Measuring Issue-Specific Preferences from Votes

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Motivation

Two challenges:

- How can we measure issue-specific ideal points?
  - ▷ Either use a subset of roll-call votes *or*;
  - ▷ Meta-data such as the text of the bills (Gerrish & Blei 2012)
- How can we interpret latent dimensions which jointly define a multidimensional policy space?
  - ▷ "Lost in translation": the two-dimensions of *nominate* have been translated into a number of different ways (Bensel 2016)

I propose a new model which . . .

- arises from classic ideal point estimation and spatial voting theory
- estimates issue-specific hyperplane and ideal points

Setup

Data:

- roll-call votes $\{y_{ij}\}_{i=1,j=1}^{n,m}$ (source: `voteview`)
  - ▷ $y_{ij} = 1$ if legislator i votes Yea on roll-call j, and 0 o.w.
- issue label of bills $\{z_j\}_{j=1}^{m}$ (source: American Institutions Project)
  - ▷ $z_j \in \{1, \ldots, k\}$ for each roll-call j

Issue-Specific Ideal Points Model

Data Generating Process:

$$\mathbf{u}_j \sim \mathbf{vMF}(\boldsymbol{\theta}_{z_j}, \rho) \tag{1}$$

$$\Pr(y_{ij} = 1) = \Phi(w_j \mathbf{u}_j^\top \mathbf{x}_i - \alpha_j) \tag{2}$$

where $\mathbf{vMF}(\cdot)$ denotes von Mises-Fisher distribution and . . .

- $\boldsymbol{\theta}_z$: *direction* vector of issue-specific hyperplane ($||\boldsymbol{\theta}_z|| = 1$)
- $\mathbf{u}_j$: *direction* vector of the jth hyperplane ($||\mathbf{u}_j|| = 1$)
  - ▷ orthogonal to *cutting line* in nominate (Poole & Rosenthal 1997)
- w_j *magnitude* of the jth hyperplane ($w_j > 0$)
  - ▷ $w_j\mathbf{u}_j = \beta_j$, discrimination parameter (Clinton et al. 2004)
- $\mathbf{x}_i$: multidimensional ideal point
- α_j: difficulty parameter

Identification:

- Fix directionality of $\mathbf{u}_j$ to avoid reflection invariance
  - ▷ Code the voting data so that $y_{ij} = 1$ indicates a conservative vote
  - ▷ Can implement this by anchoring a conservative legislator's votes

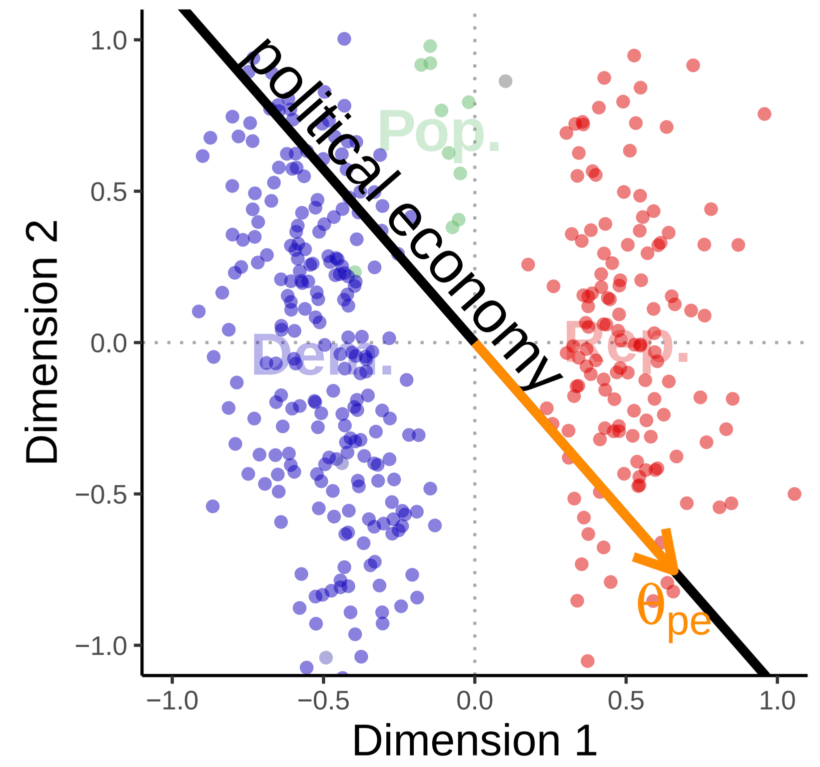
Issue-specific ideal points estimator:

$$\hat{x}^*_i(z) := \frac{\hat{\boldsymbol{\theta}}_z^\top \hat{\mathbf{x}}_i}{\hat{\boldsymbol{\theta}}_z^\top \hat{\boldsymbol{\theta}}_z} \tag{3}$$

