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Political Parties and Electoral Landscapes

by

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Abstract

This paper studies the relationship between voters' preferences and the composition of party platforms in two-party democratic elections with adaptive parties. In the model, preferences determine an electoral landscape on which parties locally adapt platforms. Varying the distribution of voters' preferences alters the landscape's ruggedness and may effect parties' responsiveness. We find that in two-party democratic elections, adaptive parties generally locate in regions of high social utility but cannot always find winning platforms. We also show that parties' ability to locate winning platforms as well as the rate of convergence of party platforms depends upon the electoral landscape's ruggedness.

Introduction

Political parties in two-party democratic elections generally try to take policy positions which appeal to as many voters as possible. Spatial election theory, which assumes parties have sufficient information to recognize and respond to voters' preferences, suggests that parties' efforts to attract votes leads them to adopt "centrist" platforms. A central concern of democratic theory is the extent to which electoral processes limit or enable parties to make normatively improving responses. In this paper, we explore how the distribution of voters' preferences influences the nature of party competition.

We consider a spatial model of two-party competition where parties respond to popularity polls by incremental adaptations in their platforms. Parties are modelled as adaptive agents competing for votes in a multidimensional issue space. While the distribution of voters' preferences matters to parties as it effects their attempts to win votes, the deeper relationship between distributions and the behavior of parties is of concern to democratic theorists because it influences party platforms, election outcomes, and perhaps, aggregate social utility. Our model explores the ability of parties, in various electoral environments, to find platforms of high social utility.

In American politics, where the focus is often on two-party electoral systems, political scientists have addressed the relationship between the distribution of voters' preferences and party competition both empirically and theoretically. Empirically, a vast literature on mass opinion and partisanship has linked voters' preferences to voting behavior, political participation, and party platforms. Research suggests that both the distribution of voters' preferences and party platforms change over time (Nie, Verba, and Petrocik, 1976; Sundquist, 1968, Part II; Phillips, 1990). Moreover, these movements may go hand in hand, which bodes well for the idea of democratic responsiveness.

Theoretically, spatial voting models have been developed to explain why parties may alter their platforms to appeal to voters and win elections. Downs (1957, 140), referring to his single dimensional spatial model, claims "the distribution of voters is a crucial determinant molding a nation's political life...[and] major changes in it are among the most important political events possible." Yet subsequent formal theory has not entirely succeeded in explaining how changes in voters' preference distributions influence party behavior in multi-dimensional issue spaces. With more than one issue dimension, two-party systems have single-point equilibria only if voters are distributed symmetrically (Plott, 1967).[1] If voters are distributed asymmetrically, equilibrium sets, such as the top-cycle, uncovered, or minmax sets, can be large, or even encompass the whole space.[2] Our model uncovers subtle relationships between the distribution of voters' preferences and two-party competition.

We pose two questions about two-party electoral competition: How do parties adapt to voters who become more or less ideological? How do parties adapt to voters who place relatively more or less weight on potentially divisive issues? To answer each of these questions, we rely on an artificial adaptive agents' model of party behavior. Changes in voters' preferences are mapped to changes in the parties' adaptive environment, or what we refer to as the electoral landscape.

Adaptive Parties

We depart from standard formal theory which largely relies on the assumption of rational political actors. Our parties' behavior is approximated with artificial adaptive agents (AAA), thereby retaining logical consistency of actions yet allowing for flexibility.[3] This sort of computational modelling, as advocated by Holland and Miller (1991), has recently been applied to economics (Marimon, McGrattan, and Sargent 1989, Arifovic 1989) and political science (Kollman, Miller, and Page 1992). Such models assist in exploring systems of well-defined agents in a replicable environment; any state of the system is fully recoverable. Inductive hypotheses can be generated, developed, and tested in a matter of moments.

Using AAA models, researchers can explore questions about the relationship between optimization and adaptation. Following Kollman, Miller and Page (1992), we compare various types of adaptive parties, which not only prevents reporting findings which are unique to a particular form of adaptive behavior, but also aids in the search for generic behavioral patterns. By employing search algorithms of known strengths and weaknesses, we can test hypotheses about the underlying adaptive environment.[4]

Our use of AAA modelling stems from a belief that the behavior of political parties can be more accurately described as adaptive and dependent on incomplete information than as vote maximizing and fully informed. Parties cannot mathematically determine uncovered, top-cycle, or minmax sets and locate platforms within them. Instead, parties locally adapt, tethered to their current platform. First, voters may not trust a party which moves across the ideological spectrum quickly in search of votes. Second, a party may be tethered to policy positions for ideological reasons. Third, a party may avoid advocating platforms which closely resemble the opposition party's simply because they are repulsed by what the other party represents. And finally, a party may have neither the information nor the foresight to locate winning platforms other than through local adaptations.

Kollman, Miller, and Page (1992) show that parties with positioning constraints and various adaptation procedures converge to platforms of high social utility. For two-party elections to have the presumed moderating effects, the rate of this convergence must be fast relative to changes in voters' preferences.[5] Not only are we concerned with whether adaptive parties converge to centrist platforms, we also want to know whether they move to centrist platforms quickly, after a few elections, or slowly, after preferences are likely to have changed.

The Electoral Landscape

A useful way to discuss how parties react to electoral environments is to refer to the "electoral landscape." The electoral landscape represents the parties' perceptions of vote totals over the possible platforms they can adopt. Like a geographic landscape, an electoral landscape has points of both high and low elevation. A platform's altitude equals its expected vote total. We assume that parties seek the high ground (in vote totals, not moral rectitude).

The number of votes a party's platform receives depends upon its opponent's platform and voters' preferences. In our characterization, an adaptive party seeking to win against the incumbent explores the local landscape for platforms that increase its vote total. A party's only information comes from polls of randomly drawn samples of voters. A party alters its platform only if it expects the change to improve its vote total. Multiple peaked, or rugged, electoral landscapes slow the rate of convergence for some types of adaptive parties, who may linger at local optima.

The Model

Following standard spatial models, our voters have perfect information about parties' platforms. Each voter attaches an integer valued strength and ideal position to each issue, where strength measures the issue's relative importance to the voter. A voter may consider an issue irrelevant if she has a strength equal to zero on that issue. The ideal position denotes the voter's preferred position. An integer valued vector of length $2n$ (where n equals the number of issues) fully characterizes a voter's preferences.

There are k possible positions on each issue $\{0,1,..,k\text{-}1\}$ and s possible strengths $\{0,1,...s\text{-}1\}$. In the findings presented below, n = 10, k = 9, and s = 3.[6] The utility to a voter from a party's platform, $y \in R^n$, equals the negative of the squared weighted Euclidean distance, with weights determined by strengths. Let s_{ji} denote the jth voter's strength on the ith issue, and x_{ji} denote the voter's ideal point. We can then write a voter's utility from platform y as:

$$u_j(y) = -\sum_{i=1}^{n} s_{ji} \cdot (x_{ji} - y_i)^2$$

A voter casts a ballot for the party whose platform generates the higher utility, and the party obtaining the most votes wins the election. We want to know whether or not parties, in their efforts to attract votes, adopt platforms which in a broad sense respond to the interests of voters. To evaluate the goodness of a platform, we employ a ***centrality*** measure. A platform's centrality equals the ratio of the aggregate utility of the median and the aggregate utility of the platform. Letting V equal the number of voters, we obtain the following formula:

$$cen(y) = [\sum_{j=1}^{V} u_j(median)]/[\sum_{j=1}^{V} u_j(y)]$$

This normalization sets c(median) $=1$, yet we attach no normative significance to the median itself as an outcome. Higher centrality means that the platform is closer to the weighted center of voters' preferences and obtains higher social utility. Centralities close to one represent strong utilitarian outcomes. Note, however, that centralities across different distributions of voters' preferences cannot be compared directly because each preference distribution generates a distinct centrality distribution.

An electoral period begins with the creation of two randomly assigned initial party platforms. One party is arbitrarily chosen to be the incumbent, whose platform remains fixed during the first election. During the campaign prior to each election, the challenger party uses information from a finite number of polls to test platform variations. After this polling, the challenger party chooses the platform which maximizes its vote total. The parties then compete for election with the winning party becoming the new, fixed incumbent. The losing party then becomes the new challenger and undertakes polls in order to determine a platform. This process continues through several elections. Parties adapt to polling information using either a genetic algorithm, multi-step hill climbing, or a random search algorithm (see appendix).

A genetic algorithm is a population based adaptive search algorithm which mimics evolutionary learning. Platforms are reproduced based on their relative performances, and portions of the surviving platforms may be exchanged with other members of the population using a crossover operator. A mutation operator also alters platforms. The multi-step hill climbing algorithm begins by testing a neighboring platform. If the tested platform outperforms the current platform, it becomes the new status quo. Finally, the random search algorithm tosses out multiple platforms in a neighborhood of its current platform and chooses the best one. At a metaphorical level, our genetic algorithm represents parties which evolve a candidate during a series of competitions, our hill climbing algorithm represents parties which fine tune their previous candidate, and our random algorithm represents parties which choose the best from among volunteers.

