Inferring Latent Influence Diffusion Networks in The United States Senate

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Influence In The U.S. Congress

Figure: John McCain [R] and Charles Schumer [D].
Legislative Influence

- Want to measure the influence of legislators on each other.
- Use temporal patterns in bill cosponsorship as evidence.
The Data – Bill Cosponsorship Times

Example Bill: S.2715, emergency unempl. benefits for 9/11 victims

Sponsor
- Clinton – 7/9/02

Cosponsors
- Kennedy – 7/9/02
- Schumer – 7/9/02
- Corzine – 7/15/02
- Kerry – 7/15/02
- Durbin – 7/17/02
- Torricelli – 8/1/02
Want To Infer: Influence Relationships

- Sponsor: 7/9/2002
- Kennedy: 7/9/2002
- Corzine: 7/15/2002
- Schumer: 7/17/2002
- Durbin: 8/1/2002
- Kerry
- Clinton
- Torricelli

Liberal
Inferring Influence
Inference Strategy

- Assume cosponsorship patterns arise from underlying cascade of influence.

- Aggregate over many bills to infer underlying influence network.

Traces of Influence

Bill Cosponsorship Delay

Temporal Cascades

[Bills and Time Diagram]

[A, B, C, D, E, F]

[A, B, D]

[A, B, C, E, F]

[A, B, C, E, F]

[A, B, C, E, F]
Diffusion Model

- Want to infer best network to explain observed cascades.

\[ P(\Delta) \propto e^{-\frac{\Delta}{\alpha}} \]  \hspace{1cm} (1)

- \( \Delta \) – time difference between action for two nodes.
- \( \alpha \) – inverse average time diff. between a node and its potential parents
How Many Edges to Include in Network?
Model Selection
Cross Validation

Strategy

- Predict when Senators will cosponsor in held-out sample.
- Fit event history models for model selection.
- Optimization over # edges and hyper-parameter (10 80/20 splits)
- Grid Search!
Rare Events Logistic Regression

Use Model Log Likelihood For Selection.
Cross Validation Results

1981-1982

1983-1984

1985-1986

1987-1988

1989-1990

1991-1992

1993-1994

1995-1996

1997-1998

1999-2000

2001-2002

2003-2004
### Large Variation in Optimal Network Size

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<tr>
<th>Session</th>
<th>Edges</th>
<th>Alpha</th>
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<td>81-82</td>
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<td>83-84</td>
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</table>

![Graph showing edge likelihood against cosponsorship time difference](image-url)
Influence Networks
Influence Networks: 1981-2004
Example Influence Network 2001-2002

- Clinton
- Collins
- Daschle
- Grassley
- Hutchinson
- Johnson
- Kennedy
- Kerry

Diagram showing relationships and influence among the mentioned senators.
Applications
Predicting Bill Advance Using Author Influence

- **Author Influence**
  - Probability of bill passing out of committee
  - Graph showing relationship between Author Influence and probability of a bill passing out of committee.

- **Sponsor Connectedness**
  - Probability of bill passing out of committee
  - Graph showing relationship between Sponsor Connectedness and probability of a bill passing out of committee.
Tenure (Sessions of Congress) and Influence

The scatter plot illustrates the relationship between tenure (sessions of Congress) and influence. Each point represents an individual's tenure and influence score. The data shows a general trend where influence increases with tenure, albeit with some variability. The red line indicates a positive correlation between the two variables.
Co-Cosponsorship Betweenness and Influence

![Graph showing the relationship between Betweenness and Influence]
Research Agenda

- Provide influence score/network dataset
- $\Delta$ structure of info. net. over time
- Temporal disaggregation

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Ideology and Influence

Influence

Ideology

-100
0
100
200
300
400
−0.4 0.0 0.4
Density of Bill Author Influence 2001-2002

Density of aggregate bill author dominance for 107th Senate
N = 3181   Bandwidth = 9.579