International Journal of Web Services Research
Volume 17 • Issue 1 • January-March 2020

A Neuro-Fuzzy Approach to Detect Rumors in Online Social Networks

Santhoshkumar Srinivasan, Vellore Institute of Technology, Vellore, India
Dhinesh Babu L.D., Vellore Institute of Technology, Vellore, India

ABSTRACT

Along with true information, rumors spread in online social networks (OSN) on an unprecedented scale. In recent days, rumor identification gains more interest among the researchers. Finding rumors also poses other critical challenges like noisy and imprecise input data, data sparsity, and unclear interpretations of the output. To address these issues, we propose a neuro-fuzzy classification approach called the neuro-fuzzy rumor detector (NFRD) to automatically identify the rumors in OSNs. NFRD quickly transforms the input to fuzzy rules which classify the rumor. Neural networks handle larger input data. Fuzzy systems are better in handling uncertainty and imprecision in input data by producing fuzzy rules that effectively eliminate the unclear inputs. NFRD also considers the semantic aspects of information to ensure better classification. The neuro-fuzzy approach addresses the most common problems such as uncertainty elimination, noise reduction, and quicker generalization. Experimental results show the proposed approach performs well against state-of-the-art rumor detecting techniques.

KEYWORDS

Cyber Security, Deep Learning, Fuzzy System, Neural Networks, Neuro-Fuzzy System, Online Social Network, Rumor Classification, Rumor Detection

1. INTRODUCTION

Recently, online social networks (OSNs) are becoming a convenient and popular source of latest news since OSNs make peer-to-peer communication easier, open, and instant. Such an open and unmoderated discussion has led OSNs a fertile land for unverified information spread on a larger scale. This unverified information is otherwise called as unconfirmed information or rumor. Rumors permeated at every corner of social networking application due to large-scale dissemination in a brief time. This kind of huge circulation of rumors leads to potential damages and elevated societal harms across online and offline social communities. Detecting rumors and controlling at the earliest is imperative to minimize the damages to the network. Consequently, the accurate identification of rumors in OSNs is highly beneficial and desirable.

In the social psychology field, the rumor is defined as a piece of information whose source cannot be verified as true or false at the time of circulation (Allport & Postman, 1947). In OSN terms, a rumor is a story or claim that is unverified and being propagated among participants in the network.

DOI: 10.4018/IJWSR.2020010104

Research task in this area of study is to identify and control the rumors using various features of every information. The prominent features that determine the veracity of rumors are the temporal, the linguistic, and the structural aspects of the information (Kwon, Cha, Jung, Chen, & Wang, Prominent features of rumor propagation in online social media, 2013). Currently, a rich set of principled rumor detection methods are proposed for online social networks which use content, temporal and structural features of the information (Castillo, Mendoza, & Poblete, Information credibility on twitter, 2011) (Kwon, Cha, & Jung, Rumor detection over varying time windows, 2017) (Liu, Nourbakhsh, Li, Fang, & Shah, 2015). Few types of research leverage the wisdom of users (Liu, Nourbakhsh, Li, Fang, & Shah, 2015) (Zhao, Resnick, & Mei, 2015), propagation network (Ma, Gao, & Wong, Rumor Detection on Twitter with Tree-structured Recursive Neural Networks, 2018) and so on. However, the fundamental problems such as input uncertainty, input noise, data sparsity, and, output interpretation of this dynamic and complicated information propagating network, OSNs, are not well addressed by these state-of-the-art methods.

OSNs are driven by information sharing across the participants in an uncontrolled environment. Participants can interpret and share the same information in different semantical directions which introduces uncertainty and inconsistency in information in its further spreads in the network. Such imprecise information needs to be handled while identifying rumors to avoid misleading classification results. Apart from this, when rumor needs to be identified earlier in its propagation, the common problem would be sparsity of input which in-turn contains more noise in data (Haufe et al., 2014) (Ma et al., 2016). Such a very less, noise incorporated, data often does not help in rumor identification. This situation causes the earlier detection job a failure. Also, machine-learning and deep-learning classifications are commonly having the problem of output interpretation (Lipton, 2016) (Lou, Caruana, & Gehrke, 2012). The output generated by these models does not have a proper interpretation as to how the results arrive. This leads to the problem of not knowing how the presented model works.

This paper is aiming to deal with these fundamental problems with the help of deep-learning and fuzzy approaches. Improper generalization and data noise can be carefully omitted with deep learning approaches. There are few deep-learning rumor classification approaches proposed so far for such tasks. Though such methods provide automation and higher accuracy of outputs, the approaches have some problems like no clear interpretation of outputs, uncertain input, noisy and lesser input data. Uncertainty and imprecision of data can be resolved with the help of Fuzzy learning and this already been a proven approach for many practical problems such as portfolio management (Atsalakis, Protopapadakis, & Valavanis, 2016) (Hadavandi, Shavandi, & Ghanbari, 2010) (Boyacioglu & Avci, 2010), image processing (Kwan & Cai, 1994), etc., Along with linguistic input, semantic aspects of the information also helps to reduce the ambiguity due to imprecise input data.

1.1. Objective

Typically, one or more users of OSN post stories about an event or a claim, based on what they hear from internal or external to the OSN platform. Others can reshare such posts in the network which enables it to propagate in OSN. If such information is not a truthful claim, then it may cause damage to the platform and the society. This paper aims to classify the underlying event of a set of posts/ stories in online social networks is a rumor or not.

An online social network having N set of users who can post a story about a set of unverified events or claims $E = \left\{e_1, e_2, ...e_n\right\}$. Each event e_i has a distinct set of posts $ST_i = \left\{st_1, st_2, ...st_m\right\}$ associated to it at given time-interval t. So, the event can be represented as:

$$e_i = \left\{ST_i, t\right\} \tag{1}$$

Rumor-Identification: Given an online social networking site G consists of E events, the task of rumor identification is to classify whether the event is a rumor or not using the set of posts related to the event: