HOW MIGHT TECHNOLOGY COUNTER

THE SPREAD OF DIGITAL FAKE NEWS ON SOCIAL NETWORKS?

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On April 1st, 1957, the BBC has broadcasted a documentary called "Spaghetti-Harvest in Ticino" commented by Richard Dimbleby (famous and respectable TV journalist). In this video, it shows three Swiss farmers collecting spaghettis from trees and laying the crop in the sun to dry. At that time, spaghettis were not common in English meals. Therefore, 8 million of people have watched this documentary, and hundreds of calls have been made to know more about this "new" agricultural activity. First April Fool's Day hoax or first fake news on television? Reactions and comments, positive and negative, have followed the publication. The TV channel has justified it as a lesson to be learnt : we cannot believe everything we can hear/watch/read. Nowadays, after various scandals, including the US presidential elections in 2016, concerns rise about the spread of digital fake news. Thanks to various articles, I will try to define the concept of fake news and the different propositions to counter the epidemic.

Introduction

There are more than just one definition of "fake news" because the concept is fuzzy.

A simple first meaning would be to put in opposition fake with real news. According to a binary and simplistic definition, a fake news is a *"factless or slanderous"* information (Fake news: belief in post-truth, p.1). In this case, satire articles are considered as fake news. However, nowadays, some famous sites of news satire are well known to public (e.g. NewsBiscuit in UK, Le Gorafi in France, The Onion in USA). Their articles are produced to hold celebrities, politicians or absurd facts of daily life up to ridicule, but it is difficult to confuse them for a real fact by verifying the author/website. Moreover, *"if readers are aware of the humorous intent, they may no longer be predisposed to take the information at face value"* (Deception Detection for News: Three Types of Fakes, p.3). Therefore, this definition doesn't seem complete : there is a notion of breach of trust and awareness that must be included in the explanation of "fake news" concept.

"Misleading information that has the function of misleading" is a definition provided by Amy Fry in a report entitled "A Brief History of Fake News" (p.1). A fake news has a malicious intention to deceive readers by providing them with unreal facts as if they were correct facts. On the contrary, satire relies on absurdity to make claims and identify itself as satire. A real news is supposed to have a higher degree of transparency to make and present the arguments.

A difference of language

B. Horne and S. Adali, from Rensselaer Polytechnic Institute, have published a research about the differences between fake and satire, real news. By examining three data sets, they have tried to understand the syntax of fake news. They have proved that the common assumption "fake and real news are written similarly" is wrong. Indeed, carefully checking the reliability of the article, by assessing the author and website, is not the only clue to uncover a fake news. Readers can also rest on the syntax of titles and contents of articles. As a result, this study could help to build an automated system to categorize articles and information.

Each article of the data sets has been examined according three categories (stylistic, complexity and psychological). First of all, there is the stylistic feature in order to understand the syntax, the text style and the grammatical elements of an article by counting the number of stop words, punctuation, quotes, negations, swear words, words in capital letters. Then, the complexity feature is made of two levels : sentence and word. On the one hand, the sentence level, we compute the number of words per sentence and the syntax tree's depth of each sentence (using Stanford Parser). If the average number of words per sentence is high and the syntax tree is deep, it means the average sentence complexity is very high. On the other hand, the word level, a score is given to the article according to the number of syllables in words, the TTR (=number of unique words divided by the total number of words in the document) and the fluency (frequency of a word compared to English corpus). It is made to understand the readability and the lexical diversity of a document. Finally, the psychological feature is the basis for the sentiment analysis of an

article. It measures the intensity of positive/negative emotion contained in each document with SentiStrength tool.

Using machine learning and data mining techniques (like Support Vector Machine algorithm), researchers have discovered that fake news use fewer punctuation, quotes, technical words and nouns. Moreover, fake articles use more adverbs, personal pronouns and capitalised words. Words are smaller with an important lexical redundancy : there is less substantial information and it's more self-referential. Besides, title is an important differentiating factor between fake and real news articles. By using only four features (percent of stop-words and nouns, average word length, the readability score) for the comparison, the accuracy of identification is between 71% and 78% (according data sets of titles) and between 71% and 77% (according data sets of contents).

