Preliminary comparison of districting plans for the Virginia House of Delegates

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The Metric Geometry and Gerrymandering Group

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Using Markov chain Monte Carlo (MCMC) techniques, we have produced a quick preliminary analysis of 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 analyzing proposed maps in a redistricting process. A fuller investigation, with larger samples and more metrics considered, will be forthcoming over the next few weeks.

In the June decision, 11 House districts were found to have been 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 are analyzing three different plans for the House of Delegates: 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). For each of those, we are focusing 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.

MCMC techniques are capable of building large sample sets of plans that are chosen only according to the stated rules and principles of the jurisdiction. As we will describe below, we are able to measure and report on population equality, compactness and contiguity, municipal boundary splitting, and racial demographic composition for a proposed plan *as compared to valid alternatives*. In this way, we get a picture of how well the plans comport with the redistricting principles found in Virginia and federal law and gain a sense of how likely it is that other agendas 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 geography like tracts, they typically keep census blocks intact.

We obtained shapefiles for each of the plans being considered (Enacted from the Census Bureau; 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 MCMC software developed and made public by the Voting Rights Data Institute, we ran processes to create alternative plans by beginning with a plan under consideration and altering it one census block at a time. At each step of the chain, the algorithm proposes a randomly chosen census block that lies on the boundary between two districts and reassigns it to the neighboring district 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. Our MCMC 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.[1] 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 this quantitative analysis.

Preliminary Analysis

Does a given plan have a pattern of BVAP that suggests that racial balances were carefully engineered with dilutive effects? To study this, we begin with each starting plan and perform many random alterations, recording a long run of these as our *ensemble* of comparable plans. The DemCaucus and Princeton plans have been released in the last few days, and we are currently able to produce ensembles of 100,000 variants in about an hour on a standard laptop. We note that in the near future, far larger samples will be constructed and analyzed.

For each of the plans in these ensembles, we can index the districts from 1st to 100th in terms of their BVAP as a proportion of VAP, so that the Index 1 district has the smallest share of Black

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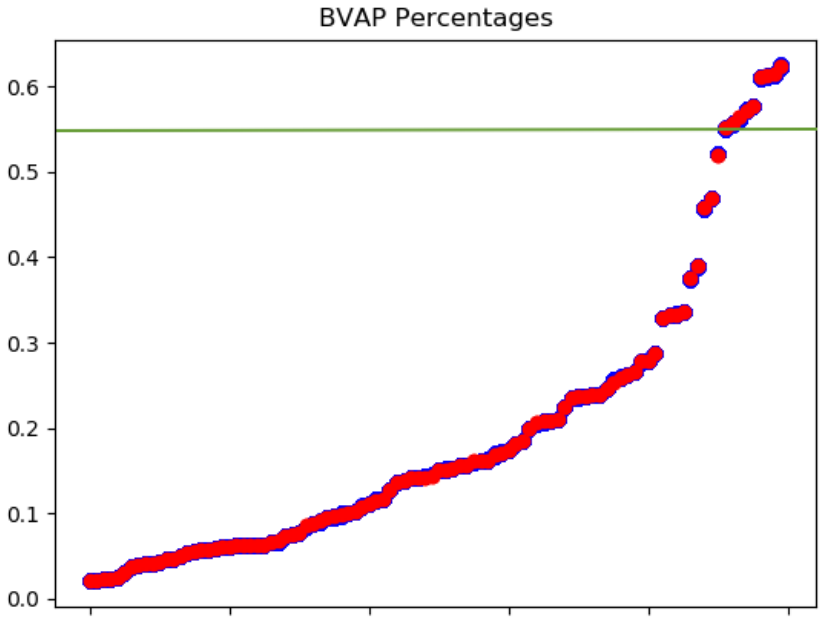
[1] Details: We performed runs of MCMC with the population limited to whatever deviation from ideal district size was present in each initial map. (That is, all the maps in our comparison ensemble have population balance *at or better than* the plans we are evaluating.) We used a discrete definition of compactness, limiting the total perimeter of the districting plan to near the value of the initial map. Finally, a proposal for a new step in the Markov chain was only accepted if the districts all remained (rook) contiguous.

residents in each plan and the Index 100 district has the highest. Then we can compare BVAP values to the expected range observed under neutral algorithmic redistricting.

It was confirmed in statements to the court that the Enacted plan was designed to have ≥55% BVAP in 11 districts, which we will call the *packed* districts, without individual justification. Compliance with the Voting Rights Act in no way requires this (or any other) numerical level of BVAP. In fact, a *racially polarized voting* analysis must be conducted, among several other considerations addressing the totality of circumstances, to determine the level of minority population needed for the opportunity to elect a candidate of choice.[2] The conspicuous elevation of BVAP in the 11 packed districts, therefore, causes unnecessarily depressed BVAP in the 22 neighboring districts.



BVAP percentages in a small ensemble around the Enacted Plan

Our preliminary MCMC runs have already found over a million valid districting plans for the Virginia House of Delegates that avoid the packing of Black residents into districts with distortedly high BVAP. In particular, both the DemCaucus and the Princeton maps provide starting points for large ensembles that entirely avoid the pattern of packing found in the Enacted plan. We are prepared to assess new maps as they are proposed.

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[2] 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.

We emphasize that there are many local and community-based considerations in play when approving districting plans, and the algorithmic sampling approach only provides data relevant to some of these, by giving a view into the ranges of properties 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.