EXAMINING LIMITING MECHANISMS FOR REDUCING
SOCIAL MEDIA POLARIZATION:
A SIMULATION STUDY

by

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EXAMINING LIMITING MECHANISMS FOR REDUCING SOCIAL MEDIA POLARIZATION: A SIMULATION STUDY

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ABSTRACT

Industry and academia are both observing an increasing polarization in how citizens inform, deliberate, and discuss with one another. Many attribute social media as a key factor accelerating this polarization. Social media offers a reach, replication, and immediacy never before possible. In this paper, we examine how variation in replication may influence the polarizing effects of social media. Using a simulation setting allowing agents to interact iteratively over social media, we introduce “caps” that limit the number of times certain actors can share existing content. The introduction of this simple cap results in 31% less polarization. Both the government and technology companies are exploring how to mitigate some of the perceived negative impacts of social media, including polarization. Our findings have important practice implications for their efforts.
INTRODUCTION

In 1958, the Gallup Organization asked a random sample of Americans what kind of man they wanted their daughters to marry — a Democrat or a Republican. The question read: “If you had a daughter of marriageable age, would you prefer she marry a Democrat or a Republican, all other things being equal?” [14]. Respondents in the late 1950’s shared that 18 percent would want their daughter to marry a Democrat, 10 percent a Republican, while the remaining 72 percent answered with no preference. However, when asked again five years ago, it was clear American’s temperament had varied. In 2016, 28 percent of respondents answered they wanted their son or daughter to marry a Democrat, 27 percent a Republican, leaving now only 45 percent to answer with no preference [14]. The results show significant change, where our partisan groups now represent a majority over neutrality. Moreover, our country’s marriage proclivity for partisan likeness is not the only area of change. Consider 2017 study conducted by the Pew Research Center.

![Figure 1 – Ideologies Grow Further Apart](image)

Partisan polarization has significantly grown since the 1990’s as standard Democrat and Republican ideologies grow further disparate. As shown in Figure 1, Pew Research Center reports in 2017 92 percent of Republicans were found to the right of the median Democrat, with 94 percent of Democrats existing to the left of the median Republican [16]. Thus, the paradigm shift towards dichotomous groups warrants a more pressing question for American society today: what has been propelling society’s polarization in recent decades and what are the consequences of our contrariety if left ungoverned?

Social media have arguably facilitated the emergence of such issues, with the scale of discussions and the publicity they foster [11]. As technology further evolves with greater connectivity and convenience, these tools integrate themselves within human interaction and alter traditional communion. Parallel to our nation’s spike in partisan polarization, from 1994 to 2014, a number of social media outlets were first launched including Facebook in 2004 and Twitter in 2006 [2]. Often to our benefit, social media facilitate superior collaboration, information, and education to occur at groundbreaking speed and scale. Innovative platforms allow individuals to stay connected with family and friends via messaging or videotelephony, provide quick access to information and research, or assist in online learning and content discovery [7]. Social media have fundamentally changed the way in which Americans consume
media and enables such discussions to take place instantly with diverse backgrounds anywhere across the globe. However, the more our nation’s political debate goes online, the faster it deteriorates. So how did social platforms, expected to connect the world, become centrifugal machines fostering society’s polarity? And furthermore, how can we as a nation limit these consequences and protect the fragility of our country’s democracy?

In the following section we review social drivers of polarization and the consequences of our group biases exhibited on social media platforms. We next explore the social media attributes affecting the spread of online information and how the study’s agent-based model addresses these topics. Lastly, we offer conclusions and implications drawn from our research.

**THEORY**

Moderate positions and neutral discussion online have become scarce in the modern world of dichotomous extremes. Society’s political discourse has become much more than civil debates but rather such positions signify the deep-rooted beliefs that define the individuals and groups that makeup American society. Today, partisan identification predicts person's preferences toward various social policy issues nearly three times as well as any other demographic factor—such as education or age [3]. Understanding the development of both societal polarization and social media usage, we directed our research attention in three areas: understanding the mechanisms of social media impacting polarization; exploring how disproportionate influence across users affects the distribution of online information; and examining what variables were most significant to the behavior of a social system.

