

Intro to Data Science

What **R** we doing?

Prof. Bisbee

Vanderbilt University

Lecture Date: 2023/08/23

Slides Updated: 2023-08-22

Agenda

1. Meet the instructor
2. Course Motivation
 - What is data science (DS) & why should we care?
3. Course Objectives
 - **Content:** Critical thinking, analysis, presentation
 - **Skills:** Computing and analysis in R
4. ChatGPT and data science
5. Course Expectations & Syllabus review

Meet the instructor

- Education
 - PhD from NYU Politics in 2019
 - Postdocs at Princeton Niehaus & NYU CSMaP
- Published some things
 - Methods-ey: external validity [1](#), [2](#); measurement [3](#), [4](#)
 - Substantive: economics & populism [1](#); Covid-19 & U.S. politics [2](#), [3](#); IPE [4](#); academic naval-gazing [5](#)
 - Popular press: [1](#), [2](#), [Podcasts](#)
- Work
 - World Bank / IFC
 - MarketCast

Meet the instructor

- Current research
 - YouTube + polarization
 - Twitter + misinformation
 - Telegram + white supremacists
- (Throughout the semester, I colorcode data science)

Why are you here?



Suggested fights

20 last fights



DATA SCIENCE vs STEM

200



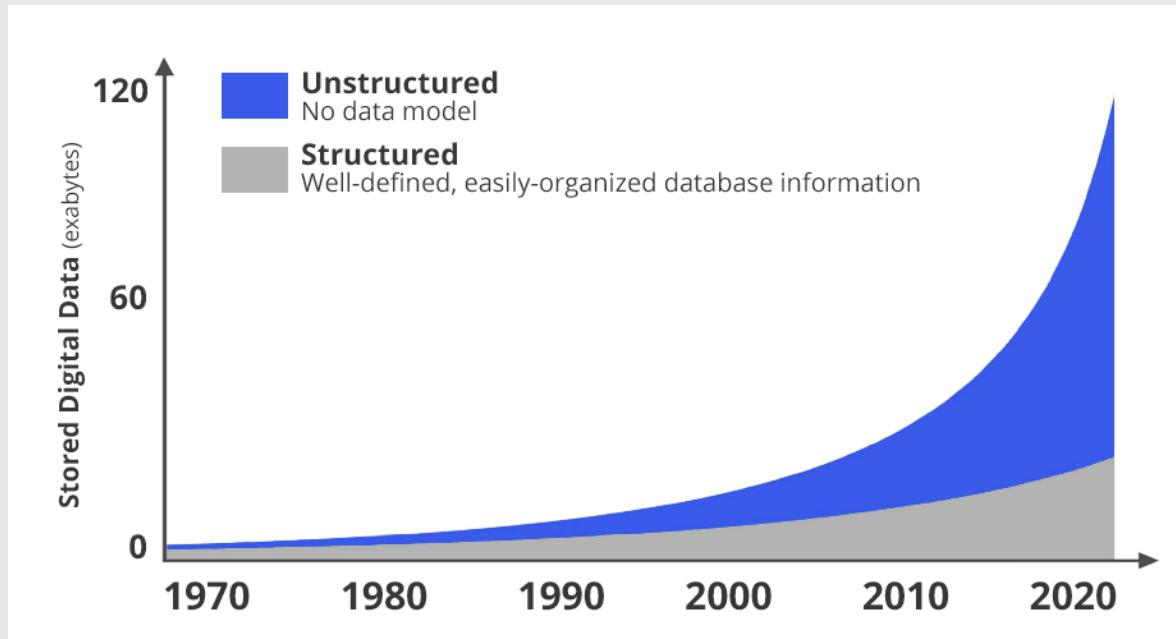
DATA SCIENCE

101

STEM

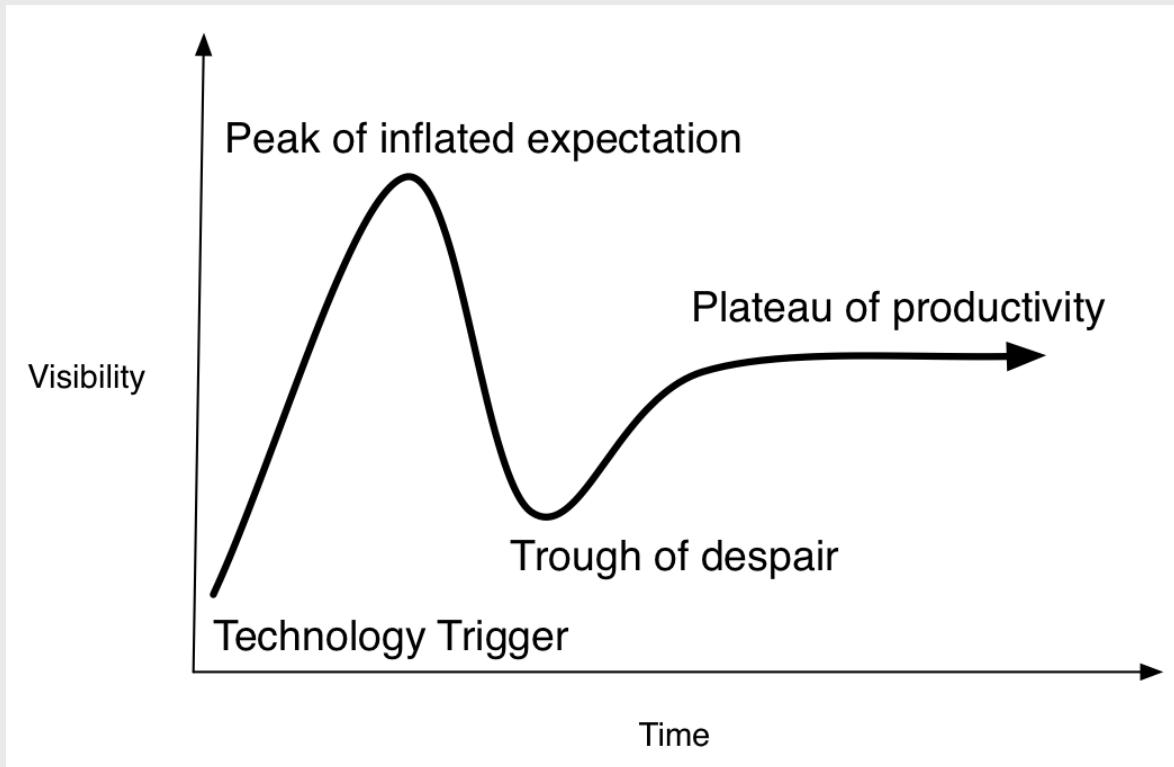
Is this all just a fad?

- No



Is this all just a fad?

- But there are faddish qualities



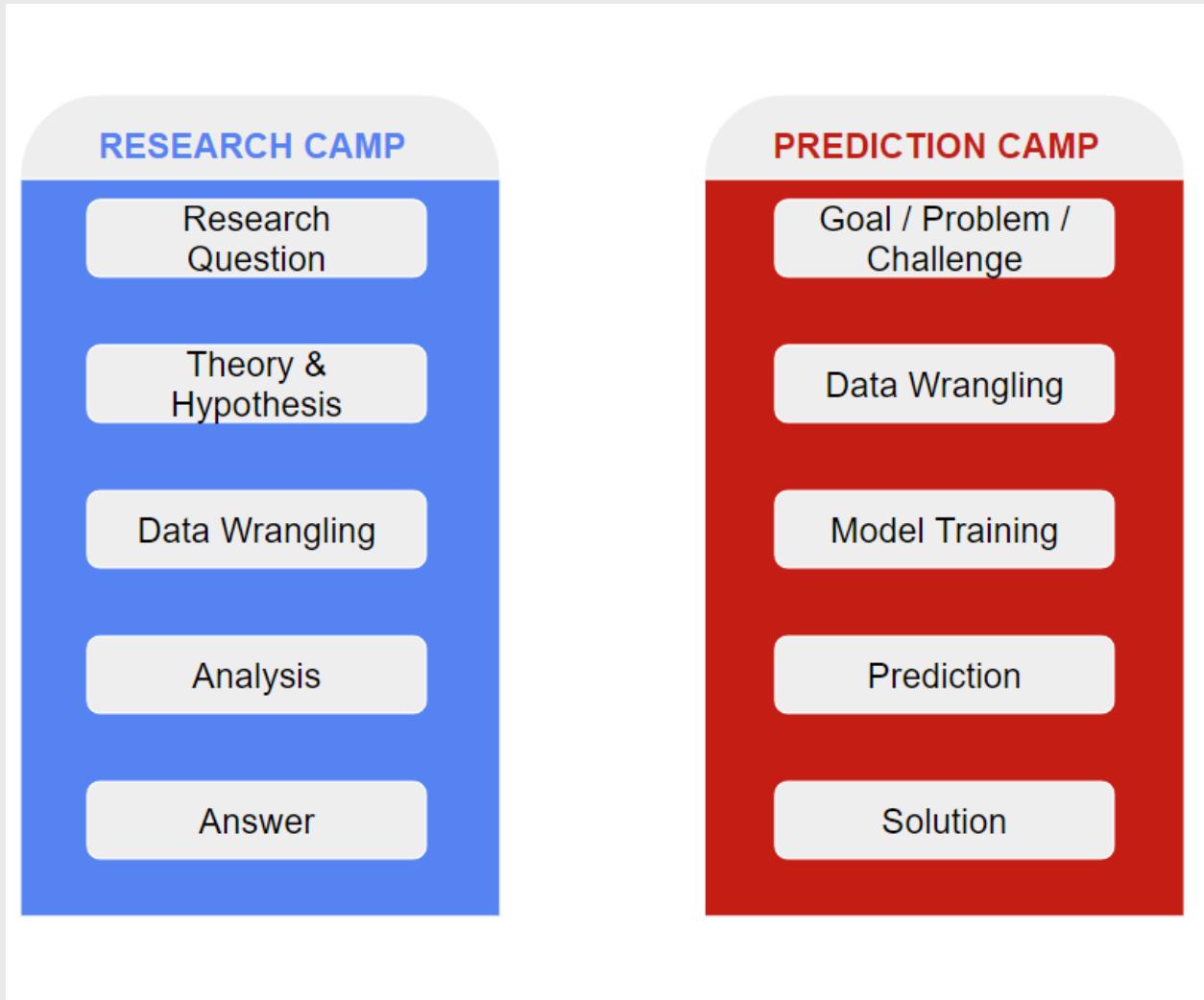
So what IS data science?

- Split into two camps
 - 1. **Research** camp
 - Focused on **answering a research question**
 - Follows the "scientific method"
 - Goal: contribute to knowledge
 - Domain: academia
 - 2. **Prediction** camp
 - Focused on **making a prediction**
 - Typically unconcerned with theory or *why* a model works
 - Goal: inform a decision / policy
 - Domain: private sector

