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Conflict Detection in Linguistically Diverse Online Social Networks: a Russia-Ukraine Case Study

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ABSTRACT

Online conflict can lead to and manifest itself in real-time emotional distress and radical behaviour. Whilst the topics are diverse, one of the most challenging and relatively under-explored topics is in real conflict landscapes. Many such places have high ethnolinguistic diversity with multiple principal and hybrid language groups. Here, we examine how online social network debates unfold for the recent Russian intervention in Ukraine. We use Natural Language Processing (NLP) to map the evolving Reddit social network, showing rich structural and sentiment signal evolution. Whilst relatively straightforward for well-resourced languages, NLP tasks for ethnolinguistic fictionalised areas with 22 languages including various *lingua franca* is challenging, and require proprietary methods. Yet, it is in this linguistic and real-world landscape that we uncover politically sensitive posts. We demonstrate how we can extract clear topic groups, echo chambers, and create the data that will enable us to track the sentiment of users and the role they play both within and between echo chambers.

CCS Concepts

- Information systems → Data extraction and integration;
- Networks → Network dynamics;
- Security and privacy → Social engineering attacks;

Keywords

Social networks; Natural language processing; Online radicalization; Topic modeling; Community detection

1. INTRODUCTION

Online conflicts [15] are an important reflection and component of real-world conflict. Real-world conflict can be difficult to analyse, requiring new mathematical and AI tools [9]. Often the online world is seen as an important reflection of the real-world, or as an essential dimension in total warfare. The formation of and conflicts between online echo-

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chambers [7] is of vital interest from both a total warfare and a radicalisation perspective. In total warfare, inciting polarisation via online fake news (via bots [19, 8]) is increasingly seen as an effective precursor to ground military action, part of long-term socio-political influence, as well as part of a wide cyber-based warfare. Diverse studies on online conflict have ranged from elections [1] and referendums [2], Wikipedia [21], online gaming [20], to radicalisation [3] and reverse engineering online interference of democracies [14]. Existing research have focused on using topological measures to differentiate communities that represent echo-chambers [1, 20, 6], including the role of real-world geography [2]. Of particular interest is the co-evolution of the online social network structure [16], the sentiment dynamics of individual users, and the impact this has on their loyalty [10], radicalisation [3] and unstable behaviour.

1.1 Reddit on Russian intervention in Ukraine

The Russian intervention in Ukraine, which included a series of military engagements started in 2014 and continues to this day in 2019. This is intermixed with political turmoil in Ukraine, including the recent election in 2019. Our focus is on the evolving social network (Reddit) discussions in this landscape [17], covering a wide range of topics and sub-topics. Time scale wise, our data for this paper covers the 2019 election, which took place in March-April 2019 and have been labelled as one of the most controversial political event in Ukraine since the country gained its independence in 1991. The choice of time period and the significance it has in the Russian intervention in Ukraine is discussed later in the paper. The linguistic landscape is also very diverse, with over 22 different principal language and hybrid languages used. The geography of languages have also evolved - see Fig.1.

1.2 Current Approaches in NLP

A key challenge in analysing online social networks (OSNs) is to reconstruct the sentiment or stance of the interactions between users for a specific topic. In contrast to human labelling alone, current scalable methodology relies on the ability to use NLP. In linguistically diverse areas, this is challenging, but here is a brief review of standard approaches in NLP that offer various levels of usefulness.

Dictionary-based approaches are arguably the most widely used as it is based on the existing electronic lexical resources and databases, accessible via various packages and libraries for the most used data science languages such as R and Python, and does not require advanced programming or spe-

