

Electoral Redistricting in France: Set of Legal Maps and Electoral Consequences of a Redistricting

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Keywords : *electoral redistricting, gerrymandering*

Many countries around the globe elect their members of parliament (MPs) based on some partition of the country into *districts*: there is a local election in each district, to choose its local MP. The legal constraints on the districts boundaries are often the following: each district must (1) be connected, (2) be included into some *state* and (3) contain roughly the same number of people as the other districts in the state. The first two constraints ensure that the election is a local election, while the third represents the principle “one person, one vote”, to ensure that any vote across the country contributes the same fraction of MP. A map which fulfills the legal constraints on the districts boundaries is called a *legal map*.

In the US, the map maker¹ has considerable freedom in designing boundaries of the district, as the states are very large and the smallest indivisible units (the *atomic units*) are particularly small – there are, on average, 160 000 atomic units in each state.

In France, the atomic unit is a *canton*, and the state – a *département* – is composed of 20 cantons on average. Even if there is less freedom for the map maker to design legal maps, there can still be very different legal maps of the same *département* (see, e.g., Figure 1).

Our first question is: *is it possible, in France, to compute for each département the set of all legal maps?*

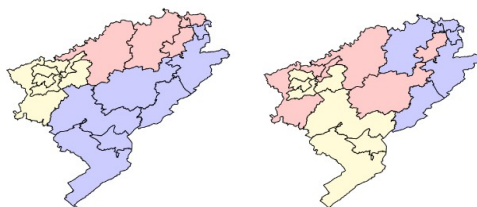


FIG. 1: Two legal maps of the Doubs département. Each district (*circonscription*) is colored differently.

The authors of this abstract and additional colleagues have partially addressed this question in [1]: for most (but not all) départements, we generated the set of all legal maps.

1 Computing the set of legal maps.

Using publicly available data (from the open platform for French public data `data.gouv`), we built in each *département* the adjacency map of each canton.

The algorithm to construct the maps of a given *département* proceeds district by district. For a given district i , the algorithm takes as input all possible (partial) maps for the first $i - 1$

¹We call map maker any person or organization that has control over the redistricting process.

districts. For each such partial map S , it computes all the possibilities for district i . This is done through a recursive depth-first-search algorithm, which essentially works as follows: S being fixed, all the possibilities for district i start with the same canton (to avoid generating solutions that differ only by district permutations). Given a canton j added to district i , the recursion considers the set $N(j) = \{k_1, k_2, \dots, k_p\}$ of yet unassigned cantons adjacent to j , and makes p recursive calls: in the z -st call, canton k_z is added to district i , while k_1, \dots, k_{z-1} are excluded from it (to avoid duplicates). Of course lower and upper bounds in population are considered to add legal maps and to stop the recursive calls.

2 Gerrymandering.

Assume that the voting patterns of the atomic units are known. Gerrymandering is the act of choosing a map, given the legal constraints, that favors one's own party.

In the U.S., a large body of research has shown that gerrymandering is widespread [3]. However, the U.S. case is particular because of the large freedom in designing district boundaries and because the political landscape is strongly polarized around two parties (which makes election simulation relatively easy). The case of France is different, because there is less freedom in designing district boundaries and because the political landscape is not strongly polarized around two parties. Our second question is therefore: *is gerrymandering in France possible at all, and if so, to what extent?*

To address this question, we proposed in [2] a definition of the *diversity* of the distribution of legal maps of a state, capturing its gerrymandering potential. For a specific electoral map of a state, we also introduced a definition of outliers (*positive outlier* or *negative outlier* with respect to a given political party), to identify the states where the electoral map ought to be audited.

In the case of France, we analyzed, party by party and département by département, whether each legal map — including the current one — is an outlier, based on the first-round results of the 2022 legislative elections. We focused on the four main alliances (NUPES, Ensemble, LR, RN). We simulated elections for all available legal maps and, for each alliance, we checked whether the map under scrutiny is an outlier for this alliance (if the map yields a better result for the party than 90% of the legal maps, we call it a *positive outlier*; if it yields a worse result than 90% of the legal maps, we call it a *negative outlier*). For a two-round electoral system, this means simulating only the first round.

We first showed that, despite the legal constraints, there is substantial diversity among the legal maps, and consequently it is possible to draw boundaries that favor a specific party in the aggregate (over all states). We then showed that many states are either positive or negative outliers, with a significant imbalance between parties. This calls for a careful audit of redistricting in those states, to determine whether the current map was indeed drawn in a way that advantages or disadvantages a particular party.

References

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