CHAPTER 1

Introduction

Overview

In this book I show how to use a simple spatial model of voting as a tool to analyze parliamentary roll call data. Each legislator is represented by one point, and each roll call is represented by two points – one for Yea and one for Nay. On every roll call each legislator votes for the closer outcome point, at least probabilistically. These points form a *spatial map* that summarizes the roll calls. In this sense a spatial map is much like a road map. A spreadsheet that tabulates all the distances between pairs of sizable cities in the U.S. contains the same information as the corresponding map of the U.S., but the spreadsheet gives you no idea what the U.S. looks like.[1] Much like a road map, a spatial map formed from roll calls gives us a way of visualizing the political world of a legislature. The closeness of two legislators on the map shows how similar their voting records are, and the distribution of legislators shows what the dimensions of the space are.

The number of dimensions needed to represent the points is usually small, because legislators typically decide how to vote on the basis of their positions on a small number of underlying evaluative, or *basic*, dimensions. For example, in recent U.S. Congresses, we can easily predict how a "liberal" or a "conservative" will vote on most issues. These basic dimensions structure the roll call votes and are captured by the spatial maps.

In this chapter I develop a simple theory of spatial maps that I call the *basic-space theory of ideology*. In subsequent chapters I use the theory to show how to construct and interpret the spatial maps that reflect it. The theory is based on the work of many scholars in psychology, economics, and political science over the past 50 years and is a parsimonious tool for understanding the construction and interpretation of spatial maps.

[1] I borrowed this analogy from Jordan Ellenberg, who used it in an article about my political polarization research with Howard Rosenthal (Ellenberg, 2001).

I begin with some observations on theory and meaning. A spatial map is a picture, and for it to be a summary, it must have a *meaning* for the viewer. That meaning must flow from *a theory about the picture*. In this sense, "a picture is worth a thousand words." My point is simple. Anyone can construct a spatial map using the computer programs I discuss in subsequent chapters. But the maps are worthless unless the user understands both the spatial theory that the computer program embodies and the politics of the legislature that produced the roll calls. A practitioner must be able to stand before an audience of her peers and explain the meaning of the spatial map.

After discussing theory and meaning, the rest of the chapter lays out my theory of spatial maps.

Theory and Meaning

To reiterate, this is a book about the use of pictures to summarize parliamentary roll call data. For the most part these pictures consist of simple geometric representations of the legislators and of the roll calls. For example, members of the left, or liberal, party cluster together on one side of the picture, and members of the right, or conservative, party cluster together on the opposite side of the picture. In this case a glance at the picture by an *experienced* researcher shows what the main sources of conflict are within the parliament and how the roll call voting is structured. By "experienced" I mean that the researcher must understand how the picture was constructed and must understand the political environment of the parliament or legislature. It is the researcher's understanding of the theory about the picture that gives the picture meaning. Without this understanding a person viewing the picture would see just a bunch of dots (or tokens; see Figure 1.2). This would be like someone not trained in physics trying to make sense out of cloud chamber photographs, or someone not trained in electronics trying to make sense out of an ammeter reading of a plate current, and so on.[2]

Although the pictures that are the subject of this book – spatial maps of parliamentary voting – are *not* art, the concept of picture-as-summary is a slippery one that must be used with caution. The boundary line between picture-as-summary and picture-as-art is not as clear as it may appear. For example, consider the most recognized picture in the world – Leonardo da Vinci's painting, *Mona Lisa* (Figure 1.1).[3] Why does this painting seem to

[2] Philosophers of science have explored this topic in great depth. Kuhn (1962/1996, pp. 187–191) has a nice discussion of the training of physicists that illustrates the shift in meaning between amateur and specialist.

[3] Leonardo began painting *Mona Lisa* about 1503 and worked on it for many years. Francis I of France bought the portrait but let Leonardo keep it until his death in 1519.

