DRAFT - do not circulate

Comparison of districting plans for the Virginia House of Delegates

October 1, 2018

The Metric Geometry and Gerrymandering Group
www.mggg.org/va2018

Using a random-walk technique called a Markov chain, we have analyzed several alternatives for districting the portion of the Virginia House of Delegates map that is affected by the federal court ruling of June 26, 2018. This is intended to show the power and flexibility of approaches from mathematics and computing for asssessing proposed maps in a redistricting process.

In the June decision, 11 House districts were found to be unconstitutional; by expanding to the districts neighboring those, we arrive at a minimum of 33 House districts out of 100 that must be reexamined. The majority in the three-judge panel found that racial considerations predominated over traditional districting principles, namely that Black residents were concentrated in a way that diluted their voting strength.

We have analyzed three different House plans: the enacted plan approved by the Legislature in 2011 as House Bill 5005 (Enacted), the Democratic Caucus Plan released on Aug 29, 2018 (DemCaucus), and the "reform map" independently released by the Princeton Gerrymandering Project on Aug 28, 2018 (Princeton).[1] For each of these, our analysis focuses on the distribution of Black Voting Age Population, or BVAP, across the districts, though we note that this analysis can equally well be extended to focus on partisan performance, preservation of city boundaries, or any other quantifiable priority.

Markov chain techniques build chains of valid plans assemble large collections of alternatives that are designed *only according to the stated rules and principles* of a jurisdiction. We can control and study levels of measured quantites along the chain (such as population equality, compactness, contiguity, municipal boundary splitting, and racial demographics) to assess a proposed plan *as compared to an ensemble of valid alternatives*. In this way, we get a picture of how well the plans comport with the principles found in state and federal law and we gain a sense of how much other agendas may have impinged on these principles.

Data Collection and Preparation

We have chosen *census blocks* as the units for building a plan; they are the smallest units of census geography, and the Census Bureau provides population and race breakdown information at this level. Though electoral districts frequently split precincts and larger census

---

[1] We would like to analyze the new plans proposed by the Republican caucus, but as of today have been unable to locate block assignment information needed to study them.

geography like tracts, they typically keep census blocks intact. We obtained shapefiles for each of the plans being considered ([Enacted](), [DemCaucus]() and [Princeton]() from their respective online repositories) and either produced block assignments from the shapefiles or used assignment information that had been provided.

Using Markov chain software developed and made [public]() by the Voting Rights Data Institute, we ran processes to create alternative plans by beginning with each starting plan and altering it by moves we can call (1) *flip*: taking small steps by changing the district assignment of one census block at a time; and (2) *merge*: taking larger steps that combine and randomly re-split pairs of neighboring districts using a mathematical construction called a spanning tree. At each step of the chain, the algorithm proposes a move at random and accepts it if it meets some validity conditions, described below.

Traditional Districting Principles

The following districting principles are represented in Virginia or federal law and were recognized by the district court to be relevant in this process: population equality; compactness; contiguity; preservation of municipal boundaries; preservation of communities of interest; and adherence to the Voting Rights Act of 1965 (VRA). Our Markov chain sampling process constrains valid plans by limiting their allowed population deviation and requiring them to be contiguous and to meet a minimum standard of compactness.[2] We can then report on the level of municipal boundary splitting and on the racial demographics relevant to VRA compliance. Unfortunately, Virginia statute and case law does not provide a precise enough interpretation of "communities of interest" to incorporate it in a quantitative analysis.

Black Voting Age Population and the "Automatic RPV Range"

The range of BVAP values from 37% and 55% is a crucial zone for VRA analysis, and we will say that a district with BVAP between these limits is in the *Automatic RPV Range*. Though we emphasize that BVAP alone is never enough to confirm VRA compliance, this wide range of BVAP values often triggers the evaluation of RPV (or *racially polarized voting*) patterns as one of several other considerations addressing the totality of circumstances in a possible VRA lawsuit.[3] In some cases, less than 37% BVAP will suffice for a district to provide an opportunity to elect a candidate of choice of the Black community; in other cases, more than 55% BVAP will be required. Nonetheless this range reflects our best estimate of current best practices for civil rights organizations that pursue VRA challenges by litigation.

---

[2] Details: We performed runs of MCMC with the population limited to 2% deviation from ideal district size. We used a discrete definition of compactness, limiting the total perimeter of the districting plan by constraining the number of census blocks on the boundary between two districts. Finally, a proposal for a new step in the Markov chain was only accepted if the districts all remained (rook) contiguous.

