

Social Media Analytics: An Overview of Applications and Approaches

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Abstract: Users' activities on social media generate useful and valuable information about the general public that can be used in policymaking and the decision-making processes. In this paper we review social media analysis approaches and its' application areas by sampling and reviewing studies from IEEE Xplore, Science Direct, and SpringerLink. The primary focus of this paper is on the role of social media data in extracting, tracking, and evaluating general public activities, public opinions, and public behaviour. We look at several application areas, including disaster, urban planning, public health, politics, business, and marketing. The frequently used approaches in these areas are topic analysis, sentiment analysis, social network analysis, spatial and temporal analysis. Moreover, this study provides insight for those who wish to learn about social media's role as a data source for research related to our real-world issues and events.

1 INTRODUCTION

Through social media platforms, people can share their ideas, thoughts, feelings, pictures, and videos about different subjects and interact with other people. People's social media activities generate valuable data that can be used to discover users' behaviours, thoughts, emotions, and interactions. Recently there is a growing trend in using social media data in different research areas; also, this data has attracted the attention of many research fields related to real-world issues and events.

"The process of gathering data from social media and analysing them to help decision-makers address specific problems" is called social media analytics by Lee, I. (Lee, 2018). Social media data can be considered a data source for data-driven research. This data will help researchers gain information about the general public and apply the information to improve the quality of decisions and policies related to the general public issues and business goals.

Some review papers studied social media data analysis from different aspects. Ghani et al. discussed employing machine learning techniques to analyse social media big data (Ghani et al., 2019). The authors in (Al-garadi et al., 2018) discussed the application of big social media data analysis based on content

analysis and network analysis. These application areas included health surveillance, political campaigns, monitoring disasters, detecting threats, news sources, education sector, information diffusion, security, internet traffic, and human behaviour. Also, (Drus & Khalid, 2019) cited world events, healthcare, politics, and business as applications of Twitter data sentiment analysis. The authors in (Liu & Young, 2018) discussed social media data's ability to monitor physical activity by considering topic modelling, sentiment analysis, and social network analysis (SNA) as the approaches to study this data. In (Rousidis et al., 2019), Rousidis et al. presented a literature review of predictive analysis with social media by discussing current used techniques from 2015- 2019. They studied social media data as a predictive tool in the financial, marketing, and socio-political contexts.

Many papers on social media analysis methods, social media analysis application areas, and various social media analysis tasks have been published over time. This paper contributes by reviewing published papers from 2011 to 2020 to look at social media analysis from a different angle. This paper aims to identify areas of application of social media analysis related to real-world issues and events and to identify the most used analysis approaches in these areas.

The rest of this paper is organized as follows: Research methodology, Social media data analytics applications, Social media analytics approaches, and Conclusion.

2 RESEARCH METHODOLOGY

According to the goals stated in the introduction section, this paper tries to answer the following questions:

Q₁: What are the application areas of social media user-generated data analytics in real world?

Q₂: What approaches have been used more often to learn about the public?

We classify papers related to social media data analytics into 4 categories:

1. Task-oriented research
2. Approach-oriented research
3. Technique-oriented research
4. Application-oriented research

The Task-oriented research focuses on the tasks related to social media data analytics, such as opinion mining, rumour detection, and trend detection; the second group focuses on the approaches that can be applied to analyse social media data to do these tasks to extract knowledge. The third group focuses on techniques and methods used to perform this analysis approaches. These techniques include methods such as machine learning, data mining, natural language processing, and deep learning methods. The Application-oriented research focuses on the applications of the extracted knowledge in various research fields.

This paper answers the research questions by focusing on the papers published in the application-oriented and approach-oriented groups. We reviewed 62 related studies among the studies published in IEEE, Science Direct, and SpringerLink databases between 2011 and 2020.

Initially, we used the following query strings in major computer science research databases: “social media”, “social media analysis” and “social media analytics”. We sampled studies belonging to the application-oriented group to find various research areas that utilized social media data in real-world investigations.

