

# The Struggle over YouTube's Recommendation Algorithm

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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## **The Struggle over YouTube's Recommendation Algorithm**

The online video-sharing platform YouTube has fundamentally changed the way that users interact with digital content. In early 2012, engineers at the company “encourage[d] people to spend more time watching, interacting, and sharing” in order to “increase the amount of time that the viewer will spend watching videos on YouTube” (Meyerson). YouTube CEO Susan Wojcicki prioritized growth above profit, supporting the major shift from channel-based subscriptions to a system that revolved around recommendations (Nicas, 2016). By 2017, the company was celebrating a significant milestone in its efforts to “make YouTube a more engaging place” with viewers watching over “a billion hours of YouTube’s incredible content every single day” (Goodrow). However, the deliberately engaging nature of the platform has been the center of intense controversy. Over the past decade, critics and defenders of the YouTube recommendation algorithm have utilized various strategies to advance their agendas. Influential technology reporters, content consumers, academic researchers, and public interest groups have played an essential role in shaping the algorithm’s evolution. Intense pressure from reporters and consumers initially prompted YouTube to change their policies, while researchers and interest groups held the company accountable for making modifications to the recommendation algorithm.

### **Review of Research**

In the early days of YouTube, research showed that over-consumption of online media could negatively affect well-being. Shaw and Black showed that “excessive or inappropriate use of computers and the Internet has been the subject of increased attention in the professional

literature and popular media.” Researchers at the time “seem[ed] to agree that it involves problematic computer usage that is time consuming and causes distress or impairs one’s functioning in important life domains” (2008). This work suggests that internet addiction was a familiar phenomenon, something YouTube engineers should have considered. Kuss and Griffiths noted that “[social networking site] addiction treatment cannot be total abstinence from using the Internet” but rather “controlled use of the Internet and its respective functions, particularly social networking applications” (2011). Internet use was inevitable, but platforms could reduce the addictive nature of social networking sites.

The increased use of recommender systems raised concerns regarding content diversity. Pariser feared that recommendation systems would accelerate the “filter bubble effect” and create ideological echo chambers (2011). Davidson et al. revealed the YouTube recommendation system utilized “a user’s personal activity (watched, favorited, liked videos) as seeds and expanded the set of videos by traversing a co-visitation based graph of videos” (2010). Previous use patterns would be a prominent factor in recommendations. In an early study on “the potential for online personalization to effectively isolate people from a diversity of viewpoints or content,” Nguyen et al. found credible evidence that “recommender systems expose users to a slightly narrowing set of items over time” (2014). O’Callaghan et al. showed the YouTube algorithm had “identif[ed] the existence of an [extreme right] ideological bubble” and “suggest[ed] that it [was] possible for a user to be immersed in this content following a short series of clicks” (2015).

The implementation of deep learning techniques radically changed the YouTube recommendation system. In 2016, YouTube researchers announced “a fundamental paradigm shift towards using deep learning as a general-purpose solution for nearly all learning problems” would emphasize watch time over click-through rate. Engineers working on the recommendation

system would be closely aligned with Google Brain, the artificial intelligence research team (Covington et al.). YouTube's goal of increased user engagement was straightforward, but the recommendation algorithm was becoming increasingly complex.

### **Influential Media Coverage Shapes Policy Decisions**

Critical investigative reporting has been a powerful force in influencing YouTube content moderation policies. Days after a deadly shooting in Las Vegas, *BuzzFeed* reporter Charlie Warzel showed “conspiratorial content high in search results” at YouTube could cause users to inadvertently “stumble down an algorithm-powered conspiracy video rabbit hole” (2017). Within twenty-four hours of the article's publication, a YouTube spokesperson acknowledged the company's effort to “promot[e] more authoritative sources in search results” (Nicas, 2017). Less than a month after the shooting, a blog post by independent journalist James Bridle showed verified channels “using YouTube to systematically frighten, traumatize, and abuse children” (2017). The post went viral, receiving over 175,000 likes. Within two weeks, YouTube publicly announced a new approach to “protect families on YouTube” that included the application of “machine learning technology and automated tools to quickly find and escalate [videos] for human review” (Wright, 2017). Despite their increased efforts, problems surrounding the sexual exploitation of children on the platform persisted. A viral YouTube video and Reddit post by Matt Watson on the r/Drama subreddit reignited the debate (Alexander, 2019). Watson showed the recommendation algorithm was “facilitating pedophiles' ability to connect with each-other, trade contact info, and link to actual CP in the comments” (MattsWhatItIs). Again, YouTube was quick to respond. Policy changes to disable comments and limit monetization were the result of “swift action” to “keep minors and the creator ecosystem safe” (YouTube Team, 2019b).