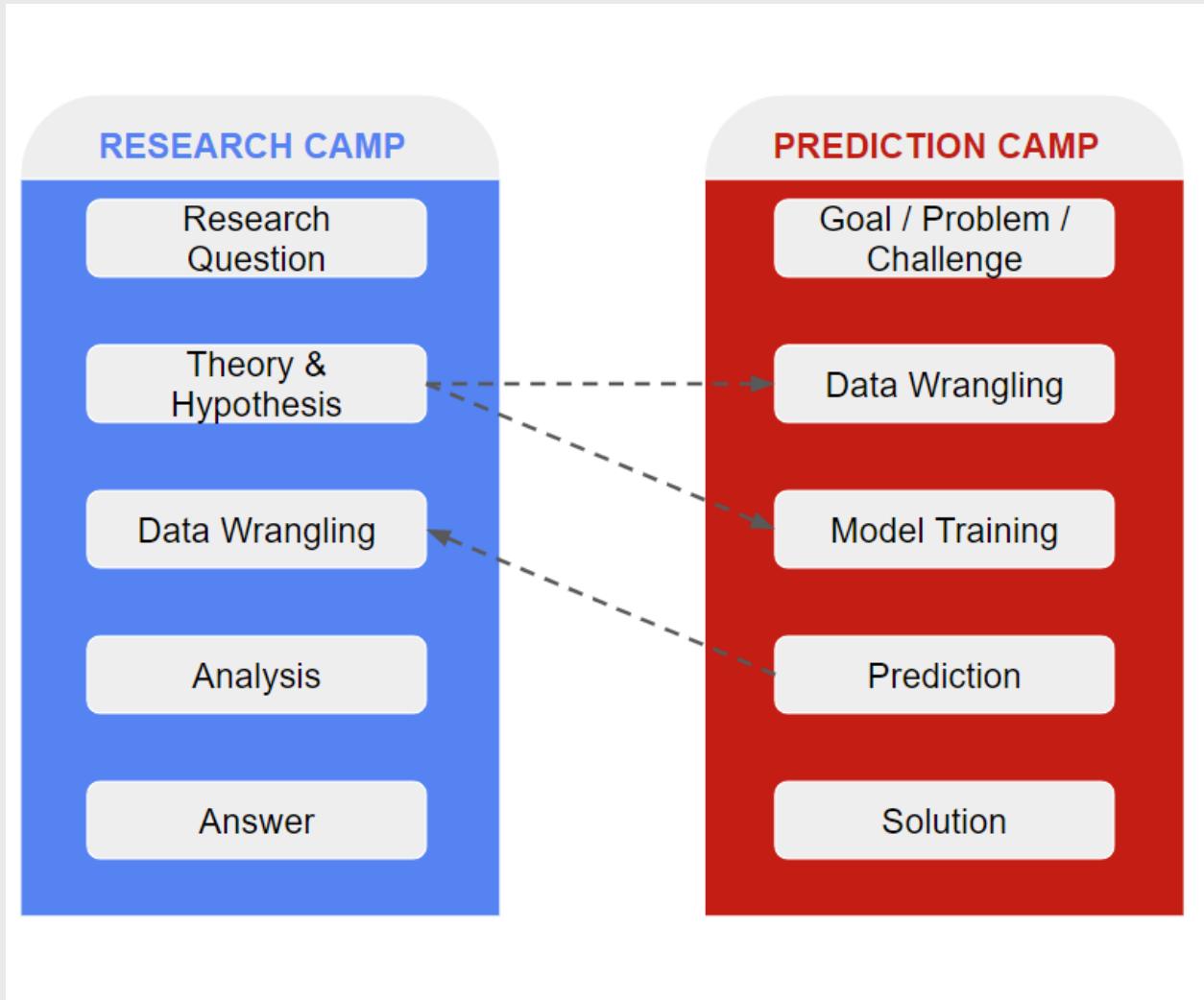
The Two Camps



The Two Camps

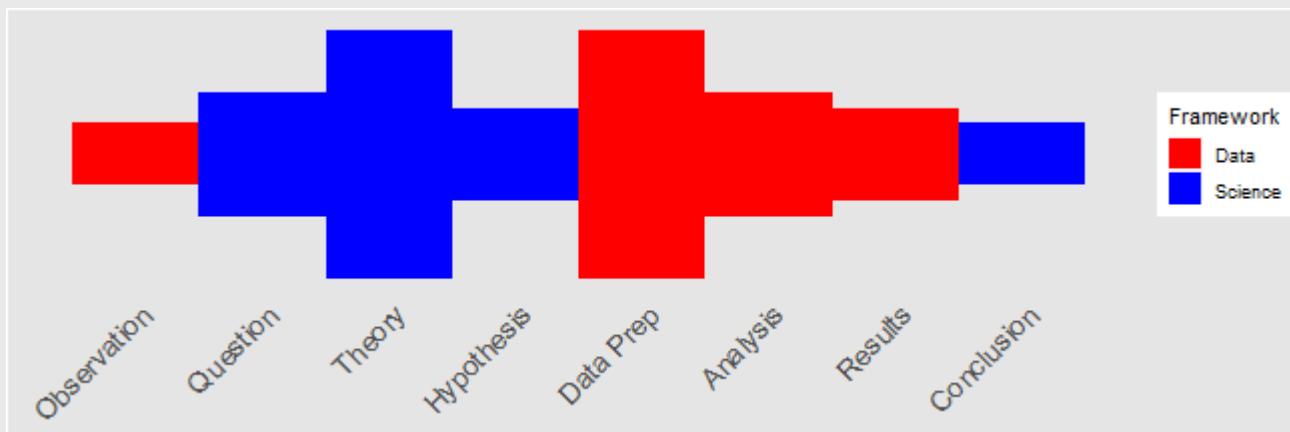


The Two Camps



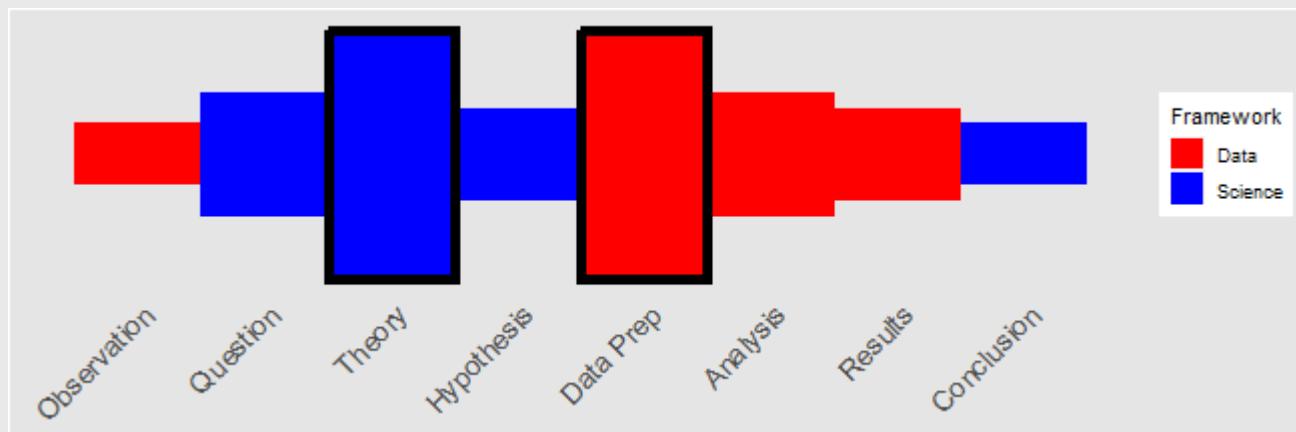
Research Camp

- The scientific method
 1. Observation → Question
 2. Theory → Hypothesis
 3. Data Collection / Wrangling → Analysis
 4. Results → Conclusion



Research Camp

- The scientific method
 1. Observation → Question
 2. Theory → Hypothesis
 3. Data Collection / Wrangling → Analysis
 4. Results → Conclusion



Research Camp

Echo Chambers, Rabbit Holes, and Algorithmic Bias: How YouTube Recommends Content to Real Users

Megan A. Brown,^{1†} James Bisbee,¹ Angela Lai,^{1,4}
Richard Bonneau,^{1,3,4} Jonathan Nagler,^{1,2,4} Joshua A. Tucker^{1,2,4}

¹Center for Social Media and Politics, New York University

²Politics Department, New York University

³Biology Department, New York University

⁴Center for Data Science, New York University

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August 23, 2023

Abstract

Research Camp

1. Observation → Question

- Observation is facilitated by **data** (Descriptive analysis)



Research Camp

1. Observation → Question

- Observation is facilitated by **data** (Descriptive analysis)

The image shows a screenshot of a CBS News video player. The main content area displays a split-screen interview. On the left, a Black male anchor in a blue patterned shirt and dark tie looks directly at the camera. On the right, a white female anchor in a bright pink V-neck top also looks at the camera. Below the anchors is a red horizontal bar with the text 'PRES. USES SOCIAL MEDIA TO DENOUNCE "RIGGED" ELECTION'. The CBS News logo is visible in the bottom right corner of the video frame. At the bottom of the screen, there is a navigation bar with icons for play, volume, and time (0:06 / 1:14). A small text overlay says 'U.S. elections' and 'The AP has called the Presidential race for Joe Biden. See more on Google.' In the bottom right corner of the video frame, there is a 'SHOW ME' button. To the right of the video player is a sidebar titled 'Up next' which lists several news clips from different networks like FOX, CBS, NBC, and CNN, each with a thumbnail, title, and view count.

PRES. USES SOCIAL MEDIA TO DENOUNCE "RIGGED" ELECTION

LIVE CBSN

SENATE HEARING ON RUSSIAN INTERFERENCE IN 2016 ELECTION
cbsnews.com/hearing

U.S. elections

The AP has called the Presidential race for Joe Biden. See more on Google.

Robust safeguards help ensure the integrity of elections and results. Learn more

SHOW ME

Trump continues to push false claims of election fraud in Facebook video

12,798 views • Dec 3, 2020

CBS News 3.29M subscribers

President Trump posted a long Facebook video where he repeatedly denounced the November election as "rigged," even though Attorney General William Barr said the Justice Department has seen no evidence of election fraud. CBS News White House correspondent Paula Reid joins CBSN's

942 LIKES 182 DISLIKES SHARE SAVE

SUBSCRIBE

MARY TRUMP SAYS IT'S "IMPOSSIBLE" FOR TRUMP TO...

THE VIEW 7.5K VIEWS • 1 HOUR AGO

ATTORNEY GENERAL WILLIAM BARR'S JOB IN JEOPARDY

ABC NEWS 57K VIEWS • 5 HOURS AGO

'A FOOL': MAGA FANS TURN ON BARR AFTER DEBUNKING TRUMP'S...

MSNBC 875K VIEWS • 19 HOURS AGO

16 / 75

Research Camp

1. Observation → Question

- Observation is facilitated by **data** (Descriptive analysis)

The image shows a screenshot of a CBS News video player. The main content area features a split-screen interview. On the left, a Black male anchor in a white shirt and dark tie looks directly at the camera. On the right, a female anchor with long dark hair, wearing a pink top, also looks at the camera. Below the anchors is a red horizontal bar with the text 'PRES. USES SOCIAL MEDIA TO DENOUNCE "RIGGED" ELECTION'. The CBS News logo is visible in the bottom right corner of the video frame. At the bottom of the screen, there is a navigation bar with icons for play, volume, and time (0:06 / 11:40). A small note below the play bar says 'U.S. elections'. The video has 12,798 views and was posted on Dec 3, 2020. A 'SUBSCRIBE' button is located in the bottom right corner of the video frame.

Up next

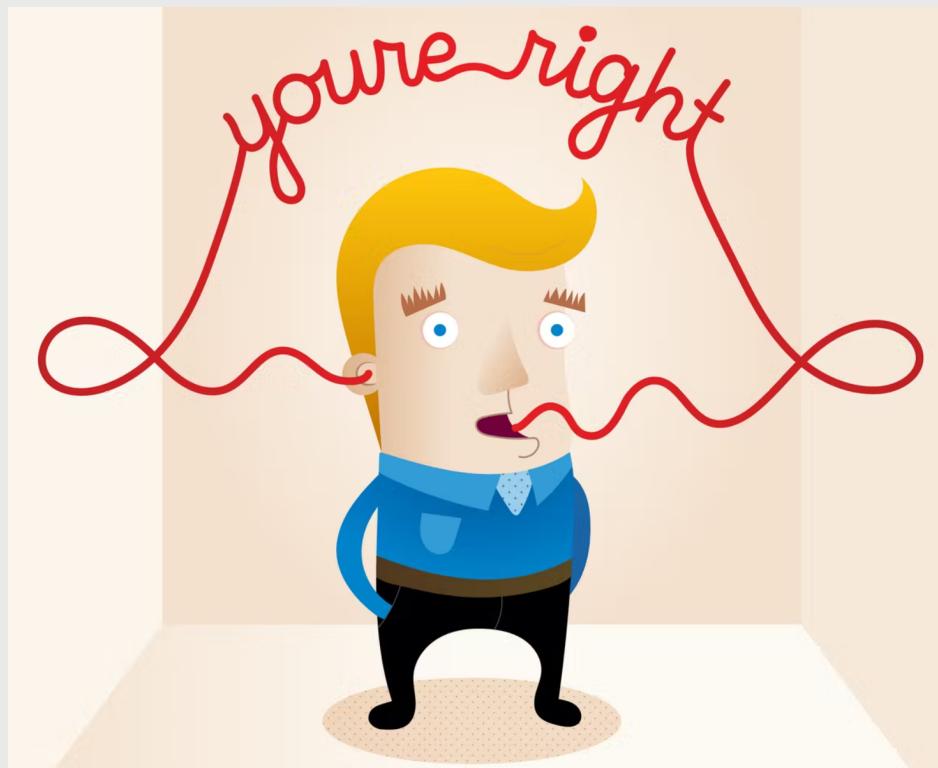
- HOW IT STARTED: Senate Hearing On FBI Investigation I...
ABC News
47K views • 3 hours ago
- Attorney General William Barr's job in jeopardy
ABC News
57K views • 5 hours ago
- The Full Story of Trump and COVID-19 | NowThis
NowThis News
1.8M views • 1 month ago
- Live: New York Gov. Andrew Cuomo Holds Briefing On Cov...
NBC News
9.2K watching
- See Bernie Sanders' reaction to Trump floating 2024...
CNN
963K views • 18 hours ago
- Mary Trump Says Trump's Legal Battles Could Prevent a 2024...
The View
5.5K views • 1 hour ago
- Trump releases Facebook video full of false claims about...
CBS News
14K views • 4 hours ago
- Election Lawsuits Meltdown... With Prejudice!
LegalEagle
996K views • 4 days ago
- Second Georgia Senate election hearing
11Alive
9K watching
- 'A Fool': MAGA Fans Turn On Barr After Debunking Trump's...
MSNBC
875K views • 19 hours ago

17 / 75

Research Camp

1. **Observation** → **Question**

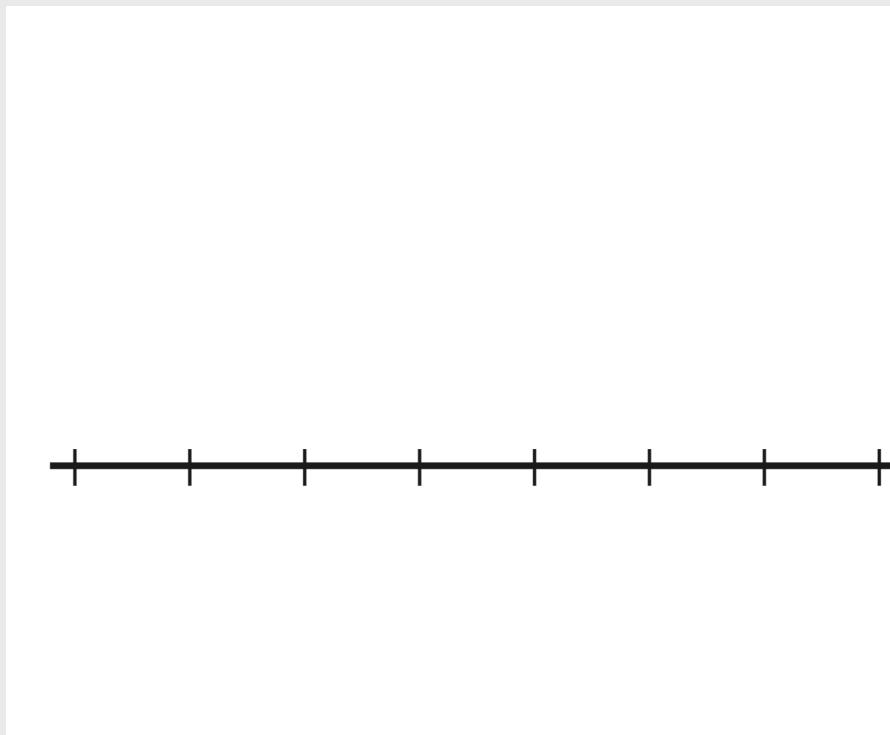
- The question pertains to science
- I.e., does YouTube's algorithm put users into "echo chambers"?



