

Abstract

Fair maps are the foundation of a representative democracy. Gerrymanderers wish to create an **un**representative legislature. The counter to gerrymandering is a fair map where share of districts favored by each party matches that party's share of voting behavior in the state. This redistricting criterion was recently codified in the Ohio State Constitution.

<https://www.legislature.ohio.gov/laws/ohio-constitution/section?const=11.06>

Two works are available below. The first is a "Guide to Fair Redistricting." This Guide is written for citizens, advocates and members of redistricting commissions, as well as legislators and judges. The Guide explains why fair maps are important, includes a test for gerrymandering, and provides evaluated examples of fair maps for a wide range of states.

The second work, "Fair and Square Mapmaking," is a research article that details, justifies and applies the new approach for constructing fair district maps. The procedure is transparent, nonpartisan and straightforward. The approach can be used to construct fair maps of Congressional or State Legislative districts, or of any other jurisdiction.

As more people become aware of approaches such as this, more are likely to ask, "Why aren't we using procedures such as this to build maps where the districts are compact and the maps are fair?"

GUIDE TO FAIR REDISTRICTING

James N. Fox

This Guide is written for citizens, advocates and members of redistricting commissions as well as legislators and judges. The Guide

- Describes why Fair Maps that eliminate gerrymandering are so important;
- Presents a test to determine whether or not a map is gerrymandered and demonstrates how to conduct that test;
- Illustrates that maps which have been verified to be free from gerrymandering can honor other redistricting criteria, as well.

HOW TO ERADICATE GERRYMANDERING

“Gerrymandering” is drawing electoral district lines in a way that assures that one political party gains an unfair advantage. In a gerrymandered map, lines are drawn to pack voters of the disadvantaged party into a few districts so all the other districts are likely to be won by the unfairly advantaged party; or, lines are drawn so voters of the disadvantaged party are never the majority in several districts.

Why are fair maps important?

The foundation of a representative democracy is that the legislative body represents the will of the people. The fundamental principle of democracy is majority rule. Gerrymandering countermands democracy. In Wisconsin, the two-party composition of voters is 50.67% for the majority party and 49.33% for the other.¹ However, the current State Assembly Legislative District map is likely to yield only 35% of representatives to the *majority* party. In other words, in Wisconsin, the gerrymandered map results in a State Assembly ruled by the *minority* party. We see the same pattern in Pennsylvania. Here, the composition of voters in the state is 52.80% and 47.20%. However, the current map for the

¹ See appendix B, below. This guide deliberately avoids mentioning political party names. The principles and procedures discussed in this guide apply equally to any political party. All maps mentioned in this guide are published at <https://davesredistricting.org>

State House is designed to allocate only 47% of the representatives to the majority party. A fair map eliminates gerrymandering and ensures that the legislature is truly representative.

How can I tell if a map is gerrymandered?

A straightforward transparent test for gerrymandering is to simply compare statewide voting behavior to voting behavior among the districts. Statewide voting behavior is based on votes cast for recent statewide elections, such as for President, Senate, Governor and Attorney General.² District voting behavior is based on these votes within each district. Many map making apps provide these numbers.

To conduct the test, simply count the number of districts that favor one party and the number of districts that favor the other. The map is verified to be fair, that is, free of gerrymandering, when each party's share of districts matches that party's share of statewide voting behavior. This standard, often called representational fairness, was recently codified in the Ohio Constitution.³

Let's use the Wisconsin State Assembly as an example of how to conduct the test. For Wisconsin, a measure of the party distribution of statewide voting behavior is 50.67 % for majority party and 49.33% for the other. (See Appendix B.) The Wisconsin State Assembly has 99 seats. The matching distribution of districts is calculated as follows: $.5067 \times 99 = 50.16$ (rounded to **50**) districts favored by the majority party, and $.4933 \times 99 = 48.83$ (rounded to **49**) districts favored by the other party. That is, the map is verified to be free of gerrymandering when the map generates 50 districts favored by the majority party and 49 districts favored by the other; each party's share of districts matches the party's share of statewide voting behavior.

The process of redistricting should include a test of whether or not a proposed map is gerrymandered. Citizens, members of redistricting commissions, and

² Appendix B (below) presents a measure of voting behavior for each of the 50 states based on data from the mapmaking app DRA2020..

³Article XI.06(B) <https://www.legislature.ohio.gov/laws/ohio-constitution/section?const=11.06>

legislators should have access to the type of test for gerrymandering that was applied, and what data were used to implement the test.⁴

What goals are associated with redistricting?

Often a redistricting movement calls for establishing an independent redistricting commission. Often the movement will support such goals as assuring that districts are compact, contiguous and have nearly equal populations; assuring that the maps honor local jurisdictional boundaries; and/or assuring that minorities and communities of interest will be represented. Each of these goals is very important, but none of them, either alone or in combination, assures that gerrymandering will be eliminated. That is, even if every one of these goals was met, the map could still be gerrymandered. Only if representational fairness is included among the desired criteria will gerrymandering be assuredly defeated and a truly representative legislature emerge.

Is it enough to have someone representing my interests in the legislature?

Representation of your interests in the legislature is important, but speaking on your behalf in the legislature is not enough. The ultimate goal is to have legislation passed that is meaningful to you. For representatives to enact meaningful legislation, they must be participating in a representative legislature. If the maps are gerrymandered, the voices of many representatives will be stifled by the opposition who were placed into office through gerrymandered maps. The result of a gerrymandered legislature is rule by the minority, not majority rule.

Must every district be competitive?

In competitive districts, about the same number of votes are received by each party. Legislators from competitive districts are most likely to weigh both sides of an issue when considering legislation. In any state, maximizing the number of delegates from competitive districts is likely to come at the expense of sacrificing other critical redistricting goals. The answer is to create a competitive *legislature*,

⁴ The Virginia Redistricting Commission implemented the interesting approach of employing two mapmaking firms, one favored by the Democrats, one favored by the Republicans. https://www.washingtonpost.com/local/virginia-politics/virginia-redistricting-partisan-maps/2021/08/17/7471a9dc-ff6f-11eb-85f2-b871803f65e4_story.html In 2010, this approach would probably have been cost prohibitive. However, today many fine mapmaking apps are available; the cost equation has changed. An advantage of two independent mapmakers is that each can critique the work of the other and even run maps through alternative apps to check the results.

where the votes of representatives from competitive districts are needed to pass any legislation. This is done by building maps that yield a critical mass of such legislators.

Weighing the benefits of redistricting criteria

Avoiding splitting cities and counties is a criterion often associated with redistricting. Cities and counties are administrative jurisdictions which serve those who reside within their boundaries, for example, through such agencies as local police and emergency responders, public schools, and recordkeeping organizations. On the other hand, the impact of the work of state and national legislators most often crosses local jurisdictional boundaries. Witness, for example, tax policy, health policy, and welfare policy. Furthermore, representatives are usually able to serve the needs of their constituents whether or not their district crosses local jurisdictional lines. Occasionally, administrative coordination might be enhanced if legislative districts are matched to local jurisdictional boundaries. If tradeoffs are required between redistricting criteria, the benefits of each should be weighed.

Examples of Fair Maps

Fair maps can be produced. Shown below are examples of fair maps for the North Carolina Congressional delegation, the Wisconsin State Assembly and the Pennsylvania State House. For all three maps, the districts are compact, contiguous and meet population requirements; the maps respect local jurisdictional boundaries; and, because the districts are compact, the maps are designed to assure that minorities and communities of interest are represented. Most importantly, the maps are verified to be fair, that is, free of gerrymandering. In each of these maps, each party's share of districts matches the party's share of statewide voting behavior.

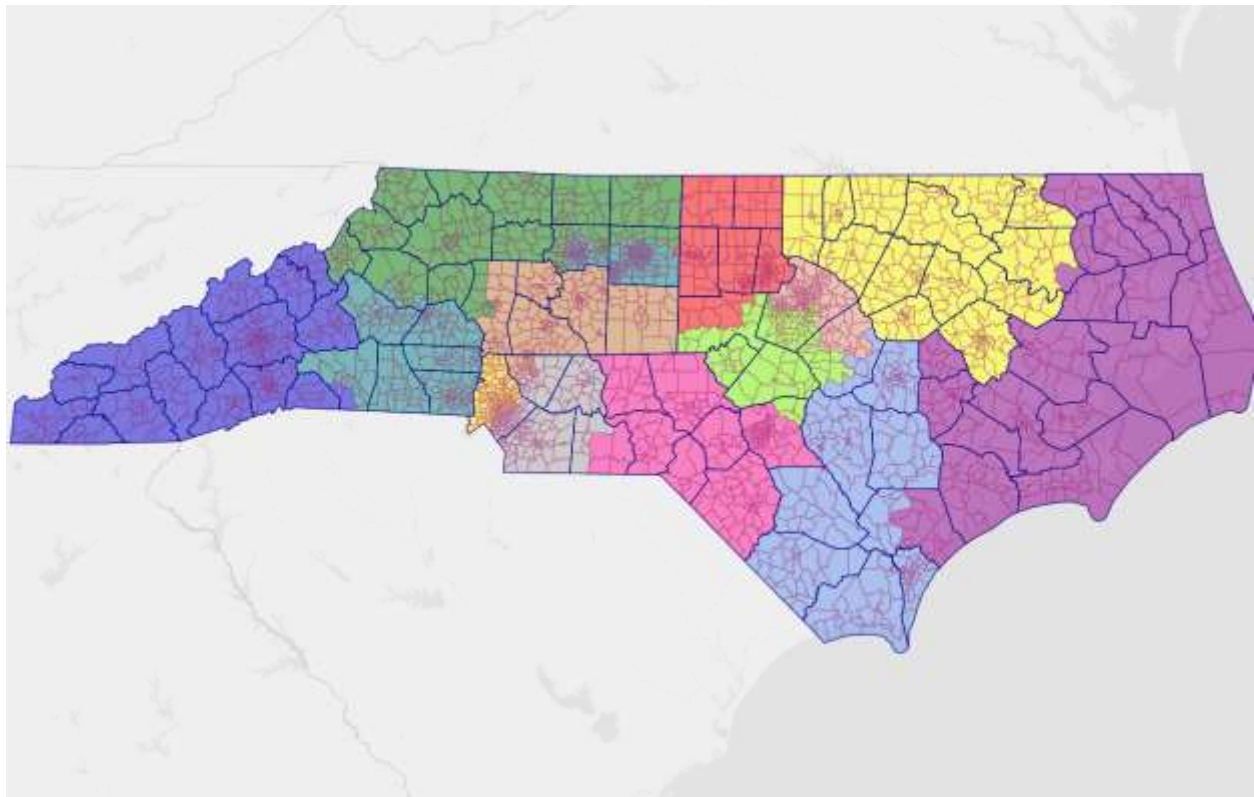
NORTH CAROLINA

In North Carolina, the distribution of voting behavior is 50.58% for the majority party and 49.42% for the other. (See Appendix A below.) In 2018, this state's Congressional District Map was adjudicated before the United States Supreme

Court.⁵ That gerrymandered map allocated not close to 50.58% of the Congressional Delegation to the majority party, but 76.92%!

In a fair map, 7 seats would be allocated to each party. The map below does exactly that.

VERIFIED FAIR MAP OF NORTH CAROLINA CONGRESSIONAL DISTRICTS⁶



WISCONSIN

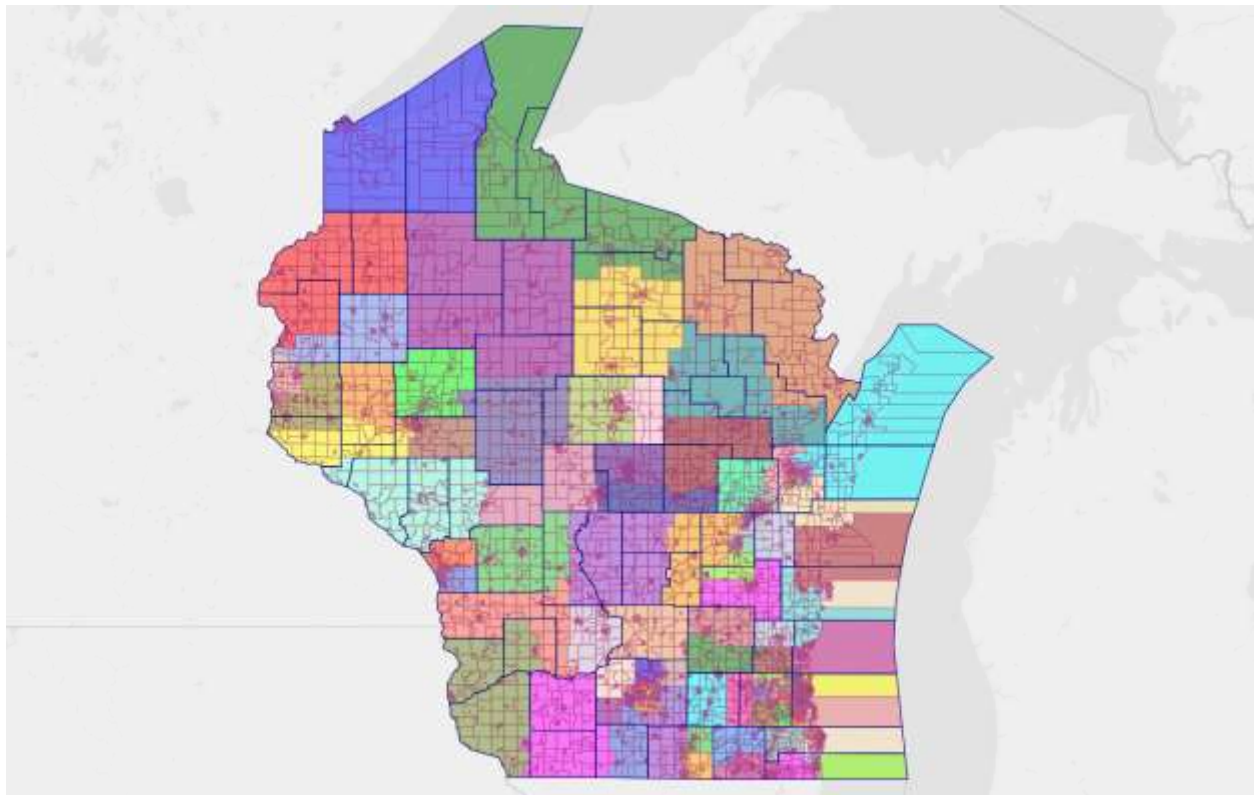
As noted previously, the two-party distribution of Wisconsin voting is 50.67% to 49.33%. A fair map would allocate 50 seats to the majority party and 49 seats to the other. The current gerrymandered map for the Wisconsin State Assembly allocates only 35 seats to the *majority party* and 64 seats to the *minority party*.

⁵ Rucho v. Common Cause 18-422, 588 U. S. ____ (2019). https://www.supremecourt.gov/opinions/18pdf/18-422_9ol1.pdf

⁶<https://davesredistricting.org/maps#viewmap::cb3d10b0-3f63-4fec-a4e3-5ba9761c61b0>

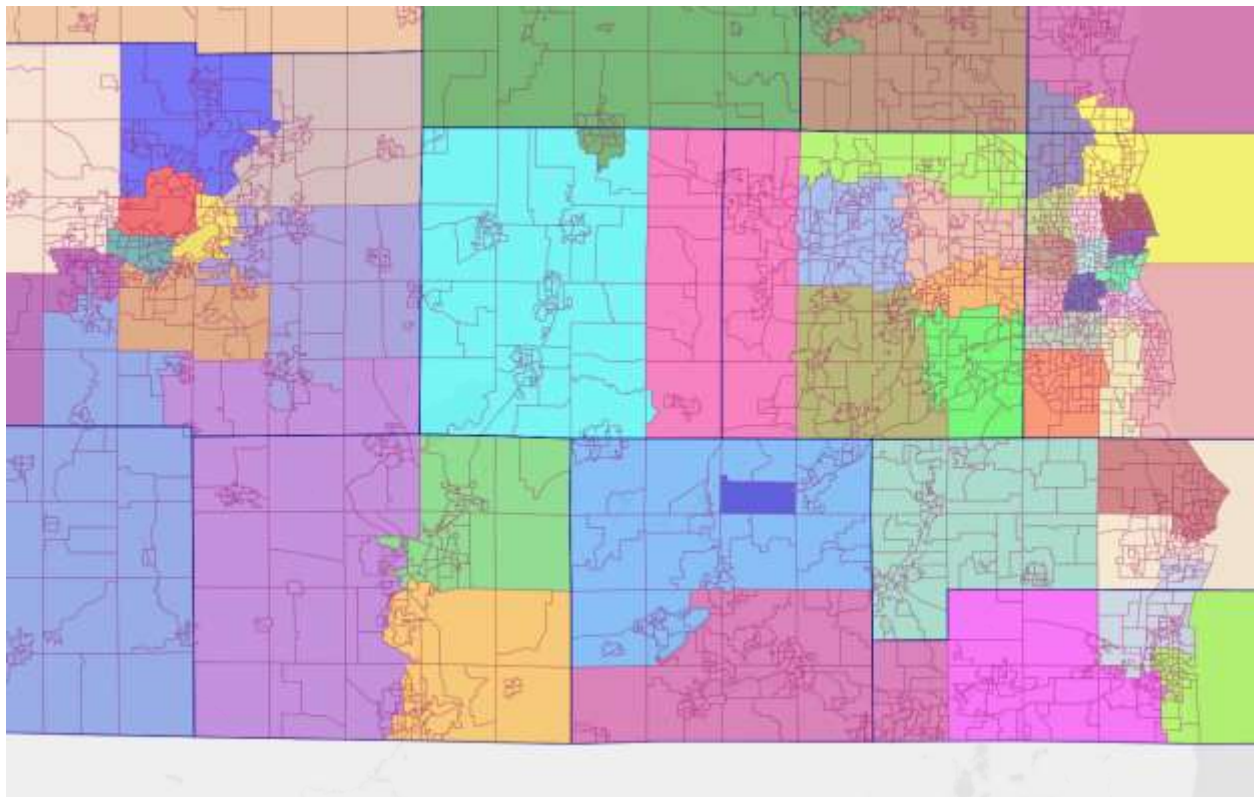
The map below is fair, allocating 50 seats to the majority party and 49 seats to the minority party.

VERIFIED FAIR MAP OF WISCONSIN STATE ASSEMBLY⁷



⁷ <https://davesredistricting.org/maps#viewmap::8dd8064d-9e51-4aa3-bd78-19a26526af73>

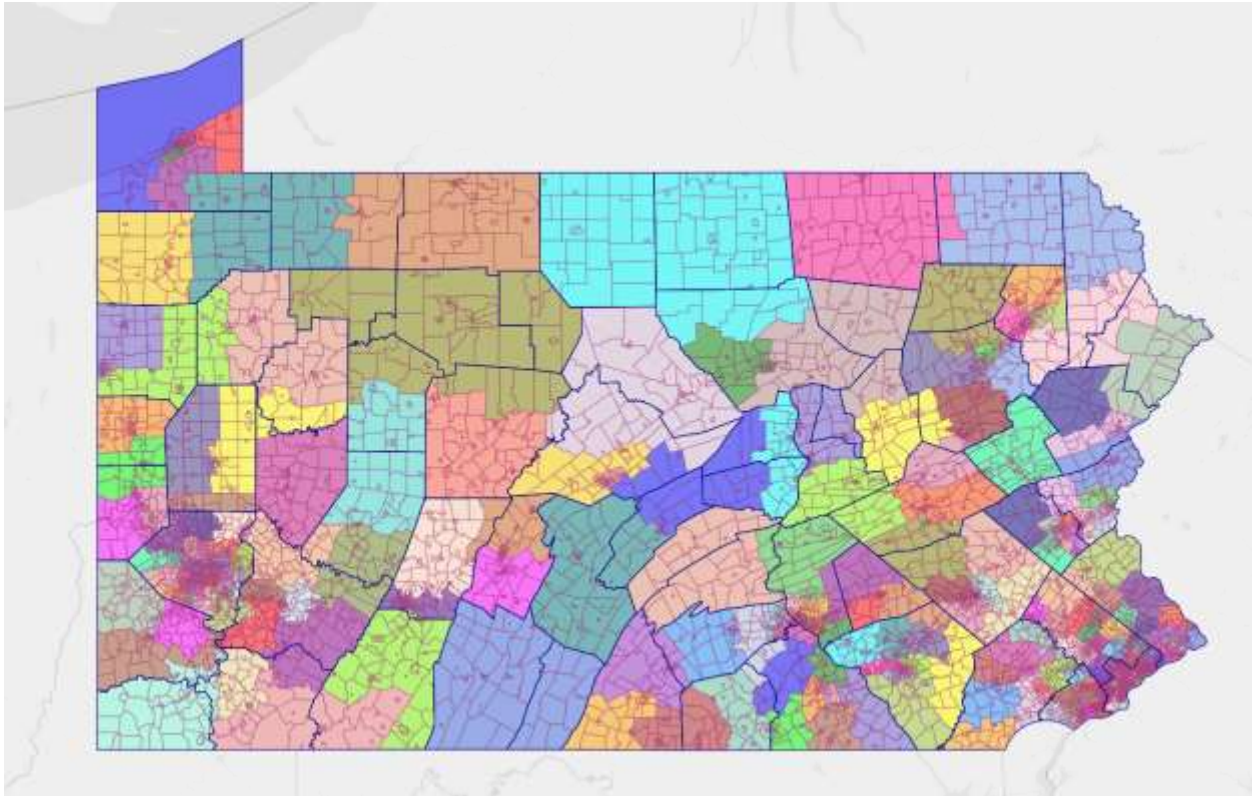
(Magnified section)



PENNSYLVANIA

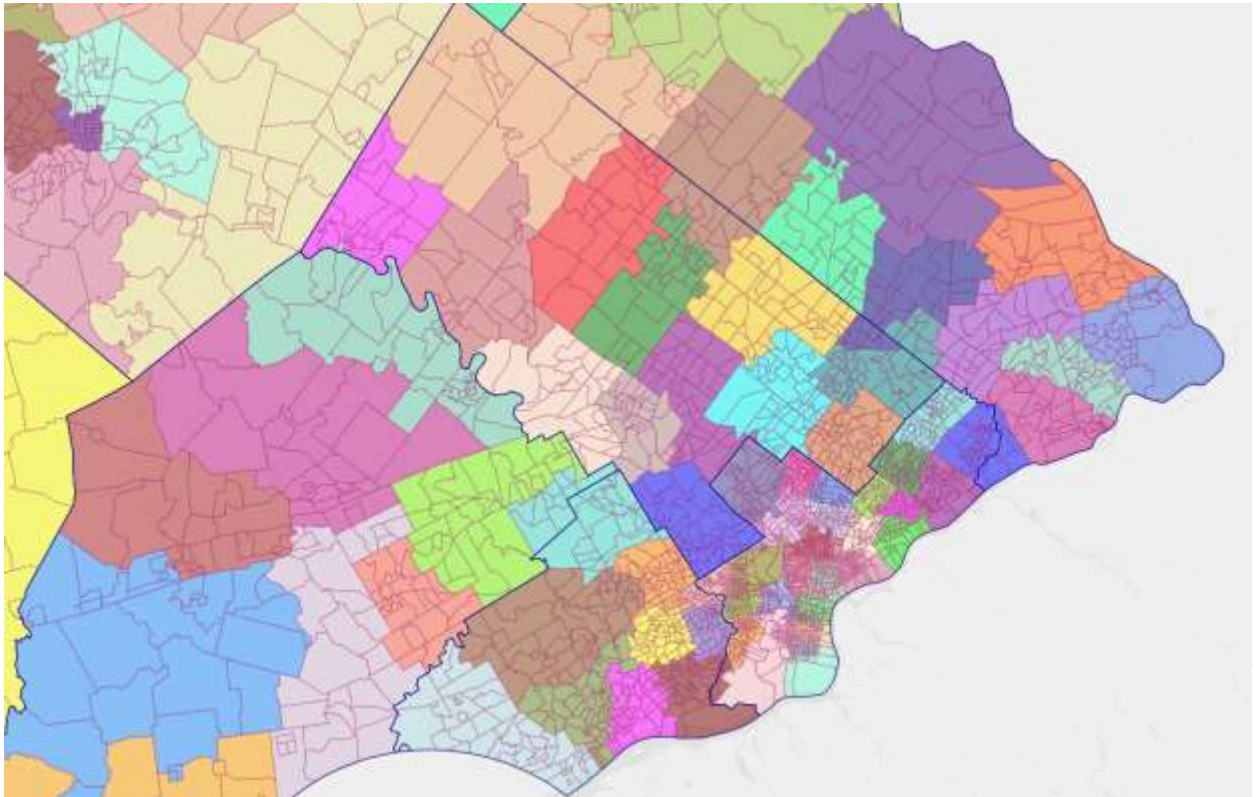
The two-party distribution of voting in Pennsylvania is 52.80% and 47.20%. The fair distribution of likely seats for the State House would be 107 and 96. The current Pennsylvania State House Map flips this, exactly. That unfair map allocates 107 seats to the *minority party*, and only 96 seats to the *majority*. The map below achieves fairness by allocating 107 seats to the majority party and 96 to the other.