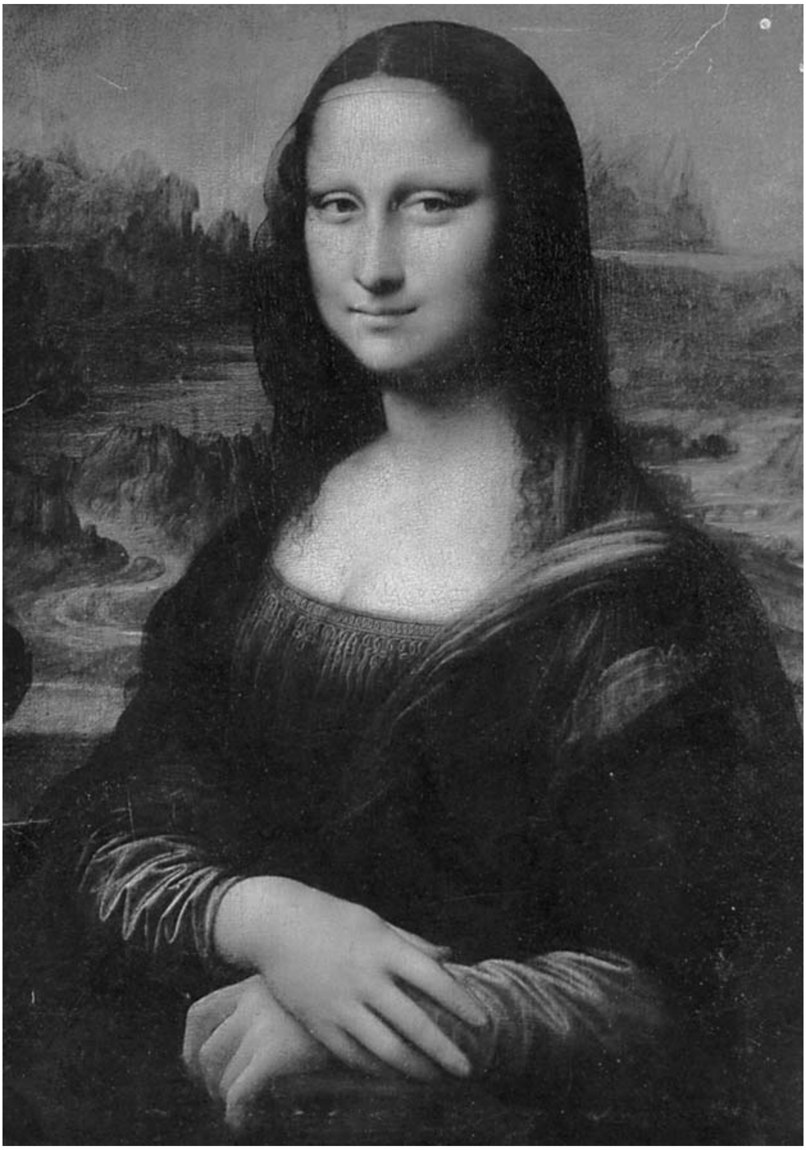

FIGURE 1.1. *Mona Lisa.*

transcend cultures and national boundaries? Is it the finest portrait ever painted? Is it more important than Picasso's *Les Demoiselles d'Avignon*?[4] The answer

[4] *Les Demoiselles d'Avignon* was painted in 1907 and is considered a landmark in modern art. It marked the beginning of Picasso's long Cubist period.

of course is obvious – the *smile*. But why the smile? In my opinion Leonardo's genius was, figuratively, to flip a coin and have it land on its edge. He managed to paint a facial expression that is exactly on the cusp between a smile and a frown. Consequently, when we look at the painting, it does not instantly match what we recognize as a smile or a frown. So we attend to it longer than we normally would, and we have to think about it. Hence our fascination.

Not everyone will agree with my interpretation[5] of *Mona Lisa*, but consensus is not my purpose in offering it. Clearly, *Mona Lisa* is not a picture-as-summary for most people. Most people see a beautiful painting of a woman with an ambiguous smile. I see a perceptual trick much like the simple figures used by the Gestalt psychologists. It is high art *and* the work of a great scientific mind. This meaning of the picture for me flows from my theory of the picture.

A Theory of Spatial Maps

Unlike my *Mona Lisa* theory, the basic space theory of ideology underlying the spatial maps of parliamentary voting analyzed in this book is the end result of the work of a large number of scholars. I am deliberately using the word "theory" broadly and loosely for now. In the notion of theory I include: (1) the technical apparatus of the spatial model; (2) a theory of how legislators make decisions; (3) a theory of belief systems (ideology) that is tied to the assumptions of the spatial model and the theory of decision-making; (4) the computer program that embodies (1), (2), and (3) and actually generates the spatial maps; and (5) a substantive understanding of the political system that the parliament or legislature is embedded in. All these are *necessary* for meaning to flow from the spatial map. Simply pushing a matrix of roll call data through a computer program does not itself produce a meaningful picture.