Next, we constructed new queries by combining each of these areas with the previous queries. For example, we used “social media analysis” AND “public health” (Boolean AND) to find what analysis

approaches have been used. Figure 1 shows the distribution of papers for each application area.

Again, we created new queries by combining approaches and first queries such as “social media analysis” AND “sentiment analysis”. Figure 2 shows the distribution of papers for each approach.

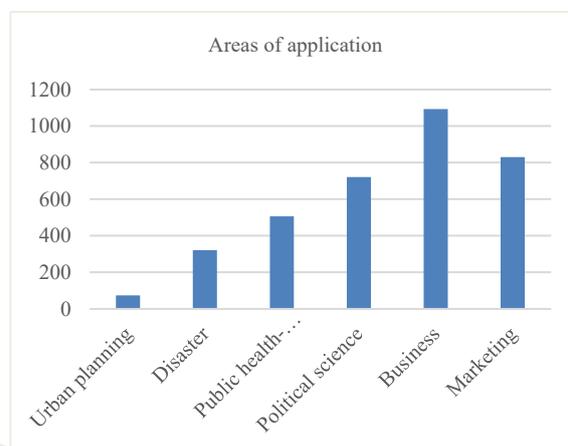


Figure 1: Number of papers for each application area.

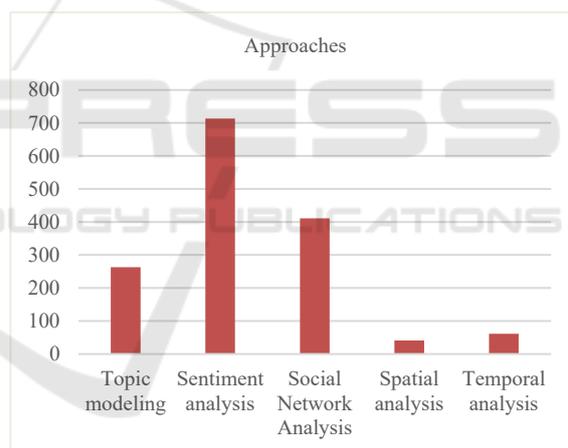


Figure 2: Number of papers for each approach.

When sampling papers for each of the above steps, we considered papers that focused on discovering information about the general public for business goals and general public goals. In addition, we only considered papers that used social media as a data source for real-world application areas. We excluded papers that dealt with issues and tasks specific to social media.

3 SOCIAL MEDIA DATA ANALYSIS AREAS OF APPLICATIONS

There are research areas such as political science, psychology studies and human behaviour mining studies, and many others that employ social media analysis (Topîrceanu & Udrescu, 2018). In this paper, we are interested in research papers that utilize social media data to learn about public thoughts, public actions, and public behaviours to improve strategies related to the decision-making process for real-world issues. This section discusses the identified research areas to answer the first question Q_1 of this study.

3.1 Disaster Studies

Disaster studies use social media data to learn about human emotions toward disaster, to track human emotions and behaviour over disaster times, to understand group behaviour, to track the disaster situation and to track trends during a disaster (Kankanamge et al., 2020; Kim & Park, 2020).

The result of these studies can help to improve the decision-making process related to disaster management (Shibuya, 2017). For example, (Kim & Park, 2020) proposed a framework that utilizes a group-based social network analysis and semantic analysis to see online group behaviours during a disaster event. (Kankanamge et al., 2020) studied Twitter data to determine disaster severity changes over time and to identify the zones affected by the disaster. Also, (Li et al., 2017) investigated the human emotions associated with extreme disasters using data obtained from Twitter and ReliefWeb using clustering-based and semantic lexicon LIWC approaches. This approach also helped to study the dynamics of human emotional responses such as sadness, anxiety, and anger during the period of an entire event. The authors in (Hong et al., 2018), using spatial and temporal analysis and topic modelling on Twitter data, investigated emerge, and change of topics during the snowstorm in urban and rural areas to find the people's needs for information and communication with governments.

