Effectively Leveraging Social Sensors and Machine Learning for Event Detection During Crisis Situations

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1 Incorporating Content Beyond Text: A High Reliable Twitter-Based Disaster Information System

Reference

Hou Q., Han M. (2019) Incorporating Content Beyond Text: A High Reliable Twitter-Based Disaster Information System. In: Tagarelli A., Tong H. (eds) Computational Data and Social Networks. CSoNet 2019. Lecture Notes in Computer Science, vol 11917. Springer, Cham. https://doi.org/10.1007/978-3-030-34980-6_31

Short Summary

This paper presents a multimodel pipeline which combines textual and graphical information, creating a more comprehensive framework for event detection during crises. Google Vision AI is used to capture and label the content of the image. The image model is then integrated into the text-based prediction to validate the results. The text classifier achieves an F-Score of 0.92, and their image classifier achieves 90% accuracy.

Why did I read this paper?

Incorporating graphical data is a novel idea within event detection which piqued my interest.

Personal view of the paper

Initially, the paper comes across very comprehensively, on a closer look the work they have contributed is very narrow and may not be applicable.

What problem does this paper address?

They are improving the accuracy of event detection by incorporating another dimension of data.

Is it an important problem?

More research toward utilising graphical data into event detection is needed. This is echoed by the 2019 review discussed below.

What is the significance of the result and its solution?

Their findings demonstrated that incorporating image data could considerably reduce false positive events and subsequently improve the accuracy of event detection.

What are the claimed novel contributions of the paper?

While there is a growing body of research into textual models, this paper is the first that investigates the incorporation of graphical data.

What previous work is the basis for this research?

There has been a vast body of work published over the past five years into event detection. This paper relies on that body of work, learning on work which combines addition to social media such as McGough et al. Who improved the accuracy of Zika incidence forecasting by incorporating news sources.

What methodology has been used?

The proposed architecture retrieves the tweets, sanitises and geo-tags them before passing them to a pre-trained text classifier which categorises them. A feature vector is created using pre-trained models from Google, before being passed to SVM for classifications.

A 'Detector' component is then used to group the geotagged tweets and label them. A fine-tuned pre-trained deep network then classifies the images from tweets and is used to reject or confirm events.

Does the methodology seem appropriate for this problem?

The paper makes a solid attempt to reduce the noise and filter the data, but then the lack of standardisation in the text retrieval reduces the usefulness of the results.

What conclusions are drawn from the results?

Incorporating graphical information and utilising it to reject or confirm detected events can improve the accuracy of existing classification methods. Ultimately enabling aid-responders to work more effectively, reach people quicker, and lower the human toll of crises.

Are they valid?

Very few studies use multimodel methods incorporating graphical data to improve accuracy, possibly due to the resources required, different paradigms of mining techniques. While its difficult to tell if these results are valid due to the variability of Twitter and scope of this paper, incorporating image data is likely a good, future step for crisis event detection. The

What did I learn?

At the time, there was very little research into this specific task. Providing a deeper understanding of how the problem can be compartmentalised and extended.

What (if anything) would I have done differently?

The image classification used seems reasonably rudimentary, labelling images which depict crisis events literally. More sophisticated methods such as analysing the contextual meaning of images used may provide even more significant gains in detection. While the paper is a few years old and the datasets were nowhere near today's standards, if this experiment were to be repeated today, it should be done in alliance with one of the significant initiatives - likely the CrisisMMD (Multimodal Crisis Dataset).

2 Mining crisis information: A strategic approach for detection of people at risk through social media analysis

Reference

J. Rexiline Ragini, P.M. Rubesh Anand, Vidhyacharan Bhaskar, Mining crisis information: A strategic approach for detection of people at risk through social media analysis, International Journal of Disaster Risk Reduction, Volume 27, 2018, Pages 556-566, ISSN 2212-4209, https://doi.org/10.1016/j.ijdrr.2017.12.002.