Often these search algorithms fail to locate a winning platform. If so, the incumbent remains, and the challenger begins adapting anew. At the completion of each election, we measure the centrality of the winning platform with respect to the distribution of centralities, giving us an indication of the social utility of the election outcome. Over the series of elections, we trace the trajectory of winning party platforms, their centralities, the distance from their opponents' platforms, and their distance from the median. These measures help determine whether the parties converge to similar platforms, if the convergence is toward regions of high social utility, and how fast convergence occurs.

Preference Distributions

We alter voters' preferences by correlating ideal positions and by correlating an issue's strength and position. The first type of correlation alters what we call an ideology. In one environment, voters have **uniform** ideologies, which means they have independent, uniformly distributed ideal positions. In another environment, voters have **consistent** ideologies, where ideal positions on issues are correlated. To create consistent preferences, we randomly assign an ideal base position to each voter and require that all ideal positions on other issues lie within one position of the base. For example, if the base for a voter is 3, then all ideal positions lie in the set {2,3,4}.[7]

The second type of correlation, that between strengths and ideal positions, may be independent, centrist, or extremist. With **independent** preferences, a voter's strengths on issues are independent of her ideal positions. If a voter attaches greater strengths to issues on which she prefers moderate positions, she has **centrist** preferences. If she attaches greater strengths to issues on which she prefers extreme positions, she has **extremist** preferences. To illustrate, consider the case of nine positions per issue {0,1,...8}, and three strengths {0,1,2}. Centrist voters assign high strengths (s=2) to issues with ideal positions {3,4,5}, low strength (s=1) to issues with ideal positions in {1,2,6,7}, and no strength (s=0) to issues with ideal positions {0,8}. In extremist preference distributions, voters attach greatest strength to issues on which they have extreme ideal positions. Issues with ideal positions in {0,1,7,8}, receive high strength (s=2), issues in {2,3,5,6} receive low strength (s=1), and an issue with ideal position {4} is considered irrelevant (s=0).

Since there are two types of ideologies and three types of strength-ideal position correlations, we consider six possible distributions of voter preferences.

Intuition

The distribution of voters' preferences together with the incumbent's platform determine the challenger's electoral landscape. Parties' local choices differ depending on whether the distribution of voters' strengths is centrist, extremist, or independent, or whether voters are ideologically consistent or uniform. In this section, we expand upon the concept of an electoral landscape to help interpret the findings presented in the next section.

Throughout, we confine discussion to a ten issue, nine position issue space with 2501 voters, and sample polls of 151 randomly sampled voters. Two dimensional projections can provide intuition for the formation of an electoral landscape. In Figure 1, the fixed incumbent party (I) lies in the upper left corner of the projection onto issues one and two, and the adaptive challenger party (C) begins in the lower right. We have also included a voter (V) whose ideal point projected onto the first two issues lies below and to the right of I. On the other eight issues, V's ideal point may be nearer to one party's platform, or it may be equidistant from the two parties' platforms. Suppose first that the latter holds. If the challenger party locates inside the middle ellipse (denoted by 0) on issues one and two, then it receives V's vote. If, instead, V's ideal point is nearer to the incumbent's platform on the other eight issues, then in order to win V's vote, the challenger party must be even closer to V's ideal point on the first two issues. For example, the challenger party may need to lie inside of the inner ellipse (denoted by -). Finally, if the voter's ideal point is closer to the challenger's platform on the other eight issues, then the challenger may need only be inside of the outer ellipse (+) to win V's vote.

Place Figure 1 Here

Suppose V prefers the challenger party on the other eight issues, and that any platform adaptation on issues one and two which moves the challenger into the interior of (+) yields V's vote for the challenger. Using similar diagrams we could draw an ellipse for each of the 2500 other voters, in the interior of which the challenger party obtains a vote.[8] In simplest terms, the goal of the challenger party is to locate a platform which lies in as many interiors as possible. In an electoral landscape, the elevation of a platform equals the percentage of voters' ellipses in which the platform lies. Figure 2 shows a landscape formed by a sample of 151 voters with independent preferences, a uniform ideology, and an arbitrarily positioned incumbent. The elevation at the point (2,4) represents the percentage of the vote received by the challenger party if it advocates position two on the first issue, four on the second issue, and retains the rest of its platform. The concentration of high elevation platforms near the center illustrates the moderating influence of democratic selection in two-party settings; moving towards the center wins votes.

Place Figure 2 Here

We begin with a comparison of extremist, centrist, and independent preferences given a uniform ideology. Figure 3 depicts the formation of a landscape given extremist preferences. Voter 1's (V1) ideal position is moderate on issue two and extreme on issue one. It follows that V1 places more weight on issue one as represented by the tall, thin indifference ellipses. Assuming extremist preferences, Voter 2 (V2), who prefers a moderate position on issue one and an extreme position on issue two, attaches more weight to issue two. Voter 3, who prefers generally moderate positions on both issues, has indifference ellipses which are circular.[9] As before, for each voter, the outer (respectively, inner) ellipse correspond to the challenger party's platform being nearer (further) to the voter's ideal point than the incumbent's platform on the other eight issues. And the middle ellipse corresponds to both parties' platforms being equidistant from the voter's ideal point on the other eight issues. In Figure 3, we see that even if both V1 and V2 prefer the challenger on the other eight issues, the incumbent is likely to win their votes.

Place Figure 3 Here

In an extremist landscape, it should be difficult for the challenger to win voters with ideal points in the regions around V1 and V2 using local adaptation. Similarly, voters with ideal points in the lower right should be difficult for the challenger to lose. Potential voters won through adaptation by the challenger are only those near the center. Since few voters determine the outcome, extremist landscapes will have gentle slopes and be rugged. Figure 4 shows a landscape formed by extremist preferences and a well-positioned incumbent (after five elections).

Place Figure 4 Here

As in Figure 2, the platforms of highest elevation are near the center. Both landscapes appear rugged; locating a monotonically increasing path from the edges to the center regions requires effort. Ruggedness should slow adaption toward the center. Centrist preferences should form less rugged landscapes, with smooth paths leading to the elevated region. Centrist preferences imply that the indifference ellipses for voters 1 and 2 rotate by ninety degrees (Figure 5). Voter 1 now attaches greater strength to issue two, and Voter 2 attaches greater strength to issue one.

Place Figure 5 Here

If neither the challenger nor the incumbent has an advantage on the other eight issues, then the challenger can obtain votes from both V1 and V2 by a slight adaptation towards the center. In centrist environments, compared with extremist environments, more voters are up for grabs, creating stronger incentives for moving towards the center. Therefore, landscapes formed by centrist platforms should be less rugged and should speed adaptive convergence. Figure 6 provides an example of such a landscape, with a great many increasing paths leading to the center. This reduced ruggedness implies that convergence to regions of high centrality should be faster with centrist preferences.

Place Figure 6 Here

Finally, independent preferences create ellipses which may be biased in either direction. Unlike either centrist or extreme preferences, two voters with identical ideal points may attach different strengths to issues. A comparative analysis of independent preference is aided by distinguishing between two types of voters. We classify a voter as Type A if the voter's ideal positions on issues one and two are approximately equal distance from the center. For example, the positions (6,6), (3,5) and (0,8) would be classified as Type A. Type B voters prefer positions on issues one and two which differ in their distance from the center, such as (4,8) and (1,3).

The discussion surrounding Figures 3 and 5 highlighted the importance of voters near V1 and V2 for extremist and centrist preferences. These are all Type B voters. Assuming centrist preferences, Type B voters create smooth landscapes. Assuming extremist preferences, the opposite (i.e. more ruggedness) occurs. With independent preferences, Type B voters attach arbitrary strengths to issues. It follows that, all things being equal, the landscape's ruggedness from independent preferences and Type B voters should be less than that from extremist preferences but more than that from centrist preferences.

In centrist or extremist preference distributions, Type A voters have roughly circular indifference curves. In independent preference distributions, Type A voters' strengths are arbitrary. Hence, we should expect the contribution to the landscape from Type A voters to be more rugged for independent preferences, than for the other two types of distributions. Combining the contributions from both Type A and Type B voters, independent preferences should create more rugged landscapes than those created by centrist preferences, but no definitive claim can be made concerning extremist and independent preferences.

A more formal comparison of landscapes requires a measure of ruggedness. Formalizing a notion of ruggedness can prove problematic (Page 1992), but perhaps the simplest measure would be to count the number of local maxima and minima. The question remains as to how to define 'local.' We consider a platform to have a one-dimensional maximum (minimum) on issue one at position k if both positions k+1 and k-1 obtain lower (higher) vote totals. (This definition only covers interior platforms, as it is impossible to advocate a position of -1 or 9 on an issue.) Table 1 shows, for a two-dimensional projection, the percentage of interior platforms which are one dimensional maxima or minima. A greater percentage of local maxima and minima implies a more rugged landscape. As expected, extremist and independent preferences create more rugged landscapes than centrist preferences. The comparison between extremist and independent preferences is inconclusive.

The next question is how ideology effects electoral landscapes. With ideologically consistent voters, voters' ideal points are distributed as a swath starting in the lower left corner and extending to the upper right. Again, for an arbitrary incumbent, a tested platform in the direction of the center should lead to more votes, while one further away should lead to fewer. Therefore, landscapes formed by ideologically consistent voters should also have peaks near the median.