3.2 Urban Planning Studies

Social media geo-tagged data have been used in some urban planning studies to gain information on tracking human activities, determining the distribution of human dynamics, investigating transportation behaviour, determining urban land use

and landscape, understanding urban life behaviour, urban dynamics modelling (Lin & Geertman, 2019; Abbar et al., 2018; Chen et al., 2019; Miyazawa et al., 2018). Abbar et al. investigated the geo-tagged context data from Twitter of two cities of Doha and London to understand the urban dynamics of cities (Abbar et al., 2018). (Heikinheimo et al., 2020) investigated the use of urban green spaces of Helsinki, Finland, by people. This paper applied social media data (Twitter, Flickr, and Instagram) to evaluate this data's ability to answer these questions: which urban green space do people use, what time, and how do people use and value urban green spaces. According to the findings of this study, social media data revealed patterns of leisure time activities. The authors in (Chen et al., 2019) mentioned the use of geo-referenced social media data to identify the urban spatial structure and urban vibrancy in highly dense cities. This study showed that social media data (Facebook check-ins) can be used to indicate human activities and characterize spatial structures.

Urban planning applies data analytics methods such as text mining, social network analysis, spatial-temporal analysis, and descriptive statistical analysis to get information from social media data.

3.3 Public Health Studies

Social media data can be applied to track and monitor the disease pandemics, track and detect infectious disease, identify and track adverse drug reactions, and analyse people's behaviour to gain information about their mental health (Al-garadi et al., 2018; Dredze, 2012). For example, Razak et al. in (Razak et al., 2020) presented a system that can be applied to analyse depression status using Machine Learning based on personal Twitter posts. Their proposal system used rule-based Vader Sentiment Analysis, Naive Bayes, and Convolutional Neural Network. There are other studies, such as (Biradar & Totad, 2019) that it also investigated the recognizing depression from Twitter data to monitor mental health.

Dredze in (Dredze, 2012) studied how social media can change public health by discovering the variant topics related to health on Twitter. This study applied supervised learning to filter tweets to find tweets that are related to health, then developed the Ailment Topic Aspect Model (ATAM) to investigate these tweets. The result of this study discovered 15 illnesses, such as influenza, insomnia, obesity, dental problems, and seasonal allergies. Again, Sidana et al. studied health monitoring on social media over time by considering health-related topics on twitter and

applying latent topic analysis methods (Sidana et al., 2018). They defined the problem as a health transition detection problem and a prediction problem. Then, they provided two Ailment Topic Aspect Model models to address the problems.

Social media also are being used to detect and explore adverse drug reaction (ADR) (Alimova & Tutubalina, 2017; Lia et al., 2019; Nguyen et al., 2017). Alimova and Tutubalina (Alimova & Tutubalina, 2017) worked on ADR classification task. They applied Linear SVM and Logistic Regression classifiers with a set of features including sentiment and semantic features, word embedding, and lexicon features and tested on two benchmark corpora of user reviews and tweets. Many other studies and research reveal the potential benefits of social media data to monitor public health and to get knowledge about public health, to help and to change health information management, and to affect health policymaking and decision making (Zhou et al., 2018).

3.4 Political Studies

The use of social media platform to publish and share political opinions is not deniable (Karami & Elkouri, 2019). So, it provides chances to use these data in political studies. By investigating political studies through social media data, we found that most of these studies are about mining people's opinions related to political issues or track public opinions, detecting political polarization, tracking political elections and political events, and predicting political events such as election results.

Sally and Wickramasinghe used Facebook data to study the trend in Sri Lankan politics over a period (Sally & Wickramasinghe, 2020). Singh et al., by using Twitter data related to the 2017 Punjab assembly elections and applying machine learning algorithms to do polarity analysis, provided a method to predict the result of the election (Singh et al., 2020). Using sentiment analysis, (Oyebode & Orji, 2019) and (Wicaksono et al., 2016) suggested methods to predict the results of the Nigerian Presidential Election and the US Presidential Election. Qi et al. studied Twitter and Reddit data about Hong Kong protests by sentiment analysis to track the changes in public sentiment about main events (Qi et al., 2019). Takikawa and Nagayoshi study the twitter data to investigate the echo chamber. They employed social network analysis to detect communities and applied topic modelling to study the content of twitter data (Takikawa & Nagayoshi, 2017).

