Primer - Find Important Wildfire Events

Load Libraries

Running python 3.7.7 on Mac OS

In [3]:
```
import json
import pandas as pd
import numpy as np
import string
from datetime import datetime
from tqdm import tqdm
import spacy
import re
import matplotlib.pyplot as plt
import copy
from sklearn.cluster import DBSCAN
from sklearn.metrics import pairwise_distances_argmin_min
```

Download spacy's en_core_web_lg model in terminal

In [4]:
```
#python -m spacy download en_core_web_lg
```

Load and Analyze Data

In [5]:
```
#Load data
with open('docs.json') as f:
    docs = json.load(f)


with open('entities_meta.json') as f:
    entities = json.load(f)

docs_df = pd.DataFrame(docs)
```

In [6]:
```
#Starting with the articles dataset
print('Number of articles is: {}'.format(docs_df.shape[0]))

docs_df.head()
```

```
Number of articles is: 10000
```

Out[6]:

	event_id	content	title	date	sources	people	orgar
0	4a68a737-a357-47ea-a4b9-afe4f3c1f460	FLAGSTAFF, Ariz. -- An excavator used to clea...	Spark from wildfire-prevention efforts likely ...	2019-09-13T18:17:35Z	[ABC7NY]	[8e7aff20-4281-5023-8407-f43e5ba289e4, 4fc245e...	[9c a27 7ce20
1	3b4e3874-2034-4cc7-9929-09d60f1092e7	“Wildfire raging through the Paradise region i...	Conditions of the California wildfire reflect ...	2018-11-16T12:53:23Z	[ShowMe Plettenberg Bay]	[0aa3184c-c835-5afa-a5e7-656c37a08a7b, 193958f...	[15 660 d9167
2	d3c463cc-0b2f-4e51-9f99-f2f6cfc90d0f	Montanans were fortunate this year’s wildfire ...	Hazardous homes increasing wildfire risks, costs	2018-09-27T19:14:34Z	[Bozeman Daily Chronicle]	[a9637d0a-7c6a-5eeb-8f5c-947d3fea81bd]	[81 056 f53c75
3	0d357eaa-cf9c-406b-a551-503832c6dd5b	1 Introduction \nLarge wildfires are increasi...	Resilience to Large, “Catastrophic” Wildfires ...	2020-07-09T12:13:46Z	[Earth's Future]	[6eac2fd9-b19b-5a66-b2a0-cfba00919fc9, 8cdbbf2...	[5 ed e2bdb4 6a
4	f0365861-6f2f-42bc-a0ef-35d2c5e52d00	Discussing wildfire protection and management ...	Rod Rose, Bushfire Management Expert	2020-04-28T16:01:45Z	[CSR Wire]	[d18aeb90-b77f-5f80-aaa9-98058b97d922]	[8 96 62802 fb

