From Complexity to Intelligence – project report

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Github: https://github.com/AlessandroArtoni/athens_cross_entropy_fake_news

The focus of my studies is currently fake news. Towards the European elections, it would be interesting to see if fake news spread influenced Italian European campaign, so I am currently collecting tweets that share articles from fake news sources. During the course I wanted to understand if complexity has an impact on misinformation diffusion.

Can fake news complexity be measured?

It turns out that when talking about fake news, it is well-known they can spread virally[1] often using click-baiting strategies to catch your interests leveraging on the "surprise" they give to you. So instead of measuring "complexity" it could be more relevant to consider surprise.

What is surprise?

Imagine you have a big box with 100 balls inside. You have been told that there are 99 balls blue and 1 red. If you draw the red one, you're surprised by the fact that among all the other balls you were able to draw exactly the red one.

How can surprise be evaluated?

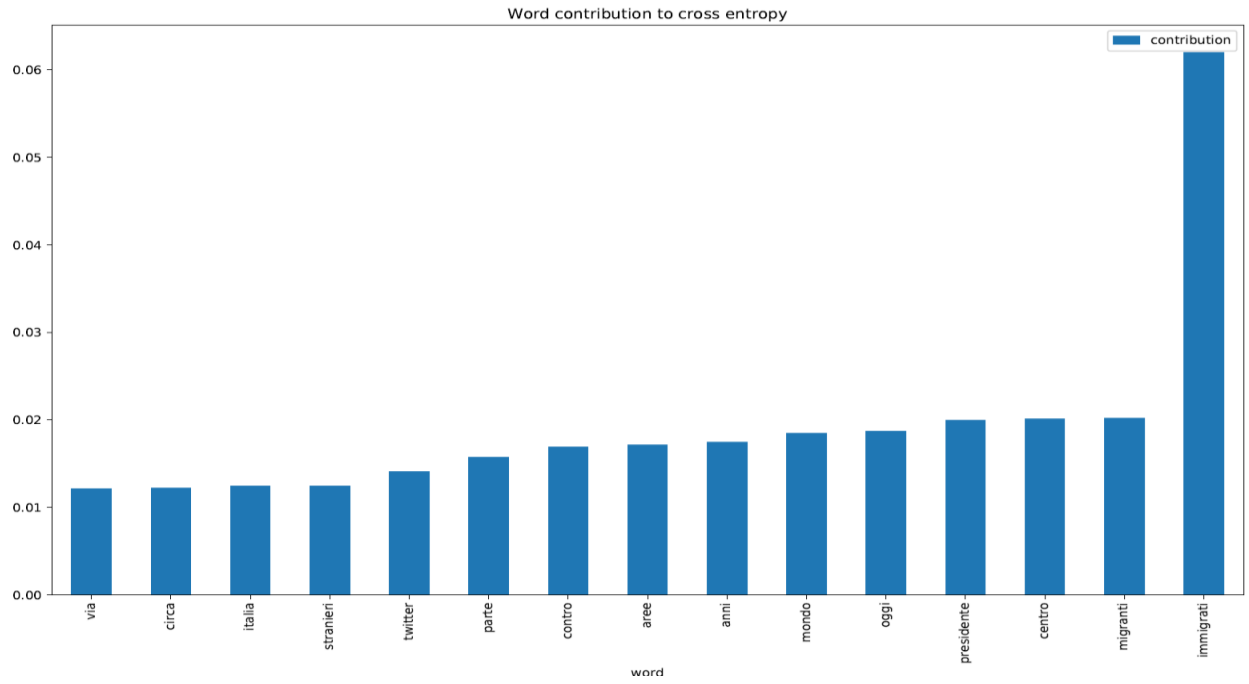
Shannon defined cross entropy, a metric to compare the minimum theoretical encoding size of a message, and the real encoding size. Thus, if cross-entropy is high it means that we have a lot of messages with different probabilities. Hence, each time a message arrive you expect a different one from the previous messages. You can think of cross entropy as surprise.

Given p and q two distributions, X the vocabulary of all words and x a word belonging to that vocabulary, cross entropy is defined as follow:

$$H(p, q) = -\sum_{x \in X} p(x) \log q(x)$$

Where, in my case, p was the true distribution of words in articles collected from ansa.it (a press agency) and q the distribution of words in fake-news articles.

