Political Polarization in Legislative Branches

Presenter: Boleslaw Szymanski
Xiaoyan Lu, Jianxi Gao

NeST Center & SCNARC
Department of Computer Science
Department of Physics, Applied Physics and Astronomy
Rensselaer Polytechnic Institute, Troy, NY 12180
Introduction

➢ Research objective: How does the social and political polarization evolve over time?
➢ Data-driven analysis:
  ○ We collect congress/parliament voting data of the countries including **Sweden** (2.4M votes), **UK** (3M votes) and **USA** (3.5M votes)
➢ Quantifying the social choices of competition and collaboration by mathematical models.
Partisan Alignment of Members of the U.S. Congress (2015)

Partisan alignment measured by the distance between parties’ centroids:

$$A_{i,p} = \mathbb{E}_b |\mathbb{E}_i [V_i^{(b)} \delta_{i,p}] - V_i^{(b)}|$$

$V_i^{(b)}$ is member $i$’s vote on a bill $b$ among the year 2015’s bills.

- Relative measure: if one party deviates, then both should move to the poles, but not exactly symmetrically because of the non-uniform population distribution.
- Members’ loyalty to the party does NOT always lead to polarization. Parties could align with each other on certain bills themselves.
- Mapping $(A_{i,dem}, A_{i,rep})$ to the diagonal, which is equivalent to PCA reducing the dimensions from two to one.
Evolution of the Average Partisan Polarization

1900-2018 Monthly

- 1960 Kennedy defeating Nixon
- 1962 Cuban missile crisis
- 1963 "I Have a Dream"
- 1980 Reagan defeating Carter
- 1993-2001 Clinton presidency
- 2001-2009 G. W. Bush presidency
- 2009-2017 Obama presidency

Political Polarization Workshop, Princeton University, August 9, 2019
Evolution of the Average Partisan Polarization

Polarization increases as a general trend, but it decreases within each congress in the 70s and 80s.
Evolution within Each Congress (2 years term)

Period I (1969-1989) Polarization decreases

Period III (2001-2017) Polarization increases (seasonal plot)

Political Polarization Workshop, Princeton University, August 9. 2019
We analyze millions of roll-call votes cast in the U.S. Congress over the past six decades to identify evolution of political polarization patterns.

Using the roll-call vote results, we quantify the level of polarization in the legislative branch of government over the last six decades.
The political polarization levels at ten evenly-distributed sampled time points exhibit an evolution of polarization patterns from one type of behavior to another.
Dynamic Social Competition Model[1]

\[ x \in [0, 1] \] measures the current polarization, so the collaboration is measured by the complementary fraction of \( x \), i.e.

\[ y = 1 - x \]

**increased competition**  \[ \frac{dx}{dt} = yP_{yx}(x, u_x) - xP_{xy}(x, u_x) \]

**lost competition**

simple symmetric transition functions:

\[ P_{yx}(x, u_x) = P_{xy}(1 - x, 1 - u_x) \]

\[ = c \cdot x^a \cdot u_x \]

**Evolution speed**  \[ \times \]  **Impact of population belief on the change of polarization**  \[ \times \]  **Perceived utility of competition**, (the benefit fighting against the other party on certain bills)

We assume a social system dominated by two parties. In such a system polarization and collaboration can convert into each other but they maintain their sum constant at 1.

\[
\frac{dx}{dt} = yP_{yx}(x, u_x) - xP_{xy}(x, u_x)
\]
Dynamical Model for Polarization Evolution

Stable system:

Unstable system:
When the initial polarization level (green cycles) is smaller than the stable polarization level predicted by our model (solid black curve), we observe an increase of polarization within one Congress. The direction of such change in 28 out of all 30 Congresses are explained by the model (green arrows).
6 of 14 Presidential election Congresses started with the polarization utilities at least 0.5 while only 1 of 15 midterm election Congresses achieved such high polarization utility.

The highest polarization utility growth (57.1%) occurs in the 112th Congress (2011-2013).

Super PACs arose following the July 2010 federal court decision.
Structural Change of Competition among States

The pairwise disagreements are at similar level while the structure of competition changes significantly. The order of states is ranked by their one-dimensional PCA projection.

Social Flocks Model (Extended Boids Model)

The three rules of social flocks movement in latent space $Z$:

1. **Separation**: steer to the opposite direction of competitors
2. **Cohesion**: steer to move toward the average position of local flockmates
3. **Gravity**: steer towards the most neural position (origin)

The Euclidean distance matrix $A_{ij}$ follows Gaussian with mean $|Z_i - Z_j|$
Competition Structure Matters

The network structure of competitors impacts the final polarization level. We simulate the evolution of polarization using a competition graph generated by planted partition model with intra-group edge probability $q$ and inter-group edge probability $p$.

$q = 0.2, p = 0.7$
$q = 0.8, p = 0.3$
Contributions

Theory: We define a dynamical model quantifying the evolution of polarization in the U.S. Congresses elected in the past six decades.
The hidden model parameter, polarization utility, correlates well with significant political or legislative changes happening at the same time.

Algorithm: We implemented a predictor based on the model that successfully predicts the direction of polarization changes in 28 out of 30 elected U.S. Congresses.
The hidden model parameter, polarization utility, correlates well with significant political or legislative changes happening at the same time.
Thanks

Questions?

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Reference: