



Understanding and Combating Fake News: A Review Study

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Abstract

Fake news presents a significant problem in today's online landscape - it influences trust and public opinion in many media outlets. With the mass usage of social media and live news, many people are prone to misinformation due to many psychological and environmental factors. Previous case studies have demonstrated that the effects can be very disastrous. Many people are also abusing new technological advancements to carry out their malicious intentions. However, there have been many fruitful efforts using human intelligence and these new technologies to mitigate this threat, but there is still more that people can learn and apply to fully stop the spread of fake news.

Keywords: fake news, misinformation, deepfakes, machine learning, confirmation bias, social media

Introduction

As shown in Figure 1, within the past couple of decades, there has been a surge in the use of social media apps such as X (formerly Twitter), Instagram, and Facebook. This drastic increase in social media activity has also led to an unanticipated quantity of information being introduced and spread widely among users. Due to the popularity of these apps, however, fake news has found these apps to be platforms to feed many with misleading information. People responsible for deceptive content have adapted to measures meant to reduce fake news dissemination and have found new, more dynamic ways to spread it. Since the consequences of fake news can be devastating, there is a crucial need for a consistent and efficient solution to this epidemic. Innovative use of technology and analysis can play a key role. This paper sheds light on the complex challenge of the propagation of online misinformation, analyzing notable case studies and reviewing existing detection methods. Furthermore, this paper examines psychological factors that make people susceptible to fake news online, discusses various measures to reduce its impact, and provides particular attention to deepfakes as an example of modern technology used for deception.

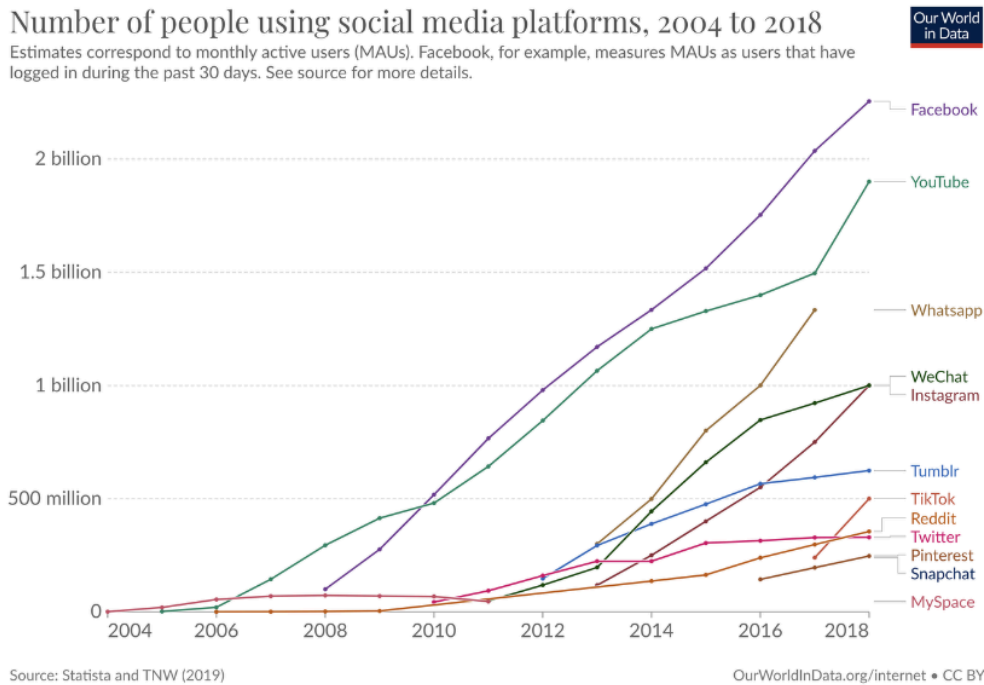


Figure 1: The graph above displays the rapid growth of many dominant social media platforms from 2004 - 2018, except for MySpace, the first popular media platform. [1]

