cd98c34a0ec2485d0f6b5b11d4c93509ad88	f100b5c1-0f3f-4c3d-ad3c-50040e98ed9d
67353	NaN	2024-08-27T18:22:14.800Z	b720724cfb17afaba95e73a92fdf09b1fc6d0e6f	fca83efc-524a-45a0-ac98-2d43b954a5ea
67354	W	2024-08-27T18:22:14.800Z	8a8bc885c003cb873c201bb6a3a2771a6c84efb1	ff821327-6b90-4246-b19f-ff8c4b288a5
67355	NaN	2024-08-27T18:22:14.800Z	413ff809d79f08a6710f6b78f361d5a7de992711	8943dfcf-9786-4e51-8989-d62014034bb2

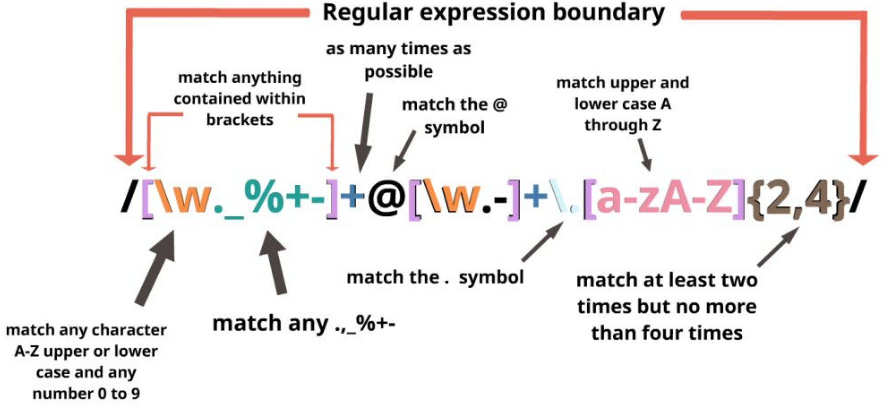
FEMA Data - Initial Filtering

Filter 1: Basic - Parsing, Merging,

- Dates included times @ midnight -> Remove times
- Geographic codes (ie. FIPS) deemed less helpful -> Remove FIPS codes
- Created DataFrame with only desired incident types to merge with original
- Drop columns that are mostly NaN

Filter 2: Advanced (Regex) - Areas

- “designatedArea” - separated by \`()\` to create area and area types
- “areaType” containing more area info - Cleaned and duplicated with new areas
- Match “areaType” by keywords for accuracy and then by bins to create granularity in data (26 types originally)
- Granularity was not used for project, but with theoretical repurposing in mind



The Geoapify API Call…

Is actually just the concept of geocoding that we've all done as a class already!

Geoapify was given freeform location info in the form of an area name, and the state it's in. It was also restricted to finding coordinate pairs only in the US and its territories within a given rectangle.

This is how we retrieved the coordinate pairs for every incident and then filtered the resultant DataFrame to only rows that had coordinates.

The intricacies are found in how the call was performed…
Limitations were:

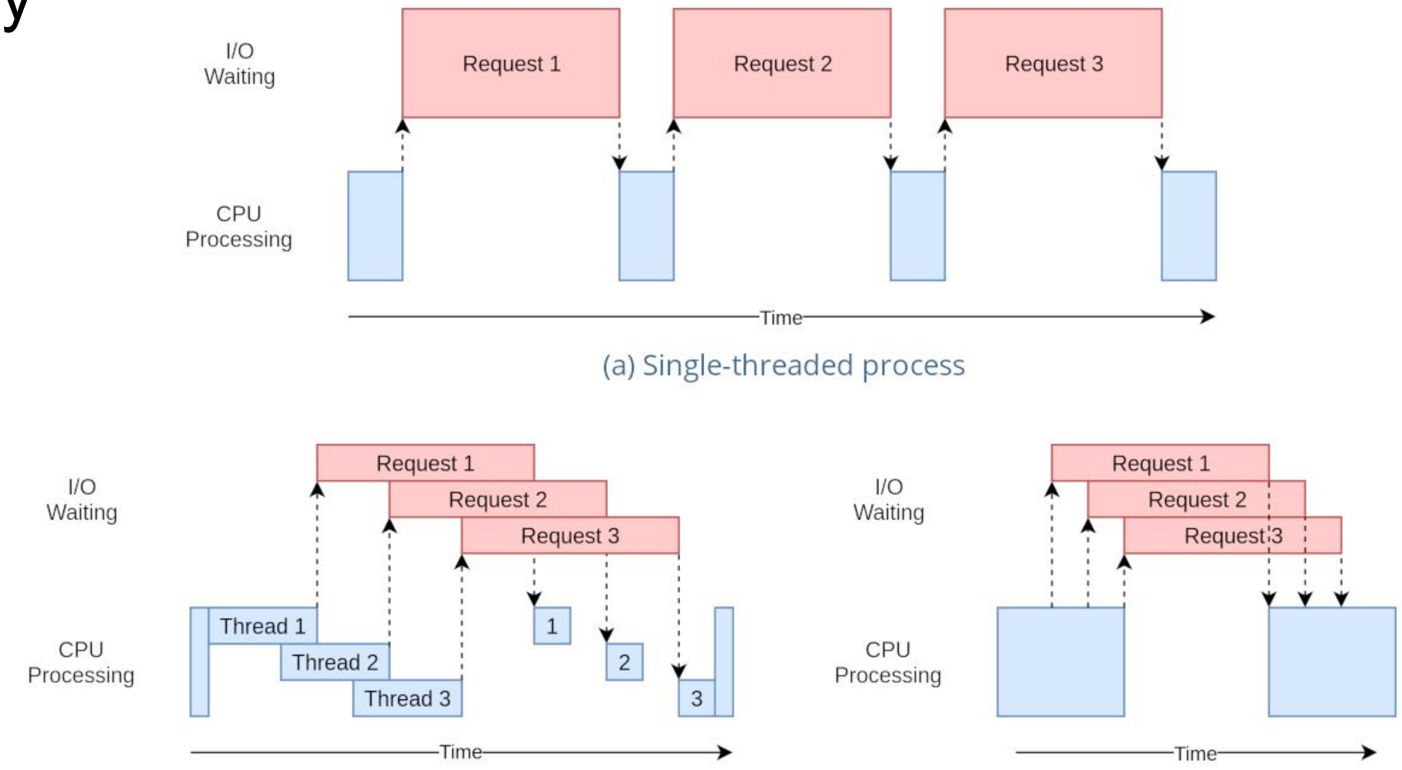
- 5 calls/second
- 3000 calls/day
- 3427 data points

→ 38 minutes, 38 seconds (runtime)