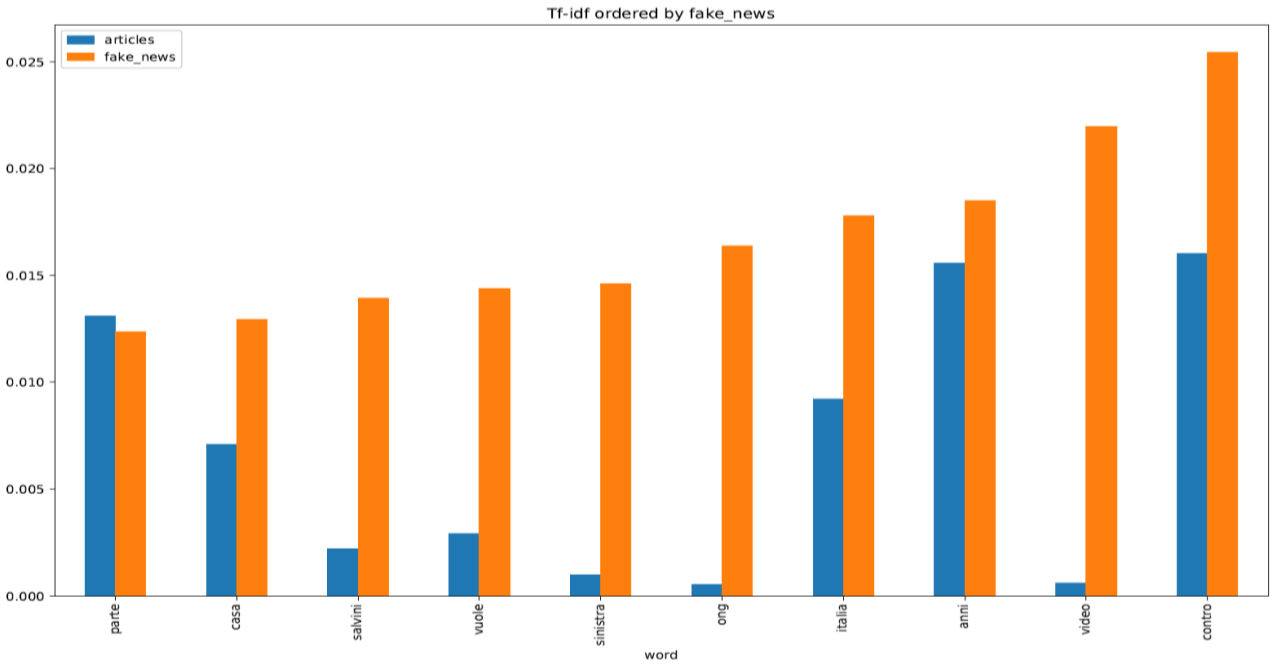
Results



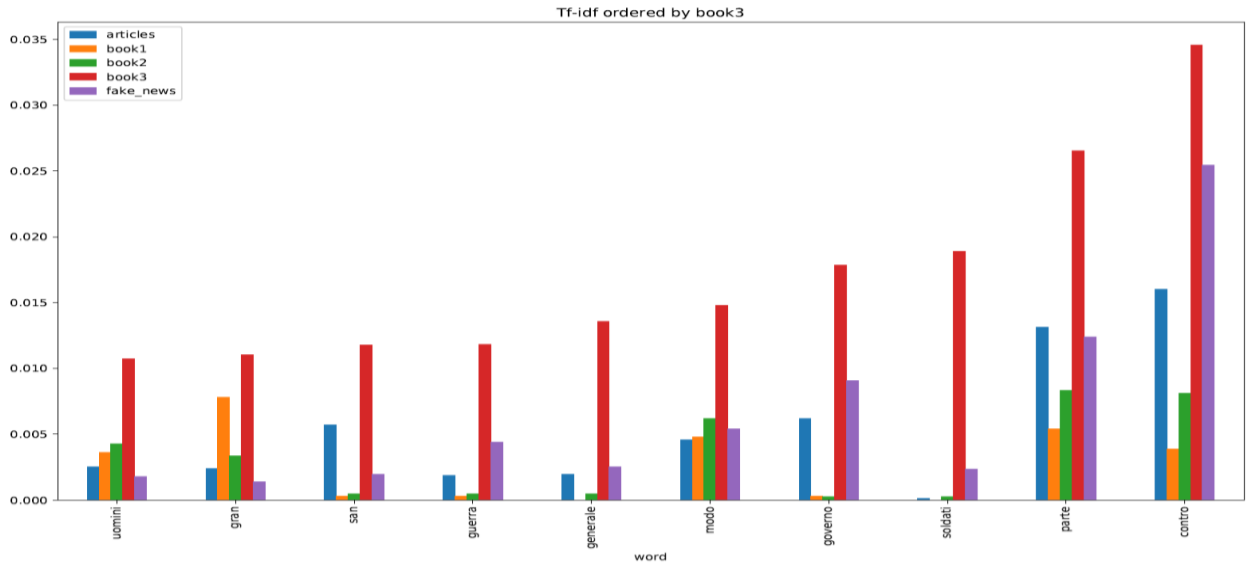
From the graph, the most unexpected words are 'immigrants', 'centre', 'president'…

Having these results, I wanted to compare these with another metric, tf-idf so I considered more documents, in order to have some relevance in the rarity of a term, choosing some open books found online ('Una donna', 'Il re bello', 'Storia d'italia 1796-1815') from "The Gutemberg project"[2]

The results I had were a little bit different from the cross entropy:



The words that are in both plots are: “years”, “counter”. Migrants is ranked only 20th. Interestingly, plotting tf-idf of all the documents selected, the most similar one to fake news was the “Storia d’Italia 1796-1815” which also had “counter”, “part” and “government” (which is 11th)



Conclusions

Even if cross entropy does not seem to behave consistently compared to tf-idf, it looks that catches the main words of fake news, reporting immigration as one of the most surprising one, and the main actors (Salvini, pd, left).

Nowadays, there are more sophisticated method to detect fake news that leverage on the difference between facts and fake news network diffusion[3]. Anyway, it can be interesting to see if cross entropy could be used as a feature for a fake news classifier.

[1] X. Qiu, D. F. M. Oliveira, A. S. Shirazi, A. Flammini, and F. Menczer. Limited individual attention and online virality of low-quality information. Nature Human Behavior, 1:0132, 2017.

[2] http://www.gutenberg.org/

[3] S. Vosoughi, D. Roy, and S. Aral. The spread of true and false news online. Science, 359(6380):1146–1151, 2018.

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