`ggparliament:`

Simple Parliament Plots in `R`

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Abstract

I introduce a new `R` package to visualize election results and roll call data using "parliament plots", which allow users to visualize legislatures in a variety of architectural styles. The `R` package is written as a `ggplot2` extension and uses a syntax familiar to many political scientists. I demonstrate the effectiveness of visualizing legislatures in clarifying descriptive data in political science. Word count: 3,245

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Introduction

In this article, I introduce a new data visualization tool for plotting legislatures in R. This R package, ggparliament, allows for easy visualization of legislatures, including district-level descriptive data, information on legislators, and election results; in addition, it visualizes the structure and design of political institutions (Hickman, Meers, and Leeper 2017). ggparliament is a ggplot2 (Wickham et al. 2018) extension that takes aggregate election returns, expands the length the data frame to the total number of seats in the legislature, and plots the parliament according to a specified layout. Such graphs are known as parliament plots.

Visualizing legislatures can be challenging. Users must find coordinate points for a given seat in the chamber and then plot the points on a x-y plane. While this task is not impossible, parliament plots are cubersome to create in most statistical software packages. Until relatively recently, parliament plots were created in various JavaScript frameworks which give the end-user greater freedom to draw directly on the Document Object Model[1] using Scalable Vector Graphics (Brossard 2016; Tens 2017a, 2017b). These tools, while excellent, are not particularly appropriate or useful choices for political scientists.[2] ggparliament seamlessly integrates into the quantitative political scientist's toolkit and allows for easy composition of legislatures using ggplot2 syntax in the tidyverse, a set of packages driven by an opinionated data science philosophy in R.

To highlight the utility of ggparliament in political science, I first situate this R package in the context of other data visualization tools used in the discipline. I then show how to visualize parliament plots. Finally, I expand on several cases in which ggparliament may improve comprehension of descriptive data in political science.

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[1] In common parlance, an empty webpage.

[2] D3.js and other JavaScript frameworks are more often used by front end web developers, not academics.

Literature review

Data visualization in political science is not new. Scholars have long encouraged use of graphs in communicating quantitative empirical research (King, Tomz, and Wittenberg 2000; Gelman, Pasarica, and Dodhia 2002; Gelman 2011; Gelman and Unwin 2013). Kastellec and Leoni (2007) follow up on this early effort several years later, proposing ways to graph statistical results that would otherwise be presented in tabular format. Political scientists, such as Edward Tufte, are prolific data visualizers, having helped transform the field of data visualization (see Tufte 1974; Tufte and Graves-Morris 1983; Tufte, Goeler, and Benson 1990).

Yet while statistical and scientific computing in political science has increased alongside the quantification of political science research since the 1960s, visualization tools still remain the domain expertise of computational statisticians and, to a lesser extent, data scientists. Specialist data visualization R packages in political science are rare. However, there are a few notable data visualization achievements that originate from political science, including small multiples (Tufte, Goeler, and Benson 1990), marginal effects plots (Brambor, Clark, and Golder 2006; Hainmueller, Mummolo, and Xu, n.d.; Pepinsky 2018) and the separation plot (Greenhill, Ward, and Sacks 2011). My analysis shows that visualizing data has only increased in popularity in the social sciences as computational tools become more accessible.

Data visualization in political science

Following up from Kastellec and Leoni's effort to document the number of graphs and tables in political science journals (2007), I count the number of graphs (excluding tables and other figures such as causal diagrams and maps) that appeared in the *American Journal of Political Science, American Political Science Review, The Journal of Politics* and *Political Analysis* from January to July 2018.

