

#CampFireMissing: An Analysis of Tweets About Missing and Found People from California Wildfires

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ABSTRACT

Several research studies have shown the importance of social media data for humanitarian aid. Among others, the issue of missing and lost people during disasters and emergencies is crucial for disaster managers. This work analyzes Twitter data from a recent wildfire event to determine its usefulness for the mitigation of the missing and found people issue. Data analysis performed using various filtering techniques, and trend analysis revealed that Twitter contains important information potentially useful for emergency managers and volunteers to tackle this issue. Many tweets were found containing full names, partial names, location information, and other vital clues which could be useful for finding missing people.

Keywords

social media, Twitter, missing and found people, California wildfires, disaster response

INTRODUCTION

Natural and human-induced disasters bring challenges and uncertainties among victims and emergency managers. A recent destructive wildfire in California (a.k.a Campfire)¹ started on November 8, 2018, in Butte County, in Northern California later covered the densely populated foothill town of Paradise caused total damage worth \$16.5 billion, destroyed more than 18,000 structures, and at least killed 86 people. In the early days of the fire, among several challenges that formal response organizations faced, the rapid increase in the number of people unaccounted for was a significant concern. The list of missing people once skyrocketed to more than 1,200. This work focuses on the issue of missing people during the California wildfire disaster and analyzes data related to this issue on social media.

People are increasingly using social media platforms such as Twitter during disasters and emergencies. Several research studies have revealed that information available on social media platforms could be useful for a variety of humanitarian purposes (Starbird et al. 2010; Heverin and Zach 2010). For instance, reports of urgent needs of affected people, information about injured or deceased people, reports of damages to the built structure can help formal response organizations enhance situational awareness (Imran, Castillo, Diaz, et al. 2015; Castillo 2016; Alam, Ofli, et al. 2018). Moreover, when official helpline numbers are down or overwhelmed, the general public turns to social media to get the latest updates about an ongoing disaster event to prepare their plans accordingly.

This work seeks to investigate the role of social media platforms, in particular Twitter, during the California wildfire event. Specifically, we focus on analyzing the content of tweets related to missing and found people. To the best of our knowledge, no previous study has analyzed Twitter data in-depth from the perspective of the missing and found people issue, especially during disaster situations, thus it is not known whether and in what form people share information related to this issue on Twitter. For this reason, we first aim to answer the following question. Does

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¹[https://en.wikipedia.org/wiki/Campfire\(2018\)](https://en.wikipedia.org/wiki/Campfire(2018))

Twitter contain information about missing or found people? If the answer to this question is affirmative, we seek to understand what types of information are available on Twitter related to this issue? For example, do people share the names of their family members and friends who are missing? Do they also share location or other relevant information which can be useful in this context? Moreover, we determine whether such information, if present, can be helpful for emergency managers, volunteers, or the family members of missing people?

To answer the above questions, we first select tweets relevant to the missing people issue by applying various filtering techniques on the data collected during the California wildfire event. Next, by identifying trends and spikes which occurred due to high activities on Twitter during the timeline of the whole event, we select tweets from peaks and perform their content analysis. Our analysis reveals that the communications on Twitter during the California wildfire event indeed contain very useful information about missing and found people. We observe tweets with the names of missing and found people. Moreover, several tweets found to have a location and other helpful information such as how the missing person looks like, where he/she was seen last time etc. Such information can be very useful for emergency managers, officials and volunteers who are tasked to find missing people, if identified and processed timely using automatic techniques and systems such as (Nguyen, Joty, et al. 2016; Imran, Castillo, Lucas, et al. 2014).

LITERATURE REVIEW

Over the last few years, social media platforms have been used for several disaster response and management tasks such as situational awareness (Vieweg et al. 2010; Starbird et al. 2010). Research studies have revealed that social media contains a variety of information useful for disaster managers and first responders. This information includes reports of injured or dead people, infrastructure damage, urgent needs of affected people and so on (Imran, Castillo, Diaz, et al. 2015; Castillo 2016). Lindsay 2011 reports the results of a study commissioned by American Red Cross, that social media platforms are the fourth most popular sites which are used by people during a crisis, particularly for information gathering, information sharing, and for help and support purposes.

