Intro to Data Science

What R we doing?

Prof. Bisbee

Vanderbilt University

Lecture Date: 2023/01/09

Slides Updated: 2023-01-03

Agenda

1. Meet the instructor
    - Prof. Bisbee: *james.h.bisbee@vanderbilt.edu*
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. Course Expectations & Syllabus review

Meet the instructor

- 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
  - Monkey Cage articles 1, 2
  - Podcast / Radio interviews

Meet the instructor

- Current research
  - YouTube + polarization
  - Twitter + misinformation
  - Telegram + white supremacists
- Is my current research agenda data science?

What is "data science"?

- What is data?
- What is science?

What is data?

- "It is a capital mistake to theorize before one has data." Sherlock Holmes
  - Data **informs**
- "Torture the data, and it will confess to anything." Ronald Coase, Nobel Prize Laureate in Economics
  - Data **lies**
- “Here’s an open secret of the big data world: all data is dirty. All of it.” Meredith Broussard, *Artificial Unintelligence: How Computers Misunderstand the World*
  - Data is **invalid**

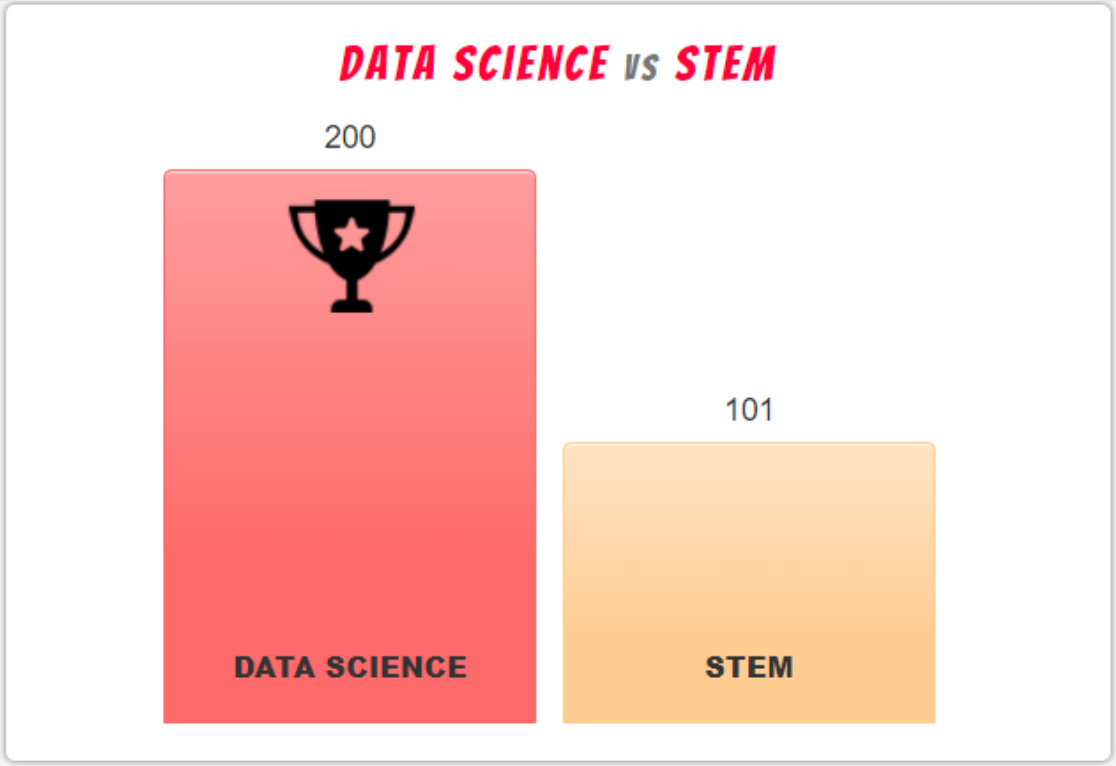
What is science?

- Simplification, codification, abstraction
  - Science identifies patterns in data...
  - ...to make predictions about the future
- As such, it is inherently:
  - Causal
  - Empirical
  - Theoretical

What is data science?

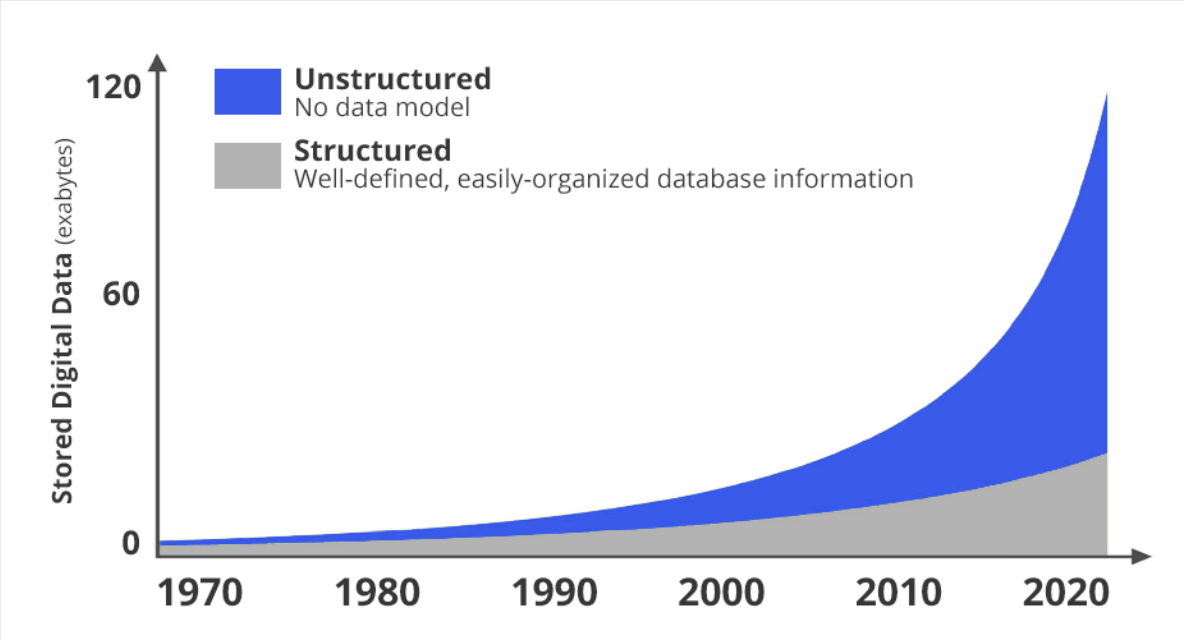
- Data: informs / lies / invalid
- Science: simplification / codification / abstraction
- Data + science = ?

Why are you here?



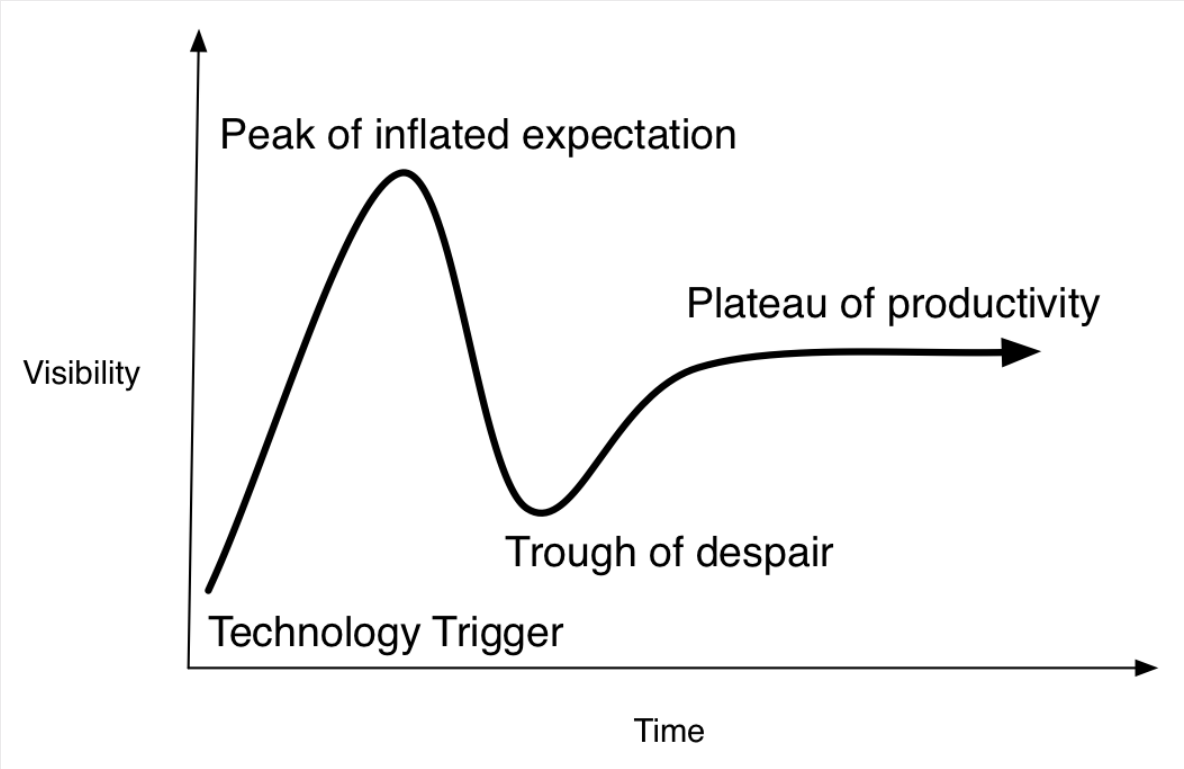
Is this all just a fad?

- No



Is this all just a fad?

- But there are faddish qualities

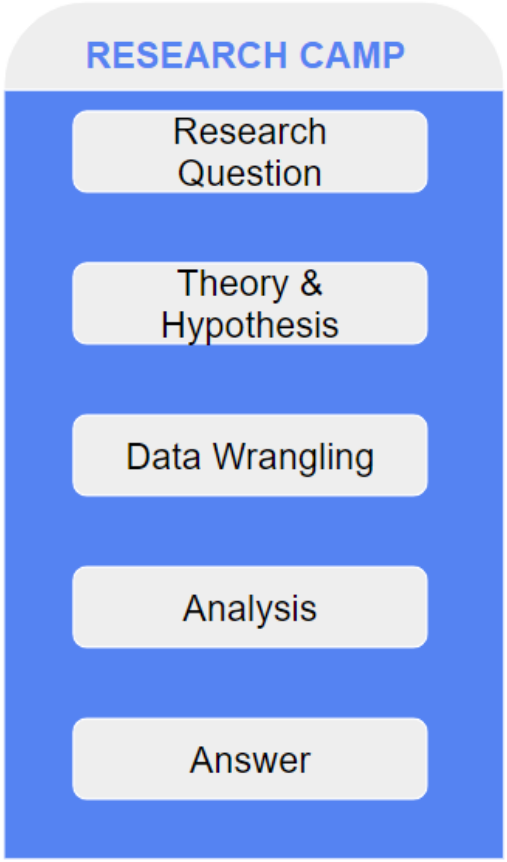


So what IS data science?

- 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



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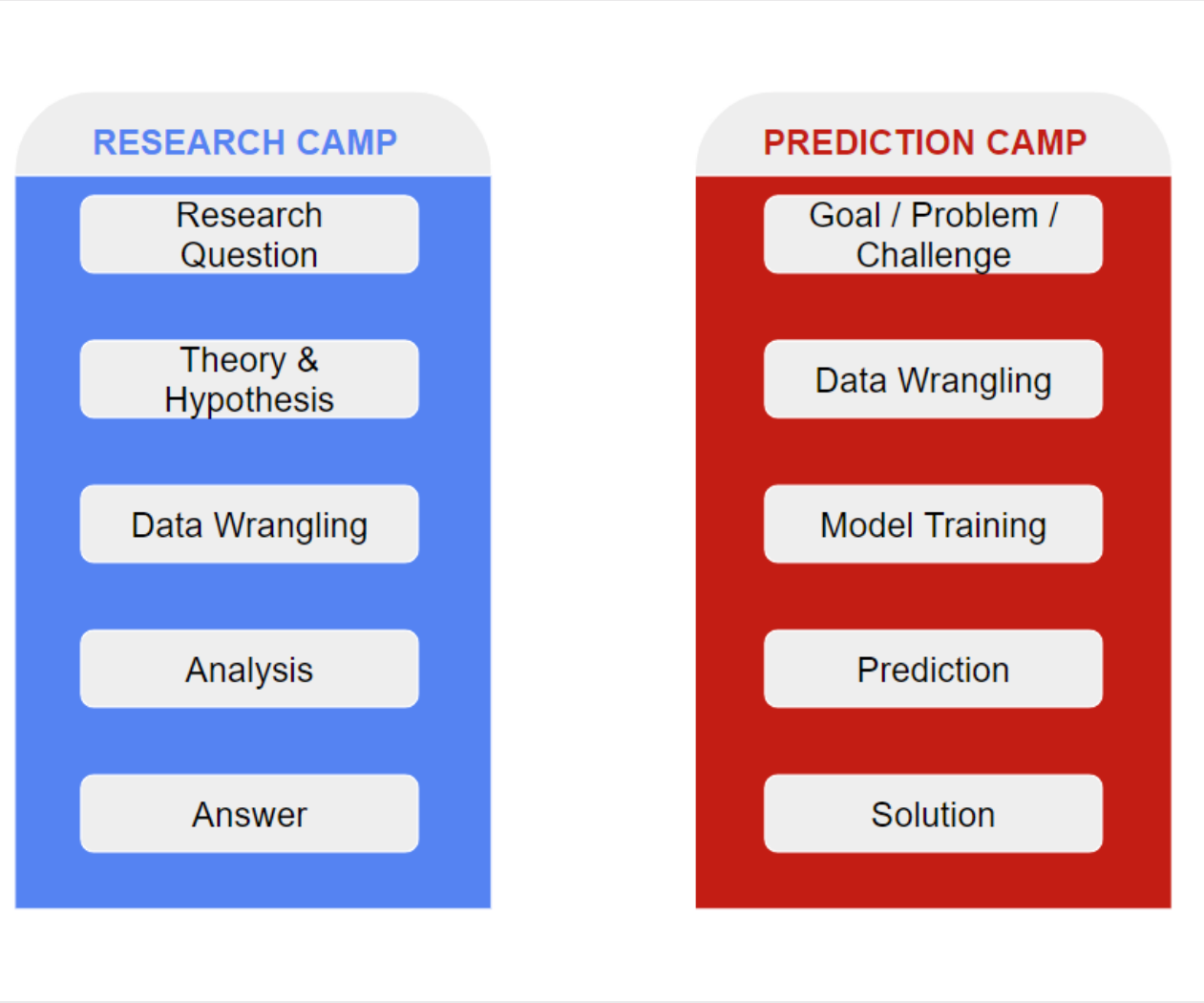

