Authors: Russell M. Hartley

Efficacy Analysis of Online Artificial Intelligence Fact-Checking Tools

Abstract:

Investments in artificial intelligence (AI) spurred development of online fact-checking tools; positioned to potentially serve as more accurate alternatives or appendages to search engines and/or nascent chatbots. This study analyzed the efficacy of four AI tools (ClaimBuster, Full Fact, TheFactual - IsThisCredible?, and Google's Fact-Check Explorer) in producing accurate readings measured by a consensus of independent fact-checking organizations. 10 unique claims were inputted into each tool to produce individual fact-check reports, resulting in 40 fact-check reports being conducted. The results reflect an efficacy rating of 100% regarding the ability of the selected tools to produce an overall accurate reading with 89% of reports producing a unanimous determination. Additionally, recommendations were made to further map and analyze the efficacy of AI fact-checking. These findings support the notion that AI can play an effective role in aiding online truth-seeking when its determinations depend on transparently referencing its source of independent human fact-checkers.

Agenda:

Author(s):

Russell M. Hartley

- Grand Valley State University, 1 Campus Drive, Allendale, MI 49401
- hartleyr@mail.gvsu.edu, www.russellmhartley.com

Introduction 1

Americans' trust in the media today rests in a precarious position, reflecting a disengaged citizenry who may not possess the literacy skills needed to develop sustainable trust navigating the nation's media environment. According to a 2022 Gallup study on Americans' trust in mass media (newspapers, television, and radio), when it comes to reporting the news fully, accurately, and fairly, Americans' trust rests at 34 percent who say they have a "great deal or fair amount"[1]. That is near a record low, which was in 2016 when Americans reported only 32 percent trust. A Statista 2019 survey of 6,127 Americans 18 years and older found 67 percent experiencing a "great deal of confusion" caused by fake news about basic facts of current societal issues and events in the United States[2].

The effect of widespread distrust not only has the potential to confuse audiences but to turn them away from consuming news and political information altogether. Forty-two percent of Americans surveyed during 2022 via the Reuters Institute Digital News Report indicated they "sometimes or often" avoid the news due to their lack of trust in the information, a slight increase of 4 percent since 2017[3]. As University of California Irvine philosophers Cailin O'Connor and James Owen Weatherall describe in their book The Misinformation Age, "we live in an age of spin, marketing, and downright lies. Of course lying is hardly new, but the deliberate propagation of false or misleading information has exploded in the past century, driven both by new technologies for disseminating information–radio, television, the internet–and by the increased sophistication of those who would mislead us"[4].

Calls to address misinformation and other elements contributing to distrust in media in our physical and digital communication spaces often invoke notions of media literacy as a potential solution to educate publics how to discern credible and trustworthy information from something less than. The working definition of "media literacy" for this paper will draw from the Center for Media Literacy's definition as "a 21st century approach to education. It provides a framework to access, analyze, evaluate, create and participate with messages in a variety of forms – from print to video to the internet. Media literacy builds an understanding of the role of media in society as well as essential skills of inquiry and self-expression necessary for citizens of a democracy"[5]. Media communication scholars who have called for improved media literacy mechanisms for society include Marshall McLuhan who argued in 1964 for a more media literate society to better understand the impacts of current and emerging communication mediums (in addition to the mere messages derived from said mediums)[6]. While new media outlets and technologies have emerged since the 1960's, the need to better equip citizens with the knowledge and tools to conduct effective fact-checks remains. In 2010, University of Rhode Island scholar and founder & director of the Media Education Lab, Renee Hobbs, argued for the fusion of media literacy and digital literacy because "To be effective participants in contemporary society, people need to be engaged in the public life of the community, the nation, and the world. They need access to relevant and credible information that helps them make decisions. This necessarily involves strengthening the capacity of individuals to participate as both producers and consumers in public conversations about events and issues that matter. Media and digital literacy education is now fundamentally implicated in the practice of citizenship"[7].

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[1] Brenan, M. *"Americans' Trust in Media Remains near Record Low."* 5 June 2023, news.gallup.com/poll/403166/americans-trust-media-remains-near-record-low.aspx.

[2] Watson, A. (2022, June 21). *Confusion caused by fake news 2019*. Statista. https://www.statista.com/statistics/657037/fake-news-confusion-level/.