Ideological consistency's impact on landscapes is twofold. First, consistent voters are a subset of the Type A voters. Recall that the existence of Type B voters smoothes out the landscape formed by centrist preferences and makes the landscape formed by extremist preferences more rugged. The absence of Type B voters (where voters are consistent) means that landscapes in the centrist case will be more rugged, and in the extremist case smoother. The effect on landscapes formed by independent preferences is indeterminate depending upon whether Type A or Type B voters make the greater contribution to ruggedness. In short, landscapes formed by ideologically consistent voters should be substantially more rugged for centrist preferences and only slightly more so for extremist and independent preferences.

The second effect of consistent ideologies stems from the correlation of ideal points. Those voters preferring high (respectively low) positions on issues one and two prefer high (resp. low) positions on the other issues as well. Suppose that after a few elections, the incumbent party's platform takes positions which are higher on average than the challenger party's positions on issues three through ten.[10] Those voters lying to the upper right on issues one and two generally prefer the incumbent on the other issues, reducing the probability that the challenger can win their votes. If they had uniform ideologies, these voters would be as likely to prefer either party on the other eight issues. Since fewer voters are up for grabs, the result is increased ruggedness. In sum, the effect of consistent ideologies is only clear for centrist preferences, which should form more rugged landscapes. Table 1 shows that the increased ruggedness manifests in later elections.

Finally, we might ask whether the landscape becomes more rugged as incumbents become better positioned. A challenger's (in)ability to win might result either from increased landscape ruggedness or from a changing percentage of available winning platforms. The data in Table 1 support the latter; landscapes do not appear to grow more rugged as the number of elections increases and the incumbent's platform improves. Challenger parties succeed less often when incumbents are well-positioned (in later elections), and it appears to be the case because of fewer winning positions, not because parties do not know which direction to move.

Results and Conclusion

We ran elections for all six types of preference distributions.[11] Our most fundamental finding is that adaptive parties locate in regions of high centrality regardless of the distribution of voters' preferences. In all electoral landscapes, parties with information limited to imperfect polls adapt toward regions of high social utility. Table 2 shows the number of elections until parties locate (on average) in the top 1% and 5% of all platforms (in centrality) as determined by a Monte Carlo simulation. Not only do adaptive parties tend toward regions of high centrality, they appear to do so rapidly. If voters' preferences change, parties may be able to adapt quickly to new distributions.

Parties which converge to the median necessarily move towards highly consistent platforms as well. Attempts to measure the effect of voters with consistent ideologies on party platform consistency did not yield any statistically significant results.[12] Adaptive parties in a two-party system do not appear to respond to ideologically consistent voters by becoming more consistent themselves, although this remains an open question.

We also find that adaptive parties cannot always locate winning platforms. As shown in Table 3, the probability of winning decreases with the number of elections, from approximately 100% of the time in the first election down to around 25% by the tenth election. Incumbency advantages may be partially a result of the limited abilities of challengers to adapt on flat landscapes. Traditional spatial theory, in which optimizing parties can defeat any position, must assume an exogenous incumbency advantage in order for the models' predictions to align with the reality of entrenched incumbents.

Parties' ability to locate winning platforms depends on the ruggedness of the electoral landscape. Using distance between parties as a measure, Table 4 shows, first, that extremist and independent preferences lead to slower party convergence than centrist preferences, and second, that consistent ideologies lead to slower party convergence especially when preferences are centrist.[13] These results agree with both the intuition put forward in previous section and the data in Table 1. The slower convergence is reflected in lower winning percentages as well, particularly for parties using random search and multi-step hill climbing.

The increased ruggedness of landscapes formed by extremist preferences and consistent ideologies may explain some reluctance by contemporary American parties to budge from platform positions. When voters attach greatest strength to those issues on which they take extreme views, for example abortion or gun control in the United States, parties appear to converge slowly to moderate positions. On issues where voters attach greatest significance to centrist positions, for example Social Security or foreign policy, parties appear to adapt quickly to similar, moderate positions.

Yet even extremist preferences and consistent ideologies lead to parties taking moderate platforms within a few elections. To infer moderate voter preferences from an electoral system with two moderate parties may be a mistake. Political moderation in two-party systems might be as much attributable to the structural incentives imposed by the democratic process as to the moderation of voters' preferences.

In sum, convergence results in spatial voting models with adaptive parties seem robust to changes in voters' preference distributions. Extremist preferences and consistent ideologies tend to create more rugged electoral landscapes, making incumbents more difficult to defeat and slowing convergence. Though the notion of adaptive parties competing on an electoral landscape contrasts with the more traditional notion of rational parties optimally locating in an issue space, we view the two approaches as complementary. The robustness of rational actor models can be tested with more flexible AAA modelling techniques. In this instance, our findings support Down's analytical conclusion that in two-party democratic elections, rational parties tend to locate near the median of voter preferences. We find that adaptive parties rapidly move towards the center, as well, and their convergence appears robust to variations in the distribution of voters' preferences.

Appendix: The Policy Location Procedures

We describe our policy location procedures in the form of computer programs. To clarify the computer codes we have *italicized* explanatory comments and placed them in brackets. For more a more complete description of genetic algorithms see Holland (1975, 1986) and Goldberg (1988).

The subroutine ***adapt***, used in all three search procedures, receives two inputs: the number of adaptations and the platform to be adapted. For example, if we call the subroutine ***adapt(2,CHALLENGER)*** then we run ***adapt*** with k=2 and PLATFORM = CHALLENGER.

adapt(k,PLATFORM)

```
Take PLATFORM and do the following k times:
begin
        randomly pick an issue
        alter PLATFORM's position on the issue by moving to a
        value one unit away
end.
```

For each procedure the challenger's current initial platform will be denoted by CHALLENGER and the campaign length by LENGTH. The platform used in the actual election at the end of the procedure will be denoted as CHOSENPLATFORM. The three procedures are as follows:

Procedure Random Adaptive Parties

```
Take CHALLENGER and do the following
begin
{each loop creates three candidates, hence it is run (LENGTH/3) times}
        for I = 1 to (LENGTH/3) do the following
        begin
{each iteration creates three candidates with I platform changes}
{the use of NUMBER allows us to number the candidates from 1 to LENGTH}
        NUMBER = (I-1)*3
        CANDIDATE(NUMBER+1) = adapt(I,CHALLENGER)
        CANDIDATE(NUMBER+2) = adapt(I,CHALLENGER)
        CANDIDATE(NUMBER+3) = adapt(I,CHALLENGER)
        end;
{The best platform from among the CANDIDATE(·)'s and CHALLENGER is chosen}
Compare CHALLENGER and CANDIDATE(1) through CANDIDATE(LENGTH) let
CHOSENPLATFORM = the preferred platform
end.
```

Procedure Climbing Adaptive Parties

```
Take CHALLENGER and do the following
begin {the search begins by setting TEMPORARY equal to CHALLENGER}
Let TEMPORARY = CHALLENGER
{each loop include three iterations of the algorithm}
        for I = 1 to (LENGTH/3) do the following
        begin
{CANDIDATE(1) differs at 1 position}
        let CANDIDATE(1) = adapt(1,TEMPORARY)
{if CANDIDATE(1) is preferred it becomes TEMPORARY}
                if CANDIDATE(1) is preferred to TEMPORARY
                then let TEMPORARY = CANDIDATE(1)
                let CANDIDATE(2) = adapt(2,TEMPORARY)
                if CANDIDATE(2) is preferred to TEMPORARY
                then let TEMPORARY = CANDIDATE(2)
        let CANDIDATE(3) = adapt(3,TEMPORARY)
                if CANDIDATE(3) is preferred to TEMPORARY
                then let TEMPORARY = CANDIDATE(3)
        end;
{TEMPORARY is the best platform to date so it is chosen}
let CHOSENPLATFORM = TEMPORARY
end.
```

Procedure Genetic Adaptive Parties

```
begin
{the following creates the initial population}
        for I = 1 to POPULATION SIZE do the following
        begin
        CANDIDATE(I) = adapt(I,CHALLENGER)
        end;
{CURRENTBEST keeps track of the best platform to date}
let CURRENTBEST = CHALLENGER
{Each iteration features crossover and mutation so is counted as two units of length, therefore, only
(LENGTH/2) generations are run}
        for GENERATION = 1 to (LENGTH/2) do the following
        begin
{the next subroutine runs the tournament selection mechanism14}
                for J = 1 to POPULATION SIZE do the following
                begin
                randomly choose A and B from [1,2,..POPSIZE]
                let NEWCANDIDATE(J) = preferred platform CANDIDATE(A) or CANDIDATE(B)
                end;
```

```
{the next subroutine modifies the winning platforms[15]}
                randomly pair the NEWCANDIDATE(·)s and for each pair
                begin
{"with probability > P" means that a random number is drawn from a uniform distribution and the
condition is met only if the random number is less than P}
                        with probability > PMODIFY do the following
                        begin
{Crossover allows the candidates to switch positions on issues.  There is a toggle switch which, if on,
allows them to trade, and if off,  does not.  The switch begins in the off position and switches on (off)
with probability PCROSS at each issue}
                        modify the pair by crossover with PCROSS
{Mutation allows each candidate to randomly change a position.  The probability of changing a
position is PMUT}
                        modify the pair by mutation with PMUT
                        end;
                end;

{the final subroutine renames NEWCANDIDATE(·)s as CANDIDATE(·)s}
                for I = 1 to POPSIZE do the following
                begin
                CANDIDATE(I) = NEWCANDIDATE(I)
                end;
{chooses the best of the CANDIDATE(·)s}
        let BESTINPOPULATION = preferred platform among CANDIDATES

{chooses from the current best or the best in the last population}
        let CURRENTBEST = preferred platform BESTINPOPULATION or CURRENTBEST
{this completes a generation of the genetic algorithm}
        end;
{the current best is chosen}
let CHOSENPLATFORM = CURRENTBEST
end.
```

Notes

1. In order to produce equilibria, spatial modelers have come to rely upon probabilistic voting and mixed strategies by parties (Coughlin, 1990).

