Fake news in the media space detection using machine learning models: A systematic review

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Abstract
Considering the inadequate literature about the usage of machine learning to detect fake news, this study intends to add up to the little available and also to contribute to knowledge in this new area of innovation. The study explores recent technologies being employed in Machine Learning to detect fake news. This is a novel study of a systematic review of the literature of papers that used machine learning techniques to detect fake news in the media space. Journals or papers reviewed in this study are those published from 2010 to 2021 involving the usage of machine learning techniques to detect fake news. A total of 60 papers or journals were systematically reviewed and subsequently analyzed using the Bibliometric analysis tool. This study indicated the types of fake news and its detection. The impact of fake news on individuals and national development was revealed together with the global perspective of fake news. Publication trends, strengths and challenges of machine learning techniques used to detect fake news were unraveled. The results from the systematic review indicated that North and South America were the continent with the highest publication regarding fake news detection using machine learning techniques followed by Europe and Asia. Africa had the least number of publications in this area of interest. The methodology used for the study was the Prisma flow diagram and paradigm funnel. These two methodologies subjected the gathered papers or journals to their respective procedures as required and the final results were obtained and used for this study. The study ended up by proposing a detection and prevention framework architecture using machine learning and also advocating for a universal fake news detector for any language, especially local dialects. The conclusion made from the study indicates that more resources and attention must be given to this area of research to detect fake news using machine learning techniques.

Keywords
Fake news; Machine learning; Artificial Intelligence; Fakedetector; Detection; Bibliometric Analysis

Contents

1. Introduction

Due to the huge amount of data regarding news items being significantly increased daily, bloggers deliberately feed the public with inaccurate or fake news in other to attract traffic to their sites. The quality of news on social media is much lower than that of traditional news outlets due to strict rules governing their operations especially in Ghana by National Media Commission (NMC). Large volumes of fake news are usually spread on social media. Political and financial gains are some of the reasons fake news is peddled online Shu & Wang (2016). Considering the recent attention being drawn to conducting research

and detecting fake news, there had not been a definitive or specific adjective or noun to describe it. As such, some experts call it "disinformation" instead of "fake news". False news is what Facebook, which happens to be the largest social media platform, refer to it. "Junk news" is what Snopes, which happens to be one of the oldest English fact-checking sites, calls "fake news" Probierz et al. (2021). Following the recent innovations in Machine Learning and Artificial Intelligence, numerous algorithms and techniques had been designed to model systems that would help detect fake news in the media space. Machine Learning is the study of how computer algorithms (i.e., machines) can "learn" complex relationships or patterns from empirical data and, hence, produce (mathematical) models linking an even large number of covariates to some target variable of interest Cabitza et al., (2018).

Due to the insufficient available literature about the usage of machine learning to detect fake news, this study seeks to add to the little available and also to contribute to knowledge in this new area of innovation. This study explores recent technologies being employed in Machine Learning to detect fake news. Thus, various methodologies were used, contributions made from the studies, results or major conclusions made, and what the authors missed in their respective studies and Bibliometric analysis of the various study. This study would equally evaluate and consider publications regarding the usage of Machine Learning to detect pieces of fake news that were published from 2010 to 2021.

The study further seeks to study new and trending models or systems that are designed to detect fake news using Machine Learning and or Artificial Intelligence. Thus, a systematic literature review of various novel conceptualized models that are proposed or designed to detect fake news from 2010 to 2021 is the general objective of this study. There would be a review of various machine learning techniques that are used to mitigate the canker of fake news. Also, a study of the publication trend of fake news detection using machine learning. Again, to ascertain the challenges and strengths of the various machine-learning techniques used to detect fake news. In addition, a proposed machine learning architectural framework for fake news detection and prevention.