Before examining social media’s influence on societal behavior, it is important to establish in this argument, social media arrived into an already polarized world – it didn’t create one. Highly partisan media and extreme beliefs are an unavoidable consequence of America’s foundational right to free expression. However, technology only acts to magnify this natural effect of democracy. Fabricating social networks of like-minded individuals and stimulating user engagement, social media platforms promote a stream of uniform opinions. Furthermore, the widespread usage of social media paired with an outright distrust in media outlets today threaten to accelerate polarizing trends. In 2018, a team from Facebook delivered a presentation to their senior executives about their platform’s societal impact. A direct quote from the presentation reads “Our algorithms exploit the human brain’s attraction to divisiveness, if left unchecked, Facebook will feed users “more and more divisive content in an effort to gain user attention and increase time on the platform” [12]. Facebook recognized this effort by launching an internal study to understand how their platform shapes user behavior. But in the end, Facebook’s interest was only ephemeral. According to unreported internal documents and people familiar with the investigation, Mark Zuckerberg and other executives weakened or blocked efforts to apply conclusions to Facebook products [12]. There is no incentive for technology companies to govern themselves as sanctions would reduce engagement and profitability of their platforms. Instead, the changes implemented over the years have targeted increasing activity and total users on such platforms. Specifically, a series of design changes implemented in 2009, signal a
transforming moment of social media services that would ultimately revolutionize the technology industry forever. These changes were the like button, the retweet button, and algorithm-powered recommendation feeds.

Social media platforms and services are powered by advertising dollars. Since services like Facebook and Twitter are free to access, the platforms generate revenue through a different manner by promoting advertisements of outside corporations while users spend time on the platform. Advertisements are more valuable when platforms can effectively categorize their users and retain individual’s attention and engagement for long intervals. Acknowledging this system, there is incentive for social media platforms to present users with information that triggers compelling emotions to drive more engagement and discussions online. The algorithms, built-in to the platforms, optimize content tailored to the individual that has the highest probability of eliciting a reaction, response, or distribution of information to propel engagement and satisfy key performance measures of the platform. However, the implicit side effects of these changes, meant to attract new users and grow engagement, results in increased polarization as well as addiction to these platforms. In our polarized world, messages of outrage in society are common, but paired with a platform of constant likes and positive reinforcement the message becomes amplified. “Majority of individuals between partisan extremes remain on the edges of the political playing field … while the most ideologically oriented and politically rancorous Americans make their voices heard” [17]. When opinions of the extreme appear as the majority by the spread and insulation of our social networks there becomes a need for governance. Long-term these trends threaten our democracy by normalizing outrage to problems in our world and distracting from our ability to make real systematic change. If everything is a problem, then how can we identify the truly impacting issues. It is an issue that requires examination and is the impetus for this study.

The impacts of social media on societal polarization can be split in to direct and indirect causes. First, our social networks consist of individuals highly similar to our demographics, interests, and political beliefs. Thus, creating a stream of dialogue and shared information that stimulates the existing biases of our in-group. This creates what is called a “filter bubble” or “echo chamber”, where beliefs are reinforced by communication and repetition inside a closed system and insulated from rebuttal of out-group views [16]. With platforms building up individuals’ beliefs and supplying their confirmation biases, the result is an increasing negative position towards opposing views. This human instinct comes from the psychological idea of tribalism where we advocate for the ideas and lifestyles of our in-group and degrade those of any out-groups [16]. These are direct impacts of social media’s makeup and often manipulate our human psychology to get the results their require. However, social media poses indirect effects upon polarization in our groups as well that becomes harder to quantify. Indirect stimulus occurred through the transformation traditional media in the United States and the heightened competition among our content distribution channels. New strategies arise as mediums blend into all-encompassing outlets of compelling news and media. Where social media and traditional media were once separated, today, activity on our social platforms such tweets written by former president Donald Trump often became widespread headlines across other mediums. Social media and Balkanized TV networks strategies today often proffer content with the biggest emotional
punch when we are exposed to a differing view, operating on the principle that if it is outrageous, it’s contagious [15]. Mr. Sabin-Miller and Dr. Abrams, both mathematicians, call this effect “repulsion.” “In addition to the “pull” of repeatedly seeing viewpoints that reinforce our own, inside of our online echo chambers, repulsion provides a “push” away from opposing viewpoints. Importantly, this repulsion appears to be a more powerful force, psychologically, than attraction to our own side of a debate” [15]. Thus, playing upon the shortcomings of our human psychology, social media is able to deliver similar reaction-driven news. Assessing the impacts upon Americana, modern social media undeniably changed the way we consume, accept, and share information forever.

