ALEX3: A simulation program to compare electoral systems

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Abstract: The paper describes a simulation program for comparing electoral systems. The user fixes some basic features, like the distribution of first preferences, their peakedness, the dimension of the districts, and so on. The program produces the resulting Parliament under a number of electoral system, an index of representativeness and an index of governability. Some possible uses are discussed.

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Part 1: Theory

1.1. Introduction\(^1\). This paper describes a simulation program for comparing electoral systems. It has been designed for the election of a (one-Chamber) Parliament. Obviously, it may be used for analogous settings as well.

An electoral system affects many aspects of the political process\(^2\). Fortunately, however, there is a general agreement that two of them are of paramount relevance, that is the efficiency in representing electors' will and the effect on the efficiency of the resulting Government. We'll label the first dimension *representativeness*, shortened with R, and the second one *governability*, G. G and R may be evaluated through the assessment of numerical *indicators*, hopefully plausible but unavoidably arbitrary. We will label them \(g\) and \(r\) respectively. There should be no shyness in suggesting that electoral policies may be based on the values of indicators: this is what happens every day in economic policies, frequently driven by changes of decimals in quite rough indicators like aggregate inflation or GNP growth rate. Section 4 describes in detail the indicators employed here. Briefly, \(g\) depends on the number of parties and of MPs supporting the Government, and \(r\) depends on the difference of seats attributed to parties under the system considered and under proportional representation, supposed to be the most representative system. The range of both is the interval 0-1.

1.2. Simulative assessment of electoral systems. Consequently, we assume that electoral systems may be evaluated through their performance with reference to \(g\) and \(r\). In order to do that, however, *real* data are of limited utility. The reason is obvious: the information collected is too poor. Among really-used systems only single transferable vote and approval vote provide information on second and further preferences. Only mixed-members systems provide information useful both for proportional and majority or plurality voting. In addition, the real vote is strongly influenced by the electoral rules. For instance, there will probably be few parties if constituencies are first-past-the-post, so there will be no basis to assess the utility of a possible change to proportionality. If we want to compare for instance Condorcet voting with majority rule or perfect proportionality, we cannot rest on reliable, comparable and generalizable real-world data.

This is why it is useful to resort to simulation. Our program, developed at the Laboratory for Experimental and Simulative Economics of the University of Piemonte Orientale, allows (for the

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\(^1\) This section summarizes the introduction of Ortona, 2002a.
\(^2\) See Ortona (2002a or 2002b) for a sixteen-item list taken from recent literature.
moment) to compare eleven electoral systems, namely plurality, runoff majority, one-district pure proportionality, one-district threshold proportionality, multi-district pure proportionality, Condorcet, Borda, two mixed-member systems, single transferable vote and VAP. VAP is a suggested new system, described in detail in other papers (see Ortona, 2000 and 2002a); by and large, it assigns a premium of votes (but not of seats) to the governing majority, in order to enhance the governability\(^3\). The basic features of the program are summarized in the next section, while a broader illustration is in part 2; for a fully comprehensive description, however, you must resort to the user's guide, see sect. 2.5. As for the remainder of this part, section 4 describes the indicators, and sections 5 and 6 draw some suggestions for policy-making and for improving the program.

1.3. Basic features of ALEX3. The experimenter may fix a number of characteristics, namely:

a) The size of the Parliament;

b) the number of voters;

c) the number of parties (i.e. the number of candidates in every constituency for non-proportional systems);

d) the share of votes of the parties;

e) the “peakedness” of the preferences of the voters. This feature is controlled through the probability that second and further preferences are the closest to the first, to the second etc.;

f) the concentration of the parties across the constituencies.

All data are requested through user-friendly windows.

The program allows to simulate realistic cases - it is for instance possible to create a “country” where there are some four medium-size parties and a cohort of small ones, with significant regional clusters, like in Italy today, as well as one with just two large parties and one or no minor ones, as majoritarian-system supporters dream.

Once the data have been assigned, the program asks in turn for the electoral systems, and for each system produces the corresponding Parliament. Then it asks for the parties entering the majority, and produces the value of the indices. Results may obviously be exported in all usual ways. This concludes the session, but data may be used for further elaboration, as will be suggested in section 5.