[3] As the expert reports confirm, very few House districts in Virginia would require numbers approaching 55% BVAP in order to comply with the Voting Rights Act. The state of the art for experts to assess racially polarized voting is the method of Ecological Inference. An open-source shiny app for using EI on voting data can be found here.

Methods and Results

It was confirmed in statements to the court that the Enacted plan was designed to have ≥55% BVAP in 11 districts, which we may call the *packed* districts, without an effort to justify that numerical cutoff on the level of the individual districts. Compliance with the Voting Rights Act in no way requires this (or any other) numerical level of BVAP. The conspicuous elevation of BVAP in the 11 packed districts, therefore, may cause unnecessarily depressed BVAP in the 22 neighboring districts. We set out to measure that dilutive effect.

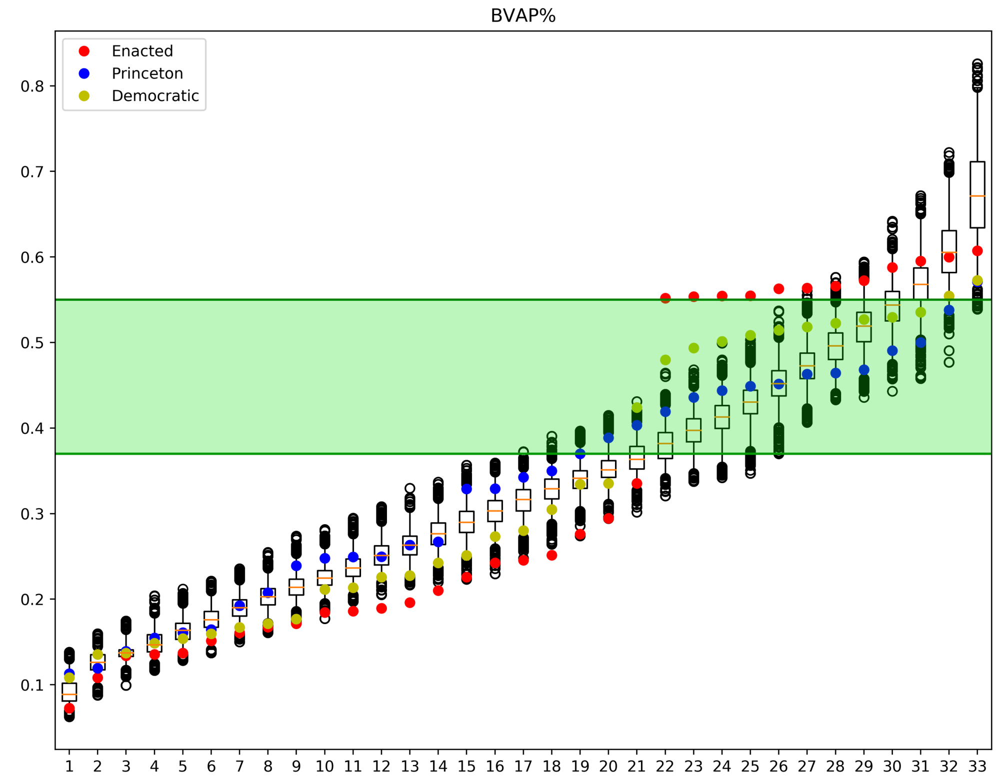
To study this, we begin with many different starting plans (100 different maps, named Tree1 through Tree100) and perform chains of random alterations, recording a long run of these as our *ensemble* of comparable plans. The attached Figure shows a selection of our results. For each of the plans in these ensembles, we index the 33 affected districts from 1st to 33rd in terms of their BVAP as a proportion of VAP, so that the Index 1 district has the smallest share of Black voting-age residents in each plan and the Index 33 district has the highest. Then we can compare BVAP values for the plans we are studying to the expected range observed under neutral algorithmic redistricting from neutral seeds.

The boxes in Figure 1 show the 25th–75th percentile BVAP scores for each indexed district, while the individual circles show outlier plans found by the chain. So for instance, looking at the top right figure, we see that the Enacted plan has over 60% BVAP in its highest-BVAP district, while the ensemble found plans ranging from about 57% to over 85%, with a typical value of about 67%. However, in the 7th through 11th highest-BVAP districts, the enacted plan has a BVAP level higher than anything at all that was found by our random walks. Note that the ranges observed in the chains with 20,000 merge steps are extremely similar to those with length 300,000 that use a combination of merge and flip steps. This is strong heuristic evidence to suggest that we have achieved representative sampling.