2. The top cycle set is the smallest set of platforms such that each member of the set defeats all platforms in its complement. McKelvey (1976) shows that generically, the top cycle set equals the entire issue space. The minmax set consists of those platforms that have the smallest m(x), where m(x) equals the maximal number of votes by which platform x can be defeated. Kramer (1977) shows in a dynamic model, that vote maximizing parties move closer to the minmax set. However, once the incumbent's platform lies in the set, the challenger may move outside the minmax set. The uncovered set is the set of all platforms that are not covered. A platform P is covered by platform Q if any platform defeated by P is also defeated by Q. A rational party would prefer to select a platform from the uncovered set. The following bound on the uncovered set is due to McKelvey (1986): Define a median hyperplane to be any hyperplane such that at least half of the voters lie above and at least half lie below the hyperplane. For each platform y, define t(y) to be the smallest real number such that B(y,t(y)) intersects all median hyperplanes. The generalized median, y_m is arg min of t(y) over the set of all platforms. McKelvey shows that the bound on the uncovered set is $B(y_m,4t(y_m))$. Therefore, less symmetric voter preferences imply a larger bound on the uncovered set. In all three constructs, the distribution of voters' preferences effects the size of the equilibrium (in this case, the uncovered) set, and the degree of convergence. Incidentally, finding the uncovered set, top cycle set or minmax set is an NP hard problem.

3. We mean logical consistency in the narrow sense of adherence to a rule and not in the broader sense of satisfying mathematical axioms.

4. One of our search techniques, a genetic algorithm, is known to perform well in environments of various complexity. This feature of genetic algorithms is often underemphasized. Most practitioners stress the evolutionary learning metaphor. See Elster (1979) for a critique of the evolutionary metaphor in social science. Regardless of the ruggedness of the electoral landscape and the means by which political parties locate platforms of high elevation, a genetic algorithm should perform approximately as well. Another of our search techniques, hill climbing, can have difficulty with multi-peaked landscapes, becoming stuck on local optima.

5. Empirically, we know that voters' preferences change over time. Using AAA, a model can be created in which voters and parties co-adapt in the issue space.

6. These parameters fall safely within a range for which no qualitative differences in outcomes are observed.

7. We also created ideological voters by selecting an initial issue (issue 1) and its ideal position, and then requiring the next issue (issue 2) to have an ideal position within plus or minus one the previous issue's ideal position. Issue 3 then had to be within one of issue 2 and so on. The results for this type of ideological preferences proved indistinguishable from those generated by the consistent ideology described in the paper.

8. In the case where strength on an issue equals zero, the ellipse becomes a line. Similar intuition holds in this case.

9. Strictly speaking, for extremist preferences exactly in the center receive no strength. However, those just off from the center get equal (but low) strength.

10. While this will not always happen, it occurs with some regularity.

11. We also considered ideological parties. These parties had lexicographic preferences. Their primary goal was to win election. Their secondary goal was to minimize the distance to their initial platforms, the platforms randomly assigned to them prior to the first election. For the most part, the findings for ideological parties agree with those for the more ambitious parties described in the text.

12. To measure ideological consistency we need a measure that varies inversely with the variance in the platform's positions. Letting var(x) denote the variance of the positions in the platform x, and Maxvar equal the highest possible platform variance (a platform alternately taking positions 0 and 8), we define the **consistency** of a platform as:

$$\mathrm{con}(x) = 1 - [\mathrm{var}(\mathbf{x})/\mathrm{Maxvar}]$$

A platform with no variance has a consistency equal to one, and all consistencies lie in the unit interval.

13. We tested whether the parties might be converging to the median as fast with consistent voters. Because they are coming at the median from opposite directions, we see greater party separation. Running a regression on separation of parties on distance to the median showed only a slightly higher coefficient for separation with consistent preferences than for uniform preferences. The difference was not significant.

14. Tournament selection is not effected by monotonic transformations of the fitness function. In other words, no bias results from our choice of fitness function scaling.

15. The parameters we chose for our genetic algorithm were PMODIFY = 0.5, PCROSS = 0.013, and PMUT = 0.07. PMODIFY and PCROSS are well within traditional ranges for genetic algorithms. Mutation rates can be chosen from wide ranges (see Goldberg 1989). We chose PMUT = 0.07 so that on average one issue will be changed each iteration.

Figure 1

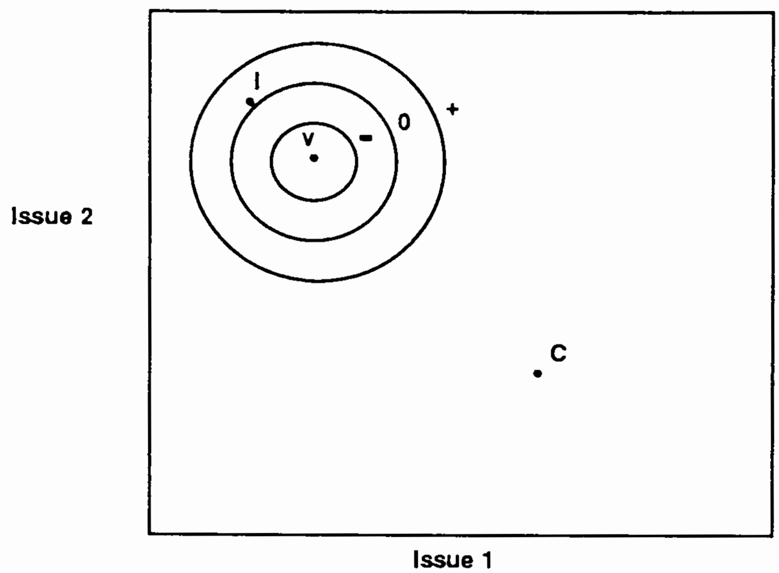


Figure 2

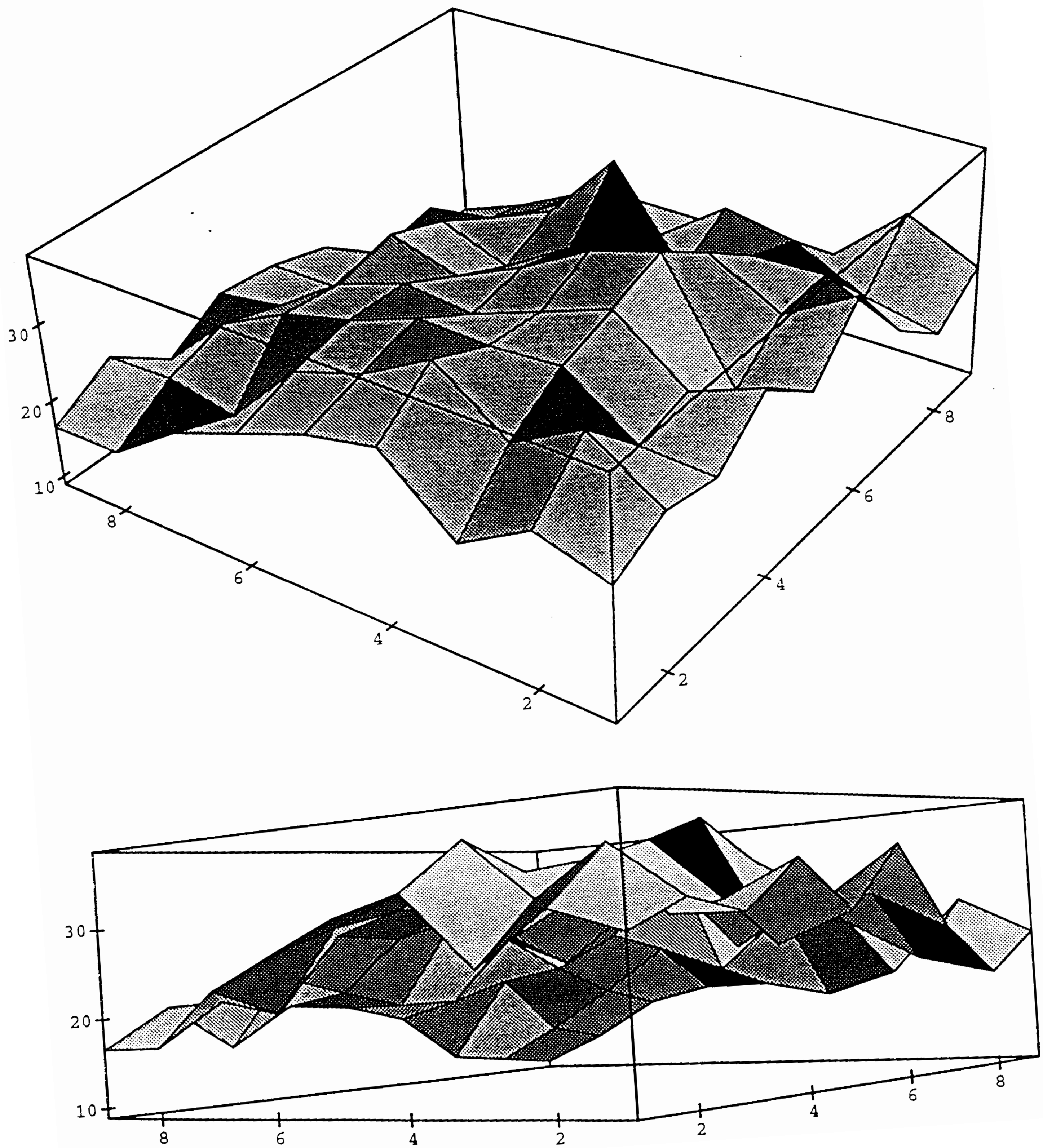


Figure 3

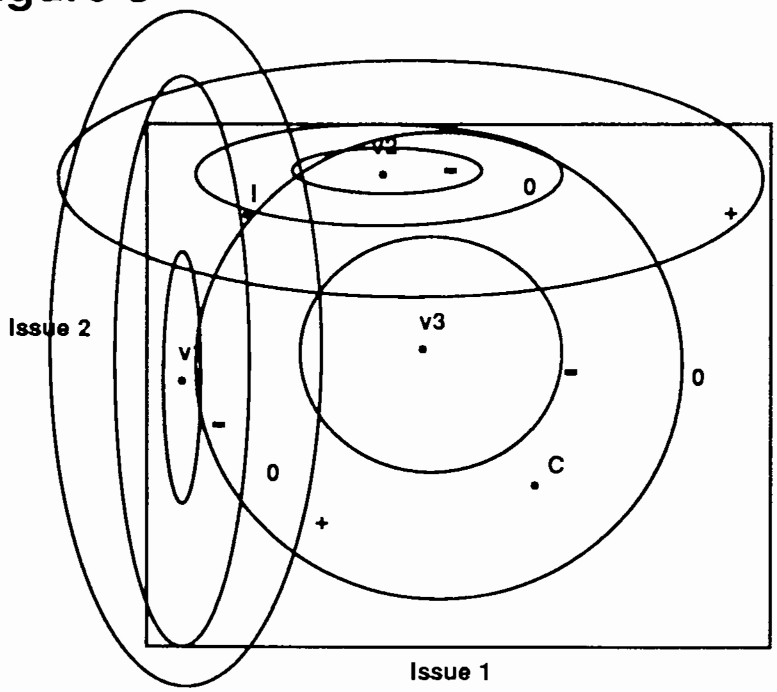
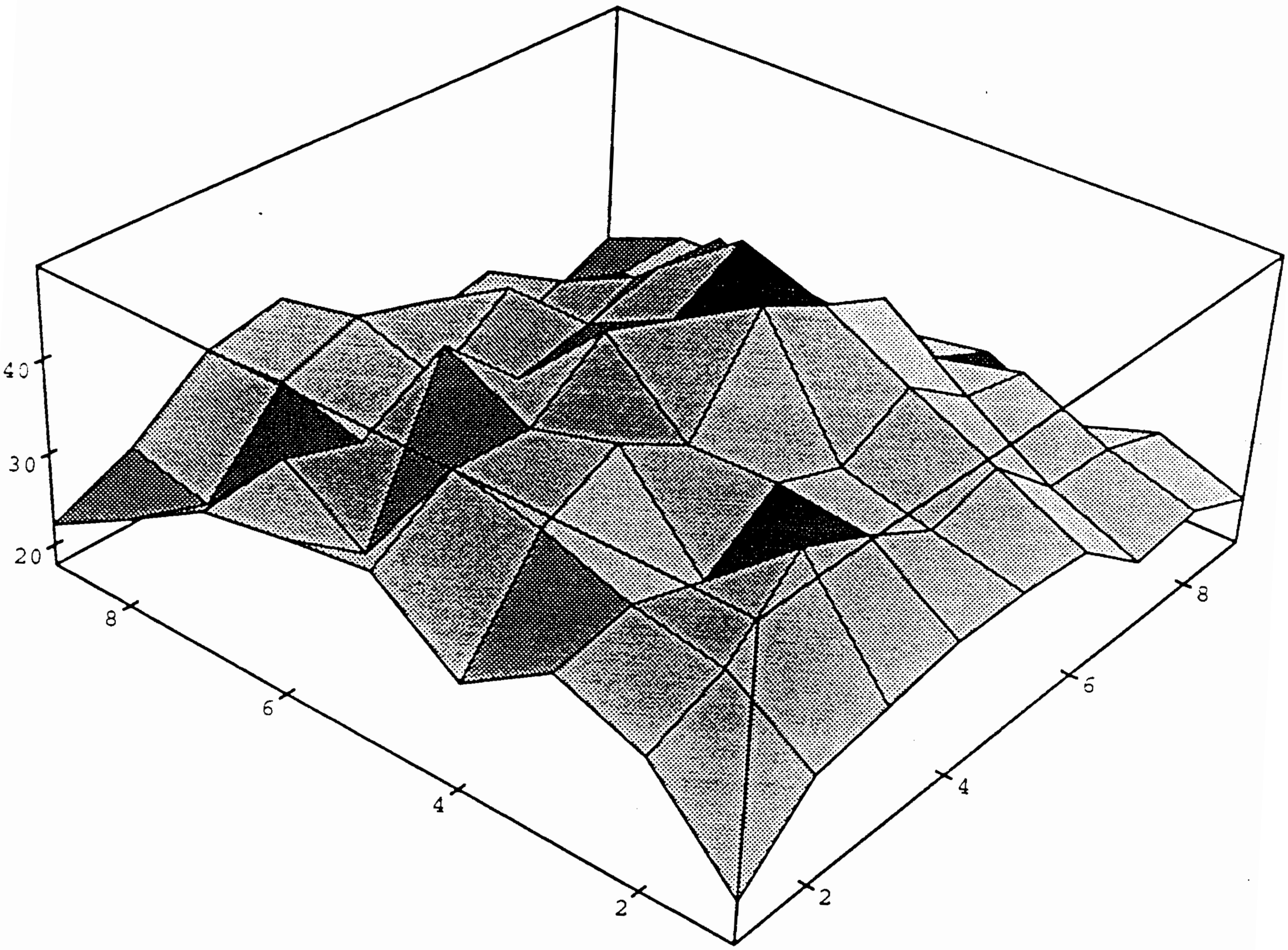