2. Review of Related Work

Machine Learning techniques used to detect fake news studies (papers) would be reviewed in this section as part of related literature works: In a quantitative and visual method to elaborate on the development of publications about fake news on social media Ding et al., (2021), data from Web of Science (WOS) and Scopus were used for the studies and Bibliometric coupling, co-citation and network of co-occurrence were determined. VOS viewer 1.6.14 was used for the bibliometric coupling analysis. The results from the study had the US (1615), China (561), India

(424) and the UK (384) were the top 4 countries followed by Australia (315), Canada (286), Germany (255), Italy (254) and Spain (252) using 6354 articles and 33503 cited references. Also, the US (5867), UK (1226), Australia (1221), Canada (635), Italy (528), China (443), Germany (222), Singapore (222), Spain (188), and South Korea (133) were the most cited 10 countries Ding et al., (2021). Institutions with the most published research in this area happened to be from the US. Thus, Carnegie Mellon University, Arizona State University, and Massachusetts Institute of Technology (MIT) were leading. Due to the importance and need to curb the menace of fake news and rumors, the world's top technology companies had also ventured into researching this area. Microsoft had 8 papers, 6 papers for Google, and 5 papers for Huawei Ding et al. (2021). The study by Ding et al. (2021) set 5 as the minimum number of documents of an author, as such, out of the 13427 authors, 281 met the target. Each author was represented by a node. The same color indicated co-authorship among authors. Distance between 2 circles conversely corresponds to collaboration between each author. The bigger the circle, the more productive the author is. Loftus with 26 was the most productive.

An analysis of citations of publications by Ding et al. (2021), set 10 as the minimum number of documents out of 6354 articles and 211 was attained. Each article was represented by a node. The link between points meant each article was cited and the circle size represented the citation frequency of each article. The closeness between papers corresponded to the distance between them. Lewandowsky (2012) was highly cited. Considering the contribution of journals, 5 was set as the minimum number of documents out of 3037 sources, and 219 were attained. The same color represented journals from the same cluster. Journals that researchers in this area should consider due to their productiveness are "Memory & Cognition", and "Applied Cognitive Psychology and Science" Ding et al. (2021).The paper concluded by recommending that other languages should be considered in the design to detect fake news. Also, there should be standard terminologies or words for all publications in this area of study Ding et al. (2021).

A study conducted by Vosoughi et al., (2018) did a thorough scrutinization of variation in depth of the spread of false and true news from Twitter, ranging from 2006-2017. Samples of true, false and mixed news items (stories) were taken from six reliable sites (snopes.com, politifact.com, factcheck.org, truth-or-fiction.com, hoax-slayer.com, and urbanlegendsabout.com), and veracity of how news spread was compared and analysed. The analyses found that fake news (falsehood) diffuse further, faster, deeper, and more broadly than real (truth) throughout the study. The number of tweets and retweets on fake news on Twitter was far higher than the number of tweets and retweets of true news on the same platform within

the same period Vosoughi et al. (2018). This further proved that fake news travels faster than the speed of light.

Again, a study by Da Silva et al. (2019) analyzed published works from 2008 to 2018 regarding the design of fake news detection systems. Parsifal tool was used online to search and sought the needed journals for review. Composite network analysis methods of machine learning need more improvements and integration for the effective design of fake news detection systems. The authors did not provide or suggest any best fake news detection system.

A study conducted by De Beer & Matthee, (2021) compiled various literature or study related to fake news detection using systematic literature review methods of studies published from 2008 to 2019. The study indicated the importance of combating fake news and its impact on individuals and society at large. It concluded by indicating that a hybrid approach to fighting fake news was recommendable.