I find that of the 173 articles published during that time period, 131 have graphs; 42 do not.
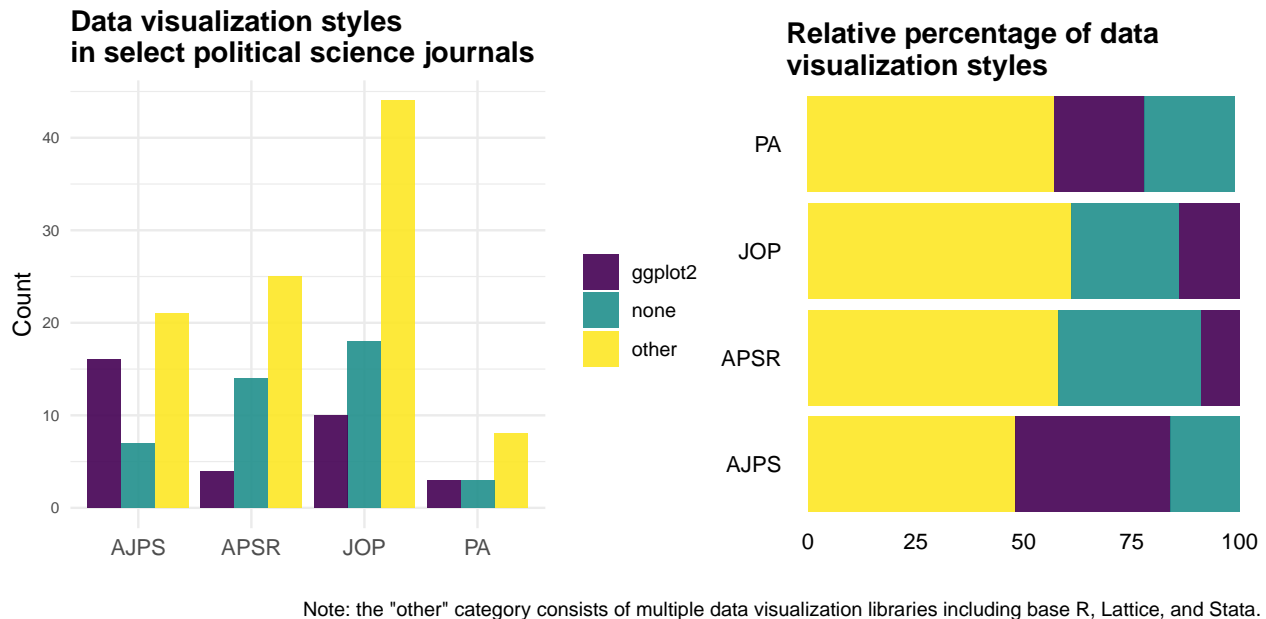

Figure 1: Political science and data visualization

On average, 76 per cent of articles published in those four journals include graphs. The *American Journal of Political Science* has the largest percentage, with more than 2/3 of articles containing graphs. 36 per cent of which are `ggplot2` objects. Graphs are an increasingly popular medium; a decade prior, Kastellec and Leoni found that political scientist overwhelmingly defaulted (by a 2:1 ratio) to tables when communicating empirical results (2007).

While `ggplot2` is just one data visualization tool out of many, this analysis provides evidence of the popularity of the `tidyverse` packages in political science. The increasing accessibility of tools like `ggplot2` enable social scientists to efficiently communicate results through visualization. Moreover, the use of figures and charts in research has increased substantially over the past decade.

Simple Parliament Plots

ggparliament is an extension to the `tidyverse`, a subset of packages in R which build off a common grammar of graphics and data analysis, enabling users to understand their data through chained functions (Wickham 2010). The output can be visualized with ease in `ggplot2`. ggparliament is the first data visualization tool in a statistical framework for displaying election returns, party structures, and legislative data in a parliament plot. The package offers five default legislative chamber layouts for visualizing parliaments (see Figure 2).
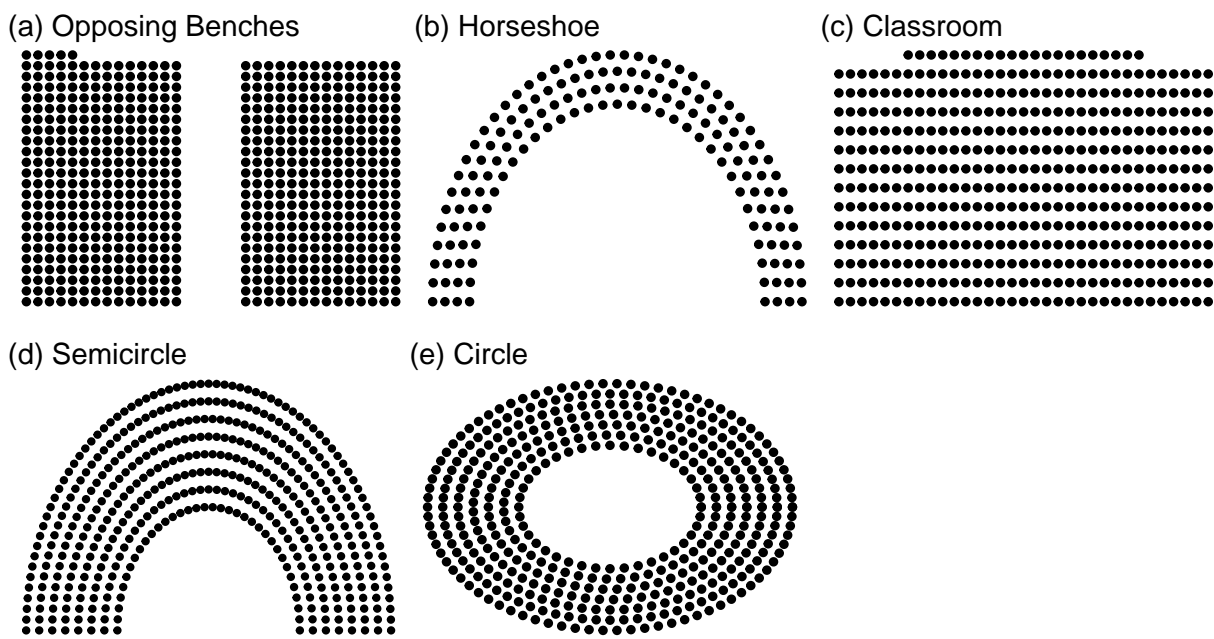
(a) Opposing Benches   (b) Horseshoe   (c) Classroom