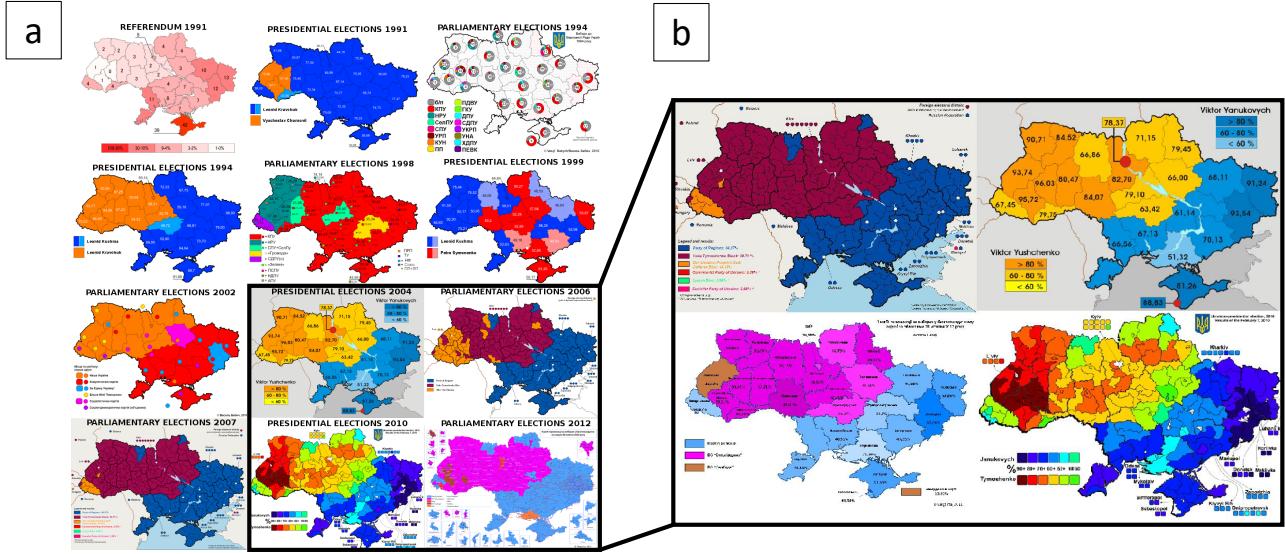


Figure 1: Diverse linguistic landscape of Ukraine: (a) historical evolution of language distribution at previous election and census points, (b) voting patterns in recent elections. Images adapted from: www.observationism.com.

cialist expertise. Proprietary dictionaries are often constructed for topic specific labeling [18], improving accuracy compared to general dictionaries. When dictionaries are used in conjunction with methods such as Naive Bayes, SVM, or CNN, it can achieve reliable automated sentiment analysis, even in challenging language groups [13]. Given the above mentioned sets of requirements, we decided to test Python library polyglot v.16.07.04, which described as one of the very few dictionary resources, capable to work with Slavic languages and perform cross-linguistic, translation and sentiment tasks. Some sources reported on advantages this method offers for under-resourced languages as they can leverage the wealth of labelled English data at low or no cost and still offer some reasonable results , whilst others reduce its usability to the lexical level only, whilst being incapable of successfully transferring sentiments embedded in syntactical and morphological linguistic structures.

Crowdsourcing is arguably the most expensive resource for NLP of the under-resourced languages as it often involves large-scale data collection and tagging. Also known as crowdsourced sentiment analysis, this method is nevertheless gaining a lot of attention from NLP industries as it offers some novel applications, such as nowcasting, in social media and customer service. Since this approach is distanced from more traditional dictionary one, it works on the assumption that there is no single ‘sentiment analysis’ program that works in all circumstances and for all use cases, and people are employed to define terms, language and contexts in which they are used in order to label situational (or environmental) sentiment values, or some other similar NLP tasks.

Commercial realisations are often regarded as ‘black-box’ tools, the majority of these NLP software packages, web interfaces and APIs have nevertheless proven their usability and demonstrated successful deployment not only in industry, but also in academia as well. Their research value is

particularly appreciated in cases, where language(s) of interest are under-resourced and poorly adapted for the automated NLP tasks. For instance, as per June 2018, Google and IBM sentiment analysis APIs still did not support Russian language, which illustrates a scope of the problem for NLP of the languages lying outside main Western-European families.

1.3 Novelty and Contribution

Like many low resourced languages in real-world conflict landscapes [11, 12], we use novel NLP approaches to discover the topics and sentiment dynamics in politically sensitive subject areas. We show how tracking signal properties of the sentiment can reveal the role individual users have in a wide social network, and in particular how they interact with echo-chambers they are in and opposing ones. The data and the analysis workflow is a useful contribution to the growing literature in understanding online conflict and we do so in a real-world conflict setting, which adds to the sensitivity and importance of the work.