2.1 Global Perspective of Fake News

The world (globe) had not been spared from the menace of fake news. As giant organizations like Facebook and Twitter still battle with this social canker, it still finds its way into affecting the daily affairs of humanity. Some of the recent fake news which threatened the global existence of humanity is given as follows: First and foremost, US Congresswoman Marjorie Taylor Greene had been suspended on Twitter. Thus, US congresswoman Marjorie Taylor Greene's account had been permanently suspended by Twitter management for violation of its rules repeatedly regarding Covid-19 vaccine conspiracy theories. The Georgia Republican Congresswoman had been suspended several times without her learning her lessons. The recent one happened after the Congresswoman took to her personal Twitter account on Saturday, 1st January, 2022 and allegedly tweeted that "extremely high amounts of Covid vaccine deaths in the US" Johnson (2022). Secondly, considering the recent outbreak of Covid-19, many scientists had ventured into producing a vaccine to curb the situation. Fortunately, Pfizer company had been able to produce a World Health Organization (WHO) standard vaccine which is globally accepted and being used. But recently, a piece of fake news broke out that the CEO of Pfizer Albert Bourla's wife died from taking the vaccine but it was a piece of fake news according to Ghazvini (2021). Such terrible fake news could deter people from taking the vaccine and the consequences of such would be unbearable.

2.2 Traditional Method of Dealing with Fake News

Fake news traditionally was spread through some traditional platforms like newspapers and television and or radio. As such, dealing with the spread of fake news on such platforms was quite limited to the same form of propagation. Section 76 of Ghana's electronic communication act (2008) also allocates punishments to individuals who disseminate false information which can attract a fine of GHC 36,000 and up to five years imprisonment Dispatch & Josephin (2020). Thus, dealing with fake news on traditional platforms had to consider certain factors as given below: First and foremost, Name of publisher or author: when it comes to traditional media, the name of the publisher or author is key because some authors or publishers are known for the kind of news they publish. Authors or publishers in the traditional media are often licensed or given accreditation to operate, as such, they do practice with sets of rules and regulations that meet a certain required standard. When these rules and regulations are breached, practitioners are usually punished for such misconduct. The second is credibility of the author. Thus, the credibility of a publisher in the traditional media is key in determining the content of news published. Those with less credibility are not considered credible news and vice versa. Some media outlets are known to be biased in their reportage as such are often given less attention regarding their reports on certain matters.

2.3 Impact of Fake News on Individuals and National Development

In Ghana, the dissemination of false information is a criminal offence punishable by a fine of GHC 36,000 (about $6,250) and up to five years imprisonment, according to Section 76 of Ghana's Electronic Communications Act (2008) (Dispatch & Josephin, 2020). Aside from the constitutional provisions regarding punishment being meted out to individuals involved in fake news circulation. Fake news also destroys hard earn the reputation of individuals in society. Fake news does weaken democratic trust in state institutions Colomina et al. (2021). Thus, due to the spread of fake news on social media about the operation of some state institutions, many had developed doubts about the operations of such institutions. Again, fake news might also bring chaos to society when false allegations or accusations are being peddled around. More so, fake news can result in false panic in an individual which can eventually lead to death, based on the veracity of accusations being circulated.

3. Methodology

The literature survey made use of systematic literature review taking into consideration state-of-the-art models published works on various recognized sites or journals. This novel study equally made good use of the inclusion and exclusion criteria in the selection of journals for the study. The criteria can be represented below:

Table 1. Exclusion and Inclusion Criteria

Inclusion Criteria	Exclusion Criteria
Entire work (paper) can be obtained.	The entire work (paper) cannot be obtained.
Study (paper) entirety attributed to the detection of fake news using machine learning.	Study (paper) entirety not attributed to fake news detection using machine learning.
Papers that are written in the English language.	The language of the paper is not in the English language.
Studies (papers) that were published from 2010 to 2021.	Studies (papers) published below 2010.