In [7]:
```
#Do the summaries seem like good representations of articles?
print('Conent Sample:')
print(docs_df['content'].iloc[10])

print('-----')
print('Summary Sample:')

print(docs_df['summary'].iloc[10])
```

```
Conent Sample:
In these long, dark days of winter, wildfire may seem a distant memo
```

```
ry.

But given the last few years of record-setting wildfire disasters in
Oregon and neighboring states, now is no time to forget the risks we
face. Today's wildfires are more disastrous for a variety of reasons
- a warming climate, a century of fire suppression and fuel accumula
tion, and because we are putting more people and homes in harm's way
.

Across the country, development is fastest in areas with wildfire po
tential, making future disasters more likely.

Fortunately, a decade of research, post-fire analyses, and laborator
y experiments have led to new science about how to avoid such disast
ers and build wildfire-resilient communities. It starts with where a
nd how we build homes.

A few simple, affordable modifications to a home's roof, walls, wind
ows, deck, and landscaping can be the difference between the home's
survival and loss during a wildfire.

For example, home survival increases when built with ember-resistant
, finer mesh attic vents, noncombustible gutters, and fire-resistant
decking. Maintaining a noncombustible landscaping zone immediately a
round the home can reduce the likelihood of embers igniting the home
.

Where homes are spaced closer together, additional strategies become
necessary to avoid home-to-home ignition, such as using noncombustib
le siding and tempered glass windows. Wildfire hazard maps can help
land use planners and elected officials determine where to implement
such wildfire-resistant building standards.

A study released last month by Headwaters Economics found the cost o
f constructing a home to such standards was roughly the same as a ty
pical home. Using wildfire-resistant materials can have added benefi
ts such as reduced maintenance and longer lifespans.

This month, Oregon amended its State Building Code to allow local ju
risdictions the option of requiring wildfire-resistant construction
in high hazard areas.

The code, derived from international standards and using the best av
ailable science, allows cities and counties to decide whether and wh
ere to implement wildfire building regulations.

Oregon is wise to allow communities to require wildfire-resistant co
nstruction, as Washington and California have already done.

To be most effective, mitigation must be mandatory at the community
```

```
scale in areas of high wildfire hazard. Since implementation takes t
ime, the sooner communities adopt the codes, the better.

Already, Ashland, Bend, Sisters, and Wasco County are exploring such
requirements through expert input as part of the national Community
Planning Assistance for Wildfire program.

Too often, we believe the unthinkable will not happen to our communi
ty, but such willful blindness does us all a disservice. When flamma
ble homes are built in wildfire-prone areas, taxpayers end up should
ering the burden, economies are disrupted, and individuals suffer.

We have the knowledge, technology, and the power to avoid wildfire d
isasters through better planning.

Let's get started.

Kelly Pohl holds a M.S. from Portland State University and is a wild
fire researcher with Headwaters Economics, an independent, nonprofit
research group that works to improve community development and land
management decisions. You can reach her at kelly@headwaterseconomics
.org Doug Green is a Fire Inspector and Wildfire Mitigation Manager
for the Bend Fire Department and the Safety Manager for the Sisters-
Camp Sherman Fire District. You can reach him at dgreen@bendoregon.g
ov

Your Turn

Doug Green and Kelly Pohl

Guest columnists
-----
Summary Sample:
Fortunately, a decade of research, post-fire analyses, and laborator
y experiments have led to new science about how to avoid such disast
ers and build wildfire-resilient communities. It starts with where a
nd how we build homes. A study released last month by Headwaters Eco
nomics found the cost of constructing a home to such standards was r
oughly the same as a typical home. We have the knowledge, technology
, and the power to avoid wildfire disasters through better planning.
```

In [8]:

```
#Do all articles logged have content and summary

no_content = docs_df[docs_df['content'].isnull()].shape[0]

print('{} articles do not have content.'.format(no_content))

no_summary = docs_df[docs_df['summary'].isnull()].shape[0]

print('{} articles do not have summary.'.format(no_summary))
```

```
0 articles do not have content.
107 articles do not have summary.
```

In [9]:

```
#Look at any other nulls
count_nan = len(docs_df) - docs_df.count()
print(count_nan)
```

```
event_id           0
content            0
title              0
date               0
sources            0
people             0
organizations      0
locations          0
id                 0
summary          107
dtype: int64
```

In [10]:

```
#Will use summaries to map events so remove articles with no summary

docs_df = docs_df.loc[(docs_df['summary'].notnull()) & (docs_df['summa
ry'] != '')]
```

In [11]:

```python
#How do summaries look by word count?

#Word counts
docs_df['conent_word_count'] = docs_df['content'].str.split().apply(len)

print('Size of article content by word count')

print(docs_df.conent_word_count.describe())

#Ratio of summary size to content size
docs_df['summary_to_content'] = docs_df['summary'].str.split().apply(len)/docs_df['conent_word_count']

print('Summary size to content by word count')

print(docs_df.summary_to_content.describe())
```

```
Size of article content by word count
count     9869.000000
mean       624.754382
std        554.245066
min        135.000000
25%        341.000000
50%        501.000000
75%        732.000000
max      10124.000000
Name: conent_word_count, dtype: float64
Summary size to content by word count
count    9869.000000
mean        0.174226
std         0.097092
min         0.000802
25%         0.102804
50%         0.155268
75%         0.227603
max         0.607595
Name: summary_to_content, dtype: float64
```

Note - From an initial peak, it looks like summaries are generally good and scale down the text significantly

Now analyze time series

Question 1 - create a time-series of document volume for wildfires for the time span of the query

In [12]:

```
#confirm timeframe
print('earliest date: {}'.format(docs_df['date'].min()))
print('latest date: {}'.format(docs_df['date'].max()))
```

```
earliest date: 2018-09-01T01:27:58Z
latest date: 2020-09-17T23:45:57Z
```

In [13]:

```
#Create date column from string to datetime
docs_df['date_day'] =  pd.to_datetime(docs_df['date']).dt.date
```

In [14]:

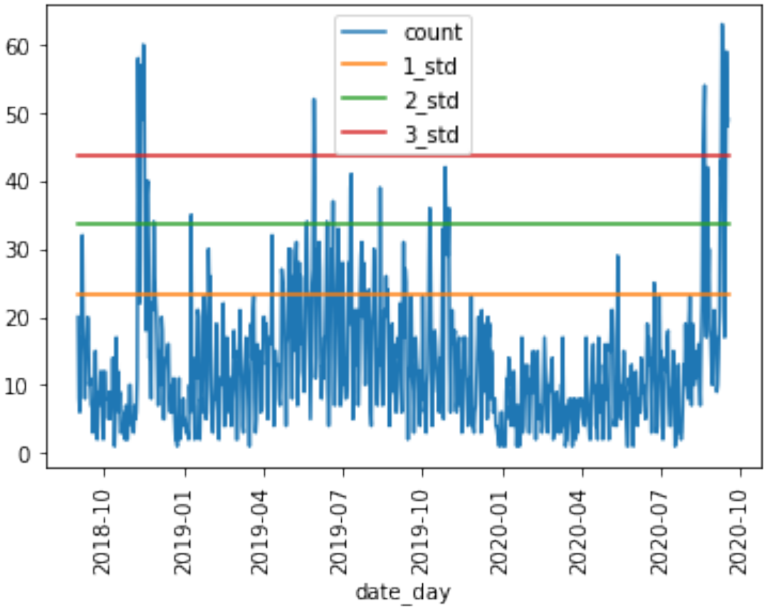
```
#Get a frequency of reporting over time
time_series = docs_df.groupby("date_day")["id"].count().reset_index(name="count")

#Calculate standard deviations away from the mean
time_series['1_std'] = np.mean(time_series['count']) + np.std(time_series['count'] )
time_series['2_std'] = np.mean(time_series['count']) + np.std(time_series['count'] )*2
time_series['3_std'] = np.mean(time_series['count']) + np.std(time_series['count'] )*3
```

In [15]:

```
#Visualize time series and standard deviations
time_series.plot(x="date_day", y=["count", "1_std", "2_std", "3_std"], rot = 90)
```

Out[15]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fdb8a452cd0>
```



In [16]:

```
#Filter to the events that were 3 standard deviations or more from the mean
key_events = time_series[time_series['count'] >= time_series['3_std']]

#
print("The number of 'days with key events' has been narrowed down to {}".format(key_events.shape[0]))
#May want to get days leading up to and after key events above
```

```
The number of 'days with key events' has been narrowed down to 14
```

Build algorithm to highlight news from peaks

Question 2 - Develop Algorithm to highlight important news, efficiently and succinctly

In [17]:

```
#filter data to the key events from #1

filt_df = pd.merge(docs_df, key_events[['date_day']],
                                    left_on='date_day',
                                    right_on='date_day',
                                    how='inner')
```

In [18]:

```
#load spacy model
nlp =  spacy.load('en_core_web_lg')
```

In [19]:

```
#function to find numbers in text as this could point to subtantive events
def hasNumbers(inputString):
     return bool(re.search(r'\d', inputString))
```

Note - The first approach will involve: A) parsing through all content and extracting candidate event sentences that could contain succint and important information based on rules. B) These candidate sentences will be cleaned and embedded using spacy C) Sentences embeddings will be grouped by date and then clustered to identify sentences talking about the same events D) Top sentences will be ordered by day and outputed

In [82]:

```
#A) and B)

sent_vecs = {} #Will store all sentence embeddings
unique_days = set() #Unique days that actually had candidate event sentences

#Counter used to index df
counter = 0
for summary in tqdm(filt_df.summary):

    #Break up into iteratable sentences
    sentences = list(nlp(summary).sents)

    #For each sentence
    for i in range(len(sentences)):

        #clean data
        clean_space = ' '.join(sentences[i].text.split()).lower()
        clean_punc = re.sub(r'[^\w\s]', '', clean_space)
        sent = nlp(clean_punc) #process using spacy

        ent_type = [e.label_ for e in sent.ents] #find event types

        ##rules to find candidate event sentences

        # if hasNumbers(sentences[i].text) and 'GPE' in ent_type:
        if 'GPE' in ent_type and  hasNumbers(clean_punc):

            unique_days.add(filt_df.date_day.iloc[counter])

            sent_vecs.update({(filt_df.id.iloc[counter], #0
                               filt_df.date.iloc[counter],     #1
                               filt_df.date_day.iloc[counter], #2
                               clean_punc,                     #3
                              sentences[i].text) :             #4
                              sent.vector})

    counter += 1
```

```
100%|██████████| 760/760 [00:31<00:00, 23.76it/s]
```

In [85]:

```
#C) and D)

all_output = pd.DataFrame([]) #will store extracted events

#for all unique peak days
for day in tqdm(list(unique_days)):
    to_cluster =[]
    sentences_clean = []
    sentences_raw = []
    time = []
    e_id = []
    for i in sent_vecs.keys():
        #if the sentence is from 'day'
        if i[2] == day:
            e_id.append(i[0])
            time.append(i[1])
            sentences_clean.append( i[3])
            sentences_raw.append( i[4])
            to_cluster.append(sent_vecs[i])


    x = np.array(to_cluster)

    n_classes = {}

    max_clusters = 0
    eps_pick = 0

    #Try different epsilon values to see which one gives me the highest number of clusters - aka more unique events
    for i in np.arange(0.001, .5, 0.002):

        dbscan = DBSCAN(eps = i, min_samples = 2, metric = 'cosine').fit(x)

        clust_num = len(pd.Series(dbscan.labels_).value_counts()) #number of clusters

        #Check if this is a 'better' epsilon
        if clust_num > max_clusters:
            max_clusters = clust_num
            eps_pick = i

        n_classes.update({i: clust_num})


    #Use the 'best' epsilon
    dbscan = DBSCAN(eps = eps_pick, min_samples = 2, metric = 'cosine').fit(x)

    #Dataframe with dbscan outputs
    db_scan_results = pd.DataFrame({'label': dbscan.labels_, 'sent': sentences_raw, 'id': e_id,
                                    'embed': to_cluster,'time': time, 'top_sent': None})
    #join with other columns to have acess to the source information
    results = pd.merge(db_scan_results, filt_df[['sources', 'people', 'id', 'event_id',
                                             'organizations', 'locations', 'summary']],
                                    left_on='id',
                                    right_on='id',
                                    how='inner')

    #Empty dataframe to store top sentences
    final_results = pd.DataFrame([])

    #For each unique cluster, find the sentence that depicts the event
    ## best based on distance from the mean embedding vector

    for i in results.label.unique():
        #-1 indicates no cluster was found these
        if i != -1:
            tmp = copy.deepcopy(results)

            tmp = tmp[tmp['label'] == i].reset_index()

            #Calculate mean vector
            mean_vec = np.array(tmp['embed']).mean(axis = 0)

            #Find the sentence with the closest distance to the mean vector
            index = pairwise_distances_argmin_min(np.array([mean_vec]), list((tmp['embed'])))[0][0]

            #Tag top sentence
            tmp['top_sent'] = np.where(tmp.index == index, True,  False)

            #Append top sentence from label to the compiled output
            final_results = final_results.append(tmp, ignore_index=True)


    #Sort and order based on time of the day
    final = final_results[final_results['top_sent'] == True].sort_values(by = ['time'])
    final['day'] = day

