IN THE SUPREME COURT OF WISCONSIN

No. 2023AP1399

Rebecca Clarke, Ruben Anthony, Terry Dawson, Dana Glasstein, Ann Groves-Lloyd, Carl Hujet, Jerry Iverson, Tia Johnson, Angie Kirst, Selika Lawton, Fabian Maldonado, Annemarie Mcclellan, James Mcnett, Brittany Muriello, Ela Joosten (Pari) Schils, Nathaniel Slack, Mary Smith-Johnson, Denise Sweet and Gabrielle Young,

Petitioners,

Governor Tony Evers In His Official Capacity, Nathan Atkinson, Stephen Joseph Wright, Gary Krenz, Sarah J. Hamilton, Jean-Luc Thiffeault, Somesh Jha, Joanne Kane and Leah Dudley,

Intervenors-Petitioners,

v.

Wisconsin Elections Commission, Don Millis, Robert F. Spindell, Jr., Mark L. Thomsen, Ann S. Jacobs, Marge Bostelmann, Carrie Riepl, in their Official Capacities as Members of the Wisconsin Elections Commission; Meagan Wolfe In Her Official Capacity as the Administrator of the Wisconsin Elections Commission; Andre Jacque, Tim Carpenter, Rob Hutton, Chris Larson, Devin Lemahieu, Stephen L. Nass, John Jagler, Mark Spreitzer, Howard Marklein, Rachael Cabral-Guevara, Van H. Wanggaard, Jesse L. James, Romaine Robert Quinn, Dianne H. Hesselbein, Cory Tomczyk, Jeff Smith and Chris Kapenga in Their Official Capacities as Members of the Wisconsin Senate,

Respondents,

Wisconsin Legislature, Billie Johnson, Chris Goebel, Ed Perkins, Eric O'Keefe, Joe Sanfelippo, Terry Moulton, Robert Jensen, Ron Zahn, Ruth Elmer and Ruth Streck,

Intervenors-Respondents.

AMICUS BRIEF OF MATTHEW PETERING, PhD

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INTEREST OF AMICUS CURIAE

Matthew Petering, PhD is an Associate Professor of Industrial and Manufacturing Engineering at UW-Milwaukee and owner of District Solutions LLC, a Milwaukee-based redistricting consulting company. He earned a PhD and Master's Degree, both in Industrial and Operations Engineering, from the University of Michigan. He has more than 20 years of experience developing algorithms to optimize the productivity of seaports, warehouses, universities, and high-speed railway, car-sharing, and healthcare systems. Petering has also developed a redistricting algorithm, named *FastMap,* which produces fair maps based upon objective criteria. Petering believes his algorithm, or other similar redistricting algorithms developed by nonpartisan interests based upon the principles of mathematical optimization, should guide the Court in implementing a new map if the current maps are determined to be unconstitutional.

STATEMENT OF THE ISSUE

This brief responds solely to question 3 of the Court's October 6, 2023 Order: "If the Court rules that Wisconsin's existing state legislative maps violate the Wisconsin Constitution…and the legislature and the governor then fail to adopt state legislative maps that comply with the Wisconsin Constitution, what standards should guide the Court in imposing a remedy for the constitutional violation(s)?"

INTRODUCTION

This amicus brief conveys five points to the Court. **A.** Legislative redistricting in Wisconsin is an enormously complex endeavor involving up to 14 criteria and a near-infinite number of possible maps. **B.** The most effective,

objective, and just way to address this complexity is to use a powerful computer algorithm to make new maps. **C.** Fair maps require proportionality. **D.** The Court should invite maps from *Amici* and should establish an unambiguous procedure, based on mathematical standards, by which it will select the final map, with fairness, i.e., proportionality, established as a central factor. **E.** Petering submits an example of a fair map generated by *FastMap* which has excellent performance for 9 redistricting criteria, and urges the Court to consider additional maps created by *FastMap*.

ARGUMENT

I. The *FastMap* Algorithm Can Create a Legislative Map that Complies with the Wisconsin Constitution and Federal Law and Provides Voters of Each Party With Representation Proportional to Their Numbers in Recent Statewide Elections.

A. Legislative redistricting in Wisconsin is enormously complex.

Legislative redistricting in Wisconsin is a complex endeavor involving numerous trade-offs and a near-infinite number of possible maps that satisfy legal requirements.

Table 1 shows the criteria that could apply to legislative redistricting in Wisconsin. There are 14 criteria, each identified by a number from 1 to 14. Most criteria consist of two subcriteria, one for assembly (A) and one for senate (S) districts. In Table 1, subcriteria are indicated by a number followed by the letter A or S. Criteria 1-4 relate to strict legal requirements, and Criteria 5-14 can be used to compare maps that satisfy the strict legal requirements. This table shows that a huge variety of criteria come into play in the construction and evaluation of maps.

Importantly, Wisconsin has more redistricting subcriteria, and stricter standards for several criteria, than other states. First, Wisconsin is one of only 15 states where assembly districts must be "nested" in senate districts (Criterion 1). Brennan Center for Justice, *50 State Guide to Redistricting* (2019). This means that the Wisconsin Assembly and Senate maps are interdependent; assembly and senate subcriteria are simultaneously in play. Second, Wisconsin is one of only three states with a 3-in-1 nesting requirement. Third, Wisconsin traditionally requires districts to have an overall range in population deviation of 2% or less, whereas most states allow up to 10% (Criterion 2). Finally, Wisconsin is one of only a few states where the entire land area consists of municipalities (i.e., cities, towns, and villages), adding to the difficulty of keeping municipalities intact (Criterion 9).

Table 1. Possible criteria for Wisconsin legislative redistricting

Criterion	Description		
1	Nesting of assembly districts within senate districts		
Assembly Subcriterion	**Description**	**Senate Subcriterion**	**Description**
2A	Population deviation (legal requirmnt)	2S	Population deviation (legal requirmnt)
3A	Voting Rights Act compliance	3S	Voting Rights Act compliance
4A	Contiguity	4S	Contiguity
5A	Political fairness	5S	Political fairness
6A	Compactness	6S	Compactness
7A	Competitiveness	7S	Competitiveness
8A	Keeping counties intact	8S	Keeping counties intact
9A	Keeping municipalities intact	9S	Keeping municipalities intact
10A	Keeping communties of interest intact	10S	Keeping communties of interest intact
11A	Population deviation (beyond leg req)	11S	Population deviation (beyond leg req)
12A	Incumbent pairings	12S	Incumbent pairings
13A	Core retention	13S	Core retention
		14S	Staggered-senate-term disenfranchisement

Another difficulty facing the Court is the near-infinite number of possible maps. Wisconsin has more than 200,000 census blocks to be assigned to assembly and senate districts. There are more ways to divide Wisconsin into 99 assembly districts of equal population than atoms in the universe. Among these, only a tiny fraction satisfy the

federal Voting Rights Act. Significantly fewer maps also have contiguous districts. Even fewer are likely to give fair representation to both Republicans and Democrats. Of these, a diminishingly small number of maps also have nice-looking, compact districts. Far fewer maps have many competitive districts. The list of criteria goes on (Figure 1).

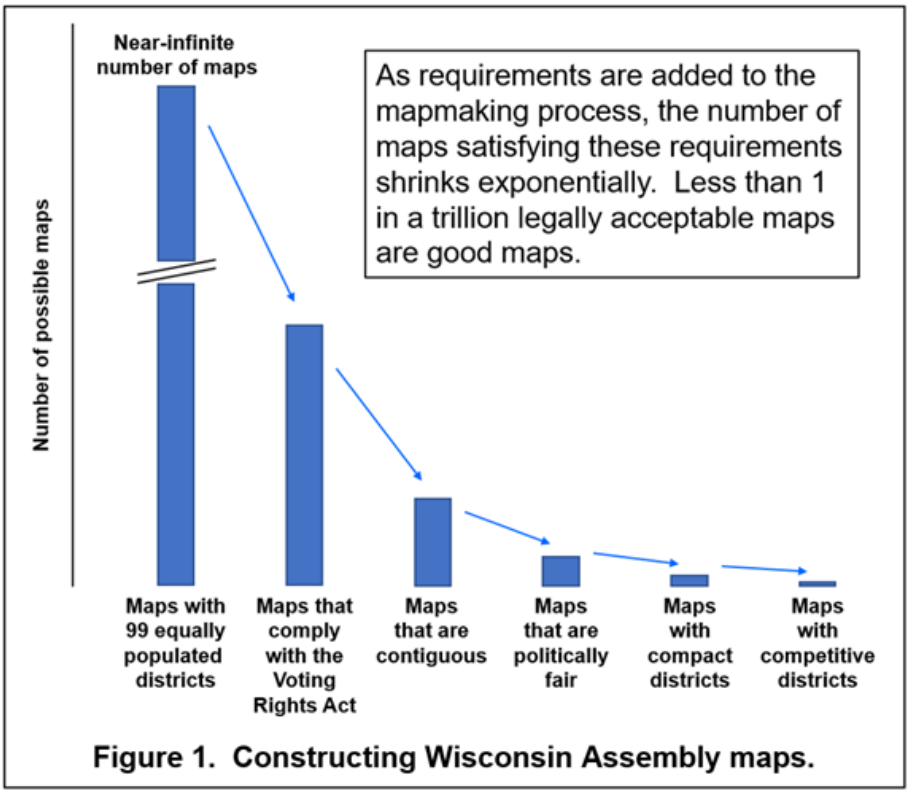

Figure 1. Constructing Wisconsin Assembly maps.