[3] Newman, N. (2022, June 15). *Overview and key findings of the 2022 Digital News Report*. Reuters Institute for the Study of Journalism. https://reutersinstitute.politics.ox.ac.uk/digital-news-report/2022/dnr-executive-summary.

[4] O'Connor, C., & Weatherall, J. O. (2019). *The Misinformation Age: How False Beliefs Spread* (p. 9). Yale University Press.

[5] Center for Media Literacy. (n.d.). *Media Literacy: A Definition and More.* https://www.medialit.org/media-literacy-definition-and-more

[6] McLuhan, M. (2010). *Understanding media: The extensions of man*. Routledge.

[7] Hobbs, R. (2010). *Digital and Media Literacy: A Plan of Action* [White Paper]. The Aspen Institute. https://www.aspeninstitute.org/wp-content/uploads/2010/11/Digital_and_Media_Literacy.pdf.

While elements of digital literacy vary, from in-person literacy training to the development of new cognitive practices, one crucial component deals with the notion of fact-checking. And as technologies have changed to adjust to a changing media environment, new tools have emerged bolstered by machine learning or "artificial intelligence" (AI). This research paper will borrow the University of Stanford Human-Centered Artificial Intelligence (HAI) definition of artificial intelligence, coined by emeritus Stanford Professor John McCarthy in 1955 as "the science and engineering of making intelligent machines. Much research has humans program machines to behave in a clever way, like playing chess, but, today, we emphasize machines that can learn, at least somewhat like human beings do"[8].

As advances in artificial intelligence technology continue to spur such as the developments that resulted in the creation of enhanced neural networks, reinforcement learning systems, and new algorithms, AI has been increasingly tasked with aiding humanity's efforts when it comes to fact-checking and deciphering what is factual from what is lesser than. The challenge when it comes to how to verify the credibility and accuracy of the information users find online is ongoing, but the use of artificial intelligence and automation tools have become increasingly employed to aid human fact-checkers. While Google's standard search engine functionality increasingly operates as a response mechanism to a user's question, programs using AI have been developed and employed as fact-checking apparatuses for delivering results related to truthfulness for a given claim. These advancements in AI fact-checking have already been developed by companies such as Google, and often serve as tools to help identify disinformation efforts, especially from a national security standpoint and/or in relation to election interference efforts. While AI-assisted fact-checking tools vary in scope, formula, and function, their emergence poses strong potential to act as an effective aid in supporting existing media and digital media literacy practices. Therefore, it is crucial these tools demonstrate effective fact-check reporting ability if they are to be considered valuable assets to discern factual information from less than factual information. This paper explores said efficacy in an effort to provide an empirical analysis regarding the notion of AI fact-checking tools in the age of misinformation.

Methods and Materials 2

This study selects four artificial intelligence and/or automated fact-checking tools to run fact-check searches and reports on both three widely debunked political claims as well as three widely debunked claims that are based in and/or supported by scientific consensus.

AI Fact-Checking Tools 2.1

The AI/automation-supported fact-checking tools selected for this study are as follows:

1. ClaimBuster: functions as a search engine for fact-checking keywords or key phrases and produces results from fact-checking sources such as Politifact, FactCheck.Org, USA Today, Washington post Fact Checker, and more. This tool allows users to fact-check either claims or copy/paste article text through a search engine function[9].
2. Full Fact: launched in 2009 and offers several fact-checking tools with its more automated and artificial intelligence capabilities currently in development. The website features a search functionality for fact-checking supported by automated measures[10].

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[8] Manning, C. (2020, September). *Artificial Intelligence Definitions*. https://hai.stanford.edu/sites/default/files/2020-09/AI-Definitions-HAI.pdf

[9] *CB | Fact Checker*. CB | Fact Checker. 15 Dec. 2022, https://idir.uta.edu/claimbuster/factchecker/.

[10] *Full Fact - Full Fact Is the Uk's Independent Fact Checking Organisation*. Full Fact - Full Fact Is the Uk's Independent Fact Checking Organisation. 15 Dec. 2022, https://fullfact.org.

3. The Factual - IsThisCredible?: an algorithm that rates 10,000+ news articles daily for how informative they are. With this data, The Factual offers five products to get the most factual news: newsletter, website, IOS app and Android app, Google Chrome extension, and IsThisCredible.com[11].

4. Google Fact Check Explorer: according to its website, "This tool allows you to easily browse and search for fact checks. For example, you can search for a politician's statement, or for a topic. You can also restrict results to a specific publisher. You can search by keywords and see a list of matching claims and the corresponding fact checks"[12].

Political Claims 2.2

During the study, each of the AI fact-checking tools were tasked with fact-checking the following widely debunked political claims and/or conspiracies:

1. Claim #1: There was widespread voter fraud in the 2020 U.S. Presidential Election
2. Claim #2: Elected officials in the United States are involved in a human-trafficking operation otherwise known as or is related to the "pizzagate" conspiracy
3. Claim #3: The attack on the U.S. capitol on January 6, 2021 was part of a secret anti-Trump government operation
4. Claim #4: Russia is conducting a special military operation in Ukraine to "denazify" the Ukrainian government and/or military
5. Claim #5: The mass shooting that occurred at Sandy Hook Elementary in Connecticut in December 2012 was a staged event or a "false flag" event

Scientific Claims 2.3

During the study, each of the AI fact-checking tools were tasked with fact-checking the following widely debunked scientific claims and/or conspiracies:

1. Claim #1: Climate change is a hoax
2. Claim #2: COVID-19 is a hoax
3. Claim #3: Childhood vaccines cause autism
4. Claim #4: The earth is flat
5. Claim #5: 5G causes cancer and/or COVID-19

Degree of the Claim's Fact-Check 2.4

When measuring the fact-check rating for each of the four AI tools, the results for each fact check vary slightly by program. While some fact-checking AI tools (such as Full Fact) strive to deliver a single True/False response for a given claim, others (such as ClaimBuster) deliver a list of results that include:

- S = Singular (the fact-check tool produced a singular true/false result for the selected claim)
- U = Unequivocal or Unanimous (the fact-check produced several results/sources that all produced the same true/false conclusion, independent from one another)
- M = Mixed (the fact-check produced results that contained at least one leaning false result AND one leaning true result)

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[11] *Is This Credible?*. *Is This Credible?*. 15 Dec. 2022, https://www.isthiscredible.com.

[12] *Fact Check Tools*. *Fact Check Tools*. 15 Dec. 2022, https://toolbox.google.com/factcheck/.

Results 3

The totality of results, reflected in Tables 1 and 2, produced the following key findings:

- 38/38 of the falsehoods resulted in a fact-checking finding of False/Misleading/Unsupported report from the AI tool with 2 claims resulting in no reading (N/A) from the tool
  - Resulting in a 100% accuracy rate in terms of matching inputted debunked claims with their respective ratings that indicate their unsubstantiated support
- 34/38 reports resulted in a report that featured a series of independent fact-checking reports (i.e. PolitiFact, Washington Post Fact Checker, FactCheck.org, etc.) that amounted to unanimous false/misleading/unsupported ratings for the claim
- 4/38 reports featured a singular False/True output for the entered claim. While the report detailed a singular result, the report lists several sources in its explanation of its rating
- In the 10 claims that were entered through The Factual – IsThisCredible?, the "alternate viewpoint" was provided by a source that The Factual identified as being "Moderate-Right" or "Right" in 9/10 reports. In the other report, the "alternate viewpoint" was from a media source deemed to be "center."

Table 1. Political claims inputted into each fact-checking model directly followed by the degree associated with its claim determination. For example, ClaimBuster produced a "False" determination in response to Claim 1 with the indication the determination was "U" or "unanimous."

AI Tool	Claim 1	Degree	Claim 2	Degree	Claim 3	Degree	Claim 4	Degree	Claim 5	Degree
ClaimBuster	False	U	False	U	False	U	False	U	False	U
Full Fact	False	S	False	U	False	U	N/A	N/A	N/A	N/A
The Factual - IsThisCredible?	False	U	False	U	False	U	False	U	False	U
Google Fact Check Explorer	False	U	False	U	False	U	False	U	False	U

Table 2. Scientific claims inputted into each fact-checking model directly followed by the degree associated with its claim determination. For example, ClaimBuster produced a "False" determination in response to Claim 1 with the indication the determination was "U" or "unanimous."

