USING MOTION DETECTION TO MEASURE SOCIAL POLARIZATION IN THE U.S. HOUSE OF REPRESENTATIVES

Bryce J. Dietrich, 2020, Political Analysis
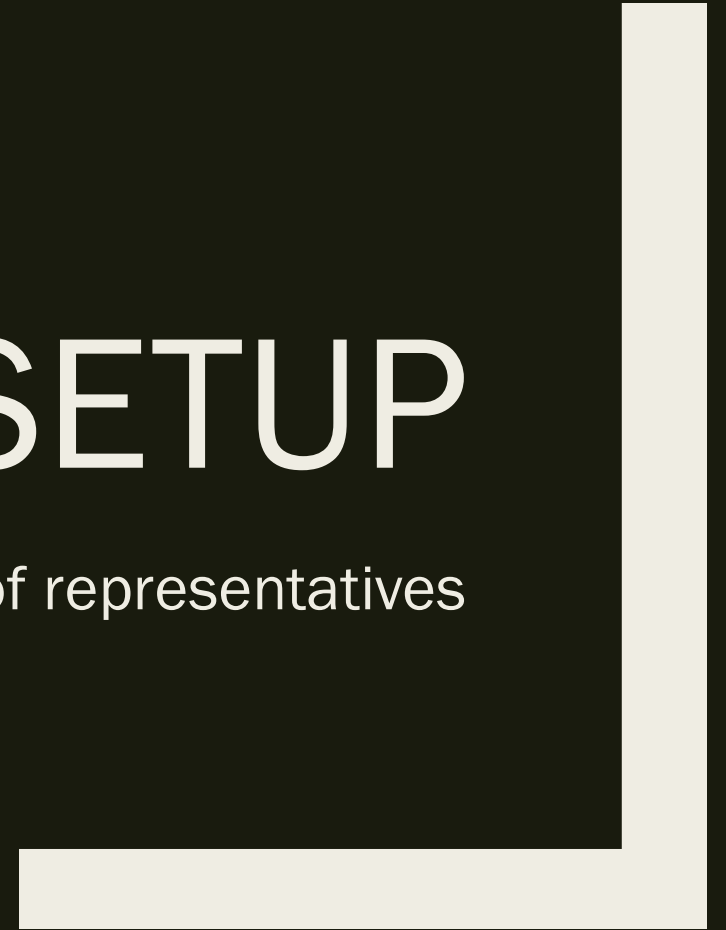
Marco Weder, Pierre Pang, Saimaneesh Yeturu

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INTRODUCTION & SETUP

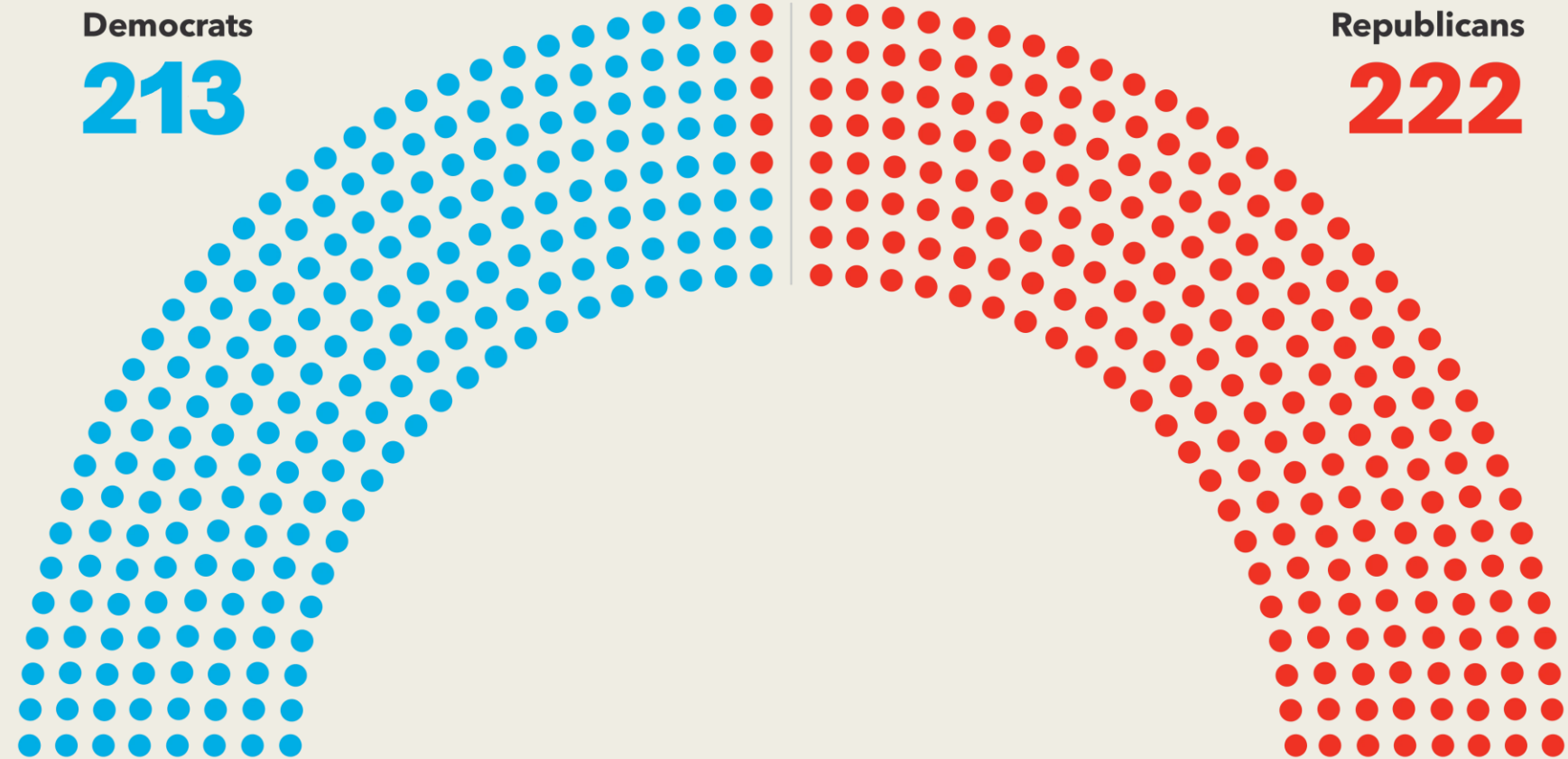US Political system + House of representatives

Setup: USA

- Two parties: Republican (right) vs Democrats (left)

- House of Representatives

'Enlarge the House of Representatives'. *American Academy of Arts & Sciences*, https://www.amacad.org/ourcommonpurpose/recommendation-1-1. Accessed 28 Sept. 2023.