2. METHODS

2.1 Data

The main source of data used at this prototyping stage was from Reddit, social news aggregation, content rating and discussion website, which allows access to its databases via various APIs. Here we used Python Reddit API Wrapper (PRAW), which allows simple access to Reddit API and is easy to use via attributable user agent. Prior to execution of the code, a list was compiled of the eligible subreddits (see Fig.2a), expected to reflect the discussions of various controversial topics, related to the ongoing political life in Ukraine. Given that conflict can manifest itself via various events, which are often sporadic, spontaneous and difficult to predict, and with the training datasets often non-existent

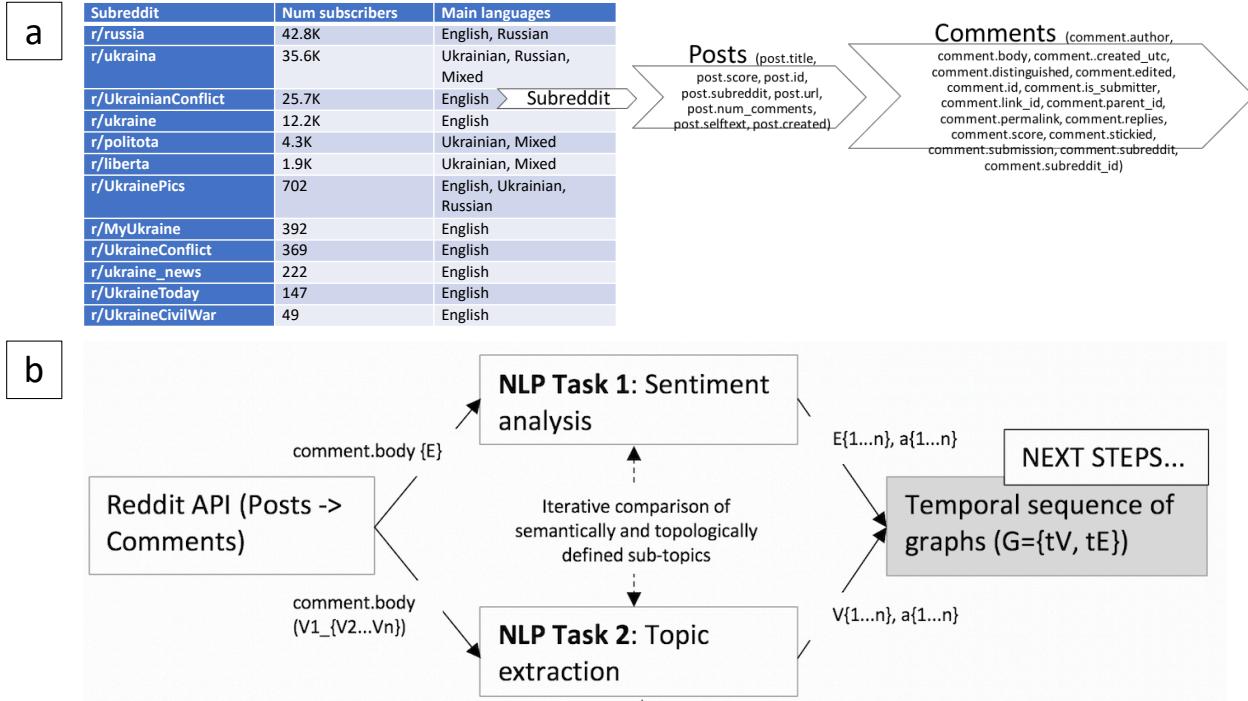


Figure 2: Data Mining from Reddit and NLP Analysis Work Flow. (a) Subreddits with number of subscribers and main languages, (b) workflow chart from data mining, to NLP, to future analysis.

or of poor quality, for the purpose of prototyping temporal networks with unstable behaviours we decided to use the topic of presidential elections in Ukraine, which took place in March-April 2019 and have been labelled as one of the most controversial political event in Ukraine since the country gained its independence in 1991. Event choice was motivated by the two main reasons: (A) political debates are known to generate substantial ‘digital footprints’, due to employment by the candidates of multiple media channels as part of their election campaigns and debates, (B) since this is event of the national importance, the data it can generate in the web sphere is the most likely to cover all ethnolinguistic groups and dialects of Ukrainian language - both inside and outside the country.

2.2 Problem Context - Diverse Language Landscape

2.2.1 Lingua Franca

Ukraine as a country is characterised by complex linguistic landscape, dominated by Ukrainian and Russian as two principal languages, in addition to which various informal bridge languages emerge in different regions, predominantly varying in direction from the east to the west of the country - see Fig.1. *Lingua franca*, or bridge languages, are common languages between speakers with the different native principal languages, which can often belong to the same linguistic families. Unlike dialects they can represent an interesting form of linguistic resilience to various external socio-political or economic situations, where people seek to adopt communication mechanisms, without exposing them-

selves to additional political risk. Therefore, where online conflict research is concerned, various lingua franca are an ultimate resource as they can help to provide far better insights into dynamics between communities, than the official languages can.