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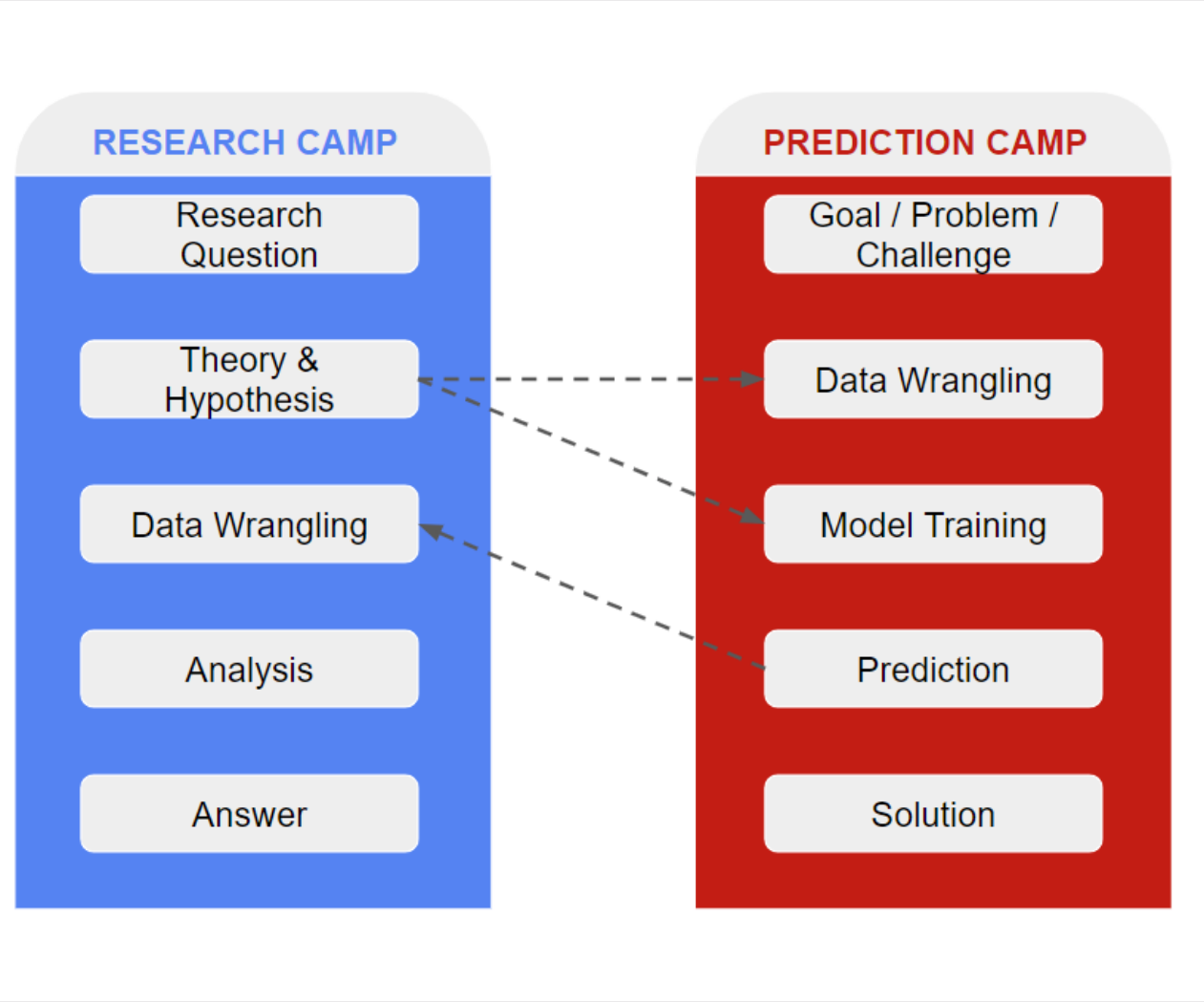
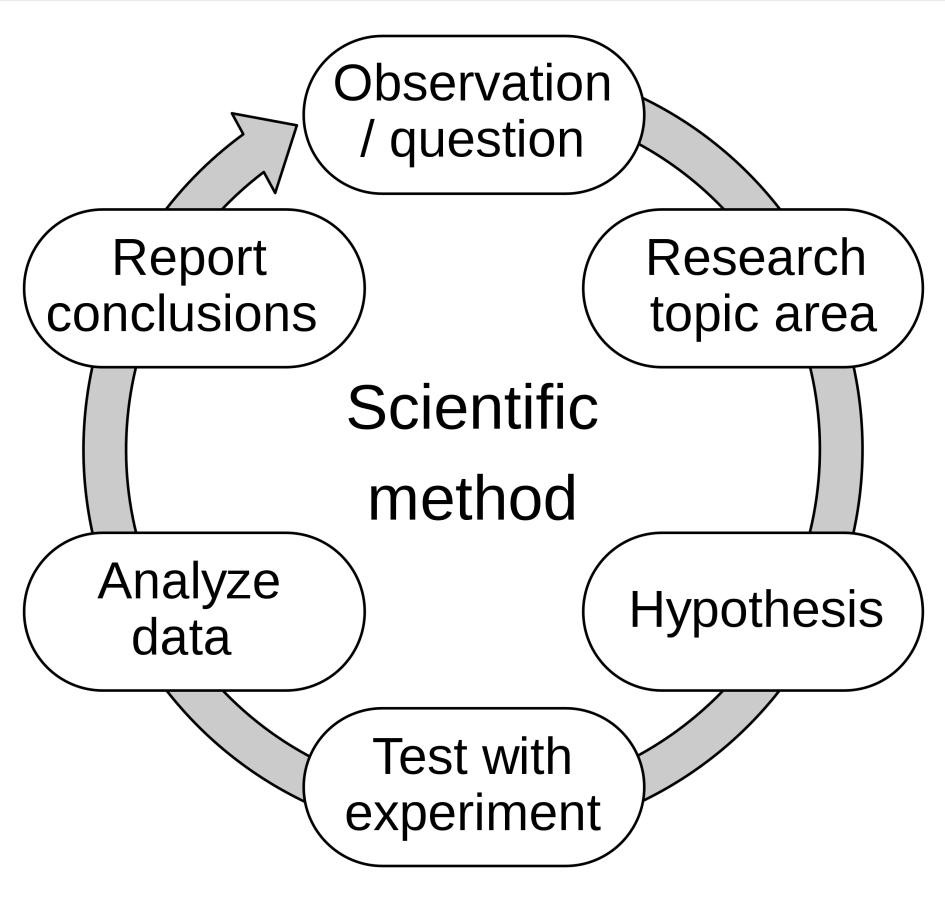


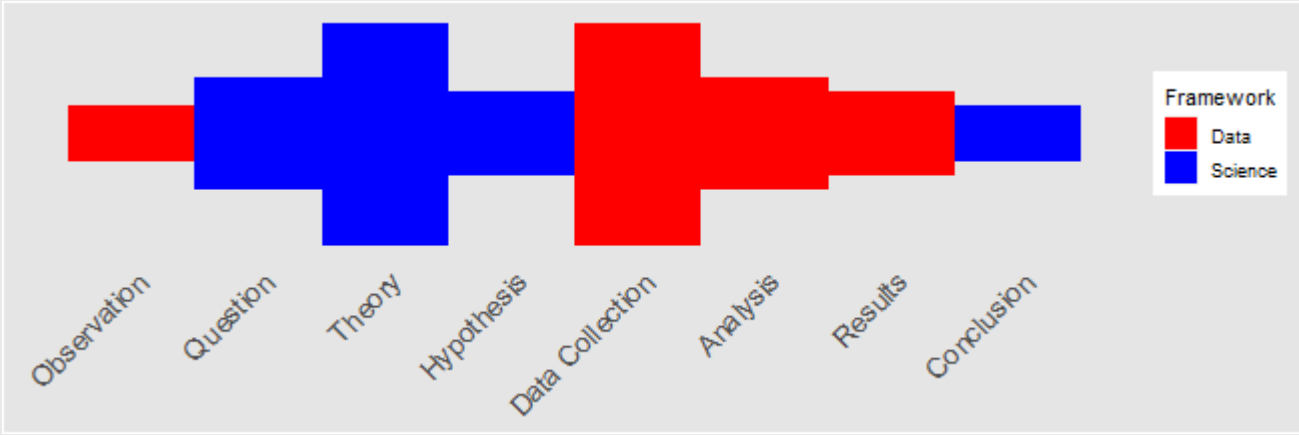
Research Camp

- The scientific method



Research Camp

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



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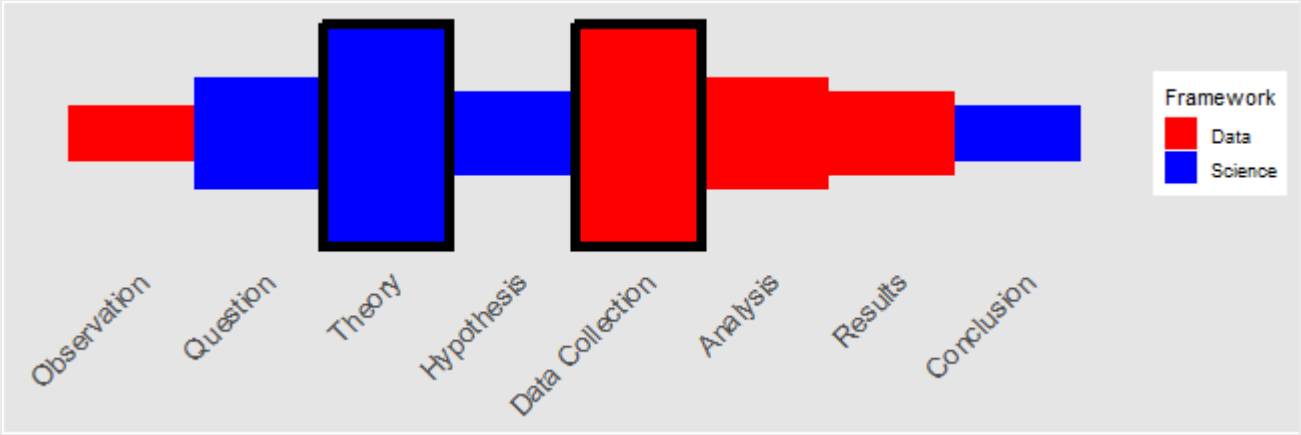

Research Camp

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]

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[4]Center for Data Science, New York University

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August 24, 2022

Abstract

To what extent does the YouTube recommendation algorithm push users into echo chambers, ideologically biased content, or rabbit holes? Despite growing popular concern, recent work suggests that the recommendation algorithm is not pushing users into these echo chambers. However, existing research relies heavily on the use of anonymous data collection that does not account for the personalized nature of the recommendation algorithm. We asked a sample of real users to install a browser extension that downloaded the list of videos they were

Research Camp

1. **Observation** → **Question**
    - Observation is facilitated by data (Descriptive analysis)

Research Camp

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Research Camp

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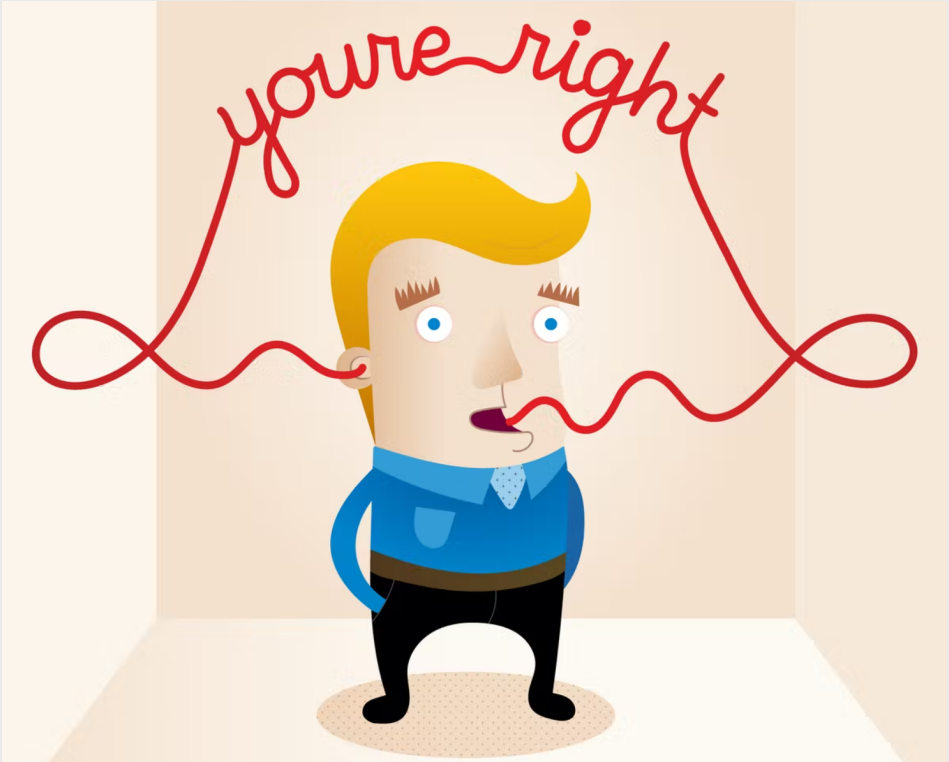
    - The question pertains to science
    - I.e., does YouTube's algorithm put users into "echo chambers"?



Research Camp

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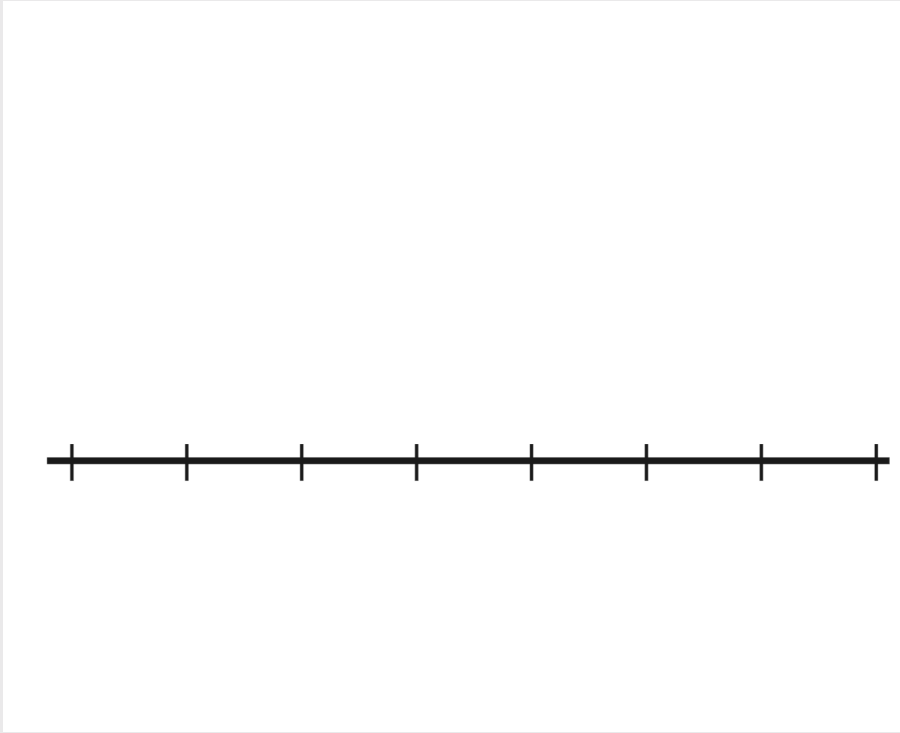
    - Theorizing requires abstraction & simplification
    - I.e., people (in general) avoid conflict



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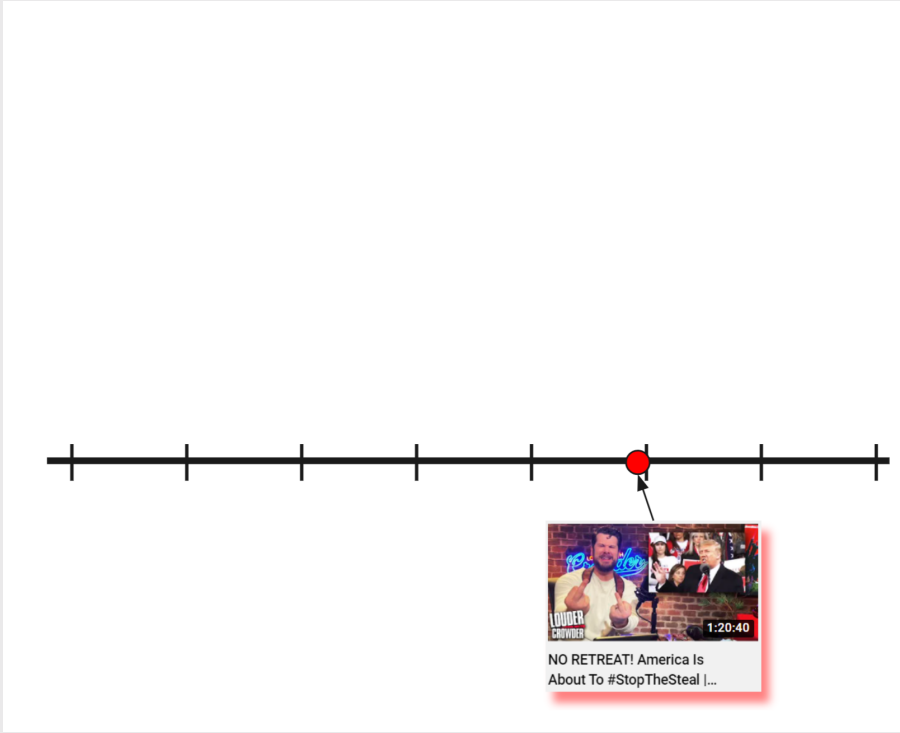