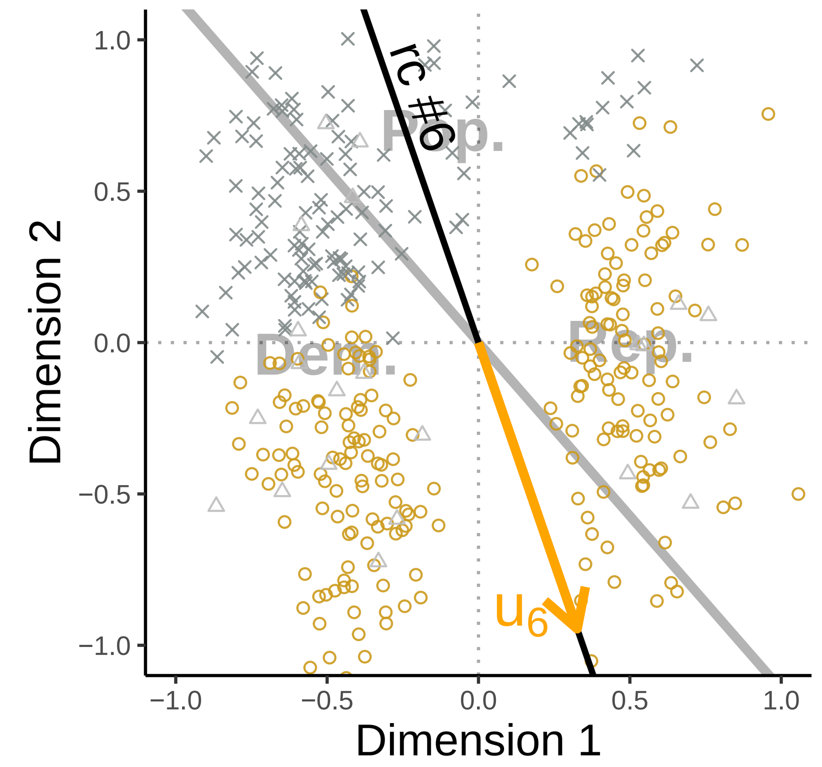
1. Estimate the issue-specific hyperplane $\boldsymbol{\theta}_z$
2. Project the ideal points onto the hyperplane

Application: U.S. Congress during the Gilded Age

Understanding the model based on spatial voting theory:



The 53rd H.R. (1893–1895)



Votes on Bland Amendment

$$\Pr(y_{ij} = 1) = p(U_i(\mathbf{o}_{yj}) > U_i(\mathbf{o}_{nj})) \tag{4}$$

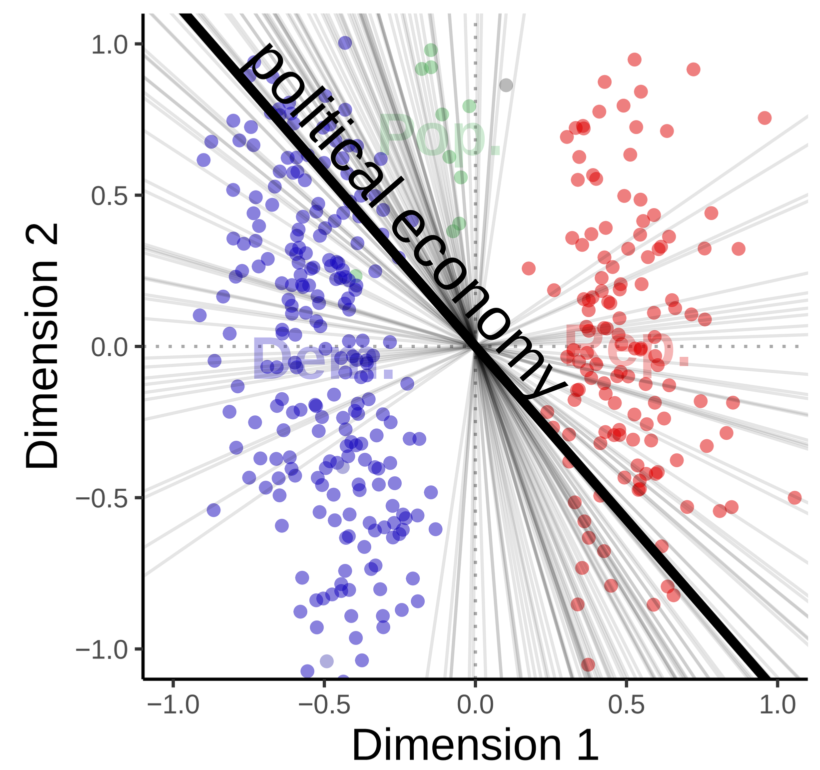
$$= p(-||\mathbf{x}_i - \mathbf{o}_{yj}||^2 + \epsilon_{yij} > -||\mathbf{x}_i - \mathbf{o}_{nj}||^2 + \epsilon_{nij}) \tag{5}$$