1.4. The indices employed. As for representativeness, there are several indices of proportionality available in the literature, and proportionality may be considered a good proxy for

\(^3\) Approval voting has been excluded as previous experiments showed that it is inferior to Condorcet voting with reference both to G and R. See Ortona, 1998.
representativeness: Gallagher, Rae, Mudambi (1997), Lijphart, etc\textsuperscript{4}. Unfortunately, they are useless. The reason is obvious: they are, by necessity, based on the difference between the share of votes and that of seats, and both figures are system-specific. All the indices quoted may be employed to compare the performance of a given electoral system across different cases, but are of no use if one aims instead to compare different electoral systems in a given case, which is the purpose of ALEX3. The situation is slightly better for governability, where at least three indices may in principle be used, plus sensible combinations of them\textsuperscript{5}. They are:

   a) \textit{Pre-election identifiability}, which scores (“impressionistically”, according to Shugart and Wattenberg) 1 if electors may designate directly the government, 0 if they do not, 0.75 if there are two well-defined blocs but neither can be identified with a government before the election, and 0.5 when only one bloc is clearly defined.

   b) \textit{Plurality enhancement}, which is defined as \( s/0.5 - v/0.5 \), where \( s \) is the share of seats of the largest party (or coalition), and \( v \) that of votes. A high value of the index means that “few” votes became “many” seats, thus allowing for a sounder majority.

   c) \textit{Majority approximation}, which scores 1 if one party (coalition) gets a majority, and \( s/0.5 \) if not, where \( s \) is the share of seats of the largest party.

Index a) is unsatisfactory, as it is too ill-defined for a simulative quantitative analysis. Index b) again combines the share of votes with that of seats. The index c) may be used, but it may provide unrealistic results, and can be improved. For instance, the score is the same whether a party, ruling alone, has 51% or 90% of the seats. If the government is made up of a coalition of two parties each with 40% of the seats the value of the index is 0.8; a much weaker coalition of four parties with 42%, 3%, 3% and 3% scores more.

To sum up, in the literature there are no indices sufficiently sensible and fine-tuned to be employed in quantitative simulations; hence we created new ones, both for representativeness and for governability. The index for R draws on the basic idea of comparing votes and seats, using the votes expressed in proportional representation as indicative of the true preferences. The index of governability accepts the principle that the governability reduces with the number of the parties in the governing coalition, so it may be considered a refinement of the majority approximation. For sake of clarity, both are standardized in the interval 0-1. Their description follows\textsuperscript{6}.

\textit{Index of representativeness, r}. In principle, the index for a given electoral system should be based on the difference between the distribution of seats assigned by that system and votes cast under pure proportionality. However, in a nation-wide district the share of votes and that of seats

\textsuperscript{4} For a review, see Lijphart (1994, p.67).
\textsuperscript{5} See Shugart and Wattenberg, 2000, p.30; Shugart 2001.
\textsuperscript{6} For a more detailed discussion of the indices, see Ortona, 2002a.
under pure proportionality may be safely assumed as equal; hence the index is based on the
difference between the share of seats of the system to which the index refers and that of one-district
pure proportionality. The formula is

\[
 r_j = 1 - \frac{\sum_{i=1}^{n} |S_{j,i} - S_{pp,i}|}{\sum_{i=1}^{n} |S_{u,i} - S_{pp,i}|}
\]

where \(j\) refers to the electoral system, \(n\) is the number of parties, \(S_{j,i}\) is the number of seats
obtained by party \(i\) under system \(j\), \(S_{pp,i}\) is the number of seats obtained by party \(i\) under perfect
proportionality rule (PPR), and \(S_{u,i}\) is the number of seats obtained by party \(i\) if all the seats go to
the largest party.\(^7\)

The loss of representativeness incurred by party \(i\) is the (absolute) difference between the
seats it would get under PPR and those actually obtained. Summing this loss across all the parties
we obtain the total loss of \(R\) \((\text{first sum})\). In order to normalize (0 to 1) this value, we divide it by the
total possible loss of \(R\). This maximum is obtained when the relative majority party takes all the
seats \((\text{second sum})\). This way we got a \textit{loss of representativeness index}, normalized in the range 0-1.
Subtracting it from 1 we transform it into a \textit{representativeness index}.

\text{Index of governability, } g.