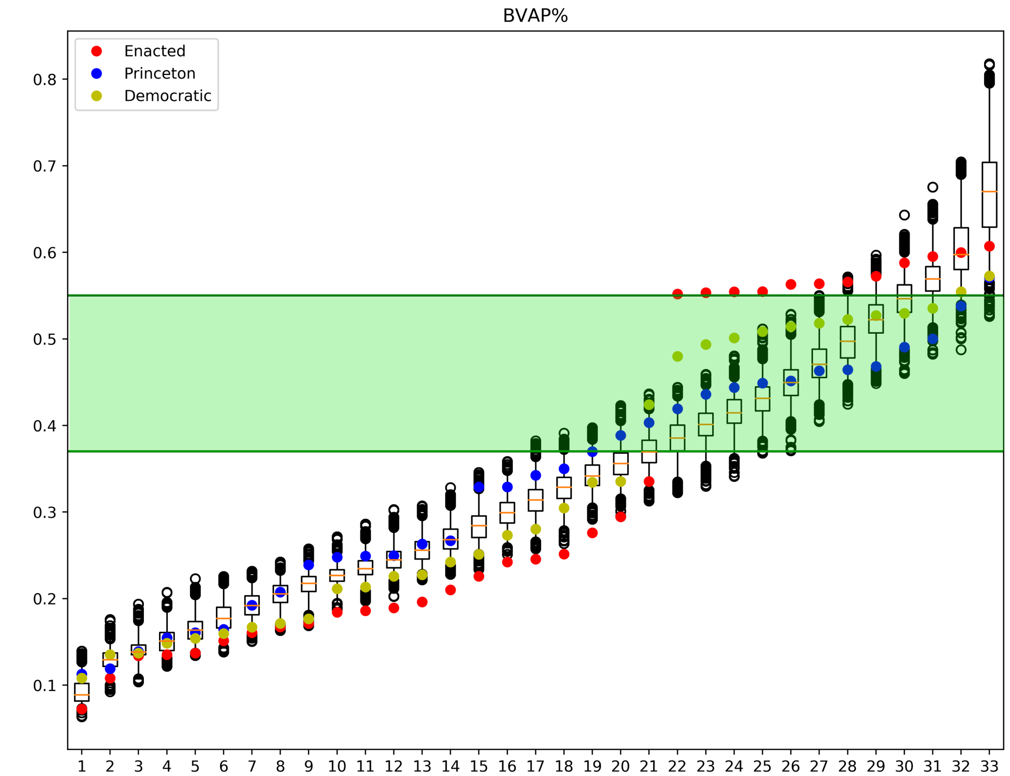
Conclusions

We find that the Enacted plan, by starkly elevating BVAP in six districts, causes at least ten and up to 17 other districts to have depressed BVAP levels far below what would be expected from race-neutral redistricting. The enacted plan has *no districts at all* in the Automatic RPV range of 37%–55% BVAP, while neutral redistricting tells us to expect as many as ten. By contrast, the DemCaucus plan creates one additional district in this range, the Princeton plan creates three, and completely random race-neutral plan could easily have provided two.