3.5 Marketing Studies

Among the reviewed papers related to social media analysis application areas, most studies are related to business and marketing. Some of these studies investigated social media data to extract information and knowledge to improve the business management system, business strategies, and marketing.

Marketers analyse social media data to detect customers and make advertising, to seek ways to do marketing about their products, and to understand the users' views about the products (Sathiyarayanan et al., 2019). Customer reviews in social networks provide the opportunity to gain information about the users' environment, customer habits, and usage behaviour (Briele et al., 2019). Social media data can be used to discover customer behaviours, users' purchasing behaviours, customer emotions and opinion (Wieneke & Lehrer, 2016). Social network analysis can be performed to study the network structure of social media data to detect the most important users to do viral marketing. Also, the authors in (Ahn & Spangler, 2014) created a model to predict the sale by applying topic analysis and sentiment analysis with time-series data.

3.6 Business Studies

Business analysts can apply social media data for business exploration to get information about products, gain knowledge about corporate, evaluate the quality of services, and compare the services provided by different companies and businesses (Arasu et al., 2020; He et al., 2018). The authors in (Arasu et al., 2020) proposed the use of the WEKA machine learning tool to develop the social media marketing strategy by predicting online consumer behaviour. The authors in (Ahmad et al., 2019) tried to provide suggestions to help businesses develop their business strategies by analysing and comparing the social media data content of the business competitors.

Social media data provide a valuable source of data for businesses and industries which need this data to improve their business strategies by learning about general public for specific goals. The authors in (Yan & Subramanian, 2018) investigated the potentiality of social media analysis in tourism industry in UAE. The authors in (Serna et al., 2017) studied the bicycle role for transportation in sustainable tourism by applying sentiment analysis approach. This paper used data from TripAdvisor, Twitter, and Facebook about bicycle-sharing system (Serna et al., 2017).

4 SOCIAL MEDIA ANALYSIS APPROACHES

Considering that we mainly focus on the text as user-generated data, we choose five social media analysis approaches to answer question Q₂ of this study. These approaches can help to extract valuable knowledge from social media data to learn about the public.

4.1 Topic Modelling or Topic Analysis

Monitoring human behaviour and human opinion, tracking different topics and events on social media, and detecting topical trends on social media provide useful information for various research areas such as political studies, public health research, and disaster management studies. Topic modelling is one of the approaches that can be used to perform the above tasks. Topic modelling is a statistical model for identifying the latent variables or topics from large datasets (Vayansky & Kumar, 2020; Ko et al., 2017). The aim of topic modelling is to detect patterns and discover the relationship among data from a collection of text documents, and in social media data analytics, the purpose is to use these obtained topics, to show the trends and hot topics (Jelodar et al., 2019; Hidayatullah et al., 2018). The topic modelling approach can discover the discussions about a specific subject on social media to understand people's opinions towards that subject.

Jeong et al. in (Jeong et al., 2019) by applying Latent Dirichlet Allocation (LDA)-based topic modelling and sentiment analysis presented a social media mining approach for product planning. (Deng et al., 2020) proposed a multi-level LDA topic model to analyse social media data to understand people's concerns during disasters caused by humans. It used this model to identify the public's information needs and the evolution of these needs over time.

4.2 Sentiment Analysis

Sentiment Analysis (SA) is another helpful analytics approach in social media data analysis that helps to convert user-generated data to useful information. The sentiment analysis method performs the classification task. It aims to detect and interpret people's opinions, emotions, and attitudes towards any particular topic by classifying the input data into positive, negative, or neutral sentiments (Drus & Khalid, 2019; Sathya et al., 2019).