3.1 Some Search Terms Used for Study

Specific search terms were used during the gathering of literature for the study. These include the following:
"Recent machine learning techniques to detect fake news",
"Detection of fake news using recent machine learning models",
"Use of artificial intelligence in detecting fake news",
"Literature survey on machine learning techniques for fake news detection"

Table 2. Search strings used for the study (Search string combinations)

("What is fake news" OR "not genuine information" OR "counter fit news" OR "inaccurate report*" OR "mislead* information") AND ("fake news detection" OR "approaches to identify fake news" OR "methods to identify fake news" OR "finding fake news" OR "ways to detect fake news")

Figure 1 above shows how literature (journals) selection was done for this study. Thus, 250 journals or research papers were obtained from well-known sources such as Elsevier, ACM, IEEE, Wiley, Emerald, MDPI, and Springer. Additional journals or research papers were obtained from unverifiable sources or predator sites. The number of journals was reduced to 210 after duplicate journals or papers were found. Again, the number was reduced to 185 after screening abstracts of the various journals to get those that are related to the topic under study. The number of journals was further reduced to 155 after assessing the eligibility of the journals' contribution or relevance to the topic under study. Finally, unique journals or papers remained after going through a rigorous process was now 60 which was then reviewed under this study. Also, to ascertain the process in Figure 1 above, the paradigm funnel was applied to the journals obtained for this study. Classification, exploration, and analysis of the composition of literature can be done with
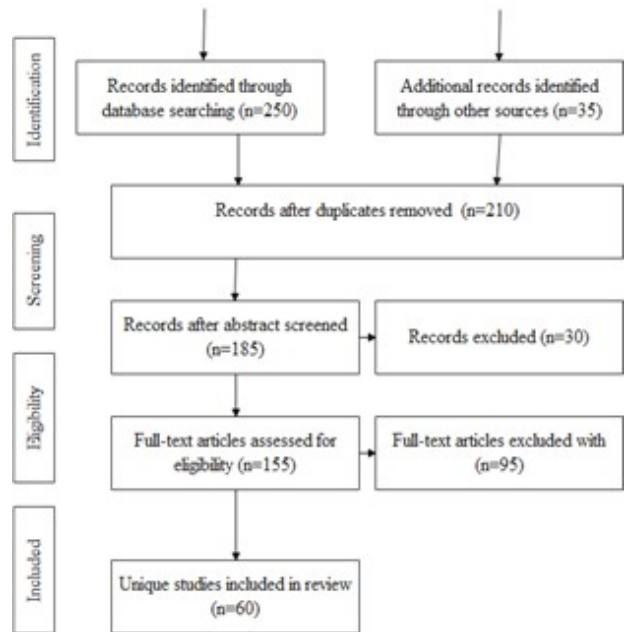

Figure 1. the PRISMA flow diagram

the aid of the paradigm funnel Berthon et al. (2016). Below is a representation of the paradigm funnel.

Figure 2 considers the various levels as follows:
LEVEL 1: Records obtained through identifiable sources (Scopus/ ACM index) and those sources which were not identifiable were $(250 + 35) = 285$. Thus, 285 represented the total number of journals that were obtained from various databases for this study.
LEVEL 2: Records after removing duplicates journals/papers was 210. After removing duplicate journals from the total of 285 journals, the remainder was now 210 journals or papers taken into consideration in the paradigm funnel procedure.
LEVEL 3: Records after screening abstract was (185-30) = 155. After thoroughly going through the abstract of the journals or papers obtained, those that met the required content for the study were now 155 journals or papers.
LEVEL 4: Full-text articles assessed for eligibility of the study was (155-95) = 60. Finally, a total of 60 journals or papers met the criteria for the study.
Finally, the number of unique studies or journals used for the study was 60.

FUNNEL LEVEL	NUMBER OF ARTICLES	PURPOSE / PROCESS
Level 1	(250 + 35) = 285	Records obtained through identifiable sources (Scopus/ ACM index) and those sources which were not identifiable.
Level 2	210	Records after removing duplicates.
Level 3	(185-30) = 155	Records after screening abstract.
Level 4	(155-95) = 60	Full-text articles assessed for eligibility.
	60	Unique studies or journals used for the study.