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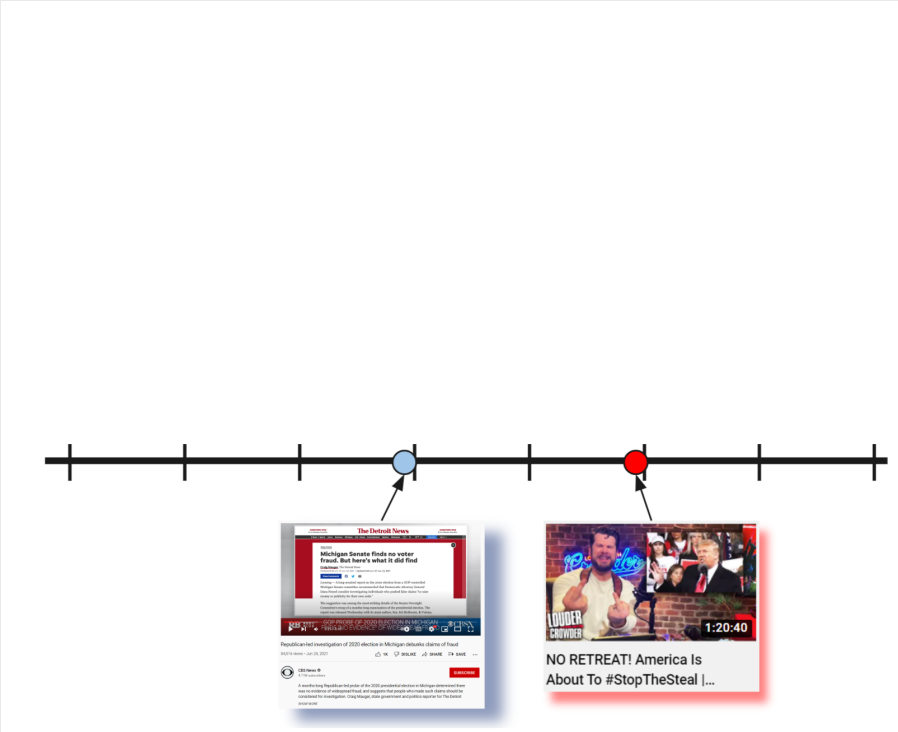

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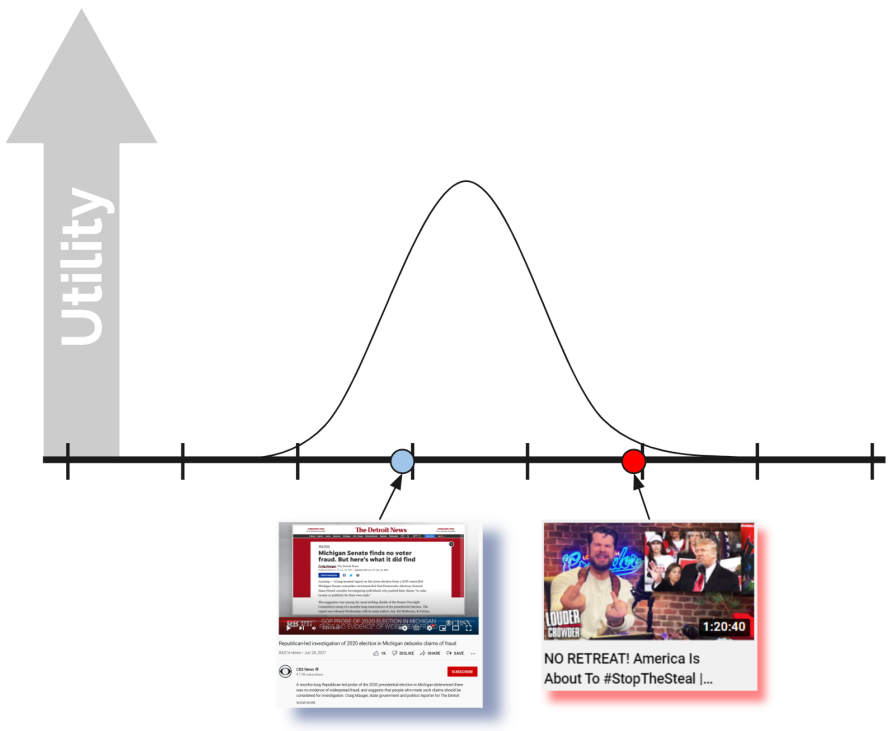

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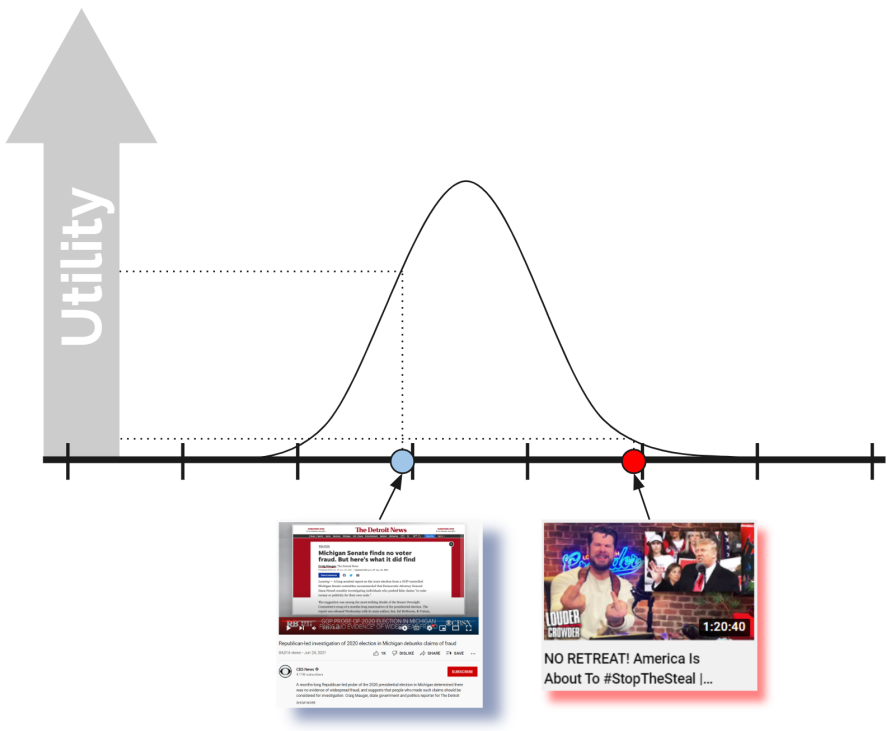

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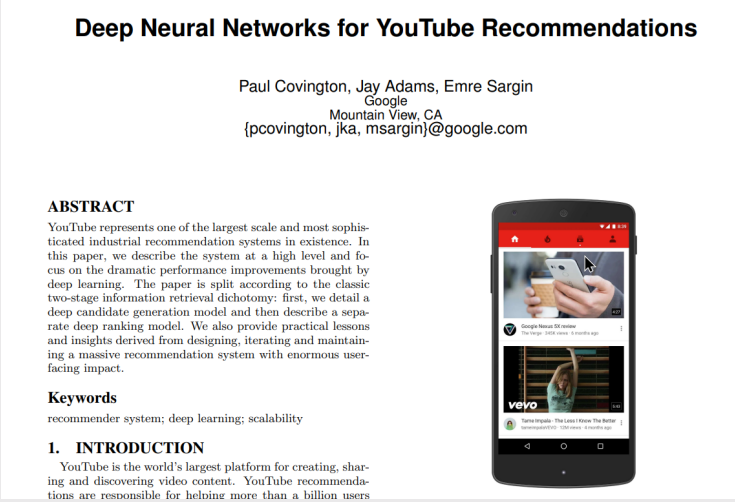


Deep Neural Networks for YouTube Recommendations

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

ABSTRACT

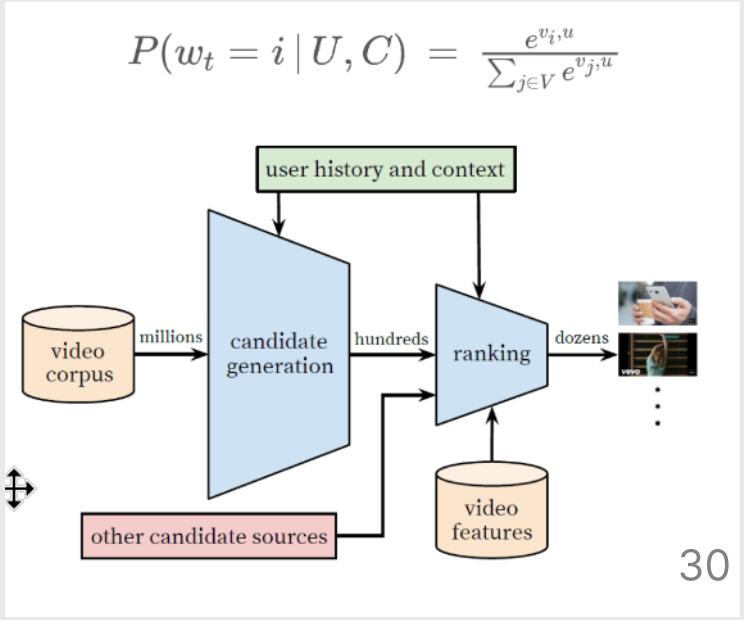
YouTube represents one of the largest scale and most sophisticated industrial recommendation systems in existence. In this paper, we describe the system at a high level and focus on the dramatic performance improvements brought by deep learning. The paper is split according to the classic two-stage information 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



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    - YouTube wants users to watch more videos
    - Hypotheses fall out naturally from well-done theory
    - **H1:** *YouTube's recommendation algorithm should suggested liberal content to liberals and conservative content to conservatives.*

Research Camp

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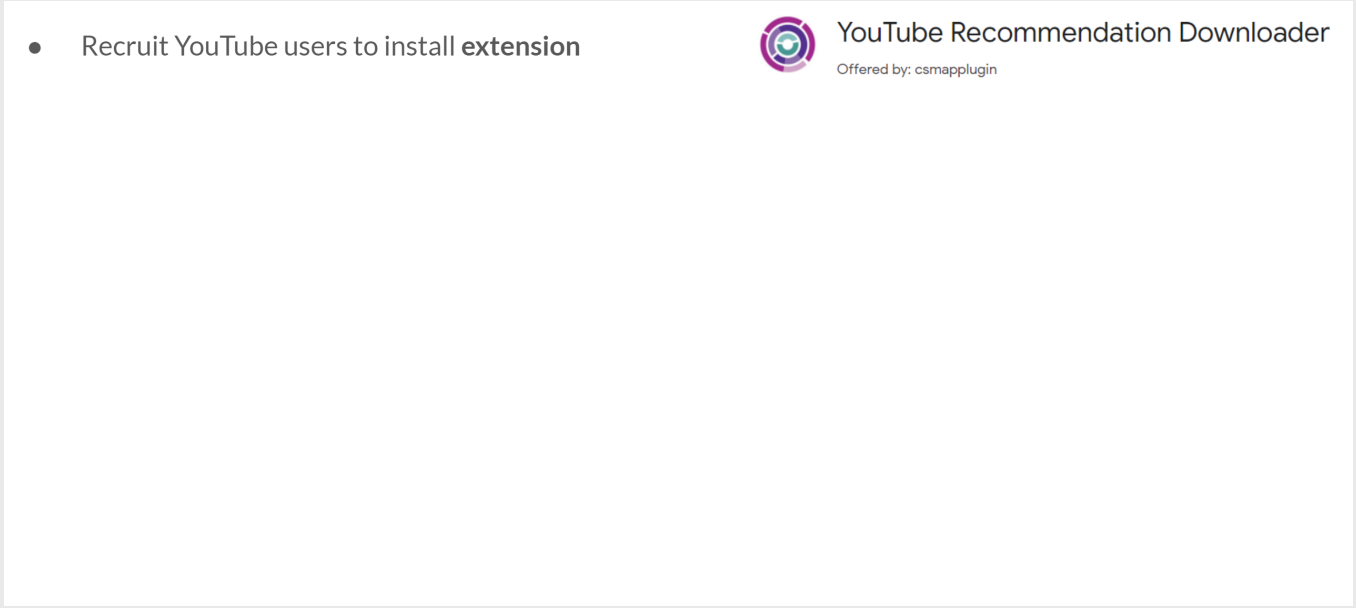
    - Data collection separates "Data Science"...
    - ...from "Science, with data"



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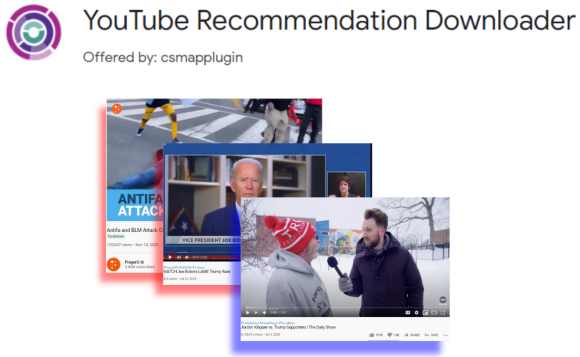
- Start on randomly assigned **seed video**



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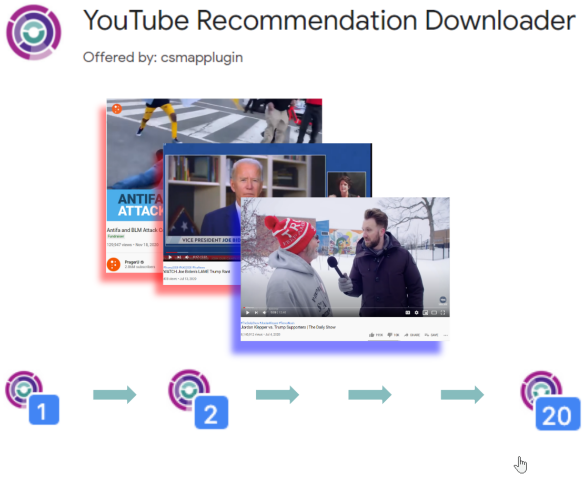

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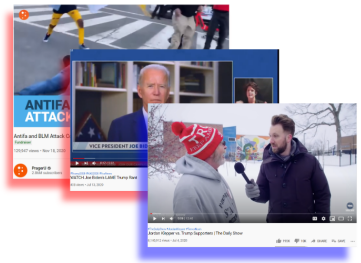