$$= p(2(\mathbf{o}_{yj} - \mathbf{o}_{nj})^\top \mathbf{x}_i - (\mathbf{o}_{yj}^\top \mathbf{o}_{yj} - \mathbf{o}_{nj}^\top \mathbf{o}_{nj}) > \epsilon_{nij} - \epsilon_{yij}) \tag{6}$$

$$= \Phi(w_j \mathbf{u}_j^\top \mathbf{x}_i - \alpha_j) \tag{7}$$

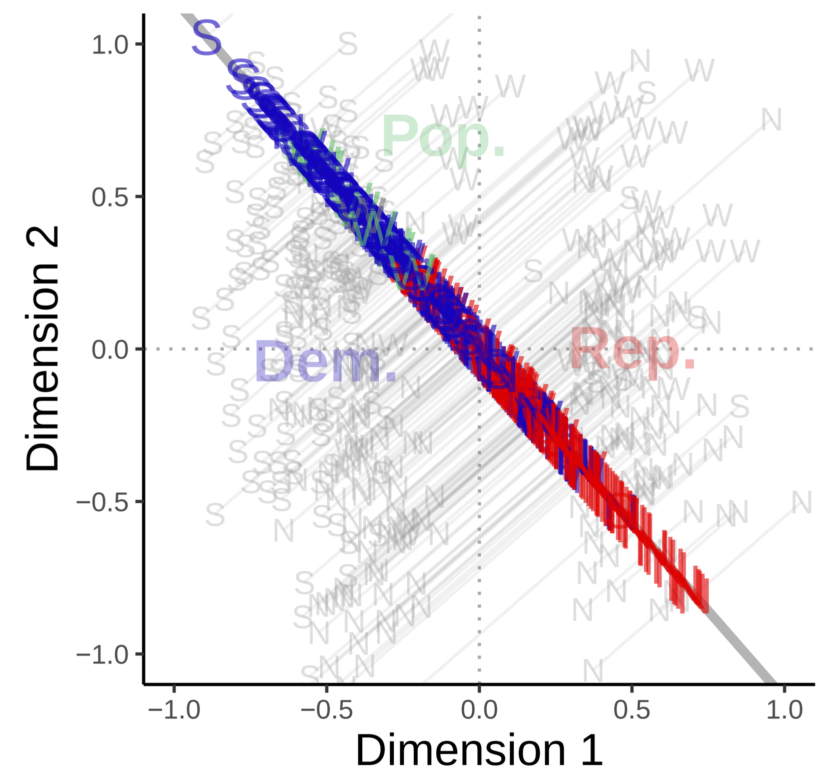
Two-step estimation:

1. Estimate the issue hyperplane



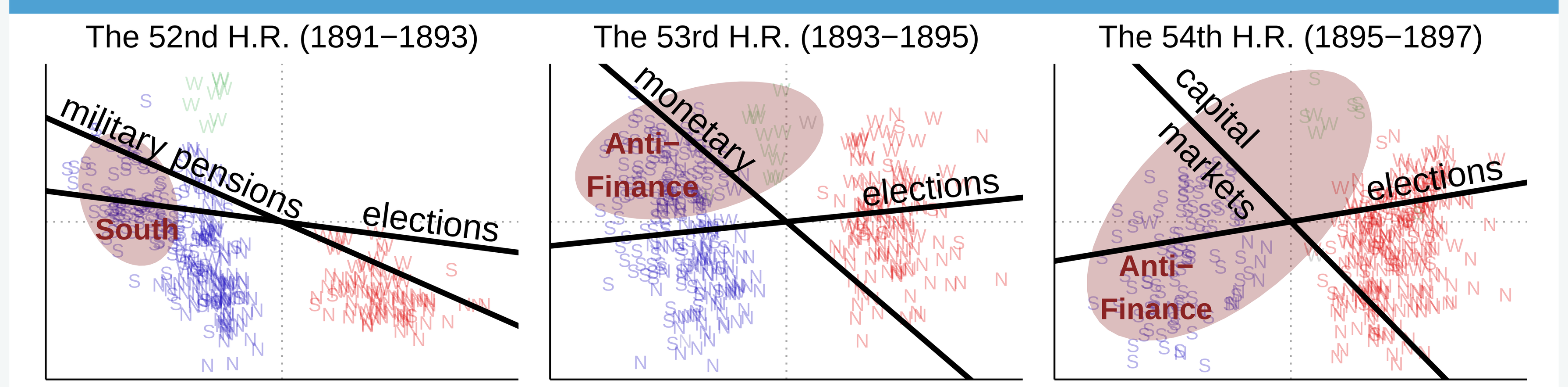
*Gray lines: u_j's such that $z_j = $ pe