Figure 2. Paradigm funnel
(Source: Author's construct)

4. Analysis and Discussion of Results

4.1 Categorization of papers reviewed based on location (continent) of publication.

Under this category, the papers that were reviewed are categorized based on the continent where they were published. Given below is a graphical representation of the various publications from each continent.
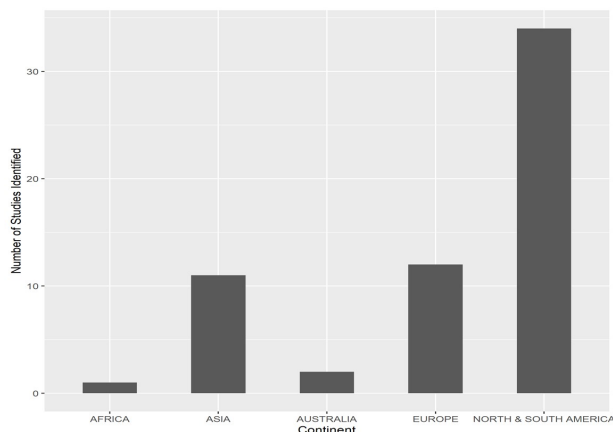
Figure 3. Bar chart of publications from each continent (source: Author's construct)

From the bar chart (figure 3), it is obvious that a larger part of the publications came from North and South America followed by Europe then Asia leaving Africa and Australia behind. AFRICA: The only paper published in Africa was done in Egypt by Girgis & Gadallah (2018) which combined deep learning with machine learning to detect fake news.
AUSTRALIA: Australia had published Shu, Wang, et al.,

(2019) and Brown et al., (2020) as the only papers which were reviewed in this study. ASIA: Out of the 60 papers reviewed, Asia had published 11 out of the total, though quite substantial.
EUROPE: 12 out of the 60 papers reviewed were published in Europe.
NORTH AND SOUTH AFRICA: This continent had the majority of the publications done in the area of fake news detection. 34 papers had been published from this continent which happens to be the continent with the highest publication in this study.

4.2 Categorization of papers reviewed based on the type of study and methodology used to conduct the study.

Below is a graphical representation of the categorization of the various study reviewed in this work into the methods/methodology used in the respective study / paper:
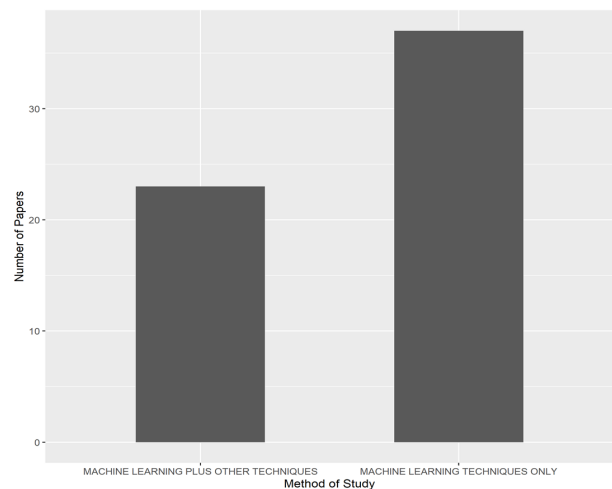
Figure 4. Bar chart representing various methods used in the study
(source: Author's construct).

From the above diagram (figure 4), it is clear that literature work(s) regarding fake news detection is woefully inadequate. As such, there is the need to do more studies in this area.