(d) Semicircle   (e) Circle

Figure 2: Basic parliament plots

Parliament plots provide a accurate summmary of the distribution of seats in a legislature. They visually group parties together, for e.g. when the number of parties exceeds a two-party system. Faceting over time allows users to see how the visual makeup of the legislature changed between elections. As ggparliament provides several parliament layouts, one can create a cross-country comparative analyis. Moreover, parliament plots allow readers to visualize the layout of the legislature. Moving away from the primary intended purpose of plotting election results, ggparliament can display information about legislative districts, roll call data, or information about legislators themselves in a relatively compact format.

The Concept

Constructing a parliament plot starts with aggregate political data. To illustrate how to use `ggparliament`, I take the 115th Congress as an example. As of August 2018, there are 236 Republicans, 193 Democrats and 6 vacant seats in the House of Representatives which are equally divided by the two political parties. Start with a data frame structured as follows:

Table 1: The United States House of Representatives

party	seats	color
Vacancies	3	gray
Republicans	236	red
Democrats	193	blue
Vacancies	3	gray

Next, we input the data frame into `ggparliament::parliament_data()`, defining the parameters of interest:

- the type of parliament layout (circle, classroom, horseshoe, opposing benches or semicircle)

- the number of rows in the legislative chamber

- a numerical variable which tells `R` the number of seats per party

- the name of the original aggregate data frame

- and if plotting a parliament with two opposing benches, a dichotomous variable that will split the legislature in half.

Table 2: `ggparliament::parliament_data()` output

	party	seats	color	x	y	row	theta
1	Vacancies	3	gray	-2.000000	0	8	3.141593
1.1	Vacancies	3	gray	-1.857143	0	7	3.141593
1.2	Vacancies	3	gray	-1.714286	0	6	3.141593
2	Republicans	236	red	-1.571429	0	5	3.141593
2.1	Republicans	236	red	-1.428571	0	4	3.141593
2.2	Republicans	236	red	-1.285714	0	3	3.141593

The function `parliament_data()` is primarily dependent on two arguments: the number of rows in the legislative chamber and specified layout. The data frame expands to an individual row for legislator i sitting in seat x_i with x and y coordinates in accordance to the legislative chamber design and the number of rows (i.e. a semicircle parliament with 4 rows will look a lot different from one with 13 rows). The user is then able to bind additional information to each seat by appending new columns to the data set. Plotting the basic output in `ggparliament` leads to the following graph (see Figure 3).
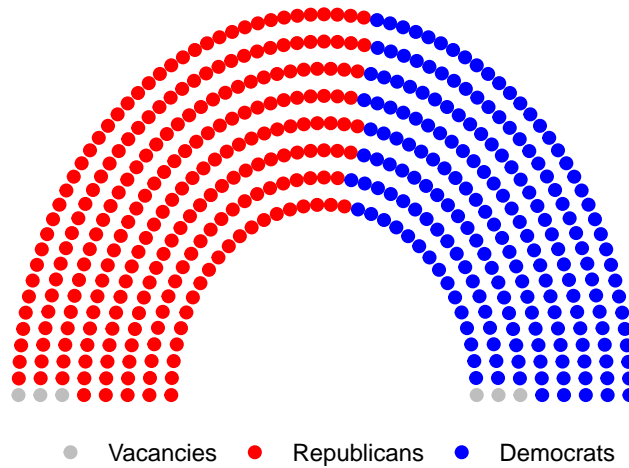