VERIFIED FAIR MAP OF PENNSYLVANIA STATE HOUSE⁸



⁸ <https://davesredistricting.org/join/9eb1aa92-1aaf-49bf-92bc-2742fbca7f70>

(Magnified section)



SUMMARY: LESSONS LEARNED

1. Fair maps that eliminate gerrymandering produce legislatures that represent the will of the people. Fair maps preserve our representative democracy.
2. Maps should be tested to verify that they eliminate gerrymandering. The test, and the data used to implement the test, should be transparent.
3. Representation in a legislative body is not enough. Your representative must have the opportunity to participate in a legislature that is not gerrymandered.
4. Representatives from competitive districts have an incentive to consider both sides of an issue. However, not every district in the state must be competitive; the *legislature* must be competitive.
5. Trade-offs are often required among redistricting criteria. The benefits of each must be weighed.

As more people become aware of the principles and results of a fair map, more will demand that fair maps be drawn to eliminate gerrymandering and defend our representative democracy.

APPENDIX A: STATE MAPS

The following maps illustrate that maps can be free of gerrymandering and honor other redistricting criteria, as well.⁹

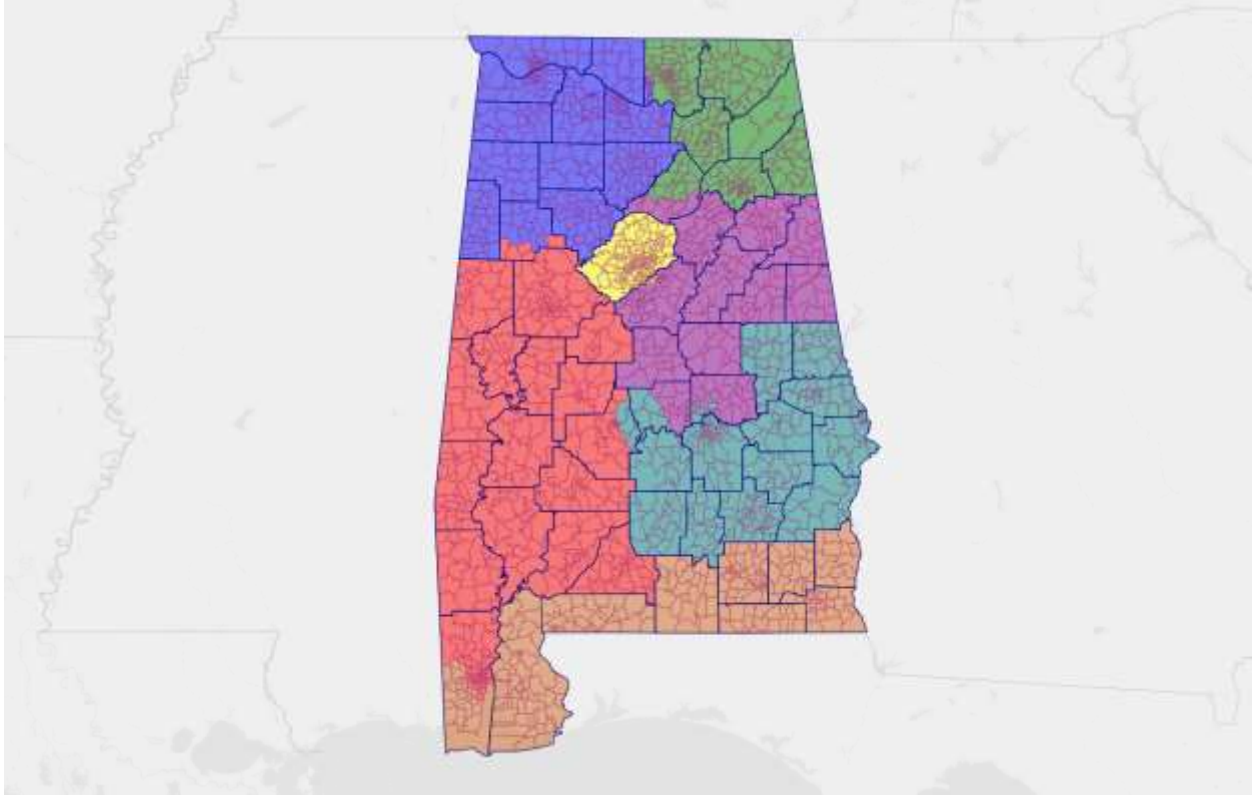
For each map, the following are reported: the party distribution of voting behavior in the state, each party's share of districts, ratings for compactness, minority representation, and not splitting local jurisdictions, as well as the number of likely delegates elected in competitive districts.¹⁰

The ultimate goal of a legislative district map is to achieve the highest rating on all criteria under consideration. Each of the maps below attempts to achieve the highest ratings possible on a set of desired criteria, and each contributes toward building a competitive legislature. Furthermore, each map has been verified to be representationally fair. That is, each map is free of gerrymandering.

⁹ In most cases, congressional district maps are presented. In those cases where a state has been allocated four or fewer congressional seats, the report presents the map for the state senate. These maps were drawn before 2020 census data were released. These maps provide examples of what can be drawn where the maps are verified to be free of gerrymandering and achieve other desired redistricting criteria, as well.

¹⁰ Some of these maps are modifications of maps chosen from the set of published maps at [DRA2020.org](https://dra2020.org). [DRA2020.org](https://dra2020.org) (also called davesredistricting.org) applies a rating of "very bad, bad, ok, good or very good" to various characteristics of a map. This Guide uses those ratings, changing "ok" to "Reasonable." Also, if an aspect of a map receives the highest rating of 100 on the [DRA2020](https://dra2020.org) site, a rating of "Best" is applied here. "Party Distribution of Voting Behavior" is the proportion of voters supporting each of the two major parties, based on a composite measure of votes over the past two presidential cycles. (Votes for minor political parties are distributed proportionally between the two major parties.) "Party Distribution of Delegation" is the count of likely delegates for each major party produced by the map. "Minority Representation" in each district is defined as the proportion of the voting age population who are members of a minority group. "Compactness" is defined by comparing each district's area and perimeter to the area and perimeter of the smallest circle that contains the district. "Splitting" is defined as the proportion of counties that contain more than one district and the proportion of districts that appear in more than one county. Note: Clicking on "Map URL" reveals the map on the [DRA2020](https://dra2020.org) site. This site contains a wealth of information about each map, such as the party distribution and distribution of minorities within each district, which counties make up each district, and how many likely delegates come from a competitive district ($\pm 5\%$ party distribution). The site also confirms that all districts are contiguous and meet population requirements. In addition, the [DRA2020](https://dra2020.org) site provides further detail on how the ratings are determined.

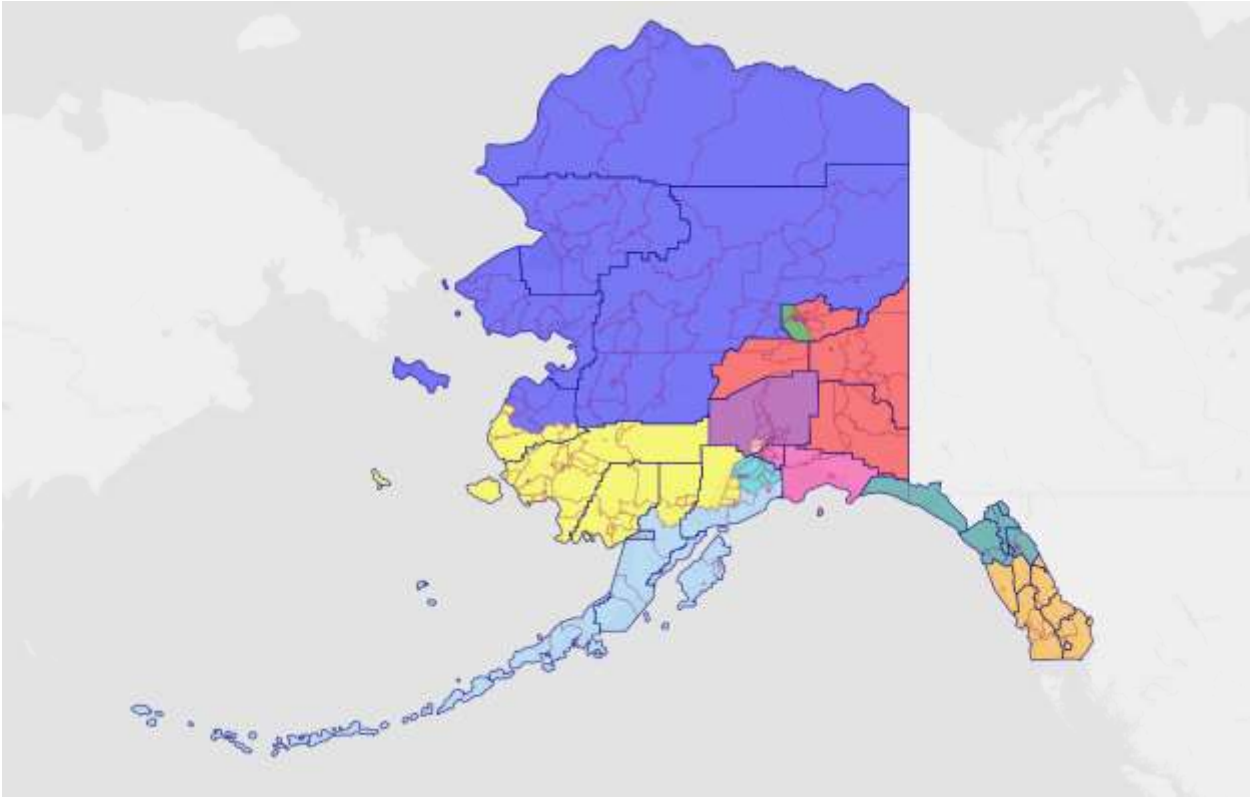
ALABAMA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
40.00% to 60.00%	3 to 4	Best	Good	Good	2 of 7

Map URL <https://davesredistricting.org/join/82614380-44ab-4b1c-9c4f-9d6598f8560d>

ALASKA¹¹



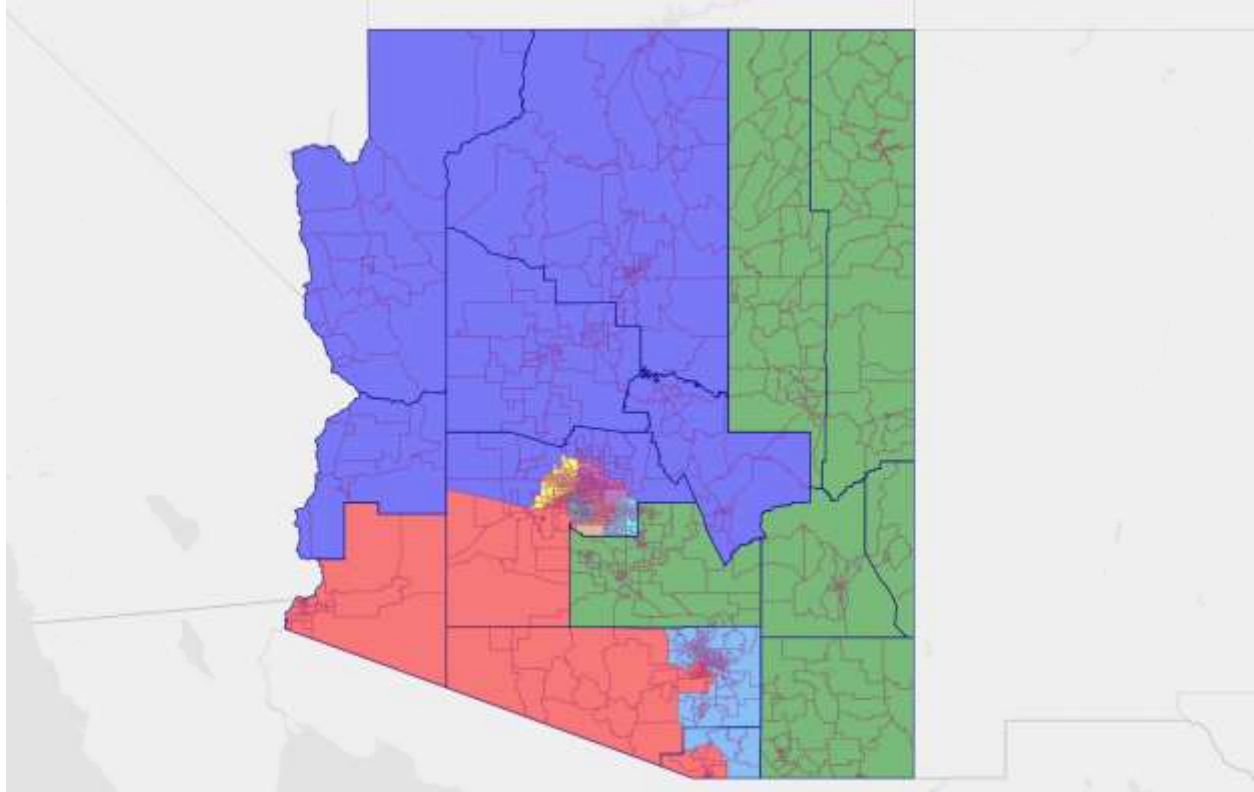
Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
43.91% to 56.09%	9 to 11	Good	Bad*	Very Good	6 of 20

*The rating on compactness is explained by the shape of the state (legs) and the state’s many island precincts. The “know it when you see it” rating for compactness is “Good.” The island precincts also explain why the map appears to have non-contiguous districts.

¹¹State Senate

Map URL <https://davesredistricting.org/join/388022ed-ce4a-4110-b71e-87274a24d40a>

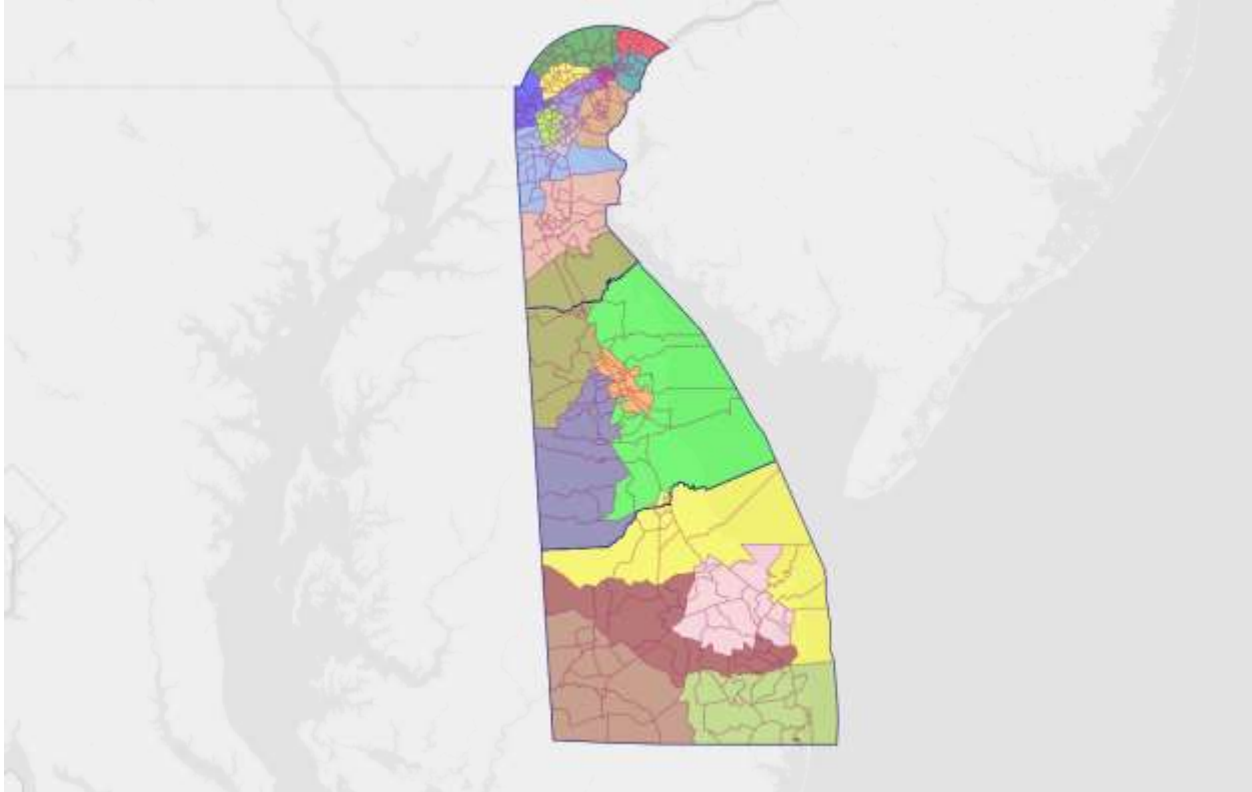
ARIZONA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
48.87% to 51.13%	4 to 5	Best	Good	Very Good	1 of 9

Map URL <https://davesredistricting.org/join/857b6a0b-967f-4ccd-9af5-dd9468d0ba53>

DELAWARE¹²

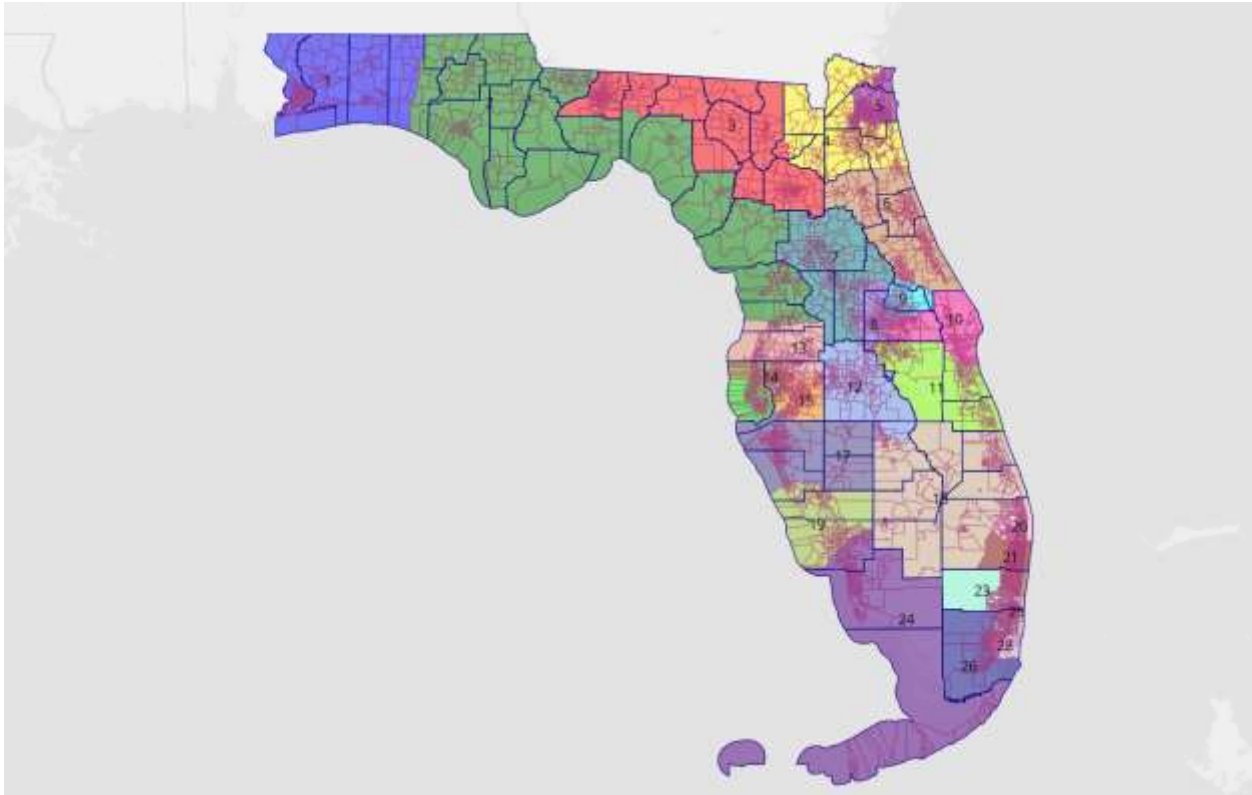


Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
59.11% to 40.89%	13 to 8	Very Good	Good	Best	5 of 21

Map URL <https://davesredistricting.org/join/0f901eaf-0c30-49dd-9346-8d37165f617e>

¹²State Senate.

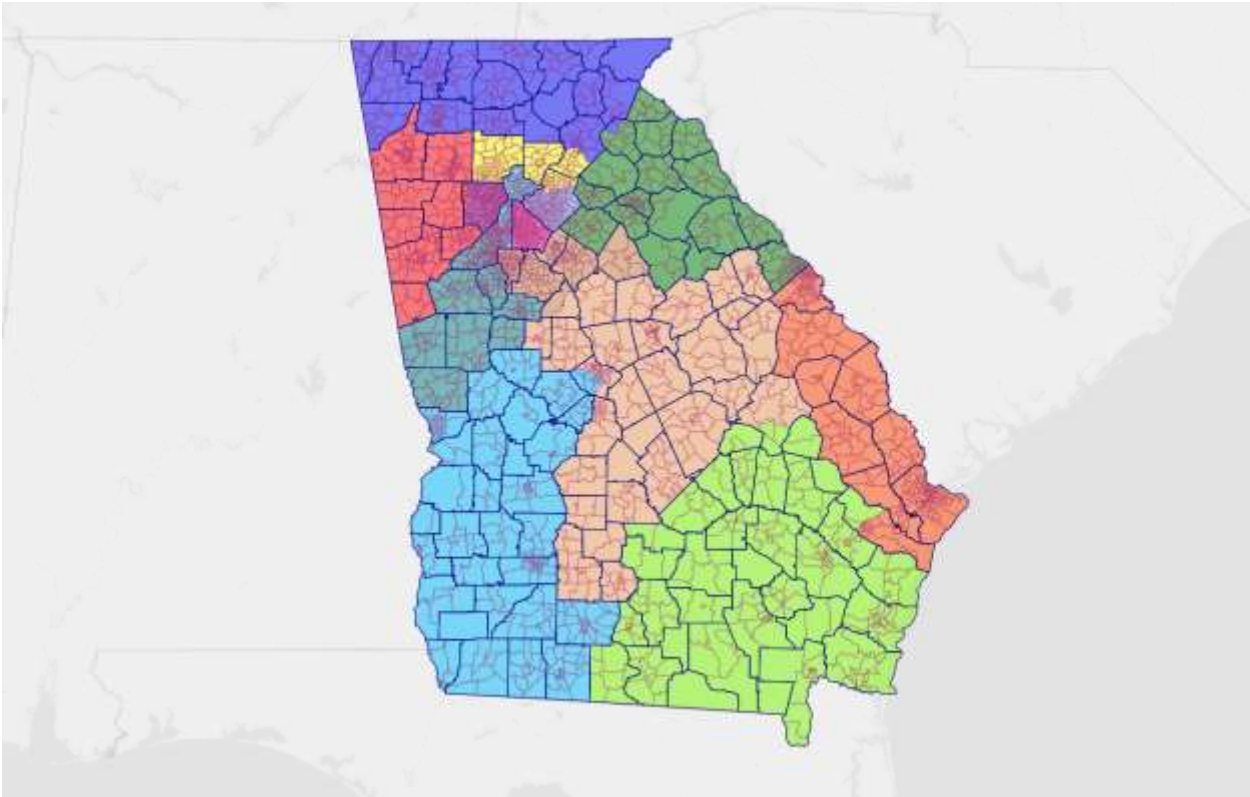
FLORIDA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
48.73% to 51.27%	14 to 14	Good	Very Good	Good	10 of 28

Map URL <https://davesredistricting.org/join/933edcb2-9f31-4e9a-a35a-4fe99b334870>

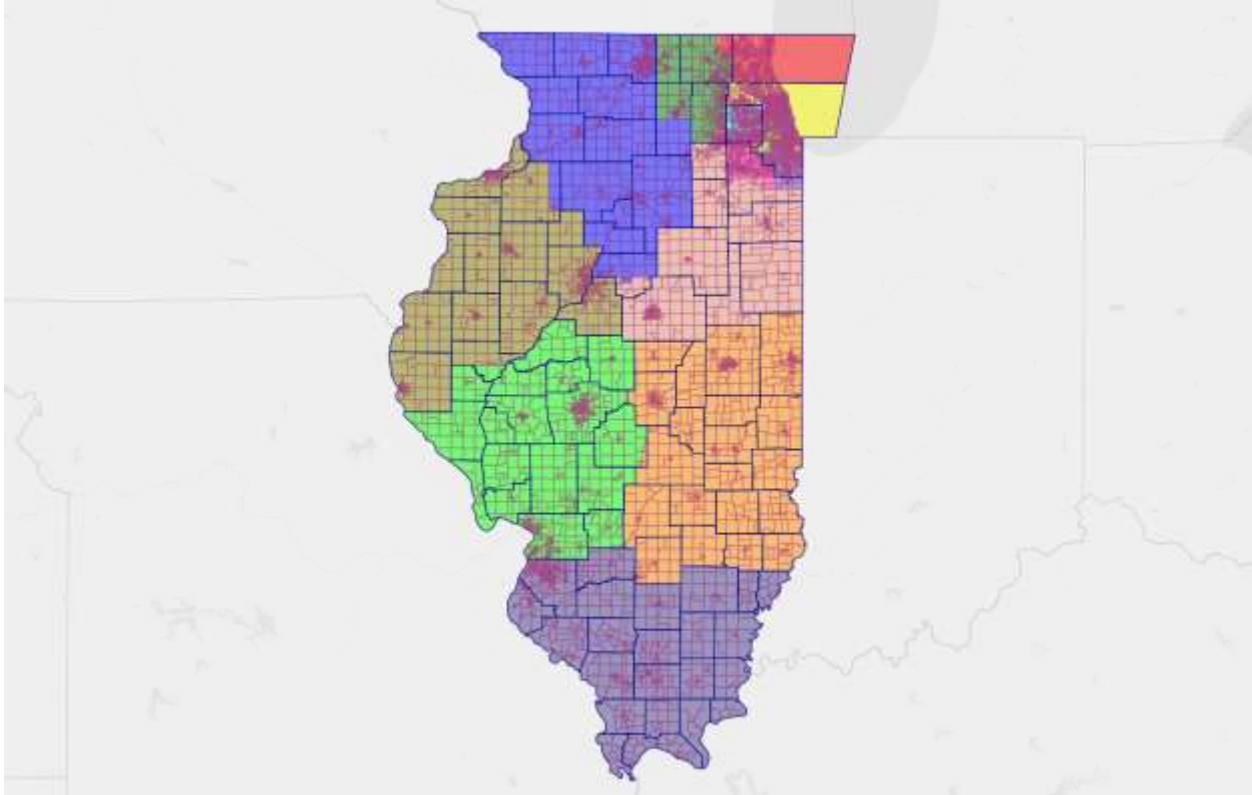
GEORGIA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
48.73% to 51.27%	7 to 7	Very Good	Good	Very Good	2 of 14