In contemporary Ukraine, the linguistic situation is characterised by shifting regional systems of asymmetric language relations, where Ukrainian and Russian, as well as mixed language varieties that result from their interaction form the main components. There are currently 22 *languages* used on the territory of Ukraine, where Ukrainian and Russian dominate and create some particular forms of lingua franca assemblages, called *surzhyk*. The principal dominant languages on Reddit are given in Fig.4a. Surzhyk is currently not accounted for in censuses and its virtual non-occurrence in various sociological surveys makes it difficult to track and associate with the exact number of users. It is being estimated that around 25% of Ukraine’s 40 million population speaks surzhyk.

2.2.2 Political Significance and NLP Challenges

Code-switching between Ukrainian and Russian as well as code-mixing (*surzhyk*) between the two Eastern Slavonic languages is challenging for NLP tasks. Despite the clear NLP difficulties that this presents, the role of *surzhyk* is very important from the perspective of political language ideologies as it is concerned with functional language forms, social groups and boundary-making. This makes this under-researched (and difficult to research) linguistic phenomenon an indispensable resource for conflict tracking on social media, where it is being widely used on various political forums,

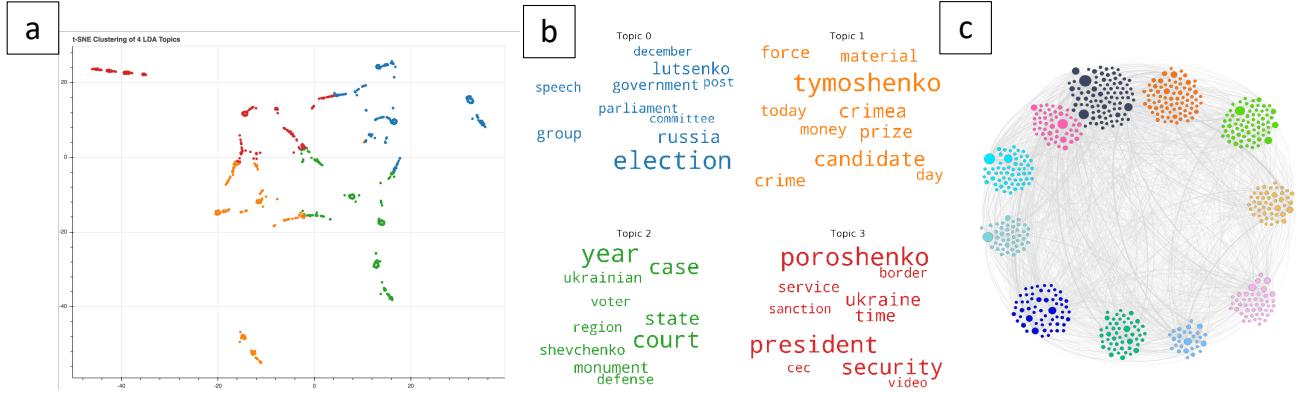


Figure 3: Topic Extraction. (a) Clustering of 4 LDA topics, (b) Topic keywords, and (c) Network structure of topic-based communities.

news and other online interest groups. However, its proliferation on the web sphere does not make it less difficult to research, as it lies on the intersection of already computationally under-resourced languages, semantic libraries for which have been largely based on the translation efforts from the Western-European dictionaries. There is therefore an enormous scope for AI and NLP to mine vast unstructured web-based resources in order to create dynamic sentiment libraries for both under-resourced formal languages and their lingua franca, however, this can come at some cost as may require some crowdsourcing and native-rating efforts.

2.3 NLP Analysis

A general flow of data mining, NLP analysis, and the results analysis can be found in Fig.2b. Sentiment analysis is the task of identifying positive and negative opinions, emotions and attitudes/stances. It has been used with success in fields where users have obvious subjective agenda such as movies reviews, blogs or customer feedback. It is much less clear how sentiment analysis techniques can be employed in the context of social network analysis where the language tends to be more free-form, informal and less structured morphologically and stylistically. In addition, the frequent use of slangs, existence of typos, and the evolving nature of language in politically sensitive topics adds to the challenge.