Many scholars assume that governability is inversely related to the number of decision
makers, i.e. of parties in the governing coalition. There is a lot of debate on this topic. Some authors
(including one of the authors of this paper) do not agree: see for instance Lijphart, 1994, or Farrell,
2001. However, this is the only general argument to prefer non-proportional system; hence we
accept it, to make the program useful for those who share this opinion, avoiding a broader
discussion that would clearly be beyond the purpose of this paper. More precisely, we assume that
Governability depends mostly on the number of \textit{crucial} parties of the governing coalition, i.e. of
parties that \textit{destroy the majority if they withdraw}, \(m\); and secondarily on the \textit{share of seats of the
majority}, \(f\). Hence, we add lexicographically the \(f\)-component, \(g_f\), to the \(m\)-component, \(g_m\). The
range of \(g_f\) is the difference between successive values of \(g_m\): the term in \(m\) defines a lower and an
upper boundary, and the term in \(f\) specifies the value of the index between them.

The limits defined by \(g_m\) are simply \(1/m\) (upper boundary) and \(1/(m+1)\) (lower boundary).
For instance, if the Government is supported by just one party, \(g\) is comprised between 0.5 and 1; if

\(^7\) The value of \(S_{u,i}\) is the total number of seats for the largest party, and 0 for all the others. If several parties are the largest ones \textit{ex
aequo}, we take the one which is the largest under most systems in the case considered.
it supported by two (or by three and more, but with only two large enough to destroy the majority if they withdraw) $g$ is comprised between 0.333 and 0.5, and so on. Note that the addition of new parties produces smaller and smaller decreases in $g$, as it should be. The figure to be added to the lower boundary, $g_f$, depends on the lead of the majority coalition, according to the following proportion:

$$g_f[1/m - 1/(m+1)] = (f-t/2)/(t-t/2)$$

from which

$$g_f = [1/m - 1/(m+1)] (f-t/2)/(t/2)$$

where $t$ is the total number of seats in the Parliament.

For instance, if there are 100 seats, and the governing majority is made up of one party with 59 MPs, the value of $g_f$ is 0.09 ($9/50*1/2$). This value must be added to 0.5, to give a value of $g$ equal to 0.59. In sum, the formula for $g$ is:

$$g = g_m + g_f = 1/(m+1) + [1/m - 1/(m+1)] (f-t/2)/(t/2)$$

where $m =$ number of crucial parties supporting the Government, $f =$ number of seats of the majority, $t=$ total number of seats. The value of $g$ reaches its maximum, 1, when a party as all the seats (i.e. $m=1$), and decreases with the increase of $m$, thus justifying the claim that the range of $g$ is the interval $(0,1]$.

1.5. **Policy suggestions.** The limit to the use of the program is your fantasy. The simple assessment of $r$ and $g$ for several systems in realistic cases is useful by itself. The effect of clustering of votes on the performance of an electoral system could be assessed. It could be of interest to compare the results of pure proportionality with those of single transferable vote, given different characteristics of the voters. One could investigate the relative performance of Condorcet and Borda, thus giving rest to their souls, as their ghosts are probably still debating somewhere in the skies. Also, it is possible to investigate experimentally the "real" occurrence of Condorcet cycles. And so on. Just to give a suggestion, we discuss at relative length three more ambitious topics that could usefully be tackled with the aid of ALEX3.
The first one is no less than the choice of the best electoral system. A system that performs better than any other with reference to both G and R may safely be deemed the best one, albeit on a pure empirical basis and with reference to the considered systems only. Yet, such system probably will not be found, as there is normally a trade-off between the two objectives.

However, the policymaker can in principle establish \textit{a priori} a relationship between the two dimensions, in order to leave it to the electoral process to produce “objectively” the best system. A sketch of the procedure follows; a more detailed description may be found in Ortona (2002b) and in Fragnelli, Monella and Ortona (2002).

First, Assume that the social utility function for electoral systems is a Cobb-Douglas function in \( g \) and \( r \), \( U = A g^a r^b \). This form is suitable not only for its simplicity and versatility, but also for the meaning of \( a \) and \( b \), the partial elasticities of \( U \) with reference to \( g \) and \( r \) respectively.