AI Tool	Claim 1	Degree	Claim 2	Degree	Claim 3	Degree	Claim 4	Degree	Claim 5	Degree
ClaimBuster	False	U	False	U	False	U	False	U	False	U
Full Fact	False	U	False	S	False	U	False	U	False	S
The Factual - IsThisCredible?	False	U	False	U	False	U	False	U	False	U
Google Fact Check Explorer	False	U	False	U	False	U	False	U	False	U

Sample Report: Claim #1 3.1

In this sample report, you will find a full fact-checking report where the input is Claim #1 and the output varies by the four selected fact-checking AI tools (ClaimBuster, Full Fact, The Factual - IsThisCredible?, and Google Fact Check Explorer). These reports include a brief description for each tool to highlight unique distinctions along with its Claim #1 fact-checking report which may feature text, source links as they appear verbatim, and/or screenshots that display the results for each AI tool.

Inputted claim: There was widespread voter fraud in the 2020 U.S. Presidential Election.

ClaimBuster 3.1.1

The report references a search of "knowledge bases" that derive from Google and Wolfram along with the Google Fact-Check Explorer API which returned the following fact-checks shown below[13].

- Gateway Pundit:
    - Claim: "A STOLEN ELECTION: State totals minus illegal ballot trafficking numbers give President Trump decisive victories in AZ, GA, MI, PA, and WI"
    - Reading: False
    - Source: PolitiFact[14]
- Gateway Pundit:
    - Claim: More than 8 million excess votes for Biden counted during the 2020 election
    - Reading: False
    - Source: USA Today[15]
- Dinesh D'souza:
    - Claim: There were "400,000 illegal votes" cast in the 2020 presidential election
    - Reading: Not proven
    - Source: PolitiFact[16]
- Donald Trump:
    - Claim: The 2020 presidential election was "rigged"
    - Reading: Pants on Fire
    - Source: PolitiFact[17]
- David Perdue:
    - Claim: The 2021 Georgia Senate runoff and the 2020 presidential election "were stolen"
    - Reading: Pants on Fire
    - Source: PolitiFact[18]
- Kari Lake:
    - Claim: Arizona elections are corrupt
    - Reading: 2020 election was secure
    - Source: PolitiFact[19]
- Social media users:
    - Claim: The media said "Russia stole the election" in 2016 and now says the 2020 election is "impossible to steal"
    - Reading: False

[13] *CB | Fact Checker. CB | Fact Checker.* 15 Dec. 2022, https://idir.uta.edu/claimbuster/factchecker/.

[14] *Politifact - Claims That the 2020 Election Was Stolen Are Still False. Politifact - Claims That the 2020 Election Was Stolen Are Still False.* 23 Aug. 2023, https://www.politifact.com/factchecks/2022/may/04/gateway-pundit/claims-2020-election-was-stolen-are-still-false/.

[15] *Fact Check: No Evidence of 8 Million 'excess' Biden Votes from 2020 Election. Fact Check: No Evidence of 8 Million 'excess' Biden Votes from 2020 Election.* 15 Dec. 2022, https://www.usatoday.com/story/news/factcheck/2021/08/10/fact-check-8-million-excess-biden-votes-werent-counted-2020/5512962001/.

[16] *Politifact - the Faulty Premise of the '2,000 Mules' Trailer About Voting by Mail in the 2020 Election. Politifact - the Faulty Premise of the '2,000 Mules' Trailer About Voting by Mail in the 2020 Election.* 15 Dec. 2022, https://www.politifact.com/article/2022/may/04/faulty-premise-2000-mules-trailer-about-voting-mai/.

[17] *Politifact - the Facts of a Fair US Election Have Only Gotten Stronger Since Capitol Attack. Politifact - the Facts of a Fair US Election Have Only Gotten Stronger Since Capitol Attack.* 15 Dec. 2022, https://www.politifact.com/article/2022/jan/06/facts-fair-us-election-have-only-gotten-stronger-c/.

[18] *Politifact - Georgia's David Perdue Said Elections Were Stolen from Him and Trump. Pants on Fire!. Politifact - Georgia's David Perdue Said Elections Were Stolen from Him and Trump. Pants on Fire!.* 15 Dec. 2022, https://www.politifact.com/factchecks/2022/mar/29/david-perdue/georgias-david-perdue-said-elections-were-stolen-h/.

[19] *Politifact - Why the 'stop the Steal' Arizona Republicans Are Wrong About 2020. Politifact - Why the 'stop the Steal' Arizona Republicans Are Wrong About 2020.* 15 Dec. 2022, https://www.politifact.com/article/2022/aug/03/why-stop-steal-arizona-republicans-are-wrong-about/.

○   Source: USA Today[20]

The Factual - IsThisCredible.com 3.1.2

The Factual offers several fact-checking tools such as its search engine model IsThisCredible.com. When running a report on the political claim that "the 2020 US election was stolen," The Factual report produces results of references that are categorized in three distinct categories: 1) Most Relevant 2) Highly Credible and 3) Alternate Viewpoint as shown in Figure 1.
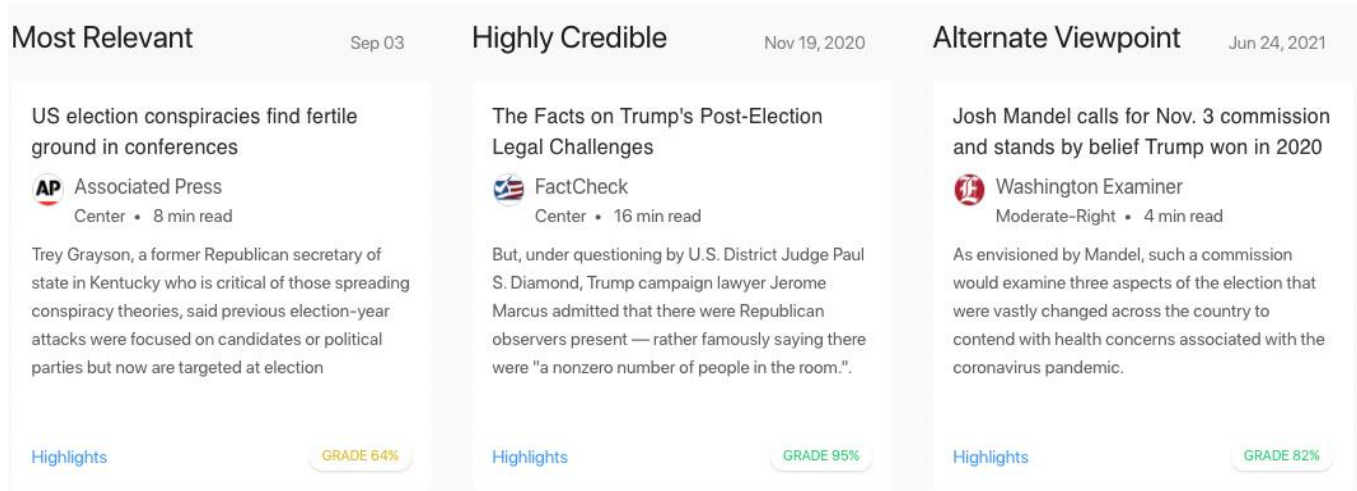

Figure 1. Screenshot of The Factual - IsThisCredible.com's fact check report in response to the claim of evidence of widespread voter fraud in the 2020 U.S. elections. The figure displays the three categories of reference presented in the report.

The Factual Grade Guide:

● Highly Credible = Above 75%
● Moderately Credible = 50% - 75%
● Less Credible = Below 50%

The report also features search engine results for recent articles that are related to the claim from sources such as The Washington Post, New York Times, FactCheck.org and more. The report shows articles from selected sources that are identified based on their political leanings. The search engine results allow the user to select articles that are sourced from customizable political leanings. For example, you could select to receive articles that are from media sources that are "left-leaning only" or "right-leaning only" as shown in Figure 2[21].

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[20] *Fact Check: Meme Makes False Claims About Media's 2016 and 2020 Election Coverage. Fact Check: Meme Makes False Claims About Media's 2016 and 2020 Election Coverage.* 15 Dec. 2022, https://www.usatoday.com/story/news/factcheck/2020/11/25/fact-check-false-claims-medias-2016-2020-election-coverage/3770232001/.

[21] *The Factual's IsThisCredible.com* - 15 Dec. 2022, https://www.thefactual.com/news/#!/search?s=The%202020%20US%20Election%20was%20stolen.
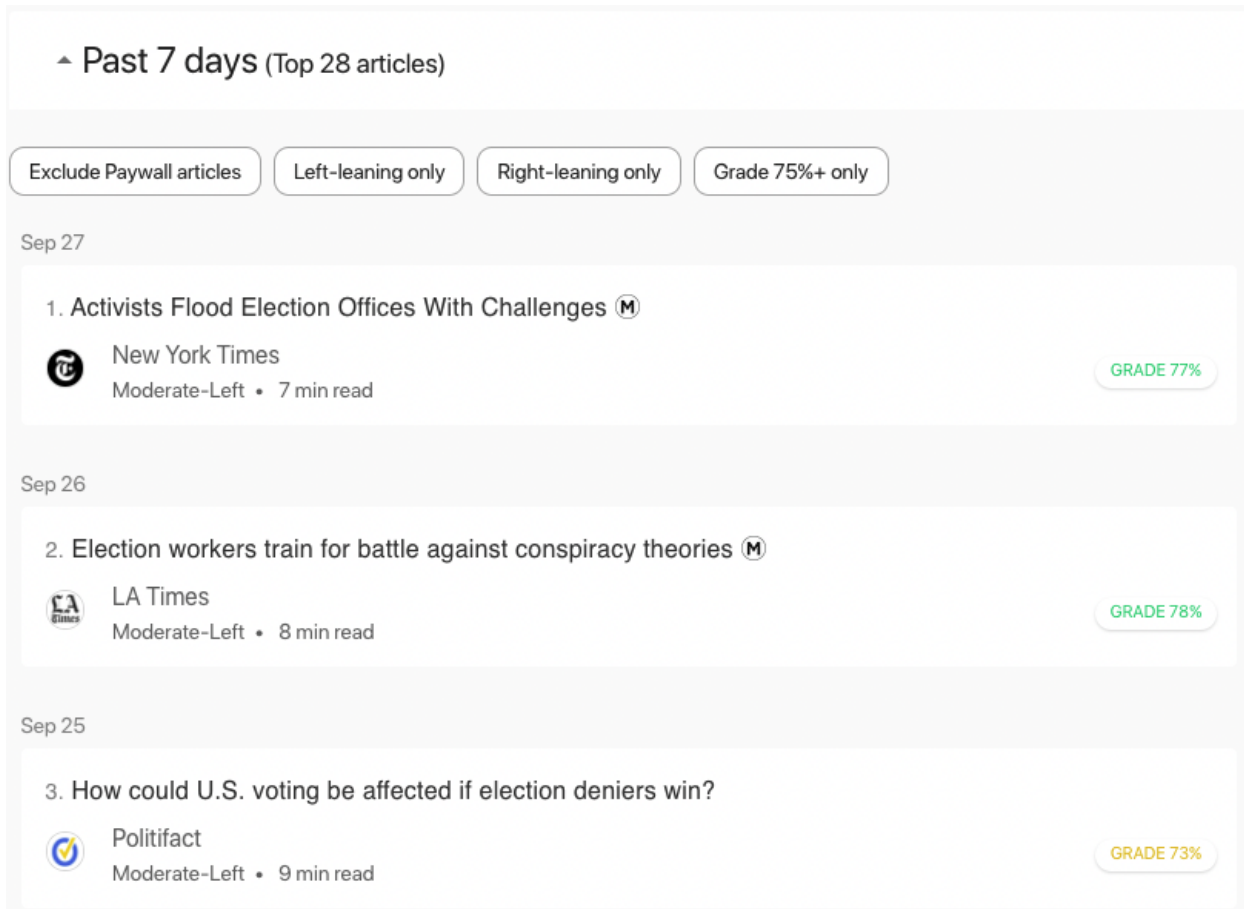
Figure 2. Screenshot of The Factual - IsThisCredible.com's fact check report in response to the claim of evidence of widespread voter fraud in the 2020 U.S. elections. The figure displays the sourcing of its fact checks related to Claim #1 along with its generated credibility grade and the political leaning of the organization that provided the fact check.

Full Fact 3.1.3

Full Fact functions as an editorial approach to AI fact-checking by determining which topics and opinions are fact-checked as opposed to building a search engine database of searchable claims (as evident in the other AI models selected for this study). Once the topics have been selected, related claims are then pulled using AI technology and are reflected in its corresponding verdict included in the fact check report as shown in Figure 3[22].

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[22] *Express Opinion Piece Wrong to Allege Evidence of Widespread Voter Fraud in US Elections. Express Opinion Piece Wrong to Allege Evidence of Widespread Voter Fraud in US Elections.* 15 Dec. 2022, https://fullfact.org/news/express-trump-election-voter-fraud/.