Map URL <https://davesredistricting.org/join/d6482ba4-dc23-486b-a55b-ec39e2dabe36>

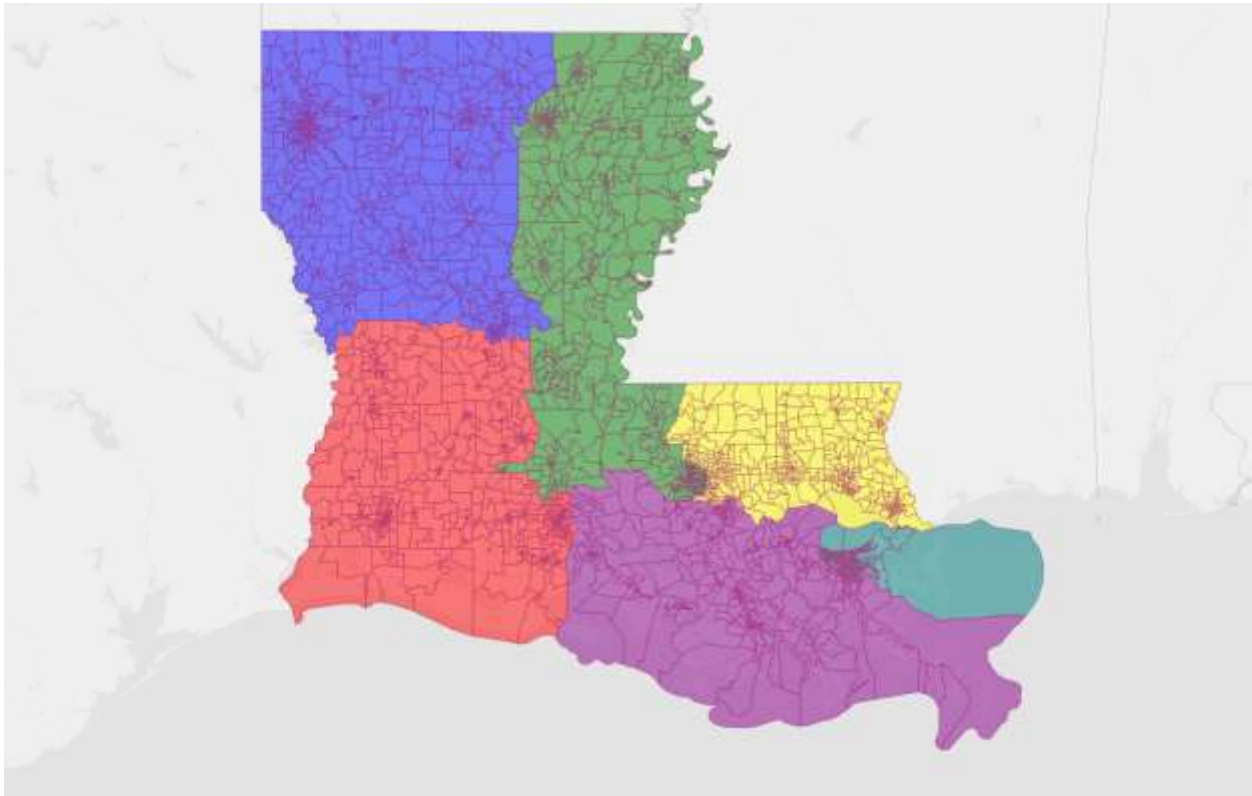
ILLINOIS



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
58.16% to 41.84%	10 to 7	Good	Very Good	Good	3 of 17

Map URL <https://davesredistricting.org/join/409f7ccf-8a56-4aed-bdad-67b1429c6af8>

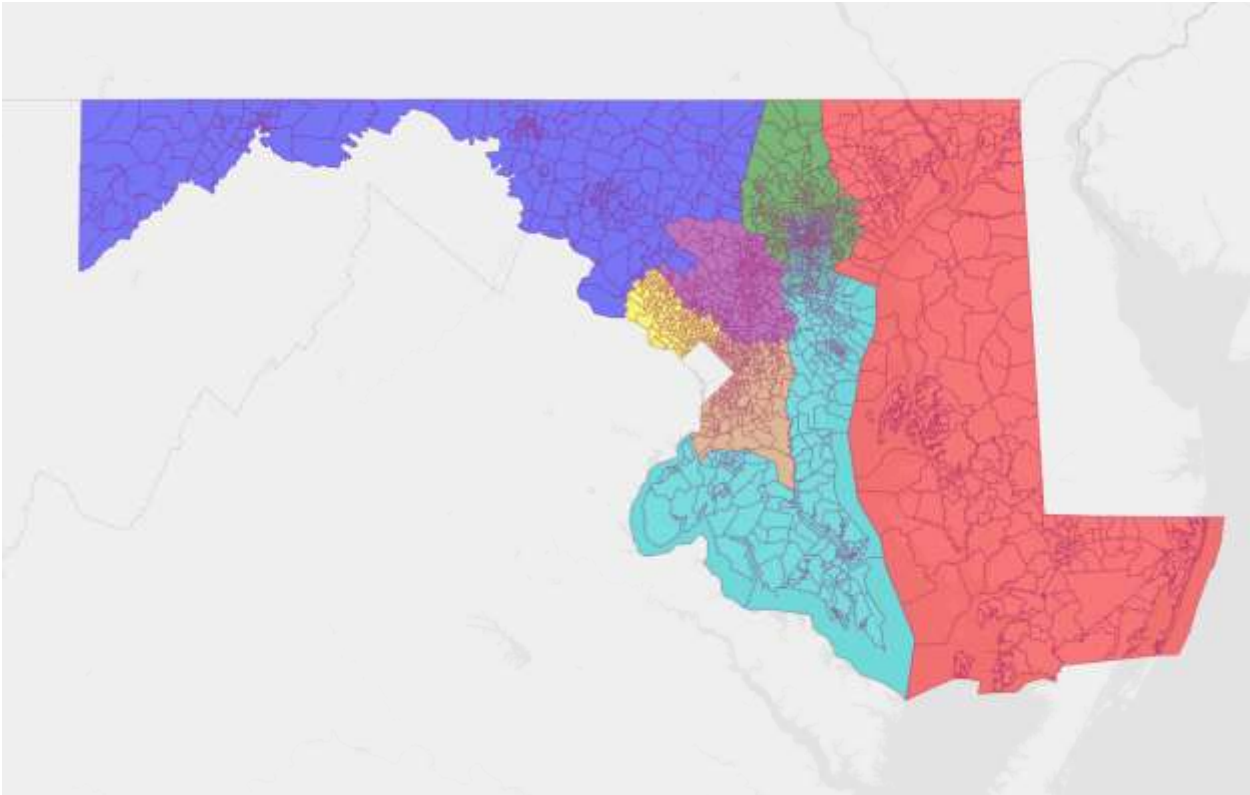
LOUISIANA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
40.38% to 59.62%	2 to 4	Very Good	Good	Good	1 of 6

Map URL <https://davesredistricting.org/join/3e1b495b-c092-4819-9b07-0e5e57ada760>

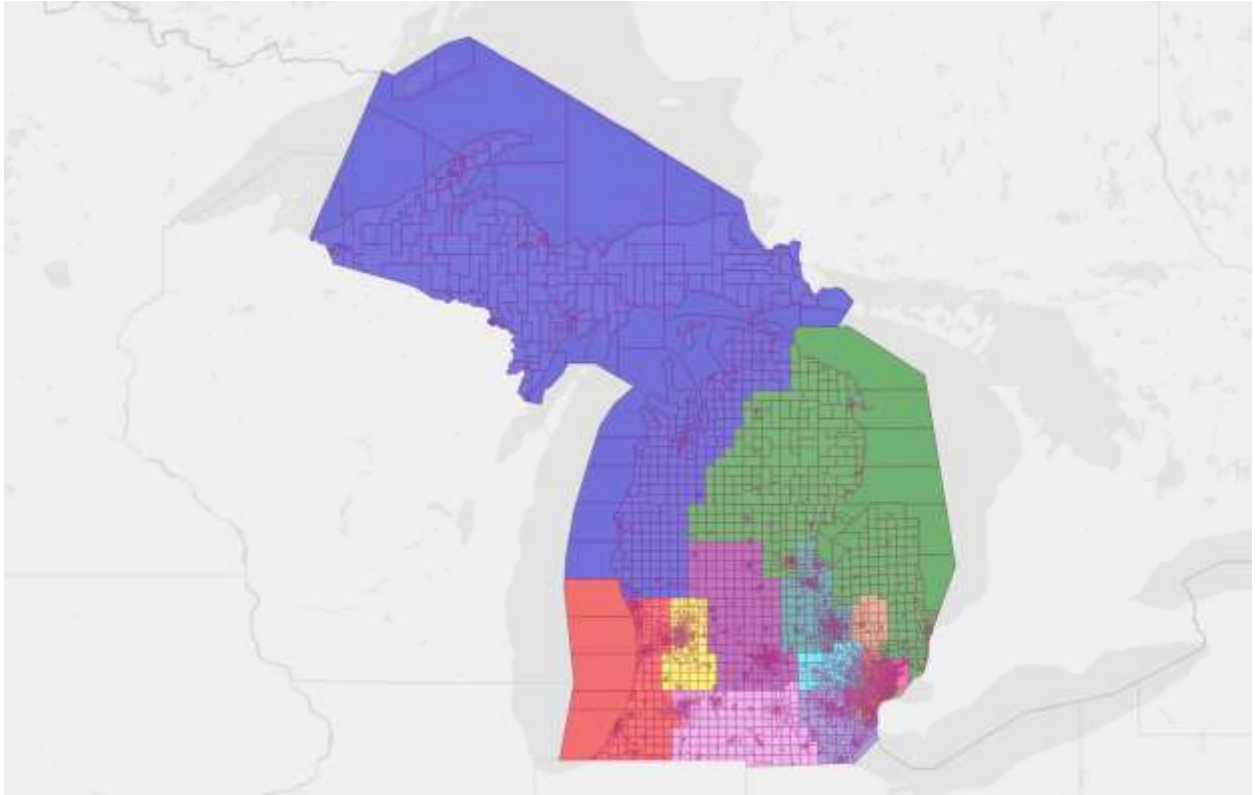
MARYLAND



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
61.35% to 38.65%	5 to 3	Best	Good	Good	1 of 8

Map URL <https://davesredistricting.org/join/1d398a87-f542-463b-98e7-dd36af71263c>

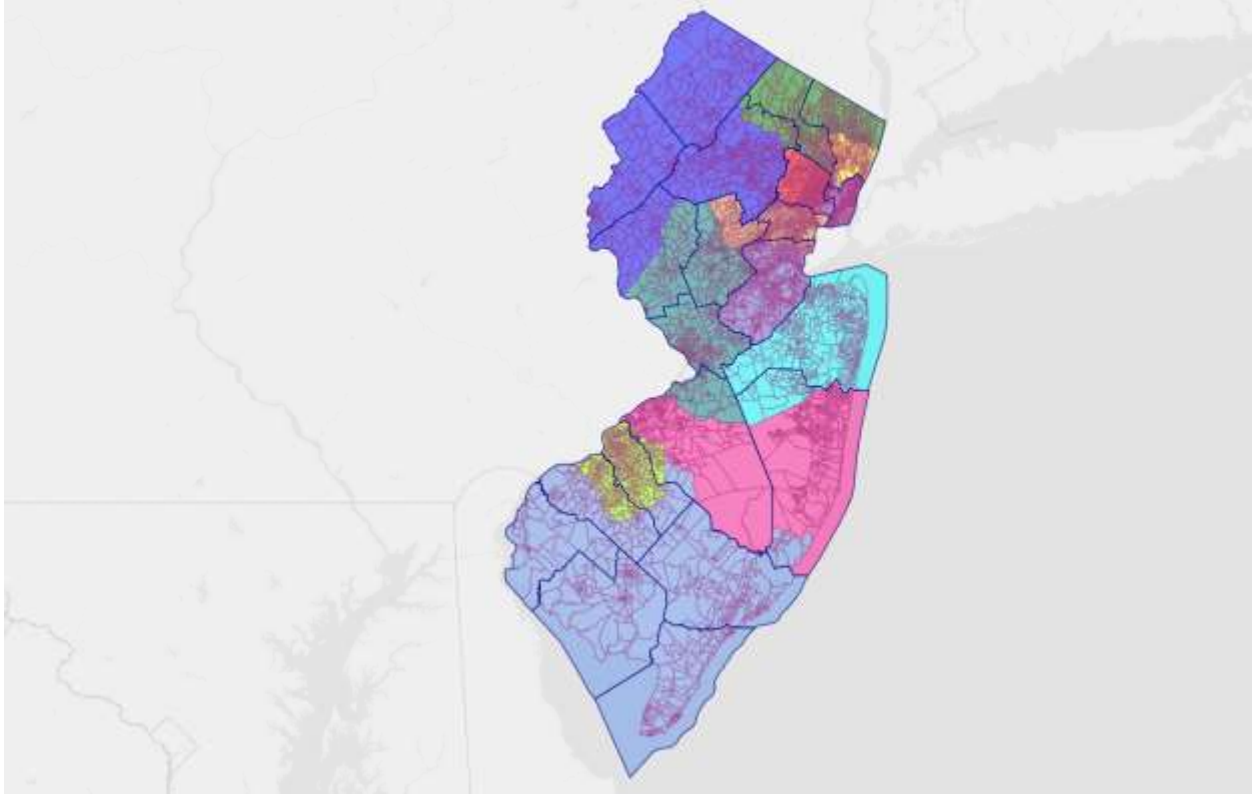
MICHIGAN



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
52.95% to 47.05%	7 to 6	Very Good	Very Good	Good	6 of 13

Map URL <https://davesredistricting.org/join/e2fb254e-6beb-4119-abcd-019074c82916>

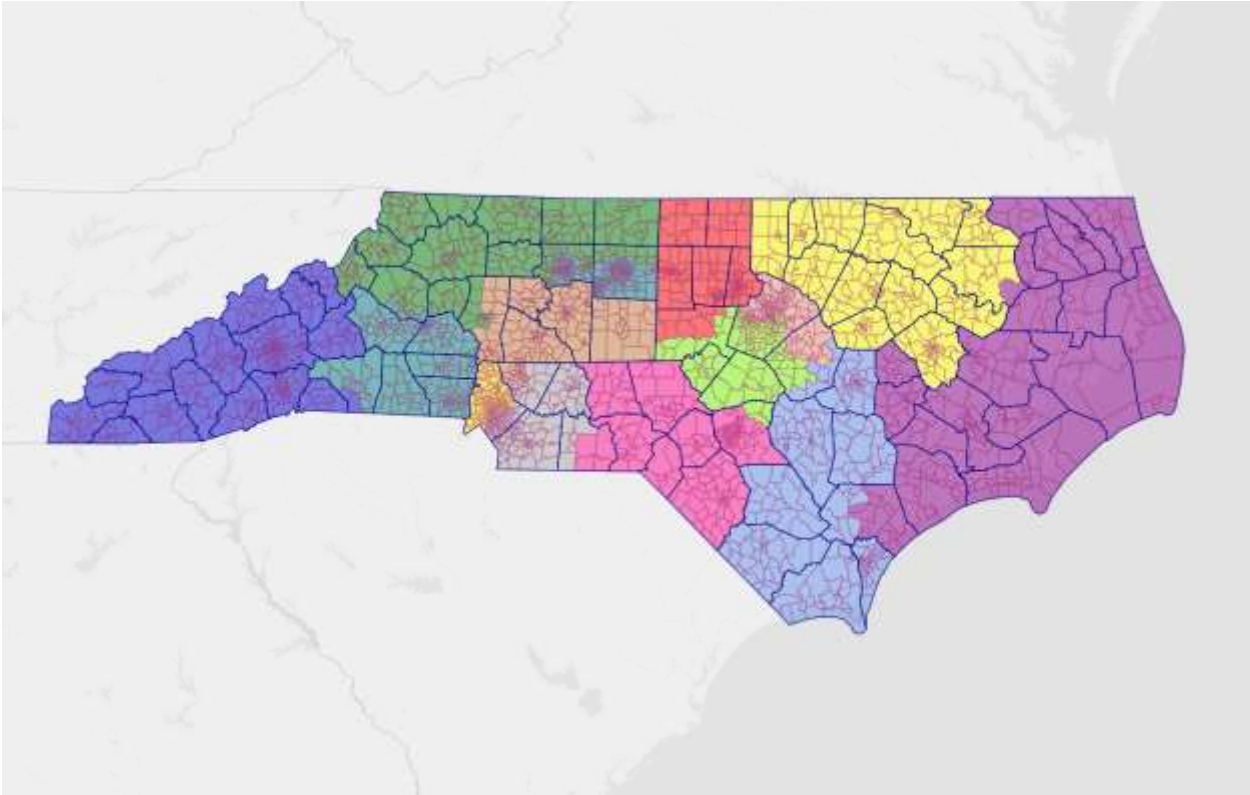
NEW JERSEY



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
57.09% to 42.91%	7 to 5	Good	Good	Good	3 of 12

Map URL <https://davesredistricting.org/join/86875828-d308-402e-a4b1-4486256f8242>

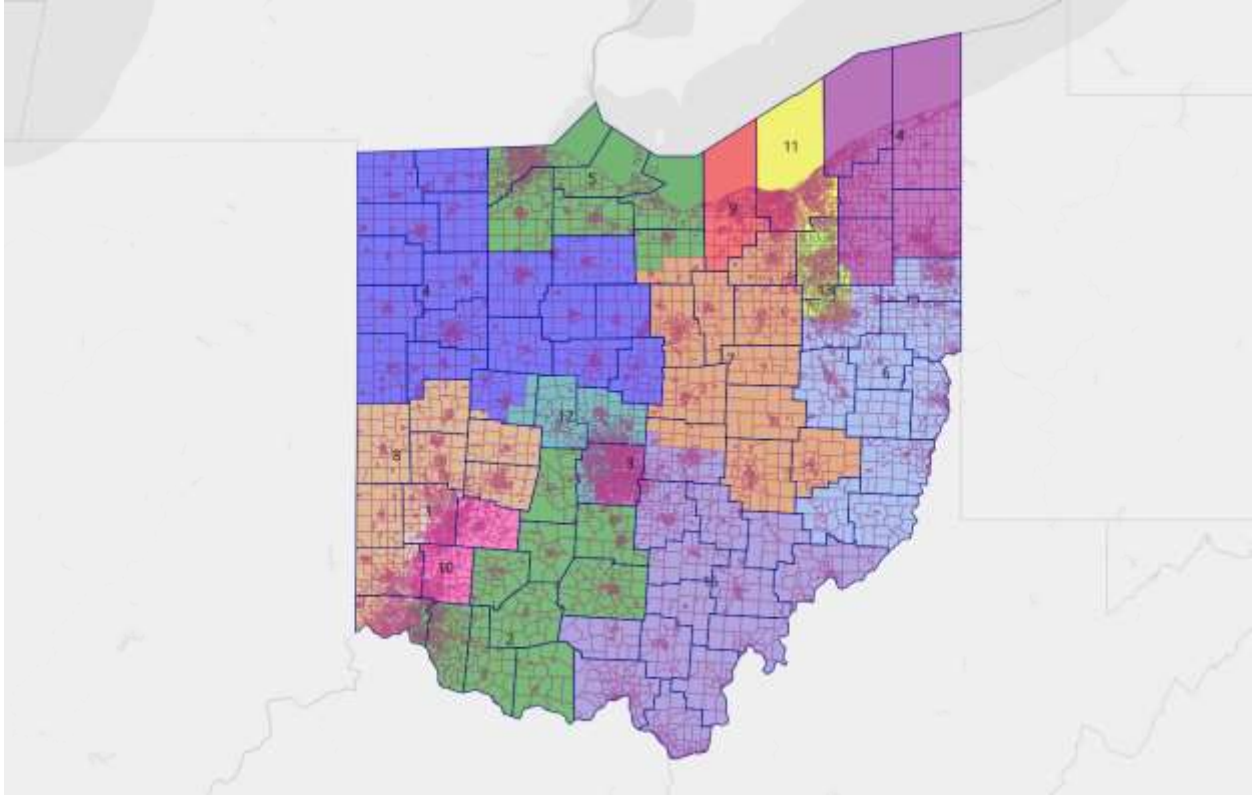
NORTH CAROLINA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
49.42% to 50.58%	7 to 7	Very Good	Good	Good	4 of 14

Map URL <https://davesredistricting.org/join/dd7982a2-07f0-4fdb-ae3f-215ccee2688a>

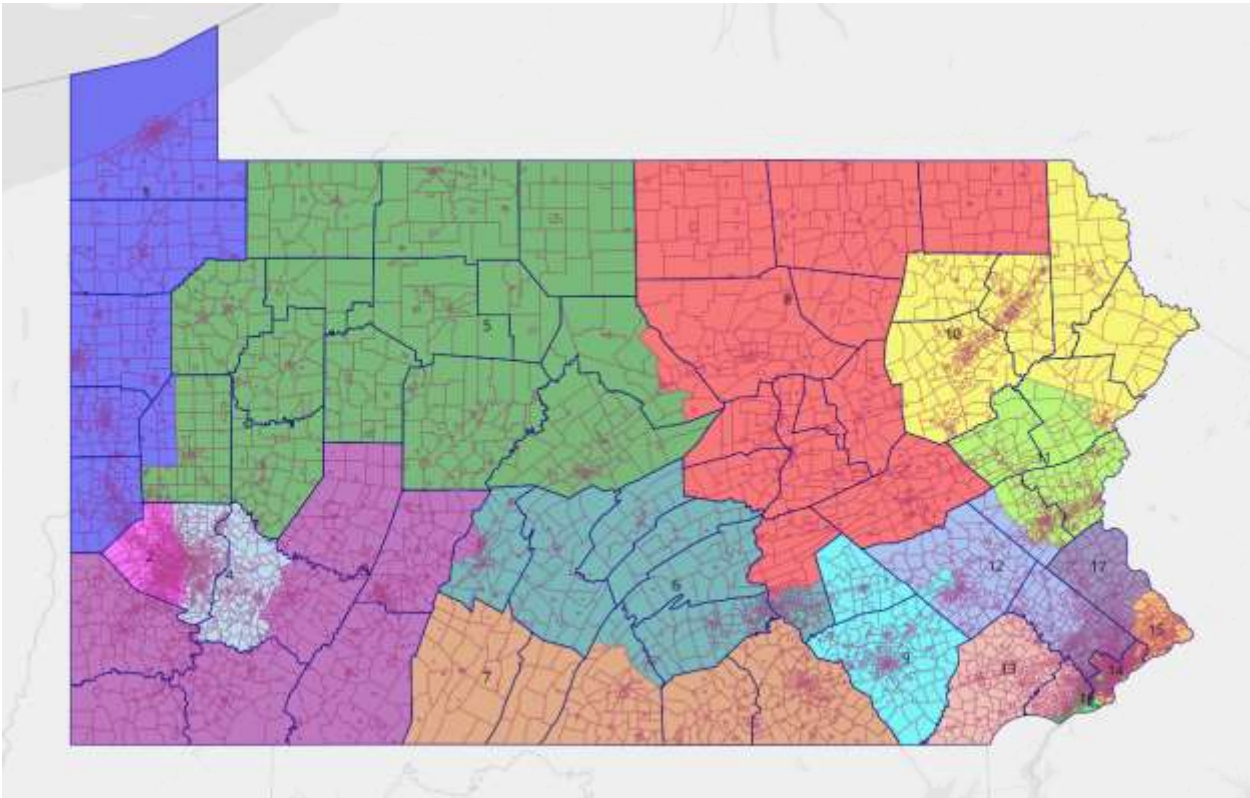
OHIO



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
46.38% to 53.62%	7 to 8	Very Good	Good	Good	4 of 15

Map URL <https://davesredistricting.org/join/c57d7df9-2232-4a4c-9f83-0c1d626888e5>

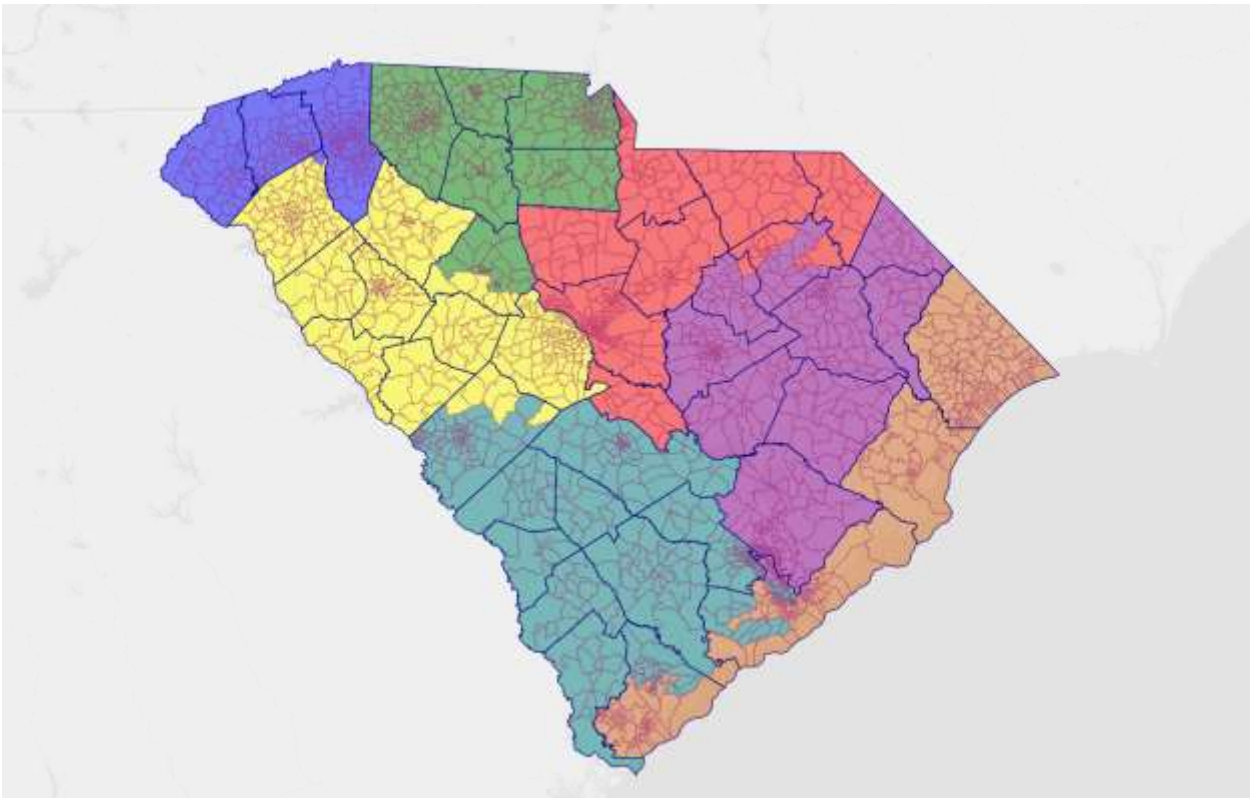
PENNSYLVANIA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
52.80% to 47.20%	9 to 8	Good	Good	Good	6 of 17

Map URL <https://davesredistricting.org/join/0216a211-61e9-4898-8125-073f72865ba6>

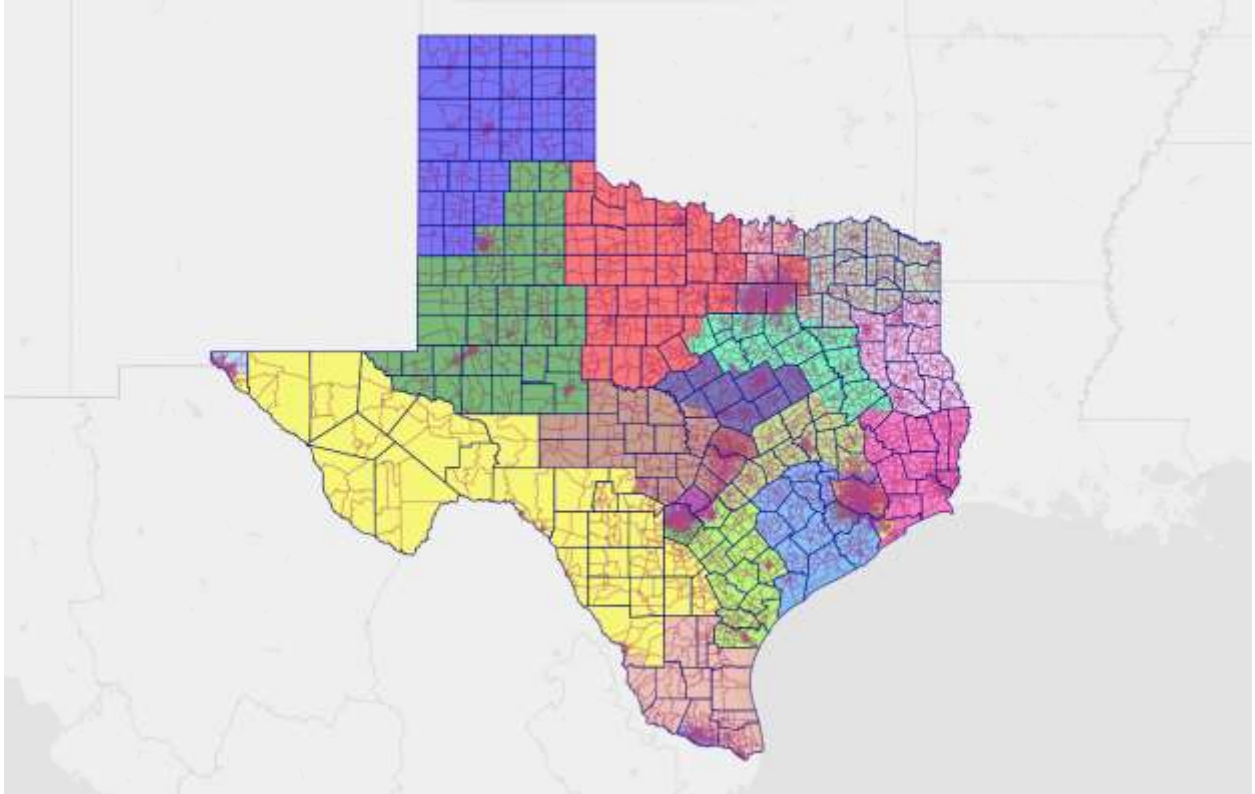
SOUTH CAROLINA



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
43.19% to % 56.81	3 to 4	Best	Reasonable	Good	2 of 7

Map URL <https://davesredistricting.org/join/432873ea-d1ba-41e0-924e-669225bec303>

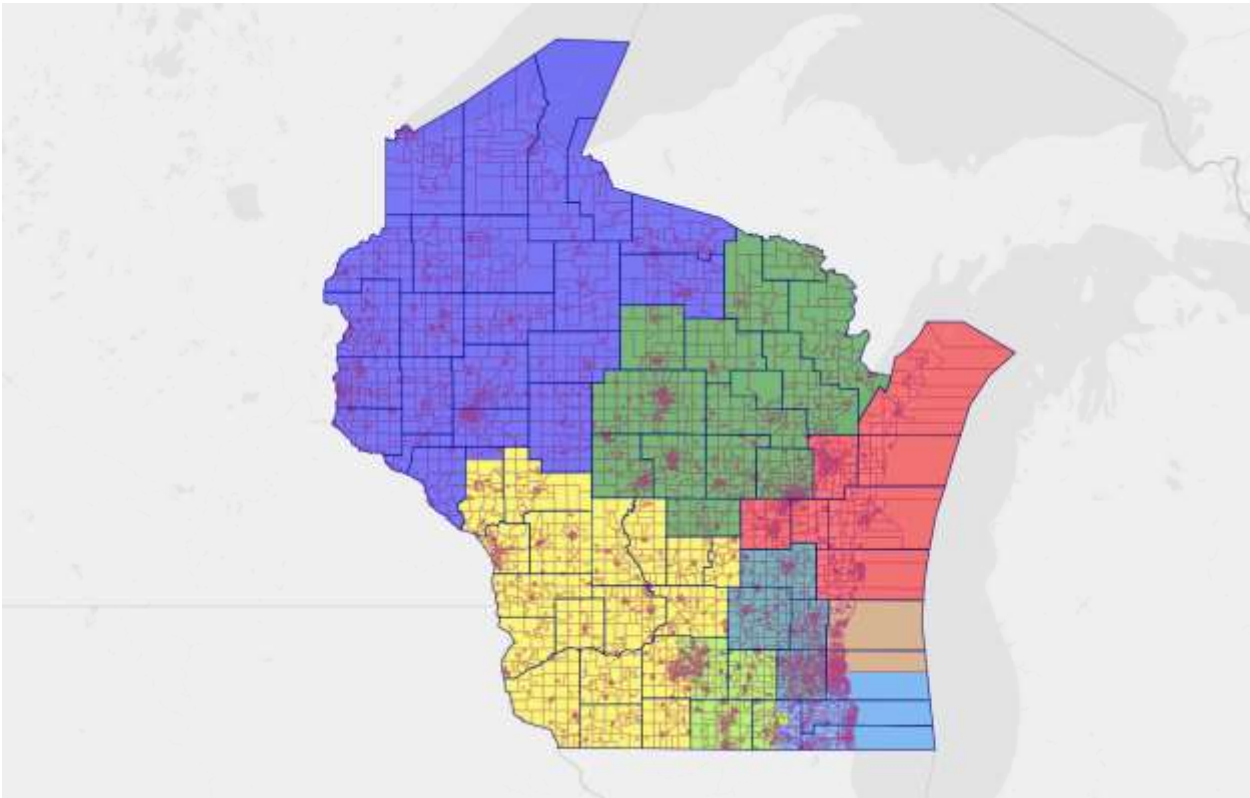
TEXAS



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
40.58% to 59.42%	15 to 23	Good	Good	Good	4 of 38

Map URL <https://davesredistricting.org/join/a25c81e0-42ab-48ed-81cc-fa84cd8b7ea6>

WISCONSIN



Party Distribution of Voting Behavior in the State	Party Share of Districts	Representing Minorities	Compact Districts	Not Splitting	Delegates from Competitive Districts
51.29% to 48.71%	4 to 4	Reasonable ¹³	Very Good	Very Good	3 of 8

Map URL <https://davesredistricting.org/join/eae7787f-ebdd-4135-8dd3-577e580dbac6>

¹³ Fewer than 20% of Wisconsin voters are members of a minority group. The low proportion and the geographical dispersion of these voters affects this rating.

APPENDIX B:

STATEWIDE VOTING BEHAVIOR¹⁴

State	Democrat	Republican
Alabama	40.00%	60.00%
Alaska	44.19%	55.81%
Arizona	48.87%	51.13%
Arkansas	35.29%	64.71%
California	64.24%	35.76%
Colorado	54.48%	45.52%
Connecticut	58.05%	41.95%
Delaware	59.91%	40.09%
Florida	48.37%	51.63%
Georgia	48.06%	51.94%
Hawaii	68.26%	31.74%
Idaho	33.93%	66.07%
Illinois	58.16%	41.84%
Indiana	43.41%	56.59%
Iowa	45.26%	54.74%
Kansas	41.86%	58.14%
Kentucky	41.45%	58.55%
Louisiana	40.38%	59.62%
Maine	50.58%	49.42%
Maryland	61.35%	38.65%
Massachusetts	61.40%	38.60%
Michigan	51.88%	48.12%
Minnesota	54.50%	45.50%
Mississippi	42.61%	57.39%

¹⁴The composite reported here is most often a compilation of statewide votes over 2016-2020 for President, Senate, Governor and Attorney General. (These data were gathered by the team at davesredistricting.org. These data appear at that site on the analytics page under the Proportionality criterion. Votes for minor parties were distributed proportionally among the two major parties.) If data are available, a more comprehensive composite might add, for example, votes for Secretary of State, Treasurer and Auditor. Although different composites for a particular state may vary slightly, they tend to match to very similar shares of district voting behavior.

Missouri	42.74%	57.26%
Montana	43.53%	56.47%
Nebraska	37.68%	62.32%
Nevada	51.46%	48.54%
New Hampshire	46.54%	53.46%
New Jersey	57.09%	42.91%
New Mexico	57.86%	42.14%
New York	62.99%	37.01%
North Carolina	49.42%	50.58%
North Dakota	30.74%	69.26%
Ohio	46.38%	53.62%
Oklahoma	33.56%	66.44%
Oregon	55.69%	44.31%
Pennsylvania	52.80%	47.20%
Rhode Island	61.90%	38.10%
South Carolina	43.19%	56.81%
South Dakota	35.91%	64.09%
Tennessee	36.66%	63.34%
Texas	46.27%	53.73%
Utah	32.97%	67.03%
Vermont	61.16%	38.84%
Virginia	54.77%	45.23%
Washington	58.16%	41.84%
West Virginia	32.01%	67.99%
Wisconsin	50.67%	49.33%
Wyoming	27.64%	72.36%

OVERVIEW: FAIR AND SQUARE MAPMAKING

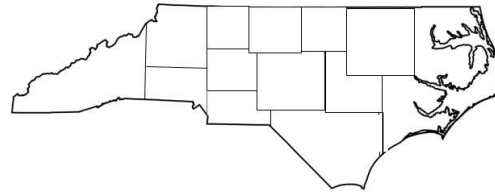
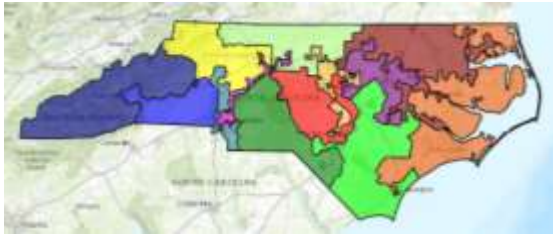
What is the goal of the Fair and Square Mapmaking?

The Fair and Square Redistricting Procedure is a new straightforward nonpartisan approach for constructing fair legislative maps. Advocates can use knowledge of such procedures to demand that such approaches be used to draw the maps in their states. In short, the goal of this work is to help citizens, advocates and commissioners, as well as legislators and judges, use approaches such as the Fair and Square Procedure to finally lay the gerrymandering dragon to rest.

What does Fair and Square Mapmaking do?

The Fair and Square procedure draws Congressional or State Legislative district maps (or maps for other jurisdictions) that are free from gerrymandering. A gerrymandered map constructs districts that deliberately group voters together in a way that gives one party or the other an unfair advantage. The result is often oddly shaped districts.¹⁵ An approach such as the Fair and Square Procedure solves this problem. The diagram below shows, for example, a gerrymandered Congressional district map that was adjudicated before the Supreme Court (on the left)¹⁶ alongside a rendering of the Congressional district map generated by the Fair and Square approach for that state (on the right).

¹⁵ Certain states explicitly prohibit districts that are “oddly shaped,” “irregularly shaped,” or have a “bizarre shape.” National Conference of State Legislatures, “Redistricting Criteria.” Washington, D.C.: NCSL, 2019. ncsl.org/research/redistricting/redistricting-criteria.aspx



How well does the procedure work?

The maps drawn in this work were constructed by hand using an app at [DRA2020.org](https://dra2020.org). This app constructs a series of “analytics” for the maps produced. All 12 Congressional District maps in the study generated a rating of adequate (ok) or better on the measure of compactness. Ten of the maps generated the highest rating of “very good” on a measure of fairness (proportionality)¹⁷. Five of the maps achieved a perfect score of 100 on this measure of fairness.

How does the Fair and Square procedure work?

The Fair and Square approach is a two-step procedure. In Step 1 mapmakers create rows of (nested) square districts. This provides the foundation of the procedure. In Step 2, the mapmakers build upon this foundation. They maintain the square shape of districts as much as possible, and refine district lines as needed to assure that the set of districts is fair. Using counties rather than precincts as the basic building block for constructing districts makes the districts less square but helps assure that fewer counties will be split.

What does “fair” mean?

Suppose, for example, that in past elections, 60 percent of all voters in a state voted for Party A and 40% voted for Party B. A fair procedure generates a map

¹⁶ A new map was drawn for one-time use in the 2020 election. The paper, “Fair and Square Redistricting,” studies 12 states where district maps have recently been challenged in court.

¹⁷ As noted in the paper, in CT and AL, the procedure moved the map toward fairness. However, the way voters happen to be located in these states precluded complete fairness while maintaining compact districts.

where 60% of the *districts* contain a majority of voters who chose Party A in past elections, and 40% of the *districts* contain a majority of voters who chose Party B.

Why are districts square?

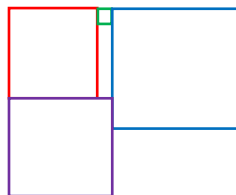
Past research has shown that citizens and redistricting experts alike see square districts as being most “compact.”¹⁸ Compact districts are important because then neighbors vote with neighbors and representatives can focus on issues relevant to a local community.¹⁹ Also, housing patterns tend to be related to particular groups and communities of interest, so compact districts allow elected officials to represent constituents in those communities.

Why aren’t all districts the same size?

Districts must contain (nearly) the same population so each elected official represents about the same number of constituents. However, population density varies across a state. Therefore, to meet this population requirement, districts in rural areas will be geographically large and districts in densely populated areas will be geographically small.

Why can’t districts simply be placed side-by-side; Why must they be “nested?”

Districts vary in geographic size. As a result, if districts were placed side by side, residents in certain areas of the state would not be included in a district. The diagram below shows four square districts (red, green, blue, purple) placed side-by-side. The residents in the rectangular area are not included in any district.



¹⁸ Aaron Kaufman, Gary King and Mayya Komisarchik, “How to Measure Legislative District Compactness If You Only Know It When You See It,” *American Journal of Political Science*, Forthcoming. Copy at <https://gking.harvard.edu/files/gking/files/compact.pdf>

¹⁹ The National Conference of State Legislatures reports that 40 states require that districts be compact. National Conference of State Legislatures, “Redistricting Criteria.” Washington, D.C.: NCSL, 2019.

The Fair and Square approach presents a procedure for tucking some of the square districts under others to assure that all voters are included in a district.

Why aren't the sides of districts straight?

Districts are made up of precincts grouped together. Precincts often do not have smooth sides, so the sides of districts are not perfectly smooth.

Does the Fair and Square procedure use a computer program to draw the maps?

No. The Fair and Square approach is completely transparent and can be, and was, implemented by hand. A computer assisted app, DRA2020, was used to keep track of the voters in each district as the districts were drawn.

Hope

As more people become aware of approaches such as this, the hope is that more will ask, "Why aren't we using procedures such as this to construct fair legislative district maps?"

Following is a research article that details and justifies this new nonpartisan, transparent, straightforward approach for constructing fair legislative district maps.

FAIR AND SQUARE MAPMAKING

James N. Fox²⁰

Abstract

This article presents a new procedure for constructing fair legislative district maps. This nonpartisan, transparent, straightforward procedure is intended to be helpful to those interested in promoting fair legislative district maps. The work draws upon a recent award-winning study of preferences of redistricting experts and lay citizens, alike. The approach draws upon that study to construct foundational maps made up of compact districts. The mapping procedure then builds on that foundation, employing the well-established concept of partisan symmetry to construct maps that are fair to both major political parties. The article opens by discussing this new view of compact districts and describes the procedure for constructing the maps. Foundational maps are drawn for 12 states that have recently been under court scrutiny. Partisan symmetry is then applied to these maps to construct legislative district maps that are fair and square.

INTRODUCTION

Fair maps are the foundation of a representative democracy. The paramount goal of a fair map is to yield a representative legislative body. The path to that goal is a map which is representationally fair -- that is, a map where voter lean across districts matches voter lean in the state as a whole.

Gerrymanderers seek to produce an **un**representative legislature (Hirsch, 2003). The counter to gerrymandering is to insist that legislative district maps are fair. The answer to partisan gerrymandering is not a redistricting commission, *per se*. The answer is not a map that meets a subsidiary goal such as matching local jurisdictional lines, *per se*. The answer is a fair map.

²⁰ B.A. Stanford, M.A., PhD.^{abd} UCLA; ORCID iD: <https://orcid.org/0000-0001-9493-8275?lang=en>.

Note: This article focuses on two fundamental redistricting criteria: compact districts and partisan (or representational) fairness. The Guide above covers a broader range of redistricting criteria.

Who draws the maps is important, but how they draw them is even more important. As more people become aware of approaches such as this, more are likely to ask, “Why aren’t we using approaches such as this to build maps where the districts are compact and the maps are fair?”

Mapmakers will soon redraw legislative district maps in response to the 2020 Census. They face a task more daunting than ever before. Myriad computer algorithms are available, such as the shortest splitline, Voroni Diagrams, the K-means algorithm (Altman and McDonald 2010, pp. 86,88) and Brian Olson’s minimizing the distance from the center approach (Olson, n.d). An expert generated 24,518 compliant congressional district maps for North Carolina in the recent *Rubio* litigation (dissent, p. 20). Which road will mapmakers follow; which path will they take?

This article offers a new path for mapmakers to consider. The article presents a nonpartisan procedure for constructing legislative district maps. The maps contain compact districts and are fair to both major political parties. A straightforward, transparent procedure such as this is likely to be appreciated by advocates, citizens, and jurists, alike.

II. COMPACT DISTRICTS

State Requirements. The National Conference of State Legislatures (NCSL) (2019) reports that 40 states require that legislative districts be “compact.” But what does “compact” mean? Based on a comprehensive review of legislation and constitutional provisions in all 50 states, Levitt (2018) concludes, “Few states define precisely what ‘compactness’ means, but a district in which people generally live near each other is usually more compact than one in which they do not. Most observers look to measures of a district’s geometric shape.” NCSL points out, for example, in Arkansas, the Courts have held that “a district shaped like a circle or a square would be ‘geographically compact;’” In Iowa, state provisions define “reasonable compact districts” as “those which are square, rectangular, or hexagonal in shape;” and the districts should not be “irregularly shaped.” Nevada provisions call for districts that are “as regularly shaped as possible (e.g., rectangular or circular).” In Arkansas, the Courts say to avoid districts with a “bizarre shape;” and Idaho provisions say to “avoid drawing districts that are “oddly shaped” (National Conference of State Legislatures 2019).

.

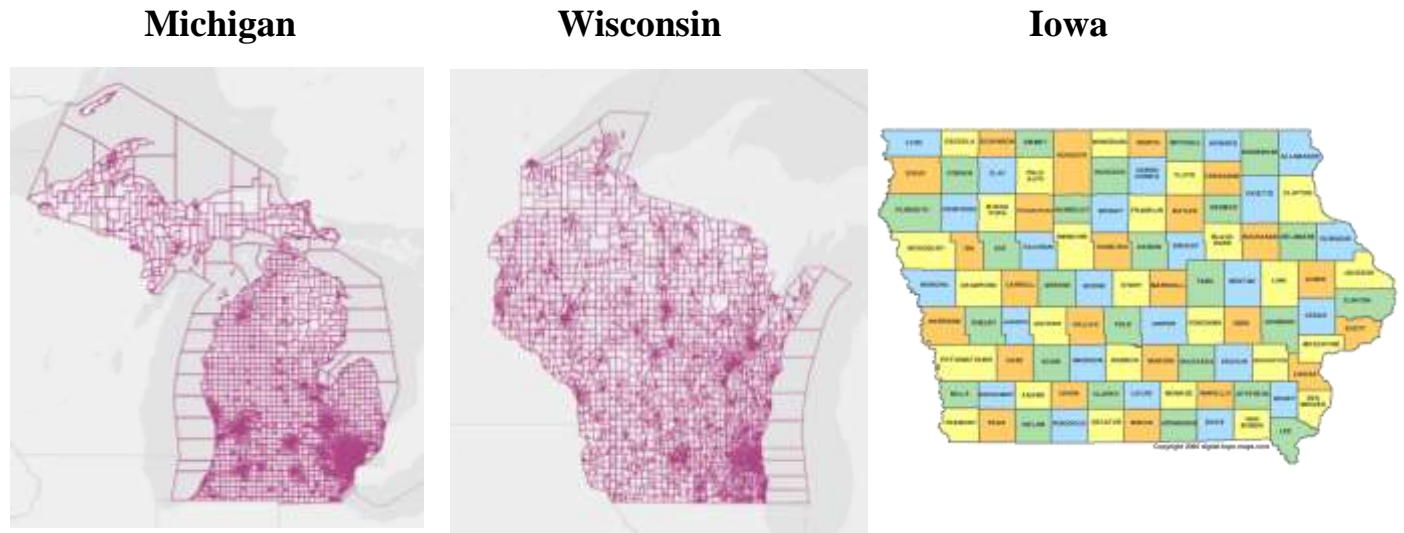
Perceptions. A recent award-winning study sheds additional light on this issue. Kaufman, King and Komisarchik (forthcoming) investigated individuals' perceptions about which district shapes appear to be most compact. These researchers employed sophisticated interview techniques to elicit the views of almost 200 respondents covering a broad range of both redistricting experts and lay citizens.

Our main test comes from 96 sitting justices, judges, and public officials, all with some responsibility for redistricting or deciding redistricting cases. We also elicited the views of 102 others ranging from less to more involved in and knowledgeable about redistricting, including Mechanical Turk workers . . . undergraduates . . . political science PhD students, law students, law faculty, redistricting consultants and expert witnesses, and lawyers involved in legislative redistricting cases (p. 17).

They found remarkable consistency among all respondents. “Our measure of compactness favors districts that are squarish, with minimal arms, pockets, islands, or jagged edges. (We use “squarish” rather than “circle-like” because many real districts are approximately square-shaped but almost none resemble circles.)” (p. 9) (See also Figure 2 and Table 2). They also found that respondents prefer shapes that are not tilted (p. 8).