However, satire news have a journalistic style similar to fake articles. Indeed, satire do not create sound arguments but, like fake news, they often make absurd claims without domain specific knowledge and a reasonable analysis. Therefore, separating them is made with an accuracy of 67% by analysing the content and 55% by examining the titles.

This study underlines that fake articles have a very specific journalistic style compared to real news. Nevertheless, it is more difficult to differentiate fake news and satire news: therefore, it requires more vigilance. Being able to identify quickly a fake article by its writing style is an important progress in the research about the spread of fake news. However, it is necessary to remember that skimming an article to have the main subject is a danger. Indeed, the title of an article can help to classify the article but it is also important to read the content in order to know if the claim is well supported by arguments and not redundant.

Influence of fact-checking platforms

As the report entitled "Hoaxy: A platform for Tracking Online Misinformation" explains, social networks bring an innovation compared to traditional websites: users of Facebook or Twitter are direct participants in the dynamic of the propagation of news. On the one hand, it gave *"a more egalitarian model of information access"* (p.1) but on the other hand, there is no authority to control the stream of news. Moreover, those information environments encourage *"low content diversity and strong social reinforcement"* (p.1). Therefore, a social network is a perfect place for fake news: misinformation perfectly matches this criteria of low content (cf. A difference of language) and, by definition, social networks are websites which enable people to share and communicate news to friends. In order to unmask the majority of misinformation, many fact-checking platforms were born during the past few years.

Snopes: the reference website regarding fact-checking

Snopes.com is a famous fact-checking organisation, defined as "a popular website documenting memes and urban legends". According to the study entitled "Rumor Cascades", its aim is to *"document the spread of the rumor […] and to determine its truth value"* (p.1). All articles from Snopes have a similar form. The title of an article is expressed as a question (e.g. Is Willie Nelson seriously ill?). Then, the content of the article is made of a claim explaining the polemic (such as Willie Nelson fell seriously ill in May 2018), a rating (i.e. the verdict of the fact-checker), the origin of this rumour, the name of the fact-checker, the date of publication of the article and a video, which summarises the column.
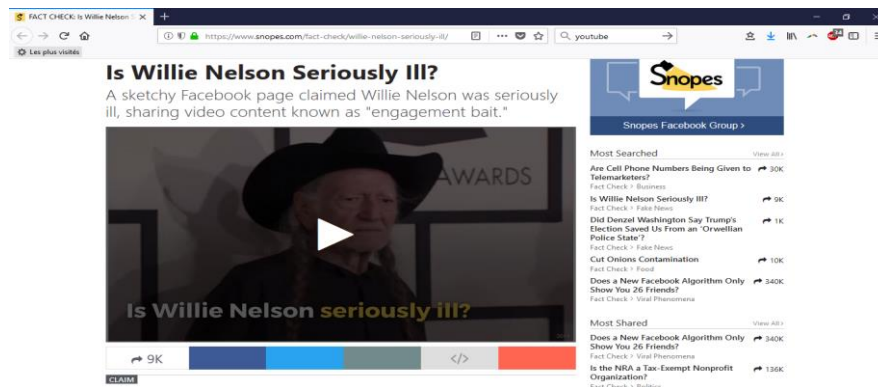
Extract of a Snopes article, published on 7th of May 2018, about the rumour "Is Willie Nelson Seriously Ill?".

The report "Rumor Cascades" examines the impact of Snopes articles on the rumours cascades on Facebook. The first part of the corpus is made of 4761 rumours collected on Snopes about diversified topics (for example, 22% of the articles are related to politics). 47% of those stories are false, 26% are true and 27% are unclassified (members of Snopes were not able to verify the rumour or the story is partially authentic). The second part of the corpus is made of 249035 comments, containing a link to a Snopes article, on photos or shares of photos from Facebook. Researchers have identified 16672 individual cascades with more than 62 millions of shares in this second corpus. By limiting the data to one rumour per photo, they have excluded 1.9% of cascades.