- Follow **traversal rule** to select recommended video

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

Research Camp

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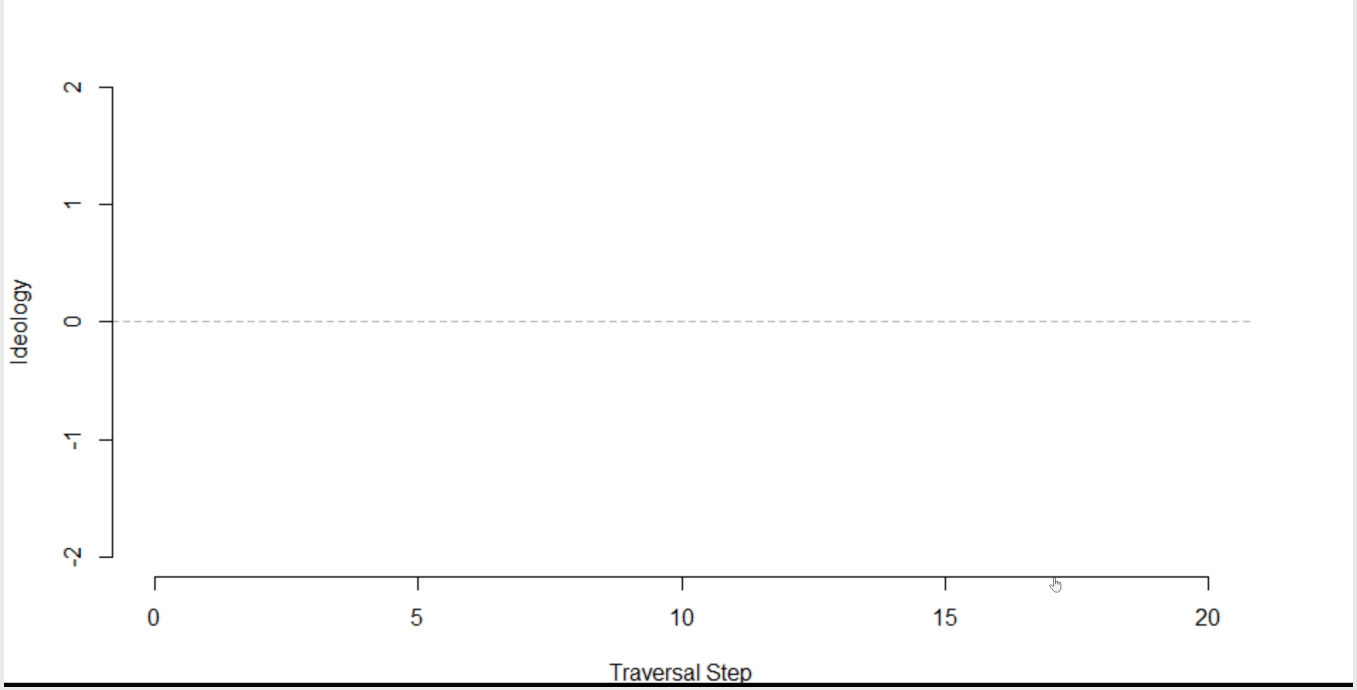

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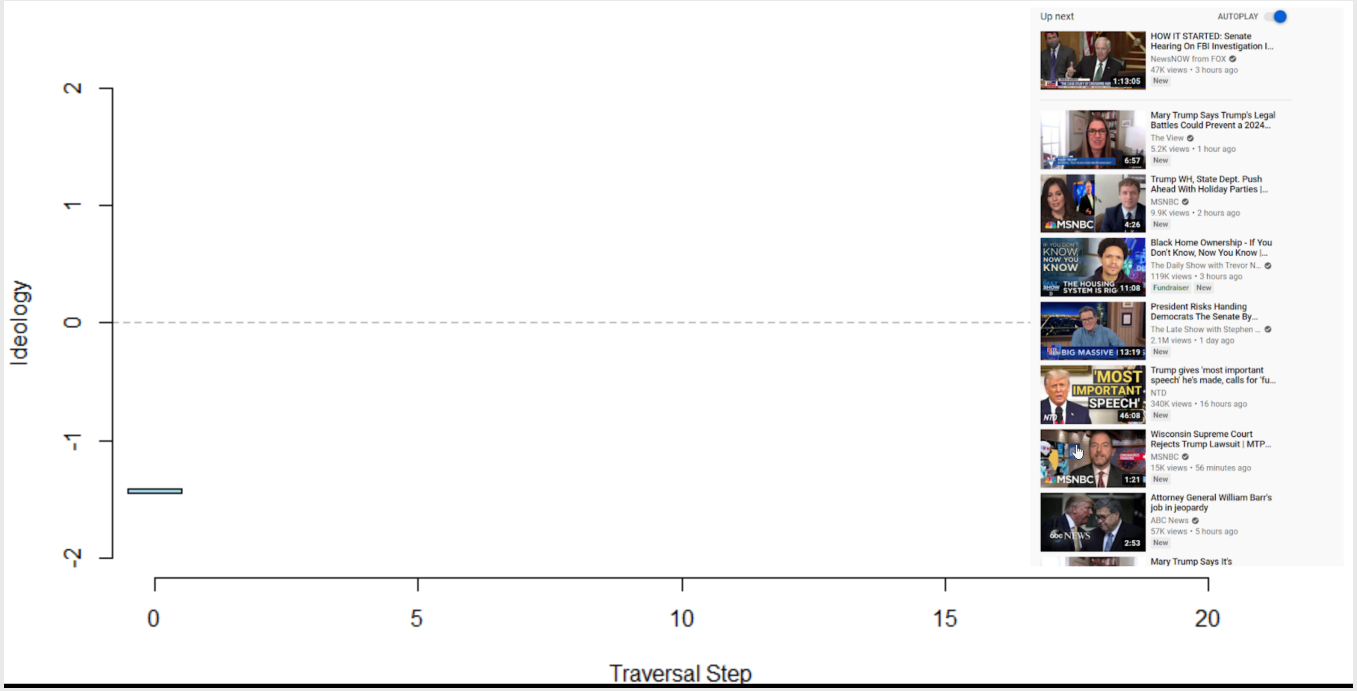

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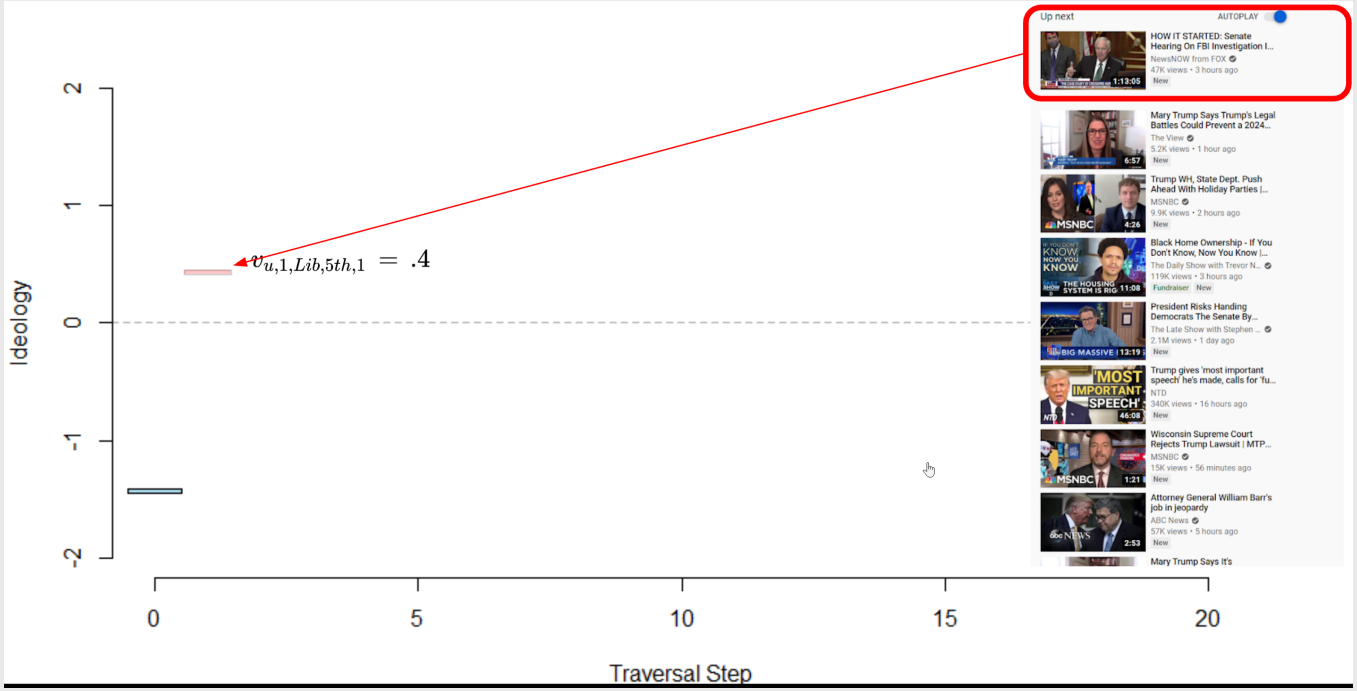

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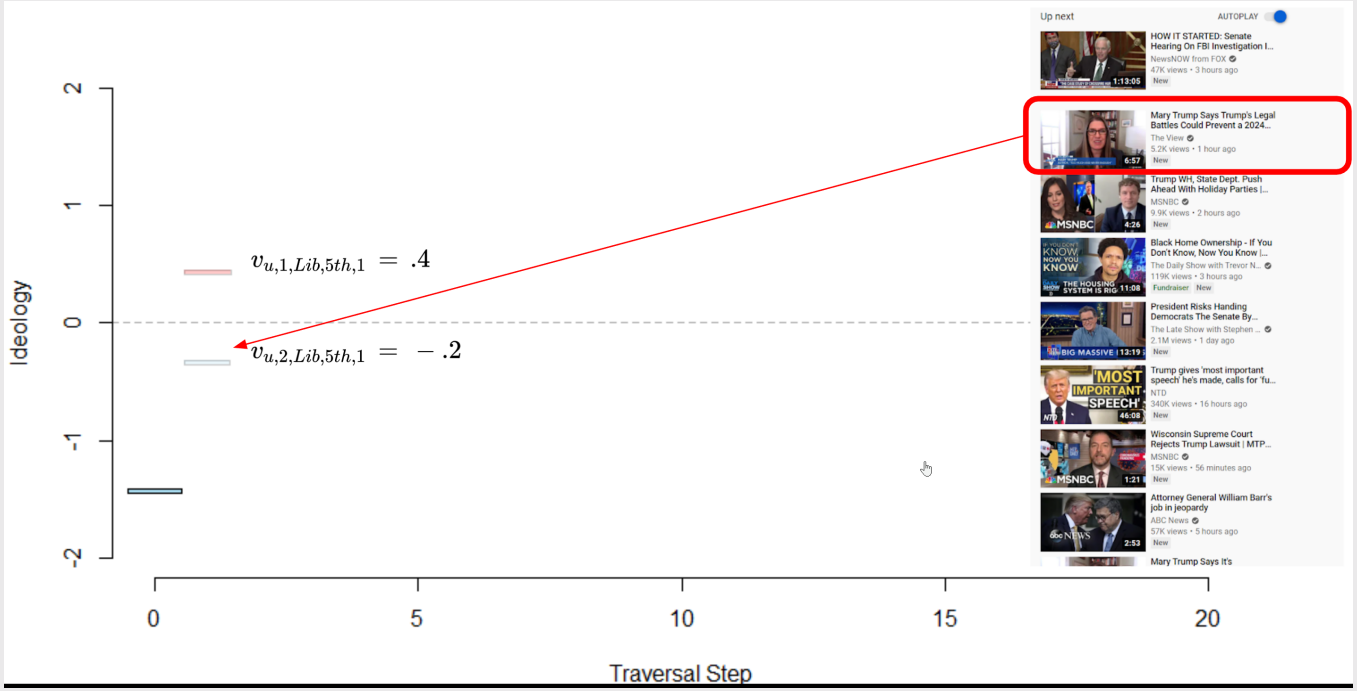

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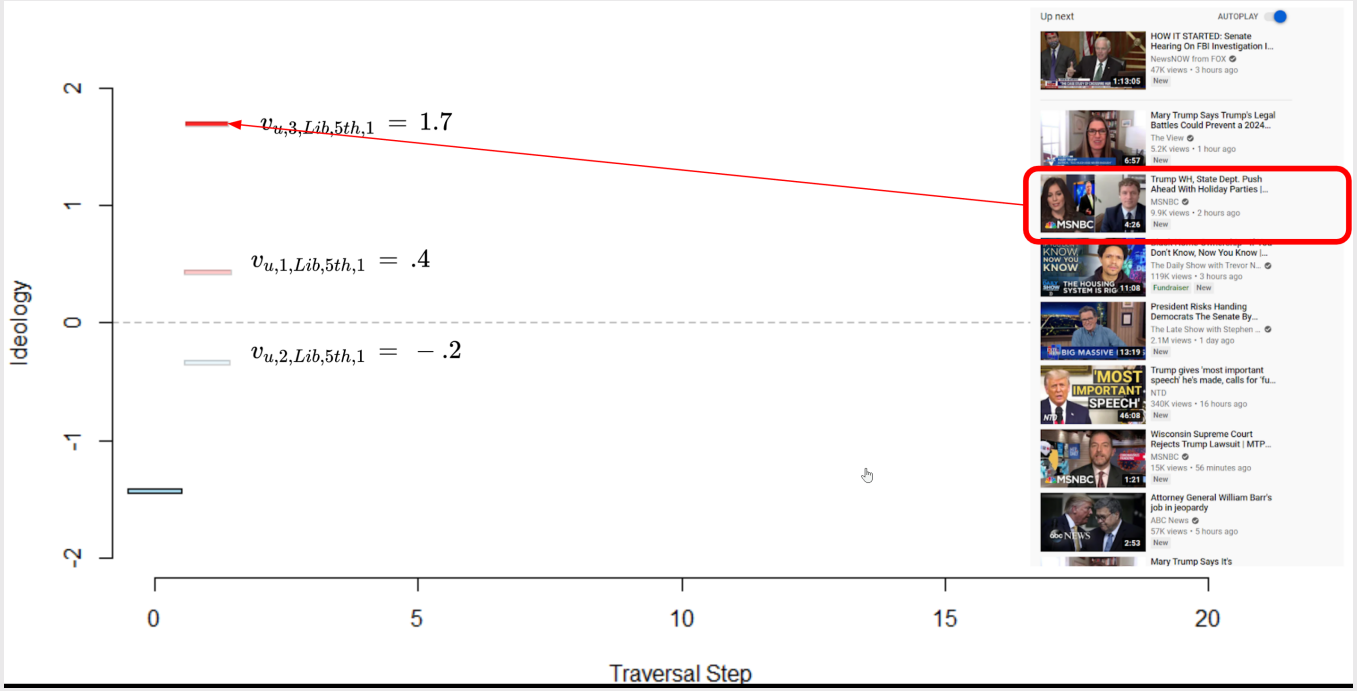

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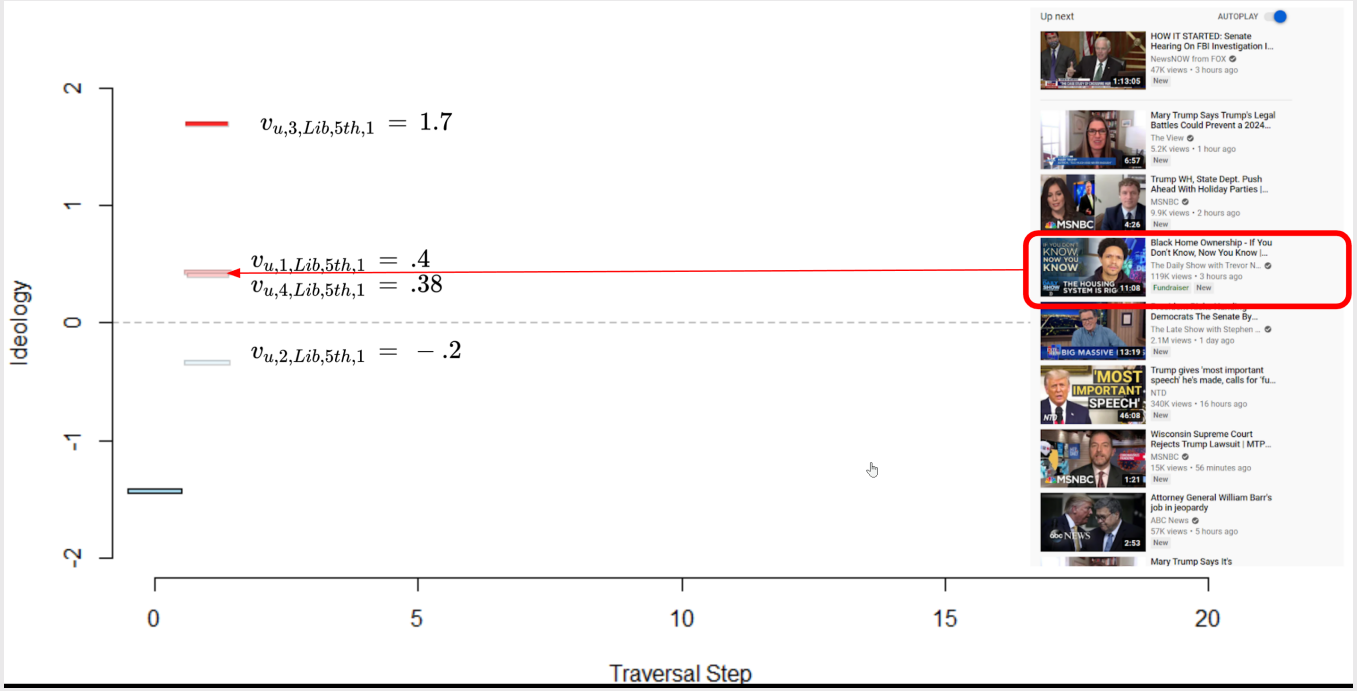