We may trace indifference curves and pick the system lying on the highest one, as follows. The expression for the generic indifference curve \( r = r(U^*, g) \) is

\[
[1] \quad r = \left( \frac{U^*}{A} \right)^{1/b} g^{a/b} \quad \text{i.e.} \\
[1'] \quad r = \frac{W}{g^p}
\]

Where \( p = a/b \).

For a given value of \( g \), the value of \( r \) increases with that of \( W \), and the value of \( W \) with that of \( U^* \). Consequently, it is sufficient to solve equation \([1']\) for \( W \), \textit{given} \( r \), \( g \) and \( p \), for each system considered. The system with the highest value of \( W \) is the best one. If you are sufficiently able in computer plotting, the solution may appear graphically.

The only \textit{a priori} information needed to compute \([1']\) is the value of \( p \), the ratio of the elasticities. The ratio may be considered a proxy for the relative weight that the community assigns to relative increases in the value of \( g \) and \( r \). If for instance a -say- 10% increase in \( g \) is valued more than the same increase in \( r \), \( p>1 \), and viceversa. We argue that this parameter may actually be provided by the political system. There are several possibilities. For instance, the community may "start" with \( a=b \), and change the ratio for the next election if the entity in charge thinks that representativeness or governability have been excessive. Another possibility is that the community orders the systems according to their supposed degree of proportionality, and chooses the first one (i.e. PPR) if the value of \( g \) is above a given threshold; otherwise it moves to the second one, and so
on. Under this rule, the best system is the most proportional one, provided that the governability reaches a given value (or viceversa, obviously)\(^8\).

Second, it becomes possible to choose the electoral system after the vote. Scholars are increasingly concerned by the problem of avoiding the exploitation of the pitfalls of electoral systems by political rent-seekers. Mixed-members systems are particularly appreciated, as they force the parties to try to maximise their support both in a majoritarian and in a proportional environment (see f.i. Shugart, 2001; Shugart and Wattenberg, 2000). Choosing the system after the vote would work better. It makes it possible not only to force the parties to behave that way, but also to avoid a wrong assignment to the seats to the majoritarian and proportional shares\(^9\). To choose the system after the vote it is not necessary to resort to the evaluation of an utility function. Practical rules will suffice: for instance, "the system to be adopted is the one with the highest value of \(r\), provided that \(g\) is not below a given threshold" Alternatively, the decision maker approach could be employed: the figure to be considered is the value of \(p\) that changes the choice for every reasonable pair of systems.

Less ambitiously, the simple evaluation of the value of \(p\) implicit in the choice of an electoral system may be of some interest –actually, in our opinion, of great interest.

Finally, the problem of system-specificity of the choice of voters remains open. The law of Duverger and/or the median voter principle force the electors in non-proportional systems to concentrate on median parties. Consequently, if the actual electoral system is, say, majority, it may look unrealistic to assume as effective preferences those cast hypothetically with PPR, as ALEX3 allows to do. However, it is also unrealistic to assume that preferences expressed in a two-party system are real, as many, possibly most voters would probably choose non-median parties, were they in condition of having their candidates elected. Is there a way to consider the actual loss in proportionality incurred in moving from proportionality to majority of plurality? The answer is yes, at least with reference to the best majoritarian system available, Condorcet\(^10\). Under (one-district) PPR the distribution of seats may safely be supposed to be the same as that of first preferences; and in the Condorcet system the winners are deduced directly from the order of preferences. Consequently, the difference in \(r\) between Condorcet and Proportionality is a good estimator of the loss of proportionality incurred in the process, for a given set of preferences.

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\(^8\) Note that \(p\) may also be characterized in another, more suggestive way. It is the price in terms of a relative decrease of \(r\) that the community accepts to pay for a given relative increase of \(g\) (and \(1/p\) the opposite). It is easy to show that if for instance \(p = 2\), it is worthwhile to accept up to a 20% reduction of \(r\) to gain a 10% increase in \(g\).

\(^9\) Note that any partition of the seats between a proportional and a majoritarian rule may be considered a specific electoral system.

\(^10\) The capacity to determine the Condorcet winner is commonly assumed as the criterion to evaluate uninominal systems. See for instance Merrill (1984) or Mueller (2003, ch. 7).
For these topics, and especially for the last one, the simulative approach is very valuable: as we saw, real data are poorly reliable and comparable.

