International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
IJARST
ISSN: 2457-0362

MULTI-MODAL META MULTI-TASK LEARNING FOR SOCIAL MEDIA RUMOR DETECTION

1. MOTRU SANDEEP MADHAV, Department of Information Technology, Jawaharlal Nehru Technological University, sandeepmadhav89@gmail.com
2. Dr. G Venkata Rami Reddy, Professor, Department of Information Technology, Jawaharlal Nehru Technological University, gvr_reddi@jntuh.ac.in
3. Mr. K. Balakrishna Maruthiram, Assistant Professor, Department of Information Technology, Jawaharlal Nehru Technological University, kbkmram@jntuh.ac.in

Abstract: Since you can't rest assured on the off chance that a post is lawful or not, the occupation of finding bits of hearsay has become more significant as web-based entertainment stages have developed rapidly and how much virtual entertainment information has developed. The perform multiple tasks perusing medium attempts to work on the presentation of the talk revelation task by utilizing the valuable data found in the station disclosure task. Until this point, numerous ways have been proposed to make the talk revelation process simpler. In any case, three things that keep most elevated are being techniques down. (1) They just gander at printed content and overlook multi-modular data, which is a significant piece of virtual entertainment information; (2) They don't consider the distinction in that frame of mind between the station disclosure task and the gossip revelation task, and that implies they use sta data in the incorrect manner; and (3) They don't give a lot of consideration to the semantic data concealed in the fine-grained station markers. In this way, we propose a structure called Multi-modal MetaMulti-Task Learning (MM-MTL) for tracking down bits of hearsay via virtual entertainment. We make a multi-modular post-implanting subcast that ganders at both composed and realistic material so we can utilize different modes. To tackle the issue of dividing focuses among the station disclosure task and the talk revelation task, we recommend a meta information taking an interest strategy that utilizes some high level meta network layers and catches the metaknowledge behind the multi-modular post. We utilize the consideration framework to sort out how significant each answer is so we can utilize the importance data that is concealed in the little station marks. Broad testing on two Twitter standard datasets shows that our recommended style gives state of the art speed.

Index Terms: *Meta learning, multi-modal, multi-task learning, rumor detection, social media*

1. INTRODUCTION

The objective of a virtual entertainment gossip spotting project is to find and stop the spread of false or inaccurate data (reports) via web-based entertainment stages. A few significant objectives are met by this sort of task: The principal objective is to prevent individuals from spreading counterfeit data, which can be hazardous, particularly during debacles, races, or general wellbeing circumstances. Deception can cause dread, turmoil, and even mischief to individuals' bodies. Trust: It assists keep with peopling's confidence in the data climate, which incorporates virtual entertainment locales. At the point when individuals acknowledge the data they find on these destinations, they are bound to involve it positively. Safeguarding Public Security: Misleading bits of hearsay can once in a while prompt public dangers, similar to fights or bogus reports during circumstances. These dangers can be diminished by tracking down these bits of hearsay and stopping them. Further developing information Education: These ventures frequently have showing parts to assist individuals with figuring out how to shrewdly utilize information more. Individuals can be more capable online entertainment clients assuming they know how to detect and look at reports. Investigation: They can likewise be valuable wellsprings of data for specialists who are investigating the way that misleading data spreads, why individuals trust bits of gossip, and how well various cures work. Stage Improvement: Talk spotting tasks can assist web-based entertainment stages with sorting out what sorts of bits of hearsay are most famous on their destinations, which can assist them with working on their frameworks and approaches to sending in reports.