Background

Fake news is a dangerous form of misinformation that is intended to manipulate people's opinions and actions based on sharing a falsehood. Fake news spreads through articles, social media apps like X, or other media outlets such as videos and images. Different types of fake news include false stories that are conceived with no factual reasoning, polarized content that manipulates the audience's emotions by exaggerating only one side of an issue, misreporting that contains a true story with omitted factual information, and factual errors that affect the story's credibility. Additionally, biased commentaries describe an author's interpretation of the subject as fact, while satire that was meant to be taken as a joke can still become as viral as a factual statement. From all of these different types of misinformation, it is essential to investigate people's susceptibility to fake news. Many factors contribute to how and why fake news is propagated, and instead of being cautious, many people believe disinformation pretty easily. One of these factors may be a lack of media literacy, which is something that others can't control and affects a wide range of demographics. For example, people who live in rural areas with limited access to resources and technology education may be inexperienced with the internet and unaware of any signs of illegitimacy in online media. This lack of digital literacy can be applied to older people, who did not grow up with advanced digital technologies. Although younger audiences still lack the evaluation skills needed to discern if news can be fake, older people may have trouble navigating online networks.

While physical limitations exist, there is also a psychological aspect. People typically invoke emotion when they see someone or something they can personally relate to. Thus, people who see media or news articles whose content aligns with their beliefs tend to trust that

information. More uncontrollable factors exist - bad actors (known as lone wolves) take advantage of social media algorithms and create an abundance of social media bot accounts for the sole purpose of spreading false information. These fake accounts can amplify the speed at which fake content spreads because so many different accounts repeat the same information and show direct support for the information as social media algorithms push that content to more people's pages. These accounts are even capable of intercepting online discussions to appear genuine and gain influence so the credibility of their false content increases. While studies show that humans play a significant role in spreading false information on X, bots contribute to the acceleration of both true and false information. For this reason, solely removing bots will not eliminate the spread of fake news. More dummy accounts can be created, and real people who believe misinformation can echo and spread it, causing fake information to be spread faster than genuine information. The largest study that examined over 126,000 rumors on X over 11 years revealed that false information spreads significantly farther, faster, deeper, and more broadly compared to true information. The study shows that the top 1% of false tweets reached over 1,000 users whereas true posts did not get this level of engagement. This means that on X, false information reaches more people than true information [2]. Parties who spread fake news abuse these phenomena to create false content that appeals to audiences holding certain ideologies, leading to potentially detrimental effects on human society. Fake news can severely affect people and cause disastrous consequences on financial markets and political events. People can face severe harassment, lose their reputation and credibility, and suffer physical and mental injury. A company's stock price is extremely vulnerable to being influenced by misinformation. Millions of fake stories painting someone in a bad light can overwhelm them with anxiety and panic. Violent protests and social unrest can be the result of disinformation that argues for distrust against policies and authorities.

Case Studies

Probing into specific cases where fake news has caused great distress reveals how devastating fake news can be from individual well-being to broader economic and political consequences.

2016 POTUS Election

The infamous 2016 U.S. Presidential Election between Donald Trump and Hillary Clinton sparked several heated controversies. A significant factor that fueled these debates was the immense amount of misinformation being spread about the candidates. This created many heavily influenced perceptions and influenced the voting decisions of the general public. A large piece of misinformation can be tracked to 11 September 2016, when a disingenuous article contained a false story that said that tens of thousands of fraudulent ballots in favor of Hillary Clinton and other democratic candidates were found hidden in an Ohio warehouse. To make their case more significant, the article also shows an altered image of a man moving multiple labeled crates that had ballots inside them (as shown in Figure 2). This story was later investigated and confirmed to be false. The original picture was taken in Birmingham, England in 2015 and was slightly altered to make it hard to find the original, depicted in Figure 3. Nevertheless, there was major potential for something devastating to happen as the story reached more than 6 million people. However, the damage to the integrity of many people involved in the presidential election still existed. There was an intense amount of political disagreement and anger because the reputation of Hilary Clinton, the Democratic presidential nominee at the time, was severely damaged. Even though the story was confirmed to be false,

there is a great chance that there were still lingering theories that influenced the outcome of the election, which Donald Trump won. This specific story falsely painted Clinton in a bad light to sabotage her campaign to become President of the United States, a compelling position that requires honor and responsibility, for herself and her political party.