House Balance of Power

Democrats
213

Republicans
222

Bloomberg Government
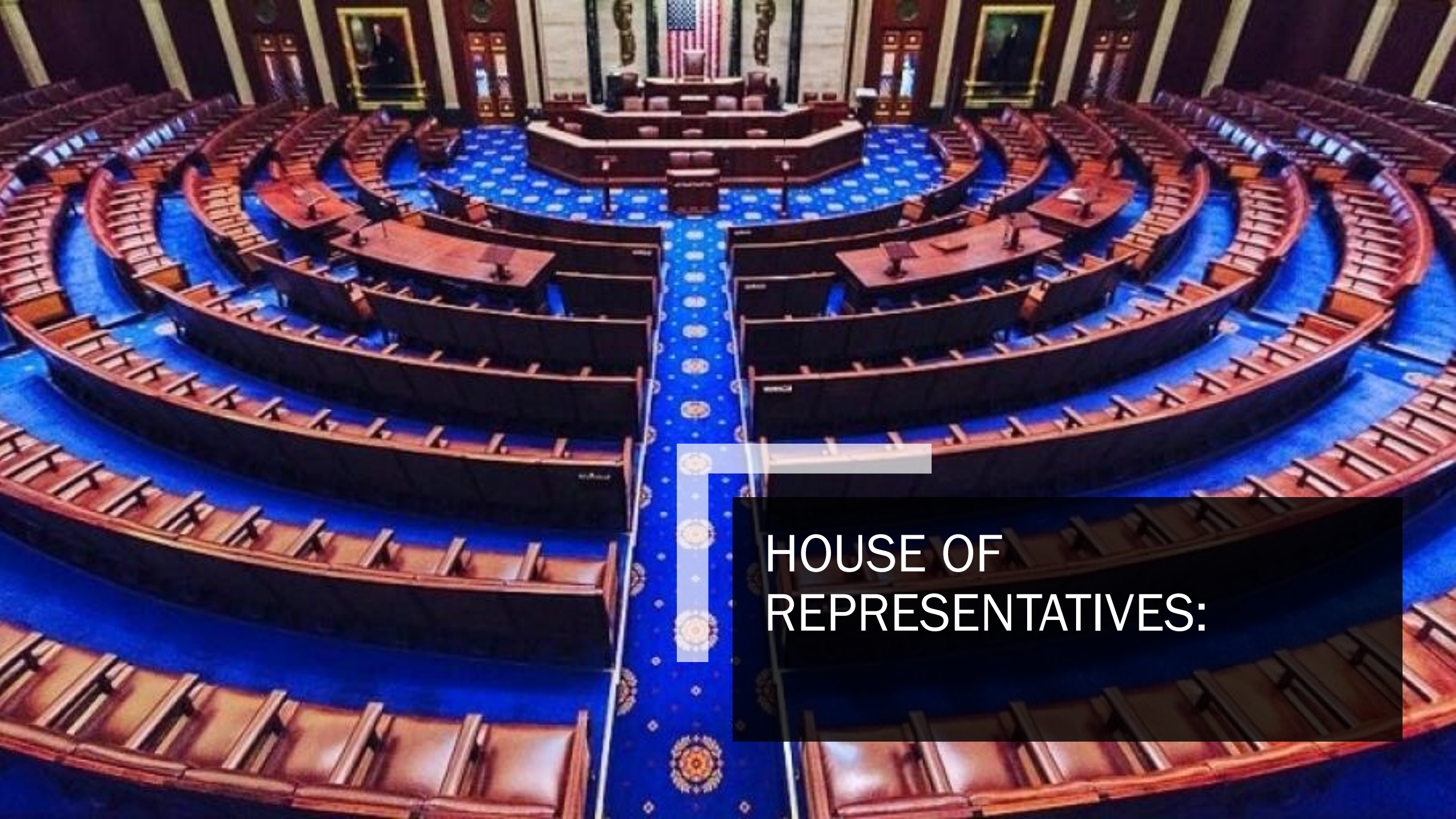
HOUSE OF
REPRESENTATIVES:

Congressional Workspace

- Interaction with people with different political views is often necessary

- Contradiction: People with different political views are physically sorted

- Strong legislative ties lead to **polarization**

    – Lack of progress

- Weak legislative ties lead to **bipartisanship**

    – Exchange of new information

    – Needs cooperation

Simulations
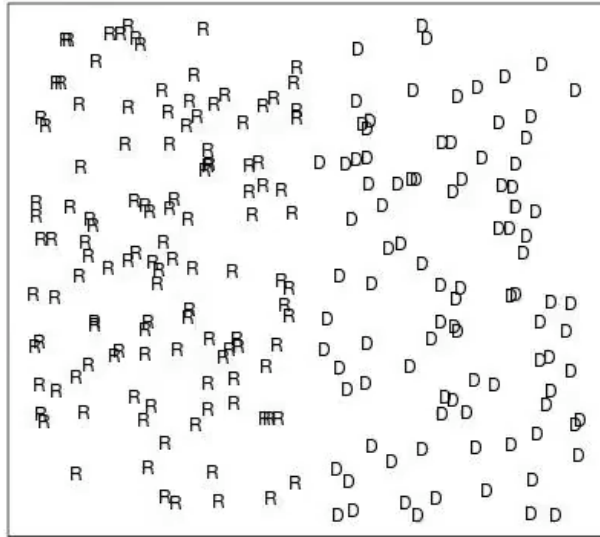
Example of "Polarized" Simulation

Example of 'Polarized' Simulation. Directed by bdietrich, 2019. *YouTube*, https://www.youtube.com/watch?v=kNBmFpqdBkw.
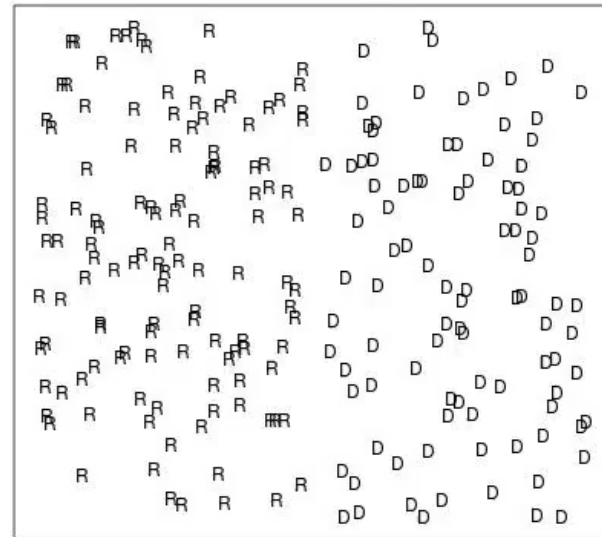
Example of "Bipartisan" Simulation

Example of 'Bipartisan' Simulation. Directed by bdietrich, 2019. *YouTube*, https://www.youtube.com/watch?v=Ot1xerXV9qw.