Firstly, they have concluded that false rumours are more likely to have a comment referring to an article from Snopes. Furthermore, it is also likely to happen faster after being posted for a fake news. Secondly, politics, food, crime and medical photos are over-represented on Facebook compared to Snopes articles. In the same way, false stories are more present on Facebook than on Snopes (62% against 45%). However, true rumours tend to become more viral (163 shares per upload for genuine rumours vs 108 shares per upload for false stories).

Finally, the most interesting conclusion is what happens after a Snopes link is added to the comments of an image: *"reshares about false rumors are 4.4 times […] as likely to be deleted when snoped than when not"* (Rumor cascades, p.6). Furthermore, even if the reshare is not deleted after a Snopes comment, the probability of resharing information decreases once a Snopes comment has appeared. However, we can notice that a comment from Snopes has a short-term effect. As Facebook promotes the most recent comments, a Snopes link will tend to become less visible after a while. Added to the fact that users do not read all comments before resharing them, this may explain the temporary effect of a Snopes comment.

In conclusion, Snopes is a reliable option to counter the propagation of fake news on Facebook, and even more generally, on social networks. However, it is consuming in term of time and effort: the first step of the process for a fact-checker is to detect a viral and intriguing rumour. Indeed, an article on Snopes is created further to a first propagation of a rumour. The aim is to detect quickly any suspicious rumour to minimize its impact in case of a fake news. Thereafter, a Snopes fact-checker needs to do his own researches before he can conclude by writing a summary of his work. It requires a lot of energy and it is legitimate to wonder what the time lag between the spread of a fake news and the fact-checking of this rumour is.

Hoaxy to track the spread of rumours

Hoaxy is a different platform : its aim is to track how the social news are shared. Visitors of the platform, like journalists or scientists, can assimilate the chronology between the three steps for an online misinformation news: its production, its spread through social networks and its process of fact-checking

thanks to visualisation tools of Hoaxy. Moreover, it allows to see how users share differently this kind of information.
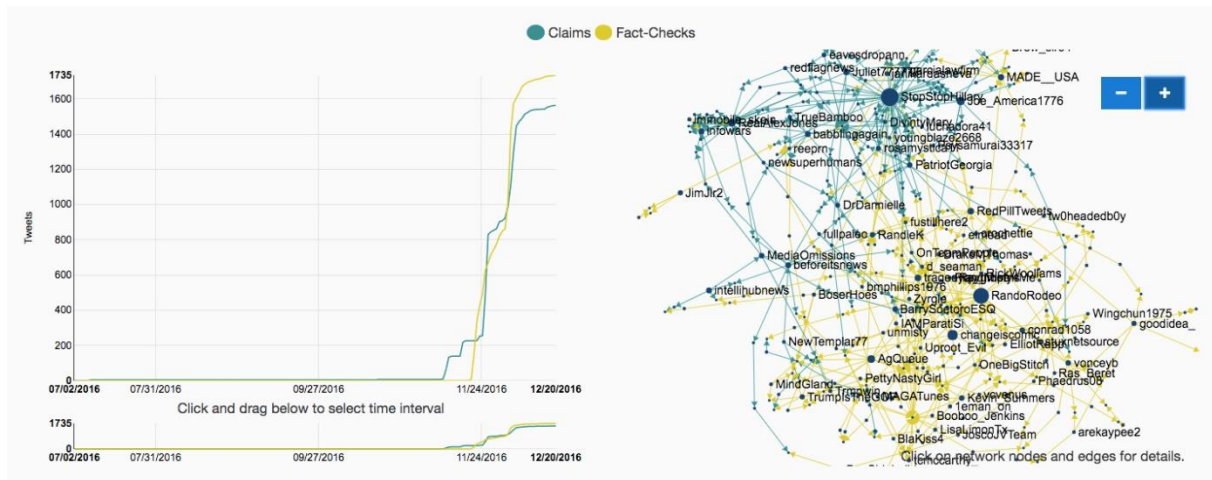
Example of Hoaxy graph representing the chronology of rumours and fact-checks of rumours.