Figure 2: The altered picture [3]



Figure 3: The original picture [3]

Pizzagate

There are many cases where real harm is done as a result of false stories. The Pizzagate scandal in 2016 highlights the danger of misinformation in the digital environment and the urgent need for improved media literacy across the country. This conspiracy theory started with the appearance of allegations of a pedophilia ring linked to Democratic political figures hidden under a local pizza restaurant in Washington, D.C. Figures 4 and 5 show examples of allegedly hacked emails and Instagram photos that were used as proof of this story. A tsunami of accusations and harassment, including death threats and tarnishing of reputations, followed these false claims and this propaganda spread all over the internet. The incident culminated in violence, as an individual from North Carolina barged into the restaurant and fired an assault rifle inside. This incident demonstrates the disastrous effects that one fake story can cause, not only in terms of reputational damage but also in its potential to incite physical violence. Officials and experts were able to deflate this story; the language used in emails was taken out of context and blown out of proportion, and the images were either fabricated or taken from someone else [20]. Although this false theory was debunked, major damage was still done to people and property and there was plenty of room for the aftermath to worsen. Even after the truth was revealed, the lasting damage to reputations and institutions persisted, decreasing the trust of innocent individuals and polarizing public discourse. Additionally, the rapid spread of conspiracy theories on social media showed how easily lies can go everywhere, making many people afraid and putting our democracy and society in danger. The incident at the pizza restaurant, where shots were fired, exemplifies the real-world danger fueled by misinformation.



From: ses@sandlerfoundation.org
To: john.podesta@gmail.com
CC: eryl.sepp@gmail.com
Date: 2014-09-02 17:54
Subject: Did you leave a handkerchief

Hi John,

The realtor found a handkerchief (I think it has a map that seems pizza-related. Is it yours? They can send it if you want. I know you're busy, so feel free not to respond if it's not yours or you don't want it.

Susaner

Figure 4: A popular claim was that Podesta's leaked emails contained secret code language. [4]

From: john.podesta@gmail.com
To: ses@sandlerfoundation.org
Date: 2014-09-04 02:28
Subject: Re: Did you leave a handkerchief

It's mine, but not worth worrying about.

Figure 5: Podesta's reply [5]

COVID-19 Vaccine

The propagation of fake news, exemplified by the conspiracy theory linking monkeypox as a "side effect" of the AstraZeneca COVID-19 vaccine, also highlights the dangerous consequences of misinformation. The false claim that the vaccine, crucial for humanity to deal with the pandemic, caused monkeypox, led to widespread confusion and panic among the public. This story undermined trust in major public health measures. The World Health Organization had to officially rename monkeypox as 'Mpox' in response to the misinformation. Furthermore, longer lockdowns would have occurred if more people remained skeptical about the vaccine. This is not only detrimental to people's health but also to many economies relying

on in-person business and activity. Businesses that get their revenue based on in-person services face larger monetary deficits that are very difficult to recover. Overall, this piece of fake news posed a very harmful threat to humanity.

Previous and Related Work

In the ongoing battle against fake news, researchers have developed various methods to detect and combat misinformation, each offering unique approaches and challenges. However, many of these techniques are outdated due to the nature of how fake news is created and spread.

