

# Language and Structure in Polarized Communities

## *Lenguaje y estructura en comunidades polarizadas*

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**Abstract:** PhD thesis in Computer Science has been written by Mirko Lai under the supervision of Prof. Paolo Rosso (Universitat Politècnica de València), Dr. Giancarlo Ruffo (University of Turin) and Dr. Viviana Patti (University of Turin). This thesis was developed under a cotutelle between the Universitat Politècnica de València, Spain and the University of Turin, Italy. The thesis defense was done in Turin, Italy on February 11, 2019. The doctoral committee was integrated by: Leo Ferres (Universidad del Desarrollo, Chile), Delfina Malandrina (Università degli Studi di Salerno, Italy) and Sara Tonelli (Fondazione Bruno Kessler, Italy).

**Keywords:** stance detection, communities detection, online social network, polarized political debates.

**Resumen:** Tesis doctoral en Informática ha sido realizada por Mirko Lai y dirigida por el Prof. Paolo Rosso (Universitat Politècnica de València), Dr. Giancarlo Ruffo (University of Turin) y la Dra. Viviana Patti (University of Turin) en el marco de un convenio de cotutela entre la Universitat Politècnica de València, España y la Universidad de Turin, Italia. La defensa de la tesis fue en Turin, Italia el 11 de febrero de 2019 ante un tribunal compuesto por: Leo Ferres (Universidad del Desarrollo, Chile), Delfina Malandrina (Università degli Studi di Salerno, Italia) y Sara Tonelli (Fondazione Bruno Kessler, Italia).

**Palabras clave:** detección de las opiniones, detección de comunidades, red social, debates políticos polarizados.

## 1 Introduction

Nowadays, social media are gaining a very important role in public debates and a significant part of the population is exposed to information through them. Furthermore, political leaders use social media directly to communicate with their citizens. On the other hand, citizens take part in the discussion, by supporting or criticizing their political opinions. For these reasons, social media provide a powerful experimental tool to deduce the mood of the public opinion and investigate how individuals are exposed to diverse viewpoints. The large amount of users' generated data motivated the need for new automated forms of textual content analysis. Research on this topic could have a positive impact on different aspects such as public administration, policy-making, and security. In fact, through the constant monitoring of

people's opinion, desires, complaints and beliefs on political agenda or public services, administrators could better meet population's needs and prevent extremely marked ideological polarization and extremist tendencies.

In this thesis, we address the problem of stance detection in social media focusing on polarized political debates in Twitter. Stance detection consists in automatically determine whether the author of a post is in favor or against a target of interest, or whether the opinion toward the given target can not be inferred. We deal with political topics such as electoral events (e.g., political elections or referendums) and consequently the targets of interest are both politicians and referendums. We also explore the communications which take place in these polarized debates shedding some light on dynamics of communications among people having concordant or contrasting opinions, particularly focusing on

observing opinions’ shifting. We propose machine learning models for addressing stance detection as a classification problem. We also explore features based on the textual content of the tweet, but also features based on contextual information that do not emerge directly from the text.

## 2 Thesis Overview

This thesis consists in a collection of our most relevant publications about the research project I was involved in during my Ph.D. It consists of 7 chapters that are briefly introduced below.

Chapter 2 (Lai et al., 2016) contains the first result of our research on political debates in social media that investigates stance detection. The paper has been published in the proceedings of the *15<sup>th</sup> Mexican International Conference on Artificial Intelligence*. Starting from a benchmark dataset of English tweets released at the first shared task on stance detection (SemEval-2016 Task 6), we propose a feature based on the context surrounding the targets of interest. In particular, we define the two concepts “enemies” and “friends” for denoting the possible relations among the target and the entities related to the target. Namely, we try to model that when a tweeter is against an “enemy”/“friend” of the target, then the tweeter is in favor/against the target, and vice versa. Since our particular interests in political debates, we focus on the two targets related to the political campaign for the 2016 U.S. presidential elections: Hillary Clinton and Donald Trump. Our results, that take advantage from the proposed feature, outperform the best ones obtained by the teams participating in the task. We show that the information about “enemy” and “friend” of politicians helps in detecting the stance towards them.

Chapter 3 (Lai, Cignarella, and Hernández Farías, 2017) provides a technical report including a brief description of our approach, an illustration of our experiments, and an analysis of our results for our submission for the *Stance and Gender Detection in Tweets on Catalan Independence* shared task held at IberEval-2017. The released dataset consists in Catalan and Spanish tweets about the regional elections in Catalonia (Spain) held in September 2015. The election has

been explained as a de facto referendum on the possible independence of Catalonia from Spain. For this reason, the organizers chose “independence of Catalonia” as target for the stance detecting task. Our system (iTACOS) ranked in as the first position among ten participating teams for both languages at the stance detection sub-task. Our approach, based on *context* and *structural* features, shows that contextual features help in stance detection even when the target of interest is not a person.