Although, several empirical analyses from different perspectives have been performed on social media data (Rosser et al. 2017; Wang et al. 2016; Acar and Muraki 2011), to the best of our knowledge no previous work has focused on studying the issue of missing and found people during natural or human-induced disasters. A recent study, which is not disaster-related, conducted by Tsoi et al. 2018, explored the effectiveness of Twitter to find missing persons suffering from dementia (a syndrome leading to progressive cognitive functional loss). The study showed convincing results, concluding that Twitter can also be helpful like traditional news reports in searching a person who got lost due to dementia (Kirkman 2006; Rowe et al. 2011). In an other study conducted by Hunt et al. 2010, the authors discuss the outcomes which can be witnessed if a driver suffering from dementia gets lost. The authors in this study accessed reports of lost drivers given by newspapers and media and concluded that patients who are lost while driving can face tragic incidents leading to death.

In this paper, we use Twitter to explore a potential issue of missing people during disasters and emergencies. We aim to analyze Twitter data shared during a wildfire event to determine whether the general public report about their missing family and friends or not. Moreover, we seek to understand what are the most prominent types of information available on Twitter related to the issue of missing and found people. We believe this study serves as a piece of foundational evidence to the research community to explore further and develop computational systems for the mitigation of this issue.

METHODOLOGY

To investigate whether Twitter data can be helpful for the missing and found people issue, we devise a methodology consisting of four steps. First, we collect Twitter data using a set of keywords during the California wildfires event. Next, we apply different filtering approaches to select the most relevant data to the issue of missing people. Third, we perform a trend analysis by plotting the frequency of tweets throughout the event and identify spikes. Lastly, we perform the content analysis of tweets taken from spikes and peaks. We describe these steps in detail in the following subsections.

Data filtering

Three types of filters are used to select relevant tweets. Specifically, in the first filter, we consider tweets mentioning the names of missing or found people; second, tweets containing particular hashtags related to the missing people issue; and the third filter selects tweets having keywords/terms related to this issue. To find tweets containing names, we first curate a list with names of missing and found people by manually searching different lists on the Internet at

the time of data analysis (i.e., January 2019). To find tweets containing hashtags relevant to the missing or found people issue, we first extract all the hashtags from our data and then manually search through them to find the relevant hashtags. To find tweets using keywords/terms relevant to the missing and found people, we first manually curate a list of terms and then search tweets containing one of those terms.

These three data filtering steps, which we describe in detail in the next section, are applied to the whole tweets set to extract tweets relevant to the issue of missing or found people. All of our further analysis uses the selected tweets.

Data analyses using emerging trends

Social media communications, in particular, Twitter, have reached unprecedented levels. Millions of users post tweets to report their thoughts, events around them, and breaking news. Each tweet is associated with a timestamp (i.e., the date and time when the tweet is posted), a user (i.e., the author of the tweet), and a short text, among many other meta-information. When a large number of Twitter users start posting about a similar topic (e.g., using a hashtag) at a given time/day, it becomes an emerging topic, which is also known as a trend on Twitter. Research studies have revealed that emerging topics often represent significant developments about an ongoing event and a real-time analysis of them can help understand the situation.

To identify significant moments during the California wildfire event, we plot day-wise distributions of both the original tweets and retweets retrieved after the data filtering steps (as described above). The emerged trends give us times and a subset of data where any significant activity happened during the wildfire event. We then closely analyze those trend and spikes to lay down our findings.

DATASET AND DESCRIPTION

Data collection

Twitter data: To collect data from Twitter during the California wildfire, we used the AIDR platform (Imran, Castillo, Lucas, et al. 2014), which is a free and open platform to collect and classify social media data for humanitarian purposes. In total, we collected approximately 4.8 million tweets from November 10, 2018, to December 7, 2018, using keywords “*California wildfire, California wildfires, California fire, California fires, Camp fire, California victims, California rescue*”.

Finding names of missing and found people (ground truth): One of the most important clues to determine whether a tweet is about any missing or found person, is to detect if the tweet contains the name of a person who is declared missing or found in an official list. With this hope that people mention the names of their loved ones who are missing in their tweets, we searched for records of missing or found people names on the Internet. The search result revealed a couple of lists shared by different sources including official, media, and volunteers. These lists contain names of missing and found people and were posted on various dates during the wildfire event. Many names were found redundant; thus we compiled a consolidated list having unique names. We include full names (i.e., when first and last names are available) and partial names (i.e., when either first or last name is present) in the final list of unique names. The consolidated list contains 4,167 unique full names and 3,363 unique partial names and referred as the Internet list in the rest of the paper.