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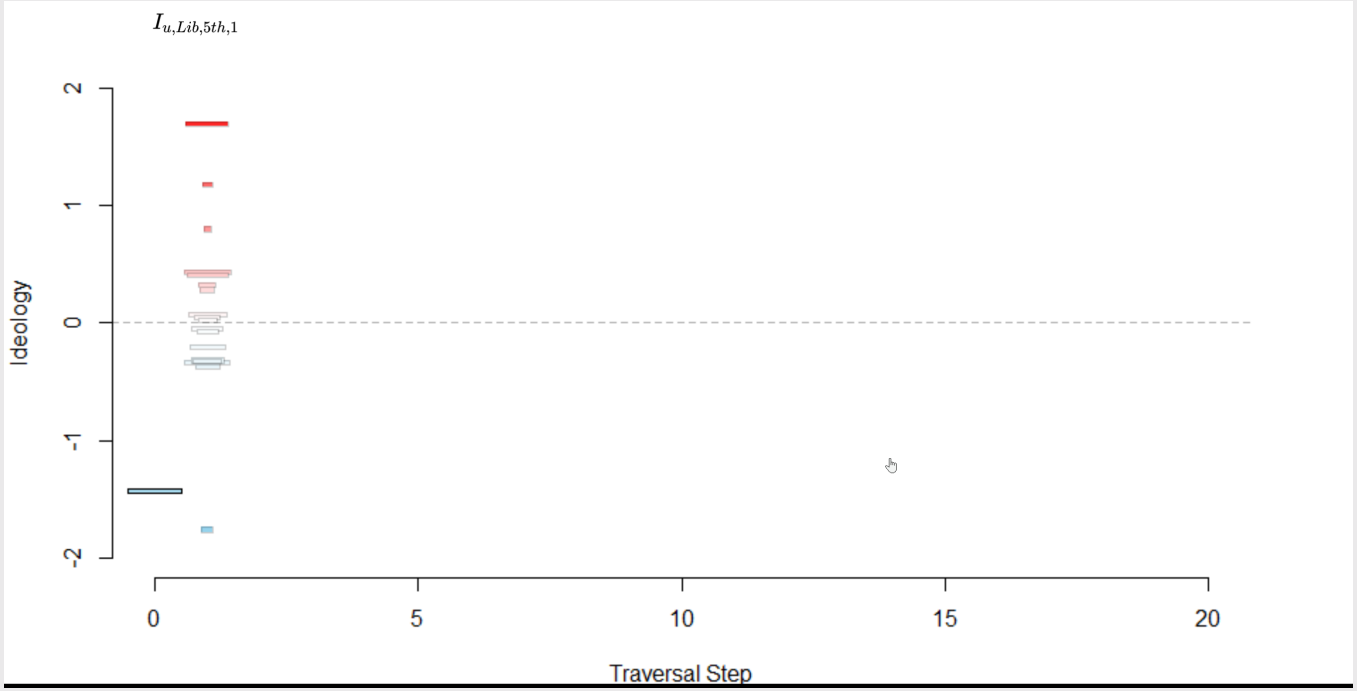

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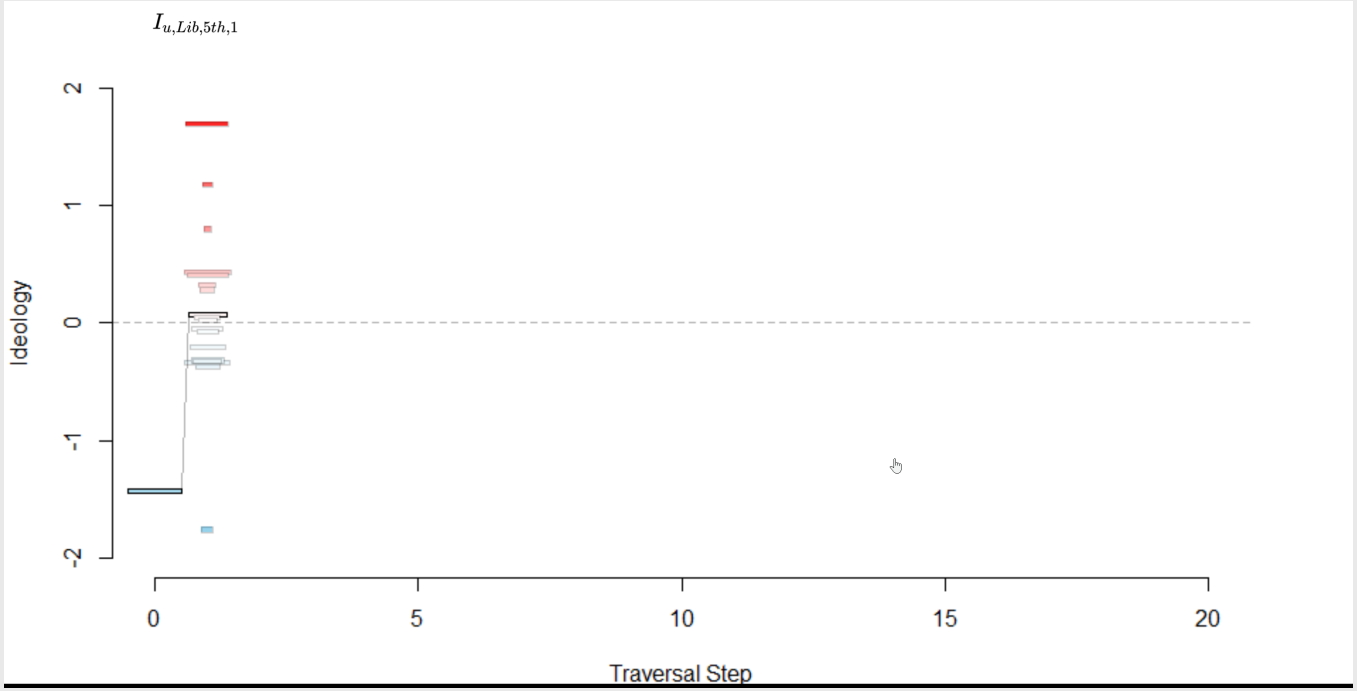

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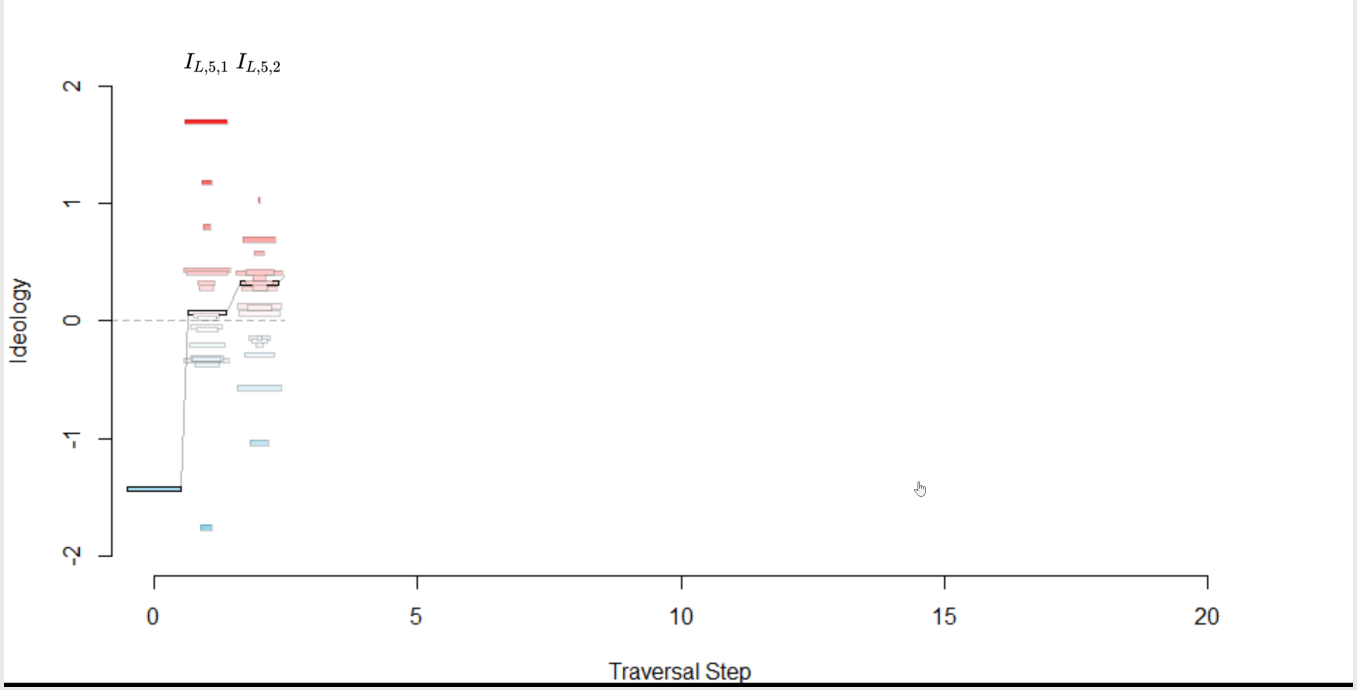

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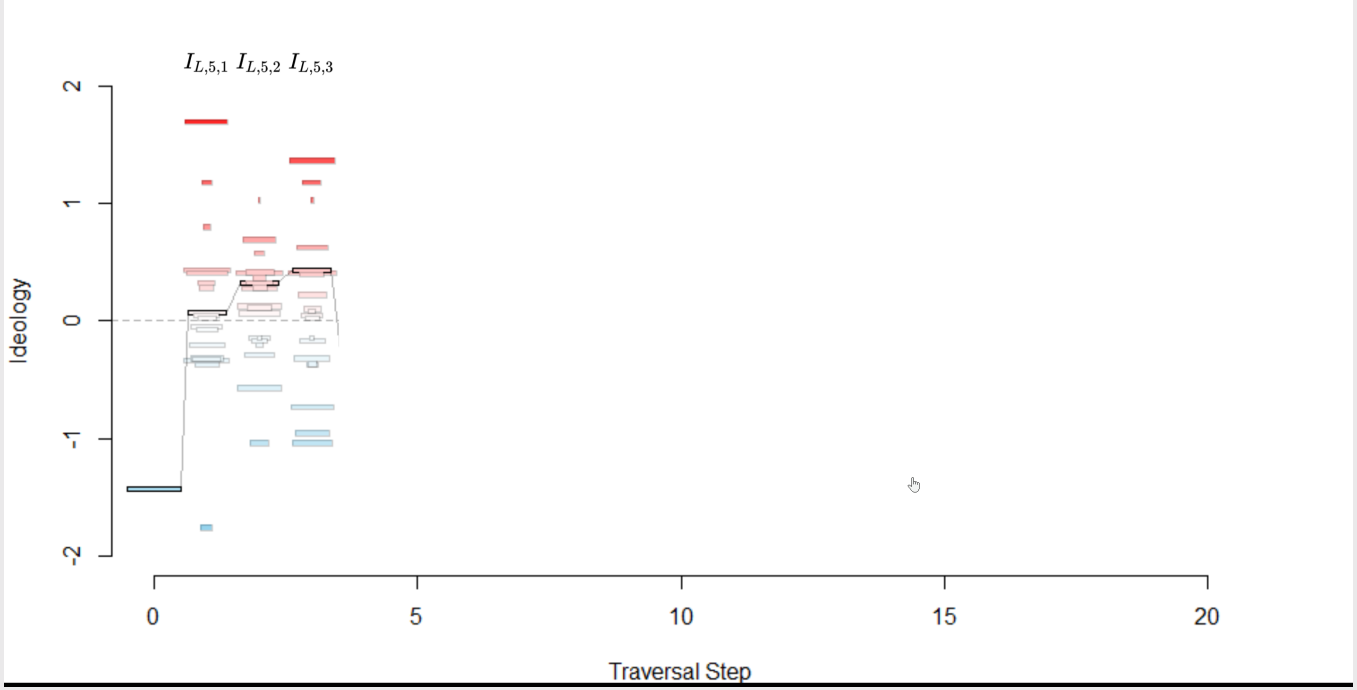

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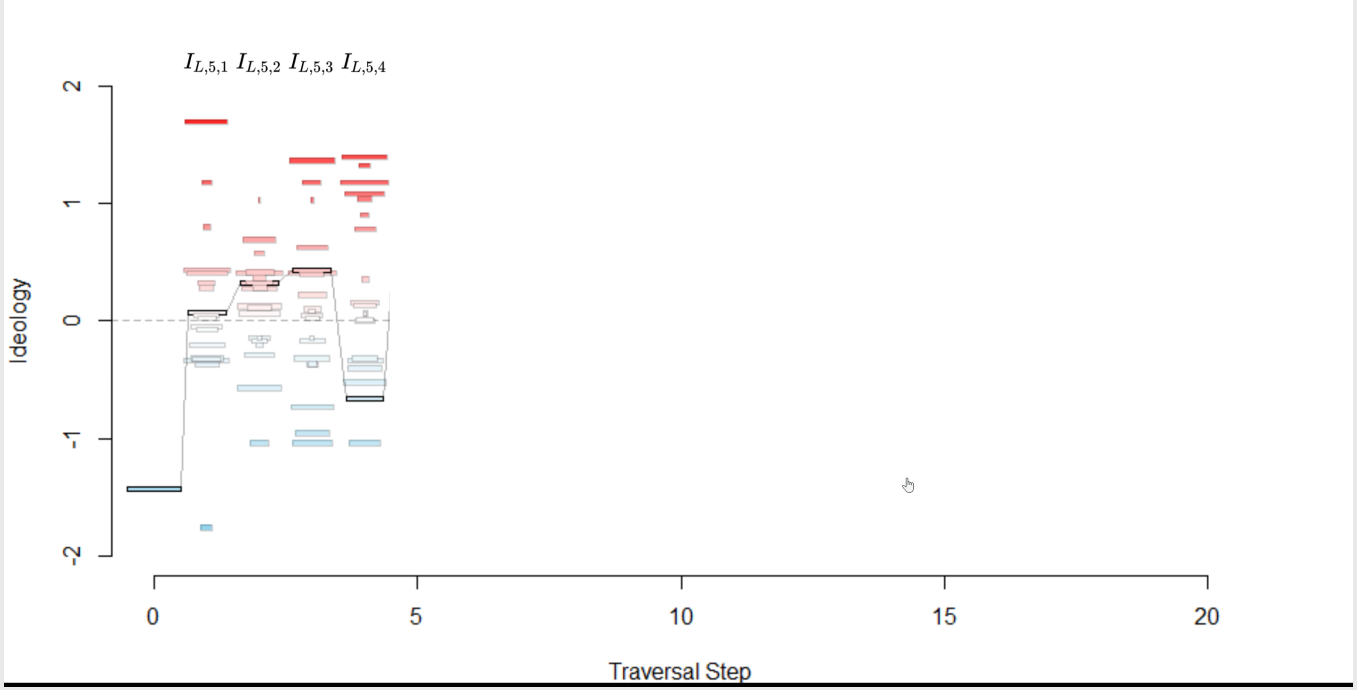