For example, Figure 1.2 is a spatial map of the final passage vote of the landmark 1964 Civil Rights Act in the U.S. Senate.[6] The act was one of the most important roll call votes in U.S. history. It was passed seven months after President John Kennedy was assassinated in November of 1963. In June of 1963 Kennedy introduced his civil rights bill to the nation in a nationally televised address. In a supreme act of leadership, he argued that it was a moral issue

[5] For a theory that supports my own, see Livingstone (2002). Her explanation centers on the way an individual's center of gaze on the eyes interacts with peripheral vision to suggest a smile. When an individual then looks directly at the mouth, the smile disappears. My view is that Leonardo deliberately painted the picture the way he did to achieve this effect. For a more traditional interpretation of *Mona Lisa*, see Gombrich (1978, pp. 227–229). He also emphasizes the role of Leonardo the scientist in the construction of *Mona Lisa*.

[6] All the spatial maps in this book were produced in R. The R code and data files for all the spatial maps can be found at the website for this book: http://k7moa.com/Spatial_Models_of_Parliamentary_Voting.htm, under the corresponding chapter links.

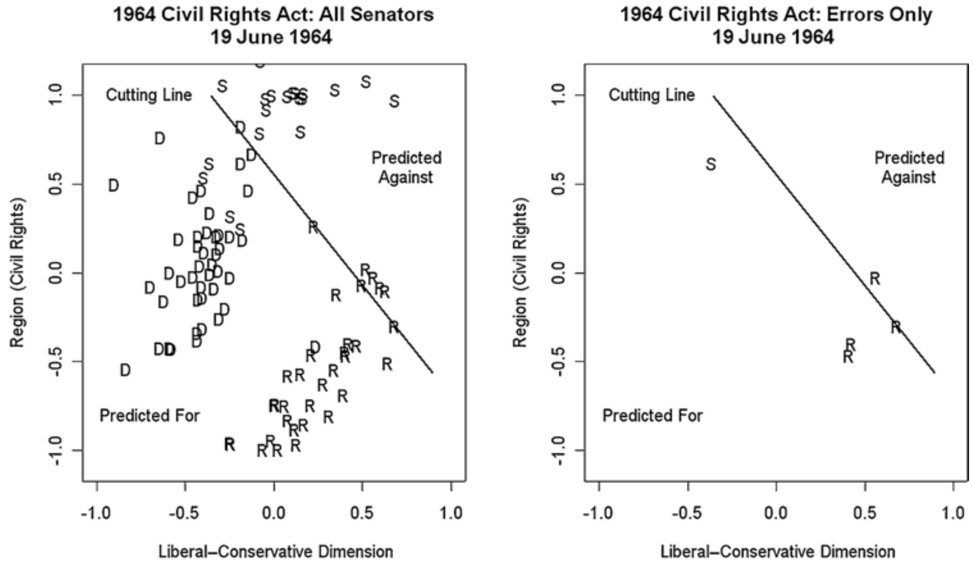

FIGURE 1.2. *Final passage vote on the 1964 Civil Rights Act. Each token corresponds to a senator's ideal point. R stands for Republican, D for Northern Democrat, and S for Southern Democrat. Errors are concentrated near the cutting line. The ideal points and the cutting line are estimates from the DW-NOMINATE model, with a linear time trend in legislator positions. The second dimension is shown* unweighted *for purposes of clarity.*

that went to the heart of how people treated one another. Discrimination on the basis of skin color was morally wrong, and it must be ended.[7] President Lyndon Johnson in his January 1964 State of the Union address made the civil rights legislation introduced by Kennedy his top legislative priority, and he pushed it through Congress with the help of the Republican and Northern Democratic Congressional leaders.[8]

The spatial map is from DW-NOMINATE (McCarty, Poole, and Rosenthal, 1997; Poole and Rosenthal, 2001). The left panel shows all the senators, and the right panel shows just the five senators who were *errors* in the DW-NOMINATE analysis.[9] Each senator's location in the map is a function of all the roll calls the senator participated in during his/her career. The cutting line is specific to the roll call and divides the senators who are predicted to vote Yea from those who are predicted to vote Nay. The senators who are predicted incorrectly are errors.