Figure 3: United States House of Representatives parliament plot

Additional Information

The primary purpose of `ggparliament` is to plot election returns. However, there exists a lot of potential for plotting other types of descriptive political data. We deliberately ensured this package is an extension to the `tidyverse` so that we could take advantage of other visualization tools in the ecosystem. One such advantage is this: we are able to facet graphs over time or over pieces of legislation. We can add extraneous information through new layers, such as a majority threshold line or we can bring certain seats to the foreground to add visual emphasis.

The `tidyverse` facilitates easy matrixing of variables through faceting. This is particularly useful plotting election returns over a number of elections or for matrixing roll-call votes over a number of legislative sessions. In the following example, I plot the House of Commons in the United Kingdom from 2010 to 2017 (see Figure 4) which allows us to see how parliament evolved over time.
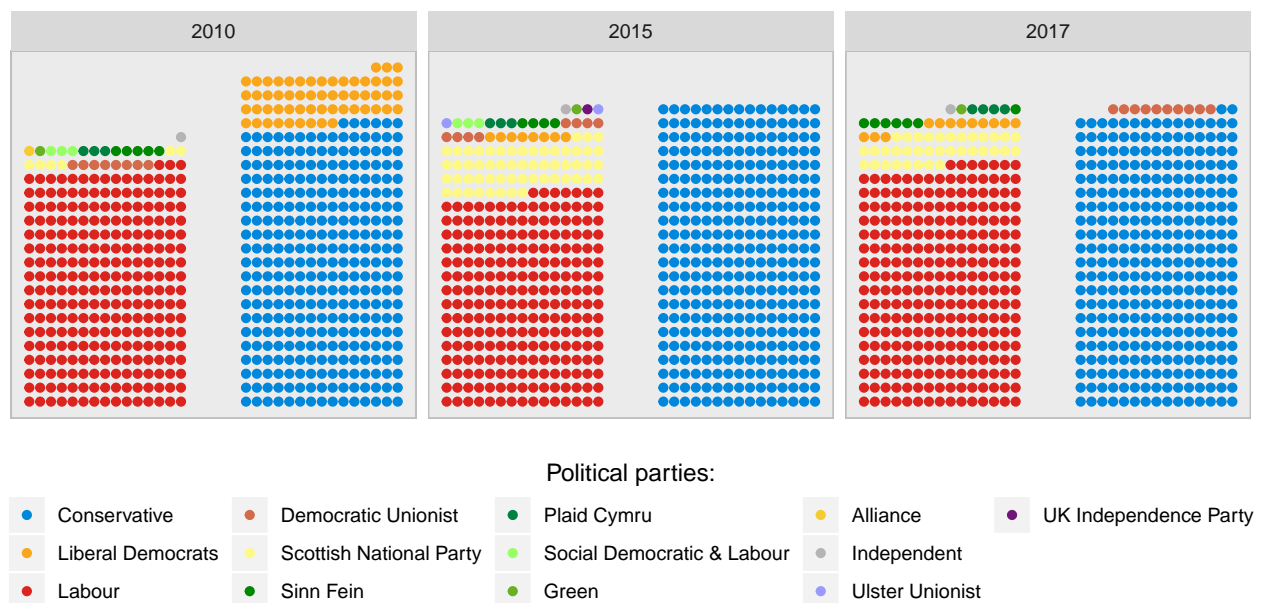

Figure 4: House of Commons small multiples

A key advantage of `ggparliament` is the user's ability to append visual layers to their data. The parliament plot can be used to highlight certain parties or parliamentarians. In particular, we introduce a function called `geom_highlight_government()` which highlights the governing

party or a coalition of parties. As an example, I provide the 2016 election results for the Australian House of Representatives in tabular format below as well as a `ggparliament` object.