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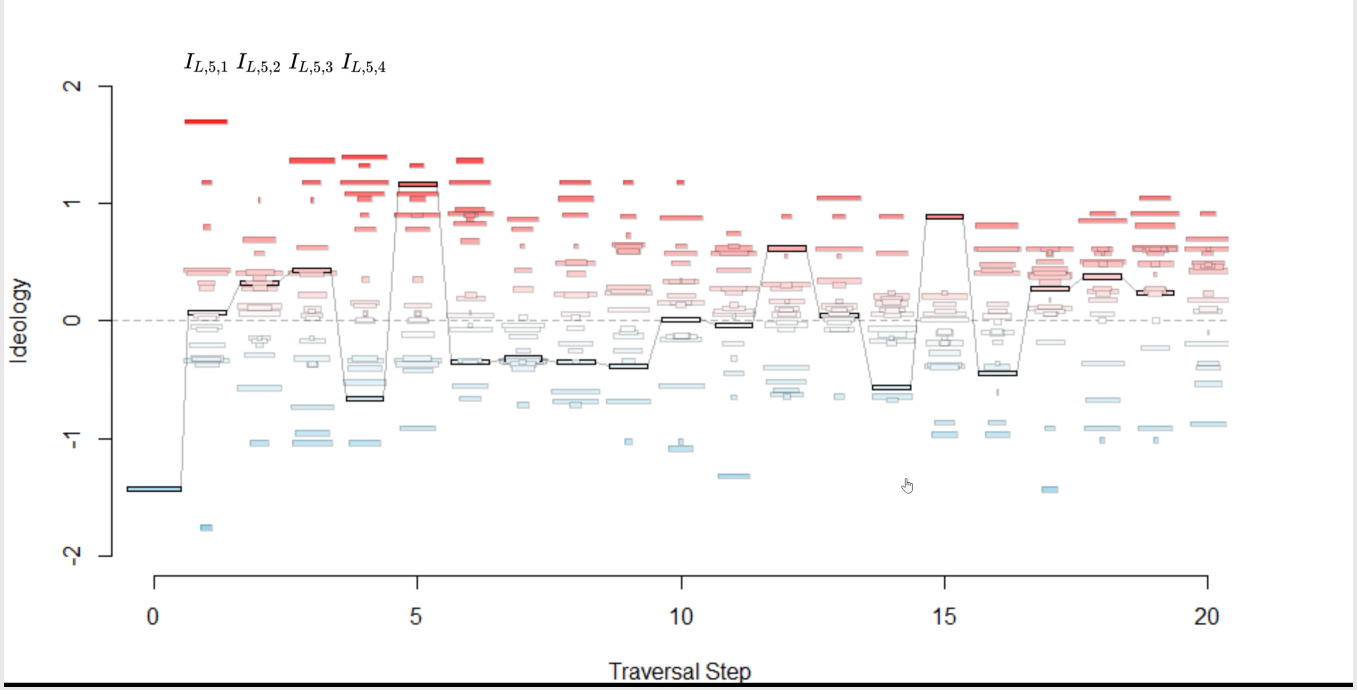

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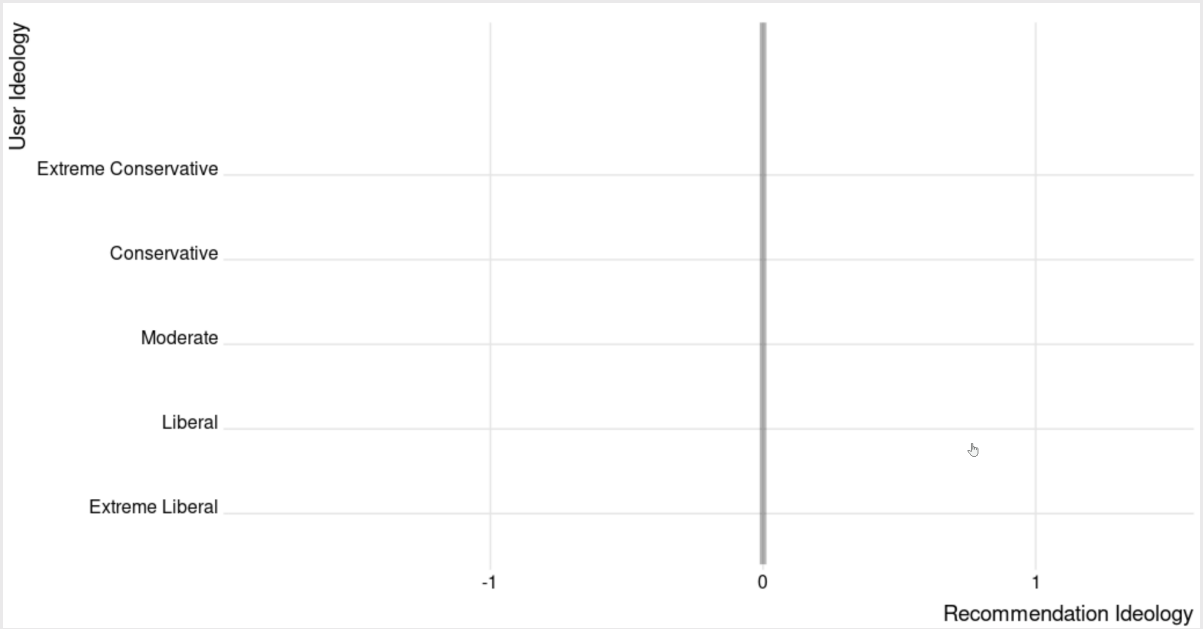

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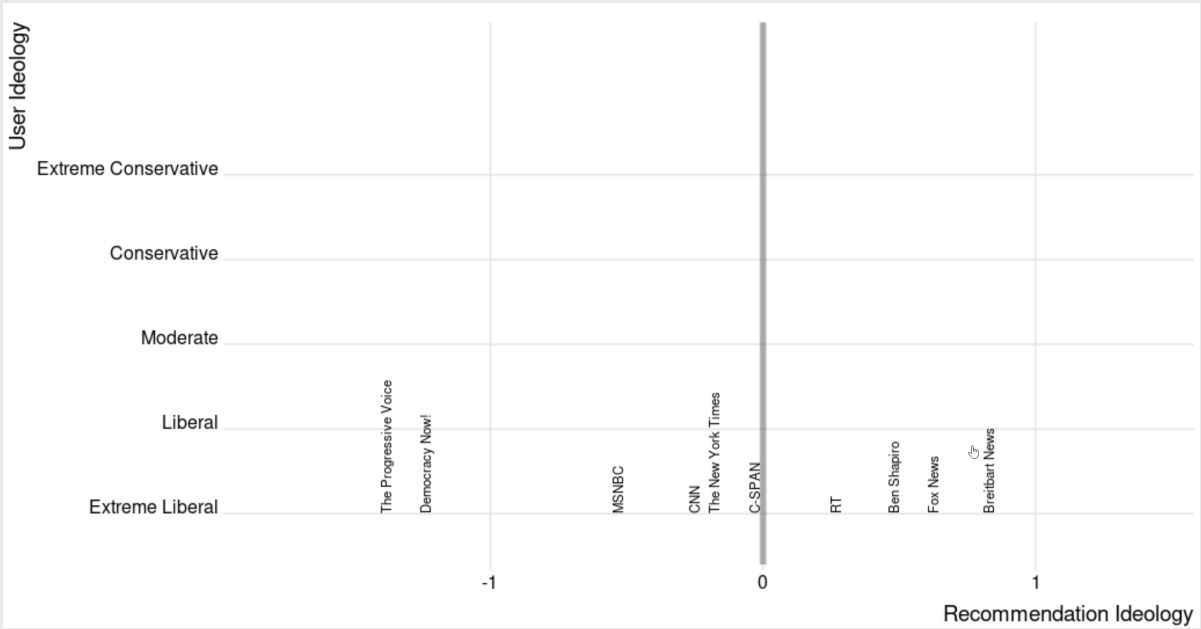

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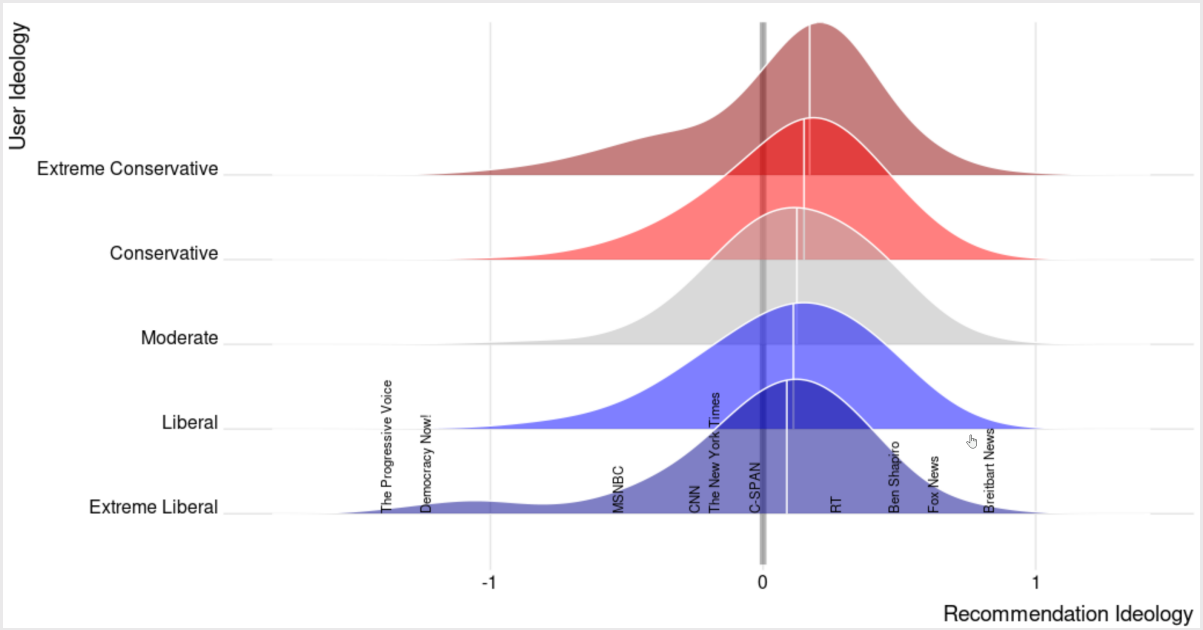
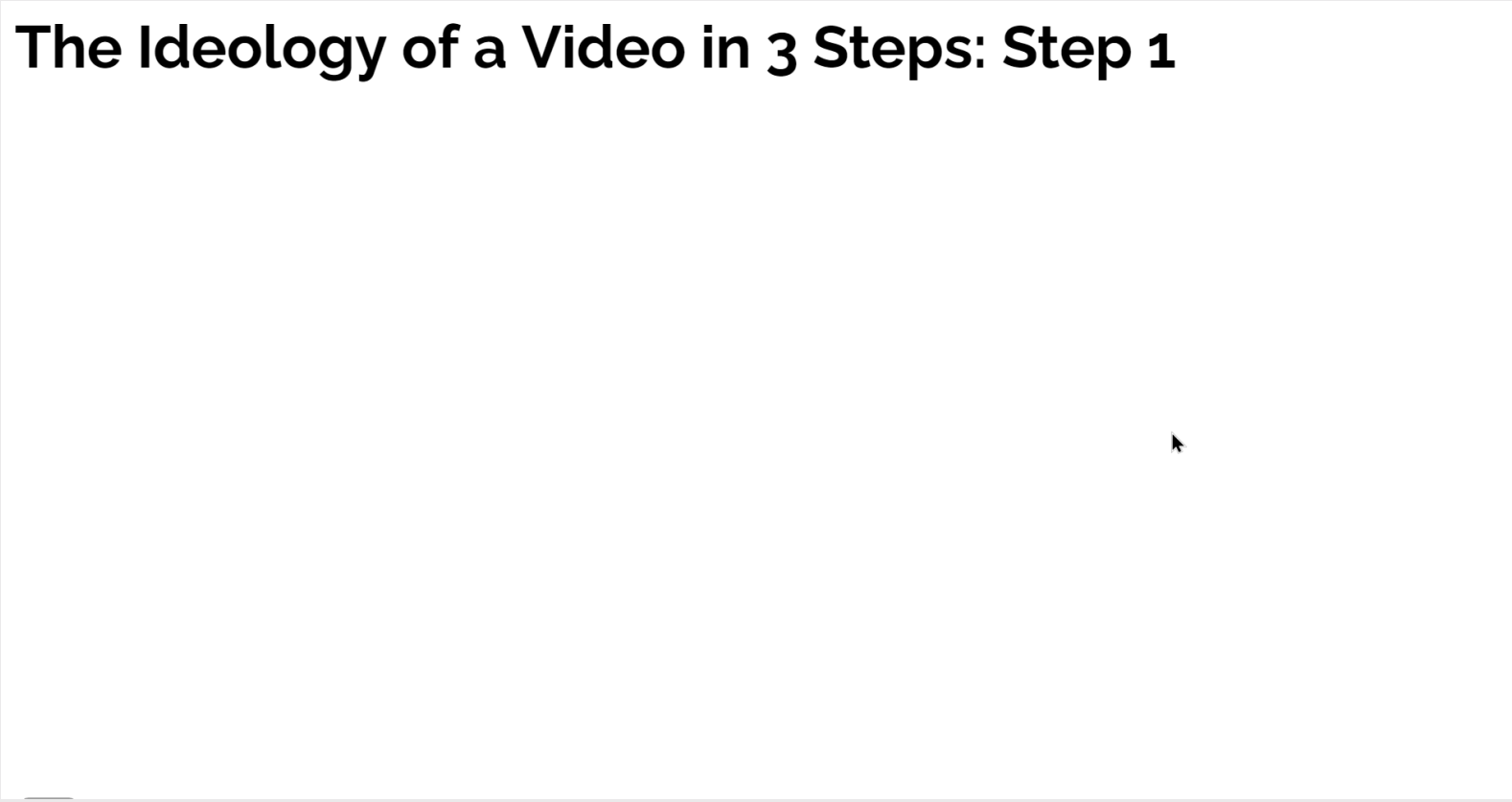
   - ...to draw conclusions



Prediction Camp

- **Goal**: Measure the ideology of a YouTube

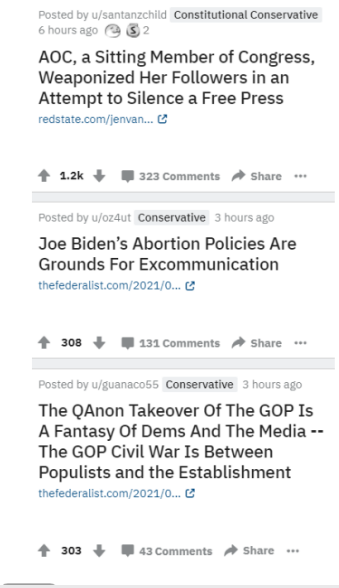


Prediction Camp

- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 1

Behavior:
Sharing URLS

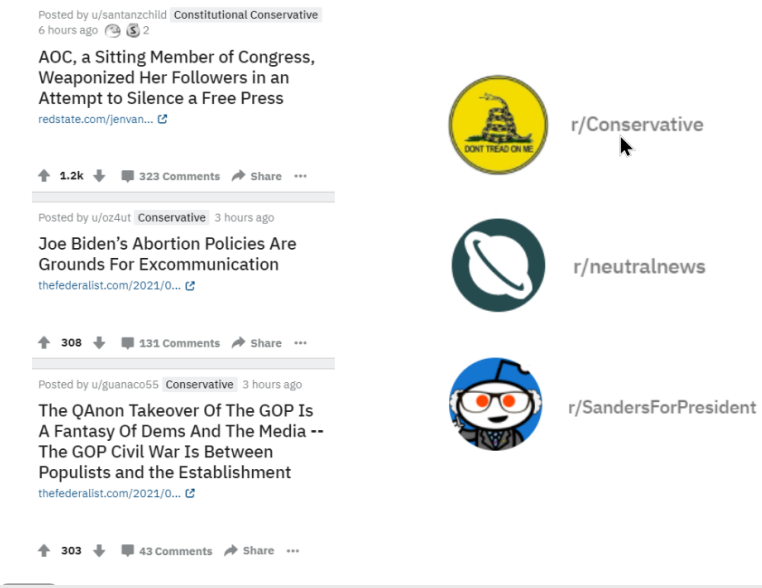


Prediction Camp

- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 1

Behavior: **Sharing URLS** + Domain: **Subreddits**

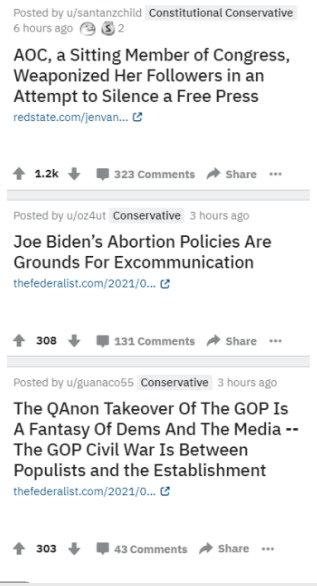


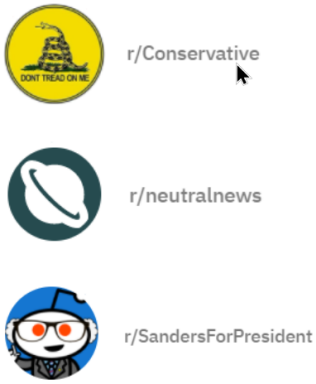
Prediction Camp

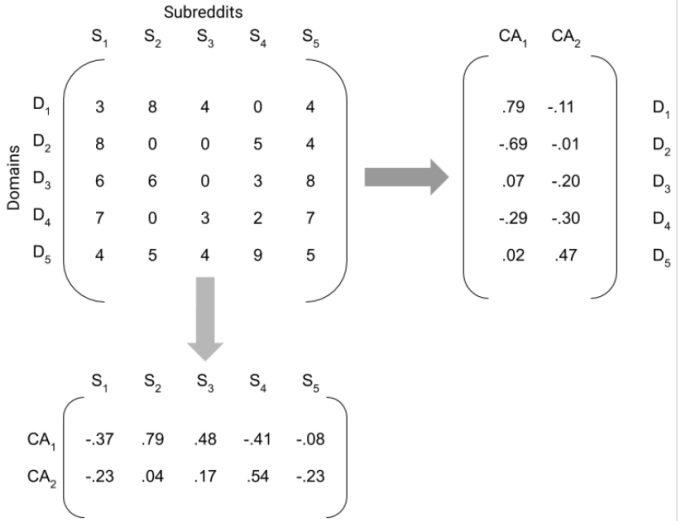
- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 1