1.6. Future improvements\textsuperscript{11}. The next version of the program will (hopefully) include some additional main features.

First, we plan to include at least a power index, probably based on Banzhaf's. The analysis of the distribution of power is obviously of great interest \textit{per se}; but it will also open the way to a different approach to the study of both governability and representativeness\textsuperscript{12}. Just to give a flavor of the problems that may be addressed: shall we desire a \textit{fair} distribution of power, for the sake of representativeness, or a \textit{concentrated} distribution of power for the sake of governability? Is it possible to find a system that best marries a fair distribution of power with a high level of governability - or viceversa a concentrated power with a high level of representativeness?\textsuperscript{13}

Second, we plan to introduce further indices both for G and R, mostly to run a sensitivity analysis on the indices.

Third, we plan to make the program apt to import databases of voters.

Fourth, further systems will be added.

Finally - further improvements may be suggested by the users. If you would like to be among them, please contact the corresponding author (see the last section of part 2 for details).

\textsuperscript{11} This is the third version of the program. The first one required a specific database and did not include plurinominal systems (see Ortona, 1998; Trinchero, 1998). The second is like this one, but without plurinominal systems.

\textsuperscript{12} An interesting discussion of power topics in is Mudambi \textit{et al.}, 2001.

\textsuperscript{13} In a previous paper, the Gini coefficient relative to the Banzhaf's power indexes was employed as an additional measure of governability; but the computing was performed outside the simulation program. See Ortona, 2002a.
2. Description of the Program

2.1 How to use ALEX3. ALEX3 is written in Java. Therefore, Java (or at least Java Runtime) must be installed on the computer. Java Runtime can be downloaded from http://java.sun.com. The program works through user-friendly windows. The first window allows to set up the number of electors in each uninominal district, the number of uninominal districts, the magnitude of plurinominal districts, the number of parties, the probability to choose the next party in the order of preferences, the probability to choose the second next party, the probability to choose the preferred candidate. The first two probabilities are employed to establish the complete ordering of preferences of the voters; the third to allow the choice of candidates of parties different from the preferred for single transferable voting. In the following window, the user is requested to set up the characteristics of the political parties: their overall share of votes (“quota”), and whether they are concentrated in one or more district. At this point, the user has the possibility to save the values of the parameters of the simulation in a text file.

When all the parameters have been established, the program starts searching for the electors’ preferences for the political parties and creates the uninominal districts. If plurinominal systems are requested the program will also compute the electors’ preferences for the candidates of each party, and the plurinominal districts will be created by grouping the uninominal ones. When the districts have been created, the user can save in a text file the electors’ preferences for the parties and the candidates (if created), and the composition of uninominal and plurinominal districts (if created). It is possible to append these results to the file created earlier.

Next, the list of electoral systems that can be simulated is displayed. To see the parliament resulting from a given system, the user must simply click on the button next to the name of the system. A new window opens with the characteristics of the parliament: number of seats and representativeness index. The user is requested to create a government; the resulting governability index will appear. Some electoral systems need some extra parameters: the user will be asked to set them up via a dialog window which appears when clicking on the name of the electoral system. Other buttons allow to save the characteristics of the parliament, or to close the program. There is no limit to the number of windows one can open, so it is possible to open a window for each system in the list\textsuperscript{14}.

\textsuperscript{14} To avoid the mushrooming of possible governments, it is almost inevitably necessary to adopt some rules concerning the coalition that will actually be chosen. A reasonable set is to suppose that (a) the government must enjoy the majority of seats and (b) the government is made by a minimum winning coalition of parties adjacent on the left-right axis. The program could easily implement
2.2. Description of the program: voters, parties and constituencies. To assign the votes to the parties, the first n1 electors are given a first preference for party 1 (n1 corresponding to the share of votes of party 1 in the population), the next n2 electors are given a first preference for party 2 (n2 corresponding to the share of party 2 in the population), etc. Parties are ordered on a left/right scale, with party 1 being on the far-left and party n being on the far-right. Once the first preferences of the elector are known, the program creates their complete preference ordering, using the probabilities defined in the first window of the program: the probability to choose the first next party and the probability to choose the second next party (if the two probabilities do not sum to 1, the rest is the probability to choose another party at random).

More precisely, in order to choose the party at the second place in the elector’s preference ordering, the program (a) removes the first preferred party from the list of parties and save it in the first place in the vector of the elector’s preferences, and (b) with probability p1 chooses the party next (randomly right or left) to the preferred party, with probability p2 choose the second next party, with probability p3 = 1 - p1 - p1 chooses another party. This party is inserted at the second place in the elector’s preference ordering and becomes the party currently preferred. To find the rest of the preference ordering, ALEX3 proceeds in the same way, using the party currently preferred as a starting point. The procedure is duly corrected for the case when the currently preferred party is at one extremity of the list of parties.

The districts are created after the electors’ preferences for parties have been computed. Each district contains E electors, E being set by the user at the beginning of the session (hence, all districts have the same size). In the program, political parties can be concentrated in a given number of districts, to simulate regional clustering or gerrymandering. A party that is concentrated in one or more districts is called a major party. When a party is major, you need to establish the number of districts in which it is concentrated, and the coefficient of concentration T > 1, which allows to compute the number of electors with this major party as first preference assigned to the district(s). In other words, we define (a) the number of districts in which a given party is concentrated, K and (b) the total number of electors in the population who have that party as first preference, F. Each district in which the party is concentrated contains T*F/K electors who have this party as first preference. Obviously, in remaining districts they are less than the average share, as the overall share has been fixed.

the conditions, thus producing automatically the government; however, we preferred to leave this task to the user, as condition (b) is not that frequent in real world, and it may be of interest to explore different governments.
The plurinominal districts are created by grouping the uninominal ones, keeping the concentration in due account.

2.3. Short notes on the electoral systems

*One-district Proportionality*

The districts are aggregated, and the seats in the parliament are distributed according to the shares of votes of the parties in the population. In other words, the seats represent the weight of the parties as inserted in the third window of the program. By construction, the value of the index of representativeness is 1.

*Threshold Proportionality*

When the user clicks on the button next to this system, a dialog window appears, asking for value of the threshold. All the parties who have a share of votes (strictly) smaller are excluded from the parliament. The seats are distributed proportionally among the remaining parties.

*Plurality*

The candidate (i.e. the party) with the most votes wins in each district.

*Runoff majority*

In each district all parties but the two with the most votes are excluded. The second round is executed with these two parties only and the one with the most votes wins. If after the first round the first party has at least 50% of the votes, it is elected without the need of a second round.

*Mixed Member System, 1*

Part of the parliament is elected with the Plurality System, and the rest is elected using the Proportional System. The share of seats assigned through the Proportional System is a parameter specified by the user. The program computes an entire parliament with the Plurality System, and another parliament with the Proportional System. The final parliament is produced using a weighted mean of the two temporary parliaments, the weights being determined by the value of the parameter set earlier by the user.

*Mixed-Member System, 2*

Part of the parliament is elected with the Plurality System, and the rest is elected using the Proportional System. Contrary to the mixed system above, the votes used to elect the ‘plurality part’
are lost for the ‘Proportional part’. The share of the parliament elected with the Proportional System is decided by the user. As in the previous mixed system, the program creates first a parliament with the plurality system, then a parliament with the Proportional System, employing only the votes not used by the plurality part. Finally, the two parliaments are unified.

**Borda Count**

This system uses the electors’ complete preference ordering. Each elector gives points to each party, according to its position in his preference ordering. The points given correspond exactly to the position of the party in the elector’s preference vector (0 for the most preferred party, N-1 for the least preferred party, where N is the total number of parties). The program sums the points for each party of each district. The party with the least points wins, in each district.

**Condorcet Winner**

The Condorcet winner is chosen in each district. It is the party that beats all the others when taken in pairs.

**The VAP System**

In this system, there is a difference between the true parliament and a virtual parliament (see below). The true parliament is elected with (one-district) Proportional System. The virtual parliament depends on the composition of the government. Therefore, in the program, we see first a window with the true parliament. In order to have the virtual parliament, the user has to decide the composition of the government. When the parties chosen obtain the absolute majority, a dialog window appears, asking the user whether the government is complete. If the answer is ‘no’, the user can add more parties to the government. If the answer is ‘si’ (yes), the virtual parliament is created according to the following rule: the MPs belonging to the larger parties of the majority (see below) are given a weight \( a > 1 \); i.e., these MPs have \( a \) votes in the parliament instead of 1. This feature allows the government to keep the majority of the votes even if some small party leave the government’s coalition. Governability is enhanced, as small parties lose their blackmail power. The governments loses the majority only when the big parties leave the coalition.

\( a \) is computed according to the following formula:

\[
\begin{align*}
a &= \frac{(T - \sum_{i=1}^{m} X_i + 2y)}{\sum_{i=1}^{m} X_i}
\end{align*}
\]

where \( X \) is the number of seats of the \( m \) biggest parties in the government, and \( T \) is the total number of seats in the parliament. This way, the government keeps a majority of \( y \) if the small
parties leave. X and y are parameters. They have the following values in the program: $y = 1$, that is the government keeps a majority of 1 if the small parties leave; $X = 18\%$, that is we consider crucial a governing party that has at least 18% of seats in the parliament. X can be set up by the user when the virtual parliament is created (18% is only the default value). Note that r and g are computed with reference to the virtual Chamber. For further details on the VAP system, see Ortona, 2000.

**Multi-district proportionality**

The user may choose among several methods for the assignment of seats, i.e. Hare, D'Hondt, Imperiali and Sainte-Lagüe. It may be useful to remember that the most proportional system is probably the last one, at least according to Lijphart (1994).\(^{15}\)

**Single Transferable Vote**

The seats for each party, in each plurinominal district, are assigned according to a quota value. If some seats are not assigned, the votes unused by the elected candidates are transferred to the next candidates in the elector’s preference ordering, and the candidates with the highest number of votes (obtained + transferred) are elected. The operation is repeated until all the seats have been assigned. If at a given round there is no assignment, the candidate with less preference is excluded, and her/his votes are distributed as above.

Three methods can be used to compute the quota, i.e. $N.B. \ [\text{votes}/(\text{seats}+1)]$, $Droop \ [\text{votes}/(\text{seats}+1)+1]$ and Hare ($\text{votes}/\text{seats}$). For each elected candidate (number of votes greater than or equal to the quota), the surplus is computed as the difference between the number of votes and the quota. The surplus is transferred, starting with the largest, in the following way: (a) from the candidate’s electors, a number of electors equal to the surplus to share out is extracted at random. (b) the votes of these electors are transferred to the candidate indicated as next preferred in their preference ordering, and not yet elected; (c) if as a result a candidate’s votes becomes equal to or greater than the quota, this candidate is elected and eliminated from the list of candidates available to be elected.

**2.4 How to add a new electoral system.** To add electoral systems, or to modify the program, the user needs to have Java Standard Edition installed. The program uses the features of Object Oriented programming in Java, hence each electoral system must be derived from another system,\(^{15}\)

\(^{15}\) Actually, this claim could be tested through ALEX3.
and one has to re-write only the functions that change between one system and another (at least allocazioneSeggi).

In short, to create a new electoral system:

1. create a new class in the package (and the directory) parlamentiUninominali or parlamentiPlurinominali, giving it a name representing the system;

2. this new class must extend an existing class in the package parlamentiUninominali or parlamentiPlurinominali;

3. write down (keeping the same name and the same parameters as in the extended class) all the functions that change between the ‘mother’ class and the new class. At least, one must write a new function allocazioneSeggi and the class constructor (which contains its name).

4. compile the program using the make command.

The new system will appear automatically in the list of electoral systems seen by the user after the districts are created. Note that a plurinominal system will only be shown if the user has requested plurinominal systems (parameter ‘numero seggi per collegio plurinominale’ greater than 1).

2.5 How to receive the program. The program may be obtained, for free, writing to the corresponding author; you will only be requested to fulfil the following requirements, on a gentleman agreement basis:

(a) The program must not be used for profit uses;
(b) The program should be quoted in every research paper or article that employs it;
(c) A copy of the study where you use the program should be sent to the corresponding author.

A complete user's guide (in PDF format) will be provided together with the program.

Finally, note that the program for experiments ALEX3 is still... experimental; it may contain errors, and is surely susceptible of improvements. The authors apologize for the errors and will be grateful to those who will suggest improvements.
References


The full text of the working papers is downloadable at http://polis.unipmn.it/

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