Human Fact-checking

Many people took advantage of the limitations of early detection methods for fake news. One of these methods is professional fact-checking. Dedicated organizations and professionals used this to deeply investigate and determine the accuracy of news and social media information. These people specifically analyze claims and rumors by comparing them with the information made and published by other reliable sources. In fact, the power of fact-checking was harnessed to debunk voter fraud propaganda during the 2020 presidential election. Fact-checkers examined the evidence presented to support false claims, such as staged videos and incorrect vote counts. They cross-checked it with official records and statements from trusted and reliable election officials. This method is still useful as an evidence-based approach to addressing and debunking these myths. However, since there is a large amount of content for people to cover, it can be overwhelming and an opportunity for human error.

Crowdsourcing

Crowdsourcing is another method to detect misinformation and is an evolution of fact-checking using human intelligence. In crowdsourcing, however, online communities debunk theories rather than subject matter experts. Anyone in the community can report suspicious content and contribute to verification efforts by sharing their knowledge with others to fight against fake news. A great example of this concept is the website Wikipedia, where volunteers collaborate to maintain the accuracy of millions of articles. People within these communities stick to strict editorial policies to maintain the content on the platform, cite and link reliable sources for audiences to see, and boost each other's motivation to keep flagging down malicious content. Due to the combined efforts of thousands of people, Wikipedia remains a huge hub of valuable information that many people use for free. However, if a community is vulnerable, misinformation could still be spread within it and challenge the reliability of methods to identify fake news. The quality of user-contributed content must be maintained and managed for crowdsourcing to still be a viable detection method.

NLP Methods

While traditional methods have been proven useful in modern society, technological advancements allow more options for addressing the specific patterns found in fake news. Natural Language Processing (NLP) consists of computational techniques that allow machines



to process and interpret text of human language that is input into the system. A common NLP technique is sentiment analysis, which can be used to analyze the emotional tones expressed in written text. Sentiment analysis has various applications; it can analyze customer reviews to keep track of opinions on specific goods/services, allowing businesses to make more impactful decisions. Additionally, it can analyze tweets or social media posts to keep track of opinions on online news, trends, and campaigns - beneficial for flagging fake news. For example, if a news article is constantly and strongly negative, there is reasonable suspicion for it to be further investigated for misinformation and bias. Replies or other responses to these posts and articles can also be assessed. Detected backlash and negative responses, people will be more inclined to fact-check the article's content or utilize other traditional methods. Other useful NLP methods exist; algorithms that can automatically translate text from one language to another, identify people or organizations mentioned in the text, or condense large volumes of text into short summaries.

However, there are many challenges when implementing NLP methods. For an NLP method to be effective, it needs to understand tones and emotions in any given text contextually. Without context, there will be mistakes in the NLP analysis because the meaning of multiple components of text can vary without changing the wording, leading the algorithm to interpret the text differently than what was intentionally conveyed. Another major issue is the use of sarcasm and idioms in a text. In normal conversation, people can recognize sarcasm based on voice tone and facial expressions - both of which are not interpretable in lines of text. In most cases, NLP cannot discern the difference between genuine or sarcastic use of words. For example, the sentence "Oh, great - more traffic," contains the word "great," a word with a normally positive connotation. In the sentence, however, the word is used differently to ironically express the person's displeasure with traffic. NLP may not perceive this difference as it may interpret that the person genuinely likes traffic, therefore labeling the sentence with a positive sentiment instead of a negative one. An idiom, such as "Break a leg," may be interpreted as a harrowing experience instead of as a positive piece of encouragement.