    #Append all model outputs
    all_output = all_output.append(final, ignore_index=True)
```

```
100%|██████████| 14/14 [00:05<00:00,  2.50it/s]
```

How are the outputs looking?

In [86]:

```
#Let's look at a couple of examples

df = all_output[['sent', 'time']][all_output['day'] == all_output['day'].min()] #Looking at the oldest event

for index, row in df.iterrows():
    print('----')
    print(row['time'])
    print(row['sent'])
```

```
----
2018-11-09T02:05:37Z
A state of emergency has been declared for Butte County due to the e
ffects of the Camp Fire, which began around 6:30 a.m. Thursday and q
uickly spread, said the California Department of Forestry and Fire P
rotection, known as Cal Fire.
----
2018-11-09T02:05:37Z
About 3,300 students and staff members from Paradise's 11 schools we
re evacuated in buses and employees' cars to a center in Chico,
----
2018-11-09T16:26:11Z
Fire officials have issued evacuation notices for parts of Chico, a
town of 93,000 people north of Sacramento.
----
2018-11-09T19:26:51Z
A burning sign is seen outside Paradise Skilled Nursing home during
the Camp Fire in Paradise, California, US on November 8, 2018.
----
2018-11-09T19:26:51Z
A wildfire that moved so fast that firefighters couldn't hope to sto
p it quadrupled in size Friday after destroying several thousand bui
ldings and leveling much of a Northern California town of nearly 30,
000 people, authorities said.
----
2018-11-09T19:26:51Z
Thousand Oaks, California (Reuters) Officials said fires across Cali
fornia have forced 157,000 people from their homes.
----
2018-11-09T22:19:24Z
The location known as "Western Town" is set in the mountains west of
Los Angeles dates to 1927 when Paramount Pictures leased the ranch a
nd began making films there.
```

In [87]:
```
df = all_output[['sent', 'time']][all_output['day'] == all_output['day
'].max()] #Looking at the most recent event

for index, row in df.iterrows():
    print('----')
    print(row['time'])
    print(row['sent'])
```

```
----
2020-09-17T14:32:26Z
More than 200 B.C. firefighters and related personnel are heading to
the U.S. to help battle extreme fire activity in Oregon.
----
2020-09-17T23:45:57Z
At least 36 people have died in the fires, which are ravaging parts
of California, Oregon, and Washington State, and many others are mis
sing.
```

Join entities data provided

In [88]:

```
#####Joining entities data

###Map people

people_dict = {}

for i in entities['people']:
    people_dict[i['id']] = i['display_person']


all_output['people_dec'] = all_output['people'].apply(lambda x: ','.join(map(str, x))) #convert list to strings

all_output['people_dec'] = all_output["people_dec"].replace(people_dict, regex=True) #replace with entities

#Now map locations

location_dict = {}
for i in entities['locations']:
    location_dict[i['id']] = json.dumps(i)

all_output['locations_dec'] = all_output['locations'].apply(lambda x: ','.join(map(str, x))) #convert list to strings

all_output['locations_dec'] = all_output["locations_dec"].replace(location_dict, regex=True) #replace with entities

#Need to map organization
```

In [89]:

```
#Let's look at it with the new entities

df = all_output[all_output['day'] == all_output['day'].min()] #Looking
at the most recent event

for index, row in df.iterrows():
    print('-------')
    print(row['time'])
    print(row['sent'])
    print('People Involved: {}'.format(row['people_dec'].split(',')))

    for j in row['locations_dec'].split('},'):
        if j[-1] != "}":
            loc = json.loads(j+'}')
        else:
            loc = json.loads(j)
        print('--')
        print('Location: {}'.format(loc['name']))
        print('Latitude: {}'.format(loc['latitude']))
        print('Longitude: {}'.format(loc['longitude']))
```