The platform obtains data from news websites (to collect the origin, the evolution of news and their fact-checking process) and from social media (in order to collect URLs shared online). Different techniques are used to obtain this data, like web scraping or the APIs of social networks platforms. Firstly, when a website is added to the database, a "deep" crawl (i.e. depth-first algorithm) is performed to understand the link structure using the programming language Python. If it is possible, there is the identification of the URL of RSS feed. Then, regularly, a "light" crawl (i.e. breadth-first algorithm) is made by checking the updates of the RSS feed. Finally, all those information are stored into the database to provide an interactive dashboard in the future.

In the analysis provided by "Hoaxy: A Platform for Tracking Online Misinformation", scientists have collected tweets during three months about fake news (excluding satire news), from 71 domains, and fact-checking articles from six popular websites (Snopes.com, PolitiFac.com, FactCheck.org, OpenSecrets.org, TruthOrFiction.com, HoaxSlayer.com).

Table 1: Summary statistics of tweet data.

source	N_{sites}	N_{tweets}	N_{users}	N_{URLs}
fake news	71	1,287,769	171,035	96,400
fact checking	6	154,526	78,624	11,183

Composition of the corpus for the report "Hoaxy: A Platform for Tracking Online Misinformation"
made of sites, tweets, users and URLs.

First of all, logically, we track more fake news tweets than fact-checking tweets (probably because of the lag between fake sites and fact-checking sites). It is interesting to notice that there is a correlation between the activities of misinformation tweets and fact-checking tweets i.e. there are same peaks of fluctuations for particular dates. Therefore, scientists have measured the similarity between those two-time series. They have concluded that fake news tweets always precede fact-checking tweets: the characteristic lag between the beginning of a fake news's spread and the fact-checking's one is around 13 hours.

Secondly, tweets are categorized as original or retweets (80-90%), quotes and replies (10-20%). Scientists have measured the activity of users by counting the number and the popularity of tweets (for example, the number of times this URL was tweeted). They have discovered that fact-checking tweets

have more replies and quotes (20%) than fake news tweets (10%) : we could say that *"fact-checking is a more conversational task"* (p.4). Moreover, the globality of tweeter accounts share more retweets than original tweets, as fake news as fact-checking articles. However, for the 1% most active tweeter accounts, fake news are more promoted by original tweets than retweets. It tends to confirm that misinformation is created by a handful of super active accounts (likely social bots) whereas fact-checking is more a popular business.

In conclusion, thanks to the Hoaxy platform, the time lag between the creation of a rumour on social networks and its fact-checking has been estimated at 13 hours. Therefore, it confirms that the "manual" fact-checking by the journalists can be efficient in reducing the spread of a rumour over a short period. Famous companies, like Google for YouTube or Facebook, are using this methodology of fact-checking. However, as it is excessively energy consuming, new ideas are proposed and begin to be developed.

Efficiency of algorithms
The spread of fake news is a curse for social networks. Frequently, criticisms are formulated against Facebook, Twitter or Weibo because the lack of control over the published information has the exceptional power to affect millions of people. Aware of the problem, those companies are investing in different methods to counter the spread of fake news.

Crowd-powered procedure
Various areas, as web security or spam detection, use the feedbacks from the crowd to improve the quality of the process. To reduce the impact and the propagation of fake news, the crowd-powered procedure became a popular method for social networks. When an user is exposed to an article through his news feed, he may choose to report this news as a fake one. Then, third-parties, paid by the social network, will apply a fact-checking process, similar to the one of Snopes.com. The article will officially be declared as trusted news or misinformation. In consequence, the social network could take actions such as deleting the article or downgrading its visibility, hoping it would decrease the impact of the rumour. The report "Leveraging the Crowd to Detect and Reduce the Spread of Fake News and Misinformation" underlines encountered difficulties of common crowd-powered procedures. The first obstacle is the uncertainty about the number of exposures. Indeed, it depends on the subject of the article, the weight/recognition of the publisher and the influence of the user, who shares or comments the news. Secondly, the cost of fact-checking is important (cf. Snopes: the reference website regarding fact-checking) and the algorithm should take into account this fact.