We further examine how modern dissemination of information online creates a disproportionate rank of influence among users. The exchanges happening within our social networks rely on trust between not simply the user and the platform but also among various users who engage on that platform [28]. As users establish networks of online relationships, “opinion leaders” become trusted purveyors of significant commentary to the group. “The theoretical notion of an opinion leader suggests there are individuals who are trusted sources of political information for their everyday associates who tend to pay less attention to news or other political messages from elites” [28]. Operating social media with superior influence, opinion leaders bear great responsibility to their groups and society to mitigate digital threats such as bias among echo chambers or misinformation from malicious sources. However, are our opinion leaders equipped to burden this responsibility or does this threat signify a need for higher governance? Current trends signal the latter. As social media platforms continually focus on personalization and optimizing for clicks, likes, and shares, the climate of online dissemination favors sensational information regardless of accuracy as people tend to encounter more information that conforms to their existing beliefs [28]. Our platforms’ authority over opinion leaders coupled with the imbalance of influence among online groups suggest we implement mechanisms to limit key users bearing on online behavior. With our opinion leaders well-positioned in administering the information flow on our social media platforms, controlling these users’ online behavior demonstrates significance towards governing unsought events across the entire social system.

We explore a subset of the variables that affect polarization through a simulation model. These variables are age by generation, frequency of social media visits, allocation of partisan medias within the environment, and the receptibility of foreign ideologies. Age is a necessary variable to establish because levels of frequency, engagement, preconceived beliefs, and acceptance all carry distinctive values similar to each group’s generation. By utilizing previous studies and their percentages, our simulation gains accuracy and credibility of implementation in the real world. For example, studies confirmed the “long-standing notion that people become more politically polarized as they age” [8] which supports the integrity of the model and its agents. Next, willingness of an individual or group to accept or reject information on social media is largely rooted in existing beliefs. Whether the idea identifies with their in-group values versus an out-group, triggers different processes to affect their polarization. Studies have shown that while many solutions call for a more diverse feed of news from all parties this actually results in a deeper position in their existing partisan beliefs [4]. Next, the frequency of social media visits by different individuals and groups act an important role in examining the effects of
polarization throughout a social system and will be addressed further in this study’s findings and discussion sections. Lastly, the percentage of one’s news allocation, exposed to both in-group and out-group ideas, or specifically blue versus red media in this simulation, is an important variable to signify how powerful social media can act especially targeting such attributes.

METHOD

We examine polarization levels in our social networks by creating an agent-based simulation model using programming language and development environment, NetLogo. Simulation modeling is “the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world”. More specifically, with agent-based modeling, active entities, known as agents, are identified and their behavior defined. The global dynamics of the system then emerge from the interactions of the many individual behaviors [27]. This section begins with the advantages of developing a simulation model then begins describing the aspects of this study’s agent-based model.