The datasets used in this paper are available at: <https://CrisisNLP.qcri.org/>

Data filtering and selection

Since the focus of this work is to analyze tweets related to missing and found people, we apply various filters to select the data associated with this issue. Next, we provide details of these filters.

Name-based filtering

This filter aims to select tweets which contain one or more full or partial names of missing or found people. For this purpose, we use the Internet names list to find tweets which match any of the names. Due to some partial names like “Shell”, “Donald”, “Have” etc., a large number of tweets are retrieved. We further reduced this set by discarding exact duplicates. This filter yields 306,198 tweets in total from which 409 tweets were found to have at least one full name and 305,789 with at least one partial name.

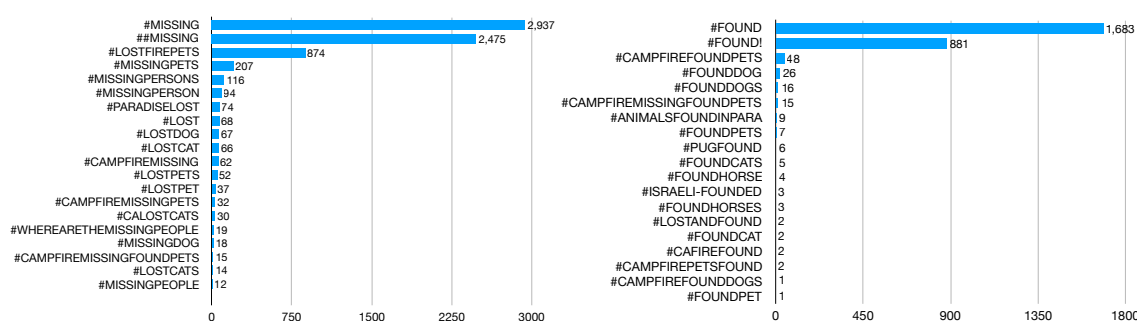


Figure 1. Top hashtags related to the missing (left) & found (right) people/pets issue

Hashtag-based filtering

Hashtags on Twitter allow users to tag a tweet with one or more topics. Famous hashtags start appearing on Twitter trends, which then allow users to search through related content easily. For example, #CampFire was one of the most used hashtags during the Campfire (California wildfires) event. To determine hashtags related to the missing and found people issue, we first extract all the hashtags used in the collected data. Hashtags related to the missing and found people issue are then manually selected from the list of extracted hashtags. In total, 63 hashtags were selected pertaining to missing-related and 19 to found-related tweets. Figure 1 shows the top 20 hashtags and their frequencies for both missing and found people and pets. Next, we find tweets containing at least one of the selected missing or found hashtags. This filter yields a total of 7,404 tweets having at least one of the missing hashtags and 2,720 tweets with at least one of the found hashtags. The complete list of hashtags are provided with the shared data.

Keywords-based filtering

After selecting tweets which fulfill the above two selection criteria, we may still miss tweets which are relevant but not mentioning any names or one of the selected hashtags. To overcome this potential issue, the third data selection strategy tries to find tweets based on keywords/terms related to the missing or found people issue. We use the following terms for this purpose. Missing-related terms: “missing, search, searching, finding, find, looking, heard, contact” and Found-related terms: “found, safe, update, located”. Next, tweets having one of these terms are selected, which were 144,113 for the missing case and 61,072 for the found case.

After removing the exact duplicates, the resultant set from all of the above filters consists of 340,452 tweets. We use these tweets for our further analysis.

TREND ANALYSIS

Trends related to the names of missing and found people

Figure 2 shows the day-wise distribution of the tweets and retweets containing at least one full name (left-side plot) and one partial name (right-side plot). Generally, on Twitter the proportion of retweets to tweets is always higher, we observe the same pattern in the case of missing and found people tweets in the both full names and partial names cases. Trends and spikes help find significant developments. In this case, the two obvious spikes of the retweets containing the full names are on November 11 and on November 25. We closely investigate these two dates and found the following important reports.