By integrating my call with the "concurrent.futures" library I was able to utilize the 9 keys I acquired to create **9 different threads**, all of which made API calls every 0.2 seconds

→ 4 minutes, 20 seconds (runtime)

Multi-Threading Conceptually



(a) Single-threaded process

(b) Multi-threaded process with GIL acquired by current thread

(c) Single-threaded process with asyncio

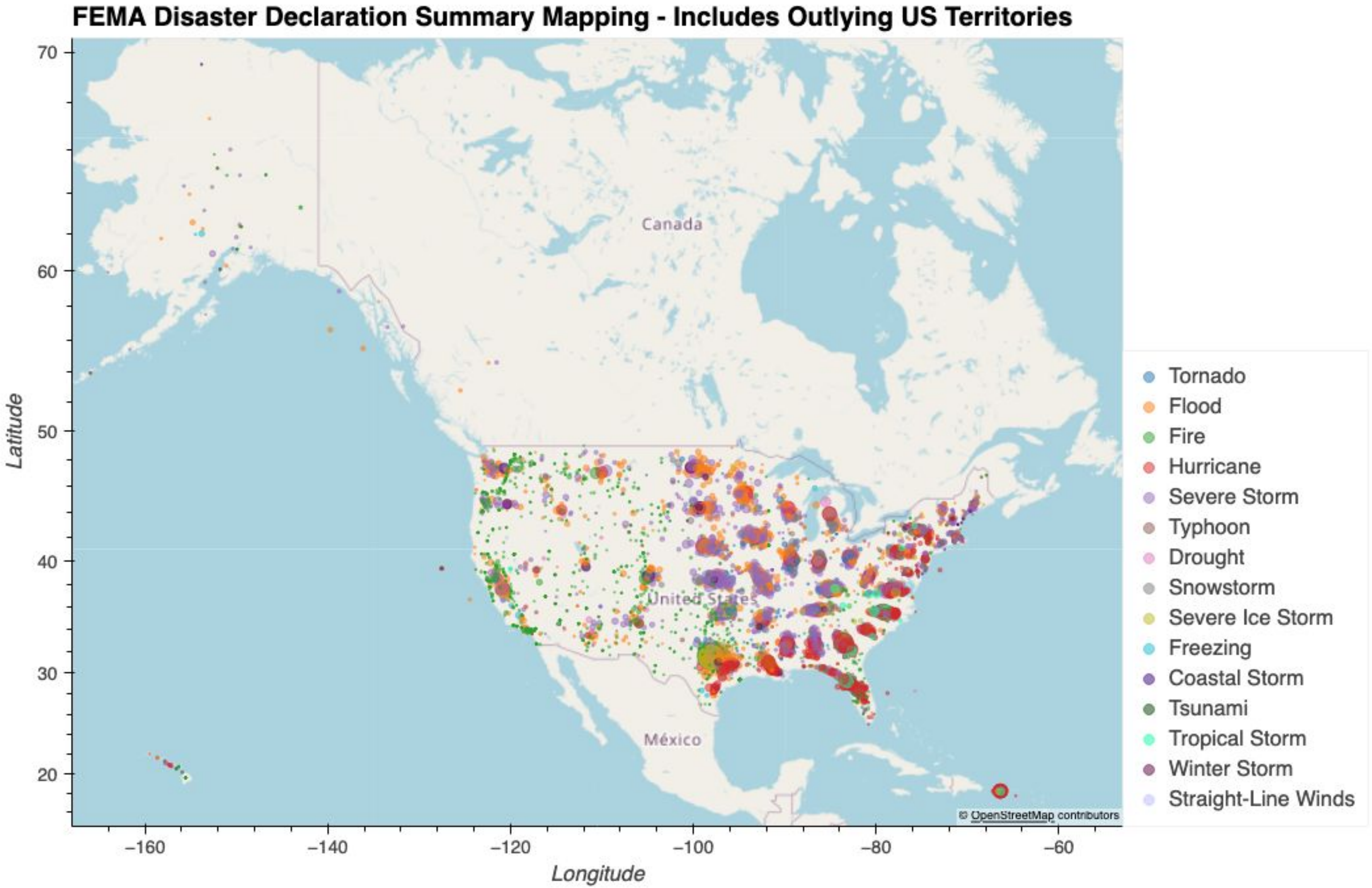
Final & Summary DataFrames

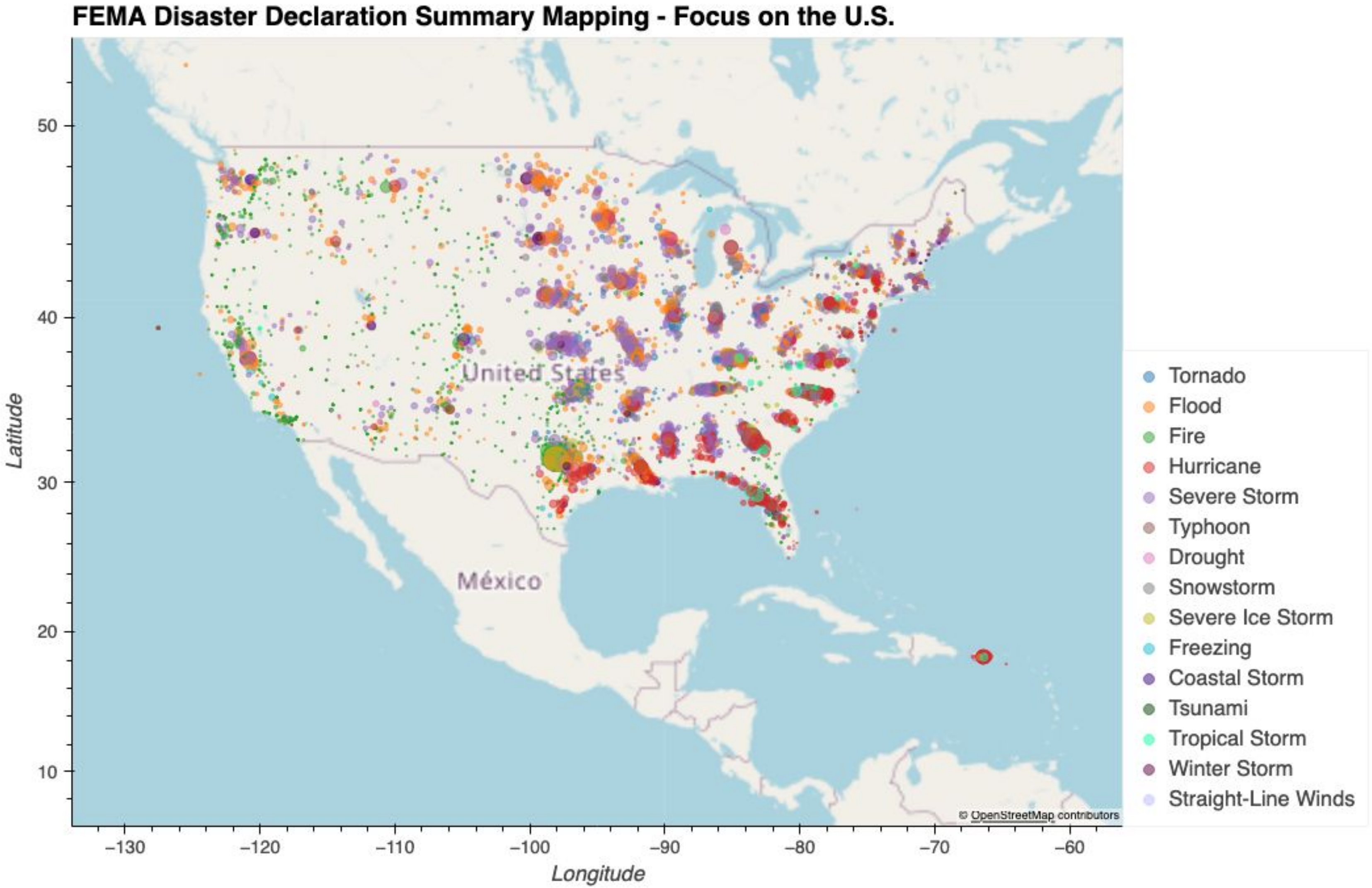
Final DF

	disasterNumber	declarationRequestNumber	declarationTitle	area	areaType	state	incidentType	declarationType	declarationDate	incidentBeginDate	latitude	longitude	tribalRequest	ihProgramDeclared	iaProgramDeclared	paProgramDeclared	hmProgramDeclared
0	5530	24123	GOLD RANCH FIRE	Washoe	County	NV	Fire	FM	2024-08-12	2024-08-11	40.584905	-119.613161	0	0	0	1	1
1	5529	24122	LEE FALLS FIRE	Washington	County	OR	Fire	FM	2024-08-09	2024-08-08	45.560188	-123.058791	0	0	0	1	1
2	5528	24116	ELK LANE FIRE	Jefferson	County	OR	Fire	FM	2024-08-06	2024-08-04	44.722434	-123.007389	0	0	0	1	1
3	5527	24111	MILE MARKER 132 FIRE	Deschutes	County	OR	Fire	FM	2024-08-02	2024-08-02	44.156923	-121.258700	0	0	0	1	1
4	5522	24102	BOREL FIRE	Kern	County	CA	Fire	FM	2024-07-27	2024-07-25	35.314570	-118.753822	0	0	0	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
58138	1967	11042	TSUNAMI WAVES	Honolulu	County	HI	Tsunami	DR	2011-04-08	2011-03-11	21.304547	-157.855676	0	0	0	1	1
58139	1967	11042	TSUNAMI WAVES	Maui	County	HI	Tsunami	DR	2011-04-08	2011-03-11	20.758059	-156.310523	0	0	0	1	1
58140	1964	11029	TSUNAMI WAVE SURGE	Coos	County	OR	Tsunami	DR	2011-03-25	2011-03-11	43.218414	-124.109621	0	0	0	1	1
58141	1964	11029	TSUNAMI WAVE SURGE	Curry	County	OR	Tsunami	DR	2011-03-25	2011-03-11	41.858425	-74.581269	0	0	0	1	1
58142	1964	11029	TSUNAMI WAVE SURGE	Lincoln	County	OR	Tsunami	DR	2011-03-25	2011-03-11	42.108750	-122.403078	0	0	0	1	1