Useful term

■ **Party-vote:** members of a political party largely vote together, following the ideology of the party rather than individual preferences.

■ A vote in line with the majority of the party, or in opposition to the vote of the majority of the opposing party

Expectations
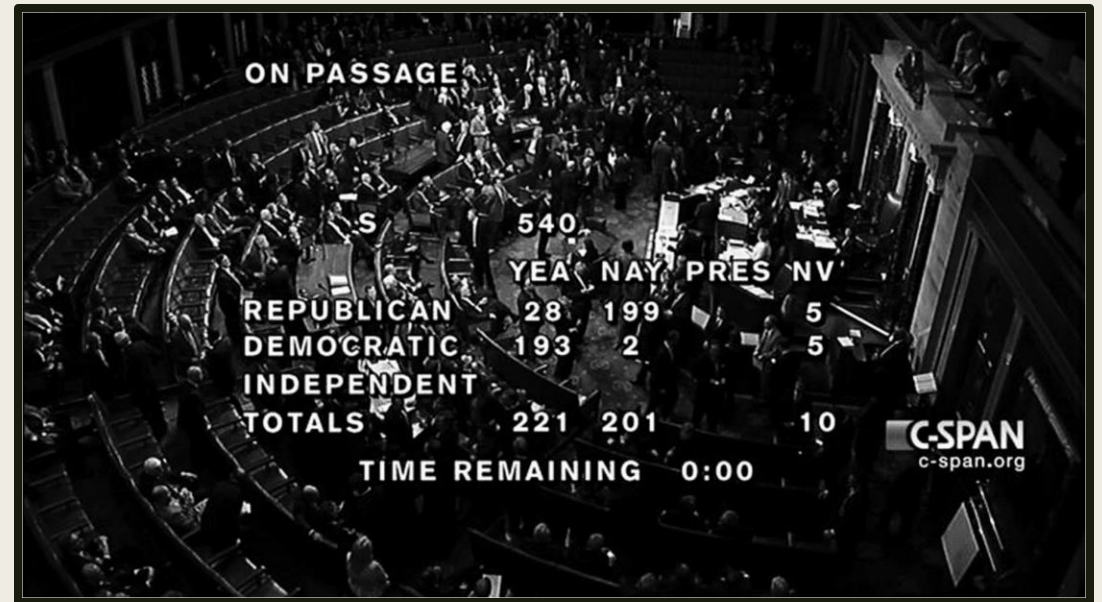
■ "This leads to the following expectation: 'on average, when the videos of social interactions immediately after floor votes display less motion, party votes are more likely to occur later that day'."

Less Motion ▷ Less Interaction ▷ More Polarization ▷ More Party Votes

DATA

6526 videos of Congress

■ C-SPAN: US satellite/cable network

■ Sequence of overhead shots needed

■ 1997-2012

6526 videos of Congress

- C-SPAN: US satellite/cable network

- Sequence of overhead shots needed

- 1997-2012

House Session, Part 2 | September 20, 2023 | C-SPAN.Org. https://www.c-span.org/video/?530564-3/house-session-part-2&start=1826. Accessed 25 Sept. 2023.