Therefore, this study has developed its own algorithm, named CURB, by mixing the information from the crowd (i.e. flags) and the expert knowledge (i.e. fact-checking organisms). Firstly, it simulates the number of users affected by news as a stochastic process (i.e. random process evolving with time). Furthermore, the innovation of this method is to decide *"which stories to fact check and when to do so"* (p. 2). Then it follows that the article will need to receive a certain quantity of flags before being sent to fact-checking organisations. In consequence, CURB will try to find a trade-off between the number of flags (called "misinformation evidence") and the number of limitations of exposures before the fact-checking process (named "misinformation reduction").

The first step in developing the algorithm was to represent the complex process of the news broadcasting on social networks. Two type of actions were defined. On the one hand, there is the exogenous event, *"which correspond to the publication of stories by users on their own initiative"*. On the other hand, there is the endogenous event, *"which correspond to the resharing and/or flagging of stories by users who are exposed to them through their feeds"* (p. 3). Both events are characterised by the user, the subject of the article, the time t of the action. Furthermore, the endogenous event depends on the decision to reshare or not and to flag it or not (simulated as a Bernoulli distribution). Then, CURB

will estimate the rate of misinformation of the story thanks to the number of flags and estimated exposures. The algorithm will update *"its belief about the best time to fact-check based on how quickly the story is spreading as well as what is the likelihood that the story is misinformation"* (p.5).

CURB has been tested on a dataset of 28 486 posts/reshares from 18880 users on Twitter. There were 7 fake articles and 39 authentic stories. The algorithm has also been controlled via a dataset of 93 943 posts/reshares from 88 913 users on Weibo for 23 fake news and 133 genuine articles. The precision of classification and the misinformation reduction of CURB were compared to another algorithm, named Oracle. Results are relatively similar, which tends to prove the efficiency of the procedure.

In conclusion, CURB allows to increase the impact of a crowd-powered process. However, it assumes that every user reports equally misinformation: it will be interesting to build an algorithm able to counter *"adversarial behavior from part of the crowd"* (p.8) (cf. Point process-based intervention). Moreover, CURB considers that stories are independent from each other in order to simplify the problem. Another assumption limits the reliability of the results from the algorithm: once the story has been sent to a third-party, the article has been directly classified as fake or authentic. As it was explained previously (cf. Hoaxy to track the spread of rumours), the time lag between those two events is around one day.

Point process-based intervention

As the research "Fake News Mitigation via Process Based Intervention" underlines it, issues can also come from the community support. Indeed, this study takes the example of Facebook : by allowing its users to report a potential fake news, the mechanism can be used maliciously in order to contest real news with an opposite point of view. It can also be an unconscious process: the report "A Brief History of Fake News" has explained this backfire effect. Internet users assimilate more easily information reinforcing their existing opinions. Therefore, they can resist facts which are not in agreement with their personal believes. Moreover, if the fake article shares the same state of mind of an individual, correcting misinformation would not change the trust in the fake article : it would just reinforce the trust in the fake news and facilitate the process of the conspiracy theory. This phenomenon is also called the "post-truth society" (cf. Misleading problem). Finally, we can also mention the case of "trolling". This unformal word, often assimilated to the spread of satire news, became a tendency during the last previous years. For those reasons, scientists are searching for alternatives to the crowd-powered procedure.