Short Summary

This paper presents a hybrid method which combines rule-based methodology, linguistic features and machine learning for classifying calls for help on social media into categories for first-responders. This rule-based methodology (RBM) is utilised alongside linguistic features (LING) to sanitise the tweets from crisis events, removing those who are narrating the events.

Why did I read this paper?

Event detection utilising machine learning on Twitter has exploded in the past five years, due to the inherent downfalls in the data, there is a big push to build accurate prediction algorithms. This paper, published in 2018 is one of the most significant in recent years.

Personal view of the paper

The hypothesis itself is sound, and likely a positive contribution to event detection during a crisis. The small datasets, however, limit the practical use of these findings.

What problem does this paper address?

Leveraging the data effectively in order to improve the classification of calls-for-help during crisis events

Is it an important problem?

Ensuring first-responders have access to the correct people is a pressing issue in this area. First-responders tend to value recall over precision. They would rather have a human annotator quickly dismiss a relevant tweet than miss any.

What is the significance of the result and its solution?

Adding modules like this to our event detection system could increase response and ultimately, reduce casualties.

What are the claimed novel contributions of the paper?

While previous work has analysed the sentiment of the entire tweet stream, this hybrid method instead uses sentiment analysis on tweets already identified as calls-for-help and classifies them into positive and negative.

What previous work is the basis for this research?

Learns on the work by Joachims et al. to justify the use of Support Vector Machine (SVM), Kamal et al.

What methodology has been used?

Several different combinations of their hybrid method are examined in a comparative analysis to determine the one that leads to the highest accuracy. A tweet stream is filtered by keywords, of which 32 are identified manually as being from people trapped. Given this minuscule dataset, a questionnaire mimicking the disaster environment was distributed among students at University. Commissions have been made for people typing panicked state.

Does the methodology seem appropriate for this problem?

They have used a relatively small dataset (140,000) tweets and are forthcoming about the reduced accuracy on foreign tweets. However, it is not entirely clear at how a questionnaire mimicking a disaster could provide comparable data. Relies on rudimentary techniques based on location data, assumes that geoannotated data is likely to grow. However, the reference cited for this claim only appears to discuss the use of said data, rather than any potential future upticks in availability.

What conclusions are drawn from the results?

Using a combination of their predefined rules, feature extraction alongside linear SVM improves the granularity of the data, sanitising the data for first-responders, ultimately lowering the casualty rate as they can more effectively respond to calls-for-help.

Are they valid?

By applying the hybrid pipeline, they were able to improve their measured value by 10%, a notable improvement. However, it is unclear how well this system will perform on other datasets.

What did I learn?

This paper provides insight into the challenges in crafting a 'general' model for crises detection under the unstructured nature of Twitter.

What (if anything) would I have done differently?

Utilising a model from a recent review which has already been evaluated would demonstrate the effectiveness more rigorously would allow for a more general comparison between methods.

3 Incident Streams 2019: Actionable Insights and How to Find Them

Reference

McCreadie, Richard, Cody Buntain, and Ian Soboroff. "Incident Streams 2019: Actionable Insights and How to Find Them." Proceedings of the International ISCRAM Conference. 2020.

Background

Text Retrieval Conference Incident Streams (TREC-IS) is a global initiative to improve event detection by developing annotated data and evaluating various techniques and methodologies to improve detection of real-time calls-for-help during emergency events. During the past three years, there have been four editions, generating over 125,000 labels across 33 events.

Short Summary

This paper gives an overview of the 2019 edition of TREC-IS with an analysis of techniques used by participants. This analysis is used to provide an overview of the current state-of-play and

Why did I read this paper?

This paper is the most published in the TRECIS series and provides the most up-to-date information regarding the techniques and methods used by the participants.

Personal view of the paper

This standardisation is much needed within this area; this paper provides a comprehensive analysis of the various state of the art techniques, providing a springboard for future research.

What problem does this paper address?

The TREC-IS event is an initiative that aims to develop test collections and bring standardisation to the categorisation of calls-for-help made on social media. Incorporating re-occurring data challenges in which developers and researchers can participate, creating a comparison of state-of-the-art systems.

Is it an important problem?

This research area still in its infancy feels very disjointed; the standardisation this paper attempts to bring is much needed.

What is the significance of the result and its solution?

In tweets that were labelled 'critical' priority, there was a greater incidence of linked content and mentions of location.

What previous work is the basis for this research?

This study is an update to the results of the annual TRECIS competition,

What methodology has been used?

The work uses a manually annotated ground-truth datasets which participant results are evaluated against to provide a comprehensive analysis.

Does the methodology seem appropriate for this problem?

Using labelled ground-truth data is a concrete way of verifying successful classification, often avoided due to the lack of annotated data or resources to create it.

What conclusions are drawn from the results?

The authors outline some 'guidance for future systems' allowing researchers to utilise their work. Deep learning significantly outperformed classical methods.

Are they valid?

It is noted that the performance of deep runs may have been impacted by the addition of large sets of training data to their judging pools.

What did I learn?

Research seems to be slowly shifting towards utilising Deep Learning exclusively due to the increased effectiveness.

What (if anything) would I have done differently?

While not directly related to the methodology, attempts to expand the target audience from researchers working in the field into a more public 'Hack this problem' type of task may widen interaction and accelerate research. The supplied data feel somewhat disjointed to a novice in event detection; this area has many ambiguous definitions, further adding to this inherent confusion in the vast, noisy datasets.

4 What's Happening Around the World? A Survey and Framework on Event Detection Techniques on Twitter

Reference

Saeed, Z., Abbasi, R., Maqbool, O., Sadaf, A., Razzak, I., Daud, A., Aljohani, N.R., Xu, G. (2019). What's Happening Around the World? A Survey and Framework on Event Detection Techniques on Twitter. Journal of Grid Computing, 17, 279-312.

Short Summary

This 2019 survey proposes a framework based on research trends, challenges, standard practices, and techniques used for event detection on Twitter. It discusses the shortcoming of existing techniques as well as possible solutions to address them.

Why did I read this paper?

This paper was reviewed under the understanding that it was the most comprehensive overview to-date on event detection.

Personal view of the paper

Does not contribute much to the progression of this area but gives a good summary.

What problem does this paper address?

This survey was published to consolidate the state-of-the-art research.

Is it an important problem?

Previous to this, the last comparable survey was in 2016. Given the rapid development in this area, these papers are critical every few years to push research forward.

What is the significance of the result and its solution?

There is a research gap concerning multilingual content. Event detection techniques must be capable of coping with the diversity of different types of events on Twitter.

What are the claimed novel contributions of the paper?

It presents a model framework *(EDoT)* based on best practices.

What methodology has been used?

Critically analyses the models, techniques, case studies and benchmarking used in event detection.

Does the methodology seem appropriate for this problem?

It reviews the existing data, systematically evaluating each method and seems reasonably rigorous.

What conclusions are drawn from the results?

That there are still significant opportunities to develop existing event detection techniques as well as the incorporation of new dimensions of social and tradition media to improve results.

What did I learn?

Gave a greater understanding of the state-of-the-art techniques used in event detection research.

5 What happens where during disasters? A Workflow for the multifaceted characterisation of crisis events based on Twitter data

Reference

Kersten, J, Klan, F. What happens where during disasters? A Workflow for the multifaceted characterisation of crisis events based on Twitter data. J Contingencies and Crisis Management. 2020; 28: 262 280. https://doi.org/10.1111/1468-5973.12321

Short Summary

This paper looks into the design and evaluation of a general workflow for Twitter data analysis using state-of-the-art deep learning and clustering methods.

Why did I read this paper?

I was able to set up a tool scrape Google Scholar by keyword output to a spreadsheet sorted by citation count which led to the discovery of this comprehensive review paper published two months ago, specific to crises detection.