Behavior: **Sharing URLS** + Domain: **Subreddits**

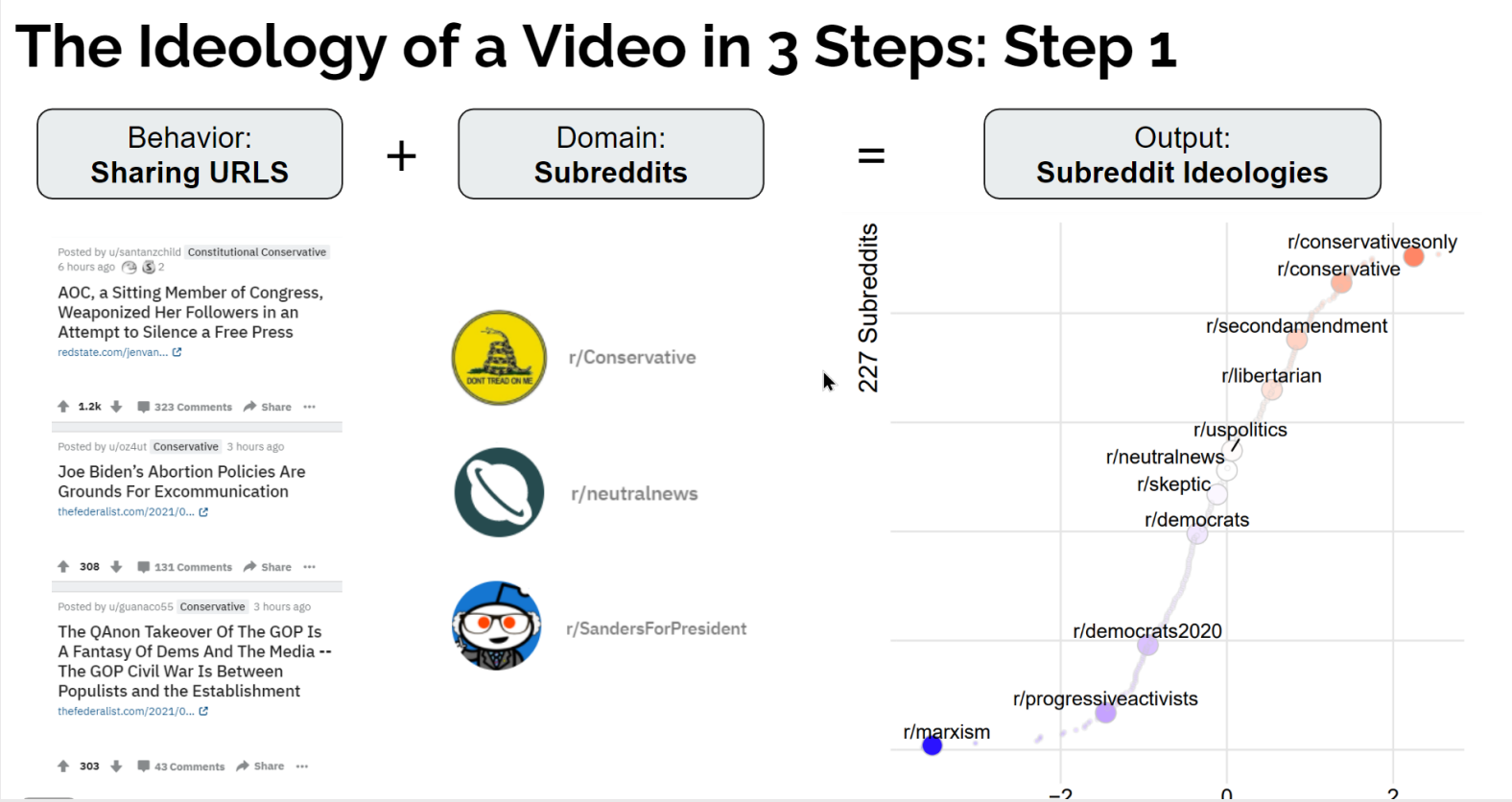






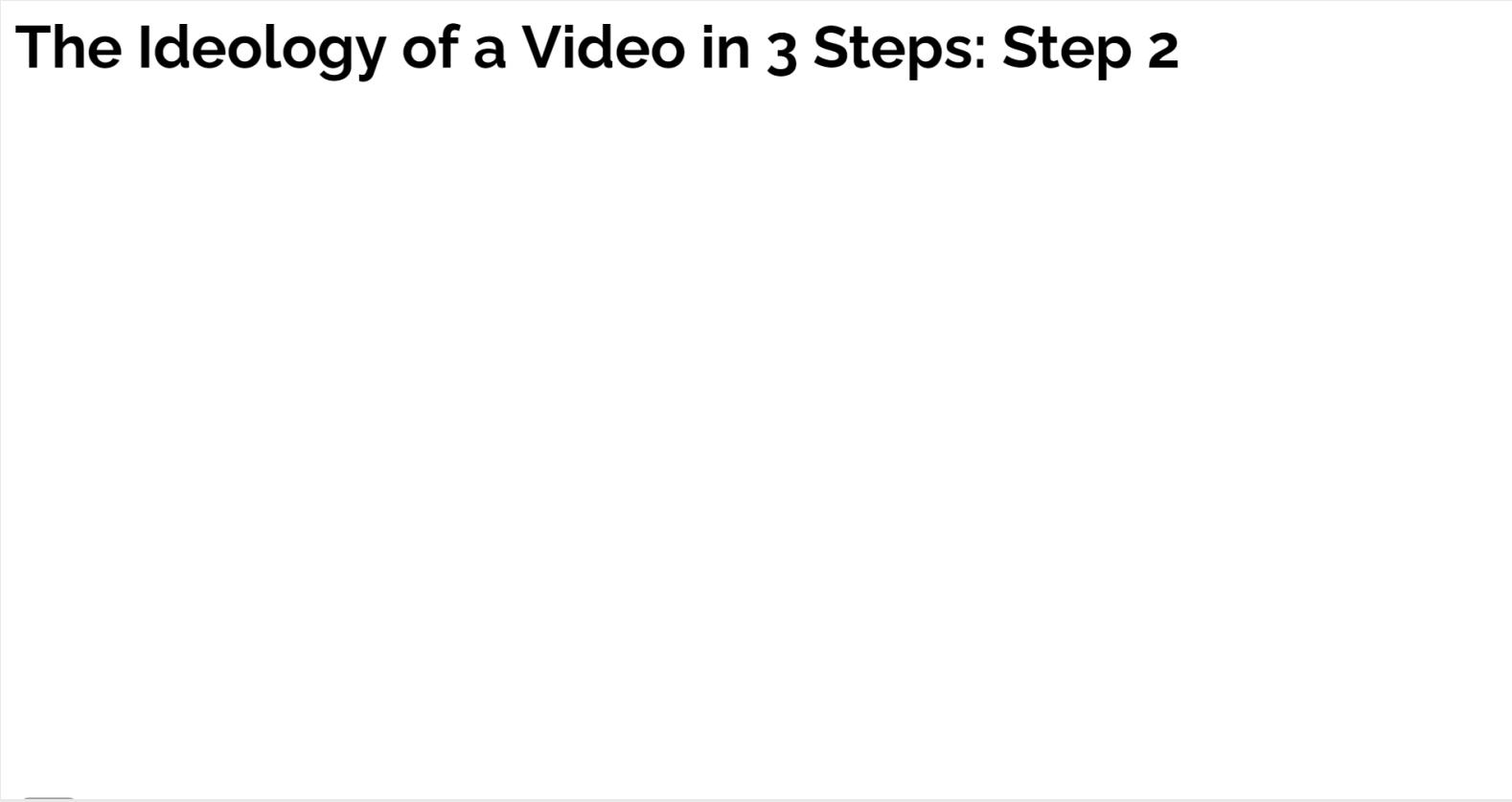
Prediction Camp

- **Goal**: Measure the ideology of a YouTube



Prediction Camp

- **Goal**: Measure the ideology of a YouTube

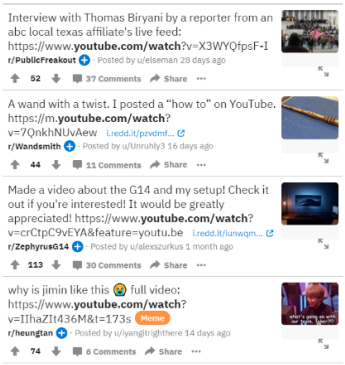


Prediction Camp

- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 2

Behavior:
Sharing Videos

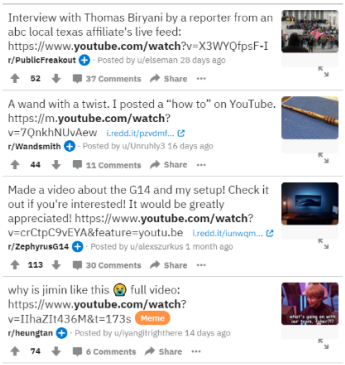


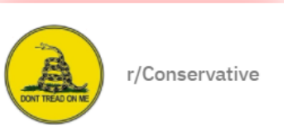
Prediction Camp

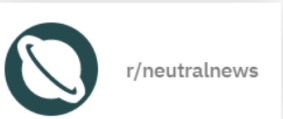
- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 2

Behavior: **Sharing Videos** + Domain: **Ideological Reddit**





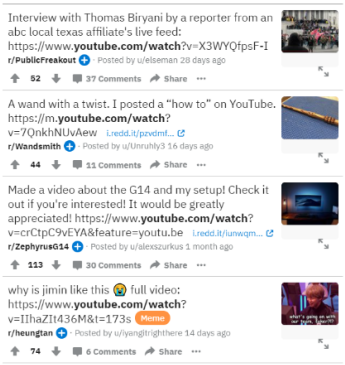


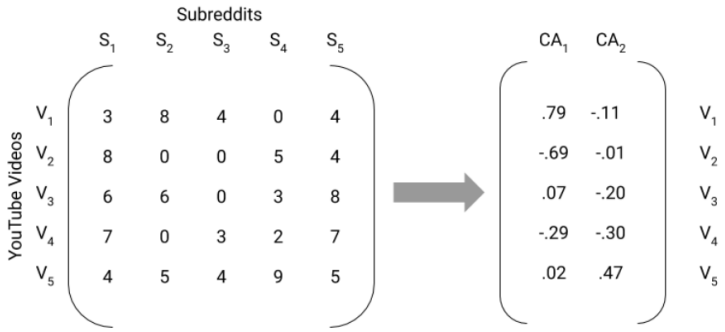
Prediction Camp

- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 2

Behavior: **Sharing Videos** + Domain: **Ideological Reddit**



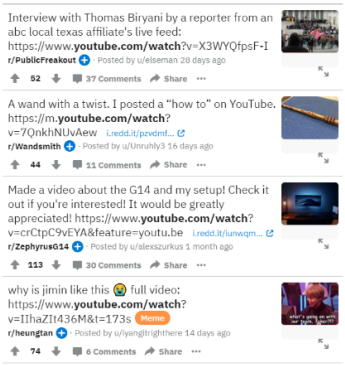


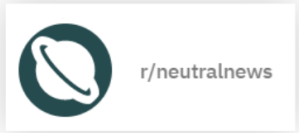
Prediction Camp

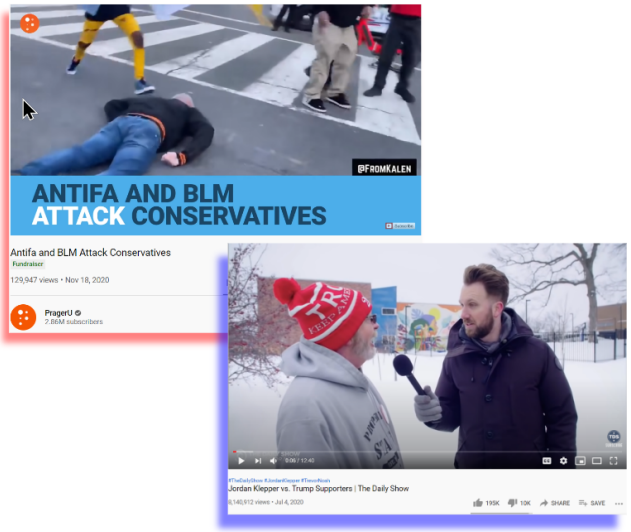
- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 2

Behavior: **Sharing Videos** + Domain: **Ideological Reddit** = Output: **Video Ideologies**







Prediction Camp

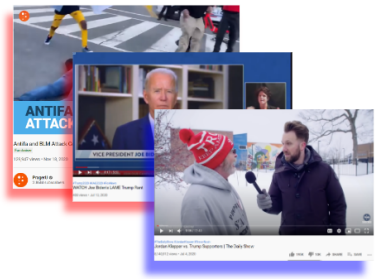
- **Goal**: Measure the ideology of a YouTube

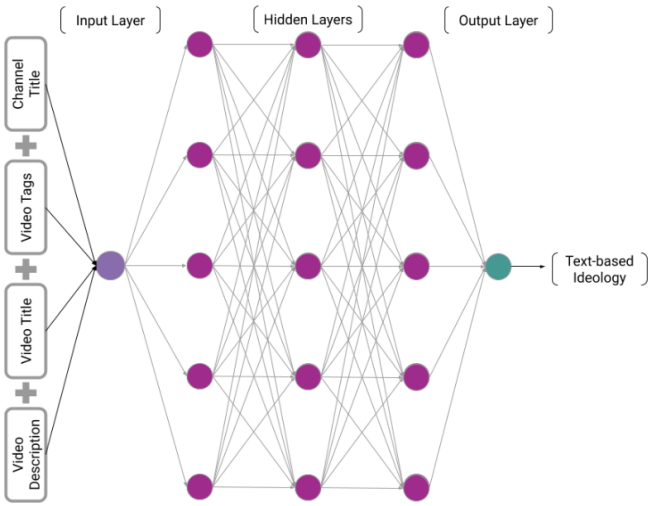
The Ideology of a Video in 3 Steps: Step 3