Related State Practice. States can, and do, use squares to frame various subdivisions. Witness for example the precinct maps for Michigan and Wisconsin and the county map of Iowa.

Figure 1. Square Precincts in Michigan and Wisconsin and Square Counties in Iowa



III. A NONPARTISAN TRANSPARENT PROCEDURE FOR CONSTRUCTING LEGISLATIVE DISTRICT MAPS

Nested Squares. This section of the article presents a straightforward, transparent procedure to construct nonpartisan legislative maps formed by upright (not tilted) square, compact districts. Square districts cannot simply be placed side-by-side to construct a legislative map. Federal and state requirements stipulate that legislative districts must contain (approximately) equal population (NCSL 2019). Each state has a predetermined number of congressional districts (or within state senators or delegates). The required population in each district is the state's total population divided by the number of predetermined districts. Districts in densely populated areas will be geographically smaller than districts in more sparsely populated areas. To assure that all areas of the state are covered, this procedure uses nested squares.

To construct a map of nested squares, start at the upper left of a state map and draw a square which expands to the right and down until the district contains the required population. Then move to the upper left corner of the unoccupied area and proceed from left to right (as we read in America). Produce a series of

adjoining squares across the top of the map. Then move to the far left of the unclaimed area in the map and draw the second row of districts. Continue the process until the map is complete. Whenever a square meets an already claimed area, “tuck” the new square under the existing square and readjust the size of the square to meet the population requirement. The result is a map of compact nested squares.²¹ The procedure is straightforward and transparent. It can be done by hand.

Application. The Brennan Center has identified redistricting cases in 12 states (Li, Wolf and Lo 2019). Shown below, for each of these states, is the current congressional district map alongside a conceptual rendering of the map drawn by the nonpartisan nested squares approach.

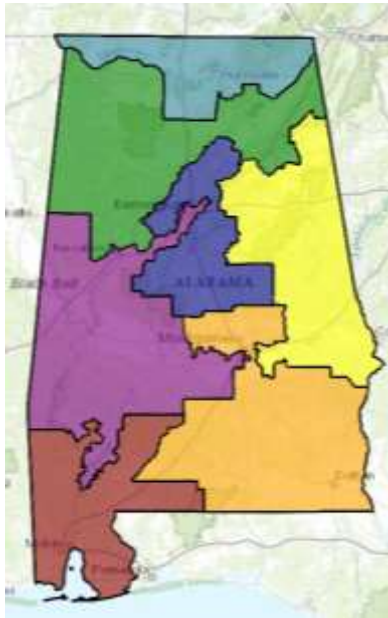
²¹Appendix A describes in detail the procedure for constructing a legislative district map with compact districts made up of nested squares.

Figure 2. Congressional District Maps²²

Current

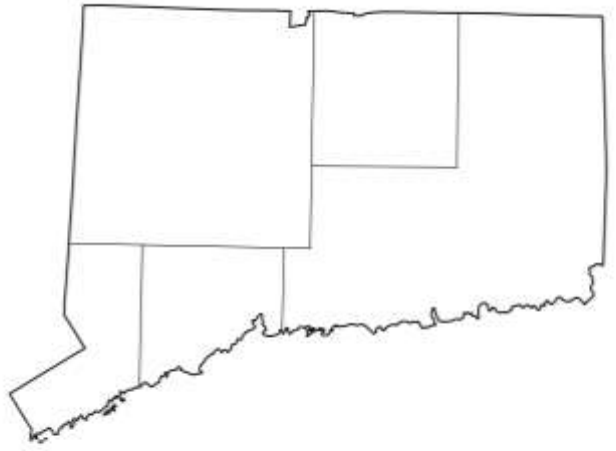
Nested Squares

ALABAMA

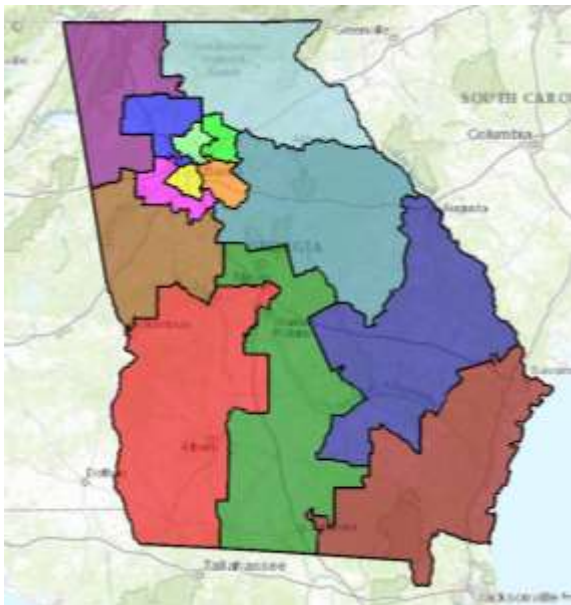


²² Current maps are from Wikipedia except Ohio which is from Cleveland State University. State outlines for the nested square maps are from Gisgeography.com.

CONNECTICUT



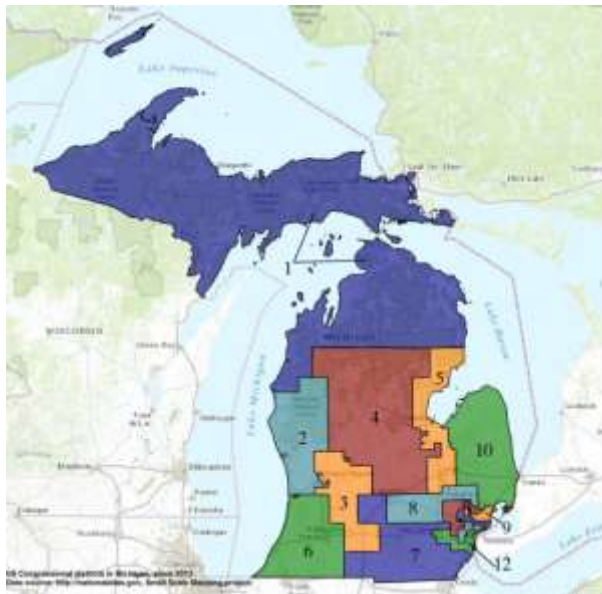
GEORGIA



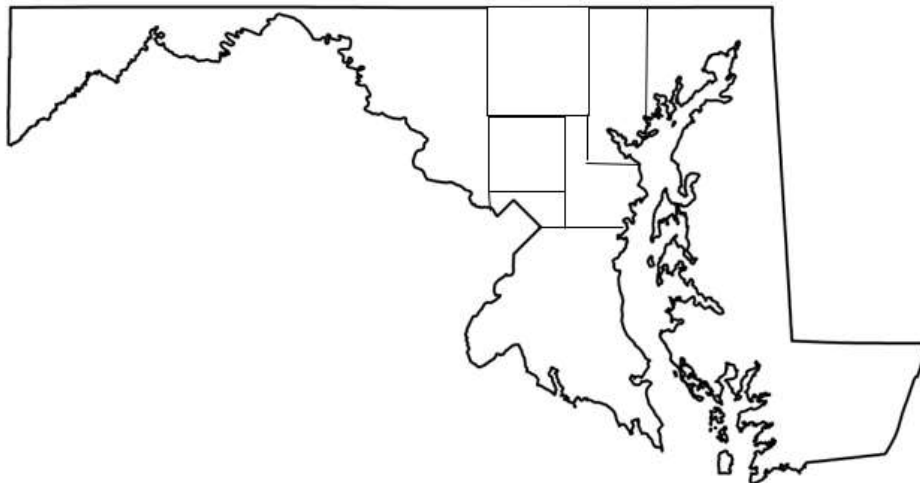
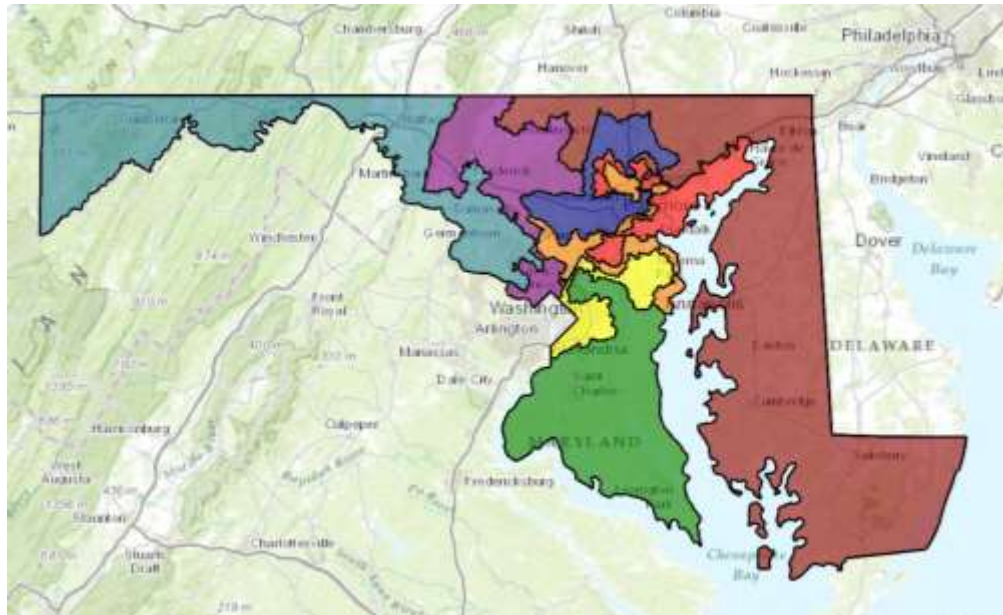
LOUISIANA



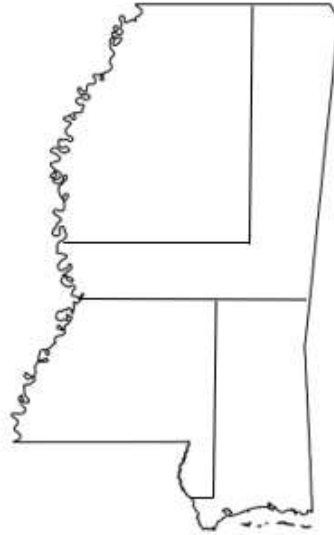
MICHIGAN



MARYLAND



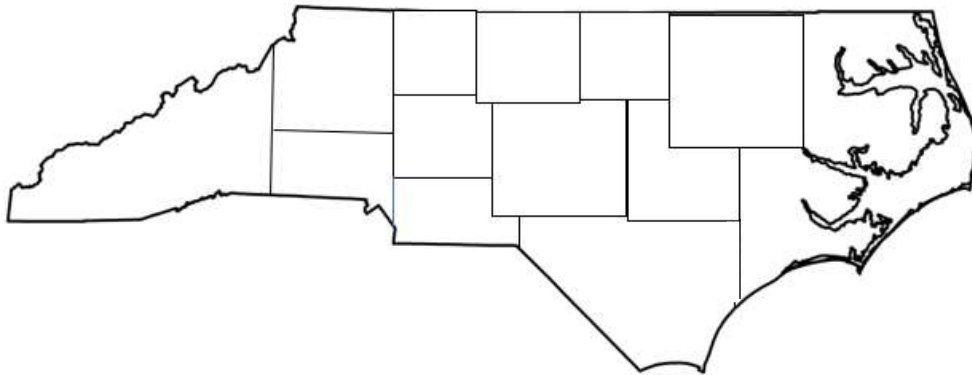
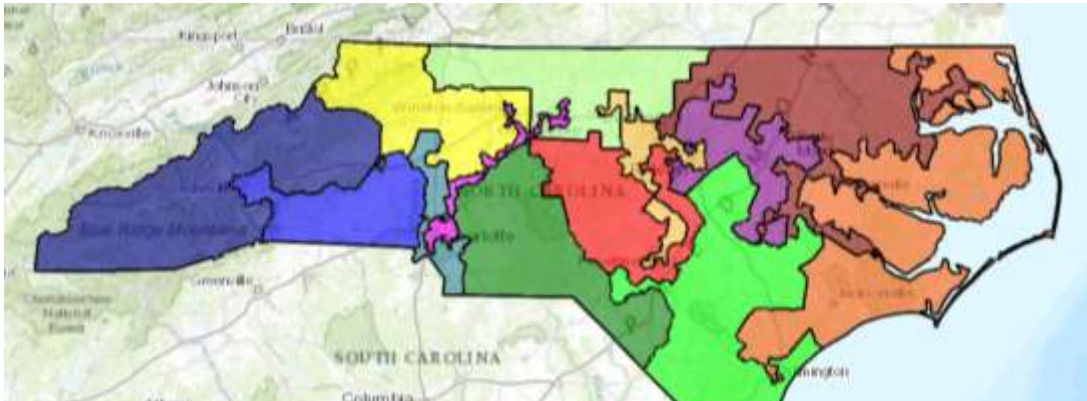
MISSISSIPPI



OHIO

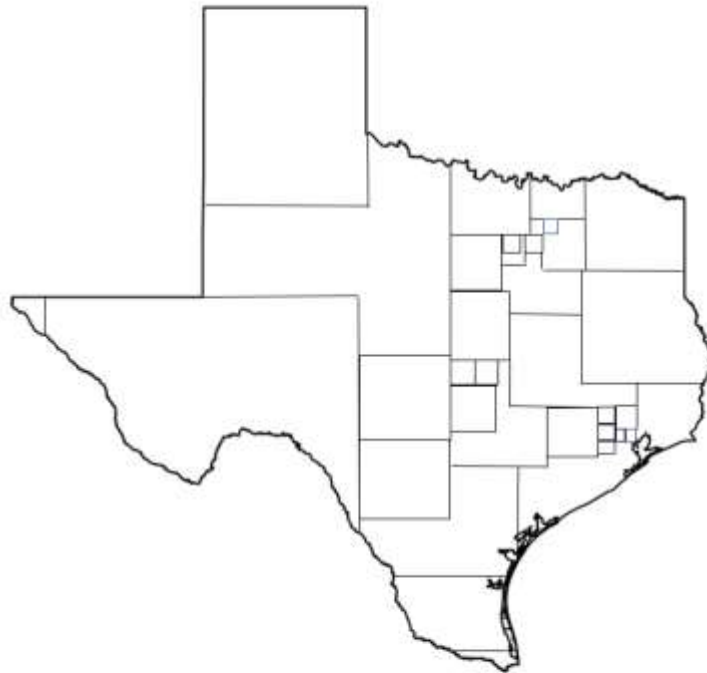
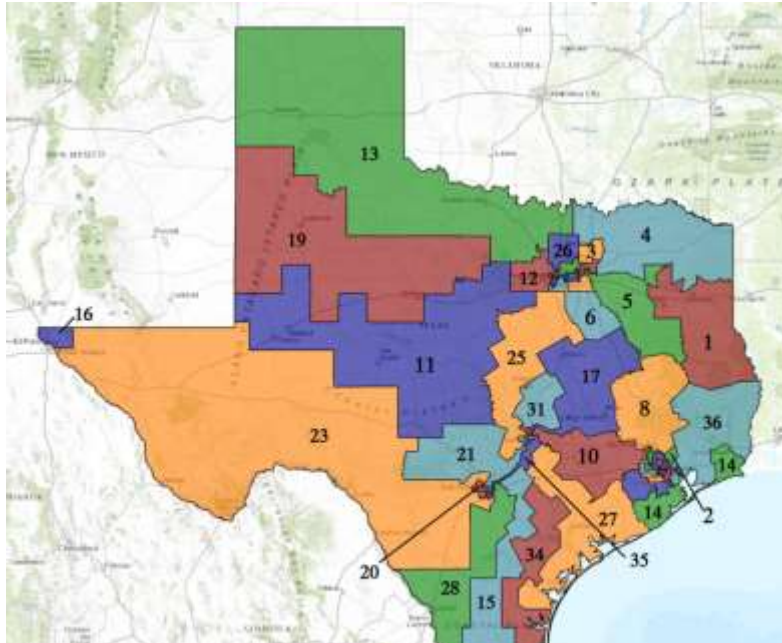


NORTH CAROLINA²³

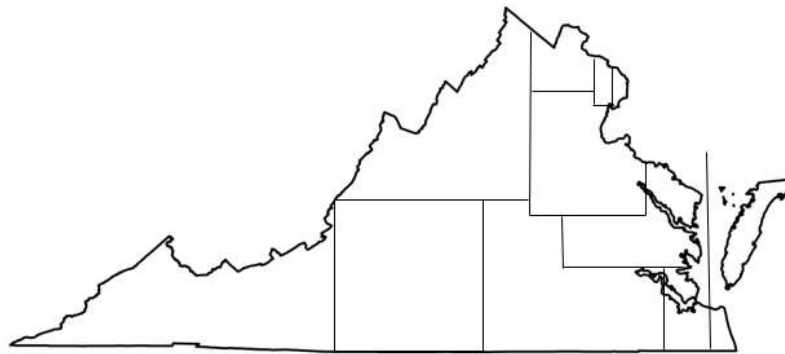
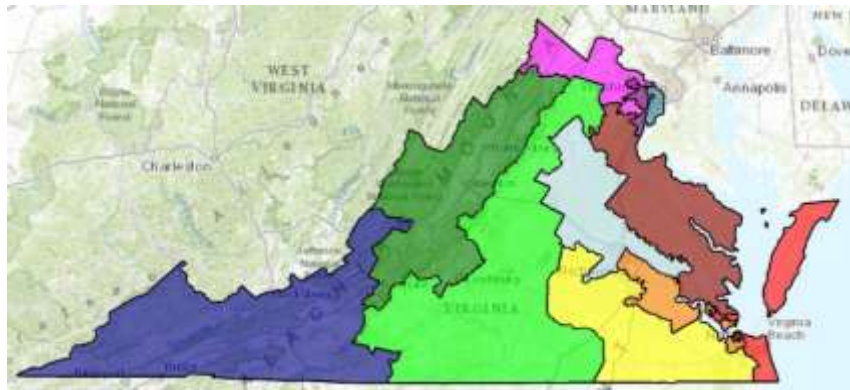


²³ This is the map that was adjudicated in *Rucho*. A new map has been drawn for one time use in the 2020 election (Melnik and Meko 2019).

TEXAS



VIRGINIA



WISCONSIN



Partisan Fairness. The ultimate goal of redistricting is not simply to construct a legislative map made up of compact districts. The ultimate goal is to achieve partisan fairness. Scholars have explained the concept of partisan symmetry as a standard for partisan fairness:

The key to the symmetry definition of fairness is that it evaluates the electoral system as a whole by evaluating how voter preferences statewide are translated into the division of legislative seats between the parties. . . . The symmetry standard requires that the electoral system treat similarly-situated parties equally, so that each receives the same fraction of legislative seats for a particular vote percentage as the other party would receive if it had received the same percentage [of the vote]. Social scientists have long recognized *partisan symmetry* as the appropriate way to define partisan fairness in the American system of plurality-based elections (Grofman and King 2007 pp. 6-7).

This concept is starting to find its way into practice. In the *Rucho* decision, Justice Roberts references Section 3 of Article III of the Missouri Constitution as an example of the type of standards and guidance that states can provide for state courts to apply when addressing gerrymandering complaints. Passed overwhelmingly as a ballot initiative in 2018, this provision in the Missouri Constitution establishes the position of a non-partisan state demographer to draw legislative district maps and specifies: “[d]istricts shall be designed in a manner that achieves both partisan fairness and secondarily, competitiveness. Partisan fairness means that parties shall be able to translate their popular support into legislative representation with approximately equal efficiency”²⁴ (Missouri Constitution).

Article XI §6(B) of the Ohio Constitution now reads: “The statewide proportion of districts whose voters, based on statewide state and federal partisan general election results during the last ten years, favor each political party shall correspond closely to the statewide preferences of the voters of Ohio.” In other words, the voter lean across legislative districts must match the voter lean in the state as a whole.

NCSL reports that 19 states prohibit the drawing of legislative maps that intentionally favor or disfavor an incumbent, candidate or party (NCSL 2019).

²⁴ The demographer shall develop an index based on past electoral performance of the two major parties and calculate “wasted votes.” The difference between the two parties’ wasted votes as a percentage of total votes shall be as close to zero as practicable.

Furthermore, the tie-breaking chairman of New Jersey's Commission on Redistricting used partisan fairness as the main criterion for producing a fair legislative district map (Hirsch 2003).

The procedure described in this article employs a two-step process to construct legislative maps that are partisan fair. Step one constructs the set of compact districts as described above. That forms the starting point, the foundation.

Step two assures that the maps are fair. Initially, determine the statewide share of past votes between the two major parties in the state. The metric used in this work was a composite index of the votes for the 2012 and 2016 Presidential elections, the 2016 and 2018 Senate elections, and the 2018 elections for Governor and Attorney General (from Bradlee and others, 2020). (Any votes for a third-party candidate were distributed proportionally between the two major parties.) Then reformat district lines, as needed, so each of the major party's likely share of seats most closely corresponds to its statewide share of past votes. The goal is to preserve compact districts while achieving partisan fairness. In this final step, districts could also be reformatted to achieve other desired goals such as to preserve county lines or to encompass communities of interest. However, the commitment to fair maps should remain paramount.

Results. The table below summarizes the consequences of redistricting congressional districts based on nested squares and partisan fairness. The states are ordered by the percent of districts changed as a result of redistricting based on this procedure. The entries represent the expected number of seats for each party. "Goal" is calculated by multiplying statewide share of past votes for each party by the number of congressional districts in the state and rounding to the nearest whole number. "Current" represents the distribution across parties of the partisan lean of the current map (as of 2020) (Wikipedia). "Foundation" represents the expected distribution of seats from the map of compact districts made up of nested squares. These maps are displayed in Appendix B. "Partisan Fairness" represents the expected distribution of seats after applying the concept of partisan symmetry and adjusting some district boundaries to achieve partisan fairness. These maps are displayed in Appendix C.

Table 1. ACHIEVING PARTISAN FAIRNESS# of Districts with Majority of Votes by Party

State	Status	Democrat	Republican
<hr/>			
Ohio	Goal	8	8
	Current	4	12
	Compact	3 (1 even)	12
	Partisan Fairness	8	8
Maryland	Goal	5	3
	Current	7	1
	Compact	6 (1 even)	1
	Partisan Fairness	5	3
Mississippi	Goal	2	2
	Current	1	3
	Compact	0	4
	Partisan Fairness	2	2
North Carolina	Goal	6	7
	Current	3	10
	Compact	6	7
	Partisan Fairness	6	7
Michigan	Goal	7	7
	Current	4	9
	Compact	7	7
	Partisan Fairness	7	7
Connecticut	Goal	3	2
	Current	5	0
	Compact	5	0
	Partisan Fairness	4	1

Wisconsin	Goal	4	4
	Current	2 (1 even)	5
	Compact	4	4
	Partisan Fairness	4	4

Louisiana	Goal	2	4
	Current	1	5
	Compact	1	5
	Partisan Fairness	2	4

Georgia	Goal	6	8
	Current	4	10
	Compact	4	10
	Partisan Fairness	6	8

Alabama	Goal	3	4
	Current	1	6
	Compact	0	7
	Partisan Fairness	2	5

Virginia	Goal	6	5
	Current	5	6
	Compact	6	5
	Partisan Fairness	6	5

Texas	Goal	15	21
	Current	13	23
	Compact	11	25
	Partisan Fairness	15	21

In each of the twelve states studied, the procedure moved the distribution of partisan lean across districts toward partisan fairness. In four states, North Carolina, Michigan, Wisconsin and Virginia, complete partisan fairness was achieved in the first step by constructing a foundational map of compact districts made up of nested squares. In six states, Ohio, Maryland, Mississippi, Louisiana,

Georgia, and Texas, the nested squares map formed a foundation, and the principle of partisan symmetry was employed to achieve partisan fairness. In two states, Connecticut and Alabama, the procedure produced compact districts and moved the current distribution of partisan lean toward partisan fairness.²⁵

III. ADMONITION

During oral arguments in the *Gill* gerrymandering case, Chief Justice Roberts commented on using the “efficiency gap,” a measure of “wasted votes,” to describe the degree of partisan gerrymandering. Referring to this measure as “EG,” he cautioned:

[If] you’re the intelligent man on the street and the court issues a decision, and let’s say, okay, the Democrats win, and that person will say: “Well, why did the Democrats win?” And the answer is going to be because EG was greater than 7 percent, where EG is the sigma of party X wasted votes minus the sigma of party Y wasted votes over the sigma of party X votes plus party Y votes. And the intelligent man on the street is going to say that’s a bunch of baloney. It must be because the Supreme Court preferred the Democrats over the Republicans. And that’s going to come out one case after another as these cases are brought in every state. And that is going to cause very serious harm to the status and integrity of the decisions of this court in the eyes of the country (Gill, p.37).

The sentiment of Justice Robert’s admonition is that the typical thoughtful citizen is most likely to support a finding if he or she understands the underpinnings of the decision.

That same sentiment applies to redistricting approaches. Some might argue that using statewide vote share as the foundation for defining partisan fairness is too simplistic, preferring instead sophisticated statistical modeling. Some might prefer elegant computer algorithms or mathematical models rather than a transparent approach that can be done by hand. This article presents a straightforward transparent approach to nonpartisan redistricting that deliberately sacrifices sophisticated statistical modeling and computer elegance in favor of promoting public understanding and support.