Research Camp

2. Theory → Hypothesis

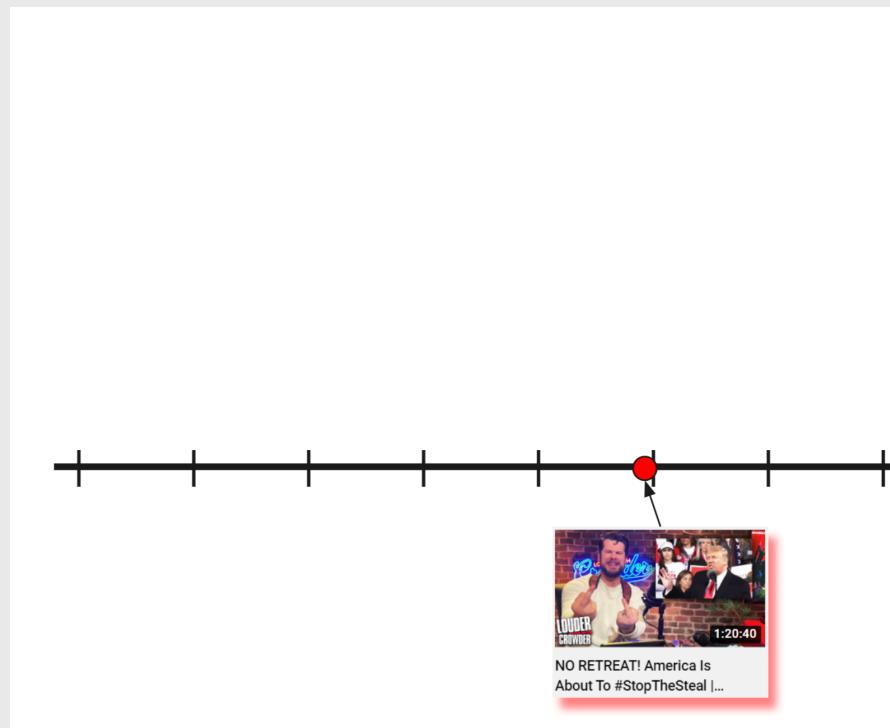
- Theorizing requires abstraction & simplification
- I.e., people (in general) avoid conflict



Research Camp

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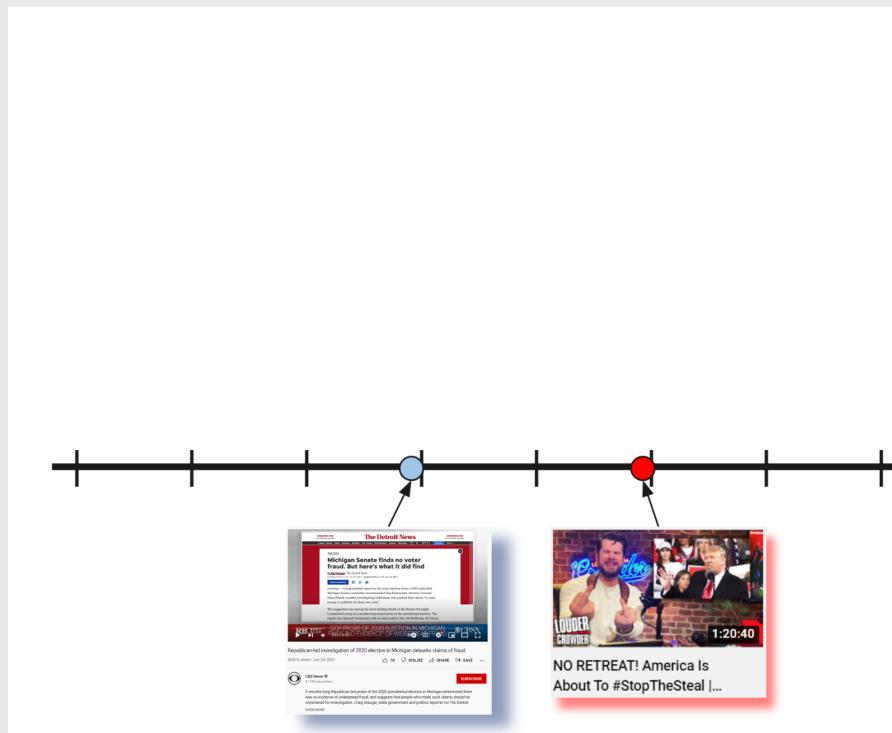
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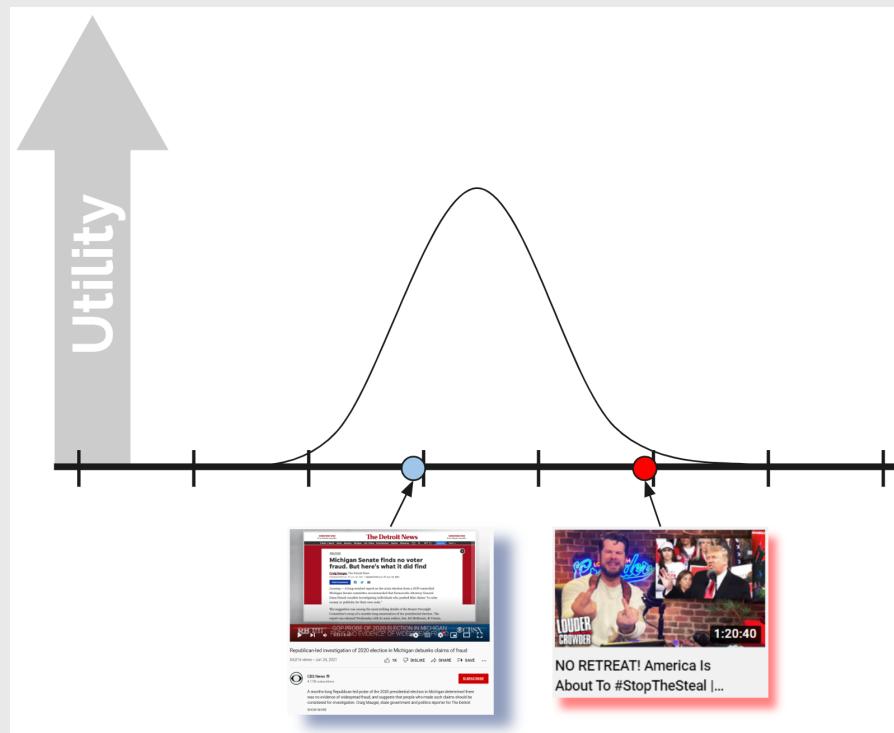
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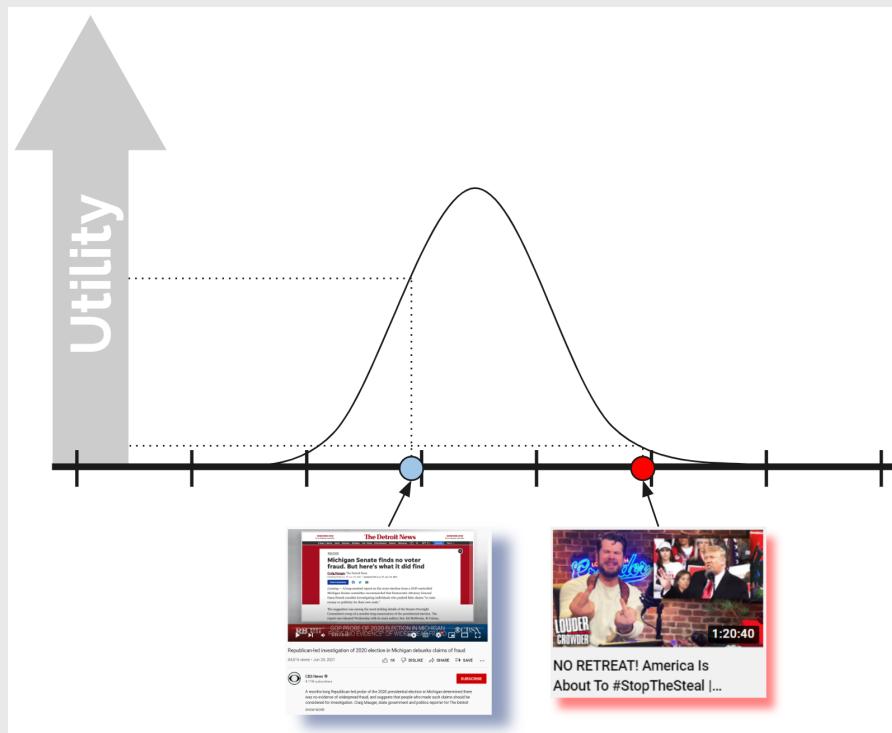
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Research Camp

2. Theory → Hypothesis

- Theorizing requires abstraction & simplification
- I.e., people (in general) avoid conflict
- YouTube wants users to watch more videos

Deep Neural Networks for YouTube Recommendations

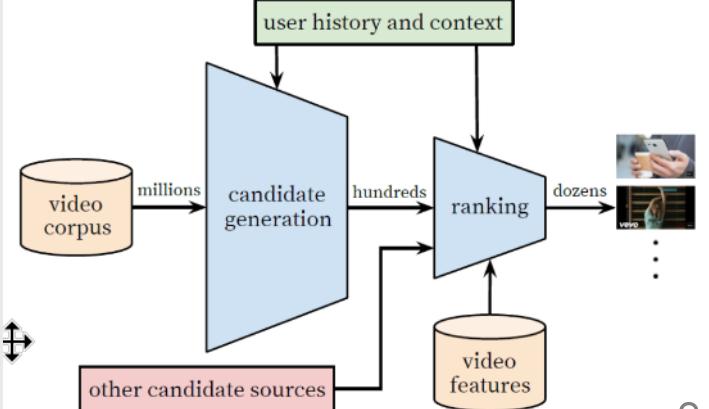
Paul Covington, Jay Adams, Emre Sargin
Google
Mountain View, CA
{pcovington,jka,msargin}@google.com

ABSTRACT
YouTube represents one of the largest scale and most sophisticated industrial recommendation systems in existence. In this paper, we describe the system at a high level and focus on the dramatic performance improvements brought by deep learning. The paper is split according to the classic two-stage information retrieval dichotomy: first, we detail a deep candidate generation model and then describe a separate deep ranking model. We also provide practical lessons and insights derived from designing, iterating and maintaining a massive recommendation system with enormous user-facing impact.

Keywords
recommender system; deep learning; scalability

1. INTRODUCTION
YouTube is the world's largest platform for creating, sharing and discovering video content. YouTube recommendations are responsible for helping more than a billion users



$$P(w_t = i | U, C) = \frac{e^{v_i, u}}{\sum_{j \in V} e^{v_j, u}}$$


The diagram illustrates the YouTube recommendation system architecture. It starts with a large "video corpus" (millions of videos) which feeds into a "candidate generation" stage. This stage outputs "hundreds" of candidates to a "ranking" stage. The "ranking" stage outputs "dozens" of results. These results are then presented to the user as a list of video thumbnails. The ranking process takes into account "user history and context", "video features", and "other candidate sources".

Research Camp

2. Theory → Hypothesis

- Theorizing requires abstraction & simplification
- I.e., people (in general) avoid conflict
- YouTube wants users to watch more videos
- Hypotheses fall out naturally from well-done theory
- **H1:** *YouTube's recommendation algorithm should suggest liberal content to liberals and conservative content to conservatives.*

Research Camp

3. **Data Collection / Wrangling** → **Analysis**

- Data collection separates "Data Science"...
- ...from "Science, with data"

- Recruit YouTube users to install [extension](#)



YouTube Recommendation Downloader

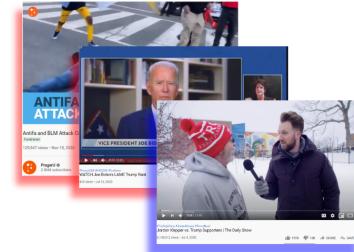
Offered by: csmappplugin

Research Camp

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- Recruit YouTube users to install **extension**
- Start on randomly assigned **seed video**



Research Camp

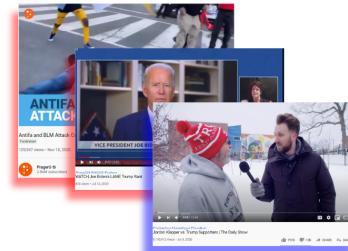
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- Follow **traversal rule** to select recommended video



Research Camp

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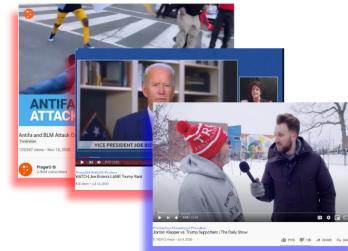
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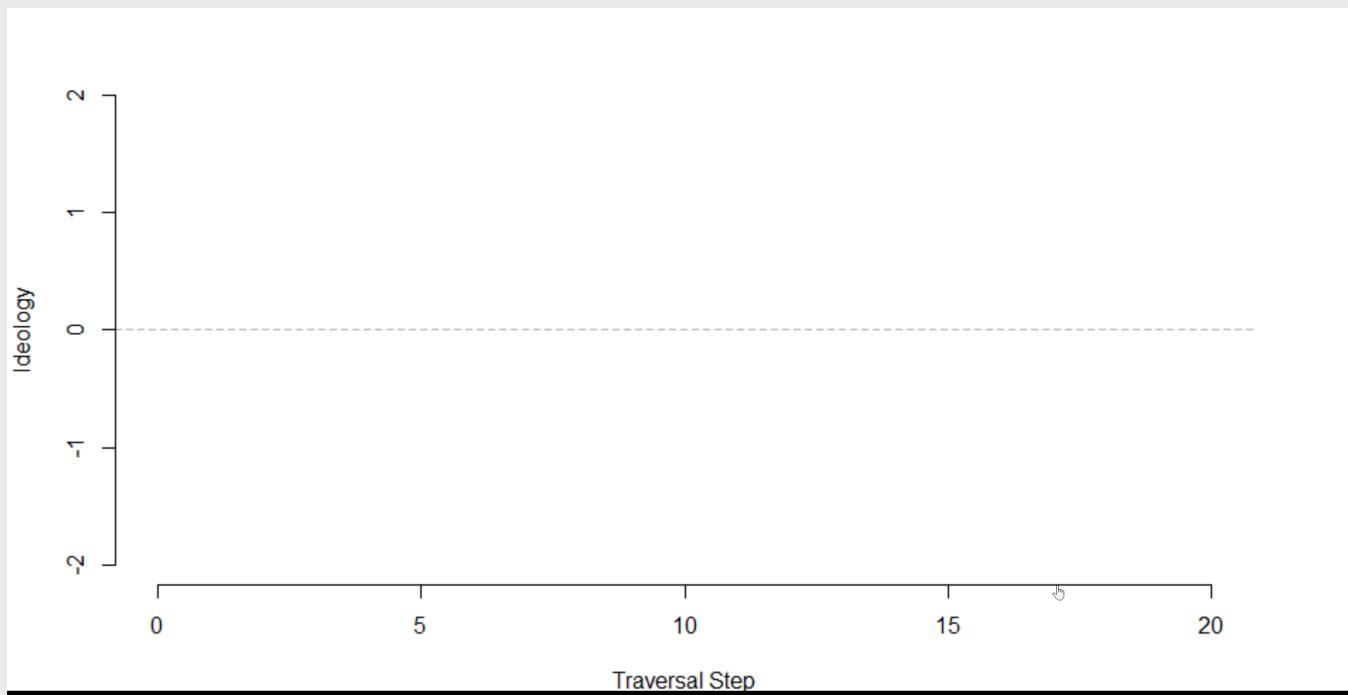
- Follow **traversal rule** to select recommended video

- Short **survey** on demographics, politics, and **BELIEFS ABOUT THE 2020 ELECTION**

Research Camp

3. Data Collection / Wrangling → Analysis

- Analysis is informed by the **data** you have collected...
- ...and the **hypotheses** you have generated