In the beginning, mainstream media coverage of the recommendation algorithm was favorable and led to a positive public perception of the platform. During an interview, YouTube's engineering director Cristos Goodrow announced their objective to maximize watch time and "help viewers find the videos that they would enjoy watching." The interviewer commended the company's effort to "increas[e] the quality of its content and promot[e] the right videos to the right people" (D'Onfro, 2015). Technology columnist Casey Newton remarked that the recommendations "started to seem weirdly good" and "not only personalized but deadly accurate" (2017). YouTube CPO Neal Mohan proudly announced that mobile users spent over an hour during average watch sessions "because of what our recommendation engines are putting in front of you" (Solsman, 2018). *Quartz* reporter Ashley Rodriguez noted that the platform was "a master of getting you to watch videos you didn't know existed" and applauded how "the algorithms are constantly evolving to get smarter" (2018). Meanwhile, Wojcicki announced five top priorities for the company, and "looking forward to YouTube's best, most transparent and most exciting year yet" made no mention of the recommendation system (2018).

Despite initially positive coverage, concern over the algorithm escalated after a former YouTube engineer publicly criticized the platform's potential to spread radicalized content. Guillaume Chaslot worked on the recommendation system at YouTube for three years. He became highly critical of the company for "not optimizing for what is truthful, or balanced, or healthy for democracy" (P. Lewis, 2018). Chaslot used computer simulations to model a YouTube user's behavior and found that "YouTube systematically amplifies videos that are divisive, sensational and conspiratorial" (P. Lewis, 2018). The company was quick to refute Chaslot's claims and "strongly disagree ... with the methodology, data and, most important, the conclusions made in [his] research" (P. Lewis, 2018). However, the story gained traction on

Twitter among many influential technology journalists. Prominent academic writer Zeynep Tufekci called it “a fascinating, important in-depth investigation of how YouTube’s recommendation algorithm apparently functioned during the 2016 election” (2018a). *New York Times* reporter Sheera Frenkel told her followers: “If you want to read something that’ll rattle you ... read this Guardian story on the rabbit holes YouTube sends you down” (2018). Another verified account commended Chaslot’s team for going “above and beyond to conduct their own research and dispute every claim that came from YouTube/Google’s representatives” (Fishkin, 2018). With criticism escalating, YouTube backtracked and updated the statement to include an appreciation for the “work to shine a spotlight on this challenging issue” (P. Lewis & McCormick, 2018).

Public pressure continued to build, and the company released a series of reactionary and ambiguous statements. An investigation by *The Wall Street Journal* found “recommendations often lead users to channels that feature conspiracy theories, partisan viewpoints, and misleading videos, even when those users haven’t shown interest in such content” (Nicas, 2018). This time, YouTube executives acknowledged the need to “help prevent the spread of blatantly misleading, low-quality, offensive or downright false information” but did not announce any specific changes to the algorithm (Nicas, 2018). In an op-ed, Tufekci dubbed YouTube “the great radicalizer.” She hypothesized the platform “may be one of the most powerful radicalizing instruments of the 21st century” (2018b). In response to Tufekci’s claim, Wojcicki disclosed that YouTube was “figure[ing] out how [they] can continue to diversify the content you’re seeing, continue to improve recommendations, and rely on the authoritativeness of the publishers” (Thompson, 2018). Wojcicki did not elaborate on how YouTube would determine the “authoritativeness of a publisher.”

The media continued its effort to hold YouTube accountable, and another compelling investigation led to the first official policy change regarding the algorithm. In a simulation of the typical viewer experience, *BuzzFeed* employees performed 147 YouTube searches and continuously clicked on the top-recommended video. In one specific viewing session, “the list of consecutively recommended videos ... goes from a BBC News clip to a series of QAnon conspiracy videos after 10 jumps” (O’Donovan et al., 2019). However, the results were inconclusive, and the user experience was inconsistent. Repeated searches of identical queries would often result in different recommendations (O’Donovan et al., 2019). One researcher was “not sure anyone — perhaps even many inside the company — truly understands YouTube’s recommendation algo” (Warzel, 2019). The system was flawed, and the goal of improving recommendations was unfulfilled. Shortly after the simulation results were published, YouTube announced an official effort to “begin reducing recommendations of borderline content and content that could misinform users in harmful ways,” regardless of whether the videos directly violate YouTube’s community guidelines (YouTube Team, 2019a). Although significant, the statement from YouTube “did not reveal much about how it would determine which videos would be excluded from recommendations,” and skepticism surrounding the algorithm remained (Wakabayashi, 2019).