The strategy of this study "Fake News Mitigation via Process Based Intervention" is to optimize the spread of real news on the social network. The objective of the mitigation process is different from the other propositions because it does not try to decrease the number of fake news but to reduce their influence by *"ensuring that people […] are also exposed to real news"* (p.1). Therefore, one of the complexities of this research has been to accurately quantify the user activities and the spread of news. The solution is to model the network as a multivariate Hawkes process with self and mutual excitations. Mathematically, the optimisation of the network is formulated as a Markov decision process (MDP), which can be solved by the model LSTD (i.e. least-squares temporal difference). Another issue has been to measure the effects of the algorithm: quantifying the impact of fake and valid news is made by counting event exposure i.e. *"the number of times that a user is exposed to fake or real news posts from other users whom he follows"* (p.1).

Nevertheless, this report has limits. For example, there is a powerful assumption: on a social network, an user pays close attention to all the events and activities of his friends. Therefore, in order to improve the efficiency of the algorithm, it could be interesting to estimate the probability for an user to be online and to be attentive to his feed news. Moreover, researchers are aware that *"the content-neutral real-time experiment does not perfectly represent fake news processes"* (p.13). In conclusion, the point process-based intervention has produced good first results but the introduction of deep neural nets or nonlinear features could be useful to perfect the procedure.

Misleading problem

Finally, the report "Fake News: belief in post-truth" broaches the subject of fake news differently. According Nick Rochlin, someone can be exposed to incorrect rumours without classifying them as "fake" because this rumour is in agreement with his own believes. With the development of social networks, a person can now choose to create a sealed and (partly) controlled environment where pleasant news (i.e. news which do not challenge a personal conviction) will be approved and other disturbing news will be ignored and censured/unfollowed. As Mark Zuckerberg has explained in 2016, *"the power of Facebook is that you control what you see by who you choose to connect"* (Fake News: belief in post-truth, p.2). Therefore, conscientiously or not, an individual will seek medias *"where those beliefs are unlikely to be challenged"* (p.2) : it is known as the selective exposure theory. In consequence, when a person will be exposed brutally to an uncomfortable and challenging news, this article will be described as a "fake" because it does not comply to personal believes, as the other news did.

The study also focuses on the purpose of the creation of a fake news (poor content, surprising story, a title in the form of a catch line, published on a site which looks like a real news website). In fact, the author of a fake news hopes that his article will become viral in order to receive an important number of clicks (and therefore, earn more money in advertising). As a *"fake news is a provocative headline that is shared and believed at face value, with no thoughtful investigation"* (p.3), Nick Rochlin underlines that the sharing of a fake article happens because the user already believed in (or was not really surprised by) the title of the news. The degree of truth of the article does not really matter: this article just gives an individual the possibility to express his own opinion. For example, if a person shares an "obvious" fake news about an increase of rapes or robberies, this can demonstrate the feeling of insecurity from the reader. In consequence, the author of fake articles will deliberately target his public and will adapt the content of the news to provoke reactions and clicks. Thereby, all techniques to unmask fake articles have difficulty impacting the spread on social networks because readers want to believe in those news.

Furthermore, techniques of classification of articles can be contested according to the personal belief of a social network user. In this study, the attempt to establish a bibliography of fake news websites in 2016 by Melissa Zimdars is mentioned. This corpus of sites is composed of 11 various types: fake news, satire, extreme bias, conspiracy theory, rumour mill, state news, junk science, hate news, clickbait, proceed with caution, political and credible site news. However, as Nick Rochlin points out, this system can only be considered as effective and efficient if the reader shares her political/ideological point of view.

The famous rumour "Obama was not born in USA" is a perfect example. Indeed, Polling Report published in 2012 that more Republicans followers believe this rumour to be genuine than Democrats supporters (33% against less than 19%). Thereby, an article named "The proof that Obama was not born in USA" could be classified by a reader as a conspiracy *"from hate news sources with extreme biases"* (p.4) or as a reliable news. The categorization will be influenced by different factors, including the political opinion of the individual. Regardless the chosen classification, readers will feel *"assured that their own belief is backed by credible"* (p.4) sources and proofs. According Nick Rochlin, this is a characteristic of the *"current post-truth society"* (p.4): *"facts of the matter are of secondary importance to free-floating opinion characterized by a willful blindness to evidence, a mistrust of authority and an appeal to emotionally based arguments often rooted in fears or anxieties"* (Laybats and Tredinnick, 2016, p. 204 according to Fake News: belief in post-truth, p.6). The study "Leveraging the Crowd to Detect and Reduce the Spread of Fake News and Misinformation" has explained that this resistance to evidences also involves *"factual rebuttals"* presented by *"media or independent experts"* (p.1).