Research Camp

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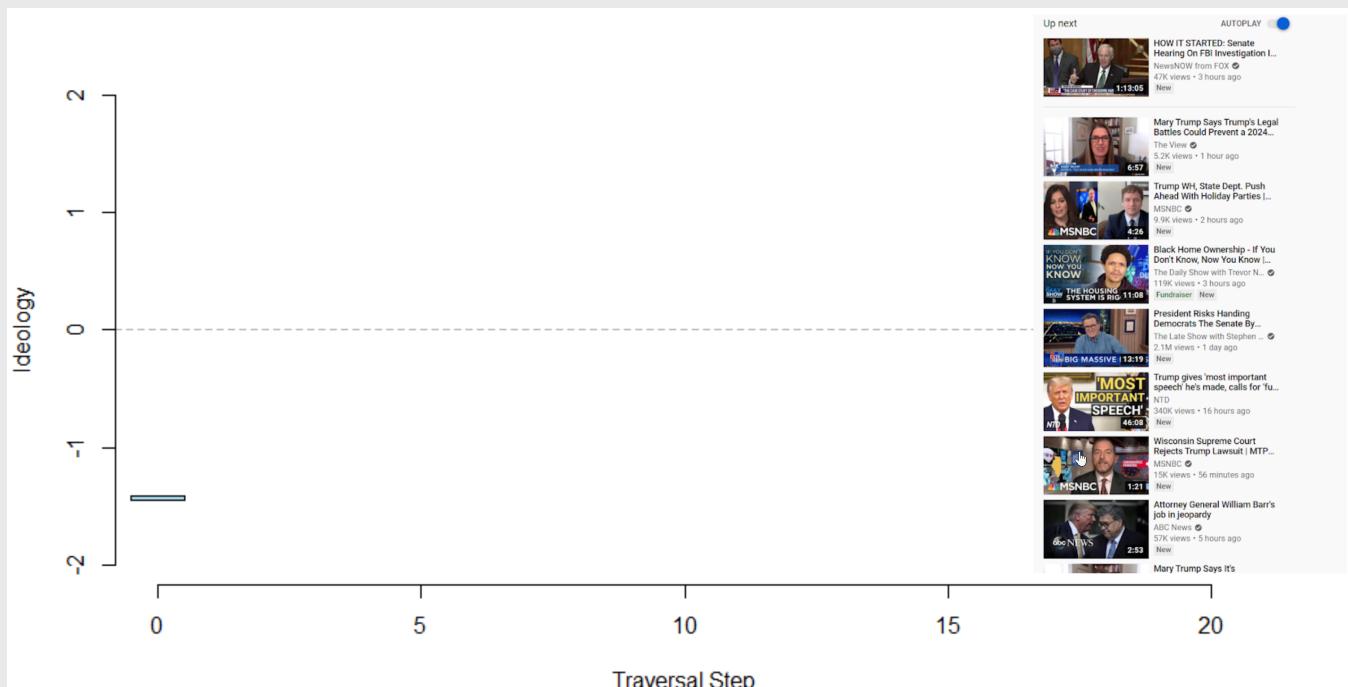
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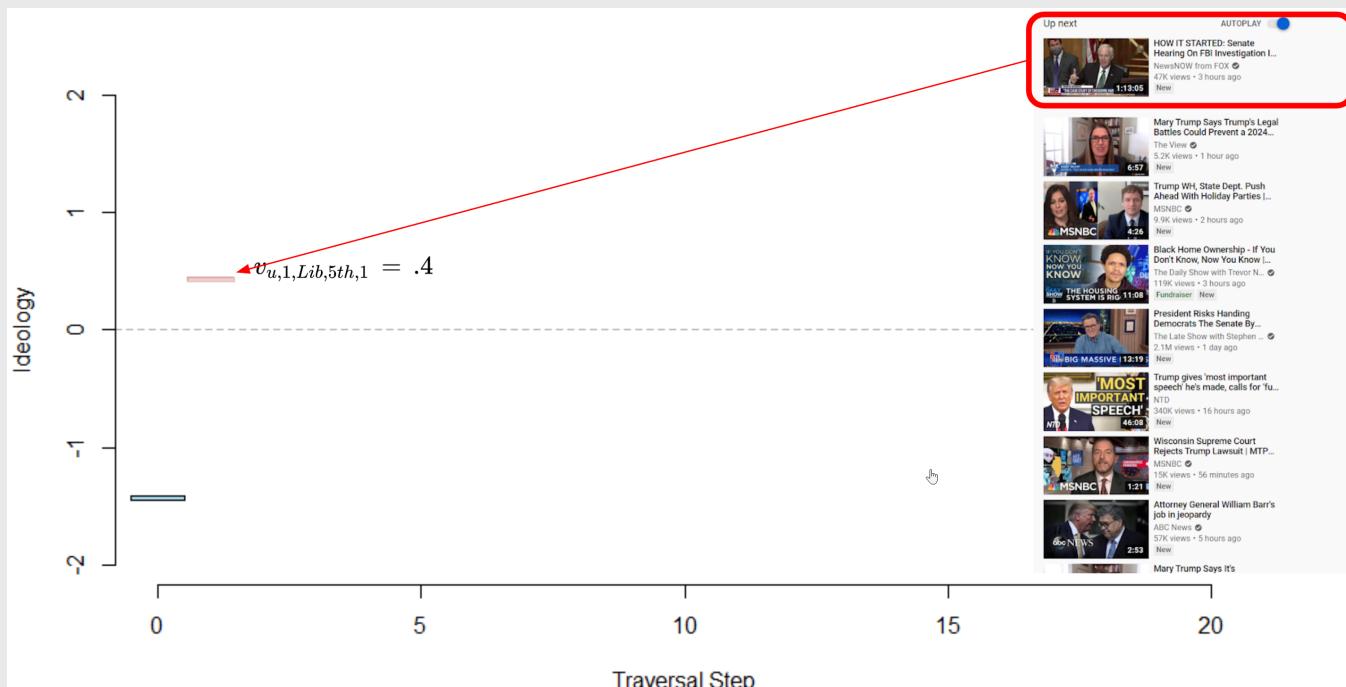
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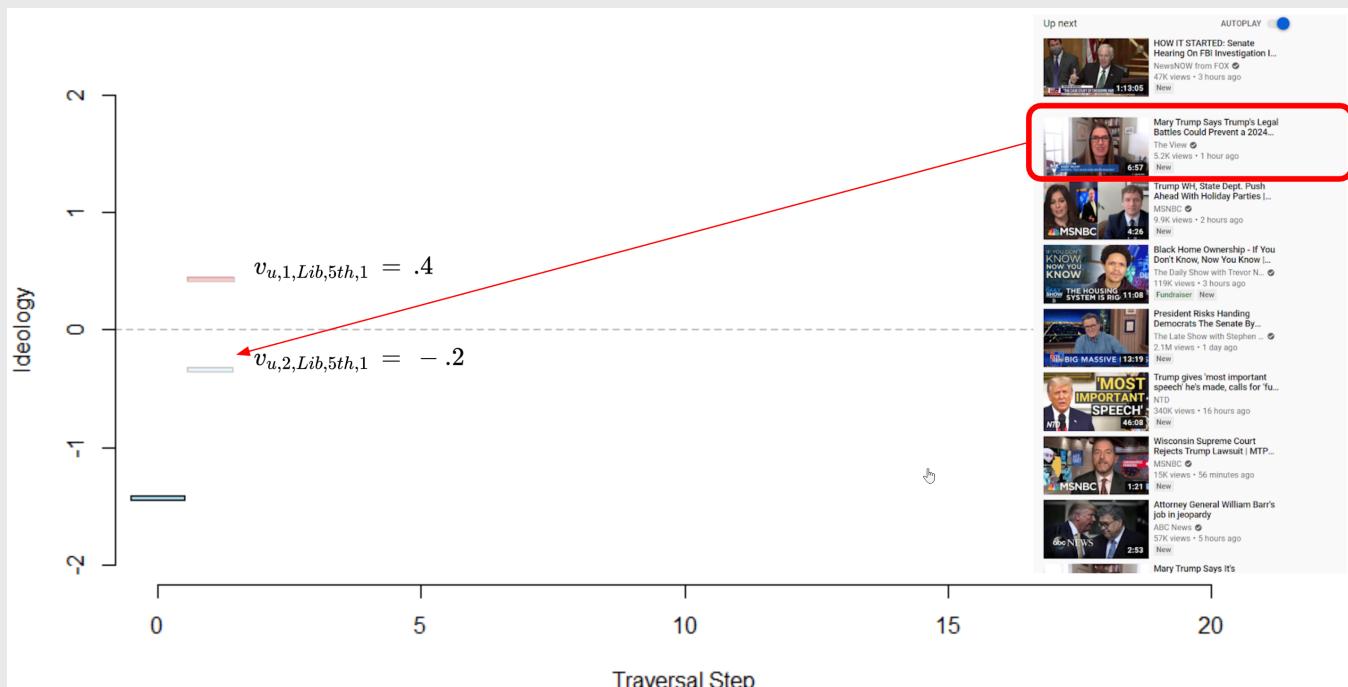
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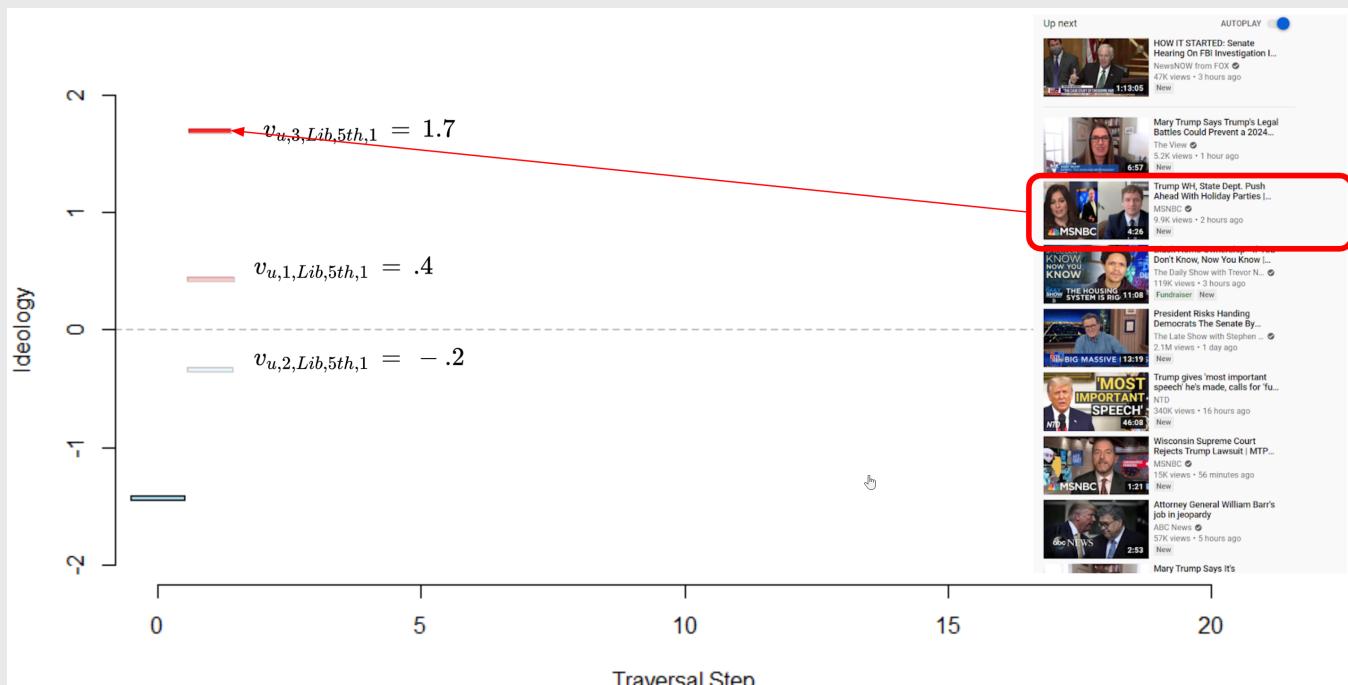
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Research Camp