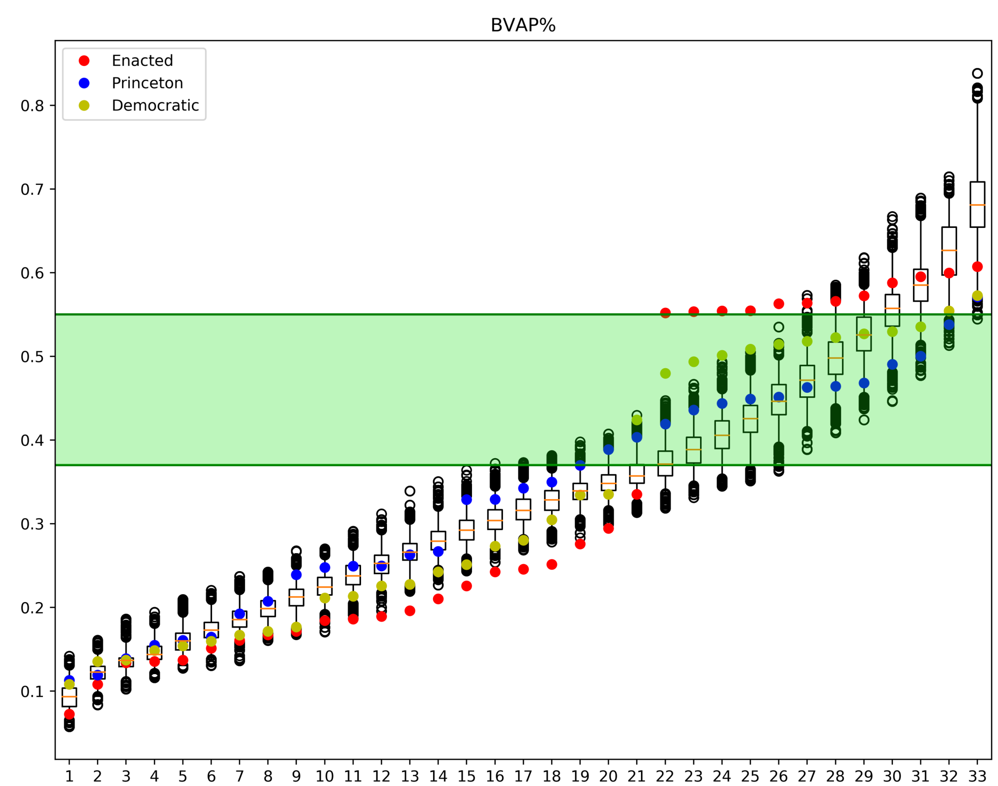
We emphasize that there are many local and community-based considerations in play when approving districting plans, and the Markov chain approach only provides data relevant to some of these, by giving a view into the ranges of properties typically observable in the enormous landscape of valid plans. We view this approach as one tool among many in a complex process for evaluating districting plans, and we hope it will incorporated into the analysis of proposed plans by the Legislature. We are prepared to analyze new maps as they are proposed.



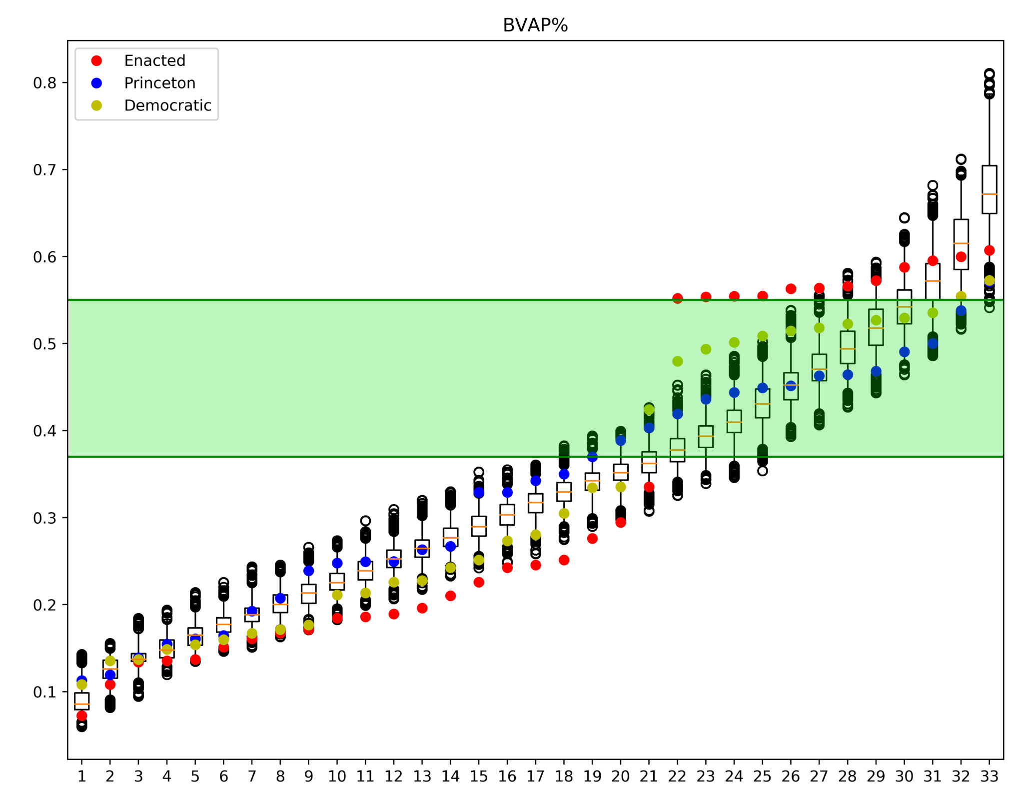
20,000 steps from Tree31



300,000 steps from Tree31



20,000 steps from Tree23



300,000 steps from Tree23