How Best To Impartially Define Electoral Districts

By Roy A. Minet -- (Rev. 03/31/18)

One of many techniques politicians use to keep themselves in power is the process known as "gerrymandering." That is, deliberately drawing the lines of electoral districts to favor themselves, or their political party. The practice has rightly been bemoaned for decades. It is past time to fix it.

Many approaches have been proposed which are messy, not totally satisfying and fail to hit the nail squarely on the head. It turns out that a really good and clean solution is possible; it should be implemented as soon as possible.

As usual, the first step toward determining the best solution is to correctly identify the requirements and clearly write them down in order of importance:

1. **One Person, One Vote –** It is a hard requirement that each of multiple districts must contain, as nearly as is reasonably possible, the same number of eligible electors. This is an obvious good thing, and the SCOTUS has decreed it.
2. **Impartial –** The process by which districts are determined must not give any systematic advantage or disadvantage to any group or faction.
3. **Understandable –** The process by which districts are drawn should be understandable by a reasonably bright high school student. (In fact, anything having to do with voting and elections should meet this requirement.)
4. **Verifiable –** It should be possible for reasonably equipped and motivated citizens or organizations to independently verify that districts are correctly drawn. It is a bonus if a rough verification can be done quickly just by visually inspecting the map.
5. **Well-defined and Stable –** The process should be clearly and publicly spelled out. It should not be changeable on a whim or when different people are implementing it. Enshrining the process in the state or even the U.S. Constitution would be a good idea.
6. **Preserve Precinct Atomicity –** Precincts are very small areas of roughly 600 to 1,800 voters which are determined locally based upon available polling places and their proximity to voters. It is unnecessarily disruptive if redistricting requires redrawing precinct boundaries. Therefore, each precinct should be entirely contained within a single district. (If precincts straddling a district boundary should need to be merged, the merged precinct lands in the district from which most of its voters came until the next redistricting is done.)
7. **Contiguous –** It is required in many jurisdictions that voting districts be geographically contiguous, and that no district be completely contained within any other district. This requirement tends to support requirements 3 and 4.
8. **Compact –** Compactness can have several definitions. Fortunately, it is not critically important. Compactness does make it easier for candidates who must repeatedly traverse the district for campaign purposes and easier for elected representatives to commune with constituents. But primarily, compactness is believed to be desirable today mainly because it is

felt to be an indication that the district has not been gerrymandered. However, this requirement does support requirements 3 and 4.

One thing NOT part of the requirements is "fairness." People sling the word "fair" around all the time, but the criteria by which they judge fairness can vary radically. Without a detailed understanding of the criteria, the word is meaningless.

Popular proposed solutions seem to revolve around establishing an unbiased commission which figures out how to draw boundaries. No semi-intelligent individual is completely unbiased, so what that means is a commission on which it is lightheartedly hoped that opposing factions hold each other in check. How commission members are selected becomes very important and is quite problematic. A commission does not guarantee requirement 2 and definitely does not satisfy requirements 3, 4 and 5. It doesn't seem sensible to make a commission re-invent the redistricting wheel (with somewhat variable and unpredictable results) every time a redistricting is needed.

A much superior approach is to clearly define a *procedure* that satisfies all requirements. It doesn't matter who (or what) executes the procedure, the same impartial boundaries are the result.

A procedure which well satisfies all requirements (except 6) was proposed circa 2002 by Warren D. Smith. It is called "splitline." The splitline procedure very simply divides a state into two sections having the desired populations using the shortest possible line. If more than two districts are needed, the process is repeated (as many times as necessary) to subdivide one or both of the two sections until the desired number of equal population districts has been drawn.

There is a three-minute YouTube video which very clearly explains the procedure. Also, maps are viewable online which show the splitline Congressional districts for each state.

In order to meet requirement 6, "the shortest possible line" of the splitline method is changed to "the shortest distance along precinct boundaries." Because of precinct granularity, this will introduce small errors in population (completely inconsequential for large districts, perhaps 1% for very small districts containing only 25 or 30 precincts). Some small tweaks to the algorithm could further reduce population errors. Appendix A spells out the procedure in detail and discusses such variants in more depth.

Splitline districts are always contiguous and maximally compact (geometrically). They are based *only* on the boundaries and populations of precincts; no voting history or registration data are ever used. The procedure is easy to understand. If you're familiar with the state's population distribution, you can see that the lines have to be pretty much correct by just looking at them on a map. Lots of individuals and organizations are capable of independently verifying the boundaries. Also, it should be obvious that this one simple procedure can be used for any kind of district: Congressional, State Senator, State Representative, etc. Finally, it also should be obvious that splitline can be done in minutes by a computer at near-zero cost.

No matter how straightforward and impartial splitline may be, there still will be objections. The first probably will be that splitline is necessarily going to ignore geographic features and political boundaries. Chalk that up as part of being impartial. It definitely will divide cities and counties.

But this is not an actual problem. It's more a vague "feel good" notion in people's heads. As proof, we've lived just fine for decades with many of the craziest such divisions which were introduced by gerrymandering. Also, quite a few splits of political entities will be inevitable just to achieve the one-person-one-vote requirement, no matter what method may be used. If it's OK some places, it won't hurt to do it other places as well. (One could even argue that it's "fairer" to do it everywhere.) Certainly, it is conceivable that geographic features (e.g., a river) could make traversing a district somewhat less convenient, but as a practical matter, this cannot be a large problem, especially when precincts are preserved.

The second complaint will be that some faction or another doesn't receive fair (!) representation. Well, what faction did you have in mind? There are so many. Factions might be defined by various political philosophies, religions, races, etc.; there are many factions of each type. And, of course, the smallest and most important faction is the individual. So, good luck! Whether a real or imagined issue, it is certainly not something that can be solved by playing around with district boundaries; wrong mechanism. Other remedies to consider which may partially address such concerns are multiple-representative districts, ranked-choice voting (MRCV, not IRV) and proportional representation. These definitely are good things to think about, but they don't have anything to do with impartially defining equal-population electoral districts.

Appendix A

Pure Splitline – We wish to impartially divide a political entity having a total population of p and some arbitrary, but well-defined boundary (e.g., a state) into n contiguous and geometrically compact districts which have populations as nearly equal as is reasonably possible. This can be accomplished in a straightforward manner by repeating the following three steps as many times as may be necessary.

1. If n is 1, no subdivision is necessary and this is a final district. If $n > 1$, then define two new numbers $i = n/2$ rounded up and $j = n/2$ rounded down. (Note that $i + j$ always equals n, and if n is even, i obviously will equal j.)
2. Draw the shortest possible line dividing the area into two sections so that one section has a population equal to p multiplied by i/n, while the population of the other section has a population equal to p multiplied by j/n. If there is more than one such line, use the line closest to a north-south orientation and if there is still a tie, use the westernmost line.
3. For each of the two sections separately, go back to step 1 using the section's population for p and either i or j as n.

The fact that Earth is a sphere means that the shortest line of step 2 must be along a great circle route, but this will differ significantly from plane geometry only for very large areas. When subdividing an irregularly shaped political entity, it is possible that a great circle route may enter, then leave and re-enter the entity. If/when that happens, the line's length is defined to be the total distance between the two most distant points at which the line intersects the boundary of the area being subdivided.

Obviously, the shortest line will cut right through many things, occasionally even someone's residence. Impartial rules determine on which side of the line any such "dead hit" cases will be placed. However, this is an annoying problem with the pure splitline algorithm. Also, each redistricting will force all intersected voting precincts to be redefined, sometimes into inconvenient entities. A better tradeoff would be to preserve the atomicity of precincts, the smallest political subdivisions, at the cost of introducing very small errors in the equality of district populations.

Preserve Precincts, Shortest Boundary – The most obvious way to accomplish this is to change "the shortest possible line" of step 2 to read "the shortest possible distance along precinct boundaries." Imagine that you are traveling from the opposite side of the world along the great circle route of the pure splitline method. Mark the first intersection with the area being divided as point A. Mark as point B the (last, normally only) point where the great circle line exits the area being subdivided. Now, the problem is simply to determine the shortest route from point B to point A (traffic always seems to be much lighter going this direction) which follows precinct boundaries. This is the familiar problem that your GPS unit's routing software solves all day, every day. Errors in population equality among districts will be inconsequential for large districts. The smallest districts (consisting of only 25 or 30 precincts) may have errors of about 1%.

Preserve Precincts, Smallest Population Deviations – The best way to maintain precinct atomicity will achieve the lowest possible population errors. It is only slightly harder to understand. Make a list of just the precincts that the great circle line of the pure splitline method traverses. Any of the traversed precincts which have 75% or more of their area on one side of the line are assigned to that side. Assign the remaining precincts to the two sections in the manner which most closely approaches the target populations. Then draw the boundary line accordingly. The distance along precinct boundaries may now be slightly longer, but minimum population errors are achieved. Here is a procedure which can be incorporated into the Constitution:

In all cases where a political entity (e.g., a state) is entitled to elect multiple representatives, the (sometimes iterative) procedure defined here must be used to draw the electoral district boundaries for such representatives. If the population of the political entity is p and the number of districts to be drawn is n, follow these steps:

1. If n is 1, no subdivision is necessary and this is a final district. If n > 1, then define two new numbers i = n/2 rounded up and j = n/2 rounded down. (Note that i + j always equals n, and if n is even, i obviously will equal j.)

2. Draw the shortest possible (great circle) line dividing the area into two sections so that one section has a population equal to p multiplied by i/n, while the population of the other section has a population equal to p multiplied by j/n. If there is more than one equally short line, use the line closest to a north-south orientation and if there is still a tie, use the westernmost line. For irregularly shaped political entities, it is possible that a line could exit and then re-enter the entity; the length of the line is defined to be the total distance between the two most distant points which lie on the boundary of the area being subdivided.

3. Make a list of just the voting precincts that the great circle line of step 2 traverses.

4. Any of the traversed precincts on the list which have 75% or more of their area on one side of the line are then assigned to the section on that same side of the line.

5. If any precincts remain on the list, assign the largest to the section which needs the most people to hit its population target. Repeat this step until all precincts have been assigned.

6. Then draw the final boundary accordingly.

7. For each of the two sections separately, go back to step 1 using the section's population for p and either i or j (whichever was associated with the section) as n.