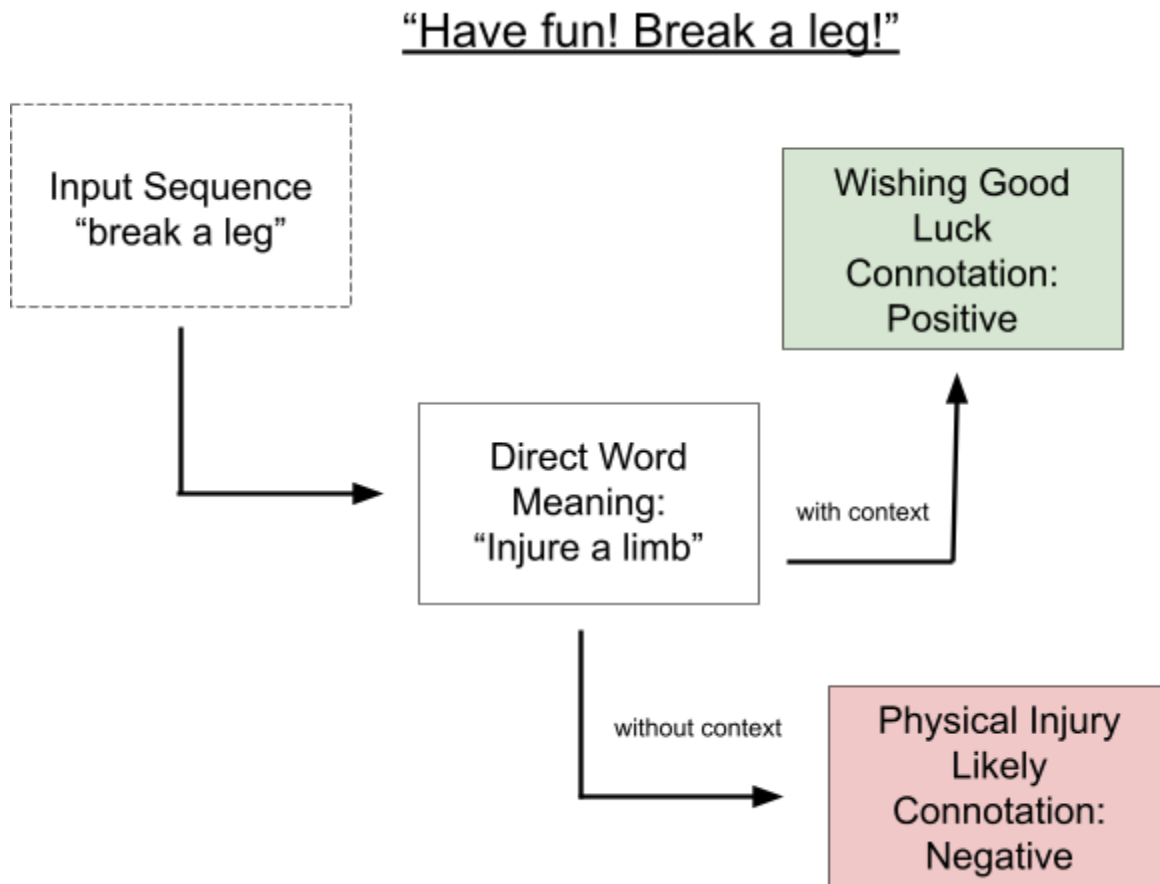


Figure 6: NLP can confuse idioms such as “Break a leg”. The computer will only understand the figurative meaning if it has enough context, otherwise it will confuse the phrase for its literal meaning.

Graph Theory

Social network graphs can effectively model social media networks. These graphs contain nodes and edges; nodes represent each user and edges represent different interactions between users. Each node has specific identification information such as a user ID, username, profile photos, and other data. Depending on the social media platform, edges can be formed by users interacting with another user’s post, such as follows, likes, replies, reposts, and shares. For example, if user X replies to user Y’s post about the beach, a direct edge is formed between user X and user Y.

Different types of graphs depend on the social network being focused on. Platforms such as Facebook can be represented as an undirected graph because mutual friendships between two users are required for an edge to exist. User X being friends with User Y is the same as User Y being friends with User X. A directed graph, however, can plot other media platforms like X and Instagram, where one node can interact with the other without any interaction back. User X can follow User Y, but User Y does not necessarily need to follow User X to like or comment on User X’s post(s). Each edge can also have a weight depending on the frequency of

interactions two users have. The more messages and likes that each user has with another, the heavier the edge between these two users will be.