On November 11, a total of 72 tweets and 644 retweets were posted which were having at least one full name from our list. The following tweet about a missing person named “Barbara Carlson” was posted on November 11 at 00:08:15 2018², which received 322 retweets on the same day.

“HELP: my grandma (Barbara Carlson) and her dog (strawberry) are missing in the Camp Fire in paradise! My dad and I have been searching refugee camps with no luck. Her address is 5577 heavenly place, paradise California. We believe SHE IS STILL IN THE HOUSE.”

The tweet clearly mentions the name of the missing person, and in this case the name of the missing pet too. Moreover, the tweet author specifies the address of the missing person. Several hours later on the same day at 05:01:05 2018, the following tweet about the same person was posted by another Twitter user.

²The time zone of all the times mentioned in this paper is UTC.

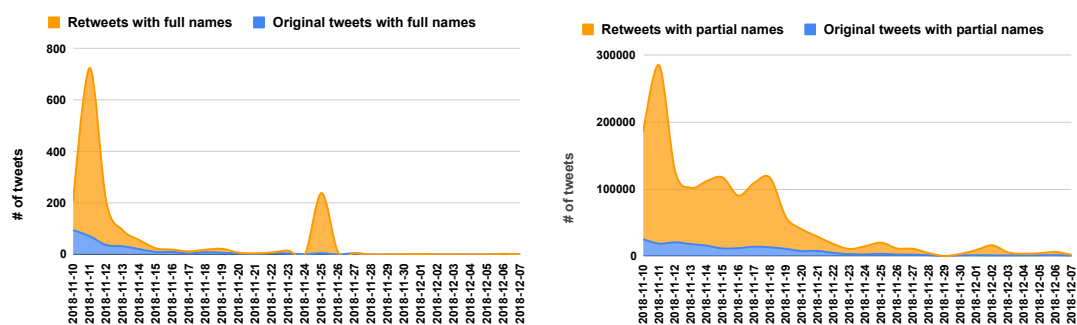


Figure 2. Distribution of tweets with at least one full name (left) and at least one partial name (right)

"The family of Barbara Carlson, who lived on Heavenly Place in Paradise with her sister Shirley and dog Strawberry, are still looking for her. She's 4'11 with gray peppery hair, freckles on her face and glasses. CampFire".

This tweet contains more information about the missing person i.e., the missing person lives with her sister and is 4'11 with gray peppery hair, freckles on her face and glasses. These are all important pieces of information useful for emergency officials and volunteers who are tasked to find missing people.

An update in the form of the following tweet came on November 12 confirming the sad demise of Barbara Carlson and her sister.

"Thank you for all the amazing support from everyone. We got confirmation the house where my grandma and her sister lived had two bodies found today. Barbara Carlson and Shirley Haley were two loved victims of the camp fire."

On the same day, we found several tweets (see below a few cases) reporting missing people and asking help.

T1: "Camp Fire Paradise, CA Missing Marc Handschuh who knows him, and has seen in the last few days, or has contact with him and Christina - Please let us know, we miss him"

T2: "@975krock @hitsfm @VOCMOpenline former coworkers please pray for my Uncle Randy Dodge who is still missing in the Paradise California fires! If you have any connections in the area please let me know. His house has burned down and we have called everywhere!"

T3: "We are looking for Tracey Philipson. If you have any information please contact"

T4: "A son looking for his mother, Barbara Allen who is well-known in Paradise, asked for help at the Camp Fire community meeting held at Chico State Saturday evening."

Moreover, we observe tweets about found people on the same day. For example, "Martin Sheen", who went missing in the early days, is reported found on November 11 in this tweet:

"Martin Sheen has been found after his son Charlie Sheen feared he had gone missing in the devastating wildfires in Southern California."

Another tweet about a found person came like this: "FOUND- Dan Sloane Camp Fire has been located and is safe with his two dogs."

A relatively small spike on November 25 also reveals important updates. One tweet that received more than 100 retweets out of all 208 tweets posted on that day was the following reporting several still missing.

"Soon Warner would discover that no one knew where his uncle Greg Rader, his aunt Michelle Sherman, his grandma Anne Thomas Sherman or his grandpa Fay Hubert Sherman were. His 96 yr old Grandpa was a WW2 Vet and was still living with his wife in Paradise."