Table 3: 2016 Australian federal election results

party	seats
Labor	69
Greens	1
Xenophon Team	1
Independent	2
Katter's Australian	1
Liberal	45
Liberal National	21
National	10

Table 4: Simplified election results

party	seats
Labor	69
Other	5
Coalition	76

For the purpose of visually displaying the parties that make up the Australian government compared to the opposition, a *simple* parliament plot provides as much utility as the tables above (i.e. very little – indeed, a visual drawing of Table 3). However, using visual tools to highlight subsets of the data allow for near-instant comprehension (see Figure 5). We gain the additional information from visually grouping and highlighting the coalition. In doing this, we do not *lose* information about individual parties.
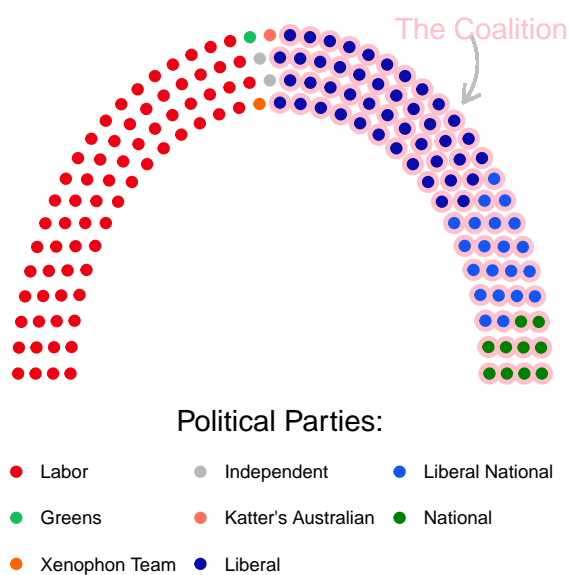

Figure 5: Highlighting the Coalition government in the Australian House of Representatives

Another quantity of interest is the absolute majority threshold, which we can calculate by halving the total number of seats in the legislature, rounding to the next integer to reach an absolute majority of seats. The formula for this metric is simply:

$$Absolute\ majority = \lfloor \frac{seats}{2} \rceil$$

Graphically, `ggparliament` draws a line through the majority threshold seat, with an optional annotation noting the number of seats required to claim a majority.
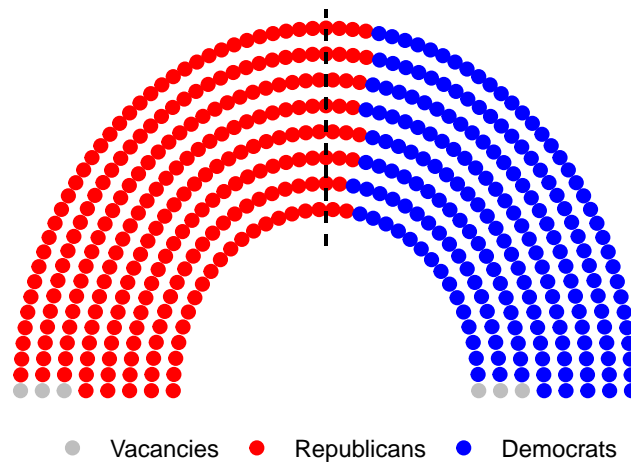

Figure 6: United States House of Representatives with a majority threshold line

Drawing a majority threshold may be of interest when the majority margin is slim. Threshold lines offer additional advantages in explicitly making clear the difference between the number of seats held by a party in control of the legislative chamber compared to the minimal number of seats needed to call an election or to secure a vote.

The package also comes with several smaller functions. `ggparliament` distinguishes overhang seats in Mixed Member Proportional electoral systems by drawing hollow circles. Additionally, the R package includes functions to calculate and plot the seat share in the legislative body, the total number of seats, and the seat count per party.
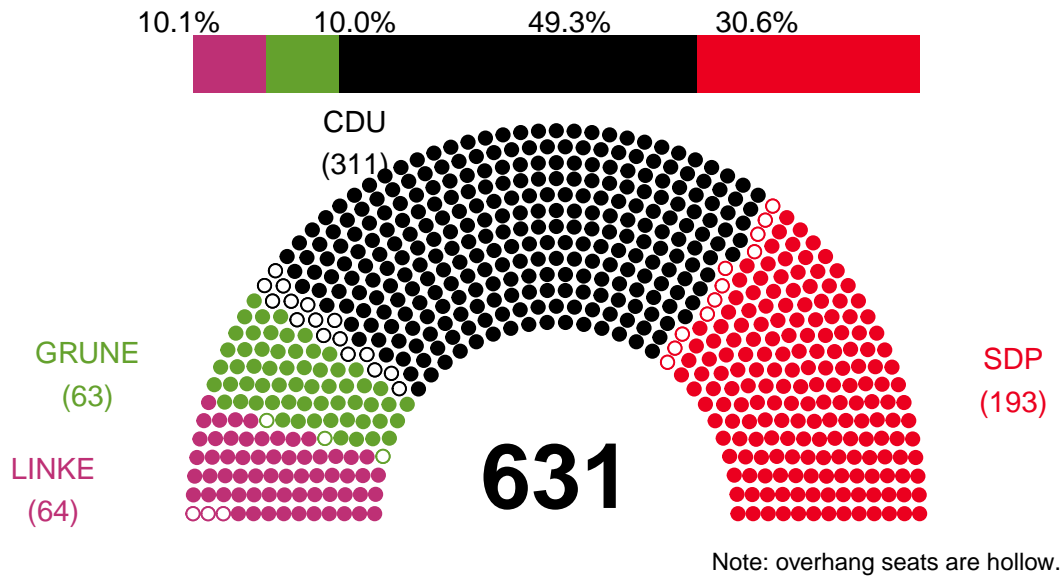
Figure 7: German Bundestag - 2013 election