2. Project the ideal points



*Labels: State (South/ North/ West)

Main Findings: Partisan v. Sectional v. Sectoral Alignments



- "Southern Nation": unity among Southern Dem. (Bateman et al. 2018)
- Division over gold: farmers/miners v. int'l fin./commerce (Frieden 2015)

Properties of Issue-Specific Ideal Points

Issue-specific voting behavior

$$y^*_{ij} := w_j \boldsymbol{\theta}_{z_j}^\top x^*_i(z_j)\boldsymbol{\theta}_{z_j} - \alpha_j \tag{8}$$

$$= w_j \boldsymbol{\theta}_{z_j}^\top \mathbf{x}_i - \alpha_j \tag{9}$$

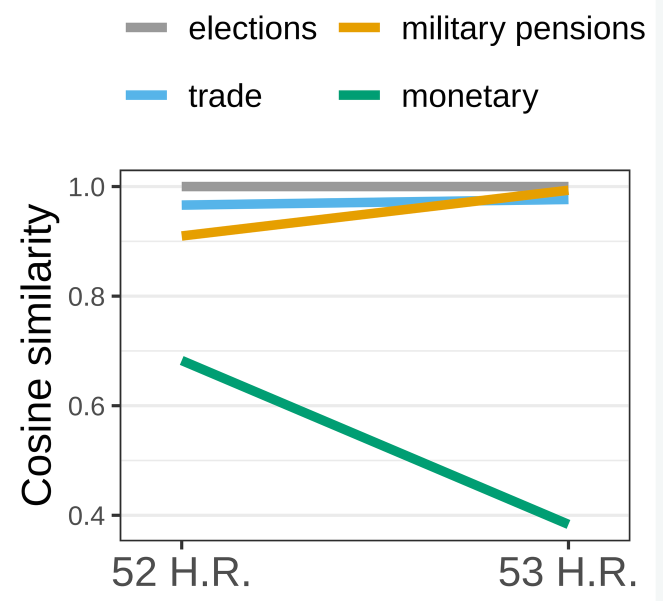
$$= \mathbb{E}_{\mathbf{u}_j}[\mathbf{1}\{y_{ij} = 1\} | \boldsymbol{\theta}_{z_j}, w_j, \mathbf{x}_i, \alpha_j] \tag{10}$$

- A nice summary of issue-specific voting behavior w.r.t. (1) stochastic noise of the utility and (2) deviation of the jth roll call's hyperplane($\mathbf{u}_j$) from the issue-specific hyperplane($\boldsymbol{\theta}_z$).

Comparing issue hyperplanes

$$|cos(\boldsymbol{\theta}_{\text{Issue A}}, \boldsymbol{\theta}_{\text{Issue B}})| \tag{11}$$

- A measure of "constraint": the degree to which policy attitudes on issue A are aligned with those on issue B (Marble & Tyler 2021)
- Related measure: mean `item2vec` alignment (Sohn 2017)



Identified under rotations

$$\frac{\boldsymbol{\theta}_z^\top \mathbf{x}_i}{\boldsymbol{\theta}_z^\top \boldsymbol{\theta}_z} = \frac{(R\boldsymbol{\theta}_z)^\top R\mathbf{x}_i}{(R\boldsymbol{\theta}_z)^\top R\boldsymbol{\theta}_z} \text{ for } R^\top R = \mathbb{I} \tag{12}$$

- Rotational invariance of the likelihood does not threat the identification.

Concluding Remarks: Issue and Dimension

The notion of *dimension* and its limitation:

- "The 'spaces' of interest are ultimately metaphors and both the dimensions spanning these spaces and agents' positions on these dimensions are fundamentally unobservable (Benoit & Laver 2012, p.196)"
- "[F]rom a technical point of view, choosing the dimensionality of the policy space is essentially a model selection problem (Moser et al. 2021, p.146)"
- Multidimensional ideal points models are only identifiable with ad hoc conditions due to the rotational invariance

By incorporating *issue* labels in the model,

- The proposed method suggests a way to construct linear combinations of low dimensional latent traits, which explain the voting behavior for each substantive issue;
- And further provides a principled way to (1) interpret the latent dimensions using issue hyperplanes and (2) compare the alignments of different issues.

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