Similarly, the following tweet posted on November 25 reports about a person (Sheila Santos) who was still missing several weeks after.

"STILL MISSING: Sheila Santos of Paradise. campfire campfiremissing campfirejameswoods"

We try to look back into our data and found that the first report about "Sheila Santos" came on November 13 in the form of the following tweet.

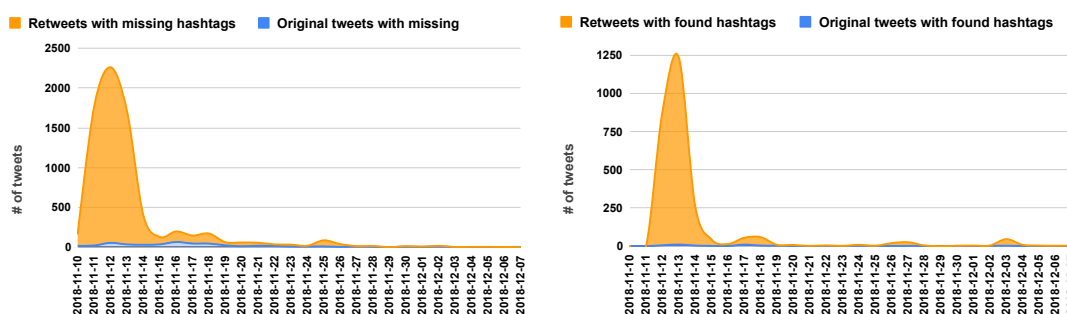


Figure 3. Distribution of original and retweets with missing hashtags (left) and with found hashtags (right)

"The last time anyone spoke to Sheila Santos, she was still groggy from sleeping pills. By that point the CampFire had already swept through town, and the roads leading to her Paradise trailer were closed."

The final update (see the following tweet) about "Sheila Santos" came on December 1 when sadly she found dead.

"Sad to report that, Tammie Konicki just learned that her mother's remains were found. Sheila Santos, 64, was another person killed in the state's deadliest and most destructive wildfire. CampFire @vicenews"

Overall, the spike on November 11 mainly represent several tweets and retweets of missing people. As time passes, the activity on Twitter reduced. However, on November 25, tweets with full names of missing and found people suddenly picked up. This was due to the sharing of missing and found people list by Sheriff around those days.

Several spikes appear on the right-side plot of the figure 2, which shows the distribution of tweets and retweets containing partial names. These spikes also reveal many important but similar updates³ as in the case of the tweets with full names. However, we observe that partial names filter bring more noise than the full name filter. Hence, we recommend officials and automated system developers to first focus on analyzing tweets containing full names, as during a disaster situation both time and resources are usually scarce.

Trends related to the hashtags

Another convenient way to find updates about a specific topic on Twitter is through hashtags. Figure 3 shows the day-wise distributions of the tweets containing one of the missing hashtags (left-side plot) and found hashtags (right-side plot) from our selected hashtags.

In the case of missing hashtags, a big spike appears on November 12 followed by three, comparatively, small spikes on November 16, 18, and 25. On November 12, the following tweet from a daughter about her missing mother received several retweets.

"#Paradise #ParadiseFire #ParadiseLost #ParadiseEvacuees My mother lives in Magalia and I have not heard from her since the Camp Fire in Paradise started. We are searching all the shelters from Sac to Chico. Please share this post and pray that we can find her"

The tweet contains several hashtags, which is one of the reasons it reached to a broader audience. However, we found it using the #ParadiseLost hashtag. The tweet text does not contain the name of the missing person, however the name and a contact number are given in a photo attached to the tweet. Such cases signify the importance of analyzing other content types such as images, however this work only focuses on textual content analysis.

We observe several tweets about missing and found pets on the days with high tweets activity. People used different hashtags such as #CALostCats, #LostPet, #MissingPet, etc. to report about missing or found pets. Moreover, a large number of tweets found to give suggestions to the families of missing people to particular hashtags or follow particular Twitter users as doing so may help find their loved ones quickly. For instance, look at this tweet which suggests to follow the Twitter account of James Woods⁴, a Hollywood star. "Please follow @RealJamesWoods as he helps find the missing lost in the CaliforniaWildfires use hashtags..."