Personal view of the paper

Provides a rigorous overview along with a supporting model which is built based on the best practices.

What problem does this paper address?

The paper proposes a workflow to gather both large-scale and local natural disaster events from Twitter data.

Is it an important problem?

While the novel contributions are sparse, papers like this make the body of work more cohesive and push research forth.

What is the significance of the result and its solution?

This framework is significant as a starting point for further experiments and research. Having a general classifier which works universally at some level and then can be further tweaked would provide much-needed unification to the area.

What are the claimed novel contributions of the paper?

Aims to bring some cohesion around the workflow for event detection problems.

What previous work is the basis for this research?

This survey encompasses previous work in event detection, due to the scale of this research area, subsections such as crisis detection are not included.

What methodology has been used?

The study utilises a variety of agile and flexible analysis methods,

Does the methodology seem appropriate for this problem?

The authors take a systematic approach and evaluate various popular methods in this area. This methodology provides the flexibility in the system, making it adaptable to additions. The omission of references to some of the notable papers in crises detection draws the comprehensivity of this paper into question.

What conclusions are drawn from the results?

That there are immense opportunities to improve various techniques used in event detection. The paper concluded by discussing the shortcomings of the existing techniques, alongside solutions which could be utilised to address those limitations.

What did I learn?

This paper provides a fairly in-depth review which provides reasoning and context to the shortcomings. Notably, this paper went into a bit of detail about the issues with multimodel detection, and the reasoning for the lack of research to support it.

What (if anything) would I have done differently?

Packaged and published the code built during research to create a springboard for further research and analysis.

6 Literature Review

Event detection is a multifaceted problem within the sphere of Natural Language Processing and Machine Learning that poses significant challenges. It is plagued by an ambiguous problem definitions and the dynamic, noisy nature of the data involved.

Event detection can be utilised for a variety of tasks from surveillance, monitoring or even observing human behaviour. Utilising event detection to identify calls-for-help during crises is a pressing problem with much research dedicated toward it in recent years. Accurate classification can reduce the effort needed by first-responders to more effectively locate those in need of help. While this problem appears well-defined at first, language variety, linguistic challenges and inconsistent labelling lead to an ambiguous problem definition, making the comparison between results from research difficult. Most of the work so far focuses predominantly on Twitter, likely due to the ease of data access. The dynamic and noisy nature of the data retrieved from Twitter has posed significant challenges during analysis over the years. Several studies rely on manually annotated data, a laborious task which produces limited data in order to filter out the irrelevant content on Twitter. Of which rumours and 'babbles' make up as much as 40%

Many existing techniques rely heavily on data that is geotagged; however, only about 1% of tweets contain this information in real-sue scenarios. The area would benefit considerably from classification methods that determine the location for non geotagged tweets based on other characteristics and contextual information.

Graphical data has mostly been ignored; however, an exciting development in this area is CrisisMMD (Multimodal Crisis Dataset). This classification technique could potentially be implemented in future for other tasks in crises detection such as determining the degree of destruction during the aftermath. There has been relatively little consideration placed so far is how events evolve. New techniques which analyse the spatiotemporal development of crises, utilising clustering methods to classify novel developments and sub-events is a promising avenue of future research.

With the exception of some efforts by large countries like China, there is very little research into general multilanguage models which classify based on non-textual features. Ignoring the issue of detecting events outside English-speaking countries, this disregards any non-natives who may be in need of help during an emergency.

Much of the existing work spends a considerable amount of time filtering and grouping tweets, but struggle to define these concepts clearly. Data limitations, linguistic barriers, and the subjectivity of the human language make this an incredibly complex task with much work still needed to create a general classifier. Great strides have been made the past few years, the emergence of "human-in-the-loop" and incorporation of linked-data in the following years within systems that are used in real-world scenarios will provide ample opportunities to improve our detection and ultimately lower the casualty rate of natural disasters.