Consider just the spatial map of all the senators. The descriptive labels and the relative positions of the party tokens in the map show that a coalition of Republicans and Northern Democrats voted for the act and a coalition of Southern[10] Democrats and a few Republicans voted against the act.[11] The map also shows a clear separation of the Democrats from the Republicans and a sharp division within the Democratic Party. All but four of the Southern Democrats are up near the top of the map.

My analysis of Figure 1.2 so far has not revealed any information that a sophisticated student of American political history would not already know. For me to go any further requires that I say something about the *structure* of the map. I have to explain what the dimensions represent and explain the relative placement of the D, S, and R tokens on the dimensions. These *explanations* of the structure of the map cannot be based on the technical apparatus that

[7] "The heart of the question is whether all Americans are to be afforded equal rights and equal opportunities, whether we are going to treat our fellow Americans as we want to be treated. If an American, because his skin is dark, cannot eat lunch in a restaurant open to the public, if he cannot send his children to the best public school available, if he cannot vote for the public officials who represent him, if, in short, he cannot enjoy the full and free life which all of us want, then who among us would be content to have the color of his skin changed and stand in his place?" (John F. Kennedy, 11 June 1963, televised address to the nation.)

[8] See Perlstein (2001) for a thorough account of the events leading up to the passage of the act and its subsequent effect on the 1964 Presidential election.

[9] DW-NOMINATE uses a *weighted Euclidean metric* (see Chapter 4). Figure 1.2 shows the dimensions without the weights for purposes of clarity. If the second-dimension weight of 0.338 were applied to the spatial map, it would squash the configuration down.

[10] Throughout this book the South is defined as the 11 states of the Confederacy plus Kentucky and Oklahoma.

[11] The vote was 73 Yea and 27 Nay. The 67 Democrats who voted split 46 Yea and 21 Nay (Northern Democrats split 43 Yea and 1 Nay; Southern Democrats split 3 Yea and 20 Nay). The 33 Republicans split 27 Yea and 6 Nay.

produced the map. Rather, they must be grounded in the substance of American politics. Furthermore, I have to assume that the reader believes that the technical apparatus that produced the map is reliable and that the reader has a basic understanding of it. Consequently, for me to go further and offer my interpretation of the spatial map of the 1964 Civil Rights Act, I need to outline my theory of spatial maps.

Spatial Models of Voting

The spatial maps used in this book rest on the work of researchers in psychology, economics, and political science. The three fields are equally important to the theory.

In psychology various methods of *multidimensional scaling* (MDS) have been developed during the past 50 years to analyze similarity and preferential choice data. For example, a set of respondents are asked to judge how similar various countries are to each other. MDS methods model these similarities as distances between points representing the countries in a geometric space. These MDS programs are designed to produce a picture-as-summary – literally to summarize a large set of data graphically.[12]

At the same time psychologists were developing MDS, economists and political scientists were developing the spatial theory of voting. In its simplest form the spatial theory of voting can be represented as a map of voters and candidates where the voters vote for the candidate closest to them. In this regard, a spatial map is literally a visual representation of the spatial model of voting. Although Hotelling (1929) and Smithies (1941) are credited with originating the idea, it was the publication of Anthony Downs's *An Economic Theory of Democracy* in 1957 that really established spatial theory as a conceptual tool.

Hotelling studied the logic of the location of a grocery store in a *linear* town – that is, a town strung out along a highway, where all the houses face a single road. It is easy to demonstrate that the optimum location for a grocery store is the *median* of the town (the median minimizes the sum of the walking distances to the store). Hotelling showed that if there are *two* grocery stores, they will locate adjacent to one another. Smithies elaborated this model a bit by introducing elastic demand, so that people at the edges of town might stop shopping at the store if it moved too far to the center (Downs, 1957, p. 117). Hence the stores might not converge at the median of the town.