Applications

I turn to additional examples where `ggparliament` may be a useful descriptive tool for political scientists. In one case study, I replicate an existing diagram of a legislature using `ggparliament`. In the other, I show how `ggparliament` can be used to plot median ideal point estimates in state legislatures. Finally, I use `ggparliament` to visualize descriptive representation in legislatures.

Where You Sit is Where You Stand: The Impact of Seating Proximity on Legislative Cue-Taking (Masket 2008)

Masket finds that vote cue-taking can be influenced by geographical location of fellow legislators. Members of the California legislative assembly take cues from those who sit near them, even if they are not members of the same party (2008). The author provides a diagram of the 1949 California assembly. I replicate Masket's figure in `ggparliament` below.
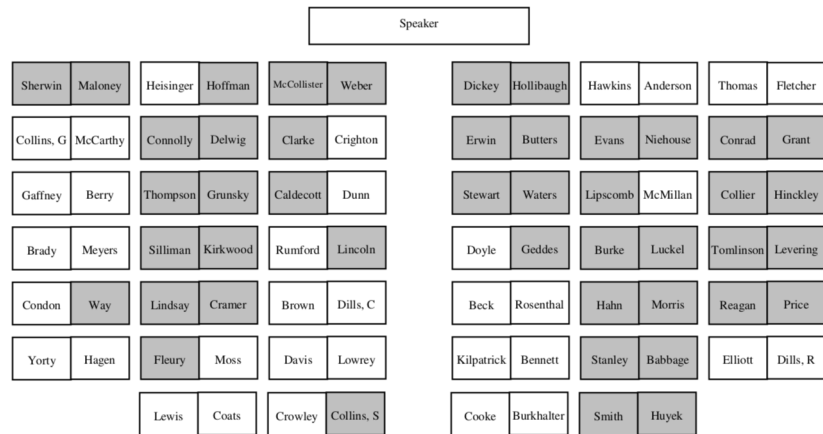
Figure 1. Seating assignments in the 1949 California assembly. Republican members are marked with gray desks, Democratic members are marked with white desks.
Source: *Assembly Final History, 1949 Regular Session*, pp. 30, 31.

Figure 8: Figure 1 in Masket (2008)
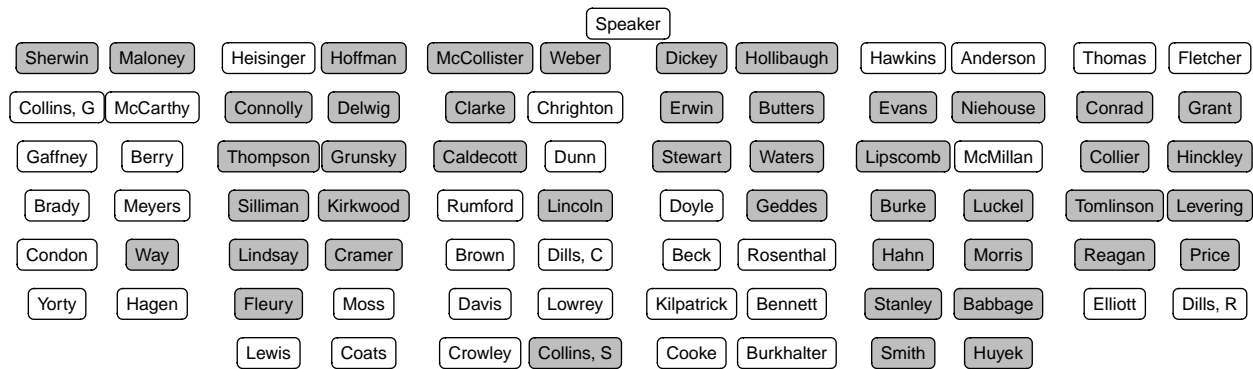
Figure 9: Replication of Figure 1 in Masket (2008)