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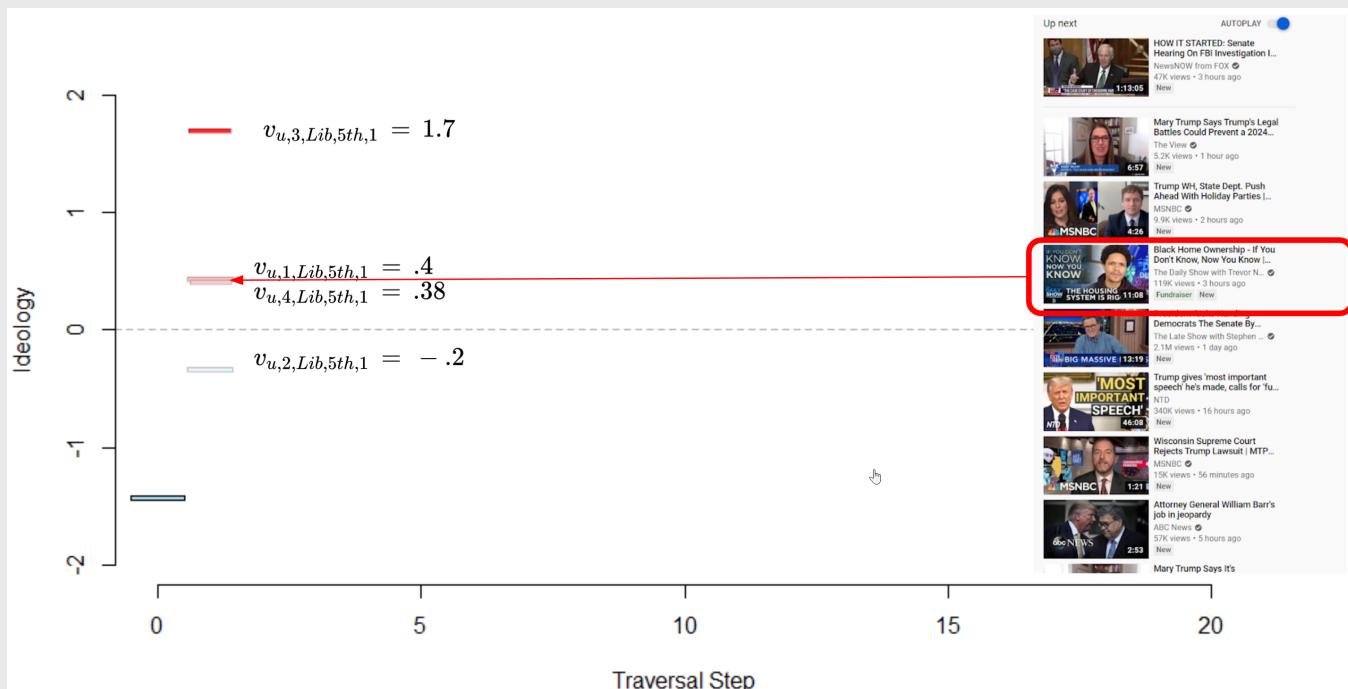
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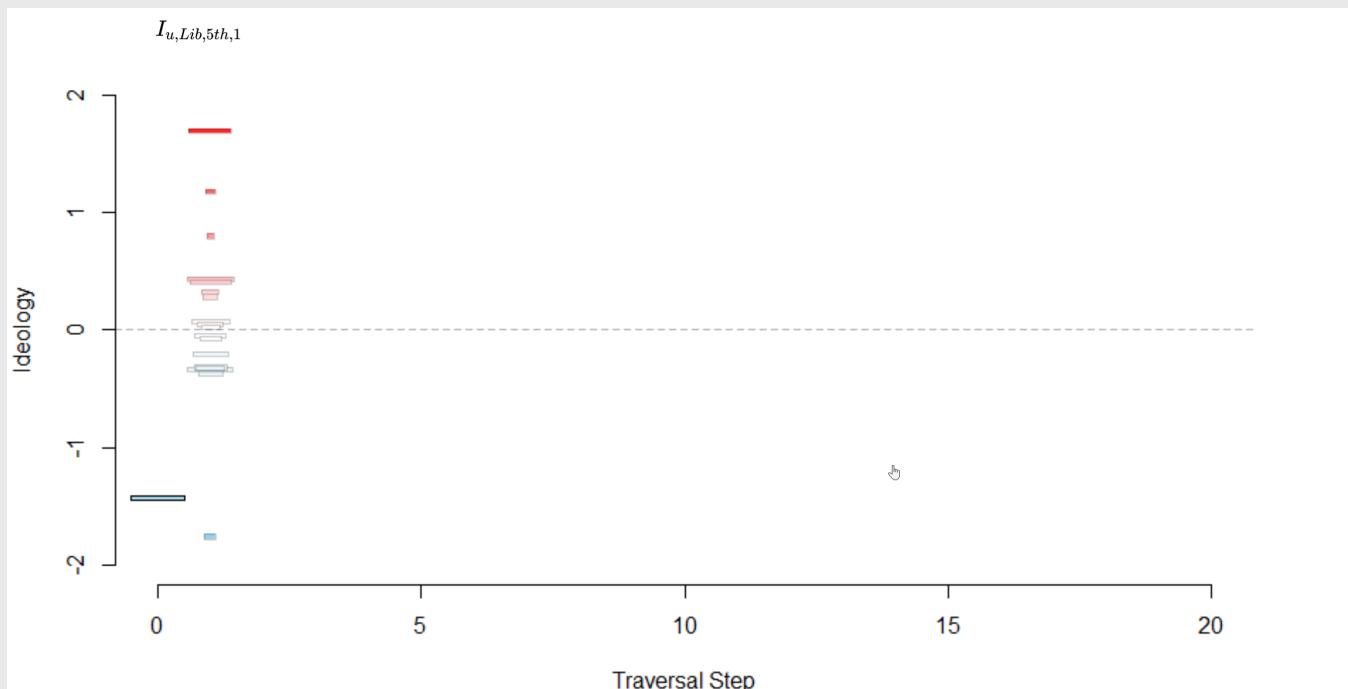
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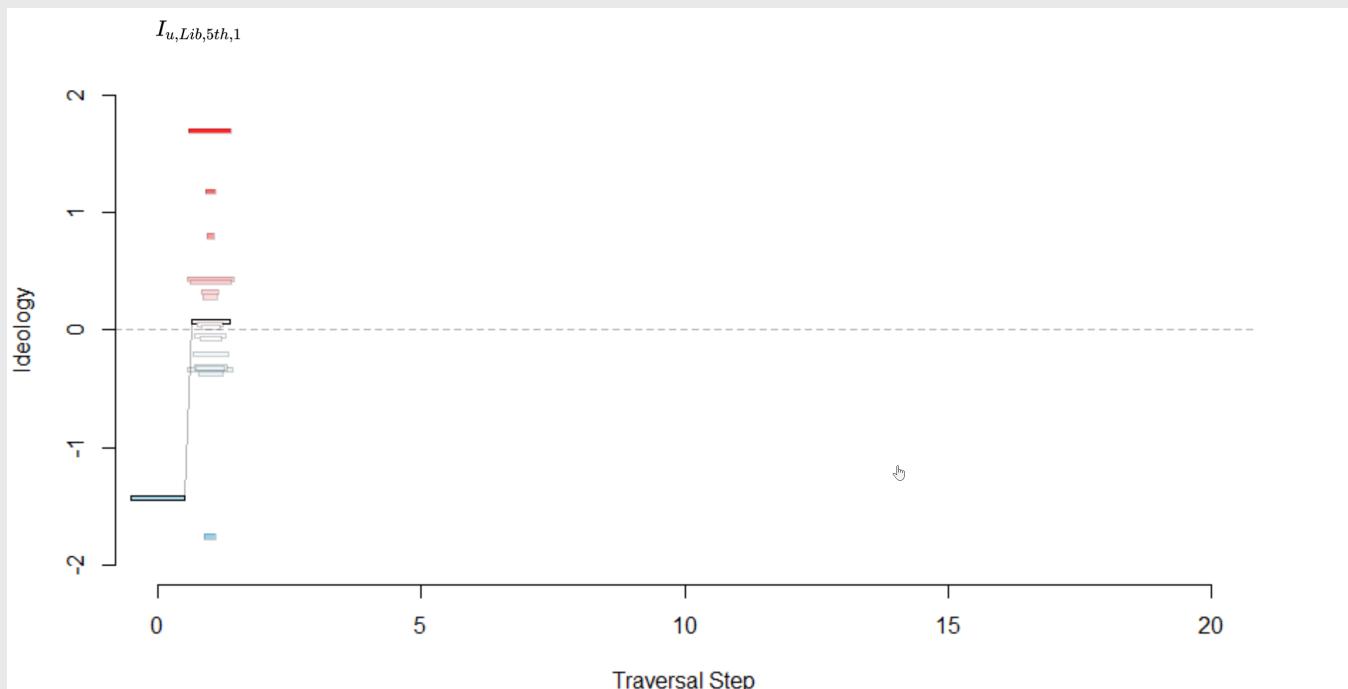
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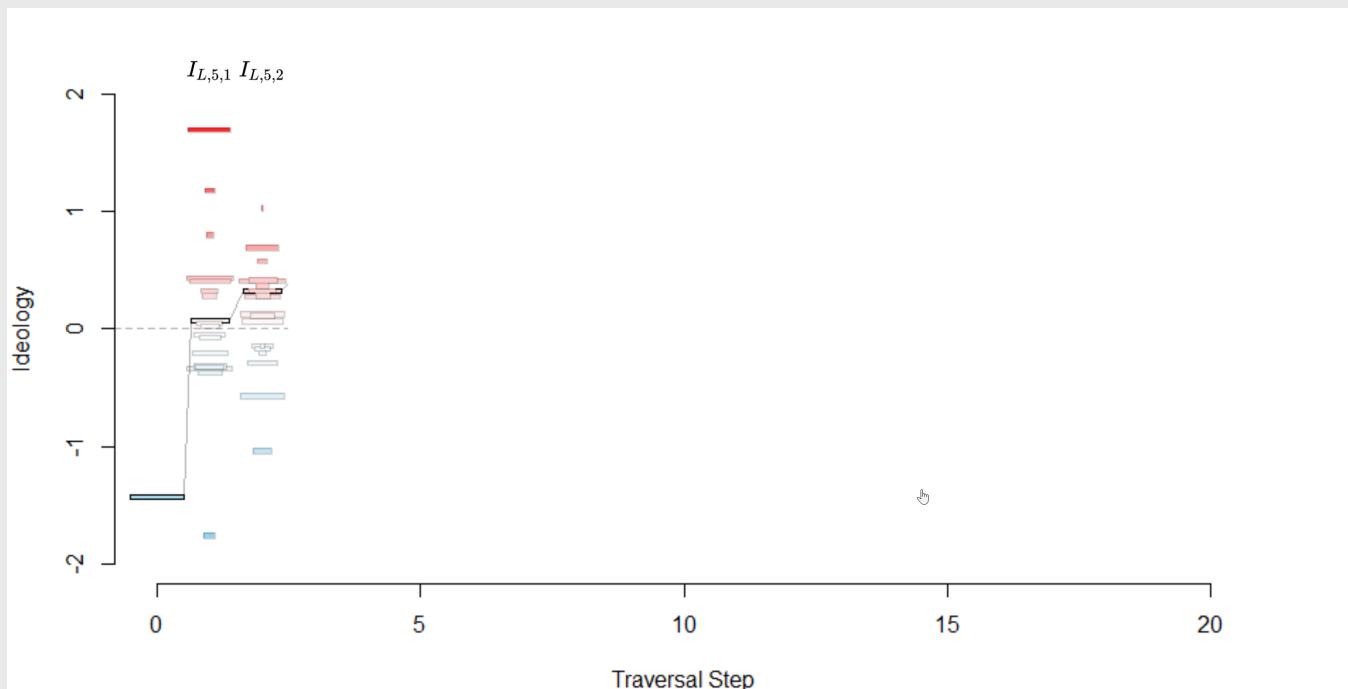
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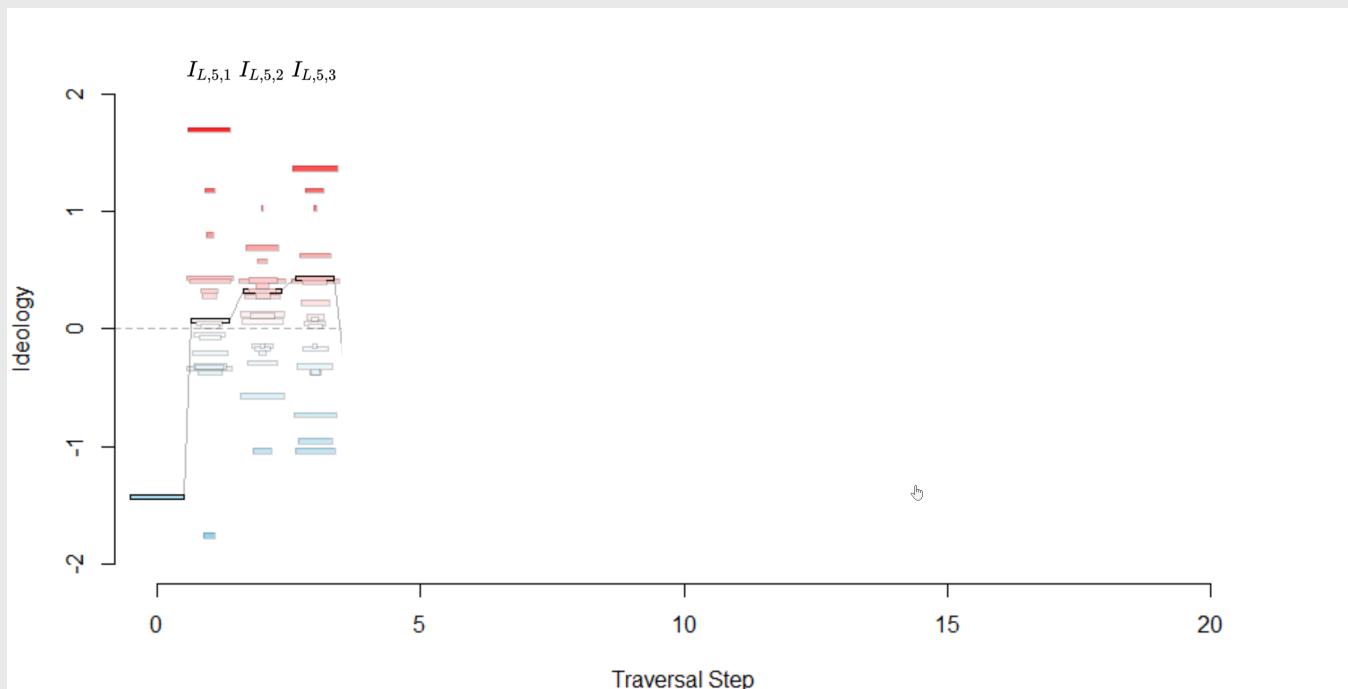
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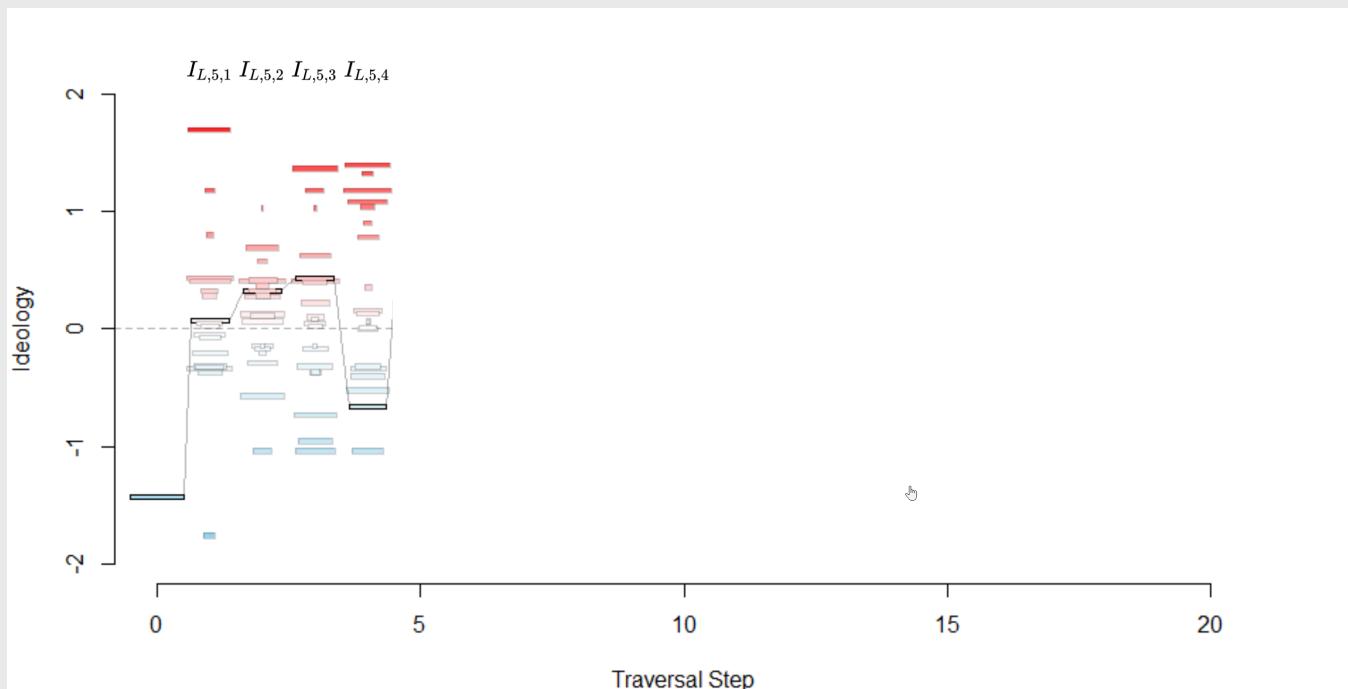
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Research Camp

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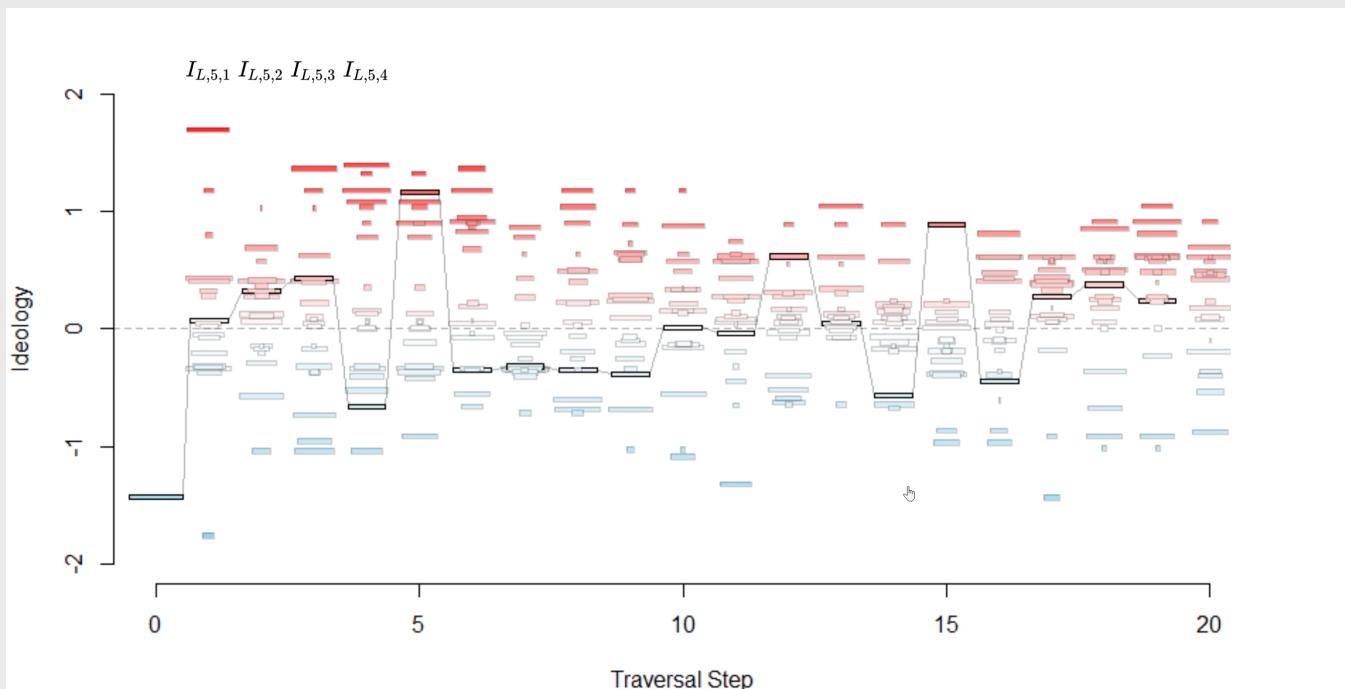
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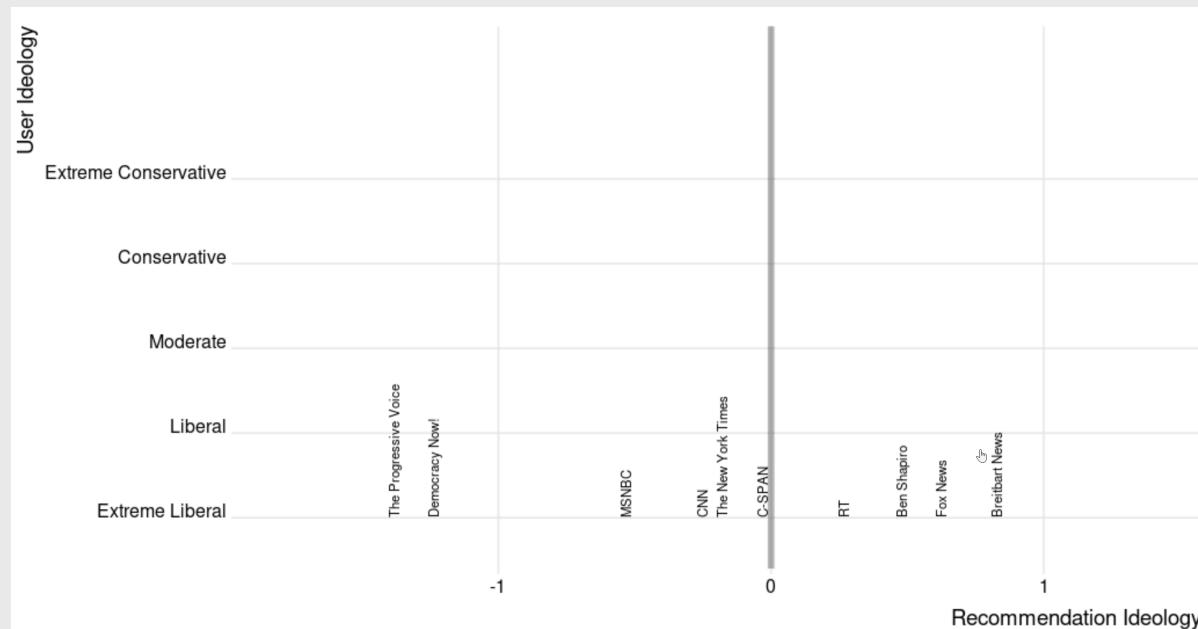
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Research Camp

4. Results → Conclusion

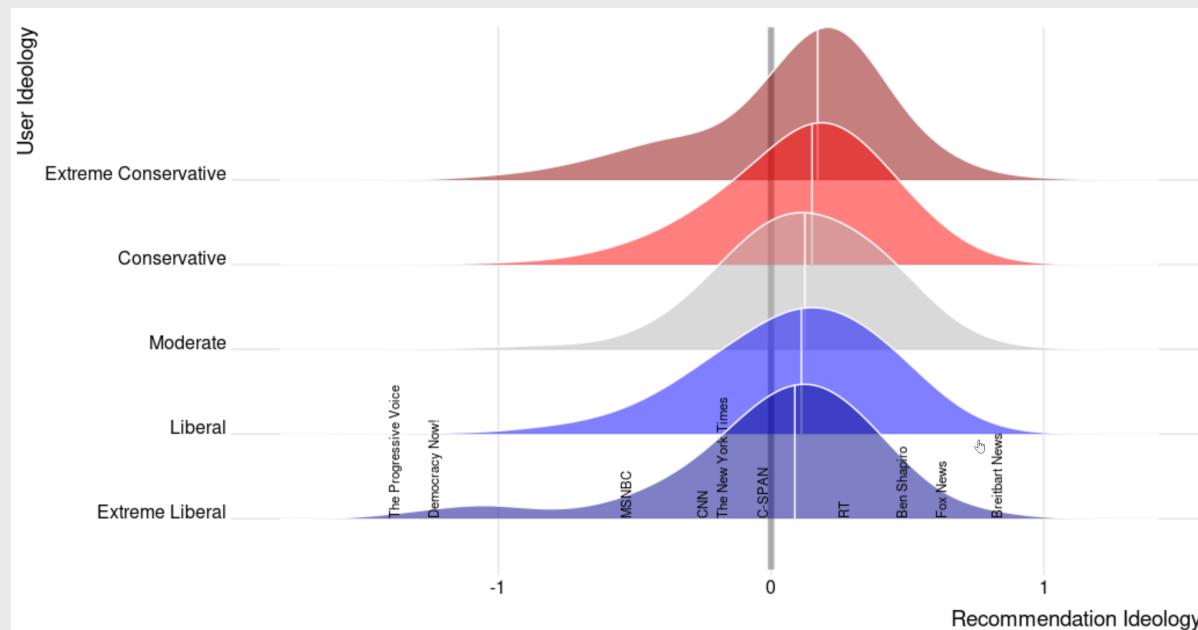
- Results fall out naturally from the analysis...
- ...and must be interpreted in terms of the theory and hypotheses...
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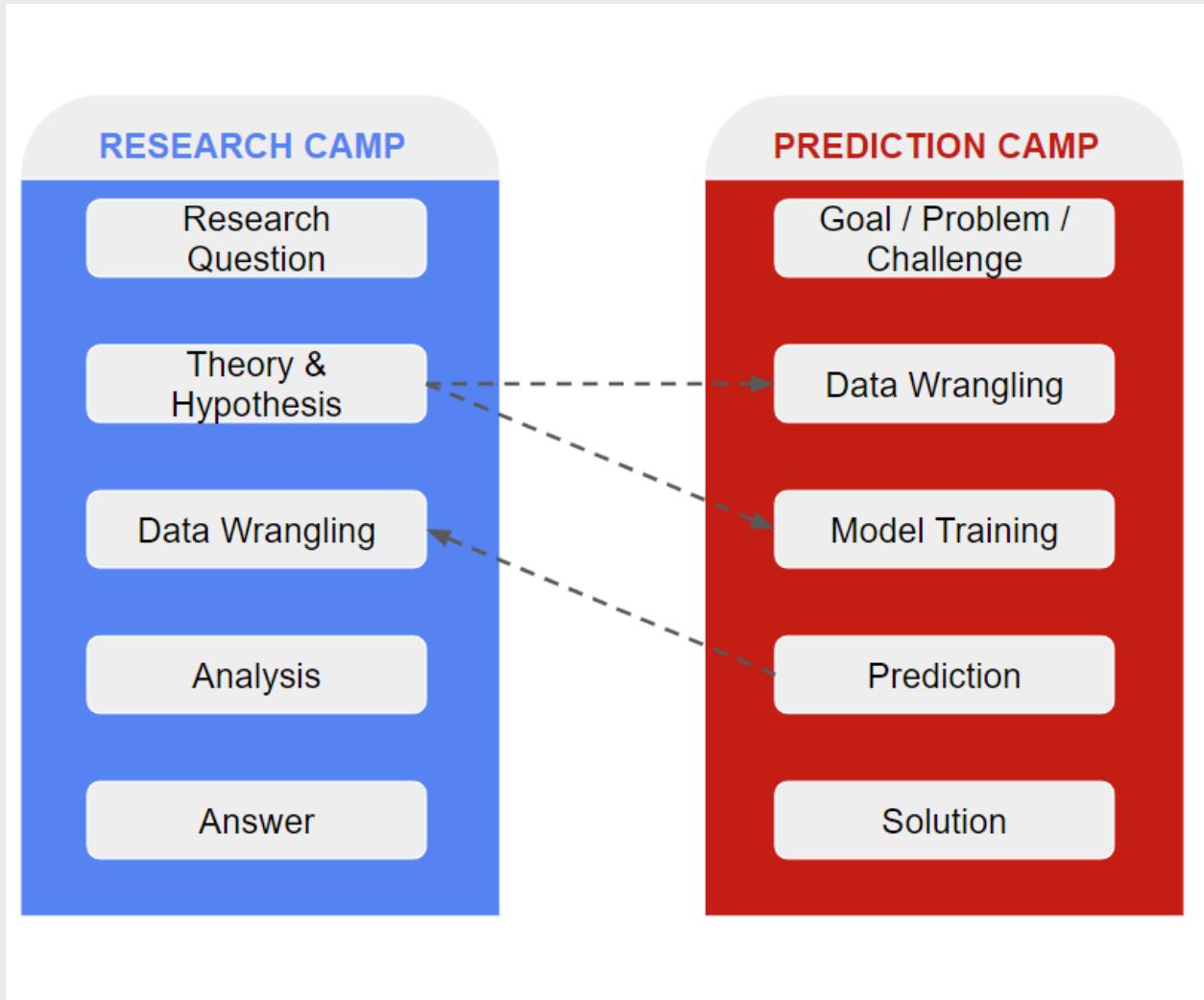
Research Camp

4. Results → Conclusion

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The Two Camps



Prediction Camp

- **Goal/Problem/Challenge:** Measure the ideology of a YouTube video

Prediction Camp

- **Data Wrangling:** Get matrix of links shared on political subreddits

The Ideology of a Video in 3 Steps: Step 1

Behavior:
Sharing URLs

Posted by u/santanzchild Constitutional Conservative
6 hours ago 2

AOC, a Sitting Member of Congress,
Weaponized Her Followers in an
Attempt to Silence a Free Press
redstate.com/jenav... 2

1.2k 323 Comments Share ...

Posted by u/oz4ut Conservative 3 hours ago

Joe Biden's Abortion Policies Are
Grounds For Excommunication
thefederalist.com/2021/0... 2

308 131 Comments Share ...

Posted by u/guanaco55 Conservative 3 hours ago

The QAnon Takeover Of The GOP Is
A Fantasy Of Dems And The Media --
The GOP Civil War Is Between
Populists and the Establishment
thefederalist.com/2021/0... 2

303 43 Comments Share ...

Prediction Camp

- **Data Wrangling**: Get matrix of links shared on political subreddits

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Behavior: **Sharing URLs**

+

Domain:
Subreddits

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redstate.com/jenvan... ↗



r/Conservative

Posted by [agent_SuperMutant](#) | [Comment](#) | 2 hours ago

Joe Biden's Abortion Policies Are Grounds For Excommunication

[thefederalist.com/2021/0... ↗](https://thefederalist.com/2021/0...)



r/neutralnews

↑ 308 ↓ 131 Comments ↗ Share ...