```
-------
2018-11-09T02:05:37Z
A state of emergency has been declared for Butte County due to the e
ffects of the Camp Fire, which began around 6:30 a.m. Thursday and q
uickly spread, said the California Department of Forestry and Fire P
rotection, known as Cal Fire.
People Involved: ['Josh Peete', 'John Gaddie', 'Morgan Mason', 'Tana
h Clunies-Ross', 'Jillian Smalley', 'Allana Hall', 'Tim Taylor']
--
Location: Chico
Latitude: 39.72849
Longitude: -121.83748
--
Location: Oroville
Latitude: 39.51394
Longitude: -121.55776
--
Location: California
Latitude: nan
Longitude: nan
--
Location: Butte County
Latitude: nan
Longitude: nan
--
Location: Paradise
Latitude: 36.09719
Longitude: -115.14666
```

```
--
Location: Magalia
Latitude: 39.81211
Longitude: -121.57831
-------
2018-11-09T02:05:37Z
About 3,300 students and staff members from Paradise's 11 schools we
re evacuated in buses and employees' cars to a center in Chico,
People Involved: ['Josh Peete', 'John Gaddie', 'Morgan Mason', 'Tana
h Clunies-Ross', 'Jillian Smalley', 'Allana Hall', 'Tim Taylor']
--
Location: Chico
Latitude: 39.72849
Longitude: -121.83748
--
Location: Oroville
Latitude: 39.51394
Longitude: -121.55776
--
Location: California
Latitude: nan
Longitude: nan
--
Location: Butte County
Latitude: nan
Longitude: nan
--
Location: Paradise
Latitude: 36.09719
Longitude: -115.14666
--
Location: Magalia
Latitude: 39.81211
Longitude: -121.57831
-------
2018-11-09T16:26:11Z
Fire officials have issued evacuation notices for parts of Chico, a
town of 93,000 people north of Sacramento.
People Involved: ['Scott Maclean', 'Kim Kardashian', 'Doug Teeter']
--
Location: Thousand Oaks
Latitude: 34.17056
Longitude: -118.83759
--
Location: Los Angeles
Latitude: 34.05223
Longitude: -118.24368
--
Location: California
Latitude: nan
```

```
Longitude: nan
--
Location: Calabasas
Latitude: 34.15778
Longitude: -118.63842
--
Location: Malibu
Latitude: 34.02577
Longitude: -118.7804
--
Location: Butte County
Latitude: nan
Longitude: nan
-------
2018-11-09T19:26:51Z
A burning sign is seen outside Paradise Skilled Nursing home during
the Camp Fire in Paradise, California, US on November 8, 2018.
People Involved: ['Mark Ghilarducci', 'Gavin Newsom']
--
Location: Paradise
Latitude: 39.75961
Longitude: -121.62192
--
Location: Thousand Oaks
Latitude: 34.17056
Longitude: -118.83759
--
Location: California
Latitude: nan
Longitude: nan
-------
2018-11-09T19:26:51Z
A wildfire that moved so fast that firefighters couldn't hope to sto
p it quadrupled in size Friday after destroying several thousand bui
ldings and leveling much of a Northern California town of nearly 30,
000 people, authorities said.
People Involved: ['Mark Ghilarducci', 'Gavin Newsom']
--
Location: Paradise
Latitude: 39.75961
Longitude: -121.62192
--
Location: Thousand Oaks
Latitude: 34.17056
Longitude: -118.83759
--
Location: California
Latitude: nan
Longitude: nan
-------
```