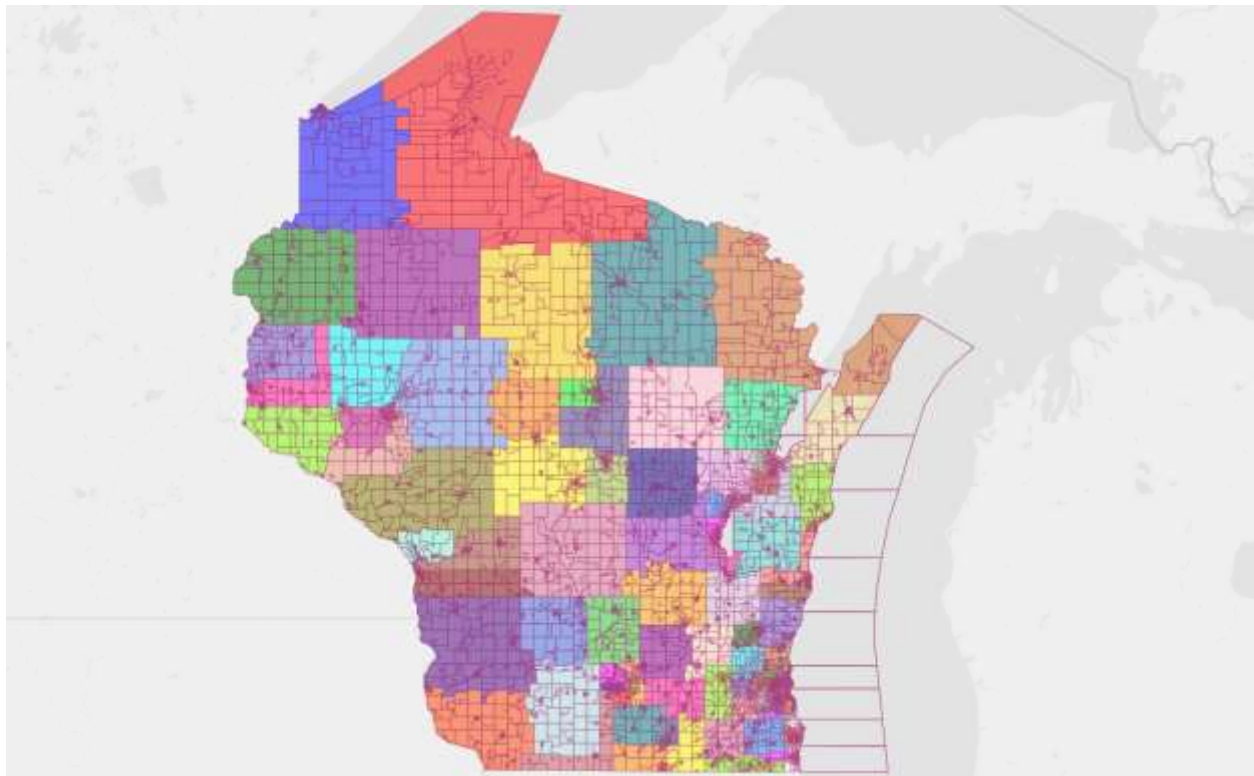
²⁵ In these two states the distribution of voters precluded a map of compact districts achieving complete partisan fairness. The procedure chosen here preserved compact districts at the expense of achieving total partisan fairness. In such instances, mapmakers might choose instead to achieve total partisan fairness at the expense of compact districts.

IV. STATE LIGISLATURES

This section of the article provides an example of how this process can be used to redistrict the map for a state legislative body. The composite measure used throughout this article shows statewide shares of past votes in Wisconsin of 51.3% for Democrats 48.7% for Republicans. Gilbert (2018) reports that the current map for the Wisconsin State Assembly yields a partisan lean in state Assembly districts of 64-35 in favor of the Republicans.

Figure 3 presents the map generated by using nested squares and partisan fairness for the Wisconsin State Assembly.

Figure 3. Partisan Fair Legislative Map
Wisconsin State Assembly



The distribution of Wisconsin State Assembly seats that is proportional to the statewide share of votes is 51 Democrats and 48 Republicans. In the map above, Democrats have the majority partisan lean in 51 districts and Republicans have the majority partisan lean in 48 districts.

V. ADDRESSING POSSIBLE CONCERNS

Concern: *Hypotheticals such as past votes in a district should not be used.* Past voting in a district predicts very well which party will win that district in the next election. Rakich (2018) examined all contests for the U.S. House of Representatives in the 2018 election. He found that for all districts for which there was at least one Democrat and one Republican candidate, the correlation between partisan lean and vote margin in a district was 0.98.

Gerrymanderers understand this and use past votes as the foundation of their gerrymandered maps. Justice Kagan in her *Rucho* dissent (p. 17) notes:

North Carolina's redistricting committee used 'Partisan Advantage' as an official criterion for drawing district lines. And from first to the last, the committee's chair (along with his mapmaker) acted to ensure a 10-3 partisan split, whatever the statewide vote, because he thought electing Republicans is better than electing Democrats.

Gerrymanderers use the powerful tool of distributing past votes among legislative districts to tilt the playing field. The approach advanced in this article uses this tool to level the playing field.

Concern: *Proportionality should not be used.* Justice Roberts in his *Rucho* opinion invokes Justice O'Connor's decision in *Bandemer* "Our cases, however, clearly foreclose any claim that the Constitution requires proportional representation or that legislatures in reapportioning must draw district lines to come as near as possible to allocating seats to the contending parties in proportion to what their anticipated statewide vote will be" (p. 130).

However, Justice Roberts also clearly distinguishes what is judiciable in Federal court vs. State courts. He states that "[p]rovisions in state statutes and state constitutions can provide standards and guidance for state courts to apply. He notes that the Federal Constitution contains no "Fair Districts Amendment," but "the Supreme Court of Florida struck down that state's congressional districting plan as a violation of the Fair Districts Amendment to the Florida Constitution (*Rucho* p. 31).

Justice Roberts also references the Missouri Constitution, Art. III, Section 3 as an example of a state's action to restrict partisan considerations in districting. As noted above, this provision states: "Partisan fairness means that parties shall be able to translate their popular support into legislative representation with approximately equal efficiency."

Furthermore, importantly, the approach advanced in this article does not allocate actual seats to correspond with past party shares of statewide votes. Rather the approach allocates the distribution of partisan lean across districts. No voter outcomes are guaranteed. The playing field is simply leveled.

In addition, Katz, King and Rosenblatt (2019, p. 10) prove that deviation from proportional representation is an inadequate measure of partisan symmetry. This article does not dispute that. However, the method used here of combining compact districts with partisan symmetry generates a set of districts, a complete legislative plan, which in turn can be used to generate a seats-vote curve. The deliberate process of adjusting the nested squares map to a partisan fair map reshapes the seats-vote curve such that the curve for each party crosses the 45-degree line at that point where the expected share of seats for each party corresponds with that party's share of statewide votes.

Concern: *The procedure does not focus explicitly on preserving political subdivisions.* Because of the requirement for equal population in districts, no congressional district map will perfectly match the boundaries of existing political subdivisions. Districts in sparsely populated areas are likely to contain several counties. Densely populated counties may contain more than one congressional district. Local jurisdictions administer activities such as public schools, police, fire and rescue, local tax collection. Policies at state and federal levels of government most often cross local jurisdictional lines, for example, state and federal tax policy, state and federal health and welfare policies, national defense and foreign policy.

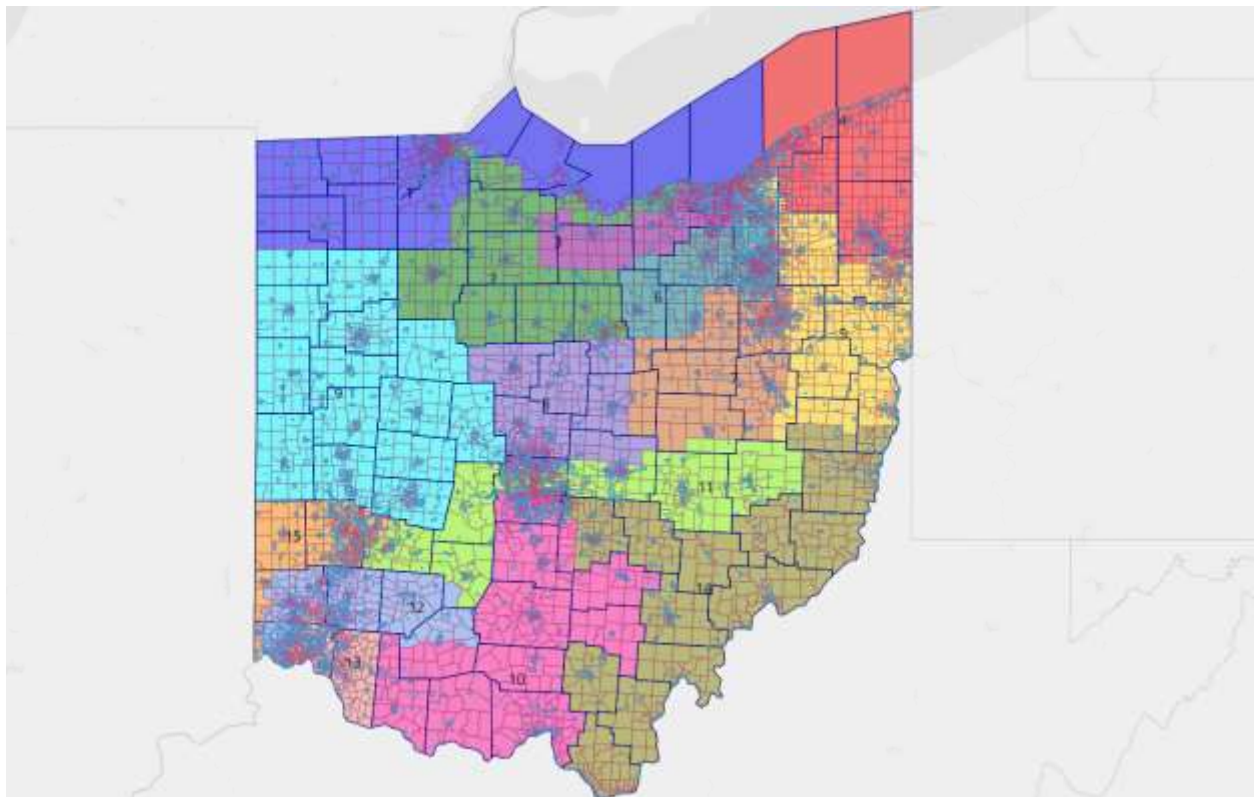
Concern: *Communities of interest should be maintained.* This procedure maintains communities of interest because it constructs compact districts. Compact districts preserve communities of interest. To a large extent, neighborhoods tend to form communities of interest. For example, the residents of Brooklyn form a community of interest different from the residents of Lower Manhattan. The residents of Boyle Heights form a community of interest different from that formed by the residents of Beverly Hills. As a result, compact districts contain communities of interest.

Concern: *Districts should be bounded by natural borders such as rivers, streams, mountains and lakes.* In the distant past, rivers, streams, mountains and lakes formed barriers to transportation. Modern infrastructure obviates this concern.

Concern: *The goal of redistricting should be to construct competitive districts.* Figure 3 is a congressional district map of Ohio where every district is competitive.

Specifically, for the vast majority of the districts, the district contains approximately the same number of likely voters from each party. This figure illustrates that for many districts, a geographic area with a high concentration of one party must be connected, often by tendrils, to an area with a high concentration of the other party in order to simultaneously satisfy the competitive criterion and the population requirements. As a result, districts are often not compact; counties are often split; one political subdivision of the state is often joined with another distant subdivision; and, the elected officials are unlikely to represent communities of interest.

Figure 4. Ohio Congressional Districts
Maximizing Competitive Districts



VI. SUMMARY AND CONCLUSIONS

Legislative district maps will soon be redrawn in response to the 2020 census. Mapmakers, be they redistricting commissions, state demographers, legislative staff, or court appointed Masters, face a task more daunting than ever before. This article presents a straightforward, transparent, nonpartisan method for generating legislative district maps that contain compact districts and are partisan fair.

The overwhelming majority of states require that legislative district maps be constructed of districts that are compact. A recent award-winning study revealed that citizens from all walks of life see districts that are “squarish” as being most compact. The procedure developed in this study generates maps that are made up of districts that are nested squares.

The procedure then builds on the map of compact districts to generate a map that is partisan fair. Partisan fairness is defined as when each major party’s likely share of seats corresponds to that party’s share of statewide votes. By uniting partisan fairness with compact districts, this procedure constructs legislative district maps that are fair and square.

APPENDIX A: CONSTRUCTING NESTED SQUARES

The Basic Procedure. The basic nested squares procedure follows:

- (1) Start at the upper left of a state map and draw a square which expands to the right and down until the district contains the required population. Then move to the upper left corner of the unoccupied area and proceed from left to right (as we read in America). Produce a series of adjoining squares across the top of the map. (Note: portions of a square near a state boundary may extend beyond the boundary of the state. Those portions would contain no population within the state.) Whenever a square meets an already claimed area, “tuck” the new square under the existing square and readjust the size of the square to meet the population requirement. (“Claimed area” means that portion of the state that is contained by a district.)

The diagrams in this appendix draw upon the state of Georgia to illustrate how the nested procedure is implemented. Georgia happens to provide the opportunity to portray both the basic procedure and its three refinements. Diagram (a) below shows the first district constructed for Georgia. The red border of the square highlights that portion of the district which lies beyond the boundary of the state.

Diagram (b) shows the top row of districts for Georgia. The district on the far-right in diagram (b) demonstrates the first refinement to the nested squares procedure. The basic procedure calls for constructing squares by moving along a diagonal down and to the right of the starting point. Thus, all portions of the resulting district will lie down and to the right of the starting point. A refinement to this procedure occurs when districts are constructed at the far-right of the state. Here, the district will be that square which contains the required population and whose right side just touches a portion of the right border of the state. On occasion, this will result in part of this district lying to the left of the starting point. This refinement achieves district compactness by avoiding long and narrow districts at the far right of a state.



(a)



(b)

(2) Return to the upper left of the remaining unclaimed area in the state and repeat the process.

Chimneys. Before returning to the far left to start a new row in the basic procedure, occasionally a “chimney” shape will be encountered. A test should be run to see if a district started at the upper left of the chimney will fit within the chimney. That is, either the left or right side of the district in question is shorter than an adjoining district. (This test guards against any district wrapping around another district on three sides.) If so, that district should be constructed. If not, the

new row should start from the far left of the map. Filling chimneys yields compact districts.

Diagram (c) below displays the top two rows of nested squares for Georgia. After the second row of districts is drawn, a “chimney” shaped area appears where the star is located. A test reveals that two districts can be constructed in this space where at least one side of each district would be completely covered by an existing district. These two new districts are displayed in diagram (d) as the districts with stars in them. These districts are formed before returning to the far left of the state to construct the next row.



(c)



(d)

The final refinement comes into play whenever unclaimed space appears above a district under construction. Figure (e) below is a rendering of nested squares for Georgia where all three districts in the third row are drawn using the basic procedure before the final refinement. The red rectangle displays space between the far-right district in row 2 and the far-right district in row 3. This space would not be included in any district under the basic procedure. This final refinement states that whenever unclaimed space appears above a district under construction, that district is moved up to include that unclaimed area. Figure (f) includes the third row of Georgia districts constructed by employing this final refinement. Each of the three districts in this row have been moved up to capture unclaimed area.



(e)

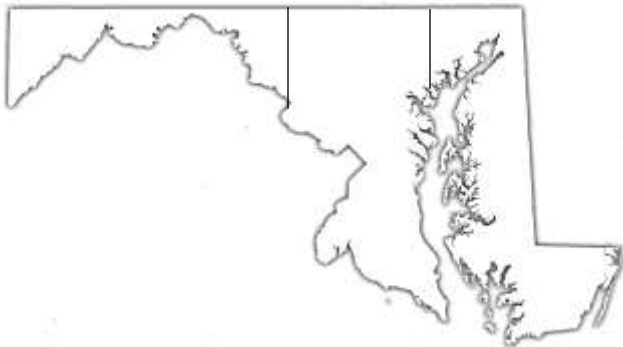


(f)

Extremities. Some states contain geographical extremities, such as Maryland's Eastern Shore, Michigan's Upper Peninsula, or the Texas Panhandle. Whenever extremities appear, the standard procedure might generate individual districts that are substantially disjoint or substantially not compact. This can be remedied by initially finding that longitude or latitude that forms the extremity, in whole or in part, into a district unto itself. Then apply the standard procedure to the remainder of the state.

The diagrams below illustrate how this initial step was applied to Maryland, Michigan, Texas and Virginia.

MARYLAND



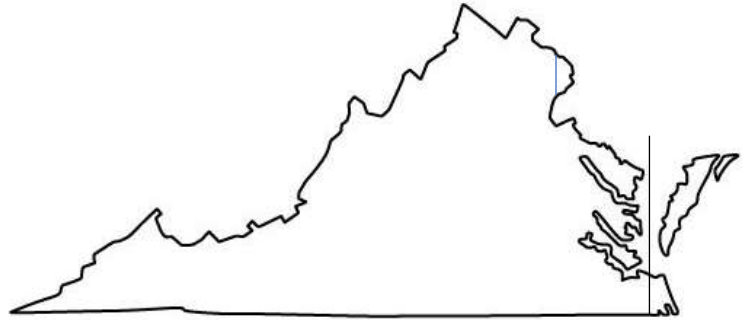
MICHIGAN



TEXAS



VIRGINIA



Summary. To construct a legislative district map composed of compact nested square districts:

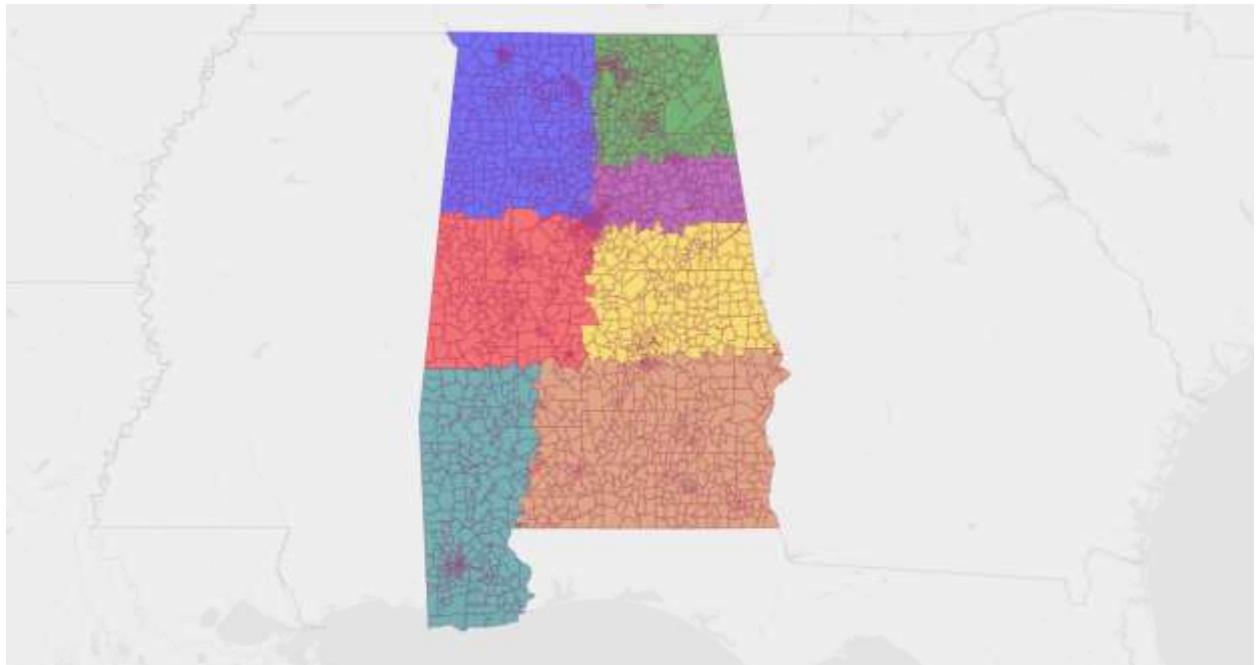
- (1) Start at the upper left side of the state and construct a square district moving on a diagonal down and to the right until you have contained the required population.
- (2) Move to the next upper left corner and repeat, to construct a row of districts across the top of the state.
- (3) Move to the far left of the unclaimed area in the state and repeat, constructing row after row of nested square districts.
- (4) When constructing the farthest right district in a row, move that district to the left until the right side of the district just touches the right boundary of the state.

- (5) Fill any chimneys.
- (6) Whenever unclaimed area appears above a district under construction, move that district up to contain that unclaimed area.
- (7) If a state has extremities, construct districts there prior to moving to the remainder of the state.

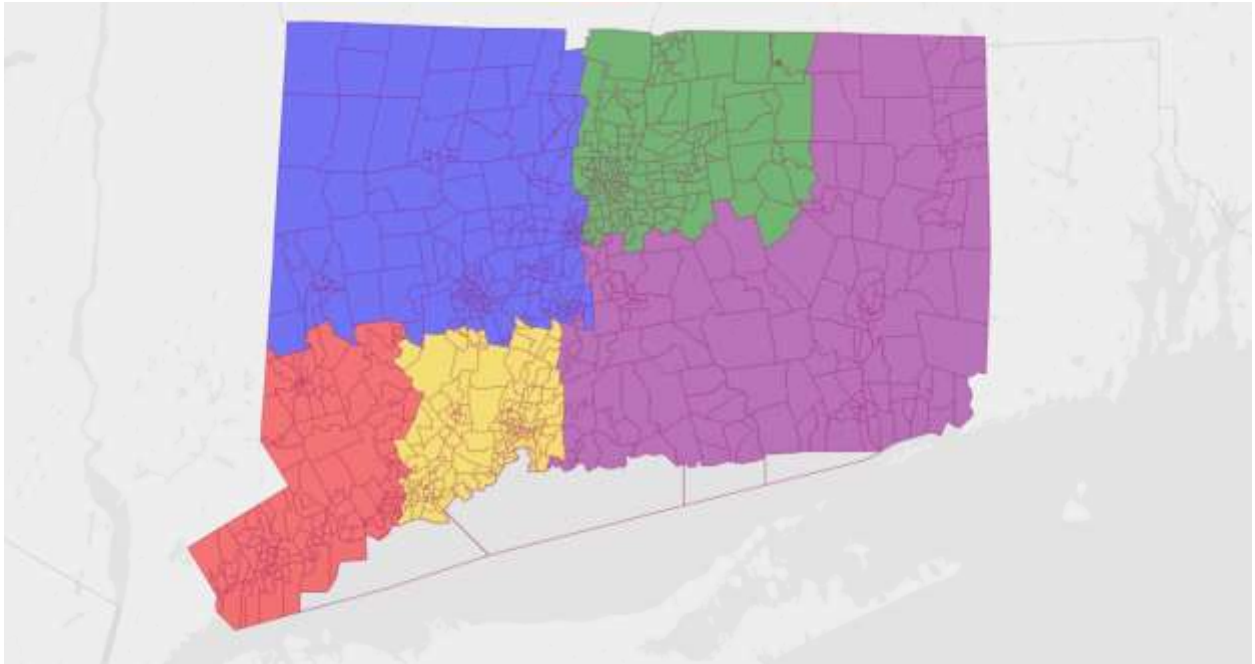
APPENDIX B: COMPACT DISTRICT MAPS

Shown below are the legislative district maps which contain compact districts constructed by nested squares. The district lines in these maps are not as straight as in the conceptual renderings because precincts at the edges of the districts are added on an all or none basis. For each state, the population variance among the districts is within the judicial standard. The maps will be published on DRA. (Bradlee and others, 2020).