Figure 4



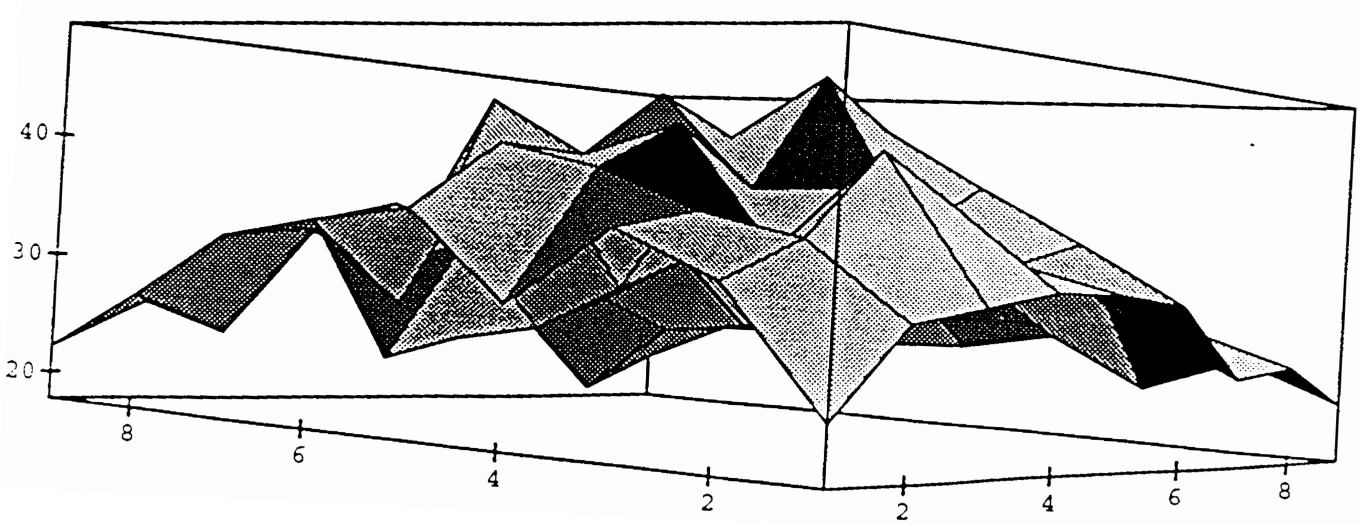


Figure 5

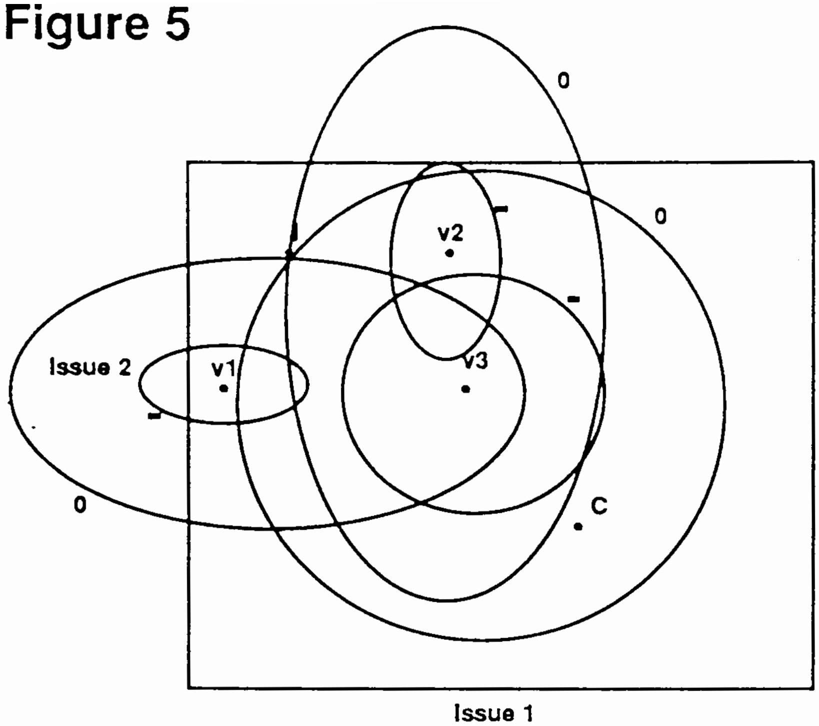
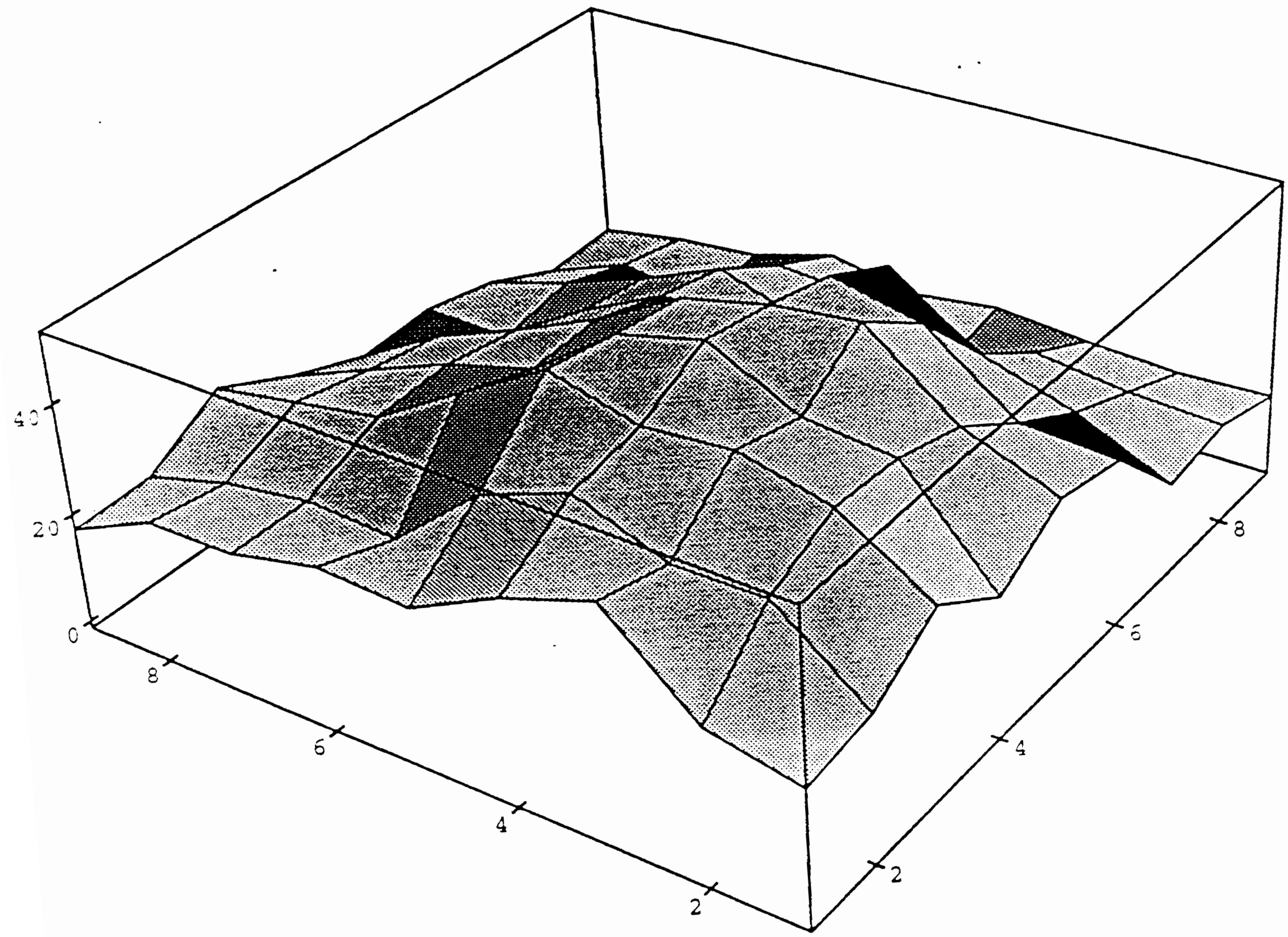