Figure 3. Screenshot of the Full Fact fact check report in response to the claim of evidence of widespread voter fraud in the 2020 U.S. elections.

Verdict: There is no evidence of widespread fraudulent ballots in the US election. It is logical that Mr.Biden received so many votes because turnout was relatively high. There is no evidence of widespread invalid votes. There is no evidence that Mr. Trump and Mr. Biden received the same popular vote. Mr. Biden currently leads by around 4.5 million.

Google's Fact Check Explorer 3.1.4

Google's Fact Check Explorer functions as a search engine optimized by keywords that are used to provide relevant claims related to the keywords entered. The model then provides a fact-check reading along with its corresponding source with the supporting link included as shown in Figure 4[23].

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[23] *Fact Check Tools. Fact Check Tools.* 15 Dec. 2022,
https://toolbox.google.com/factcheck/explorer/search/the%202020%20US%20election%20was%20stolen;hl=en.

Claim by The Gateway Pundit:

"A STOLEN ELECTION: State totals minus illegal ballot trafficking numbers give President Trump decisive victories in AZ, GA, MI, PA, and WI."

PolitiFact rating: **False**
Claims that the 2020 election was stolen are still false
May 4, 2022

Election contest

Donald Trump

Ballot

PolitiFact

Claim by Donald Trump:

The Pennsylvania Supreme Court ruled that the 2020 election was rigged

USA Today rating: **False**
Fact check: 2020 election was valid, contrary to Trump's latest claim
Nov 11, 2022

Donald Trump

Election contest

USA Today

Claim by Donald Trump, social media users:

The 2020 presidential election was 'rigged'

USA Today rating: **False**
Fact check: Donald Trump persists with false claim about 2020 results
Jan 6, 2022

Election contest

Presidential election

United States Presidential election, 2020

USA Today

Claim by Instagram posts:

"It's not that there is no evidence the election was stolen, but that no court had the guts to HEAR the evidence. They dismissed the cases, NOT the evidence."

PolitiFact rating: **False**
Courts did review Trump campaign 'evidence' of election fraud ...
Oct 28, 2022

Election contest

Court

PolitiFact

Claim by Instagram posts:

Democrats used "47 million mail-in ballots" to steal "every election in the country."

PolitiFact rating: **Pants on Fire**
No, Democrats didn't steal 'every election in the country' with mail ...
Nov 11, 2022

Election contest

Ballot

Democratic Party

PolitiFact

Claim by David Perdue:

The 2021 Georgia Senate runoff and the 2020 presidential election "were stolen."

PolitiFact rating: **Pants on Fire**
Georgia's David Perdue said elections were stolen from him and ...
Mar 29, 2022

David Perdue

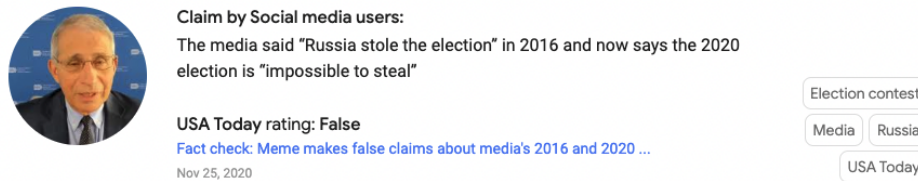Election contest

Georgia

PolitiFact

Figure 4. Screenshot of Google's Fact Check Explorer's fact check report in response to the claim of evidence of widespread voter fraud in the 2020 U.S. elections.

Insights & Observations 3.2

While all four selected AI and automation tools were given the same input, they all varied slightly in how they pulled the online information relevant to the fact-check as well as how it displayed, presented, and measured the report. However, it is important to note that the tools selected are programmed to collect fact-check ratings from particular credible fact-check sources (i.e. FactCheck.org, PolitiFact, Snopes, Washington Post Fact Checker, etc.) that were first established by human fact-checkers as opposed to AI programs that are tasked with machine learning models making determinations in response to a claim's truthfulness and accuracy.

1. In regards to The Factual's IsThisCredible?:
   a. While the claims are unequivocal, there are some sources (i.e. American Greatness) that are listed that may spread misleading claims or suggestions that are unfounded.
   b. In addition to providing a "highly credible" and "most relevant" source in its results, IsThisCredible? also features an "alternate view point." This study did not find that the "alternate viewpoint" offered a differing true/false result from the "highly credible" or "most relevant."
2. Full Fact did not return results for Political Claims 4 & 5. As opposed to relying on AI technology that scans the internet for fact checks related to the keyword, Full Fact offers an array of fact checks for pre-selected topics that are published on its website. Aside from this automated search functionality (along with any AI/automation tools utilized in the development of Full Fact's fact-checking reports), the company's more AI-centered technology is currently in development and yet not accessible to the public.

Discussion 4

When it comes to the utilization of AI to address misinformation and disinformation efforts, there are many reasons to continue to test the efficacy and effectiveness of AI mechanisms designed to separate fact from fiction. And while new tools continue to emerge, the need to analyze their functionalities may become increasingly important for the future of online content moderation in the era of rampant fake news. While that may remain true, much of the current publicly available AI tools depend on the user's initial interest to utilize a third-party fact-checking apparatus. The benefits of such a mechanism can indeed be felt by such an audience that is seeking independent analysis over their news content and information, that the impact may be more limited when compared to the majority of the general public who consumes their news increasingly on social media and across online media platforms. Given the nature of public behavior when consuming news along with the influence of confirmation bias, the threats of leveraging AI to develop and disseminate fictitious stories and information may appear to be the more significant threat at the doorstep of the efforts to preserve truth and democracy. In a recent study entitled, "Tailoring Heuristics and Timing AI interventions for Supporting News Veracity Assessments" by Dorit Nevo at RPI's Lally School of Management found that AI could be successful in identifying fake news stories when the reader did not already have an opinion on the topic. Because of the power of confirmation bias, the subjects in the study did not take it upon themselves to

investigate the validity of the claim[24]. This is important because it highlights the human behavior aspect of truth seeking in political communications. But while AI-supported fact-checking search engines might appeal to those looking for clarity beyond their traditional means of consuming news content, these tools (and research related to these tools) may serve more as a catalyst for future AI developments in the field of political communications. That said, there may be opportunities for future research into the deployment of these AI tools and programs if or when they are utilized to tackle special projects or events especially susceptible to the spread of misinformation (such as covering a particular election or supporting the fact-checking efforts of a debate).

Recommendations for Future Research 4.1

In regards to a further analysis of the artificial intelligence tools selected for the study, the following recommendations can be considered:

1. Expansion of research into AI fact-checking tool effectiveness (in terms of accuracy and truthfulness) to fact-check a much larger dataset of claims, especially those that are being discussed as current events (as opposed to more widely known conspiracies and falsehoods).
   a. A larger dataset would provide more research into the effectiveness, consistency, and accuracy of the four AI tools selected in the study. A further analysis could also benefit from a vast range of fact-checking topics that may be categorized outside the scope of politics or science.
   b. If this study were to be expanded to include more claims and data points for the four selected AI tools in the study, it is advised to consider adding additional AI-supported fact-checking search engines that may become available at the time.
   c. A replication and/or expansion of the study could consider to eliminate Full Fact as a producer of singular True/False reporting to focus exclusively on AI tools that offer an array of results from independent fact-checking organizations (i.e. FactCheck.org, Snopes, etc.). A replication/expansion would also benefit from this change to focus more exclusively on AI fact-checking search engines as opposed to searching through an array of limited topics which is found in the current format of Full Fact
2. And a comparative analysis of AI fact-checking tools and variables such as public chatbots in producing accurate truthfulness results to a given scientific or politically-based claim.

In regards to further mapping the field of fact-checking and artificial intelligence efficacy, the following are recommended:

1. Efficacy comparative analysis measuring the variables of A) existing artificial intelligence fact-checking tools that refer to human fact-checking sources against B) artificial intelligence tools that produce singular and/or unsourced reports/answers (i.e. Large Language Models, chatbots or voice assistants).
2. Efficacy comparative analysis using human subjects to test their opinions of various debunked claims (determined via scientific consensus) using common search engines (i.e. Google, Bing, DuckDuckGo, Yahoo! etc.) and artificial intelligence tools such as the ones identified in this analysis.
3. And data sets capturing the variety and depth of fact-checking sources utilized to generate determinations by various types of artificial intelligence fact-checking tools.

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[24] Horne, B. D., et al.. *Tailoring Heuristics and Timing AI Interventions for Supporting News Veracity Assessments*. Aug. 2020, https://doi.org/10.1016/J.CHBR.2020.100043.

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