Researchers plot these nodes and edges onto graphs and detect unusual patterns to flag the potential spread of false information. In the context of these graphs, a group of nodes that are more densely connected/contain more edges with each other compared to another group of nodes are called 'communities' (or clusters). These communities share common behaviors or interests. Since these clusters of nodes are formed by homophily, the natural tendency to link with others who share similar interests, and many social media apps use algorithms to show users content that matches their interests and past behavior, a situation occurs where ideas or beliefs are amplified. This situation is called an 'echo chamber'. The repeated exposure to certain ideas from echo chambers makes them seem more credible and widely accepted while limiting exposure to other perspectives, causing true information to be overshadowed by rapidly spreading misinformation.

Analyzing graphs and finding echo chambers can help to detect fake news. Identifying clusters of users where misinformation is likely to spread, and tracking how fake news moves within and between different clusters of nodes allows researchers to find unusual patterns and focus on these areas. Additionally, spotting sudden changes in interactions within these chambers can signal coordinated fake news campaigns, making it easier to catch and address misinformation early.

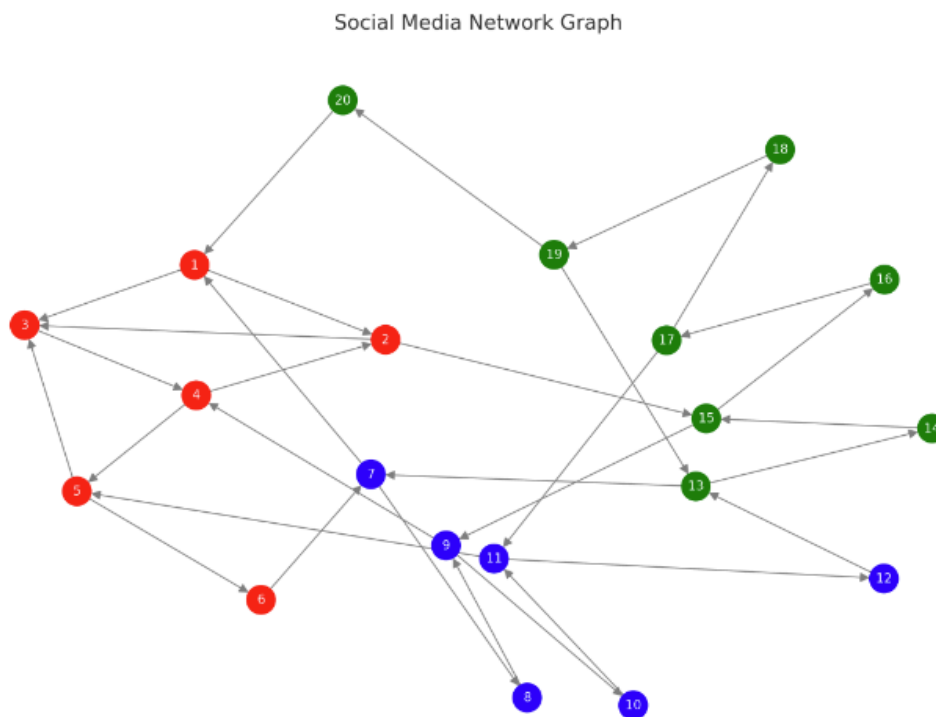


Figure 7: Three distinct communities (red, green, and blue) from 20 nodes are shown above. The arrows represent interactions/edges between nodes. Notice how there are more edges between nodes of the same color than with nodes of different colors.

Deepfakes

Recent advancements in Artificial Intelligence have led to a drastic increase in hyper-realistic deepfakes. Deepfakes are artificial videos and/or images that depict moments that did not happen. For example, someone could make a deepfake video of basketball star LeBron James insulting his teammates at a press conference or a picture of President Joe Biden signing a controversial bill into law. These deepfakes pose serious threats to vulnerable people such as children or older people due to the pragmatic nature of these deepfakes. Due to the sophistication of modern AI techniques, detecting deepfakes is extremely challenging.