During the wildfires, James Woods, through his Twitter account, invited people to use the hashtags #CampFireJamesWoods and #SoCalFiresJamesWoods to post the names of missing family members and friends. He then shares the

³Notice that we omit several details due to the space limitations

⁴https://en.wikipedia.org/wiki/James_Woods

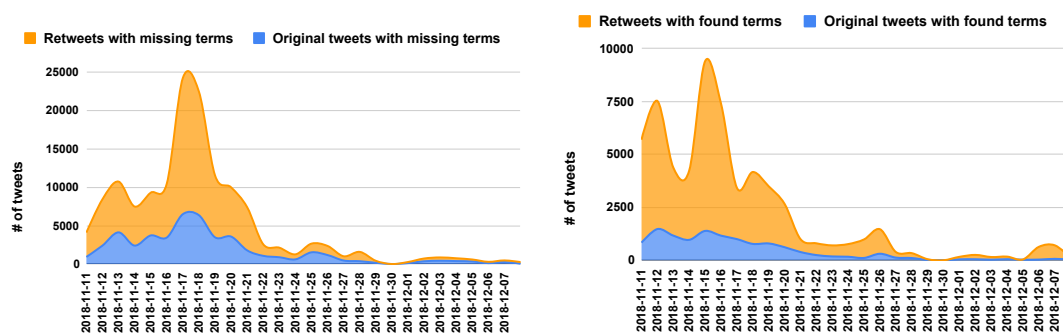


Figure 4. Distribution of original tweets and retweets with missing related keywords/terms (left) and with found related keywords/terms (right)

message to his more than 2 million followers. The following tweet was posted by James about lost horses, which were later found.

She needs help with five horses. It was previously reported that her horses had been evacuated, but she says that did not happen. Please contact her at @Alyssa_Milano to get her location or use my hashtag #SoCalFiresJamesWoods This is a serious request.

Another observation is that the tweets selected using hashtags contain more noise than the tweets selected using people names (as described above). For instance, many tweets containing missing or found-related hashtags, appear to provide general updates about this issue, e.g., see this tweet: “More than 200 still missing in California’s deadliest wildfire on record blaze...”

Moreover, many irrelevant tweets were found in which one of the relevant hashtags is used, but the tweet content is not related to the missing or found context.

Trends related to the terms

Figure 4 shows the day-wise distributions of the tweets and retweets obtained from the keyword-based filter.

One obvious observation, which is also consistent with names and hashtags trend analysis, is that the frequency of retweets increases with an increase in the frequency of original tweet. Several spikes emerged in both of the plots. In the case of missing-terms (left-side plot), spikes on November 13, 17, 18, 25, and 28 are visible. The largest activity was recorded between November 17 and 18 when 25k tweets were posted.

The tweets selected using keywords/terms contain more noise than the tweets selected using the names and hashtags. Terms such as “heard, safe, and contact” retrieved more off-topic results. Moreover, the term “Update” observed to retrieve tweets with general updates about casualties, damages, and missing people. However, rest of the terms yield many relevant results.

On November 13, we observe many general updates about various issues such as reports of deaths, ongoing humanitarian and search activities, reports of missing people and pets. Below are a few tweets from this day.

- T1: “RT @blkahn: BREAKING: The Camp Fire is officially the most deadly fire in California history. 42 dead, hundreds still missing”
- T2: “BSG Teams search for bodies in California after wildfire claims 42 lives”
- T3: “As of yesterday the death toll of CampFire has risen to 42, with more than 200 people still missing”

During November 17 and 18, which is the period with largest Twitter activity, many tweets report about the increase in the winds. The Santa Ana winds gained much higher speed, resulting in spread of fire, and increase in casualties. We show a few related tweets below.

- T1: “California fires: death toll rises to 76 as winds threaten efforts to control blaze .wow. From 700 missing yesterday to 1300 now.”
- T2: “At least 44 people are dead and more than 200 remain missing as two massive wildfires, fueled by easterly winds and a historic drought, continue to rage in California.”
- T3: “As the death toll and number of missing people rises, firefighters in Northern California are

bracing for strong winds that could erode the progress they made on the deadliest fire in the country in at least a century."