First, simulation modeling provides valuable solutions by giving clear insights into complex systems. The dynamic environment of our social networks cannot be solved by mathematic formulas or models but rather must be examined as they interact [27]. A simulation methodology offers an active study of the entities and behavior of the system with much needed flexibility. Another reason is that simulation modeling provides a practical way to explore “what-if” scenarios that may be impractical or even impossible to conduct in the real world. Consider the idea of “turning off” Facebook for an entire country or limiting usage, just to examine its effects on political polarization. This idea is not practical and must be conducted in a setting outside of the real world. Next is the advantage of analyzing a model as it runs. The ability to study changes in the simulation as exchanges between agents occur is what sets simulation modeling apart from other methods. By inspecting processes and interactions with a simulation model in action, gains further understanding and accuracy of the system [27]. Lastly with the use of a simulation, or more specifically, agent-based modeling, observants can examine effects on the system as whole and at a detailed level. Focus is directly on individual objects, their behavior, and their interaction. An agent-based simulation model is a set of interacting objects that reflect relationships in the real world. This leads to better understanding and strategies for managing the complexity of today’s social systems [27].
The simulation addresses individual and group dynamics within its environment while granting the ability to analyze attributes of the individual affecting change in polarization levels materialized from traits and behavior assessed in the real world. All figures of probability and acceptance implemented in the model were gathered from studies and related work providing validated statistics (Figure 3). Construction of the simulation aims to replicate the millions of social media interactions and daily consumption of media within a small sample space. Individuals move randomly about their world, engaging with hundreds of social media stations and other individuals (Figure 2). Based on an individual’s age, frequency of online interactions, allocation of red versus blue media stations, as well as their acceptance of foreign ideologies, their polarization levels will change. Polarization level is the driving determinant in this study and is plotted through a column chart as the simulation runs (Appendix B.5). By controlling the amount of red versus blue social media stations as well as choosing whether or not to limit user’s social media engagements, the overall frequency of online consumption and polarization levels will change throughout the social network. After thorough examination of governing online behavior conducted on social media, the study offers conclusions towards limiting society’s proclivity to polarization.
FINDINGS

We find that implementing a cap to limit a small percentage of users’ activity on social media platforms has a dramatic impact on polarization. By limiting 10 percent of users with the high polarity to 100 social media posts, resulted into the entire population’s polarization to drop by 31 percent among partisan groups.

Figure 4 – Number of Users with Cap
Figure 5 – Polarization Levels Across Population of the Simulation

Figures 4 & 5 above display how the 5% or 17 users at each partisan extreme are selected for a cap on social media activity for each run of the simulation.

Figure 6 – Polarization Results of the Agent-Based Simulation

The proportional decreases in partisan groups and respective increase in neutral/mixed group is depicted in the pie charts above in Figure 6. With the implementation of a selective cap on 10 percent of the population, polarization levels are able to maintain a healthy distribution across society and counter unsought trends of social media today.
Tables 1 & 2 display the polarization levels of several iterations of the simulation practicing a cap to limit users (Table 2) versus allowing unconstrained use of social media (Table 1). For further details and understanding, see Appendices for all Simulation & NetLogo related files.

**DISCUSSION**

In the past, any communication performed required a marginal cost on the part of the sender. However slight, ink for printing, time to reach each person, and the barriers affecting the spread of information. With social media, users can send extensive volumes for the same cost as one message. Costless communication can be abused – neither as an individual nor as a society do we have the qualities to deal with constant information. Our mind is geared to listen to information assuming there was some cost for the sender. Social media has redefined the dynamics of communication and requires a new method of cost and benefit communications in social networks and messaging.

Implementation of the results gathered in this study can materialize through voluntary adoption or government regulation to limit behavior on social media platforms. Aforementioned, Mark Zuckerberg and other Facebook executives demonstrated in 2018 their unwillingness to voluntarily apply strategies that limit user engagement. However, significant changes have occurred in recent years that may indicate a change in the industry. Most notably, Twitter exercised action against significant user, President Donald Trump, by removing him from their platform for “dangerous behavior” in breach of Twitter’s Acceptable Use Policy. Such restrictions signal the potential of social media platforms defining unacceptable behavior in greater detail and offering reform to limit the adverse side-effects of social media like polarization and addiction. If our social media companies show reluctance to such change, the federal government must rise to this urgent issue and create effective guidelines for online behavior themselves. However, federal regulations will initiate public speculation concerning a limit upon our civil liberties which must be carefully navigated as well. There must be an
effective balance between restriction on damaging behavior and protecting all Americans freedom of speech. While limiting users to 100 posts may sound unreasonable, this number remains relatively close to the interactions of the average user in the simulation which offered 178 posts and only limits users acting in extremes.