	Disaster Number	Title	Number of Requests	Declaration Request Number	Incident Type	Incident Begin Date (First)	Incident Begin Date (Last)	Declaration Date (First)	Declaration Date (Last)	Latitude	Longitude
0	1	TORNADO	1	53013	Tornado	1953-05-02	1953-05-02	1953-05-02	1953-05-02	30.876607	-84.200199
1	2	TORNADO & HEAVY RAINFALL	1	53003	Tornado	1953-05-15	1953-05-15	1953-05-15	1953-05-15	29.396013	-94.917548
2	3	FLOOD	1	53005	Flood	1953-05-29	1953-05-29	1953-05-29	1953-05-29	32.787346	-91.904878
3	4	TORNADO	1	53004	Tornado	1953-06-02	1953-06-02	1953-06-02	1953-06-02	42.233092	-84.327177
4	5	FLOODS	1	53006	Flood	1953-06-06	1953-06-06	1953-06-06	1953-06-06	46.540855	-111.946345
...	...	...	...	...	...	...	...	...	...	...	...
4713	5547	JENNINGS CREEK FIRE	1	24199	Fire	2024-11-08	2024-11-08	2024-11-15	2024-11-15	41.539816	-74.098199
4714	5548	FRANKLIN FIRE	1	24204	Fire	2024-12-09	2024-12-09	2024-12-10	2024-12-10	34.053691	-118.242766
4715	5549	PALISADES FIRE	1	25002	Fire	2025-01-07	2025-01-07	2025-01-07	2025-01-07	34.053691	-118.242766
4716	5550	EATON FIRE	1	25003	Fire	2025-01-07	2025-01-07	2025-01-08	2025-01-08	34.053691	-118.242766
4717	5551	HURST FIRE	1	25004	Fire	2025-01-07	2025-01-07	2025-01-08	2025-01-08	34.053691	-118.242766

Summary DF


FEMA Disaster Declaration Summary Mapping - Includes Outlying US Territories
70
60
50
40
30
20
Latitude
−160
−140
−120
−100
−80
−60
Longitude
Canada
United States
México
© OpenStreetMap contributors
Tornado
Flood
Fire
Hurricane
Severe Storm
Typhoon
Drought
Snowstorm
Severe Ice Storm
Freezing
Coastal Storm
Tsunami
Tropical Storm
Winter Storm
Straight-Line Winds


FEMA Disaster Declaration Summary Mapping - Focus on the U.S.
Latitude
Longitude
50
40
30
20
10
−130
−120
−110
−100
−90
−80
−70
−60
United States
México
© OpenStreetMap contributors
Tornado
Flood
Fire
Hurricane
Severe Storm
Typhoon
Drought
Snowstorm
Severe Ice Storm
Freezing
Coastal Storm
Tsunami
Tropical Storm
Winter Storm
Straight-Line Winds


Ayyy!