The objective of the virtual entertainment gossip discovery project is to make a dependable method for

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
IJARST
ISSN: 2457-0362

finding and stop the spread of phony or deceiving data (bits of hearsay) via web-based entertainment stages. The objectives of this undertaking incorporate the accompanying significant parts: 1. Make refined ML calculations and models that can naturally detect bits of hearsay and phony data in the large number of content via virtual entertainment. 2. Set up ongoing global positioning frameworks to get new reports when they start and battle them with right data. 3. Set up ways of actually taking a look at the reality of data by contrasting it and dependable sources and involving notable techniques for actually looking at realities. 4. Get clients required by adding simple to-utilize revealing instruments that let them assist with the most common way of distinguishing and checking individuals. 5. Empower advanced proficiency among individuals who utilize virtual entertainment and show them how to think fundamentally so they can sort out how dependable data is.

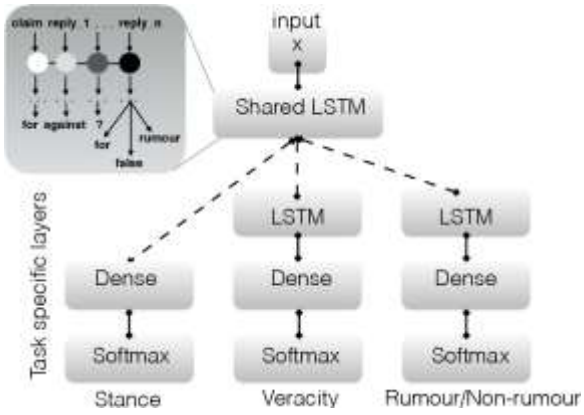

Fig 1 Example Figure

1. An excess of data: Virtual entertainment stages make an immense measure of information each day, which makes it hard to figure out and track down bits of gossip among the commotion. 2. Rapidly Spreading Data: Web-based entertainment makes it simple for bits of hearsay to spread rapidly, which could create damage or turmoil before they are exposed. 3. Various kinds of content: Reports can be in text, pictures, recordings, jokes, and different configurations, so it means quite a bit to utilize more than one sort of information to track down them. 4. How clients act and what they need to do: A few clients spread reports intentionally, while others share counterfeit data without knowing it. It is difficult to sort out who is spreading bogus data and whether they did it intentionally or coincidentally. 5. Evolving Procedures: Individuals who spread bits of hearsay are continuously changing their techniques, so it's essential to create frameworks that can change and adjust alongside them. 6. Evaluating the source's validity: It's difficult to be aware on the off chance that a source is dependable in light of the fact that even solid sources in some cases give wrong data. 7. Multilingual and social responsiveness: Reports can be intended for a language or a circumstance, so the undertaking needs to consider language and social contrasts. 8. Moral Contemplations: It is elusive a harmony between the need to battle lies and regard with the expectation of complimentary discourse and protection.

2. LITERATURE SURVEY

Social Media Rumor Detection

The main way for individuals to get information is presently through internet based virtual entertainment destinations. There is a gigantic measure of virtual entertainment information since countless individuals utilize online entertainment destinations. The examination local area gives a ton of consideration to these virtual entertainment information since they have a great deal of significant worth for investigation. A few examinations are proposed to investigate virtual entertainment, for example, web-based entertainment investigation, get-togethers understanding, cyberbullying wonders understanding, media synopsis on microblogs, political decision surveying, visual thought education, assessment mining, and multimodal information proficiency. All things considered, many models are off-base since web-based entertainment information contains bogus data. Numerous things have been finished to negate reports and reduce their destructive impacts. Work that has been done as such far considers viewing bits of gossip via virtual entertainment as a directed order issue. On the directed order way, the primary objective is to track down great elements for preparing gossip classifiers. Previously, tales were settled by hand-production a great deal of elements. As of late, a few strategies for finding tales in view of sight and sound material have been tried. We propose a repetitive brain network with a consideration instrument to consolidate picture and text characteristics of a post to track down bits of hearsay.

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
IJARST
ISSN: 2457-0362

Improvement in Our method over previous method:

Despite the fact that there have been a few decent outcomes, most techniques center around recording the text of a post while overlooking areas of strength for the between the reality of a case and the perspectives communicated in answering posts. In any case, the manner in which individuals discuss gossip can show in the event that it's valid or not. In this work, we present a new multi-modular meta-perform multiple tasks learning strategy to work on the exhibition of the talk recognition task via preparing the connected position location task simultaneously.