ON PASSAGE

		YEA	NAY	PRES	NV
S	540				
REPUBLICAN		28	199		5
DEMOCRATIC		193	2		5
INDEPENDENT					
TOTALS		221	201		10

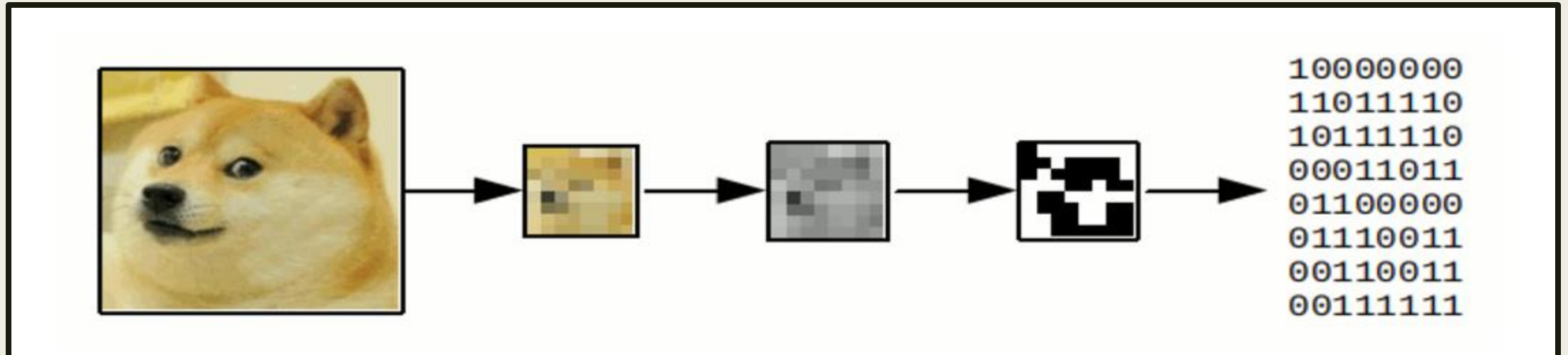TIME REMAINING   0:00

C-SPAN
c-span.org

Data processing

- Out of the data, 17'700 'good' frames were extracted manually by research assistant

- Other frames were compared to 'good frames'
  - Hashing algorithm developed by Zauner ('perceptual hashing', 2010)[1]
  - If a frame shares at least 10 of 16 hexadecimal characters (after hashing) --> it is a good frame

[1]Zauner, Christoph, 'Implementation and Benchmarking of Perceptual Image Hash Functions'. Jul. 2010, pp. 4-5. *phahsh.org (Crossref)*, https://www.phash.org/docs/pubs/thesis_zauner.pdf.

Extraction of clips

1. Converting to greyscale
2. Selecting 5 seed frames manually from 1% of the videos
3. Fingerprinting the frames (perceptual hashing)
4. Comparing each frame with each of the 5 seed frames
5. Selecting "good" frames (>10/16 bitstrings match with a seed frame)

Dietrich, Bryce J. 'Using Motion Detection to Measure Social Polarization in the U.S. House of Representatives'. *Political Analysis*, vol. 29, no. 2, Apr. 2021, pp. 250–59. *DOI.org (Crossref)*, https://doi.org/10.1017/pan.2020.25.

Data processing

- 70'717 clips of ~17 frames were created

- Next step: quantify relative motion in these clips by determining the mean Structural Similarity (SSIM) of each clip

MEASUREMENT

Measuring motion: SSIM

SSIM: Structural Similarity Index (x, y are pixel matrices representing images):

$$SSIM(x, y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)}$$

where μ_x and μ_y are the means of x and y, σ_x and σ_y are the standard deviations of x and y, and σ_{xy} is the cross correleation of x and y.

$SSIM(x, y) \in (0,1)$, where: 0 => **Low** similarity
                                                   1 => **High** similarity

$C_1 = (0.01(\max(x, y) - \min(x, y))^2$
$C_2 = (0.03(\max(x, y) - \min(x, y))^2$

Measuring motion: average SSIM

1	2	3	4

$$SSIM(1,2) \ = \ a \qquad SSIM(2,3) \ = \ b \qquad SSIM(3,4) \ = \ c$$

where $a, b, c \ \in [0,1]$.

We take the average $\mu = \frac{a+b+c}{3}$.

=> μ closer to 1 => more similarity => less motion

=> μ closer to 0 => less similarity => more motion

Measuring the amount of *relative* motion

- Calculate mean μ_{all} SSIM of all clips

- Scale to $\pm\frac{1}{2}\sigma_{all}$ above and below mean

- $1 \Rightarrow \mu_{all} + \frac{1}{2}\sigma_{all}$, i.e *less* motion than on average

- $0 = \, >$ average amount of motion

- $-1 \Rightarrow \mu_{all} - \frac{1}{2}\sigma_{all}$, i.e *more* motion than on average