```
2018-11-09T19:26:51Z
Thousand Oaks, California (Reuters) Officials said fires across Cali
fornia have forced 157,000 people from their homes.
People Involved: ['Mark Ghilarducci', 'Gavin Newsom']
--
Location: Paradise
Latitude: 39.75961
Longitude: -121.62192
--
Location: Thousand Oaks
Latitude: 34.17056
Longitude: -118.83759
--
Location: California
Latitude: nan
Longitude: nan
-------
2018-11-09T22:19:24Z
The location known as "Western Town" is set in the mountains west of
Los Angeles dates to 1927 when Paramount Pictures leased the ranch a
nd began making films there.
People Involved: ['Alyssa Milano', 'Caitlyn Jenner', 'Scott Derricks
on', 'Guillermo del Toro', 'Kim Kardashian West', 'Dick Powell', 'Ra
inn Wilson', 'James Wood', 'Scott Baio', 'Quinn Medicine Woman']
--
Location: Malibu
Latitude: 34.02577
Longitude: -118.7804
--
Location: Calabasas
Latitude: 34.15778
Longitude: -118.63842
```

In [90]:
```
#Get csv of model outputs
all_output.to_csv('model_output2.csv')
```

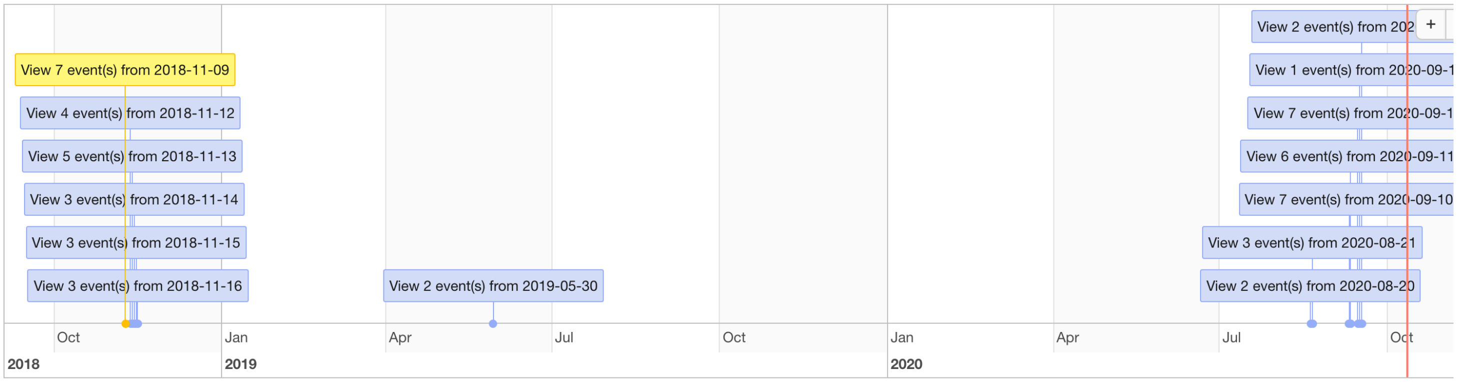
Consume Information

Question 3 - Find interesting ways to show data.

An R Shiny dashboard was created to facilitate consuming information in an efficient, seamless, and organized manner. In addition to organizing events chronologically, a user can interact with the dashboard and understand where events have transpired over time.

Key Events Extraction

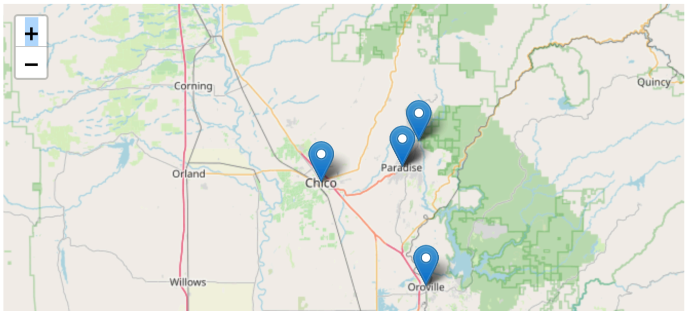
Data was filtered to days where article volume was higher than 3 standard deviations from the mean over all article volume.



Top Events

Time	Event
2018-11-09 02:05:37	A state of emergency has been declared for Butte County due to the effects of the Camp Fire, which began around 6:30 a.m. Thursday and quickly spread, said the California Department of Forestry and Fire Protection, known as Cal Fire.
2018-11-09 02:05:37	About 3,300 students and staff members from Paradise's 11 schools were evacuated in buses and employees' cars to a center in Chico,
2018-11-09 16:26:11	Fire officials have issued evacuation notices for parts of Chico, a town of 93,000 people north of Sacramento.
2018-11-09 19:26:51	A burning sign is seen outside Paradise Skilled Nursing home during the Camp Fire in Paradise, California, US on November 8, 2018.

Top Locations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Willows
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