Multi-task Learning

The objective of perform multiple tasks learning is to further develop how well you do one occupation by utilizing other related undertakings. The best perform various tasks learning or normal learning models can be considered boundary sharing techniques, where models are learned together and boundaries or elements are shared across many errands. Perform multiple tasks learning has been involved a ton in the various positions of regular language handling, and it has functioned admirably. Collobert et al. propose a brought together framework that utilizes a common query table for approaching words and convolutional brain organizations to become familiar with a few NLP undertakings simultaneously. Tune et al. propose a multi-source, perform various tasks learning technique to co-direct the consistency of the sources and the relatedness of the tree-directed errands for client interest assessment. In the majority of these models, perform various tasks structures utilize the common confidential construction to share highlights across errands. This divides the elements of various undertakings into private and shared spaces, and highlights that don't have any significant bearing to a particular errand are utilized as repetitive highlights for different undertakings in the common space. As of late, various perform multiple tasks learning techniques have been recommended to further develop talk recognition by showing both gossip discovery and position carving out at a similar opportunity. Mama et al., for instance, concoct a GRU-based perform multiple tasks learning strategy that involves similar elements for both talk discovery and position identification. To get around the issues in the past work, an arrangement for a multi-modular meta-perform multiple tasks learning technique for virtual entertainment gossip spotting is suggested.Our model is not quite the same as the above perform multiple tasks learning strategies since it shares meta-level data. The above techniques share characteristics in various errands. Specifically, a meta network is proposed to record meta-information across undertakings and control the highlights of organizations that are just utilized for one errand.

Meta Learning

Meta-realizing, which is likewise called "figuring out how to learn," is a method for causing models that help individuals rapidly to master new abilities or adjust to new settings by providing them with a great deal of instructing models. There are three standard ways of getting things done. 1) Techniques that utilization estimations to get a decent proportion of distance. 2) Model-based techniques that utilization outside or inward memory to work with the intermittent organization to further develop speculation. 3) Streamlining based strategies, which straightforwardly attempt to track down the best model boundaries for quick learning. In this part, we rapidly go over the model-based meta-learning styles, which utilize a little hyper-meta-organization to foresee the weight boundaries of a huge spine organization. Starting from the beginning of hyperactive meta-networks, it has set up wide activities in brain armature chase, Bayesian brain organizations, network managing, and perform multiple tasks taking care of. To get around the issues in the past paper, a plan for an overactive meta network-based perform multiple tasks learning for enhancesection is proposed. This plan makes meta information sharing workable for gossip related undertakings and works on the two errands through a unique weight age component. In this work, we need to manage blended multi-modular gossip related assignments where the information and result designs are altogether different starting with one errand then onto the next. This is unique in relation to the past meta-perform multiple tasks learning techniques. Likewise, we add a consideration technique to metamulti-task realizing, which can utilize the name data from the different talk related errands in a more helpful manner.

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
IJARST
ISSN: 2457-0362

3. METHODOLOGY

In customary media, news is put out by regarded gatherings, yet online news via web-based entertainment destinations emerges from the blue and is shared by a huge number of junkies. In any case, a great deal of medication clients cautiously check the reality of the data they take in. This implies that a ton of reports might begin and spread. Without exact and methodical work to back up the posts, the spread of online entertainment bits of hearsay can prompt enormous scope terrible things and can at times influence or even control significant public occasions. Thus, online entertainment stages have a major issue: they don't have the foggiest idea how to depict lies well and breaking point its terrible impacts. Many sweats have been made to attempt to make reports less hazardous. A portion of the primary reports come from news destinations like assnopes.com and politifact.com, which utilize master investigation and publicly supporting to attempt to expose or demonstrate tales. All things considered, assembling and researching bits of gossip by hand takes a ton of time and isn't really viable. In this way, the examination local area has given a ton of consideration to how to mine and find bits of gossip naturally. Generally, examination into programmed gossip identification can be summarized in two orders: (1) The principal bunch is to take out itemized and convoluted includes physically. (2) The subsequent gathering is to utilize brain organizations to get profound characteristics naturally.