RESULTS

Useful term

- **DW-NOMINATE score:** measure, that describes the political ideology of a political actor (here: member of the chamber)
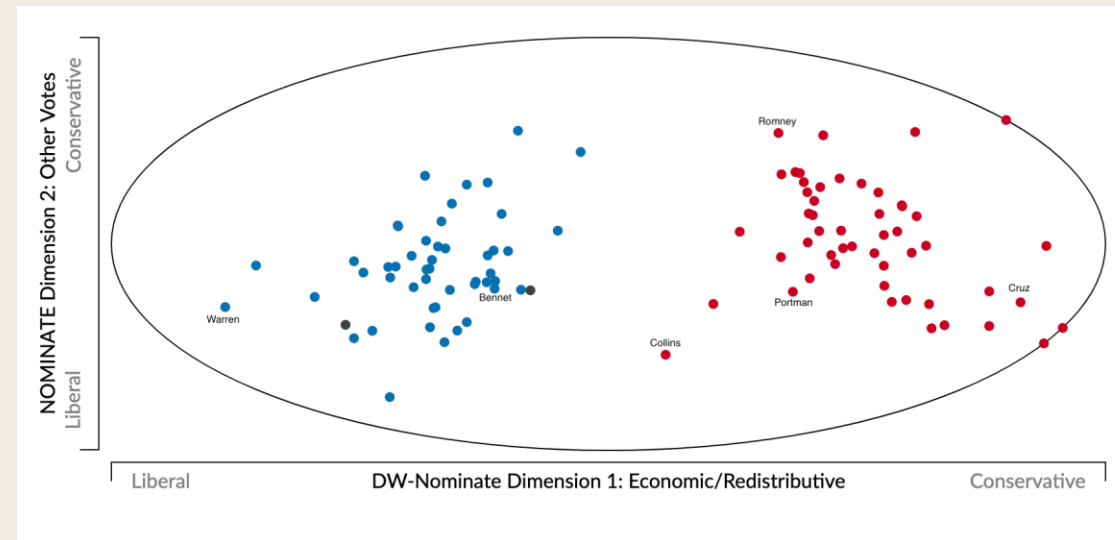
Toner-Rodgers, Aidan. *Chapter 2 Methodology | The Shape of Polarization: A Topological Data Analysis of Congressional Voting Patterns. bookdown.org,* https://bookdown.org/atonerro/topology-polarization/methodology.html. Accessed 27 Sept. 2023.

- – Paper: 1 Dimension ranging from –1 (very liberal) to 1 (very conservative)

Correlation between average SSIM and Congress polarization

- SSIM is scaled
  - *Positive*: more similarity = less motion
  - Zero: average similarity
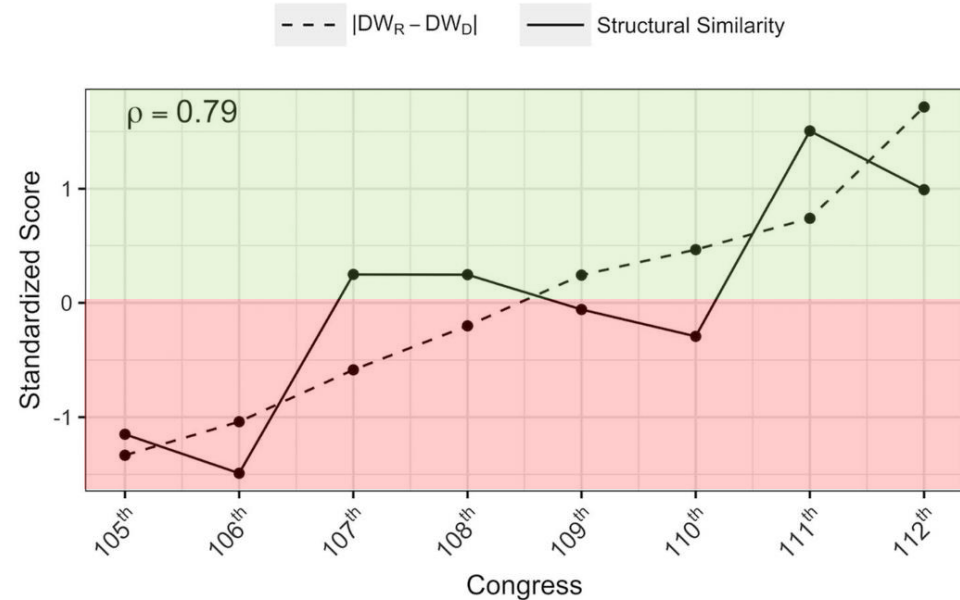 - Negative: less similarity = more motion

Figure 3. Plot of the average structural similarity for the 105th–112th Congress. Positive values imply the frames are more similar to one another implying there is *less* motion. The correlation between video motion and the absolute difference in Democratic and Republican DW-NOMINATE scores is reported in the top left. Both variables were standardized to standard deviations above/below the mean

SSIM is positive...