4.3 Categorization of papers reviewed based on the source paper obtained / name of journal of publication.

Below is a diagram representing various sources where papers were obtained for the study:

From the above chart (figure 5), various databases and their corresponding number of studies obtained from them are indicated above.
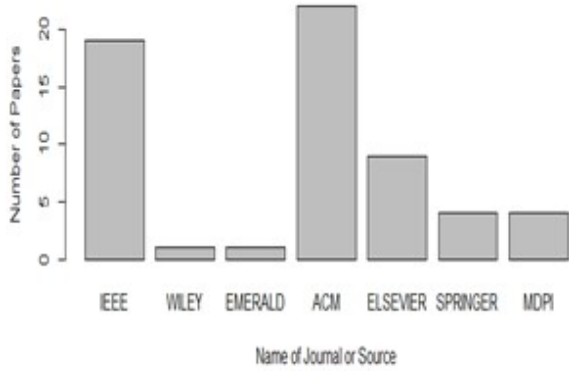
Figure 5. Chart of database and a corresponding number of papers obtained from it
(source: Author's construct).

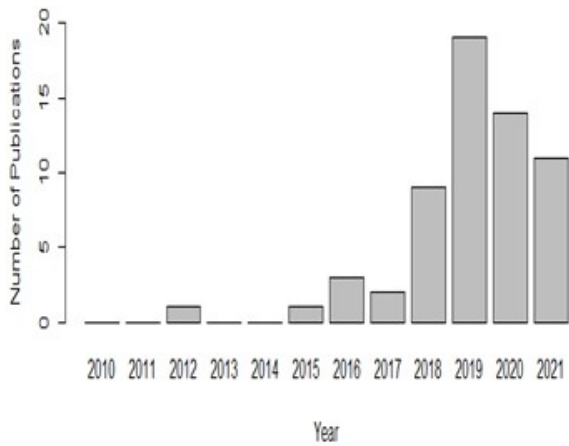## 4.4 Categorization of papers reviewed based on the Year of Publication.

Figure 6. Representation of years and their corresponding number of publications.

The above figure indicates that 2019 had 18 publications which happened to be the highest number of publications in this study.

Figure 7 represents network visualization of all the studies reviewed in this work. Thus, the various nodes in the above picture represent the relationship between the various authors whose works are used in this study, that is, the link between various authors of the reviewed papers in this study.

Figure 8 represents a map based on text data. Thus, a network visualization of Co-occurrence map based on text data; keywords used by various authors in the study. It is a visual representation of the text that occurs in all the papers reviewed. It created 77 items and 6 clusters.
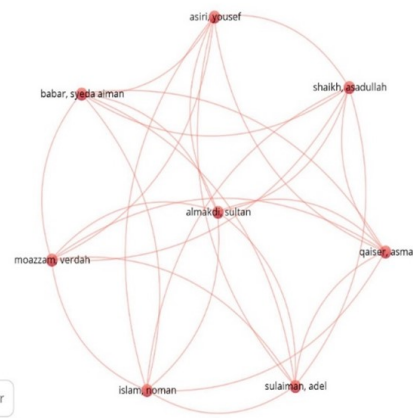
Figure 7. Co-Authorship Network Visualization
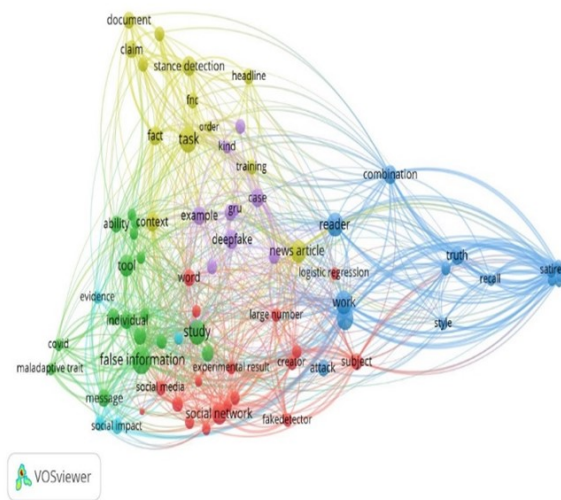
Figure 8. Co-occurrence map based on text data Network Visualization