There must be future research conducted to evaluate how groups are affected by different limits on activity and how to implement a thorough strategy to repair the divide in our polarized groups while protecting American’s freedom of speech. Similar simulation studies examining limits based on content or hashtag, by groups beyond partisan beliefs, or by time period would all be valuable in finding the most effective guidelines to reduce societal polarization while assigning restrictions on the smallest percentage of the American population as possible.
APPENDICES

Appendix A: Simulation Dashboard

Appendix B: NetLogo Code

➢ B.1: Full Script
➢ B.2: Setup
➢ B.3: Go
➢ B.4: Global Variables
➢ B.5: Plots & Histograms

Appendix C: Simulation – File

➢ https://d.docs.live.net/fb07b34b4299bb7a/Documents/Spring%202021/THESIS/NetLogo/SM%20Dots%20w%20Tribalism%20and%20Selective%20Cap.nlogo

Appendix D: NetLogo Website - URL

Appendix E: Bibliography
Appendix A: Simulation Dashboard
Appendix B: NetLogo Code

B.1: Full Script

breed [humans human]
breed [elephants elephant]
breed [donkeys donkey]

globals [gen_z millennials gen_x boomers reycolor bluecolor ;posts_by_person ;max_sharing_time ;posts_by_group ]

donkeys-own [ ;blue_social_media color-affiliation ]
elephants-own [ ;red_social_media color-affiliation ]
humans-own [ age-group contagion-chance polarization_points SM-counterR SM-counterB SM-counter cap stop_now ]

end

to setup
#number #age-group
create-humans #number
[ setxy random-xcor random-ycor ; spread people on random x&y
 set shape "person"
 set color 118 ; 116 purple
 set size 6
 set polarization_points (random (200) - 100) ; P_P starting at zero vs. random
 set SM-counterR 0 set SM-counterB 0 set SM-counter 0 set cap 0 set stop_now 0 set age-group #age-group
 ifelse age-group <= gen_z [
 set contagion-chance_chance_of_spread_gen_z ]
]
end

to setup
#number #color-affiliation
create-elephants #number
[ setxy random-xcor random-ycor ; spread medias on random x&y
 set shape "computer workstation"
 set color 105 ;set color #color-affiliation
 set size 3 ]
end

to setup
#number #color-affiliation
create-donkeys #number
[ setxy random-xcor random-ycor ; spread medias on random x&y
 set shape "computer workstation"
 set color 15 ;set color #color-affiliation
 set size 3 ]
end

to setup-globals
set gen_z 15 ;Gen Z or iGen: Born 1996 – TBD
set millennials 30 ;Millennials or Gen Y: Born 1977 – 1995
set gen_x 50 ;Generation X: Born 1965 – 1976
set boomers 70 ;Baby Boomers: Born 1946 – 1964
set redcolor "red"
set bluecolor "blue"
end

to setup-people [#number #age-group]
clear-all
reset-ticks
setup-globals
setup-people population_gen_z gen_z
setup-people population_millennials millennials
setup-people population_gen_x gen_x
setup-people population_boomers boomers
setup-medias2 red_social_media reycolor
setup-medias2 blue_social_media bluecolor
ask humans
[ ifelse polarization_points < -49 [ set color blue] ; make all carriers of message blue
 set color red] ; set color 118]
]
let affected_number round (count humans * (percent_of_population_capped / 100))
cap_redshares affected_number
cap_blueshares affected_number
end

to go ; in order to move
if ticks >= 8760 [stop]
ask humans with [stop_now <= 0]
if coin-flip? [right random 60] [left random 60] ; if coin-flip is true (0) then turn right up to 60 degrees, otherwise left
  forward random 4 ; move randomly between 0 and 3 steps forward 0,1,2,3

; if human interacts with a social media platform, run polarization equation
if any? other donkeys-here ; people in same patch?
  [random_subtract]
if any? other elephants-here ; people in same patch?
  [random_addition]
ifelse polarization_points < -49
  set color blue ; make all carriers of message blue
  [ifelse polarization_points > -49
    set color red
  ]
  set SM-counter SM-counterB + SM-counterR
if cap >= 1 [check_cap]
]
tick ; add one unit of time to our counter