Drawbacks:

Despite the fact that these projects work effectively of tracking down tales, the greater part of them just gander at the data in course books. Truth be told, the substance of a post on a virtual entertainment site might incorporate more than one kind of data (e.g., text and pictures), and these various sorts of data can function admirably together. Additionally, the tweets in talk securing positions are all made by clients, and the client's perspective can be significant in tracking down bits of gossip. Thus, it's vital to utilize video material and the client's situation to track down bits of hearsay.

Our task means to fix the issues with the ongoing technique. A new perform multiple tasks learning strategy is proposed to add the position data of clients' answers to the talk identification task and a common private perform various tasks learning technique to show data dividing and portrayal support among the position discovery task and the gossip recognition task, which can add helpful elements to each undertaking. It has been seen that suspicious and restricting feelings against bits of hearsay generally come up as they spread. This can be a useful sign that the data is valid. Despite the fact that it appears reasonable to further develop online entertainment gossip spotting by tracking down tales and dissecting various perspectives together.

Benefits:

This strategy is a multi-modular meta-perform various tasks learning framework for finding bits of hearsay on friendly media.The proposed technique isn't equivalent to general perform various tasks learning styles, which share not many things practically speaking. All things being equal, it utilizes progressed meta-information from gossip finding and position errands. With the assistance of meta-information, the errand explicit model can get a careful multi-modular image of each and every post.

• We utilize a consideration medium with multi-modular meta-perform various tasks figuring out how to utilize the temperament data of client reactions completely. With the weighted client replies, the recommended multi-modular meta-perform various tasks learning can more readily comprehend what the client needs.

•We will utilize an information sharing arrangement for perform various tasks figuring out how to manage the issue of component sharing perform multiple tasks learning styles. Rather than sharing some lower layers to track down comparative elements across errands, the proposed metamulti-task learning shares a few higher layers of a meta network, which gains joint meta-information from various undertakings. The meta-information is then used to make the boundaries of the errand explicit models such that changes after some time. Thus, the information about how clients feel about the talk from their responses is effectively added to the gossip tracking down process.

• To utilize the importance data concealed in the fine-grained position names, we utilize a consideration strategy to foresee the heaviness of each response and straightforwardly incorporate the concealed states

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
IJARST
ISSN: 2457-0362

from the position layer in the consideration calculation.

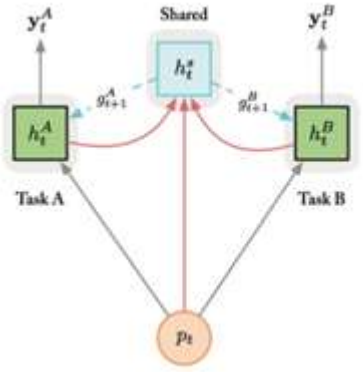

Fig 2 Proposed Architecture

There are the accompanying parts to this model:

• Multi-modular Post Implanting Layer: We model the multi-modular substance of each post in the case as implanting vectors. Specifically, we use BERT to get the text installing vector and VGG19 to get the visual inserting vector for the visual data.

• Meta Perform various tasks Layers: We recommend a meta perform multiple tasks learning strategy for identifying bits of gossip via virtual entertainment. This technique utilizes a common meta layer to gain the metaknowledge from the gossip recognition and position discovery undertakings. Utilizing the normal meta-network as an aide, the undertaking explicit layer can get an exact image of each post.

• Task-explicit Result Layer: We add a consideration technique to the assignment explicit result layer so we can completely utilize the position data from the client's responses. Particularly, reactions that firmly concur or contradict the gossip biggerly affect how genuine it is.

4. IMPLEMENTATION

Utilizing a blend of natural language processing (NLP) and machine learning strategies, finding bits of hearsay via virtual entertainment is hard. Here is a significant level gander at how the strategy attempts to track down tales via virtual entertainment:

1. Get data from virtual entertainment destinations like Twitter, Facebook, and Reddit. This is where reports are probably going to spread. Gather subtleties, for example, timestamps, data about clients, and the construction of interpersonal organizations.

2.Preprocessing of data:Tokenize the text information and tidy it up by disposing of clamor, pictures, URLs, and other pointless data. Change text information into a shape that can be utilized to investigate it, like TF-IDF vectors or word embeddings.

3.Feature Extraction: Take significant elements from the information, for example, individual highlights (e.g., client foundation and notoriety), content elements (e.g., mind-set investigation, word recurrence), and organization highlights (e.g., rehash or offer patterns).

4.Labeling: Make a named dataset where reports are set apart as obvious or counterfeit. This should be possible the hard way or by utilizing truth really taking a look at frameworks that as of now exist.

5.Machine Learning Models: Utilize the named dataset to prepare different ML models, similar to Random Forest, Support Vector Machines, and Neural Networks. For text division occupations, evaluate different NLP models, like BERT and GPT-3.

6.Cross-Approval and Assessment: Utilize cross-approval to sort out how well your models are doing. Measurements like accuracy, precision, recall, F1-score, and ROC-AUC can be utilized to gauge how well a model functions.

7.Ensemble Strategies: Use techniques like stacking and sacking to consolidate the outcomes from various models to make them more precise and solid.

8.Real-time Checking: Set up a technique to gather and dissect virtual entertainment information progressively. To manage ongoing information, use devices like Apache Kafka or ApacheFlink that can cycle streaming information.

9.User and Organization Examination: Utilize informal community investigation to find significant clients and figure out how tales are spreading. In your exploration, ponder the design of the organization (like centrality measures) and how clients carry on (like the quantity of companions and answers).

10.limits and Alarms: In view of the model's certainty scores, put forth the right lines for gossip identification. Set up an advance notice framework that lets clients or administrators know when something that may be gossip is found.

Ensure the framework can deal with large measures of information well and that it is improved for speed and utilization of assets.

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
IJARST
ISSN: 2457-0362

Recollect that gossip spotting is a continuous interaction, and the outcome of your framework will lay on the quality and measure of your information, the intricacy of your models, and the sharpness of your following and cautioning frameworks. Additionally, if you need to make talk spotting frameworks more exact, you really want to stay aware of the most recent concentrate in NLP and ML.

5. EXPERIMENTAL RESULTS

Fig 3 Server login Page

Fig 4 User Registration Page

Fig 5 Authorized users

Fig 6 Users login Page

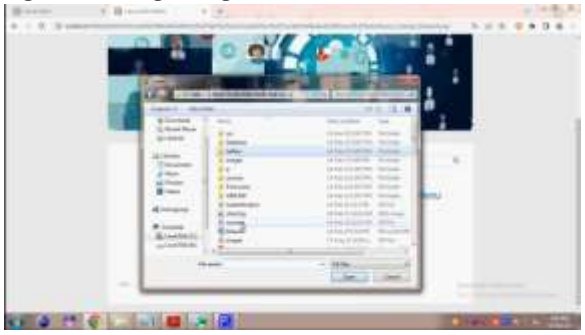

Fig 7 Dataset Uploading

Fig 8 Dataset imported successfully

Fig 9 Post Score results graph

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
IJARST ISSN: 2457-0362

Fig 10 Rating results graph

6. CONCLUSION

Eventually, multi-modal meta-multitasking for tracking down bits of gossip on friendly mediaRepresent a likely method for battling lies and misleading reports online in a world that is continuously evolving. This cutting-edge strategy exploits the force of numerous information sources, work objectives, and meta-learning methods to make gossip identification frameworks more precise and proficient. By consolidating text, pictures, recordings, and client activities, these frameworks are better ready to comprehend how confounded and unpretentious bits of gossip are via virtual entertainment. Likewise, in light of the fact that these models can change and gain from various positions connected to tales, their presentation continues to get better over the long haul. Despite the fact that multi-modular meta-performing various tasks for gossip spotting is still in its beginning phases, it offers energizing opportunities for additional strong and dependable devices to stop the spread of misleading data on the web. However, continuous review and advancement are expected to manage issues like information insurance, morals concerns, and the continually changing ways that individuals spread tales. All in all, the utilization of multi-modal meta-multitasking in web-based entertainment talk spotting is a stage towards additional compelling and key ways of battling the destructive impacts of bogus data in our carefully associated world.

7. FUTURE ENHANCEMENT

Multi-modal meta-multitasking has a great deal of potential for the future in virtual entertainment gossip spotting, and it could prompt enormous enhancements in the field of battling lies. Here are a few significant regions for future development and potential purposes:

Improved Accuracy and Robustness: Analysts can attempt to make multi-modular models more exact and solid by adding more fluctuated and enormous datasets. This incorporates information from various virtual entertainment destinations, dialects, and societies. This allows models to change to fit various circumstances and gatherings.

Real-time Detection: Making frameworks that can find bits of hearsay and bogus data via online entertainment destinations as they occur and act to them rapidly. This would require both great calculations and communication with virtual entertainment APIs so that answers could be made rapidly.

Multilingual and Cross-cultural Adaptation: Utilizing multi-modular models that can be changed to track down bits of gossip in various dialects and societies. This is vital in light of the fact that bogus data is an overall issue that appears in changed ways in better places.

Deepfake Detection: Adding deepfake content acknowledgment to the extent of multi-modular meta-multitasking. Deepfake content is getting more perplexing and harder to detect.

Customization for Specific Domains: Adjusting multimodal models to explicit regions or organizations, like medical services, governmental issues, or money, where terrible information can make serious impacts. This requires preparing models with information and data that are well defined for the subject.

Human-AI Collaboration: We are investigating ways for human commentators and AI frameworks to cooperate to track down tales. For instance, AI could help human mediators by hailing data that may be misleading for audit.

Ethical Considerations: While setting up talk recognizing frameworks, it's critical to address morals worries about security, predisposition, and control and ensure they safeguard clients' privileges and adhere to moral guidelines.

Education and Awareness: Making showing projects and instruments that utilization multi-modular meta-performing various tasks to show individuals how to track down data via virtual entertainment stages and ponder it.

Combating New Misinformation Techniques: Remaining in front of new ways that falsehood is

spread by continually changing and improving multi-modular models that can detect new sorts of deception, similar to sound material that has been changed or text that was made by AI.

Interdisciplinary Research: Specialists in AI, sociologies, brain science, and correspondence ought to be urged to cooperate to get familiar with how bogus data spreads and how to stop it.

All in all, the future potential for multi-modal meta-multitasking in web-based entertainment talk spotting is extremely enormous, and it has a ton of potential for making lies less pernicious. To utilize these cutting edge innovations to safeguard the security of data in the computerized age, there should be more review, improvement, and participation between various fields.

REFERENCES

[1] H. Allcott and M. Gentzkow, "Social media and fake news in the 2016 election," J. Econ. Perspectives, vol. 31, no. 2, pp. 211–36, May 2017.

[2] S. Kwon, M. Cha, and K. Jung, "Rumor detection over varying time windows," Plos One, vol. 12, no. 1, pp. e0 168 344-, 2017.