The Ideological Mapping of American Legislatures (Shor and McCarty 2011)

Exploiting a survey taken by state and national legislature candidates in the United States Congress, Shor and McCarty (2011) impute ideal points across state legislatures and over time. Building off an extensive body of literature on the spatial theory of voting in the United States Congress (Poole and Rosenthal 1997; Clinton, Jackman, and Rivers 2004; Heckman and Snyder Jr 1996), the authors construct an ideological map of American state legislatures. The updated data (Shor 2018) contain latent ideal points for every state legislator from 1993 to 2016, a subset of which are plotted below.
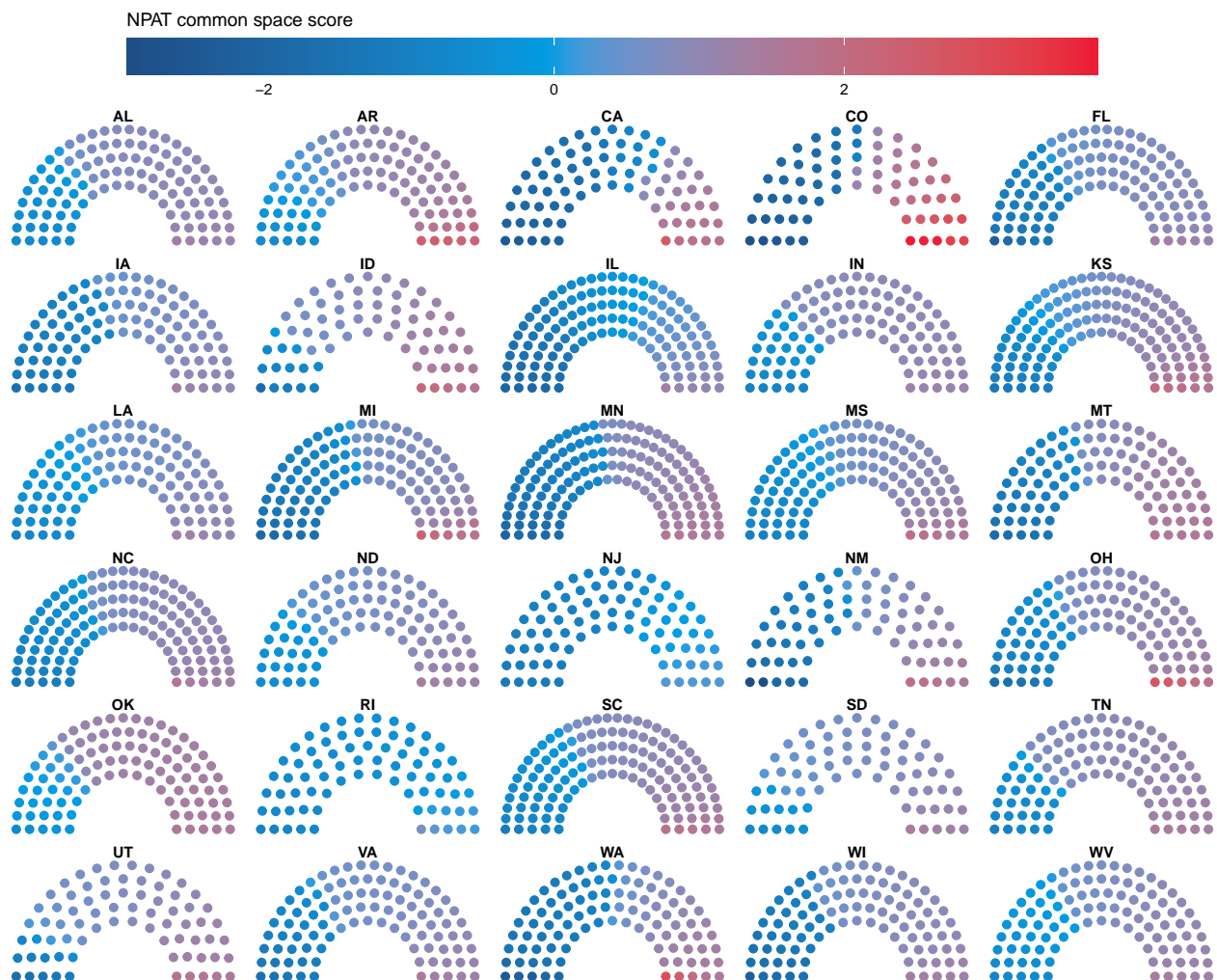
12