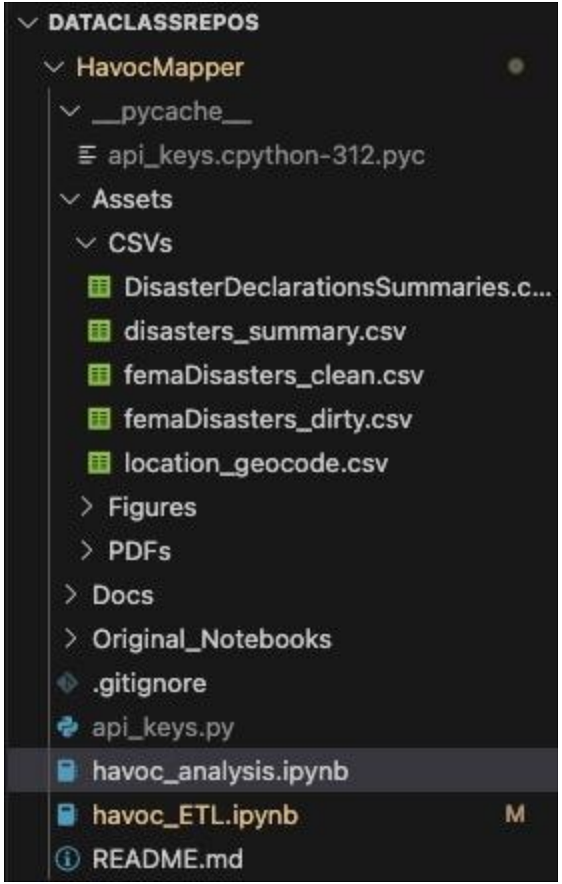
File Organization

CSV Breakdown:
- Original
- Cleaned Using Basic Methods
- Geocoded File gained from API
- Cleaned Using Regex and validated with geocoding
- Summary

Assets:
- CSVs
- Figures (exported images by Name)
- PDFs (resources)

Docs:
- For source linking and additional documentation

Original Notebooks:
- Each collaborator’s individual notebook



Data Engineering Rabbit Holes

- Learning to use Regex and vectorized function for DataFrames

- `areaType` pitfall of cleaning data that wasn't needed/used

- Deciding on API and how to use

- Encountering heavy limits on API and runtime issues/long wait time

- Deciding on group workflow

The fearsome rabbit from Monty Python and the Holy Grail

Federal Emergency Management Agency (FEMA) Data Statistical Analysis - summary

Natural Disasters Focused on the FEMA data-set

- Severe Storms - 18,399
- Hurricane - 13,721
- Flood - 11,093
- Fire - 3759
- Snowstorms - 3707
- Severe Ice Storms - 2942
- Tornado - 1623
- Drought - 1292
- Tropical Storm - 1047
- Coastal Storm - 637
- Freezing - 301
- Earthquake - 228
- Typhoon - 130
- Winter storm - 117
- Volcanic Eruption - 51
- Mud/Landslide - 43
- Tsunami - 9
- Straight-Line Winds - 2

Declaration Types

- Major Disasters - 41,116
- Emergency Declarations - 15,991
- Fire Management - 1994

Total Number of Natural Disasters

Declared over the last 72 years is

59,101

Most Common and Least Common Natural Disasters Declared

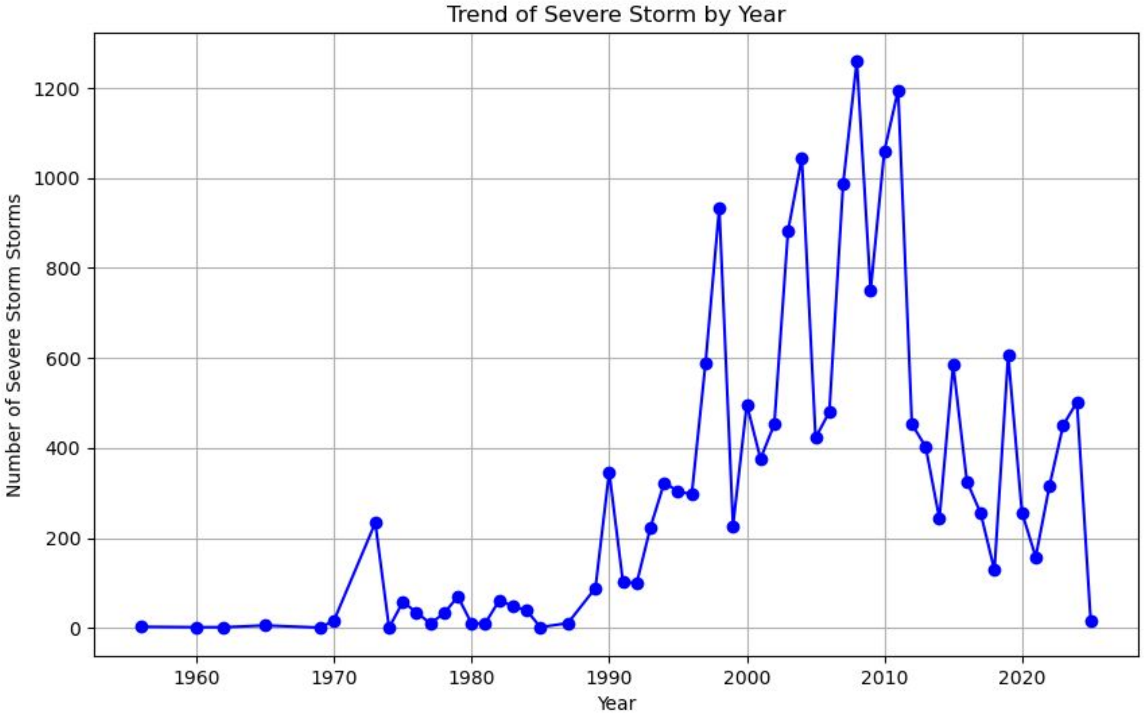
- Most Common Natural Disaster Declared
  - Severe Storms
  - Hurricane
  - Flood

- Least Common Natural Disaster Declared
  - Straight line winds
  - Tsunami
  - Mud/Landslides

Severe Storms - Trends Over the last Seven Decades

Trends:

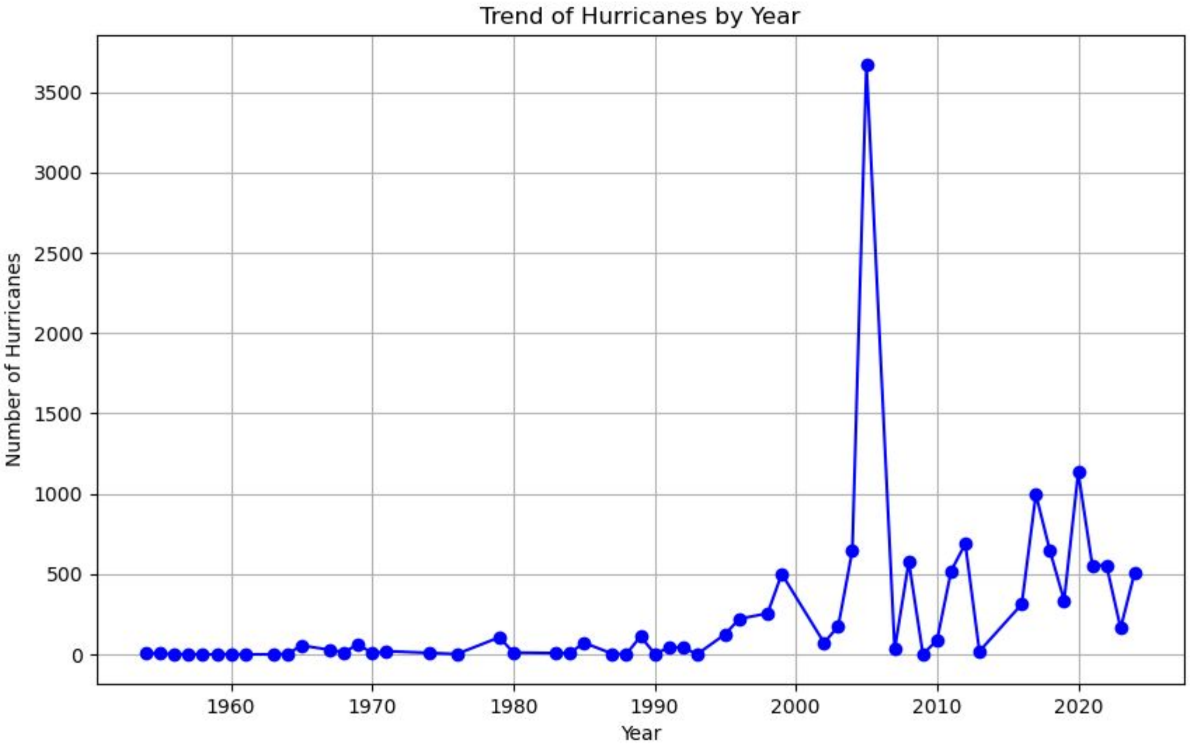
- Average Storms per year is 342.1
- Most number of Severe storms in a given year was 1263
- Least number of storms in a given Year was 1
- 2008 had the highest number of storms
- In general there was a spike in the number of storms between 2000 - 2010



Hurricanes - Trends Over the last Seven Decades

Trends:

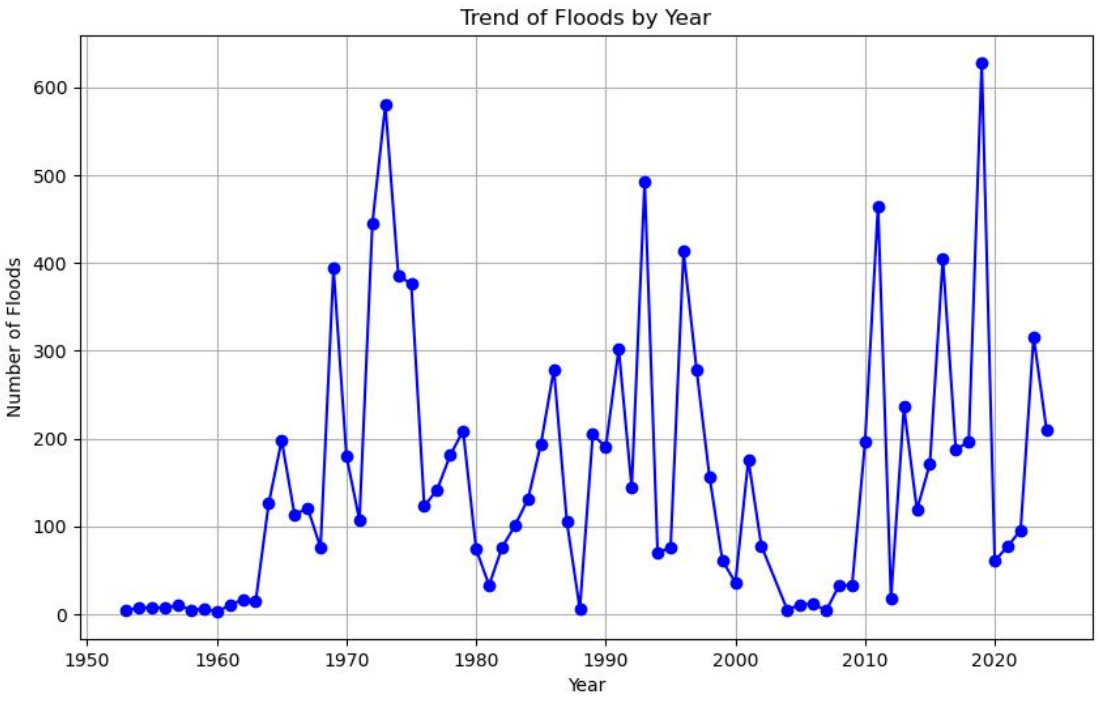
- Average Hurricanes per year is 254.09
- Most number of Severe storms in a given year was 3714
- Least number of Hurricanes in a given Year was 1
- 2005 had the highest number of storms
- Overall there was a consistent increase in hurricanes after 2005 with no major spikes



Floods - Trends Over the last Seven Decades

Trends:

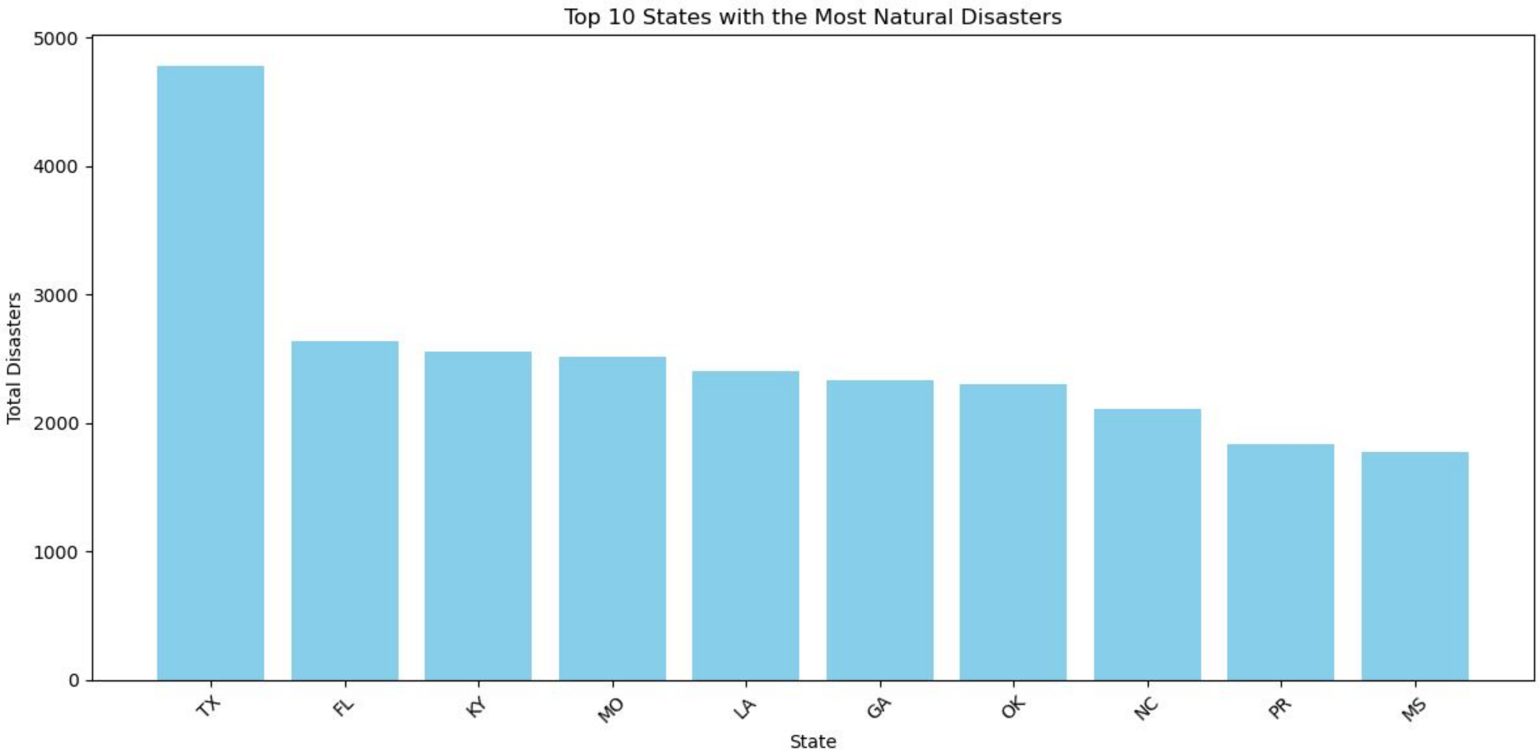
- Average Floods per year is 124.1
- Most number of Floods in a given year was 3714
- Least number of Floods in a given Year was 1
- Floods have been consistent throughout the last seven decades with two spikes in the early 70's and late 2010's
- 1950's and 1960's were two decades that had the least amount of Floods.



Geographical Data

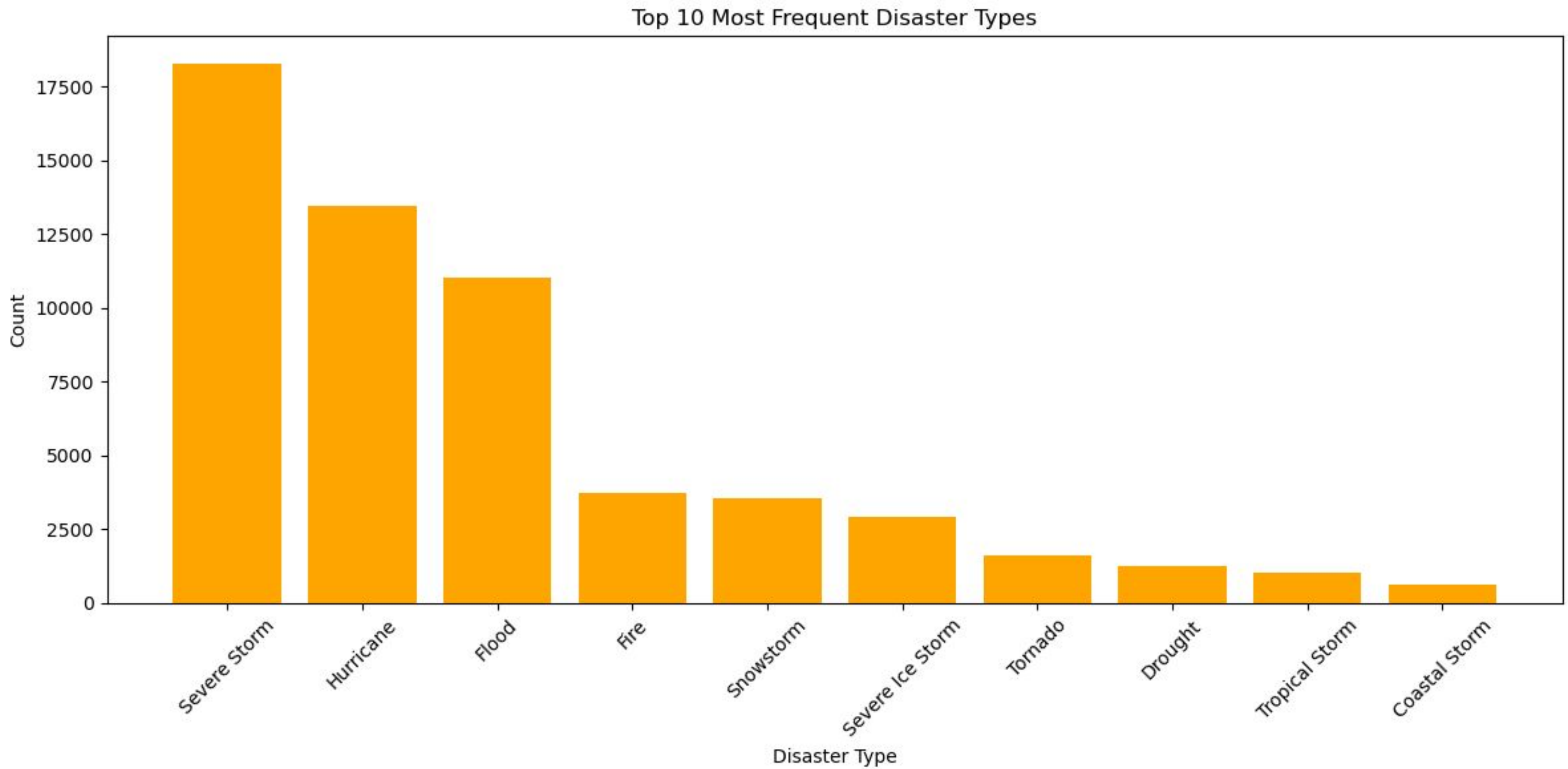
Question: What US locations experience the most natural disasters? Why?