Chapter 4 (Lai et al., 2017) contains the paper included in the proceedings of the international conference *Experimental IR Meets Multilinguality, Multimodality, and Interaction (CLEF 2017)*. In this paper, we explore in depth opinion shifting applying the 2016 United Kingdom European Union membership referendum as case of study. We created the TW-CHRONOSBREXIT corpus for stance detection that we used for training a model for automatically estimate the stance of all users of our dataset. We show that users having the same stance towards this topic tend to belong to the same social network community. Moreover, we found evidences that the neighbours are more likely to have similar opinions. The extension of this work was afterwards published in the *Journal of Intelligent & Fuzzy Systems* (Lai et al., 2020).

Chapter 5 (Lai et al., 2018) has been published in the proceedings of the *23rd International Conference on Natural Language & Information Systems (NLDB 2018)*. We created the CONREF-STANCE-ITA corpus for stance detection for inspecting stance detection at user level and in a diachronic perspective applying the 2016 referendum on the reform of the Italian Constitution as case of study. Here, we investigate in depth social network exploiting different types of relations such as retweets, quotes, and replies. The analysis shows that users with the same stance towards a particular issue tend to belong to the same social network community. For this reason, we propose three new features for stance detection based on the online social community the user belongs to. The performed experiments show that the accuracy of stance detection prediction is considerably improved adding features derived from communities extracted from retweets-

based and quotes-based networks to content-based ones. This does not happen using the feature based on the communities extracted from the replies-based network. Indeed, the users mainly reply to other users with a similar opinion and we observe about 20% of cross-stance edges among them. We also shed some light on users' opinion shift dynamics observing that in this debate, users tend to be less explicit on their stance as the outcome of the vote approaches. The research has been expanded and published in the *Journal Data & Knowledge Engineering* after the thesis defense (Lai et al., 2019).

Chapter 6 summarizes the obtained results and presents extended experiments we carried out. First, we deeply analyze our system (iTACOS) ranked in as the first position in the *Stance and Gender Detection in Tweets on Catalan Independence* shared task held at IberEval-2017. Then, we propose an extended version of iTACOS for classifying stance in a multilingual scenario (MultiTACOS). We also carry out a qualitative analysis of the features used for addressing stance detection in the debate about the BREXIT referendum, and after, we analyze the communication among users with similar and divergent viewpoints in the Italian Constitutional referendum case of study. Finally, we explore the features extracted from a network structure in a task different from stance detection e.g. talent identification in sport particularly focusing on the case of study of table tennis. The work described in this chapter was published in the *Journal Computer Speech & Language* (Lai et al., 2020) after the defense of the thesis.

Chapter 7 finally draws conclusions from the results presented in this thesis. Furthermore, the chapter outlines our publications during the Ph.D. Here we also propose some future research lines for this work.

### 3 Contributions

Stance detection has been identified as a not trivial task independent from sentiment analysis. Indeed, if on the one hand, sentiment analysis aims to detect the sentiment expressed in a piece of text, on the other, stance detection seeks to identify the user's opinion toward a defined target of interest (not necessarily mentioned in the text). In this thesis we concentrated our attention on

online political debated and we faced stance detection as a classification task proposing different type of features, in particular, increasingly focusing on contextual ones. The achievements of our research could be summarized as following:

- We presented a brief description of the approaches proposed in the literature particularly focusing on the two shared tasks on Stance Detection held at SemEval 2016 and IberEval 2017. Our method, obtaining the highest result at IberEval 2017 and amounting the state of the art achieved at Semeval 2016, validates the assumption that contextual features could be useful for the task of stance detection.
- We created four new annotated corpora of tweets for stance detection: the English TW-CHRONOSBREXIT, the Italian CONREF-STANCE-ITA, and the E-FRA and R-ITA corpora respectively in French and Italian.
- Facing stance detection in a multilingual perspective, we detected linguistic characteristics peculiar of each language. Furthermore, we showed that results are affected by the different styles used by users for communicating stance towards target entities of different types (persons or referendum).
- We observed, on two different political debates, that users tend to aggregate themselves in like-minded groups. For this reason, we proposed a contextual feature based on the community the users belong for detection their stance. The results outperform those obtained by using only features based on the content of the post.
- We show how, representing a complex problem with a network, could be useful for extracting features from the network structure for dealing with other classification task such as talent prediction.
- Users use different type of communication depending on the level of agreement with the interlocutor's opinion. Friendship, retweets, and quote relations are more common among like-minded users, while replies are often used for interacting with users having different stances.

- Approaching on stance detection in a diachronic perspective, we observed both opinion shifting and a mitigation of the debate towards an unaligned position after the outcome of the vote. In a deeper analysis, results tend to show that users having heterogeneous relations tend, approaching the end of the debate, to more likely keep their opinions unclear than user having homogeneous links.

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