T4: "RT @CTVNews: California fire latest: 76 dead, 1,300 missing and strong winds causing concern"

Furthermore, two relatively small spikes appear on November 25 and 28. Tweets posted on November 25 mainly contain general updates about the event, victims, and a few referring to people who are still not accounted for. However, many observed as less relevant to the context of missing and found people.

T1: "although the fires are contained the search for missing individuals continues hope this will be the last of these.."

T2: "authorities are still struggling to find human remains in magalia california after the horrible wildfire"

Figure 4 (right-side plot) shows the distribution of tweets containing any found-related terms. We observe spikes on November 12, 15, 16, 18, 26, and between December 6 and 7. On these days, again we observed many tweets reporting general updates about death toll, number of missing people, and showing their concerns. On November 12, a tweet giving general updates: "RT @stacos: BREAKING UPDATE: Death Tolls rise to 31, and hundreds still missing in California Wild Fire". On November 15 a tweet with updates: "California's deadliest fire: 13 more victims remains found ..".

Mostly tweets on November 16 and 18 talk about deceased and people who are still missing. Below are few examples.

T1: "At least 63 are now dead from the Camp Fire in Paradise, Calif. Officials say they have a missing persons list"

T2: "According to the Butte County Sheriff, an additional five human remains were found on Saturday, four in Paradise"

T3: "RT @DailyMail: At least 74 people have died in California wildfires as more than one thousand people are feared missing"

Many irrelevant tweets were found on November 26, December 6 and 7. Some generally discuss the event, victims, and response efforts from officials.

DISCUSSION & FUTURE WORK

This work analyzed the Twitter data posted during the 2018 California wildfires to investigate the types of information shared related to the issue of missing and found people. The analysis revealed that the tweets posted during the event contain important information in the forms of full names, partial names, locations, etc. about the missing and found people.

Around 400 tweets were found containing full names and about 300k tweets with partial names of potentially missing and found people. However, tweets with full names were found on-topic and considered more relevant to this issue compared to the tweets with partial names. Many partial names search retrieved tweets containing famous people names such as Donald Trump and other celebrities. The analysis revealed that people share names with different spellings, perhaps due to reasons such as interpreting and writing using phonetic knowledge, misspellings, typos, and sometimes using the auto-correct feature in mobiles. Officials and emergency managers can use tweets with names to help find missing people.

Furthermore, tweets selected using the related hashtags contain less noise than the tweets selected using the keywords/terms. Tweets of missing or found people with popular hashtags likely to receive more retweets. Moreover, tweets mentioning a famous Twitter user, as seen in the case of James Woods in this study, help spread the message quickly. The hashtags trend analysis revealed that many tweets report a missing person without explicitly mentioning a name. However, sometimes the names are found in an attached photo. Both hashtags and terms tweets contain general updates such as death toll, missing people count.

Although, our analysis revealed that Twitter contains useful information about the issue of missing and found people, performing manual analysis to identify relevant tweets is not a feasible option due to the sheer volume of data on Twitter. Therefore, we suggest developing or extending existing systems (e.g., AIDR (Imran, Castillo, Lucas, et al. 2014)) which can process and classify data in real-time to predict whether a tweet is about missing or found people issue or not. Moreover, automated solutions and systems to automatically detect tweets with names and locations, e.g., using named-entity recognition techniques need to be developed. Furthermore, we remark that incorporating images shared on social media related to the issue of missing and found people can substantially help concerned authorities to find missing people. Automatic image processing for this purpose would need extending existing techniques in this domain e.g., (Nguyen, Alam, et al. 2017; Alam, Imran, et al. 2017). We aim to work on these directions and develop needed solutions in the future.

CONCLUSIONS

This work analyzed Twitter data shared during the 2018 California wildfire event to investigate whether family and friends share information about their missing loved ones and whether that information can assist officials finding those missing people. Various filtering techniques were employed to select potentially relevant data. Moreover, a trend analysis of around 300k tweets was performed to investigate large activities during the timeline of the event manually. The analysis revealed that indeed Twitter contains various types of useful information about missing and found people. The study found that tweets containing the names of missing and found people, their last known locations, how they look like, etc. can provide vital clues to official responders to mitigate the issue of missing people. However, to achieve this goal, automatic systems need to be developed, which we consider as a future work.

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