Opinions are valuable knowledge that has a significant role in some tasks, such as planning,

reasoning, and decision-making (Zul et al., 2018) (Li et al., 2019). The authors in (Drus & Khalid, 2019) referred to health, business and marketing, politics, and public action as the application of SA, and it can be used to study world events such as a disaster. The authors in (Singh & Wu, 2021) applied SA on Tweeter data to study substance abuse during COVID-19, which is one of the global healthcare system concerns. (Raginia et al., 2018) proposed a method based on SA of social media data to understand people's needs and classify the needs during times of disaster to improve the helping process.

4.3 Social Network Analysis

Social network analysis (SNA) represents the users and actors as nodes. It shows connections and interactions as edges, and it studies the structure of these nodes and their links based on social network theory (Lemay et al., 2019; Mrsic et al., 2019; Lee, 2018). SNA is used to display and visualize the network, leading to understanding the circulation of information and interactions in the network. SNA is used to improve the strategies to expedite the circulation of information about a subject. And SNA can be applied to find influential users or groups that have strong influences on other users in a network (Lemay et al., 2019) (Pudjajana et al., 2018). The authors in (Struweg, 2020) applied SNA to study the spread of the announcement of the South African health insurance bill on Twitter. The authors in (Huang & Chiu, 2020) employed SNA in mining public opinion and needs on health issues. They used SNA to investigate the interaction between health agencies and the public through the health-related policy posts on Facebook.

SNA, along with content analysis, has been used in some research areas to improve decisions and strategies. For example, Kim and Hastak in (Kim & Hastak, 2018) applied SNA on Facebook data of the city of Baton Rouge, which are after the 2016 Louisiana flood, to extract knowledge from emergency social network data. The goal was to help emergency agencies develop their social media operation strategies to lead to a better disaster mitigation plan. Also, authors in (Van der Zee & Bertocchi, 2018) applied SNA on user-generated content on TripAdvisor to study tourists' behaviour for a single urban tourist destination. They stated that the extracted knowledge can help to improve destination management strategies in distributing tourists in urban tourism spots of an area.

4.4 Spatial and Temporal Analysis

The spatial and temporal analysis study the users' data to extract spatial and temporal information and features of data. These analyses can reveal the temporal pattern and geographical information of data (Gosal et al., 2019; Zhao, 2018). Check-in and Geo-tagged social media data can be scrutinized by applying spatial and temporal analysis to provide valuable information about human mobility activities, the spatial distribution of public opinion, and the emergence, evolution, and decline of public opinion over time (Yao et al., 2018; Zhu et al., 2020). For example, the authors (Wu et al., 2020), by applying spatial and temporal analysis, studied public behaviour in disasters. They employed LDA topic modelling and DBSCAN clustering and Markov transition probability matrix to perform spatio-temporal analysis in their proposed framework. The authors in (Zhu et al., 2020), studied social media data about COVID-19 by topic mining, text sentiment, and spatial-temporal analyses. They tried to discover information about public opinion toward COVID-19. Also, the authors in (Gong et al., 2020) mentioned the use of social media data in crowd managing in cities during city events. This paper explored the social media data by employing temporal analysis with other analysis methods to understand crowd and pedestrian behaviours.

5 CONCLUSIONS

In this paper we discuss the social media analysis role in discovering information about the general public to improve decision-making for real-world issues. We review 62 papers by sampling published papers between 2011- 2020. This study focuses primarily on user-generated data and network structure as data because of their abilities to reveal information about the general public that is used in decision-making and planning for real-world problems.

For areas of applications of social media analysis related to real-world concerns, there are disaster studies, urban planning studies, public health studies, political studies, and business and marketing studies. And the most common data analysis approaches used in these areas are topic analysis, sentiment analysis, SNA, spatial and temporal analysis. Applying a proper mix of these approaches for each of these application areas can provide a powerful tool to achieve meaningful information and knowledge about the public for a target application.

The spatio-temporal analysis is rarely used alone. It is used in most papers along with other approaches.

As a future research goal, social media data's problems and limitations to cover the data-driven research for real-world issues should be investigated.

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