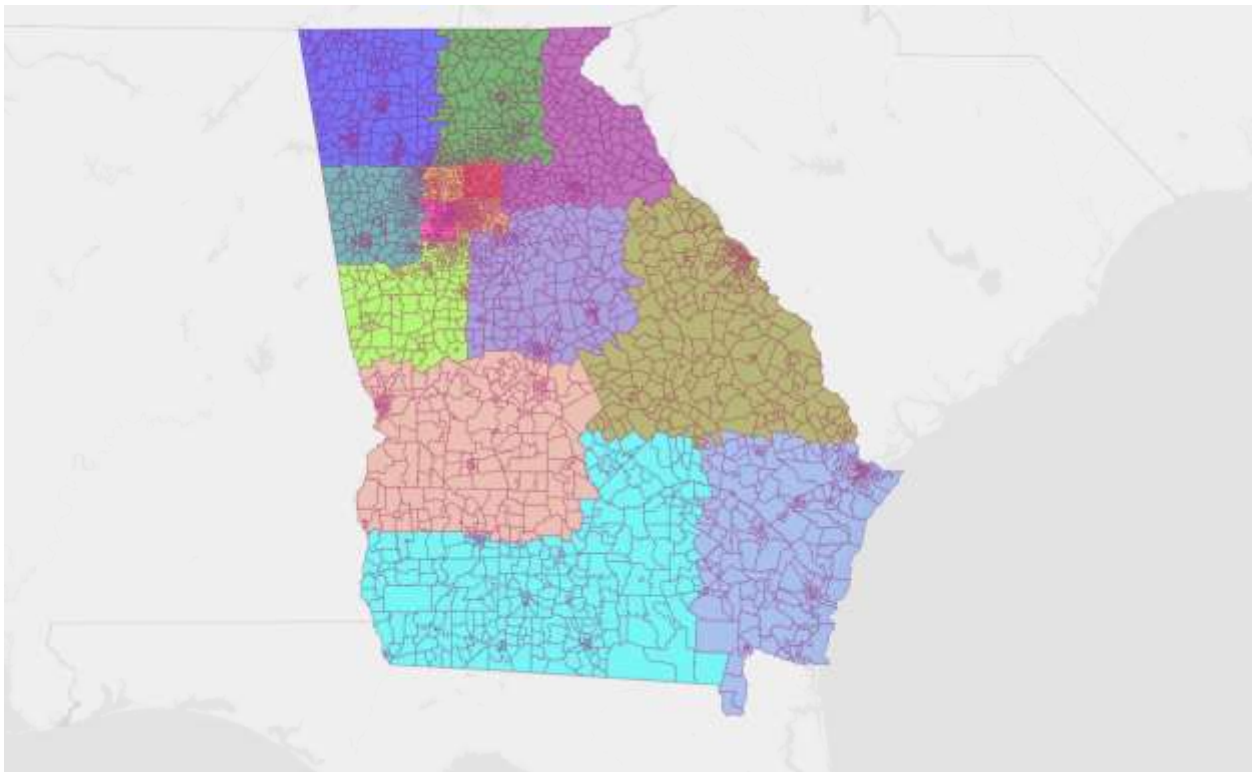
ALABAMA



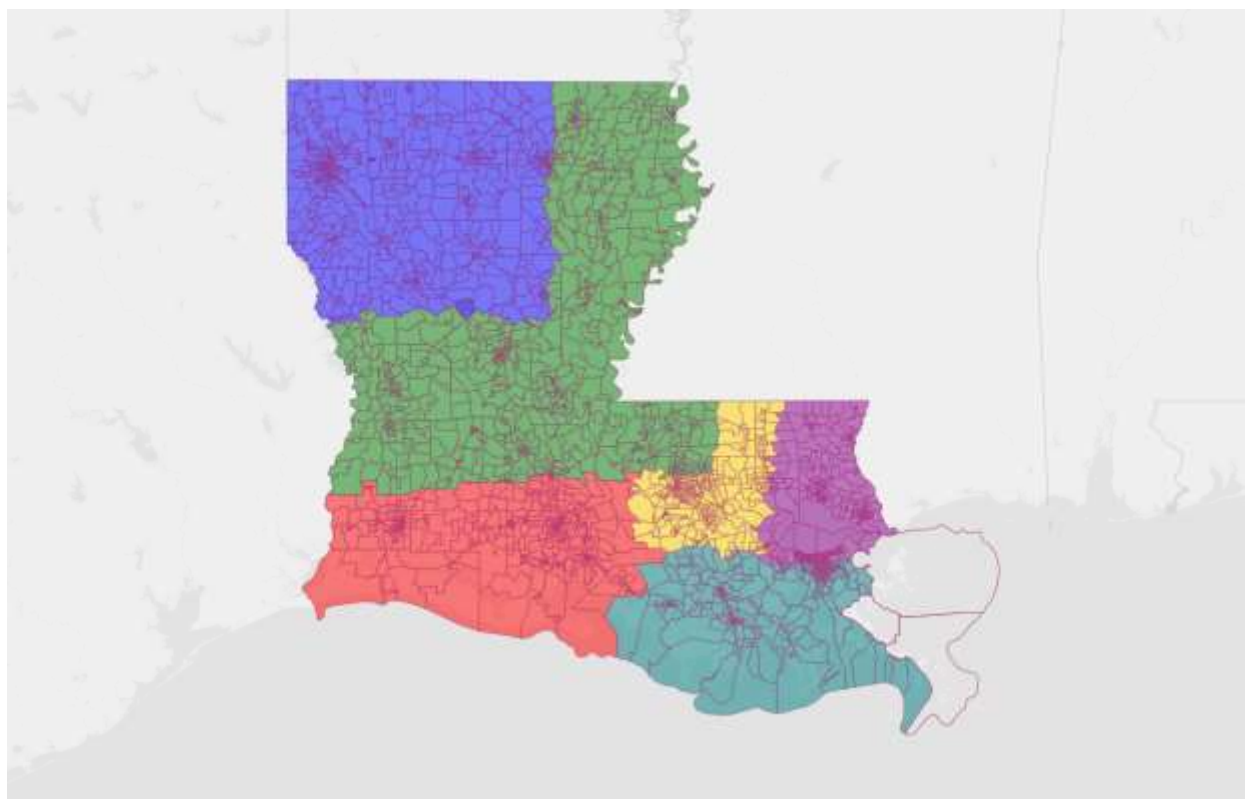
CONNECTICUT



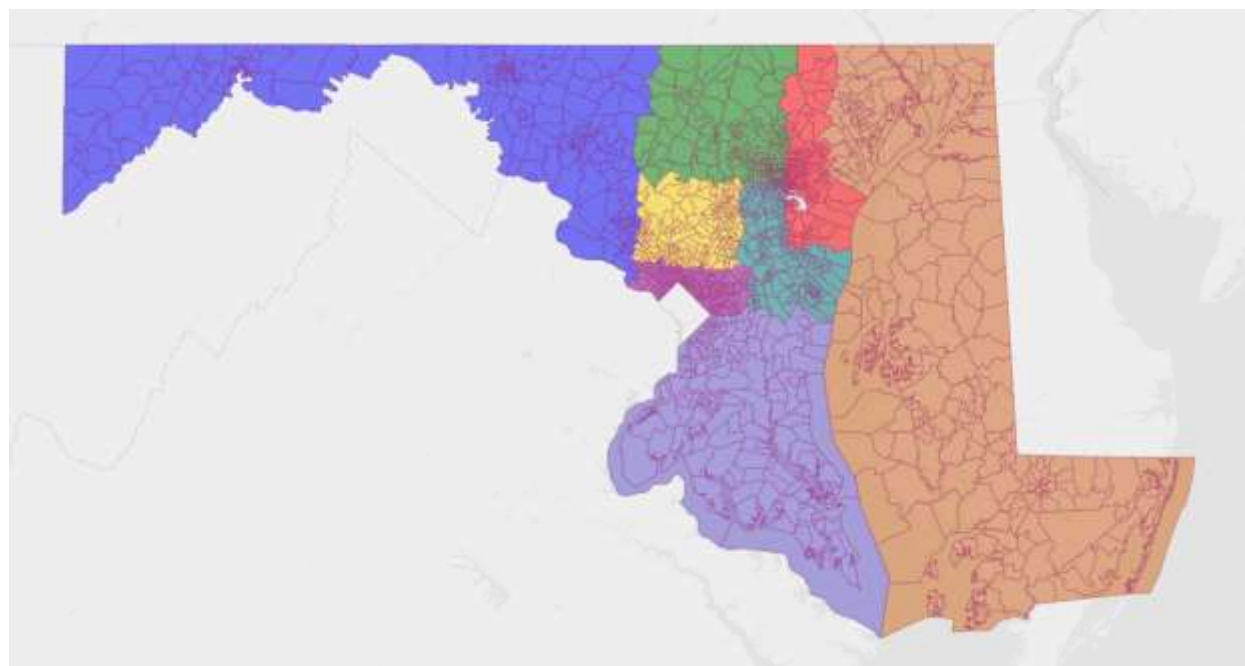
GEORGIA



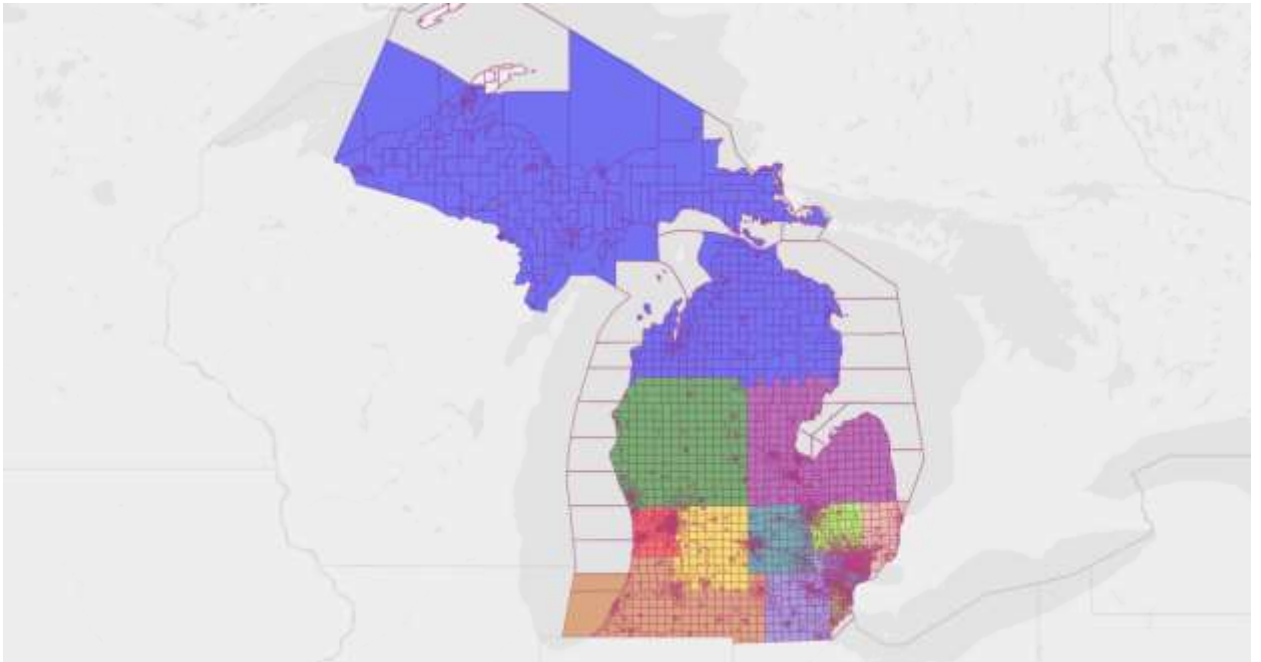
LOUISIANA



MARYLAND



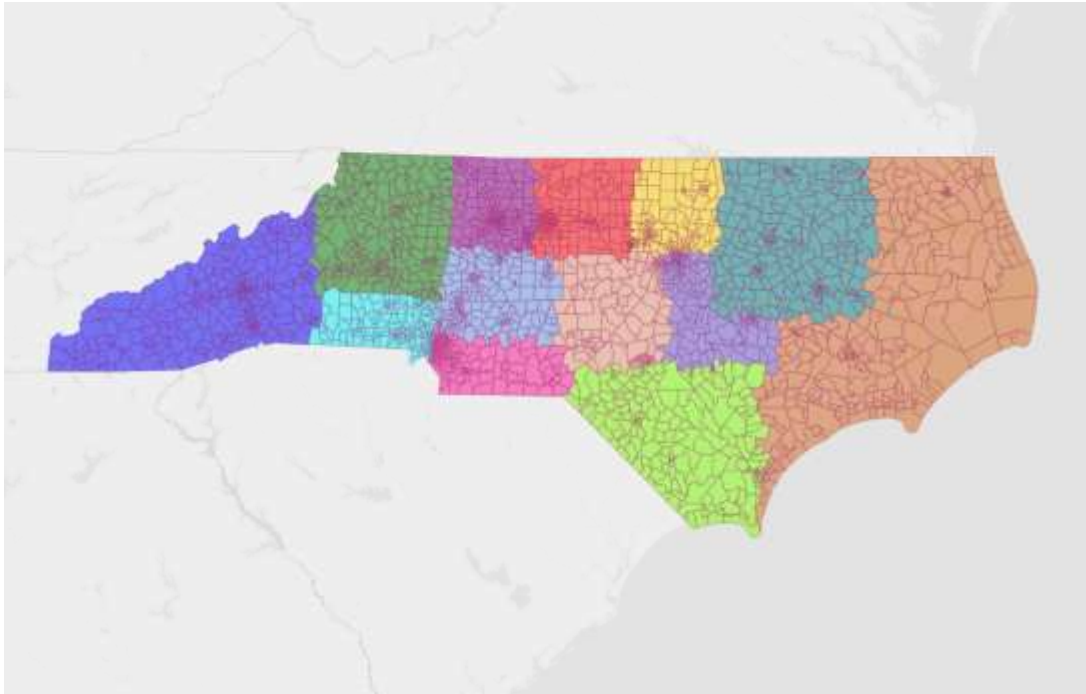
MICHIGAN



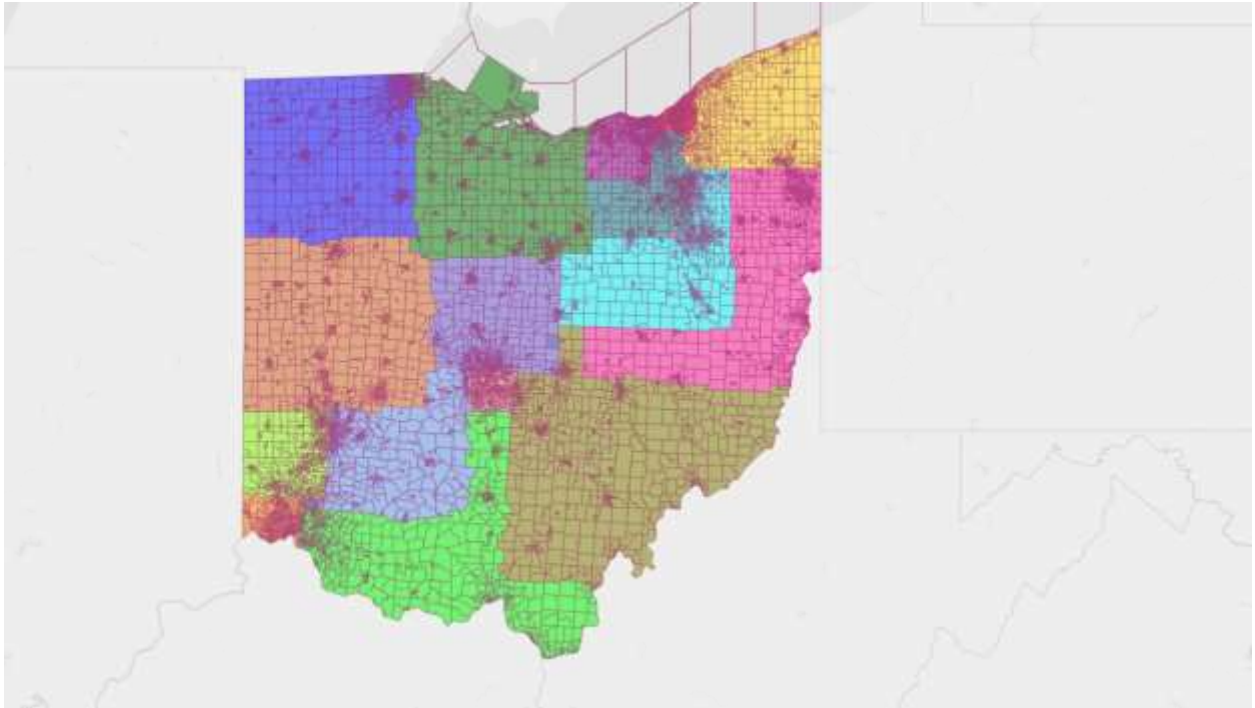
MISSISSIPPI



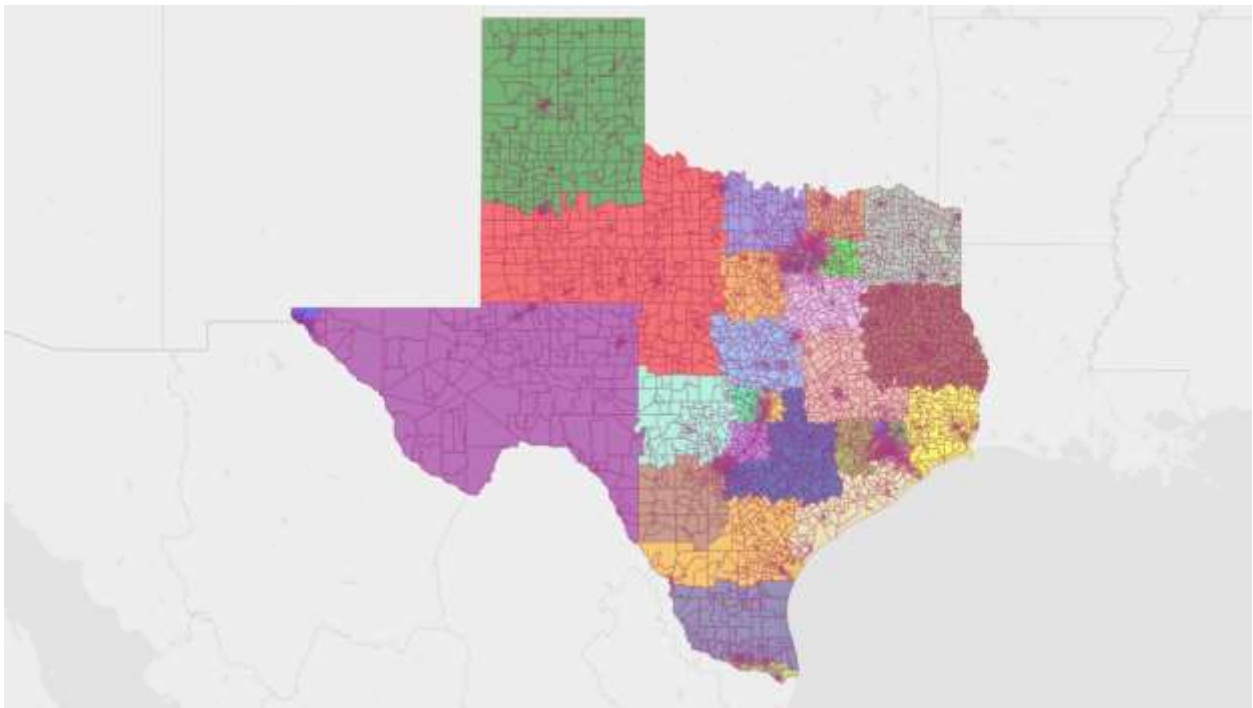
NORTH CAROLINA



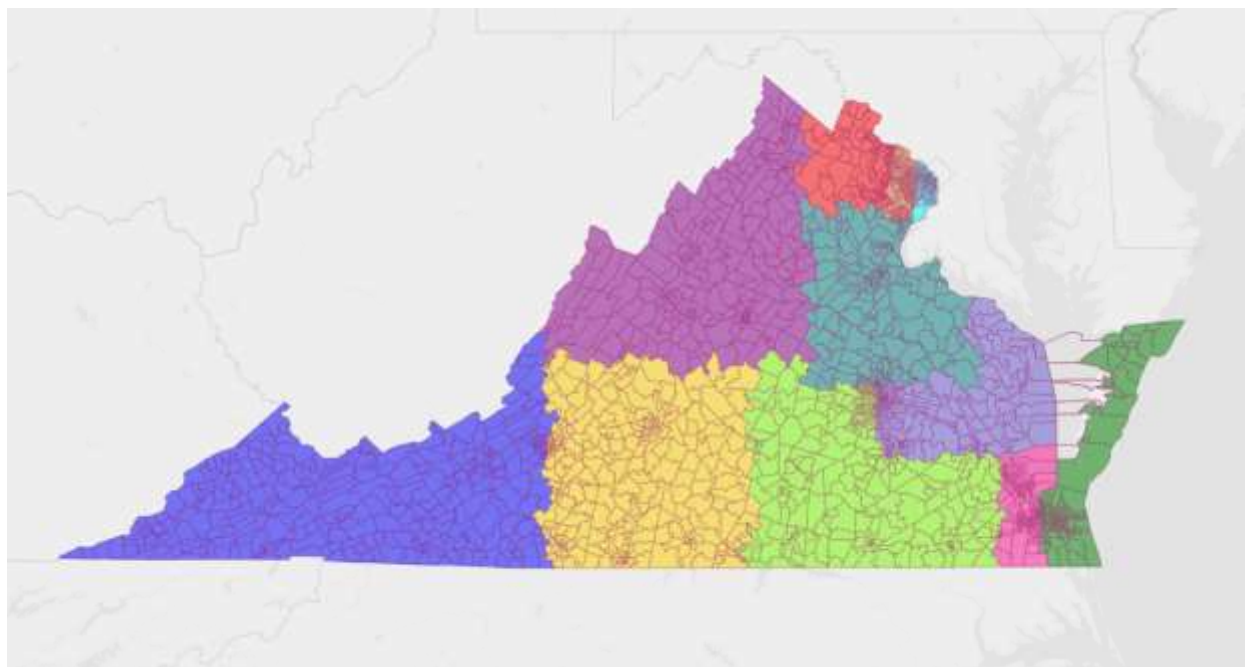
OHIO



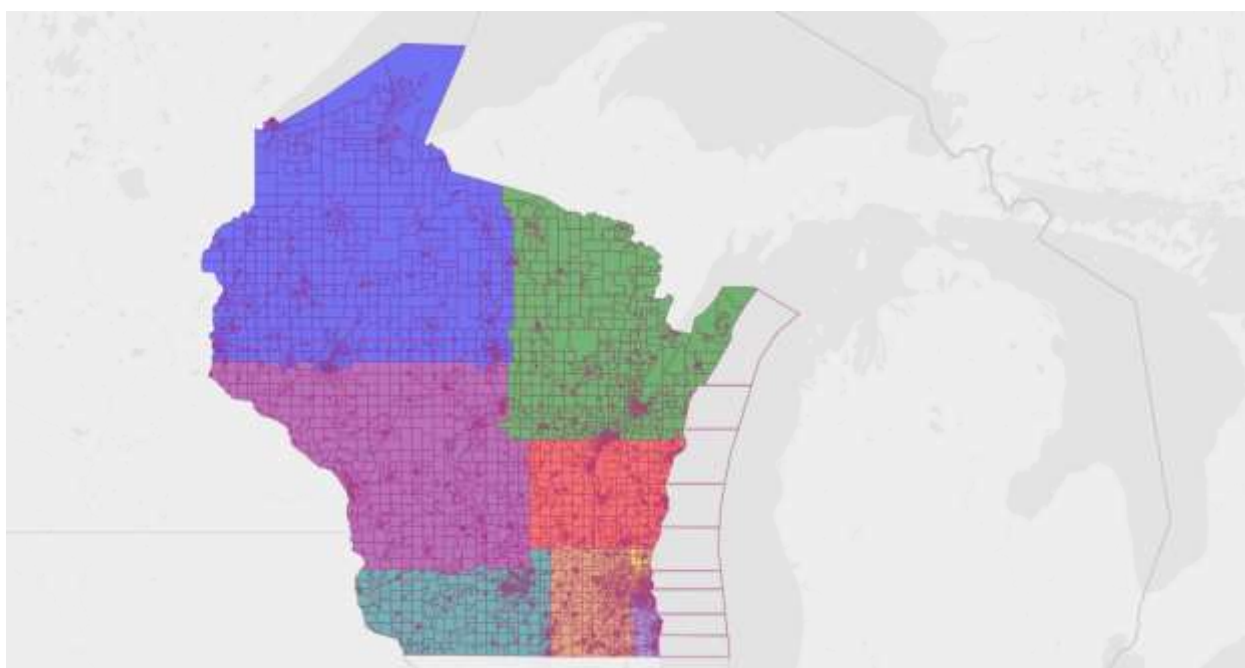
TEXAS



VIRGINIA



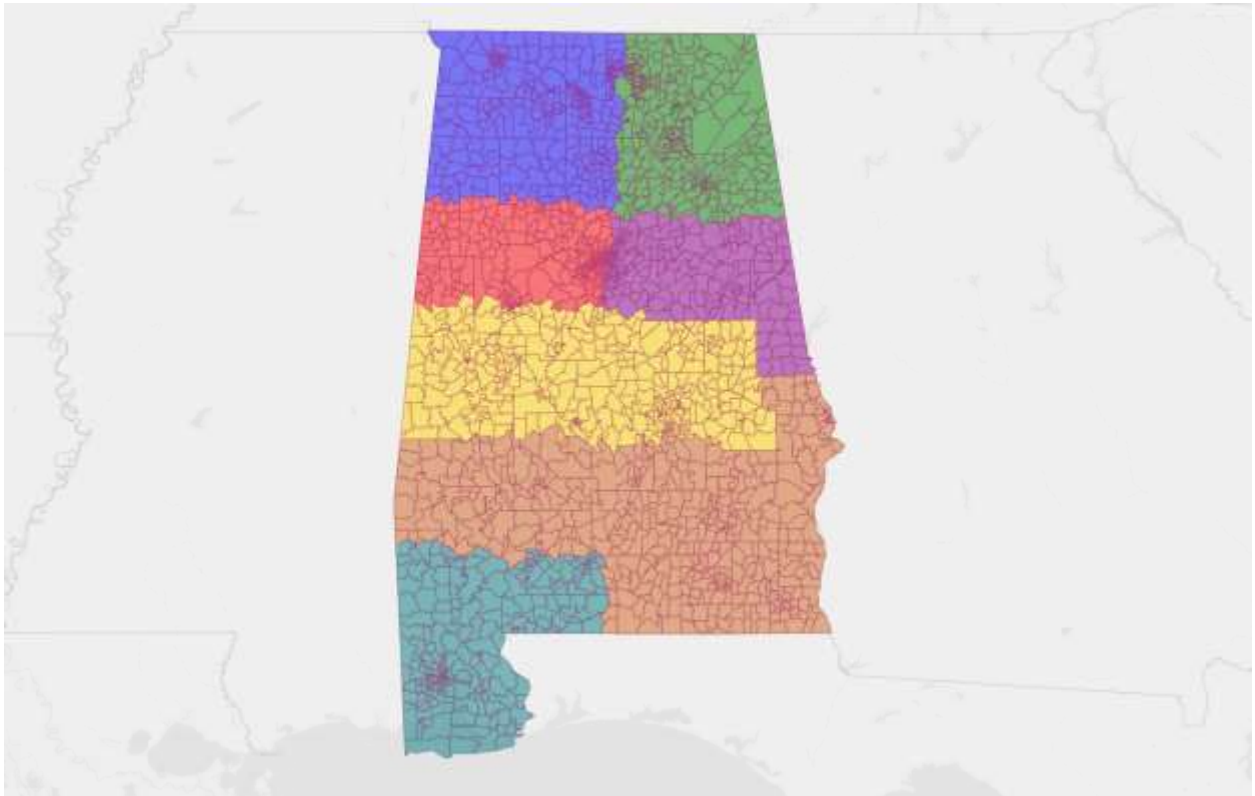
WISCONSIN



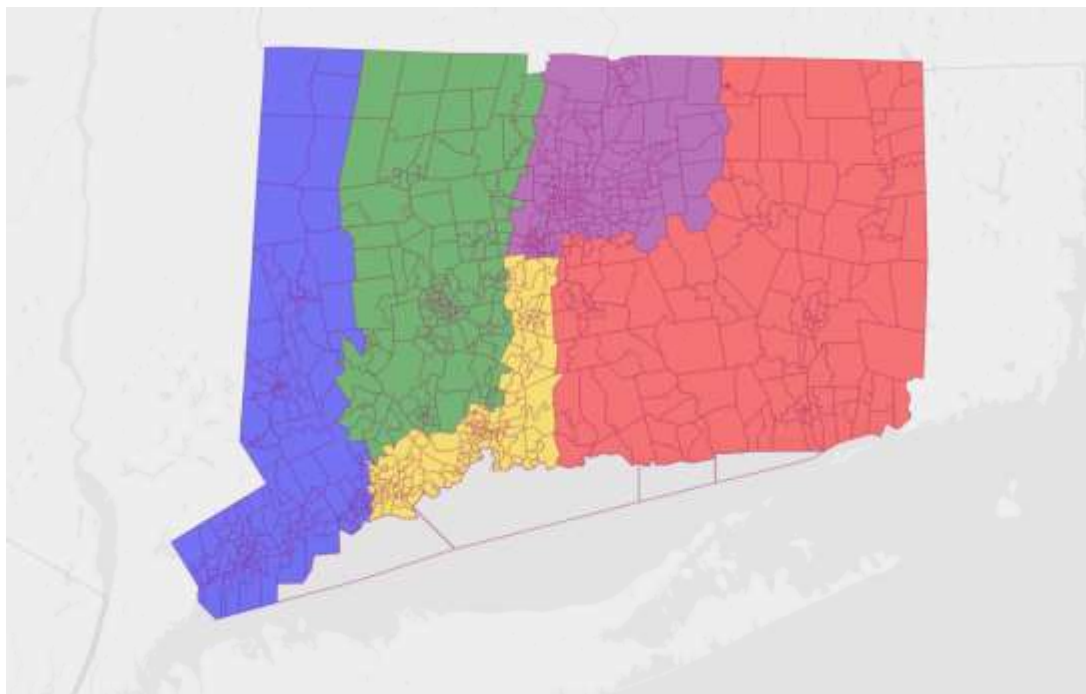
APPENDIX C: PARTISAN FAIR MAPS

As noted above, in four states, the nested squares map contained compact districts and was partisan fair. Shown below are the maps of the remaining eight states where the concept of partisan symmetry was applied.