Training Data:
67k Coded Videos

+

Classifier:
BERT Transformer



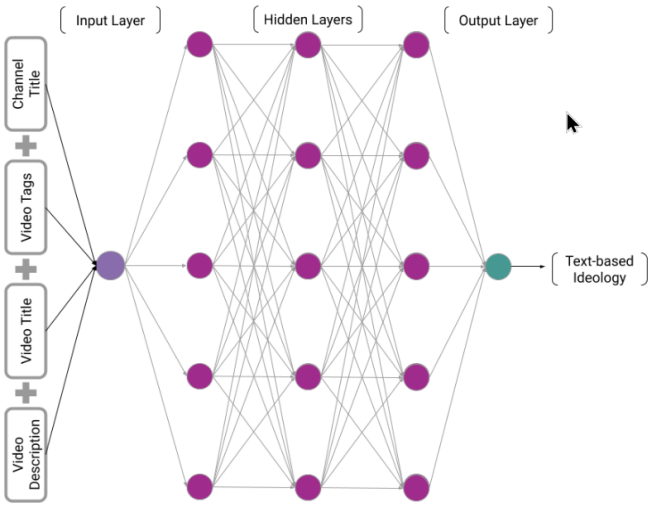


Prediction Camp

- **Goal**: Measure the ideology of a YouTube

The Ideology of a Video in 3 Steps: Step 3

Training Data: **67k Coded Videos** + Classifier: **BERT Transformer** = Output: **Any Video's Ideology**



Preview of Semester

- 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
  - You must work through the first homework assignment using an `.Rmd` file

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	25%	50
Final Exam	25%	50
Quizzes	10%	20
Totals	100%	200

The Syllabus

Date	Lecture	DOW	Goal	Assignments	Quizzes
9-Jan-23	Intro to Data Science	M	The scientific method, the camps of analysis	Pset 0 assigned	Quiz 1
11-Jan-23	Intro to R	W	Install and open R, packages, tidyverse functions		Quiz 2
16-Jan-23	BREAK	M			
18-Jan-23	Data Wrangling Part 1	W	Missingness and data types		Quiz 3
23-Jan-23	Data Wrangling Part 2	M	mutate(), ifelse(), and spread()	Pset 1 assigned	Quiz 4
25-Jan-23	R & Data Wrangling Review	W			
30-Jan-23	Univariate Part 1	M	Summaries of a single variable	Pset 2 assigned	Quiz 5
1-Feb-23	Univariate Part 2	W	Visualizations of a single variable		Quiz 6
6-Feb-23	Multivariate Part 1	M	Summaries of two variables	Pset 3 assigned	Quiz 7
8-Feb-23	Multivariate Part 2	W	Summaries of more than two variables		Quiz 8
13-Feb-23	Multivariate Part 3	M	Visualizations of multiple variables	Pset 4 assigned	Quiz 9
15-Feb-23	Multivariate Review	W			
20-Feb-23	Regression Part 1	M	The concept of a linear regression	Pset 5 assigned	Quiz 10
22-Feb-23	Regression Part 2	W	Interpreting a linear regression output and evaluating model performance		Quiz 11
27-Feb-23	Regression Part 3	M	Uncertainty and bootstrapping	Pset 6 assigned	Quiz 12
1-Mar-23	Regression Review	W			
6-Mar-23	Midterm Review	M			
8-Mar-23	**Midterm Exam**	**W**			
13-Mar-23	BREAK	M			
15-Mar-23	BREAK	W			
20-Mar-23	Classification Part 1	M	The concept of a logistic regression	Pset 7 assigned	Quiz 13
22-Mar-23	Classification Part 2	W	Interpreting a logistic regression output and evaluating model performance		Quiz 14
27-Mar-23	Classification Part 3	M	Using models for prediction	Pset 8 assigned	Quiz 15
29-Mar-23	Classification Review	W			
3-Apr-23	Clustering Part 1	M	k-means clustering	Pset 9 assigned	Quiz 16
5-Apr-23	NLP Part 2	W	k-means clustering on text		Quiz 17
10-Apr-23	NLP Part 3	M	Sentiment analysis	Pset 10 assigned	Quiz 18
12-Apr-23	NLP Review	W			
17-Apr-23	Advanced Topics in DS	M	Random forests, neural networks, image as data		Quiz 19
19-Apr-23	Ethics	W	The risks of rapid technological change		Quiz 20
24-Apr-23	Final Review	M			
26-Apr-23	**Final Exam**	**W**			

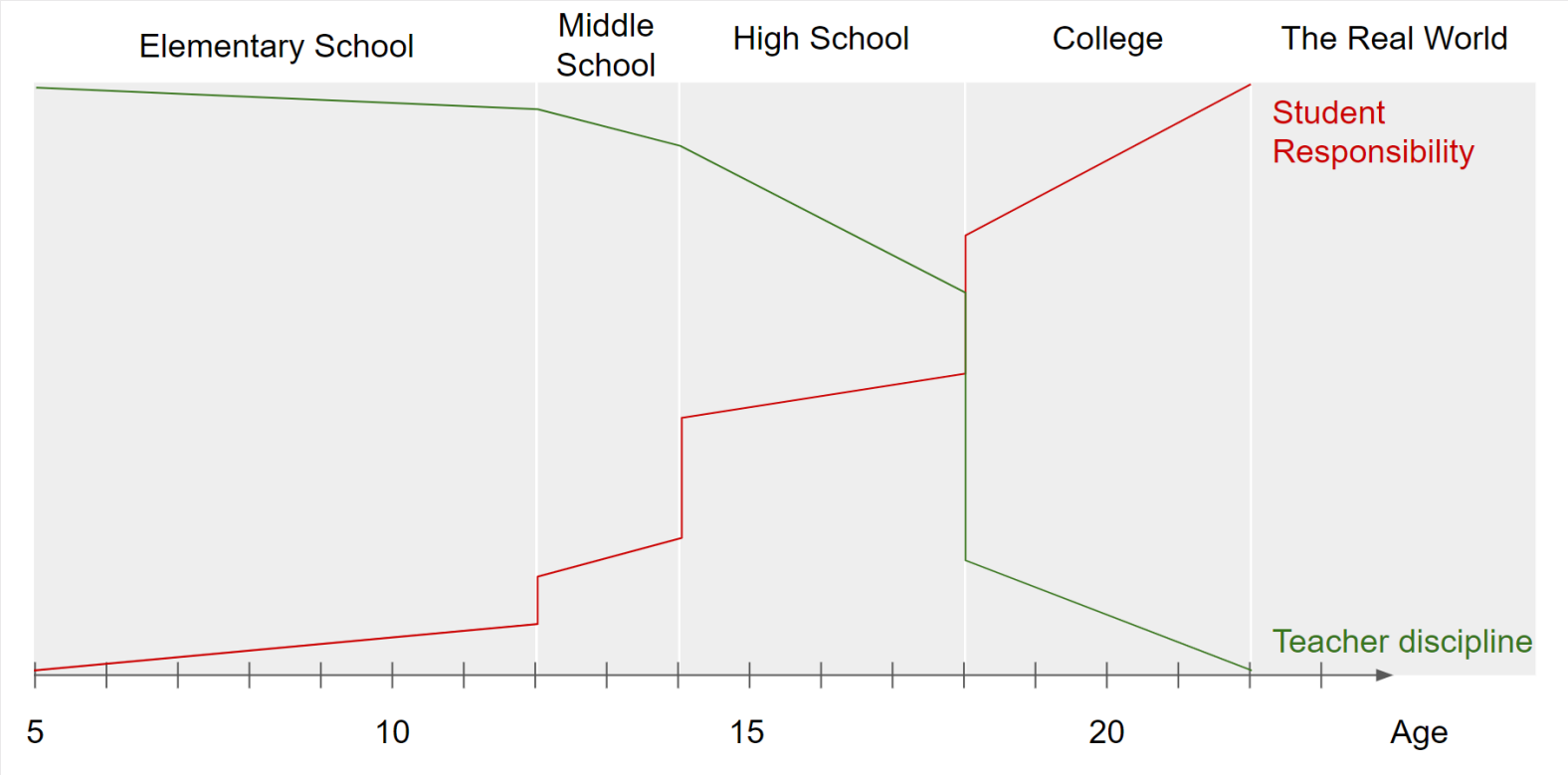
Honor Code

- 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 (place for **hands-on help**)
- Office hours (place for **hands-on help**)

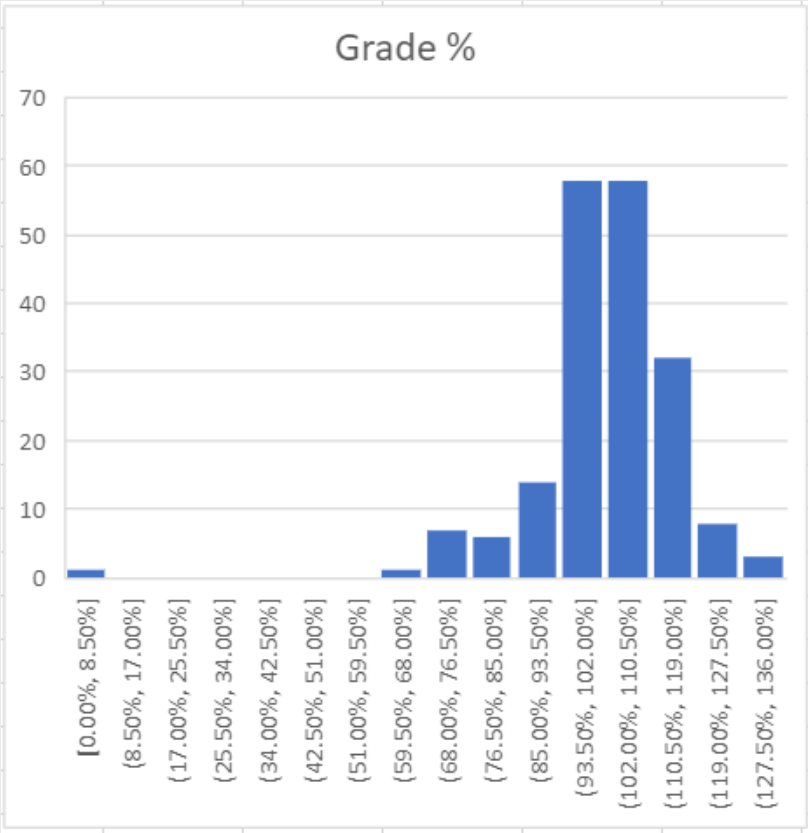
Teaching Philosophy

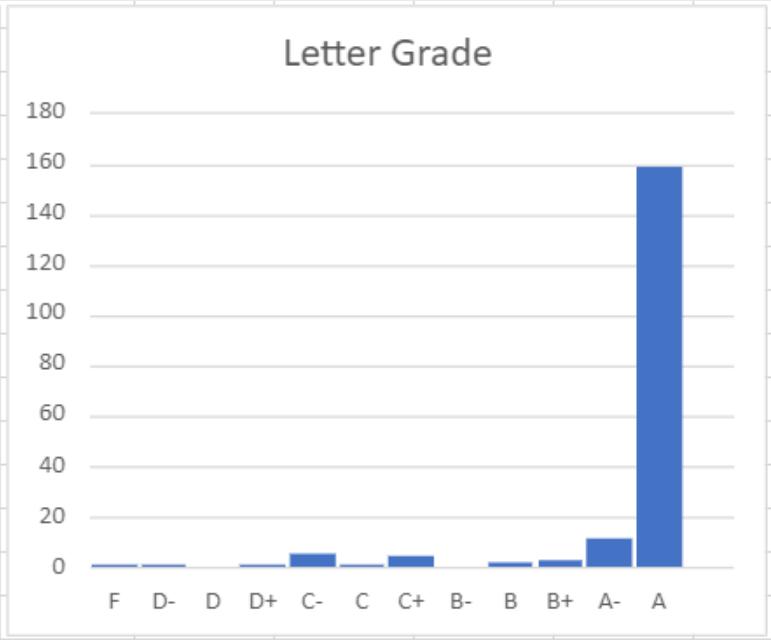


Teaching Philosophy

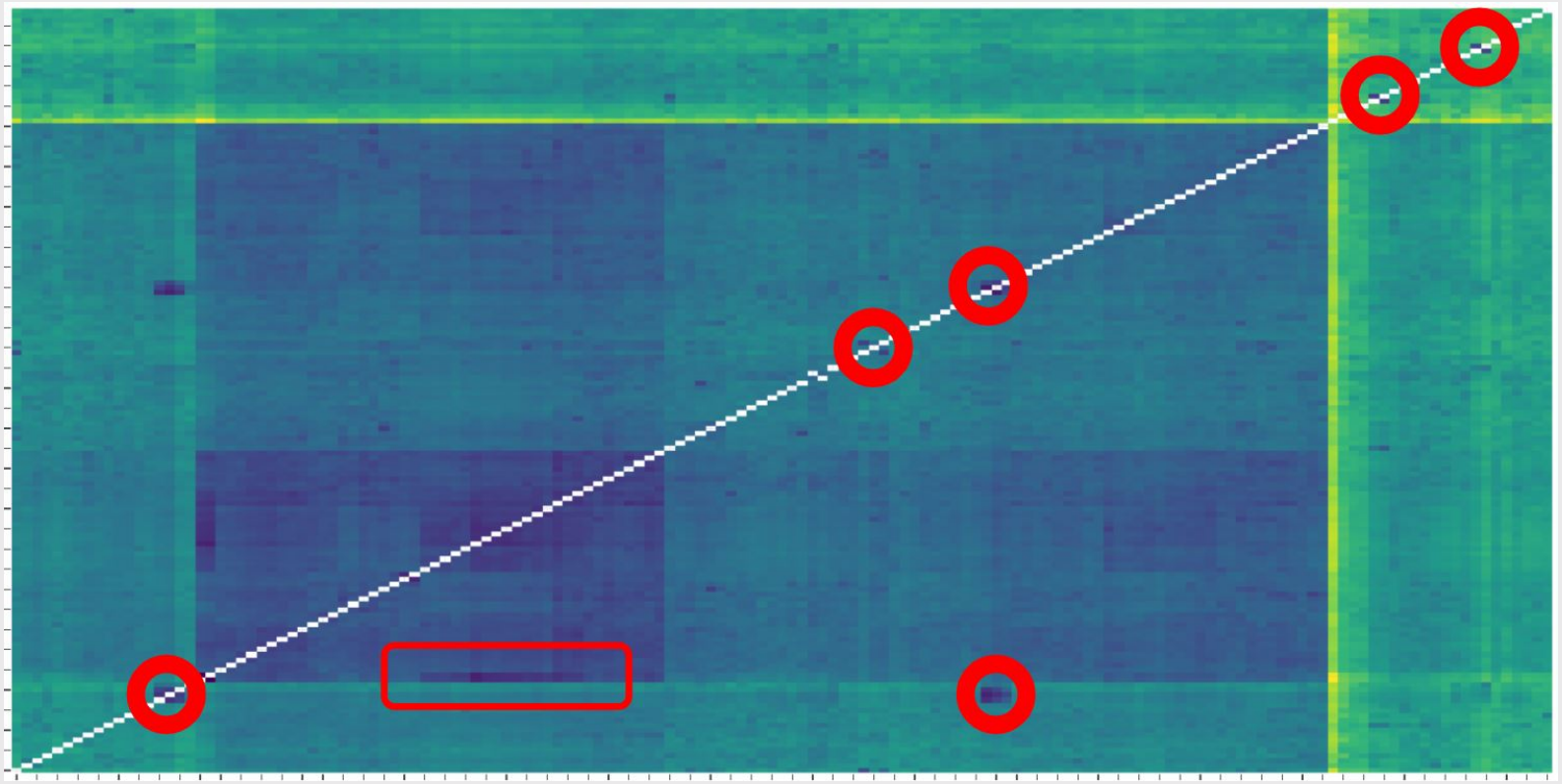
- This course is **inherently** hard
  - Learning `R` is challenging
- But the goal is to **encourage** you to pursue data science
- As such, the **nature** of the material is at odds with the **goal** of the class
- My solution: grade leniently
  - `+` lots of extra credit

Previous Semester





Previous Semester



Conclusion

- Go to Brightspace and take the **1st** quiz
  - The password to take the quiz is 3326
- Homework:
  1. Work through Intro_Data_Science_hw.Rmd
  2. Complete Problem Set 0 (on Brightspace)