Figure 10: Mapping American Legislatures in 2016: ideal point estimates

Gender Quotas

A broad literature in electoral systems focuses on gender quotas (Reynolds 1999; Tripp and Kang 2008; Krook 2010; Dahlerup 2012; Schwindt-Bayer 2009; Bush 2011; Hughes 2011). Delineating different seats is something that `ggparliament` excels at. Looking at the Tanzanian parliament which has enforced gender quotas in conjunction with reserved seats for women, one can see that the number of women MPs has steadily increased as gender quotas increased from 20% (2000) to 30% (2005, 2010) and as the total number of parliamentarians grew over time. In 2000, the Tanzanian parliament was not to consist of more than 80% men (Tripp and Kang 2008). Of course, not all women were elected; many were selected from party lists for seats specifically

reserved for women. A visualization of the evolution of women in the Tanzanian parliament is below.
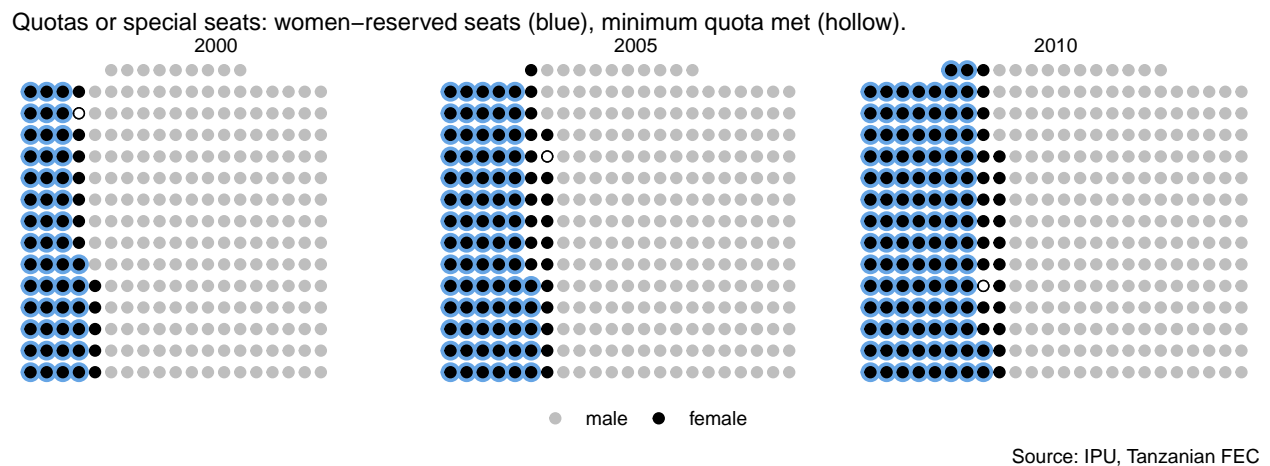
Quotas or special seats: women–reserved seats (blue), minimum quota met (hollow).

Figure 11: Women in the Tanzanian Parliament (2000, 2005, 2010)

Conclusion

The parliament plot allows political scientists to visualize election results and legislatures efficiently in R. It enhances our understanding of legislatures by providing a visual alternative to tables for descriptive data on elections and legislative bodies. I (along with Thomas Leeper and Rob Hickman) have written an R package that allows users to easily create parliament plots using ggplot2 syntax, a computing language familiar to many political scientists.

They are, of course, not without limitations. In static form, parliament plots are restricting because they merely show descriptive results. As political science begins to embrace interactive graphics, this will change – we already have interactive scripts for ggparliamentembedded into the R package but they are presumably of little use for most political scientists right now. A fascinating use case would be to link each seat to a map which pans to the geographic area for a legislative district when hovering over a given seat in a legislative chamber. However, as it stands, ggparliament fills a niche in the data visualization field and political science by making legislative and election data easy and intuitive to visualize.

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Appendix

R **package**

See https://CRAN.R-project.org/package=ggparliament.

GitHub repo

See https://github.com/zmeers/ggparliament_paper