Figure 6



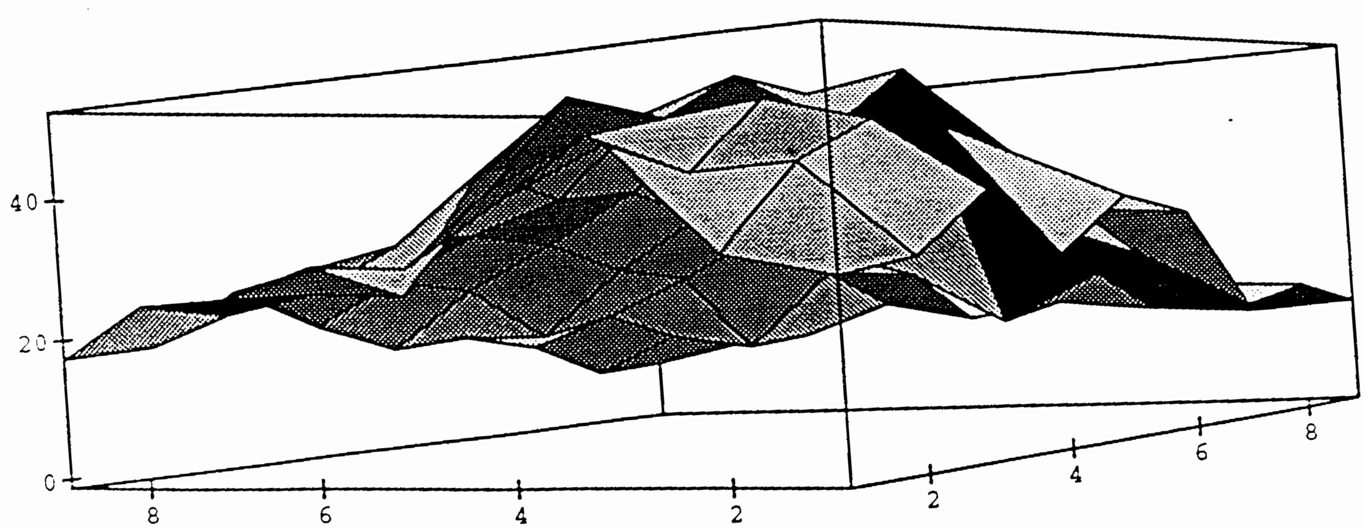
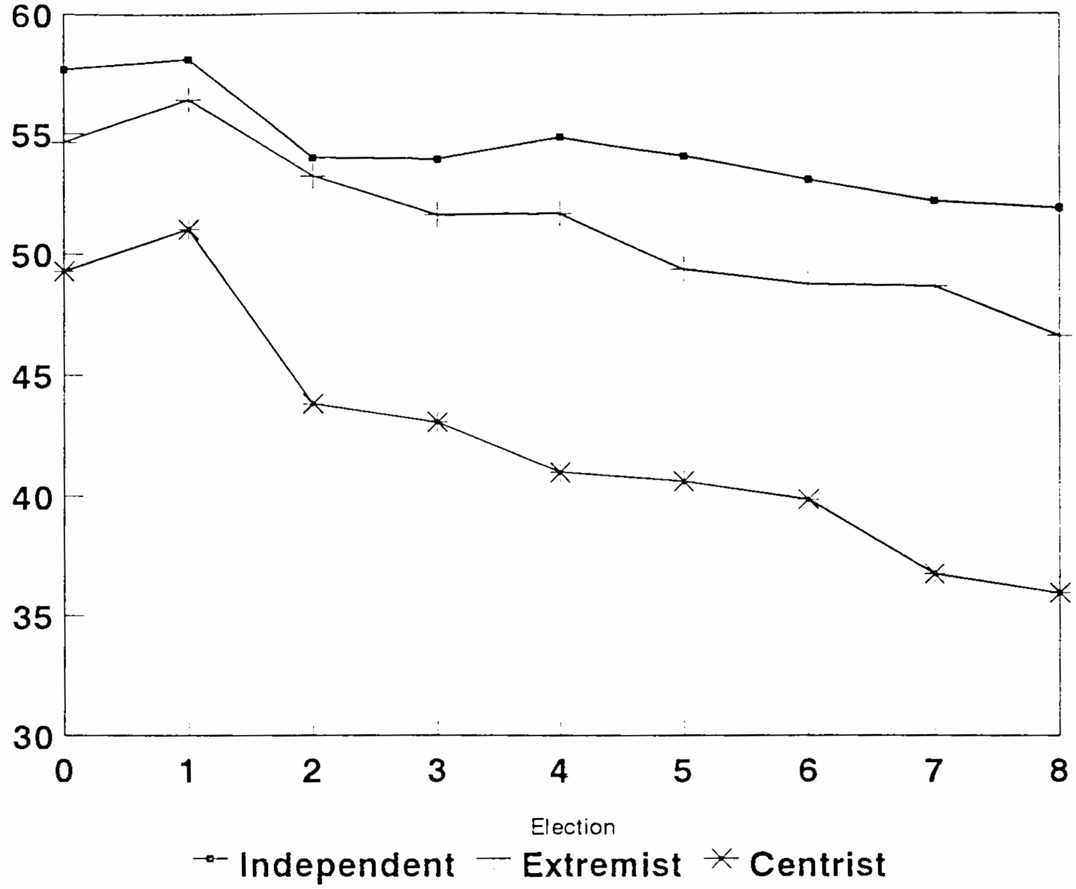
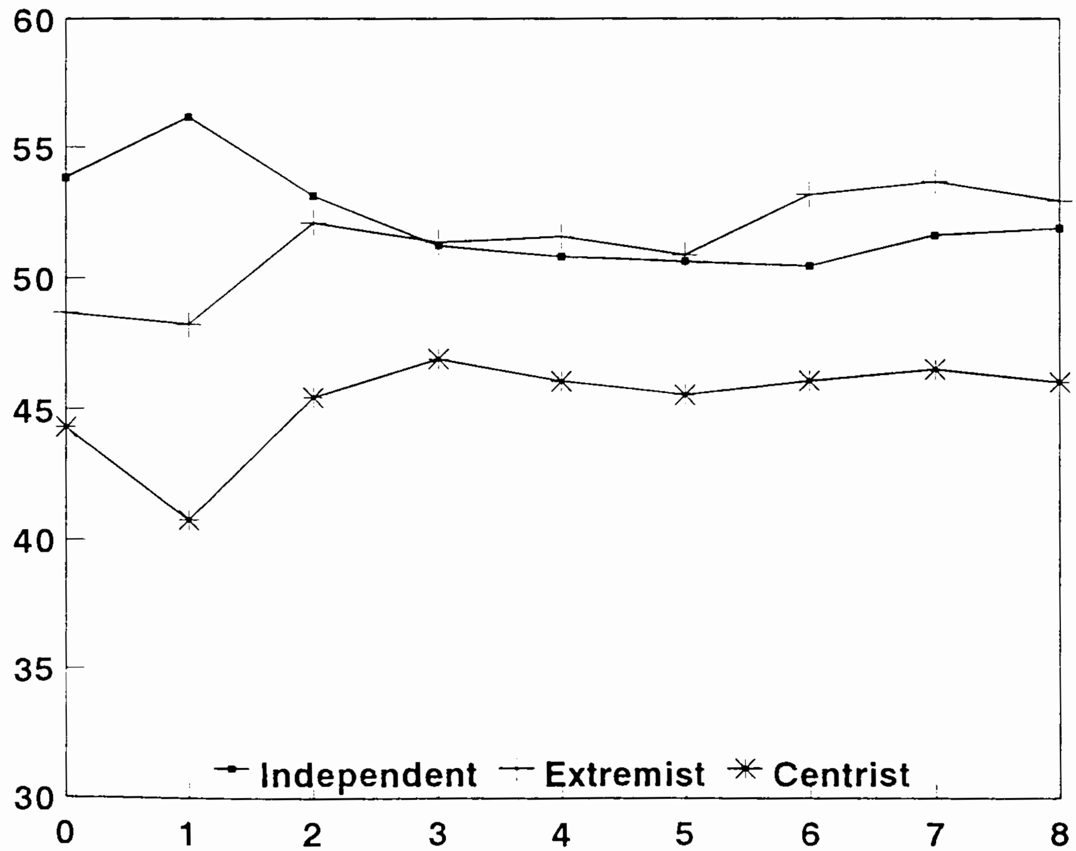


Table 1

Percentage of One-Dimensional Maxima/Minima
Platforms for Climbing Adaptive Parties



Percentage of One-Dimensional Maxima/Minima Platforms for
Climbing Adaptive Parties



Results from 100 trials, run for 40 iterations each election. Platform analyzed was that of the incumbent party prior to the challenger party's adaptation

Table 2

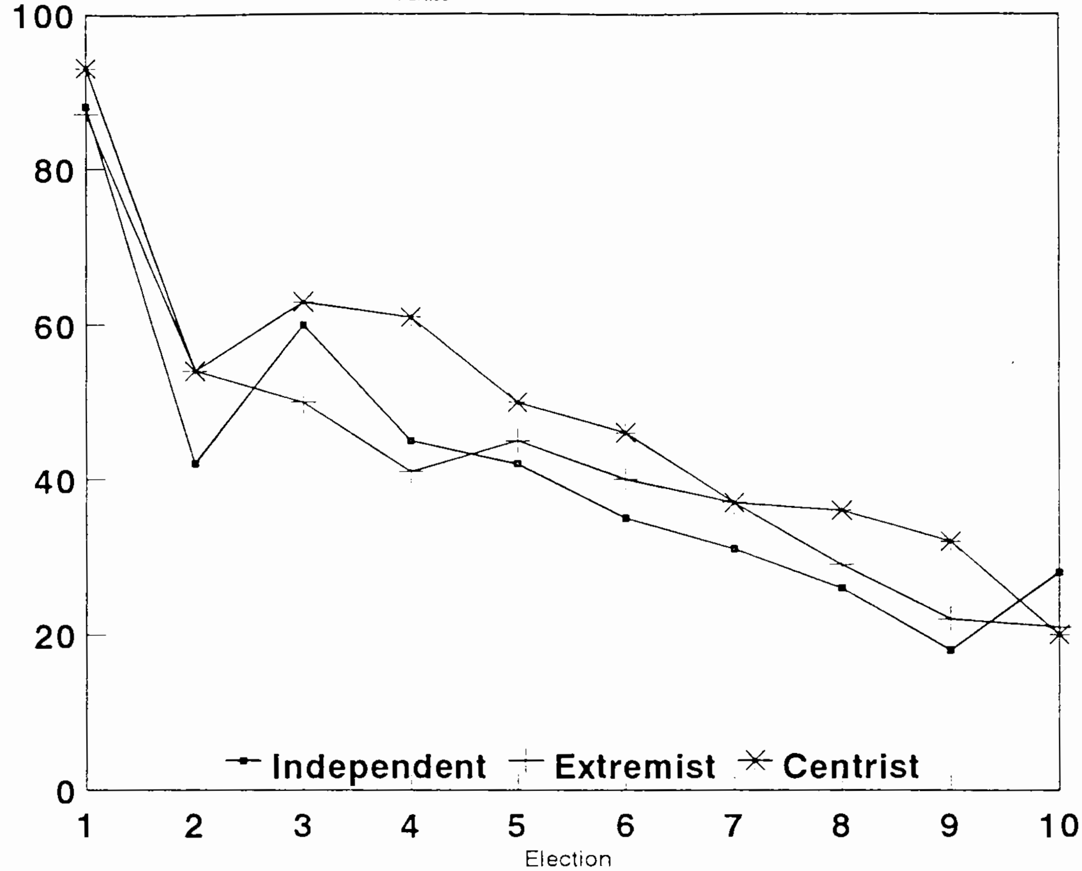
Number of Elections Until Reaching Top X% of Platforms

	Genetic		Climbing		Random	
	5%	1%	5%	1%	5%	1%
1. Uniform Independent	1	1	2	3	1	3
2. Uniform Centrist	1	1	1	2	1	3
3. Uniform Extremist	1	1	1	3	1	3
4. Consistent Independent	1	1	1	3	1	3
5. Consistent Centrist	1	2	1	3	1	3
6. Consistent Extremist	1	1	1	3	2	4