### **YouTube Users Share Their Dissatisfaction**

With limited access to large-scale user data, compelling stories from individual YouTube viewers became a necessary tool for analysis. In 2019, a profile of Caleb Cain was on the front page of the *New York Times*. Cain describes his experience “falling deeper and deeper” into a community of far-right YouTube personalities. His entire YouTube viewing history was

analyzed, and “the bulk of his media diet came from far-right channels ... exploring a part of YouTube with a darker, more radical group of creators” (Roose, 2019b). Another user was recommended transphobic videos and said the site “will always be a place that reminds LGBT individuals that they are hated” (Cook, 2019). A crowdsourced campaign by the Mozilla Foundation highlighted the abundance of these incidents. One viewer’s recommended feed “just kept feeding [them] paranoia, fear and anxiety one video after another” (Mozilla, 2019). One child using the site progressed from watching “Thomas the Tank Engine” videos to a “compilation that contained graphic depictions of train wrecks” (Mozilla, 2019). These stories are extreme, but they are not unique. The dangerous and addictive nature of the YouTube algorithm has impacted many users.

Viewers were vocal on support forums and message boards about their dissatisfaction with the quality of recommendations. In a widely shared Reddit post, users complained that “the algorithm is way too reactive,” with a top commenter admitting that he “had to start pulling [him]self away from amateur political commentaries ... that’ll suck you in and keep you glued to the site” (UnspecifiedIndex). YouTube’s support forum was full of complaints from disgruntled users. A post entitled “Why is this garbage showing up in my recommended videos?” speculated that “either the algorithm is broken or [they are] being hacked” (EvilAvocado). The post received over 1,200 upvotes and more than 300 written responses. One commentator noted that recommendations “not just irrelevant but outright offensive ... most of the time they have absolutely NOTHING to do with your current video and are blatantly agendist” (EvilAvocado). In response to user concerns, YouTube employees suggested “some tips ... to help our systems understand what sorts of videos you actually enjoy” (TeamYouTube, 2019). However, the



suggested tips involved extensive manual flagging and watch history manipulation, only available for users with an account.

Some of YouTube’s most influential users, their employees, began to speak out against the company. Multiple employees at the company “wanted to flag troubling videos” or “track them in a spreadsheet to chart their popularity” but were turned down by their superiors (Bergen, 2019). Company insiders were not immune to the adverse effects. One employee had to restrict his daughter from accessing YouTube.com after she “was recommended a clip that featured both a Snow White character drawn with exaggerated sexual features and a horse engaged in a sexual act” (Bergen, 2019). Lawyers at the company reportedly discouraged employees from investigating harmful content. “The company would have a bigger liability if there was proof that staffers knew and acknowledged those videos existed” (Garun, 2019). Meanwhile, Mohan was publicly referring to the “rabbit hole” effect as “purely a myth” and remarking that “it’s equally — depending on a user’s behavior — likely that you could have started on a more extreme video and actually moved in the other direction” (Roose, 2019a). Not everyone agreed to be silent, and “at least five senior employees have left YouTube over its unwillingness to tackle the issue,” bringing attention to the inner company turmoil (Garun, 2019).

### **Dissent Among Academic Researchers**

Multiple studies found credible evidence that the recommendation algorithm featured highly polarized and extremist content. *Data & Society* published an extensive report on “the Alternative Influence Network (AIN): an assortment of scholars, media pundits, and internet celebrities who use YouTube to promote a range of political positions” (R. Lewis, 2018). The study was not exclusively focused on the recommendation system but found that “members of

the AIN are experiencing great success, with a countless number of their videos showing up in search results and video recommendations” (R. Lewis, 2018). Researchers had difficulty identifying “the role of the recommender system in the radicalization process.” However, they found that “even without personalization, [they] were still able to find a path in which users could find extreme content from large media channels” (Ribeiro et al., 2020). Another study specifically focused on personalization found “an overall pattern of opinion reinforcement and polarization after exposure to algorithm-recommended content” with “the potential to solidify personal political convictions and encourage polarized opinions” (Cho et al., 2020). Over fifteen months, a group of researchers analyzed eight million recommendations that “indicate[d] that YouTube experienced a conspiracy boom at the end of 2018,” but “monitored a consistent decrease in conspiratorial recommendations until the beginning of June 2019” (Faddoul et al., 2020). The data suggests that YouTube’s January 2019 promise to “improve the recommendations experience on YouTube” had tangible consequences on the user’s experience with recommendations.