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[thefederalist.com/2021/01/15/the-qanon-takeover-of-the-gop-is-a-fantasy-of-dems-and-the-media--the-gop-civil-war-is-between-populists-and-the-establishment/](https://www.thefederalist.com/2021/01/15/the-qanon-takeover-of-the-gop-is-a-fantasy-of-dems-and-the-media--the-gop-civil-war-is-between-populists-and-the-establishment/)

thefederalist.com/2021/0... 6



r/SandersForPresident

Prediction Camp

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The Ideology of a Video in 3 Steps: Step 1



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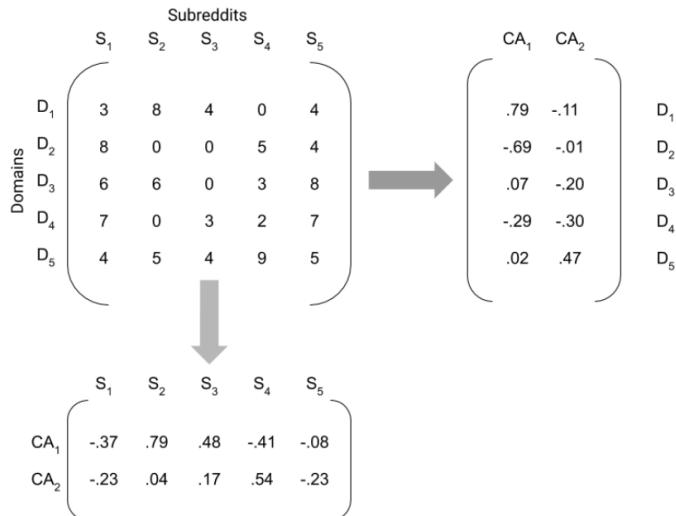
r/Conservative



r/neutralnews



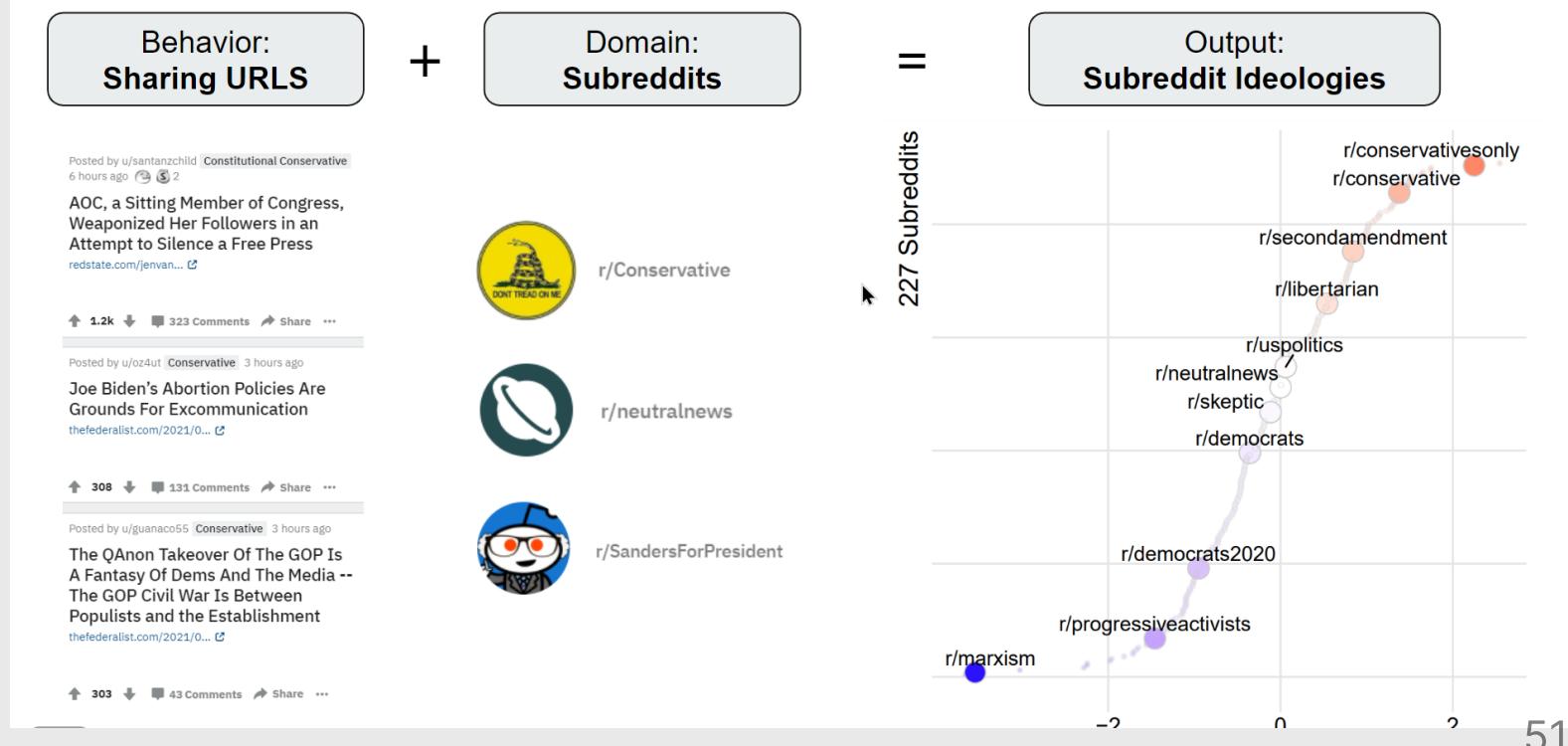
r/SandersForPresident



Prediction Camp

- **Data Wrangling:** Correspondence Analysis to estimate ideology scores for subreddits

The Ideology of a Video in 3 Steps: Step 1



Prediction Camp

- **Data Wrangling:** Get matrix of YouTube videos shared on scored subreddits

The Ideology of a Video in 3 Steps: Step 2

Prediction Camp

- **Data Wrangling:** Get matrix of YouTube videos shared on scored subreddits

The Ideology of a Video in 3 Steps: Step 2

Behavior:
Sharing Videos

Interview with Thomas Biryani by a reporter from an abc local texas affiliate's live feed:
<https://www.youtube.com/watch?v=X3WYY0fsF-I>
r/PublicFreakout Posted by u/elseman 20 days ago

52 37 Comments Share ...

A wand with a twist! I posted a "how to" on YouTube.
<https://m.youtube.com/watch?v=7QnhkNLUAvw> Credit:tpowen!_
r/Wandsmith Posted by u/tphilly3 16 days ago

44 15 Comments Share ...

Made a video about the G14 and my setup! Check it out if you're interested! It would be greatly appreciated! <https://www.youtube.com/watch?v=crcTp9vYE&feature=youtu.be> r/Zephyrus14 Posted by u/alexszurkus 1 month ago

11 30 Comments Share ...

why is jimin like this full video:
<https://www.youtube.com/watch?v=iIhaZl1436M&t=173s> r/heungtan Posted by u/yangtiglighthere 14 days ago

74 6 Comments Share ...

Prediction Camp

- **Data Wrangling:** Get matrix of YouTube videos shared on scored subreddits

The Ideology of a Video in 3 Steps: Step 2

Behavior:
Sharing Videos

+

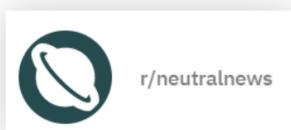
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r/Wandsmith Posted by u/tphilly3 16 days ago
44 comments Share ...

Made a video about the G14 and my setup! Check it out if you're interested! It would be greatly appreciated! <https://www.youtube.com/watch?v=crcTp9vYEY&feature=youtu.be> r/Zephyrus14 Posted by valeruszurkus 1 month ago
111 comments Share ...

why is jimin like this full video:
<https://www.youtube.com/watch?v=vIhaZtI436M&t=173s>
r/heungtan Posted by u/yangtiglighthere 14 days ago
74 comments Share ...



Prediction Camp

- **Data Wrangling:** Get matrix of 60k YouTube videos shared on scored subreddits

The Ideology of a Video in 3 Steps: Step 2

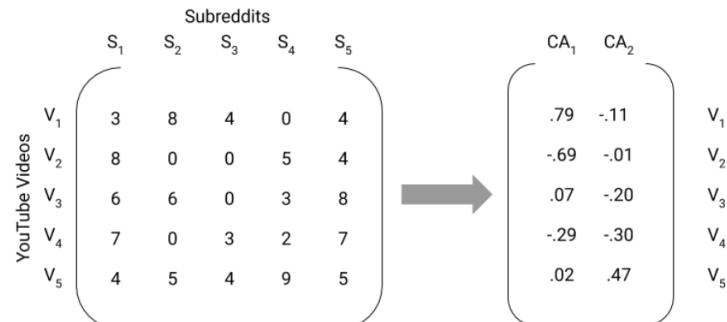
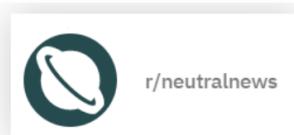


Interview with Thomas Biryani by a reporter from an abc local Texas affiliate's live feed:
<https://www.youtube.com/watch?v=X3WYY0fsF-I>
r/PublicFreakout Posted by u/eliseann 20 days ago
52 comments Share ...

A wond with a twist. I posted a "how to" on YouTube.
<https://m.youtube.com/watch?v=7QnhkNUlAew> Credit:tpowen...
r/Wandsmith Posted by u/timothy3 36 days ago
44 comments Share ...

Made a video about the G14 and my setup! Check it out if you're interested! It would be greatly appreciated! <https://www.youtube.com/watch?v=crcTp9vYEY&feature=youtu.be>
r/Zephyrus14 Posted by valeriszurkus 1 month ago
11 comments Share ...

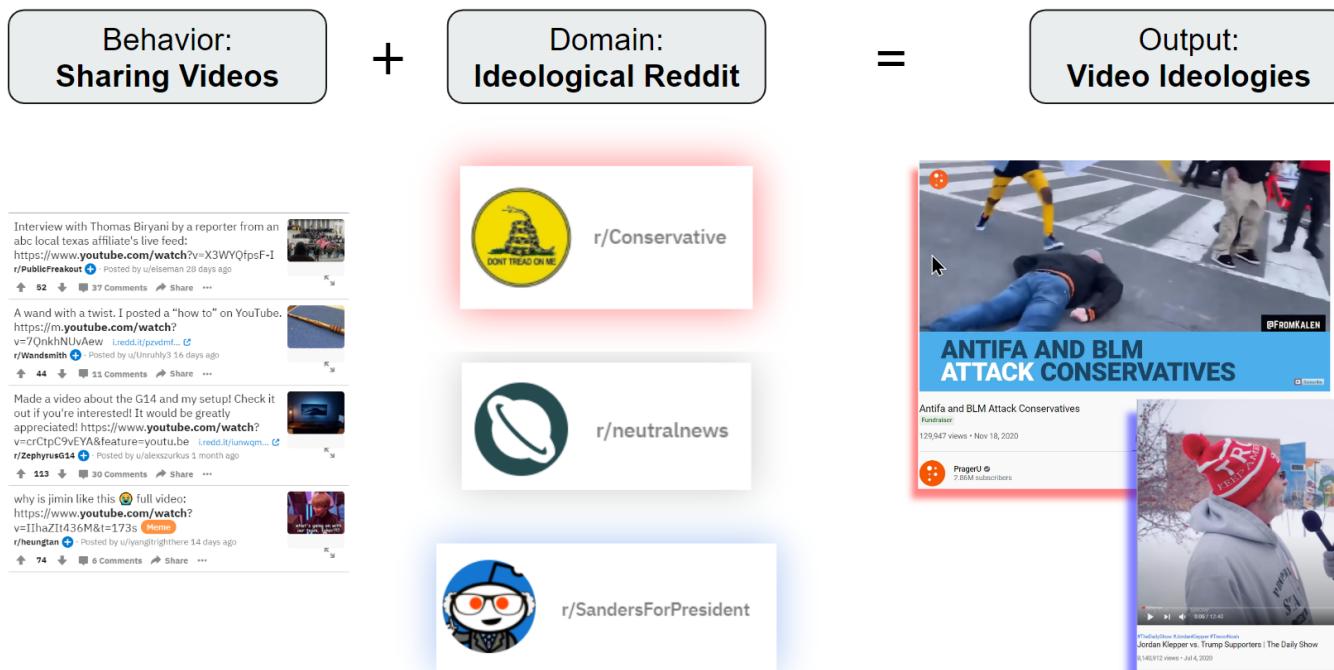
why is jimin like this full video:
<https://www.youtube.com/watch?v=1haZtI436M&t=173s> Home
r/heungtan Posted by u/yangtighere 14 days ago
74 comments Share ...



Prediction Camp

- **Data Wrangling:** Calculate video ideology as weighted mean of subreddits

The Ideology of a Video in 3 Steps: Step 2



Prediction Camp

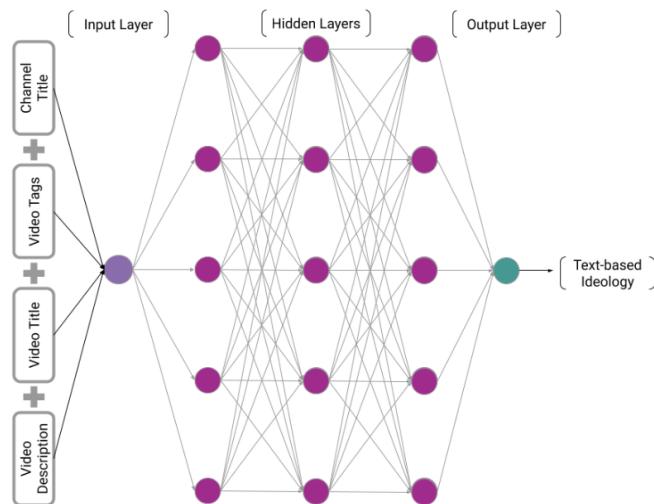
- **Model Training:** BERT transformer trained on 60k videos

The Ideology of a Video in 3 Steps: Step 3

Training Data:
67k Coded Videos

+

Classifier:
BERT Transformer



Prediction Camp

- **Prediction:** Measure the ideology of a YouTube video

The Ideology of a Video in 3 Steps: Step 3

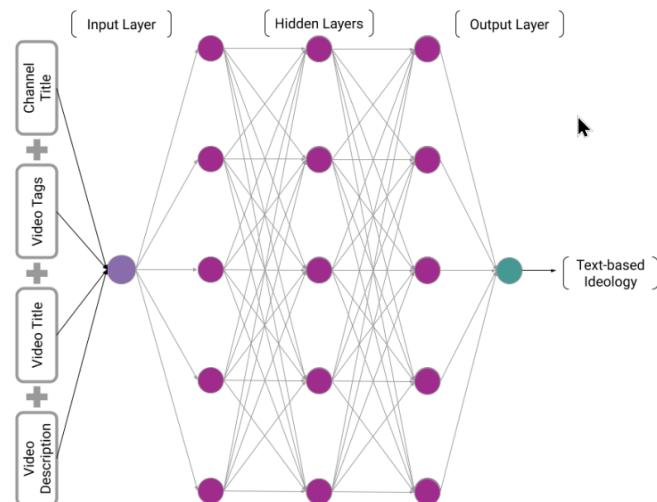
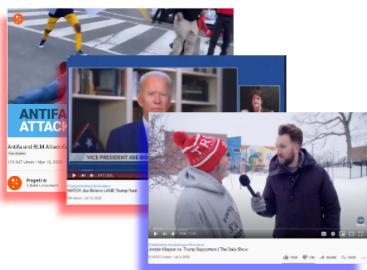
Training Data:
67k Coded Videos

+

Classifier:
BERT Transformer

=

Output:
Any Video's Ideology



Course Objectives

- This course is the menu, not the food
 - Look over many different fields, methods, and tools
 - You pick those you like, and take more advanced classes to dig into them
- But we are very **hands on**
 - You must download `R` and `RStudio` prior to next class (Problem Set 0)
 - You must work through first HW using an `.Rmd` file

Learning goals

1. Generate a sophisticated research question based on clearly described assumptions and a narrowly defined hypothesis.
2. Describe the data used to investigate this research question, including univariate and multivariate visualizations and summary statistics.
3. Apply the appropriate methods to answer the research question and evaluate the hypothesis.
4. Acknowledge limitations of method and results, and describe a superior empirical setting that would overcome these limitations.