Graphs Based on FEMA Disaster Declaration Data Set

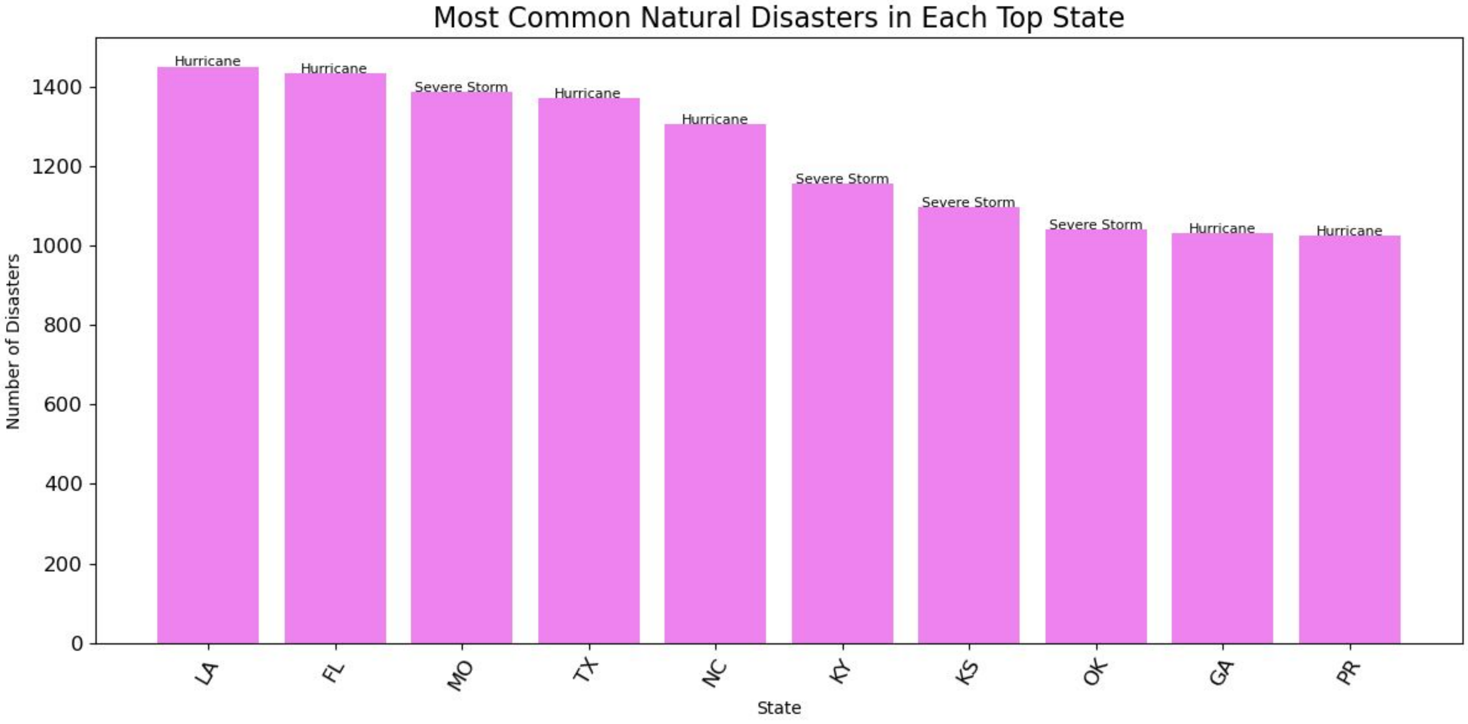


TX: 4,779 total disasters

FL: 2,635 total disasters



Top 10 Most Frequent Disaster Types
Count
17500
15000
12500
10000
7500
5000
2500
0
Severe Storm
Hurricane
Flood
Fire
Snowstorm
Severe Ice Storm
Tornado
Drought
Tropical Storm
Coastal Storm
Disaster Type



LA: most hurricanes declared out of all the states (1,450 total)

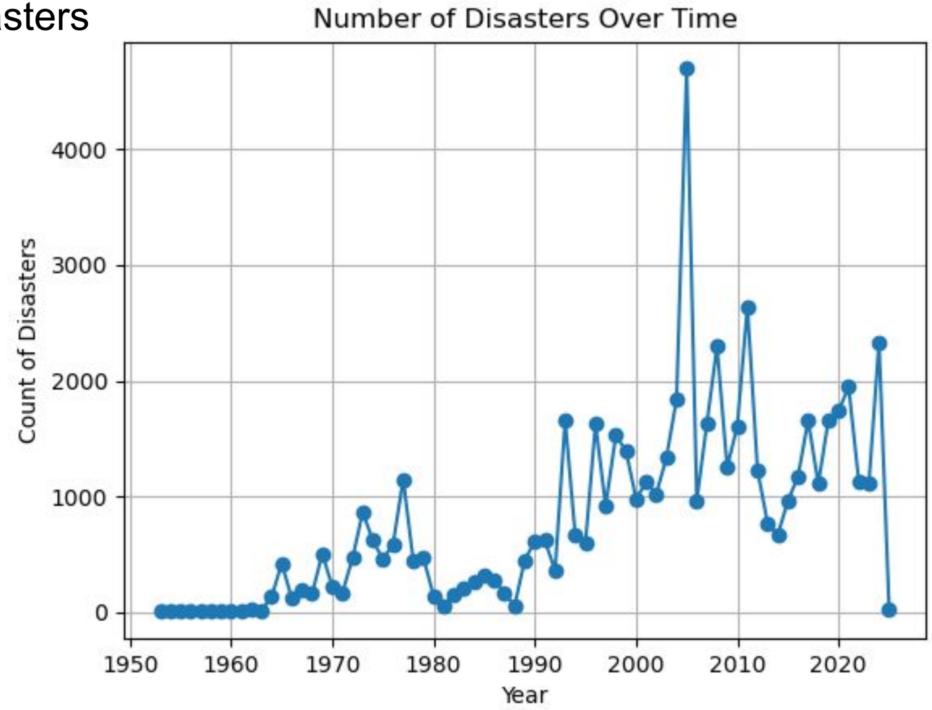
MO: most severe storms declared (1,387 total)

Why?

- Texas:
  - Broad coastline, making it more vulnerable to hurricanes and severe storms.
  - It is a very big state with lots of land that covers multiple climate zones.
- Florida:
  - Situated between the Gulf of Mexico, Atlantic Ocean, and the Straits of Florida, making the state susceptible to hurricanes from many directions.
  - Low elevation can increase the risk of floods.
- Southeast Regions (LA, GA, KY):
  - Highly exposed to Atlantic hurricanes and storms.
  - Moisture from the Gulf of Mexico can lead to frequent thunderstorms.