However, researchers are currently developing advanced methods for detecting deepfakes, with their research mostly focusing on facial landmark detection algorithms. These algorithms analyze each key point on the subject's face and use advanced generative models such as GANs (Generative Adversarial Networks) to create more convincing deepfakes, such as swapping someone's face onto another body for a video. GANs consist of two parts with separate roles - a generator and a discriminator. The generator generates multiple synthetic data, such as images, and the discriminator's job is to evaluate the generated data to distinguish between fake and real examples. Researchers integrate models like GANs into their work so they can understand these models and study their creation processes so they can work on ways to counter them.

One proposed detection model is called Uncovering Common Features (UCF). As the name suggests, this method identifies common facial and speech patterns across a dataset of deepfakes to improve its accuracy. Efforts have been made to address gender and racial bias in these datasets by making them more diverse in their subjects, so there is a lot of potential for UCF to have consistent success.

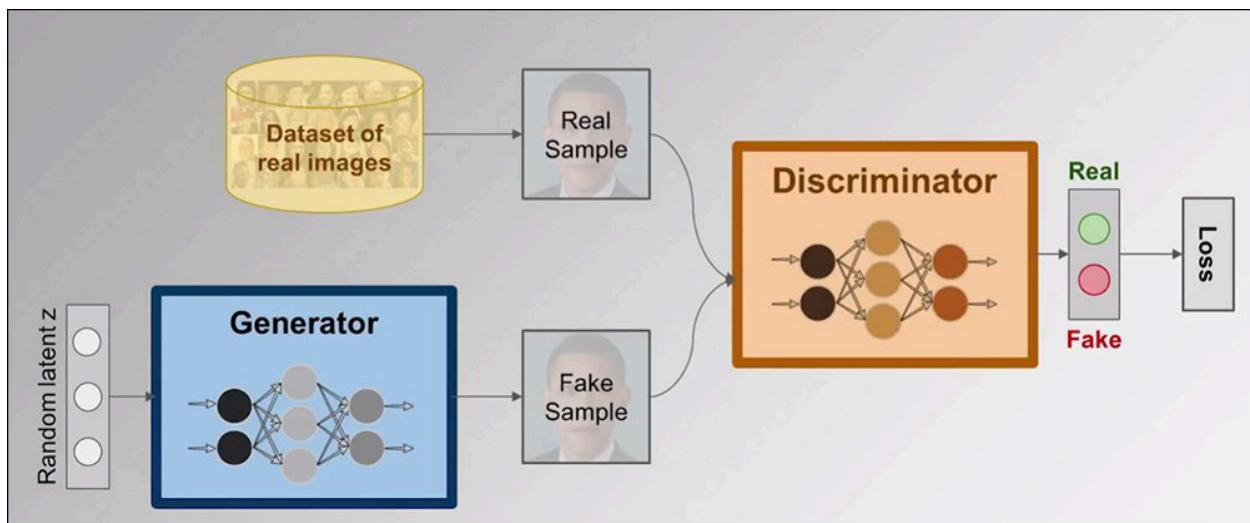


Figure 8: GAN's process. The generator creates a fake sample, and the discriminator uses the generated image data and a dataset of real images with a legitimate sample to flag the fake sample. [6]

Susceptibility Factors

Understanding why people fall for fake news involves awareness of susceptibility factors. These factors heavily shape people's vulnerability to fake news online.

Psychological Factors

Simple emotions can play a role in judgment and decision-making. It is suggested that emotions ranging from happiness to sadness and anger can influence the perception of fake news [7]. For example, being in a state of anxiety resulting from situations like the COVID-19 pandemic may lead individuals to believe and spread false information, such as the Mpox incident that was previously discussed. Positive emotions that can cause dopamine production can make it pleasurable to believe in content seen online [8].