ChatGPT in the classroom

- Are we at the precipice of a new era in human-computer relations?
 - ChatGPT can achieve these learning goals!
 - But it needs to be used wisely...it is still a tool
- It can make coding (the hardest part of this class) easier
- But it can also prevent you from learning

AI in the labor market

- McKinsey told AT&T in 1980 that, by 2000, cell phones would be a niche market of 900,000 subscribers
- Is AI-assisted work is the future?
 - Profound gains in productivity already
- Will this be like automation and globalization for US manufacturing?
 - What skills will be valuable in 5 years? 10 years?

AI in the labor market

- My answer: prepare you for both possibilities
 - If AI is a "fad", make sure you can do this work unassisted
 - If AI is the new normal, make sure you can work with it productively
- The one thing you **shouldn't** do
 - Take shortcuts / cheat
- You will still have an interview in which you are asked something like the following: "How is overfitting different from underfitting, and why should we care?"
 - **You** need to know this answer

Grades

Item	Percent	Points
pset 1	5%	10
pset 2	5%	10
pset 3	5%	10
pset 4	5%	10
pset 5	5%	10
pset 6	5%	10
pset 7	5%	10
pset 8	5%	10
Midterm	20%	40
Final Exam	20%	40
Quizzes	20%	40
Totals	100%	200

Grades: PSets

- 9 in total, only 8 are graded
 - Pset 0 doesn't count
- Posted to **Brightspace** on Mondays at noon
- Due **Friday by midnight**
 - Each day late is -1 point
 - After 3 days, scored zero
- Restrictions:
 - Open book / open note / open Campuswire
 - Can collaborate but submissions must be your own
- **Must submit a record of ChatGPT work with the problem set**

Grades: Exams

- 2 in total: midterm on October 25th, final on December 11th
- 20% of final grade
- Restrictions:
 - **In-class with pen and paper**

Grades: Quizzes

- Taken at end of each lecture
- Password protected
 - Only students in class can take them
 - 50% of quiz grade is just taking it (sign affidavit)
 - 50% of quiz grade is four questions related to lecture

Not Graded: HW

- You should work through the homeworks prior to each lecture
- Open the `.Rmd` file and Knit it
- Read the output and try and answer the prompts
- **Not graded**, but enormously helpful in preparing you to keep up with lectures

The Syllabus

Date	Lecture	DOW	Learning Goal	Assignments	Quizzes
23-Aug-23	Intro to Data Science Part 1	Wed	The scientific method, the camps of analysis	Pset 0 assigned	
28-Aug-23	Intro to Data Science Part 2	Mon	ChatGPT and the New Frontier of Data Science		Quiz 1
30-Aug-23 BREAK		Wed			
4-Sep-23	Intro to R Part 1	Mon	Objects, functions, %>%, and <-		Quiz 2
6-Sep-23	Intro to R Part 2	Wed	Visualization in R		Quiz 3
11-Sep-23	Intro to R Part 3	Mon	More visualization	Pset 1 assigned	Quiz 4
13-Sep-23 Review of R		Wed			
18-Sep-23	Data Wrangling	Mon	Replicability, R, and tabular data	Pset 2 assigned	Quiz 5
20-Sep-23	Univariate Analysis	Wed	Summaries of a single variable		Quiz 6
25-Sep-23	Multivariate Analysis Part 1	Mon	Summaries of multiple variables	Pset 3 assigned	Quiz 7
27-Sep-23	Multivariate Analysis Part 2	Wed	Visualizations of multiple variables		Quiz 8
2-Oct-23	Multivariate Analysis Part 3	Mon	Uncertainty and bootstrapping	Pset 4 assigned	Quiz 9
4-Oct-23 Multivariate Review		Wed			
9-Oct-23	Regression Part 1	Mon	The concept of a linear regression	Pset 5 assigned	Quiz 10
11-Oct-23	Regression Part 2	Wed	Interpreting a linear regression output and evaluating model		Quiz 11
16-Oct-23	Regression Part 3	Mon	Multiple regression and categorical predictors		Quiz 12
18-Oct-23	Regression Review	Wed			
23-Oct-23	Midterm Review	Mon			
25-Oct-23 Midterm Exam		Wed			
30-Oct-23	Classification Part 1	Mon	The concept of a logistic regression	Pset 6 assigned	Quiz 13
1-Nov-23	Classification Part 2	Wed	Interpreting a logistic regression output and evaluating model		Quiz 14
6-Nov-23	Classification Part 3	Mon	Using models for prediction	Pset 7 assigned	Quiz 15
8-Nov-23 Classification Review		Wed			
13-Nov-23	Clustering & NLP Part 1	Mon	k-means clustering	Pset 8 assigned	Quiz 16
15-Nov-23	Clustering & NLP Part 2	Wed	k-means clustering on text		Quiz 17
20-Nov-23 BREAK		Mon			
22-Nov-23 BREAK		Wed			
27-Nov-23	Clustering & NLP Part 3	Mon	Sentiment analysis	Pset 9 assigned	Quiz 19
29-Nov-23 Clustering & NLP Review		Wed			
4-Dec-23	Ethics	Mon	The risks of rapid technological change		Quiz 20
6-Dec-23 Final Review		Wed			
11-Dec-23 Final Exam		Mon			

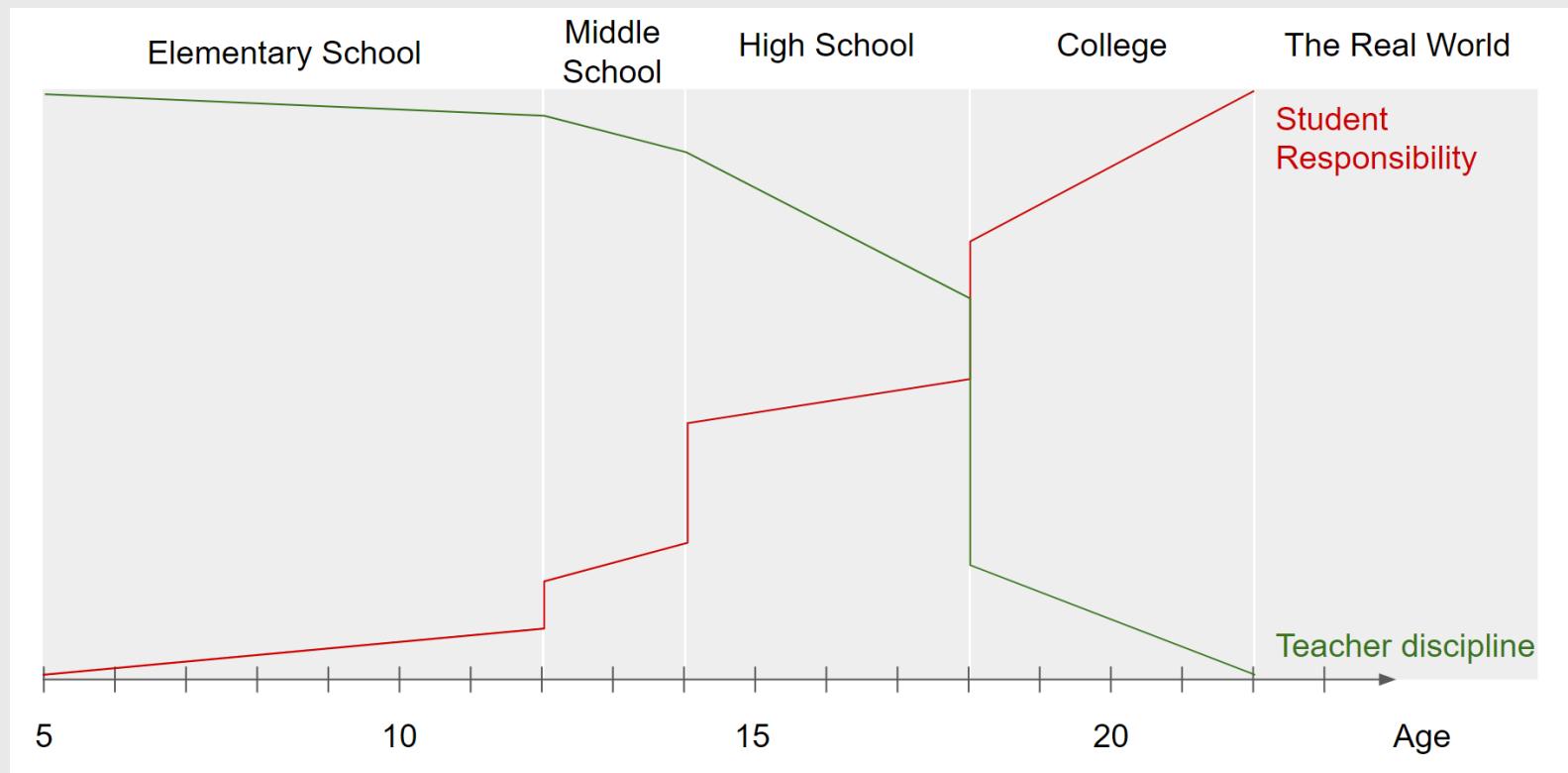
Honor Code

- Students are assumed to have read and agreed with the [Vanderbilt University Academic Honesty policy](#)
- Violations of this policy may result in:
 - An F for the semester (at minimum)
 - Suspension for a semester
 - Expulsion
- However, except where **explicitly noted**, this course is collaborative
 - Open book, open note, open internet
 - Can rely on Campuswire for help
 - Can work together on problem sets (but must submit own work)
- **Can't collaborate on exams**

Resources

- Campuswire (place for **questions**)
 - Post questions on the class feed
- Brightspace (place for **submissions**)
 - Submit problem sets, quizzes, and exams
- GitHub (place for **materials**)
 - Find all in-class materials
- TA recitations / labs (place for **hands-on help**)
- Office hours (place for **hands-on help**)

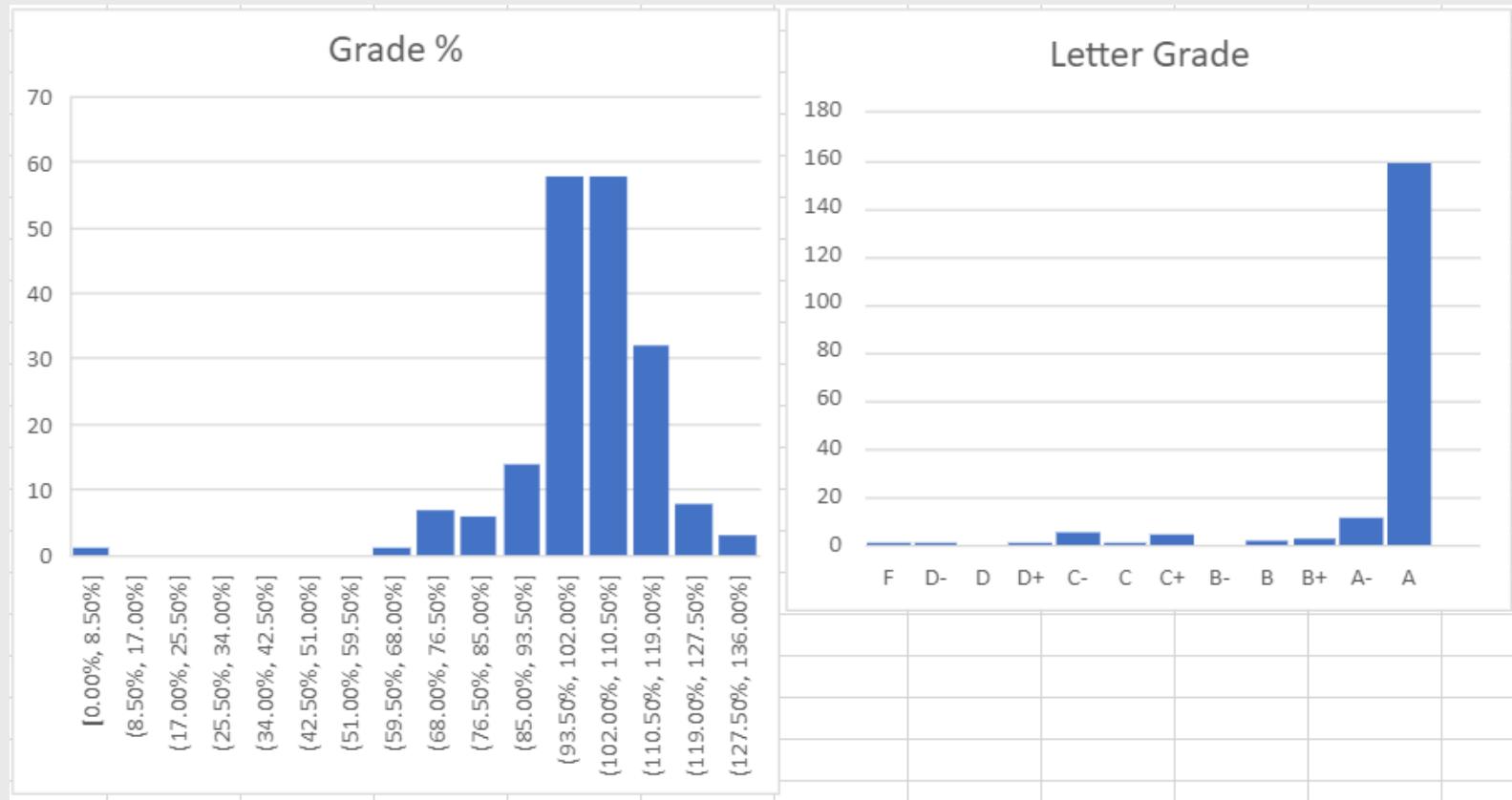
Teaching Philosophy



Teaching Philosophy

- This course is **inherently** hard
 - Learning **R** is challenging
- But the goal is to **encourage** you to pursue data science
- As such, the **nature** of the material is at odds with the **goal** of the class
- My solution: grade leniently
 - + lots of extra credit

Previous Semester



Conclusion

- Let's have a great semester!
- Homework:
 1. Work through Intro_Data_Science_hw.Rmd
 2. Complete Problem Set 0 (on Brightspace)
 3. Create an OpenAI account (<https://auth0.openai.com/u/signup/>)