4.5 Proposed Framework for Detection and Prevention of Fake News

Considering the results from the analysis of the data used in this study, a proposed framework for the detection and prevention of fake news using a machine learning model is given in the figure below: From Figure 9, supervised machine learning techniques would be applied to train 80% of the dataset whiles the 20% left would be used to undertake the study. The 80% dataset would be subjected to Tfidfvectorizer, transforming the dataset into a matrix form. The model again would be subjected to Passive Aggressive Classifier algorithm to shape it and an accuracy score would be obtained. The accuracy score would then predict whether the news is fake or real with the aid of a confusion matrix. The 20% left would be used as test data to evaluate the model, resulting in an accuracy score.
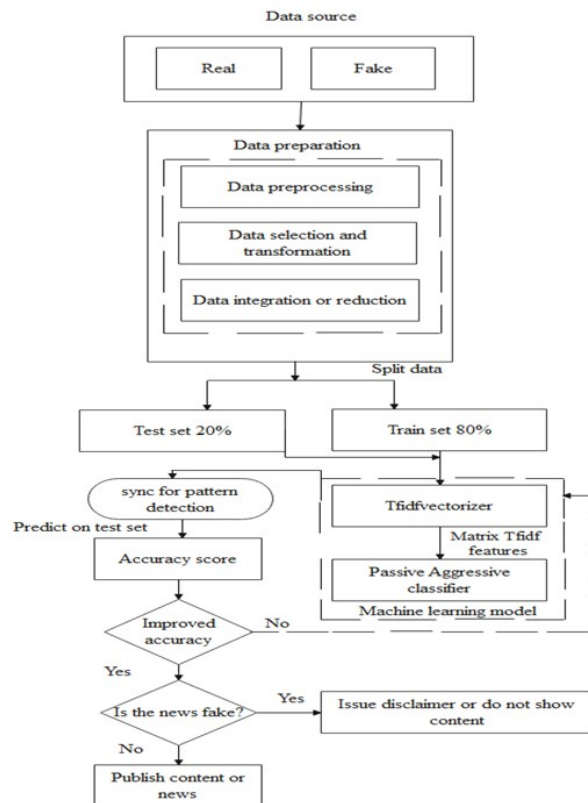

Figure 9. Proposed framework for detection and prevention of fake news
(source: Author's construct).

Afterwards, a confusion matrix would be used to indicate the performance of the model or its perfection. The higher the accuracy score with the application of the confusion matrix, the more reliable the proposed model and vice versa. Before all these processes would be done, the data sets obtained from the source to do this would undergo data preparation which involves data preprocessing, data selection and transformation, and data integration or reduction. If after thorough scrutiny at the detection stage and it turned out to be fake, such news item should not be allowed to be published on the media platform or a disclaimer should be written attached to such item. But, if it turned out to be real news, such news items should be published or allowed to appear on the platform.

5. Conclusion

Considering the data obtained in this study under the categorization of papers reviewed based on the type of study and methodology used to conduct the study, it emerged that studies that are conducted to detect fake news in the media space using machine learning techniques only had the majority of the papers whereas papers that had combined both machine learning and other techniques such as deep learning had a minority of the papers. This analysis proved that machine learning techniques only cannot solve the canker of fake news on social media but combining machine learning techniques with other novelty like deep learning, convolutional neural networks, and artificial intelligence can provide an alternative and improved way of mitigating the spread of fake news on social media. From the results of the systematic literature review conducted, it is quite clear that more attention and resources need to be invested in the area of fake news detection using machine learning to mitigate the canker of fake news, especially on social media, and also to provide enough literature for the academic domain or world.

6. Recommendation

In as much as this work is a novelty, it is recommended that future works must come up with a proposed machine learning model to detect fake news, especially in the local Ghanaian language like Twi. Also, in Figure 8, a proposed machine learning architectural framework for the detection and prevention of fake news was provided which can be implemented (and or improved) in the future. A universal machine learning model which is language independent should also be something to work on in the near future to drastically mitigate the canker of fake news in any language at any level on social media.

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