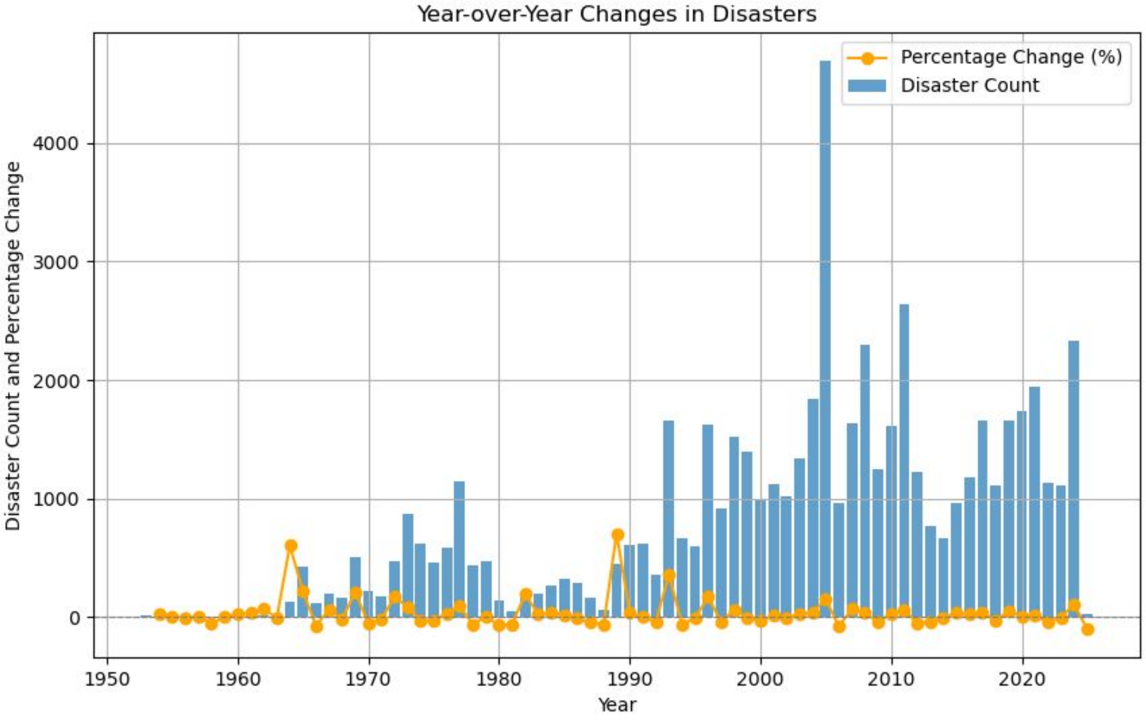
Natural Disaster Impact trend Analysis

- Year 2005 had 41 natural disasters
- 38.99% change over time of natural disasters



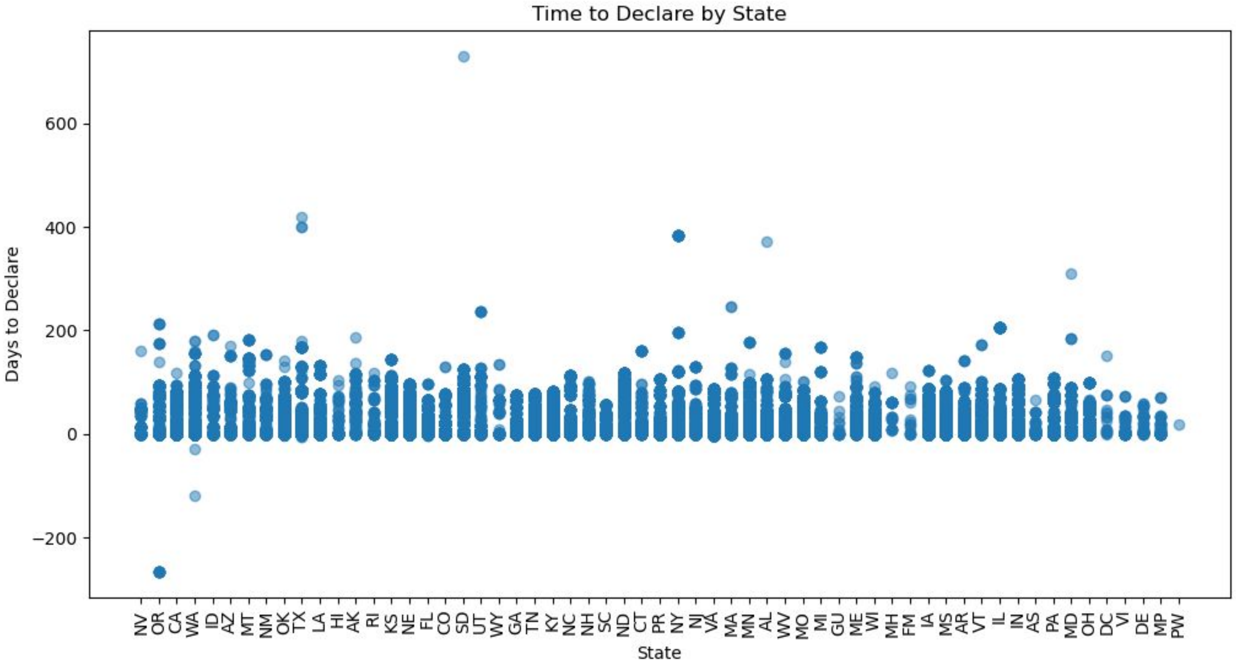
YOY Trend Analysis

- Hurricane Katrina and Rita impacted large spike in 2005 in LA and TX
- Spring: 22636
- Fall: 17310
- Summer: 15721
- Winter: 11689



Time to Declare by State

- PR and FL are the states that take the shortest time to declare a disaster with about ~ 8 days
- AK the longest at about 52 days



Utilized Libraries

FEMA Data Pipeline for ETL

Dependencies

```python
# Main ETL Libraries
import pandas as pd
import requests
from concurrent.futures import ThreadPoolExecutor
from itertools import cycle
from time import sleep

# Formating and Display Libraries
from pprint import pprint

# File Library
from pathlib import Path

# Personal API Key File (Please use your own or comment out)!
import api_keys
```

[46]

HavocMapper Analysis and Visuals

By Multiple Collaborators

Imports and bringing in cleaned CSV file

```python
# Dependencies
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import hvplot.pandas
import dataframe_image as dfi

# Seaborn, hvplot, and pyplot silencing
import warnings
warnings.filterwarnings('ignore')
```

[1] ✓ 5.0s

Additional Sources

- https://www.ncei.noaa.gov/
- https://www.spc.noaa.gov/publications/
- https://www.fema.gov/openfema-data-page/disaster-declarations-summaries-v2 (Main Dataset)
- https://www.fema.gov/flood-maps/products-tools/national-risk-index
- https://www.usgs.gov/programs/natural-hazards
- https://www.fema.gov/openfema-data-page/fima-nfip-redacted-claims-v2