Another psychological factor is altruism. Altruism is the behavior of helping others without expecting anything in return, such as holding the door for a stranger or donating money to a charity. However, this desire to benefit one's community or group without personal gain can lead people to spread fake news if they believe it is beneficial or protective of others. In a qualitative study of a Malaysian population, many individuals from a diverse range of demographic groups were surveyed about their behaviors regarding the sharing of information on social media. They found that the unique cultural factors unique to Malaysia that involved altruism significantly influenced the sharing of disinformation on social media [9].

Repeated Exposure

Another prevalent factor in online media is repeated exposure to certain topics and events. It was found that repeated exposure to false information can make people tend to perceive the ethical wrongness of spreading it to be lessened if hundreds of people are already retransmitting false information, one additional person is not going to feel as guilty for doing the same [10]. There is an observed effect where individuals continue to believe disinformation even after being corrected due to familiarity from repeated exposure [11]. This shows that succeeding debunks and fact-checking are not always enough for individuals to fully believe that the news they see is confirmed to be fake, especially with the effects of echo chambers.

Confirmation Bias

Lastly, many people tend to believe what they see online if it aligns with their beliefs. This phenomenon, called confirmation bias, is especially prevalent in topics with lots of debate and controversy, such as politics or climate change. In a study, strong positive correlations between confirmation bias and the persuasiveness of information about climate change were found [12]. Another study found a link between political affiliation and falling for fake news, narrowing it to confirmation bias in a political context [13]. People tend to be skeptical of news information that doesn't support their political beliefs [14]. This is the fuel for social homophily, the phenomenon discussed earlier that creates echo chambers that boost the spread of fake news from community to community.

Prevention Measures

Humanity must be open to many possible strategies to win the ongoing war against the spread of fake news. A multifaceted approach involving these many strategies and measures is essential to alleviate the spread of misinformation.

Media Literacy Programs

One measure we can take is to invest more time, money, and other resources into media literacy programs and education courses. Educating the public, including both older and younger generations, on how to put aside any biases and objectively comprehend the information they see online is crucial for them to discern if the information they see is misleading. If more people foster their critical thinking skills, these programs will be able to support and empower them to make informed decisions about the news and information they consume. This reduces the speed of misinformation spreading because these programs would influence the general audience of online news to be more vigilant and value more accurate information.

Utilize Modern Technology

A second strategy is to utilize our existing tools and take advantage of modern technology, such as AI. Although the previous methods mentioned (see Section 4) may have downsides, those same methods have brought researchers huge progress and foundations for what we have today, as society would still have been in a worse position without them because those efforts still have made an impact. However, newer advancements in AI, such as video and image analysis, have opened many paths for non-stale fact-checking systems to detect and flag fake news. Since artificial intelligence systems have the power to continuously improve by consuming more data and feedback, such systems remain efficient, effective, and reliable. Misinformation can be quickly extinguished before spreading like wildfire because of the ability of these AI tools to detect it.

Platform Accountability

People also have the power to work together and fight for change. As a third method, people should hold social media companies accountable for the content shared on their platforms. These platforms should be more transparent and invest more in combating fake news. Implementing strict moderation policies, providing users with clear guidelines on detecting and reporting misinformation, adjusting their algorithms to prioritize valid and reliable information, and ensuring timely responses to user reports can limit the spread of false information and protect users from malicious content. Additionally, social media companies can incorporate fact-checking resources such as AI tools as well as product teams dedicated to looking out for fake news. These are ethical and responsible ways that social media platforms can benefit user experiences and engagement on social media while simultaneously contributing to the greater good of society by developing a more trustworthy online environment.

Conclusion

The rise of online fake news is a huge challenge in modern society. It threatens the reliability of information and can diminish the integrity and image of many people. Tracing the

impact, highlighting technological advances, such as deepfakes, that intensify the problem, and recalling past major incidents involving the malicious spread of misinformation underscores the many problematic effects that fake news brings to today's online world. To win the long battle against fake news, we must hold media literacy and critical thinking to the utmost value and use our technologies to mitigate the consequences of misinformation.

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