Moreover, the report explains that the current plug-ins detectors of fake news are not efficient. Firstly, the decision of installing a such plug-in is correlated to the critical state of mind of an Internet user: the epidemic of fake news usually comes from people who did not take time to verify the arguments of

the articles. However, installing a detector of fake news is an act of involvement from the reader and requires time. Secondly, these plugins are based on a list of reliable and unreliable websites, similar to the bibliography of Melissa Zimdars and therefore, subject to the same criticisms.

To conclude, Nick Rochlin expressed his concern about the clickbait system. As the production of fake news can be a very lucrative work (advertising revenue up to $10,000 for an article), those authors will always try to defeat censor tools. During an interview of BBC in 2016, Allan Montgomery, the author of at least ten fake news websites, has explained that social networks have already tried to stop the spread of fake news. However, more and more inventive ways (like multiplication of websites) are created to beat these censors. In consequence, according to Nick Rochlin, the society should not be focused on the development of tools to avoid the spread of fake news: Internet community should seek an alternative way to the clickbait system.

Conclusion

The spread of fake news is deeply linked to the social networks: nowadays, the popularity of Facebook and Weibo continues to increase while the consequences of misinformation become more and more serious. As users and journalistic world raise concerns about this epidemic of non-genuine stories, research in the field of information propagation has become a top priority for most famous social networks like Facebook and Twitter. This report aims to summarize a few of the most interesting progress of the previous years.

First of all, contents and titles of fake articles are syntactically different from those of authentic news. Indeed, fake articles are characterized by a high redundancy, a lot of self-referential or emotional words and few valuable arguments. This conclusion is widely used to accelerate classification of news by fact-checkers organisations and algorithms for regulating articles.

Furthermore, studies have showed that fact-checking websites, like Snopes.com, can affect positively the spread of news. Indeed, a comment with a reference to a Snopes article on a fake story post will multiply the probability of the erasure of this post. Even if it is not deleted, it would decrease the probability of resharing this fake information.

Nevertheless, as fact-checking process is consuming in term of energy, other solutions have been developed like the crowd-powered procedure. The principle is to take advantage of the community: if an important number of users declare a story as doubtful then a third-party will assess the degree of truth for the article. Thereafter, the social network will be able to take actions to limit its propagation as downgrading or deleting the post. In addition of the crowd-powered procedure, we can also mention the point process-based intervention, a powerful algorithm whose aim is to promote the spread of real news.

Finally, platforms, like Hoaxy, were created to track the spread of a rumour from its creation to its fact-checking verdict. The conclusion is that fact-checking is a relatively short process. However, a few researchers have underlined the complexity of regulating the spread of fake news. In a "post-truth society", readers tend to refute evidences from an authority (like traditional media websites) in favour of their own believes. Relying on fears and emotions, fake articles are easily accepted as true because they are the expression of the reader's feelings. As the clickbait system rewards the popularity of an article, writing fake articles became an effortless and profitable process for malicious "journalists".

To conclude this report, the spread of fake news can also be related to various current social issues like the limits of the free expression or the micro-targeting system. Also known as behavioural advertising, this process can determine the perfect article for an Internet user but it can be extended to display manipulative fake news in agreement with the convictions of the reader. Moreover, we can wonder what is the degree of personal responsibility for sharing fake news: as it was explained previously, this process can be conscious or unconscious. The real question may be "how to raise awareness among

society about fake news?". Nowadays, urgently, the Internet community needs answers to this problematic.

Advert in Kuala Lumpur from Telekom Malaysia. Photo: Mohd Rasfan (AFP)

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