Downs took the Hotelling–Smithies model of spatial competition of stores and applied it to the competition of political parties. He assumed that voters were distributed over a dimension – for example, government intervention in

[12]Two eminent psychometricians, Ingwer Borg and Patrick Groenen, state this very clearly: "The main reason for doing [MDS] is that one wants a graphical display of the structure of the data, one that is much easier to understand than an array of numbers" (Borg and Groenen, 1997, p. vii).

the economy – and that political parties played the role of the stores. He derived a large number of classic results from this simple model. For example, if voters vote for the party closest to them on the dimension, the parties will converge to the median voter. Duncan Black (1948, 1958) had earlier derived a similar result for voting in committees.

Although Downs's work is a brilliant *tour de force*, it did not present spatial theory in a form that was susceptible to empirical testing. No rigorous mathematical structure was presented from which measuring instruments could be designed to test the theory. The needed structure was provided by the work of Otto Davis, Melvin Hinich, and Peter Ordeshook (Davis and Hinich, 1966; Davis, Hinich, and Ordeshook, 1970). By the early 1970s the mathematical structure of spatial theory was largely completed. The dimensions of the space represented issues or policies. Each voter had a position on each issue or policy, and this vector of positions was the voter's *ideal point* in the space. Each voter also had a utility function centered on her ideal point that assigned a utility to each point in the space. The further a point was from the voter's ideal point, the lower the utility. Each candidate also had a position on each issue dimension and therefore was represented as a point in the space. Each voter then voted for the candidate for whom she had the highest utility. In the context of parliamentary voting, the model is exactly the same, only policy outcomes rather than candidates for public office are now the choices.

This early version of the spatial theory of voting did not allow for *error* by voters. That is, voting was deterministic. Voters had ideal points and voted for the candidate closest to them in the policy space. Later, more realistic assumptions about voters' decision rules allowed for probabilistic voting.[13] Nevertheless, this version of spatial theory could at least be investigated empirically.

Psychometrics and Tests of Spatial Theory

In order to test the spatial theory of voting, you need data from voters about how "far" they are from candidates. The first comprehensive test of spatial theory was by Cahoon (1975) and Cahoon, Hinich, and Ordeshook (1976; 1978) using candidate feeling thermometers. Beginning in 1968, feeling thermometers were included in the NES surveys. A feeling thermometer measures how warm or cold a person feels toward the stimulus; the measure ranges from 0 (very cold, unfavorable feeling) to 100 (very warm, favorable feeling), with 50 as a neutral point. In 1968 respondents were asked to give feeling thermometer ratings to the presidential candidates George Wallace, Hubert Humphrey, and Richard Nixon, along with their vice presidential running mates and six other political

[13] For example, the standard formulation is to make the probability that a voter chooses the closest candidate a function of both the closeness of the candidate to the voter and a random draw from an error distribution. See McFadden (1976) for a survey of random utility models.

figures.[14] These thermometer scores can be interpreted as distances between the respondent's ideal point and the spatial positions of the candidates. For example, if a respondent gave Humphrey a 100, Nixon a 40, and Wallace a 0, then she was likely to be very close to Humphrey, very far from Wallace, but closer to Nixon than to Wallace.

Cahoon constructed a statistical model of the thermometer scores based on the spatial theory of voting and found that a simple two-dimensional spatial map largely accounted for the observed thermometer scores. His predictions of how the respondents would vote closely matched their actual voting choices.

Figure 1.3 shows a configuration of presidential candidates similar to that estimated by Cahoon. The horizontal dimension is from liberal (on the left) to conservative (on the right), and the vertical dimension is from Democratic (toward the top) to Republican (toward the bottom).

Cahoon was the first to test the spatial theory of voting using thermometer scores, but he was not the first to construct spatial maps from thermometer scores. Herbert Weisberg and Jerrold Rusk (1970) used the MDS procedure developed by Kruskal (1964a, b) to recover a candidate configuration from the candidate-by-candidate correlation matrix computed across the respondents. They did not estimate the respondents' locations.[15]

Although the spatial maps produced by Cahoon and by Weisberg and Rusk are essentially the same and are both pictures-as-summary, they have very different theoretical foundations. The MDS procedures developed by psychologists were intended to help answer questions of importance to psychologists. Namely, given a set of judged similarities between objects (nations, colors, types of crime, emotional states, etc.), researchers could use MDS procedures to uncover underlying psychological dimensions or as a tool to formulate a convincing description of the data. For example, two dimensions – communist–noncommunist and developed–underdeveloped – were found to underlie similarity judgments of nations (Kruskal and Wish, 1978). In contrast, the spatial theory of voting is a *theory of behavior* that states that *if* a set of assumptions holds, *then* voters should behave in a certain way *and* we should observe certain types of outcomes. It is a theory that makes predictions that can be tested.