β: regression coefficient

SE_β: standard error

CI: confidence interval

Explanation:

Scaled SSIM of a video clip increases by $\frac{1}{2}\sigma$ =>

Party vote percentage increases by 7.3 percentage points

Regression table

Table 1. When MC's cross the aisle, future party votes are less likely to occur.

| Variable | $\frac{\#party\ votes}{\#remaining\ votes} =$ Dependent variable Future party votes | | | | | |
| | (1) | | | (2) | | |
	$\hat{\beta}$	$SE_{\hat{\beta}}$	95% CI	$\hat{\beta}$	$SE_{\hat{\beta}}$	95% CI
Constant	0.199	0.055	[0.092, 0.307]	−0.521	0.143	[−0.802, −0.240]
Structural similarity	0.073	0.025	[0.025, 0.121]	0.054	0.020	[0.014, 0.094]
Previous party votes				0.492	0.093	[0.310, 0.675]
Passage vote				0.008	0.048	[−0.087, 0.103]
Amendment vote				0.489	0.060	[0.371, 0.607]
Total not voting				−0.020	0.003	[−0.026, −0.015]
|Sponsor ideology|				0.296	0.164	[−0.026, 0.617]
Sponsor seniority				−0.009	0.006	[−0.021, 0.002]
Sponsor party leader				−0.123	0.159	[−0.436, 0.189]
Election year				1.159	0.097	[0.968, 1.349]
N	3,605			3,605		
Log likelihood	−3,560.853			−3,178.87		
AIC	7,141.707			6,393.740		

and statistically significant!

$$p < 0.001$$

where p denotes the "p-value", i.e. the probability of obtaining current results if we assume the null hypothesis to be true.

Less motion => More party vote
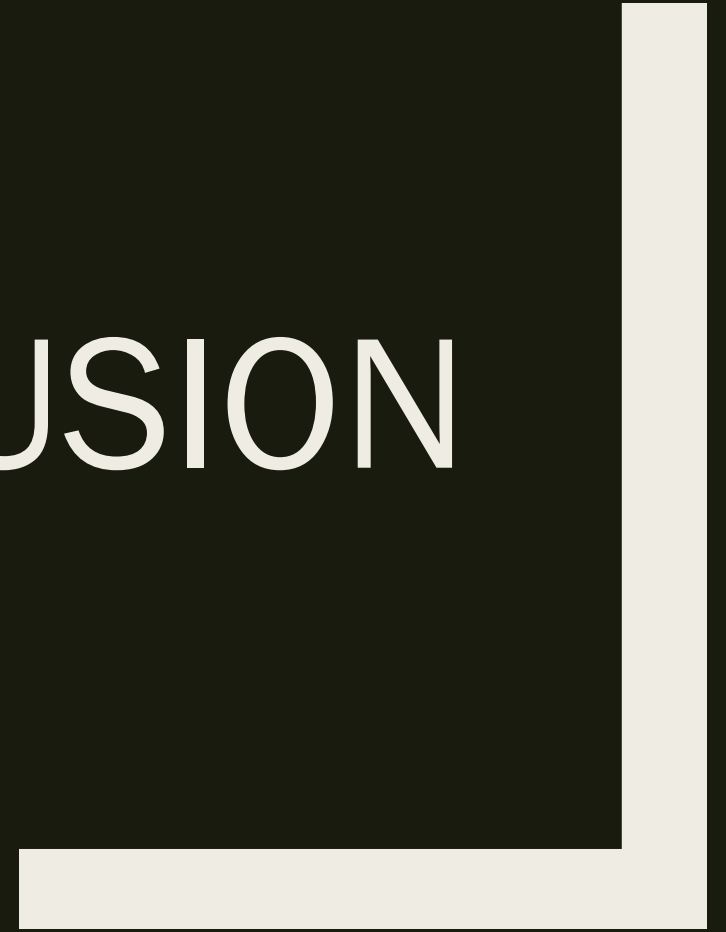
If we have time…

Code example of frame differencing to detect motion using openCV!