[3] S. Kwon, M. Cha, K. Jung, W. Chen, and Y. Wang, "Prominent features of rumor propagation in online social media," in Proc. IEEE 13th Int. Conf. Data Mining, 2013, pp. 1103–1108.

[4] X. Liu, A. Nourbakhsh, Q. Li, R. Fang, and S. Shah, "Real-time rumor debunking on twitter," in Proc. 24th ACM Int. Conf. Inf. Knowl. Manage., ser., 2015, pp. 1867–1870.

[5] J. Ma, W. Gao, Z. Wei, Y. Lu, and K. Wong, "Detect rumors using time series of social context information on microblogging websites," in Proc. 24th ACM Int. Conf. Inf. Knowl. Manage., 2015, pp. 1751–1754.

[6] C. Castillo, M. Mendoza, and B. Poblete, "Information credibility on twitter," in Proc. 20th Int. Conf. World Wide Web, 2011, pp. 675–684.

[7] J. Ma et al., "Detecting rumors from microblogs with recurrent neural networks," in Proc. 25th Int. Joint Conf. Artif. Intell., 2016, pp. 3818–3824.

[8] F. Yu, Q. Liu, S. Wu, L. Wang, and T. Tan, "A convolutional approach for misinformation identification," in Proc. 26th Int. Joint Conf. Artif. Intell., 2017, pp. 3901–3907.

[9] Z. Jin, J. Cao, H. Guo, Y. Zhang, and J. Luo, "Multimodal fusion with recurrent neural networks for rumor detection on microblogs," in Proc. ACM Multimedia Conf., 2017, pp. 795–816.

[10] H. Zhang, Q. Fang, S. Qian, and C. Xu, "Multi-modal knowledge-aware event memory network for social media rumor detection," in Proc. 27th ACM Int. Conf. Multimedia, 2019, pp. 1942–1951.

[11] E. Kochkina, M. Liakata, and A. Zubiaga, "All-in-one: Multi-task learning for rumour verification," in Proc. 27th Int. Conf. Comput. Linguistics, 2018, pp. 3402–3413.

[12] J. Ma, W. Gao, and K. Wong, "Detect rumor and stance jointly by neural multi-task learning," in Companion Web Conf. 2018 Web Conf., 2018, pp. 585–593.

[13] J. Thorne, et al., "Fake news stance detection using stacked ensemble of classifiers," in Proc. 2017 Workshop: Natural Lang. Process., 2017, pp. 80–83.

[14] S. Dungs, A. Aker, N. Fuhr, and K. Bontcheva, "Can rumour stance alone predict veracity?" in Proc. 27th Int. Conf. Comput. Linguistics 2018, pp. 3360–3370.

[15] L. Wu, Y. Rao, H. Jin, A. Nazir, and L. Sun, "Different absorption from the same sharing: Sifted multi-task learning for fake news detection," in Proc. Conf. Empirical Methods Nat. Lang. Process. 9th Int. Joint Conf. Natural Lang. Process., 2019, pp. 4643–4652.

[16] L. Derczynski, et al., "SemEval-2017 task 8: RumourEval: Determining rumour veracity and support for rumours," in Proc. 11th Int. Workshop Semantic Eval., 2017, pp. 69–76.

[17] A. Zubiaga, G.W. S. Hoi,M Liakata, R. Procter, and P. Tolmie, "Analysing how people orient to and spread rumours in social media by looking at conversational threads," in PloS One, 2016.

[18] J. Wang, et al., "Recommending flickr groups with social topic model," Inf. Retr., vol. 15, no. 3-4, pp. 278–295, 2012.

[19] S. Qian, T. Zhang, C. Xu, and J. Shao, "Multi-modal event topic model for social event analysis," IEEE Trans. Multimedia, vol. 18, no. 2, pp. 233–246, Feb. 2016.

[20] Q. Huang, V. Singh, and P. Atrey, "On cyberbullying incidents and underlying online social relationships," J. Comput. Social Sci., 08 2018.