; and (contagion-chance >= (random(100) + 1)); people in same patch?
end

to random_subtract
set SM-counterB SM-counterB + 1
if contagion-chance >= (random(100) + 1); more likely to adopt their beginning news preference vs opposite news
  [polarize_blue]
end

to random_addition
set SM-counterR SM-counterR + 1
if contagion-chance >= (random(100) + 1); more likely to adopt their beginning news preference vs opposite news
  [polarize_red]
end

to polarize_blue
ifelse color = blue
  [set polarization_points polarization_points - 1]
  [ifelse color = red
    [set polarization_points polarization_points - 1]
    [set polarization_points polarization_points - 1]
  ]
end

to polarize_red
ifelse color = red
  [set polarization_points polarization_points + 1]
  [ifelse color = blue
    [set polarization_points polarization_points + 1]
    [set polarization_points polarization_points + 1]
  ]
end

to cap_redshares [#affected_number]
  ask n-of (#affected_number / 2) humans with [polarization_points > -49]
    [set cap 1] ;and [set size 20]
end
to cap_blueshares [#affected_number]
  ask n-of (#affected_number / 2) humans with [polarization_points < -49]
    [set cap 1] ;[set size 20]
end
to check_cap
if SM-counter >= 100 [set stop_now 1]
end

to opposed_people [#affected_number]
  ; ask n-of #affected_number humans [ set message? true ]
;end
to report coin-flip?
  report random 2 = 0
end

B.2: Setup

to setup-globals
  set gen_z 15 ;Gen Z or iGen: Born 1996 – TBD
  set millennials 30 ;Millennials or Gen Y: Born 1977 – 1995
  set gen_x 50 ;Generation X: Born 1965 – 1976
  set boomers 70 ;Baby Boomers: Born 1946 – 1964
  set redcolor "red"
  set bluecolor "blue"
end

to setup-people [#number #age-group]
  create-humans #number
  [ setxy random-xcor random-ycor ; spread people on random x&y
    set shape "person"
    set color 118 ; 116 purple
    set size 6
    set polarization_points (random (200) - 100) ; P_P starting at zero vs. random
    set SM-counterR 0
    set SM-counterB 0
    set SM-counter 0
    set cap 0
    set stop_now 0
    set age-group #age-group
  ]
ifelse age-group <= gen_z
  [ set contagion-chance chance_of_spread_gen_z
  ]
ifelse age-group <= millennials
  [ set contagion-chance chance_of_spread_millennials
  ]
ifelse age-group <= gen_x
  [ set contagion-chance chance_of_spread_gen_x
  ]
ifelse age-group <= boomers
  [ set contagion-chance chance_of_spread_boomers
  ]
to setup-medias [#number #color-affiliation]
    create-donkeys #number
    [ setxy random-xcor random-ycor ; spread medias on random x&y
        set shape "computer workstation"
        set color 105
        ;set color #color-affiliation
        set size 3
    ]
end

B.3: Go

to go ; in order to move
    if ticks >= 8760 [stop]
    ask humans with [stop_now <= 0]
        [ ifelse coin-flip? [right random 60] [left random 60] ; if coin-flip is true (0) then turn right up to 60 degrees, otherwise left
        forward random 4 ; move randomly between 0 and 3 steps forward 0,1,2,3
        ; if human interacts with a social media platform, run polarization equation
        if any? other donkeys-here ; people in same patch?
            [random_subtract]
        if any? other elephants-here ; people in same patch?
            [random_addition]
        ifelse polarization_points < -49 [ set color blue] ; make all carriers of message blue
            [ifelse polarization_points > 49 [ set color red]
                [set color 118]
            ]
        set SM-counter SM-counterB + SM-counterR
        if cap >= 1 [check_cap]
    ]
tick ; add one unit of time to our counter
;and (contagion_chance >= (random(100) + 1) ; people in same patch?
end

B.4: Global Variables

globals [
    gen_z millennials
gen_x boomers
    redcolor bluecolor
    ;posts_by_person ;max_sharing_time ;posts_by_group
]
humans-own [
    age-group contagion_chance polarization_points SM-counterR SM-counterB SM-counter cap stop_now
]
elephants-own [
    :red_social_media
    color-affiliation
]
donkeys-own [
    :blue_social_media
    color-affiliation
]
B.5: Plots & Histograms

- **Group Polarization**
  - Red: 152, 44.19%
  - Neutral: 164, 47.67%
  - Blue: 28, 8.14%

- **Polarization Distribution**

- **Polarized Red by Age Group**
  - Gen Z
  - Millennials
  - Gen X
  - Baby Boomers


%20at,mobile%20devices%20is%20one%20reason.