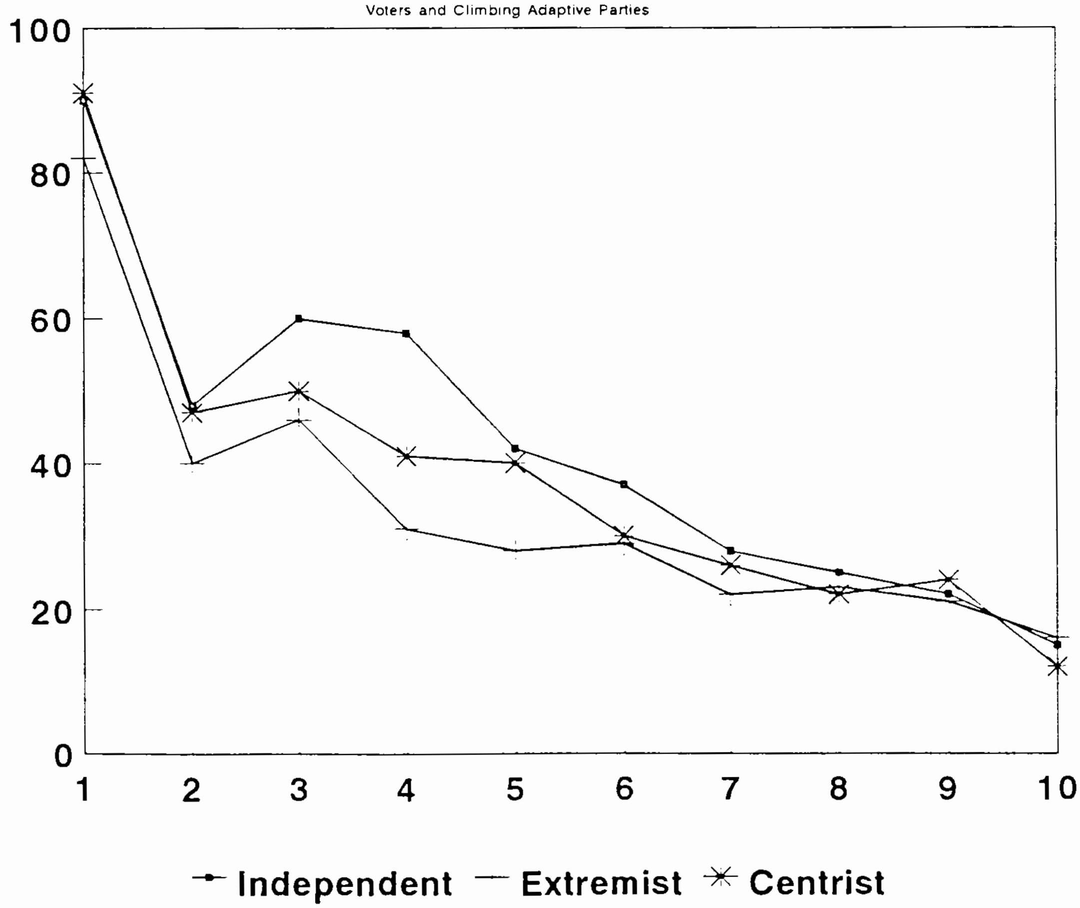
Results from 100 trials: The Climbing and Random algorithms were run for forty iterations in each election and the Genetic Algorithm ran for 20 generations with a population size of 12.

Table 3

Percentage of Winning Challengers with Uniform Voters and Climbing Adaptive Parties



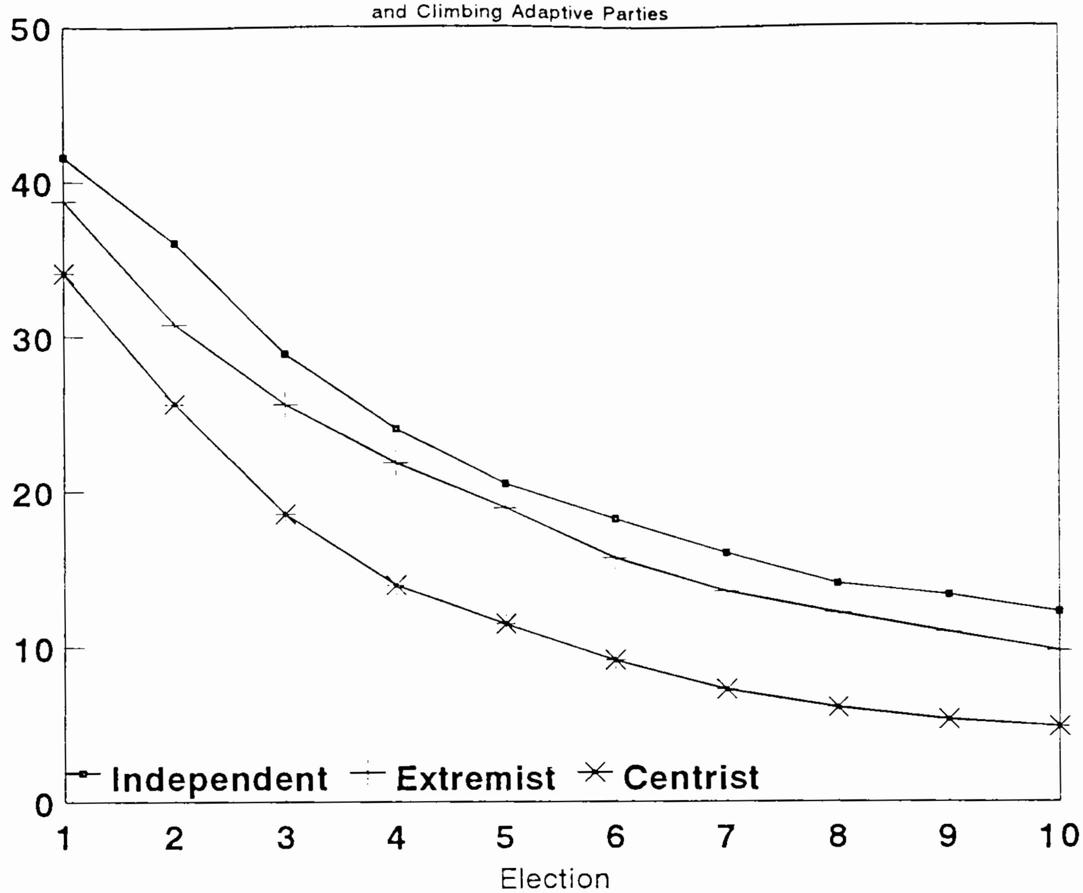
Percentage of Winning Challengers for Consistent Voters and Climbing Adaptive Parties



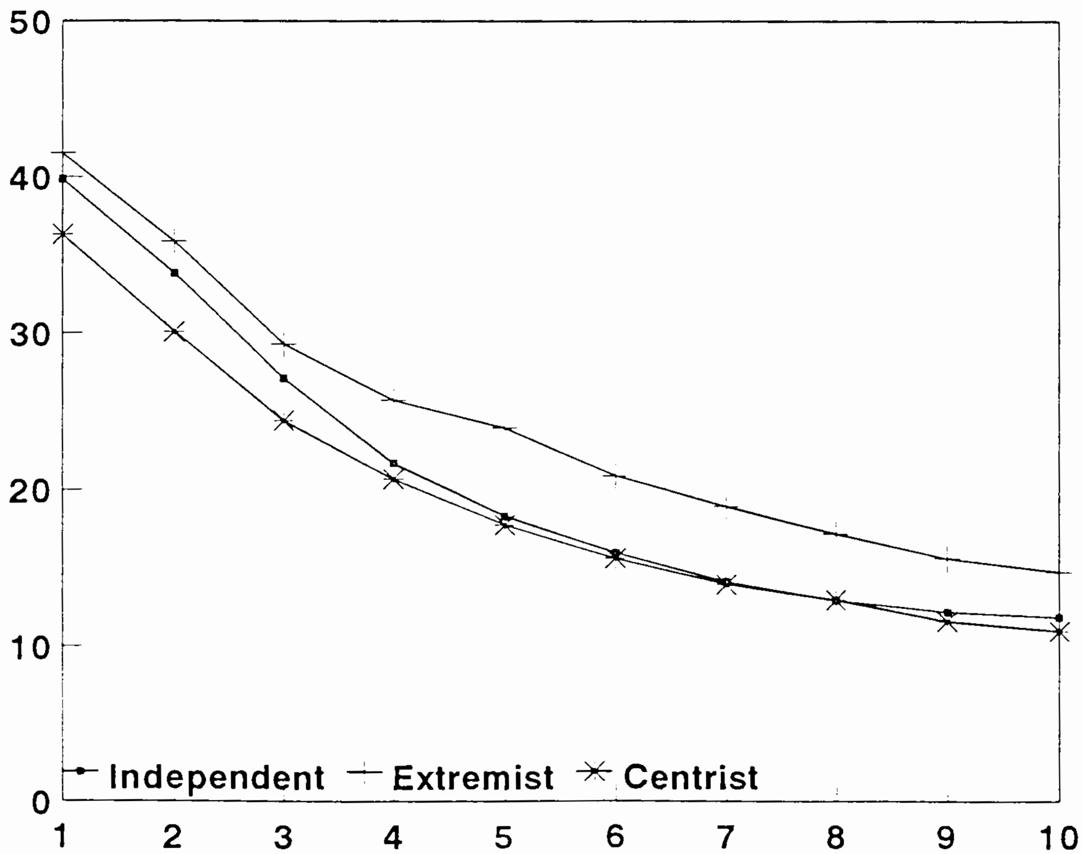
Results from 100 trials Climbing algorithm ran for 40 iterations each election

Table 4

Distance to Median: Uniform Ideology
and Climbing Adaptive Parties



Distance to Median:
Consistent Ideology and
Climbing Adaptive Parties



Results from 100 trials. The climbing algorithm was run for forty iterations each election.

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