Despite these results, contradictory research failed to identify conclusive evidence of radicalized recommendations. Munger and Phillips attributed the popularity of alt-right content to “affordances that make content creation easy for fringe political actors who tap into an existing base of disaffecting individuals” (2019). They did not find statistically significant evidence of a radicalization pipeline. Another 2019 study went a step further, suggesting “YouTube’s recommendation algorithm actively discourages viewers from visiting radicalizing or extremist content ... favor[ing] mainstream media and cable news content over independent YouTube channels” (Ledwich & Zaitsev). This research was one of the first studies to support deradicalization through recommendations. A more recent study supported “the existence of

distinct political news ‘echo chambers’ on YouTube” but found “little evidence that the YouTube algorithm is responsible for these trends” (Hosseinmardi et al., 2020).

The proprietary nature of the algorithm contributed to conflicting methodologies and dissent among academic researchers. Munger and Phillips criticized the Ribeiro study for “fail[ing] to demonstrate that the algorithm has a noteworthy effect on the audience for Alt-Right content” (2019). Ribeiro responded to their critique, noting that “their ‘Supply and Demand’ approach is unable to explain the phenomena that we have the most evidence about: user migration” (2019a). Ribeiro addressed further criticism on his blog, clarifying that “the paper says migration from these communities did happen, but does not really answer why this happen[s]” (2019b). The study by Ledwich and Zaitsev was also heavily scrutinized. Princeton professor Arvind Narayanan “wanted to call it wrong, but that would give the paper too much credit.” His Twitter thread denouncing the study received nearly 5,000 likes. Amidst the discussion, Tufekci expressed frustrations “that, at the moment, only the companies can fully study phenomenon such as the behavior of recommendation algorithms” (2019). Rebecca Lewis joined in the discussion, adding that “quantitative methods are often ill-suited to studying radicalization on YouTube via the algorithm” (2019). Ribeiro disagreed with Ledwich and Zaitsev’s methodologies but acknowledged “the research challenges associated with large-scale measurement and analysis of social media” (2019c). Ledwich and Zaitsev defended the use of anonymous recommendations and noted the lack of “any solutions around this problem that would present a representative sample and provide enough data” (2019). The lack of transparency from YouTube continued to restrict comprehensive independent analysis of the platform.

## **Formation of Internet Regulation Advocacy Groups**

Many researchers established public interest groups to bring additional awareness to the controversial nature of the algorithm. *TransparencyTube*, a website run by Mark Ledwich and Sam Clark, aimed to address the “absence of reliable data when it comes to the internal and external working of YouTube.” Their intuitive visualizations “fill[ed] this data vacuum to help journalists, researchers, and the curious better understand YouTube’s political landscape” (2020). The project exposed the severity of false election claims, showcasing that “unfounded claims of widespread election fraud garnered about 137 million views between Nov. 3 and 10” (Telford). Chaslot started a website dedicated to “spread[ing] the word about YouTube content amplification by sharing any borderline or polarizing content that YouTube is recommending” (Our Manifesto). The site outlines eight critical factors in the fight for algorithmic transparency. The Anti-Defamation League is involved in numerous efforts to reduce online hate, including a study of YouTube in 2021 (Center for Technology and Society). They found “the audience for videos from alternative or extremist channels is dominated by people who already have high levels of racial resentment” (Chen et al.). In addition to the #YouTubeRegrets campaign, the Mozilla Foundation released a list of comprehensive recommendations for YouTube. They requested “access to meaningful data,” “better simulation tools,” and “tools that empower, not limit, large-scale research and analysis” (Geurkink, 2019). These groups leveraged collective power to advocate for meaningful change.

## **Conclusion**

The evolution of the YouTube recommendation algorithm was not simply a result of technological advancements. Modification decisions resulted from persistent and calculated

advocacy from users affected by the system. The controversy surrounding YouTube resulted from a much larger problem within the technology industry. Personalized systems that make decisions based on user data can fundamentally affect consumer behavior, and the social implications of these systems deserve attention. It is increasingly common for technology executives to be motivated by growth and incentivized to keep users engaged with their platforms at all costs. While users do not have the power to amend these systems directly, they can be vocal and unapologetic in their demands. Big Tech is listening.

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