Methodologically, there exist several approaches towards definition of the sentiment or stance of various documents (i.e., comments to the various posts in the topical subreddit), ranging from single words (e.g. LDA approach [5]) to more lengthy abstracts (e.g. CNN approaches). Specifically, in the context of this data experiment we were dealing with documents, varying from words to phrases and to sentences. Therefore the algorithm of our choice was expected to meet the following criteria:

1. capable of working with multiple languages in the same session;
2. able to handle heterogeneous documents;
3. provide continuous sentiment metrics as opposed to the binary classifications.

Concentrating on the potential of the local linguistic resources, rather than more accessible news sources in English,

the subreddit ‘r/ukraina’ was selected as one of the most representative news spaces with the highest number of subscribers on Reddit for the topic ‘Ukraine’. It is also characterised by the high proportion of surzhyk-speakers and their high activity around the presidential elections in April 2019 (≈ 0.5 million posts for the period 13 April-15 May 2019).

Two main approaches were decided to be tested on the collected data, specifically dictionary based and some commercial realisations of various (hybrid) sentiment libraries (described previously). In the course of the experiment dictionary-based approach proved to be inefficient in this instance as it produced 75% of the empty entries and for the remaining 25% estimated sentiment values were binary due to the lack of the corresponding lexical entries in the underlying polyglot library. We have subsequently selected Indico Open Source Community version of the NLP tool for unstructured web content, in order to test the performance of the commercial resource, combining multiple dictionaries. This resulted in the complete data frame of corresponding to each subreddit comment sentiment values, which have been checked by the native Ukrainian/Russian speaker and judged as satisfactory. The distribution of the sentiments is given in Fig.4b.

3. RESULTS

3.1 Topic Extraction

In the context of this research, topic allocation [4] was a necessary step for data production, which will subsequently enable us to model and get deeper insights into compositions and dynamics of politically engaged communities online. Initial step here was topic allocation of all users, in the first instance, without consideration of the temporal variation of the users’ engagement into different discussions. The most common approach for topic extraction is application of the LDA [5], which is widely used and well documented method in NLP.

One innovative component of this method was co-modelling of the discussion topics alongside their social network parameters: i.e., visualisation of the degree of semantic overlap between topic-based communities. It is possible to observe on this social network that some of the semantically identified topics can significantly compositionally overlap with

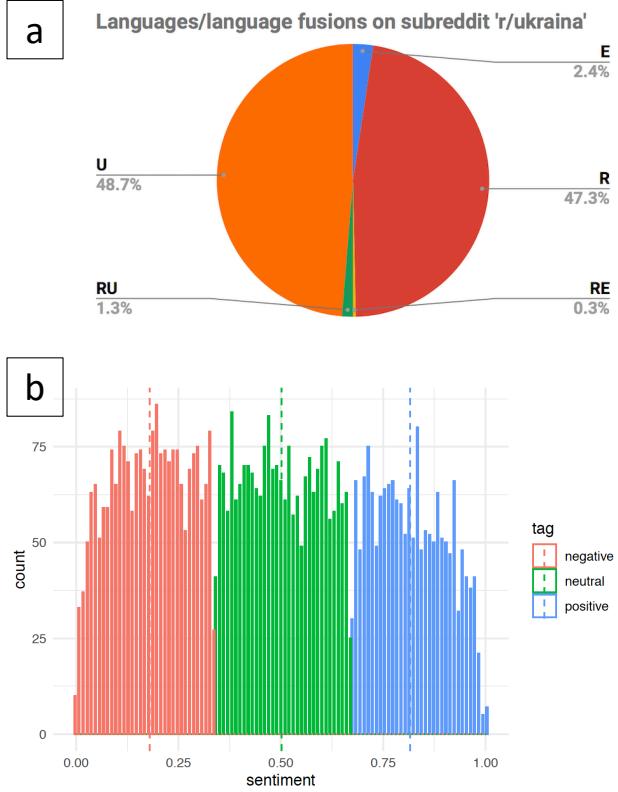


Figure 4: Dominant Languages and Sentiment Distribution.

communities, defined by the modularity algorithms, as well as diverse with the others. A n example of the LDA analysis of topics, their keywords, and the communities that they form can be found in Fig.3. This can be indicative of the presence of ‘closed’ and ‘open’ communities, and it is therefore would be interesting how those formations change over time themselves and how/whether their compositionality defines semantic stability of the edges (a.k.a., ‘bridges’), which emerge between communities.