Although the theoretical foundations are different, as a practical matter the MDS procedures developed by the psychologists are very similar in form to procedures developed to test spatial theory. A full-blown test of spatial theory

[14]Besides George Wallace, Hubert Humphrey, and Richard Nixon, the target politicians were Eugene McCarthy, Ronald Reagan, Nelson Rockefeller, Lyndon Johnson, George Romney, Robert Kennedy, Edmund Muskie, Spiro Agnew, and Curtis LeMay. The NES survey was conducted after Robert Kennedy's assassination in June 1968. The assassination obviously affected the ratings Kennedy received.

[15]The 1968 set of thermometer scores has been analyzed by a variety of scaling techniques. See Wang, Schonemann, and Rusk (1975), Rabinowitz (1976), and Poole and Rosenthal (1984a) for examples.

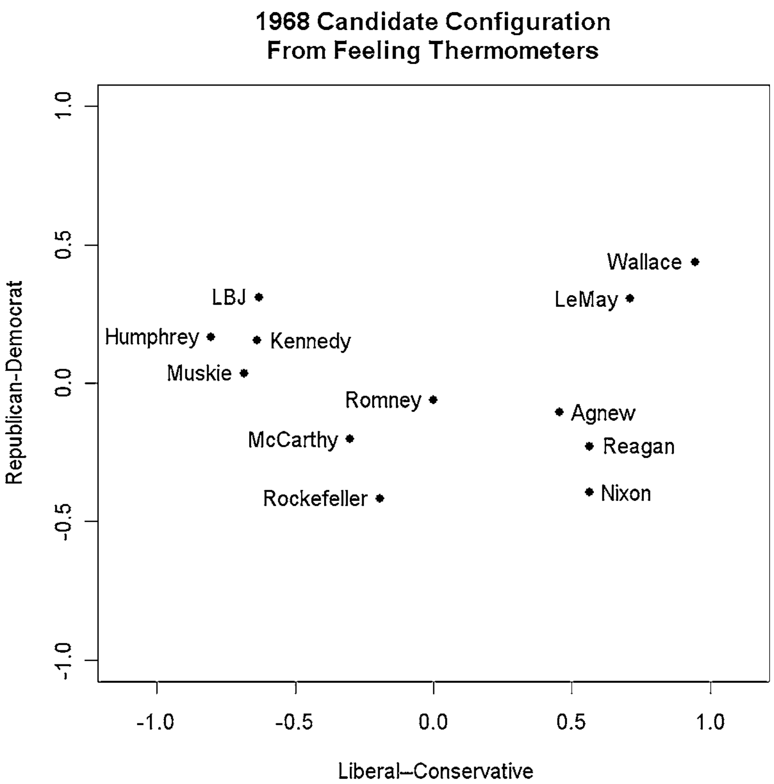

FIGURE 1.3. *Spatial map of the 1968 presidential candidates. The map was produced by applying nonmetric multidimensional scaling to the candidate-by-candidate Pearson correlation matrix computed from the feeling thermometers.*

like that performed by Cahoon estimates ideal points for the voters and points for the candidates in a spatial map such that the distances between the voters and candidates in the map are as close as possible to the original data. For example, the thermometers range from 0 to 100. Cahoon transformed these into distances by subtracting the thermometer value from 100. Finding points for the voters and points for the candidates that reproduce these distances is known as an *unfolding analysis* in psychology (Coombs, 1964). Techniques to perform unfolding analyses were developed by psychologists in the 1950s and 1960s (Chang and Carroll, 1969; Kruskal, Young, and Seery, 1973), and Cahoon's is also an unfolding methodology. Later Rabinowitz (1976), Poole and Rosenthal (1984a), and Brady (1990) developed unfolding procedures that they applied to thermometer scores.[16]

[16]Technically, Brady estimates the *distribution* of the voters rather than their ideal points.