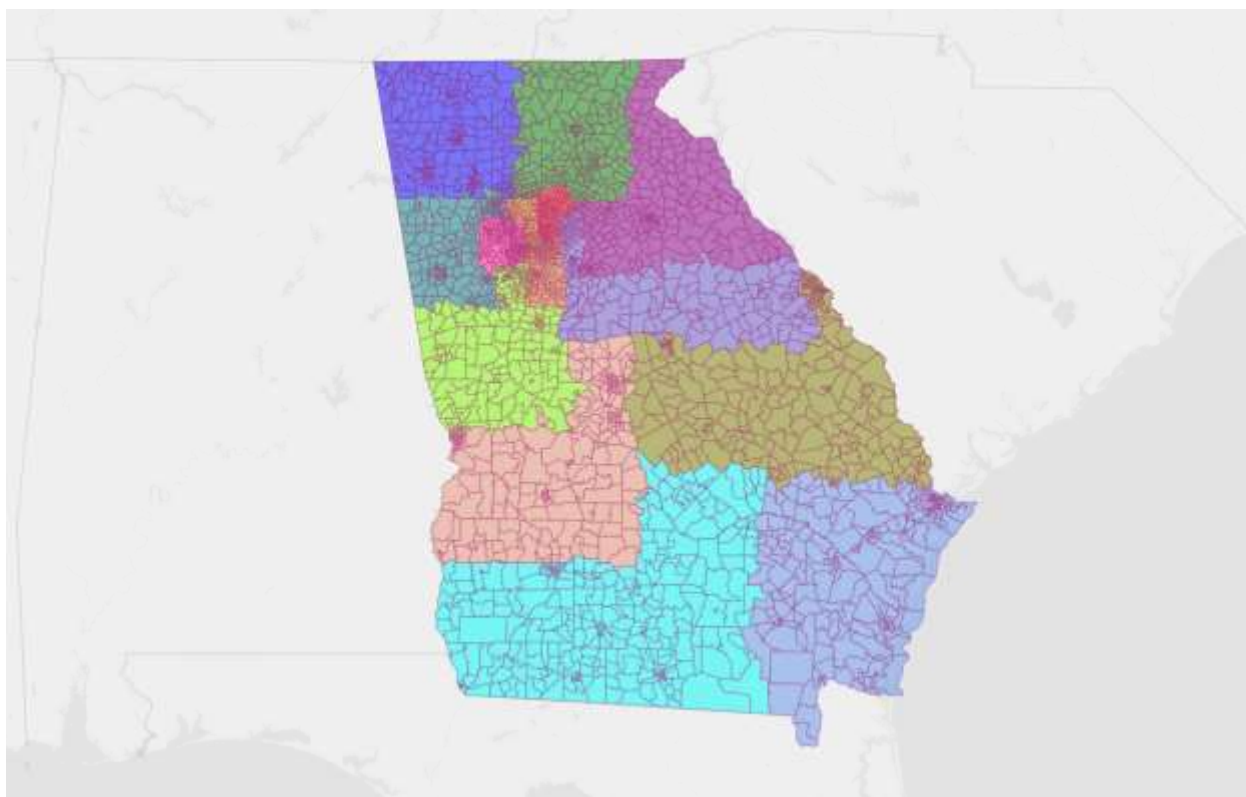
ALABAMA



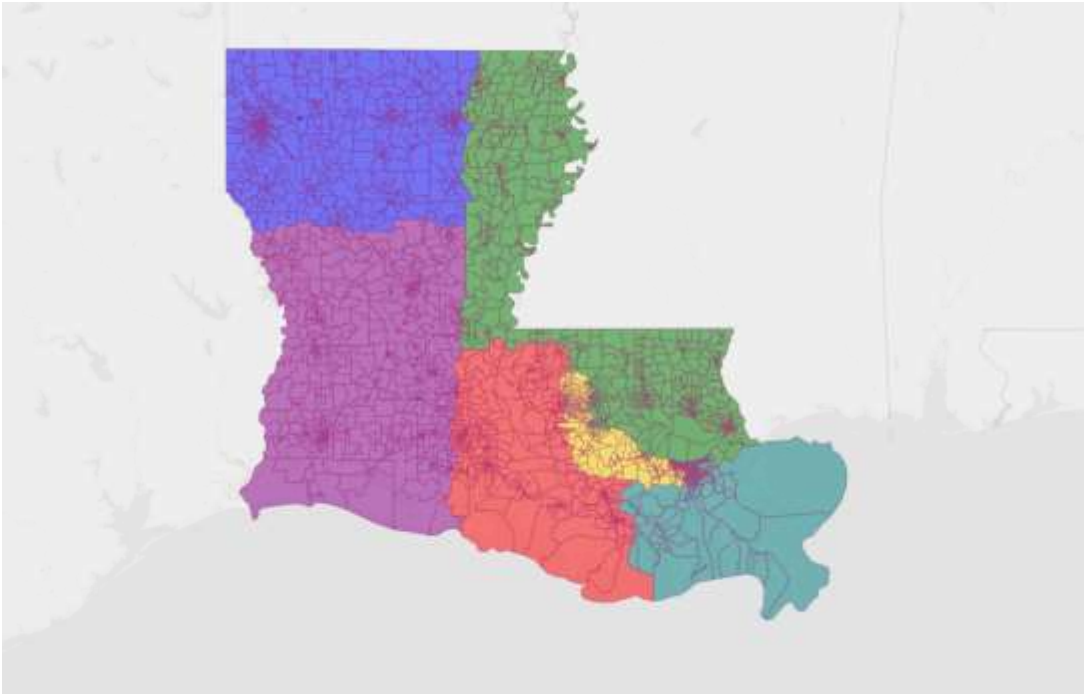
CONNECTICUT



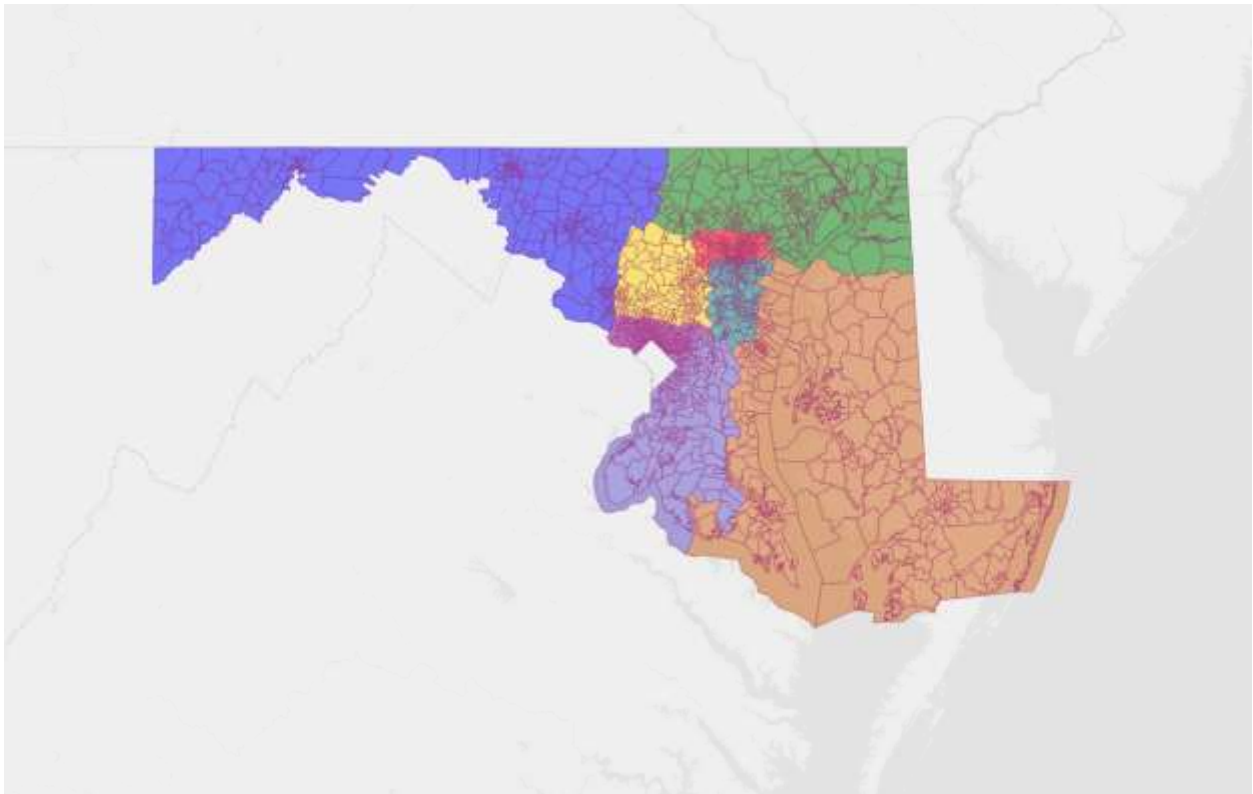
GEORGIA



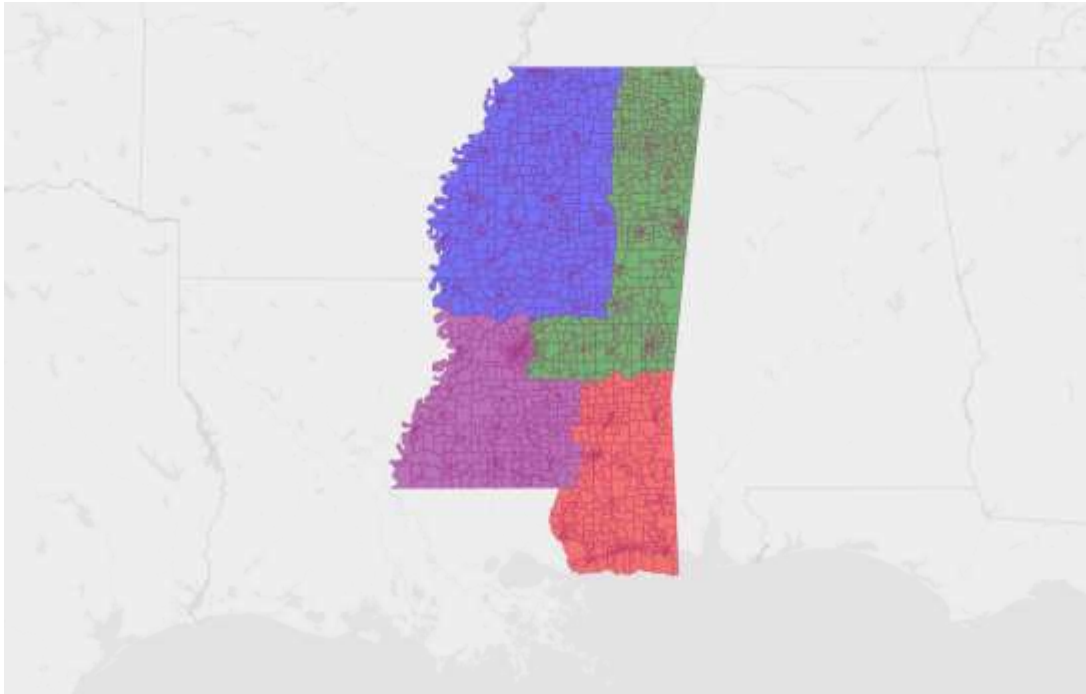
LOUISIANA



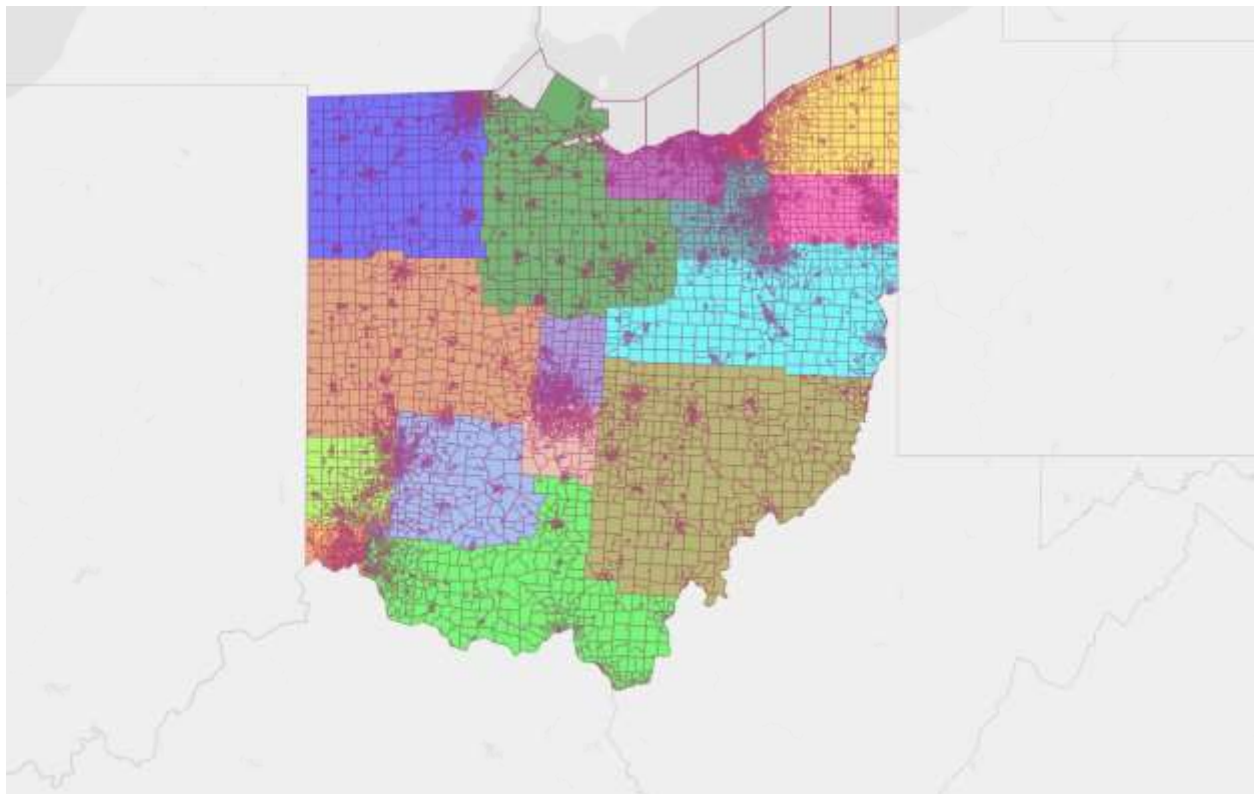
MARYLAND



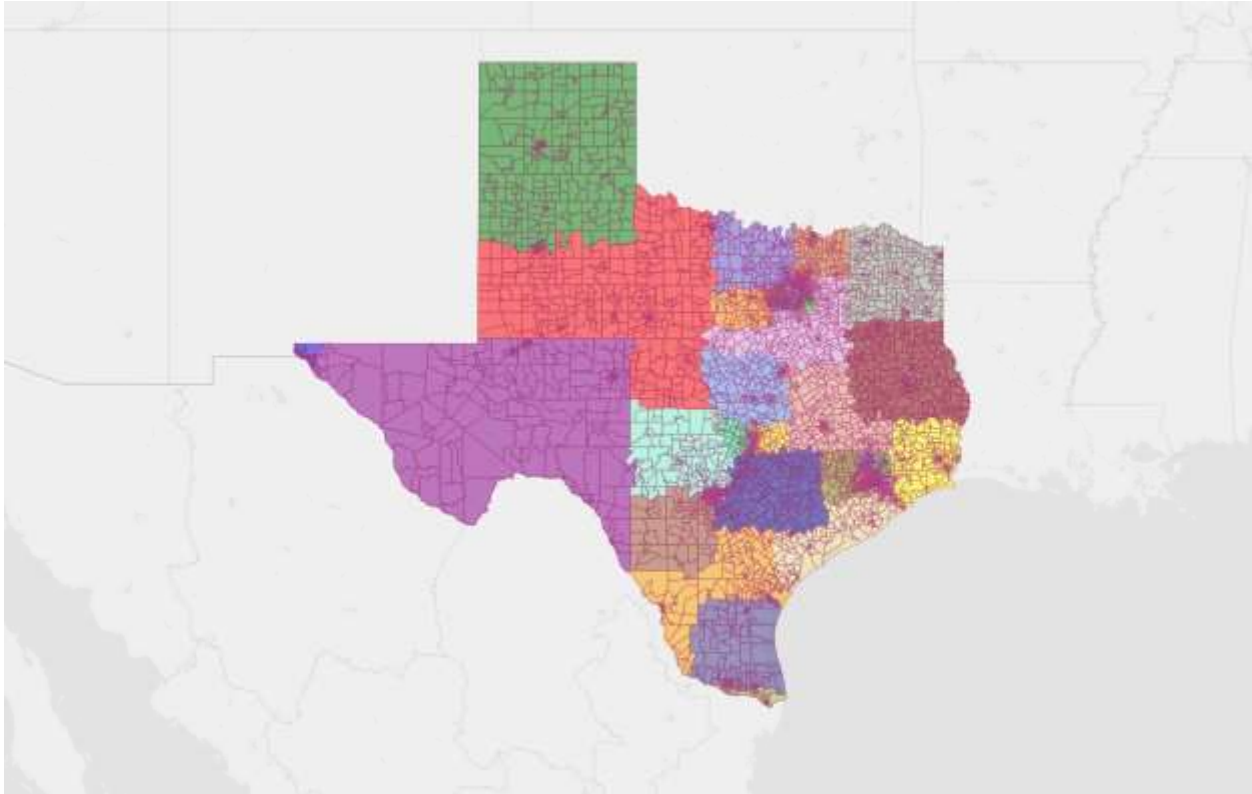
MISSISSIPPI



OHIO



TEXAS



References

Altman, Micah and Michael McDonald. 2010. "The Promise and Perils of Computers in Redistricting." *Duke Journal of Constitutional Law & Public Policy* 5(1): 69-111.

Bradlee, Dave, Terry Crowley, Mike Mathiew and Alec Ramsay. 2020. "DRA 2020." <http://gardow.com/davebradlee/redistricting/default.html>

Cook, Charles (ed.) n.d. The Cook Political Report. <https://cookpolitical.com/pvi-map-and-district-list>

"Evenwel v. Abbott." 2016. Leading Cases. *Harvard Law Review* 130(1). (<https://harvardlawreview.org/2016/11/evenwel-f-abbott/>)

Gilbert, Craig. 2018. "New election data highlights the ongoing impact of 2011 GOP redistricting in Wisconsin." *Milwaukee Journal Sentinel*. Dec. 6. <https://www.jsonline.com/story/news/blogs/wisconsin-voter/2018/12/06/wisconsin-gerrymandering-data-shows-stark-impact-redistricting/2219092002/>

Gill v. Whitford. 2017. No. 16-1161. Supreme Court Oral Arguments. https://www.supremecourt.gov/oral_arguments/argument_transcripts/2017/16-1161_bpm1.pdf

GISGeography. n.d. <https://gisgeography.com/state-outlines-blank-maps-united-states/>

Grofman, Bernard and Gary King. 2007. "The Future of Partisan Symmetry as a Judicial Test for Partisan Gerrymandering after LULAC v. Perry." *Election Law Journal* 6(1): 2-35.

Hirsch, Sam. 2003. "The United States House of Unrepresentatives: What Went Wrong in the Latest Round of Congressional Redistricting.." *Election Law Journal* 2(2): 179-216.

Katz, Jonathan, Gary King and Elizabeth Rosenblatt. 2019. "Theoretical Foundations and Empirical Evaluations of Partisan Fairness in District-Based Democracies." *American Political Science Review* 114(1): 164-178.

Kaufman, Aaron, Gary King and Mayya Komisarchik. Forthcoming. "How to Measure Legislative District Compactness If You Only Know It When You See It." *American Journal of Political Science*. Copy at <https://gking.harvard.edu/files/gking/files/compact.pdf>

Levitt, Justin. 2018. "All About Redistricting." <http://redistricting.lls.edu/where-state.php#compactness>.

Mellnik, Ted and Tim Meko. 2019. "North Carolina has a new congressional map for 2020." *The Washington Post*. Dec. 3.

Michael Li, Thomas Wolf and Annie Lo. 2019. "Where Redistricting Cases Are Still Pending." <https://www.brennancenter.org/blog/state-redistricting-litigation>.

Missouri Constitution. [https://ballotpedia.org/Article III, Missouri Constitution](https://ballotpedia.org/Article_III,_Missouri_Constitution).

National Conference of State Legislatures (NCSL). 2019. "Redistricting Criteria." Washington, D.C.: National Conference of State Legislatures. ncsl.org/research/redistricting/redistricting-criteria.aspx

Ohio Bipartisan Redistricting Commission Amendment, Issue 1. 2015. [https://ballotpedia.org/Ohio Bipartisan Redistricting Commission Amendment, Issue 1 \(2015\)](https://ballotpedia.org/Ohio_Bipartisan_Redistricting_Commission_Amendment,_Issue_1_(2015))

Olson, Brian. n.d. "BDistricting." <https://bdistricting.com/about.html#for>.

Rakich, Nathaniel, 2018. "Everything is Partisan and Correlated and Boring," FiveThirtyEight. <https://fivethirtyeight.com/features/everything-is-partisan-and-correlated-and-boring/>

Rucho v. Common Cause 18-422, 588 U. S. ____ (2019). https://www.supremecourt.gov/opinions/18pdf/18-422_9ol1.pdf

Wang, Samuel, Richard Ober and Benjamin Williams. Forthcoming. "State Constitutions and Partisan Gerrymandering (February 13, 2019)." *University of Pennsylvania Journal of Constitutional Law*. Available at SSRN: <http://dx.doi.org/10.2139/ssrn.3335622>.

Wikipedia, (e.g.) [https://en.wikipedia.org/wiki/Alabama%27s congressional districts](https://en.wikipedia.org/wiki/Alabama%27s_congressional_districts)