3.2 Sentiment and Network Co-Evolution

Here, in Fig5a we see an OSN represented as a network, whereby a node is a user and an edge is a post from one user to another. A common example of how explosive community development occurs in early part of a subreddit (e.g. 90% of network forms rapidly). A network core of posts appear early on, surrounded by an evolving periphery of posts. Red links indicate hostile posts and green links indicate friendly posts. The thickness of an edge indicates the number of posts aggregated overtime between the same two users.

Fig5b show how the dynamics of sentiment fluctuates over time, including properties such as variance and entropy of surrounding peer posts. Here we see a few key parameters to track over a discrete time based on number of posts in the subreddit:

1. Variance of sentiment: we see that the variance of sentiment for this user stabilises rapidly, indicating that it has formed a stable opinion after 800 posts out of 3905.

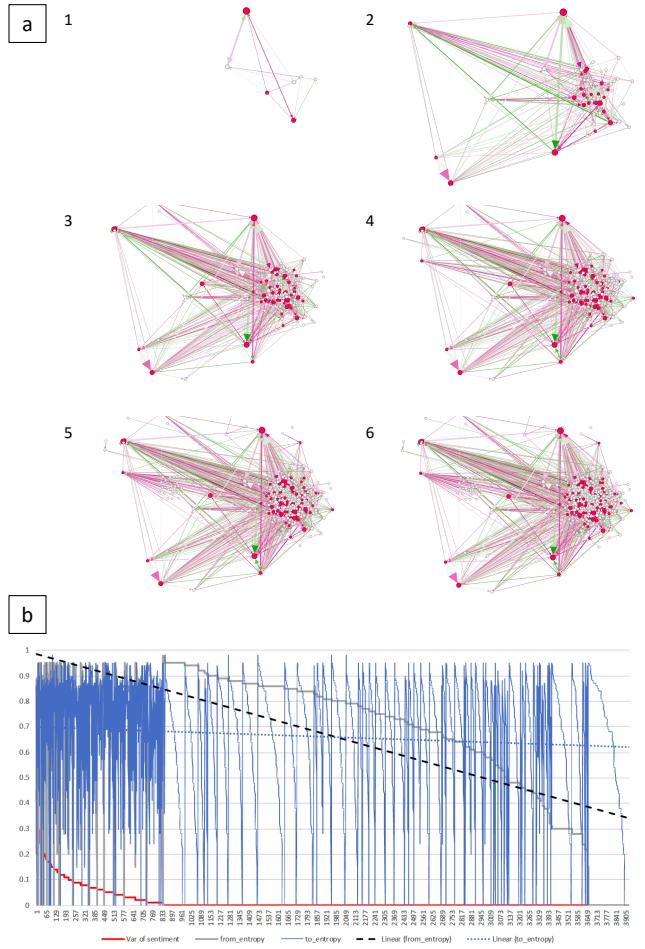


Figure 5: Co-Evolution of Network and Sentiment: (a) across 6 equally spaced time stamps, and (b) sentiment dynamics between two users.

2. Entropy (from incoming interactions): the entropy of the observed user is defined as the Shannon entropy:

$$H(X) = - \sum_i^n P(x_i) \log_2 P(x_i), \quad (1)$$

where for n incoming interactions and $P(x_i)$ indicates the probability that the interaction is from the same community as the observed user. Minimum entropy is achieved when either the interactions are from its own echo chamber or entirely from another - meaning the user will imminently switch loyalty. We can see that the incoming entropy remains very stochastic whilst variance is high, and then gradually decays over time. This is reflected by the negatively sloped linear regression.

3. Entropy (to outgoing users): Likewise, this entropy measures the distribution of posts to its own vs. other communities. We can see that the incoming entropy remains very stochastic over the full subreddit history, indicating that this user plays a vital role between communities. This is reflected by the relatively flat linear regression.

4. CONCLUSIONS AND FUTURE WORK

In this paper, we have analysed the data extracted from Reddit on the Russian intervention in Ukraine recently, with a specific focus on the 2019 Ukraine election time period. In a diverse and under-resourced language landscape, we conduct NLP to understand the topics involved, and the evolving sentiment signal with the online social network topology transformations. In terms of conflict between echo-chambers, we show that using the individual users' sentiment signal properties (e.g. variance and entropy), we can discover not only its interactions in and between echo-chambers, but also hypothesize its role in their formation and evolution. Future work will conduct the analysis within polarised communities and between them and make predictions on radical behaviour emergence.

5. ACKNOWLEDGMENTS

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