Given these myriad challenges, how can the Court ensure Wisconsin's next legislative map is rigorously fair in all respects? The answer involves two distinct actions: making good maps to begin with, and wisely selecting the best map among alternatives. These issues are addressed in the following sections.

B. The most effective, objective, and just way to make maps is to use a computer algorithm.

Mapmaking is enormously difficult, but there is a bright spot: map performance can be quantified. Numerical

scores can be attached to all map criteria—compactness, political fairness, etc.—to help the Court decide which map is the best. This quantification places redistricting squarely within the domain of mathematical optimization ("MO").

MO is an academic discipline focused on finding the best options, among an astronomical number of possibilities, when options can be mathematically scored. MO is used throughout the private sector to improve decisions in areas such as airline scheduling, factory machine scheduling, and warehouse operations management. When MO is used, it is always implemented with a computer algorithm. Amazon is a prime example.[1]

Should computer algorithms be used in redistricting? Absolutely. Currently, district maps are being constructed by humans who manually click a computer mouse to build maps piece by piece like a huge jigsaw puzzle. Such mapmaking is by nature subjective, slow, prone to human error, and, therefore, highly unlikely to achieve a good balance among multiple mapping criteria. A powerful algorithm, by contrast, can find exceptional maps without error or bias.

Algorithmic mapmaking has three main advantages. First, it eliminates subjective human manipulation of district lines. An algorithm simply performs mathematical computations defined by its human user; the output reflects the input.

Second, an algorithm works much faster than a human.

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[1] *See* The Science Behind Grouping Package Deliveries. https://www.amazon.science/latest-news/the-science-behind-grouping-amazon-package-deliveries

Third, a powerful algorithm produces higher quality maps. Consider Petering's redistricting algorithm, *FastMap*. Before the Court's "least change" ruling in *Johnson v. WEC*, 2021 WI 87, 399 Wis. 2d 623, 967 N.W.2d 469 (*Johnson I*), *FastMap* made a Wisconsin Assembly map—named *FastMap1*—that scored the best in proportionality, compactness, *and* competitiveness among all legally acceptable maps made in 2021, including those by the People's Maps Commission ("PMC"), Wisconsin Senate Democrats, all parties to the *Johnson I* case, and all maps submitted to the legislature's Draw Your District ("DYD") portal.[2] After the Court's "least change" ruling, Petering gave *FastMap* new "least change" instructions, and it again beat the competition, this time according to the least-change criterion. Dr. Don Leake of the Wisconsin Maps Assessment Project (WIMAP) used DavesRedistricting.org ("DRA"), a premier map analytics website, to do the scoring. Dr. Leake's analysis is set forth here.

Importantly, *FastMap1* is much more politically fair than any other map in the WIMAP study. To illustrate, *FastMap1* has a proportionality (i.e., political fairness) rating of 93 out of 100 at DRA, whereas the PMC and Senate Democrats' maps have proportionality ratings of 77 and 74, respectively. Accordingly, *FastMap1* would have given Democrats an estimated 34% chance of winning a majority of assembly seats in November 2022, whereas the PMC and Senate Democrats' maps would have given them 4% and 2% chances, respectively. Moreover, *FastMap1* outperforms these two maps for Voting Rights Act compliance, compactness, and competitiveness (entry dated Nov. 26, 2021 at DistrictSolutions.net/wisconsin-maps.html). These

[2] The state's Draw Your District webpage is no longer available.

results show the advantage of a computer algorithm over manual mapmaking.

In the 21st century, it is unimaginable that algorithms common to the private sector are not also being used in what is arguably our nation's most important optimization problem—political redistricting. If the current, subjectively drawn maps are found unconstitutional, Wisconsin has the opportunity to replace an outdated, vague method of mapmaking with one that introduces power, precision, clarity, and objectivity to the process. A computer algorithm such as *FastMap* can provide Wisconsin with a legislative map that is rigorously fair in all respects.

C. Proportionality is the key issue in redistricting, and the Court should use state-of-the-art mathematical techniques to evaluate the proportionality of remedial maps.

As a neutral, nonpartisan body, the Court should endeavor to make Wisconsin's next legislative map as fair as possible. Therefore, the Court should strive for a map that is just, unbiased, and treats the electorate equitably.

1. Fairness in redistricting means political fairness; political fairness means proportionality.

Which criteria in Table 1 most relate to fairness? No doubt, Criteria 1-4, which specify strict legal requirements, are crucial. However, there exist trillions upon trillions of maps that satisfy these criteria, so the next question is: Of the other criteria, which most relates to fairness?

Clearly, the answer is Criterion 5: political fairness. Why? Because the most important factor affecting statewide policymaking, by far, is the political party makeup of the Wisconsin legislature which, in turn, is greatly impacted by the *political fairness* of the legislative map. A legislature with huge Republican majorities in both chambers makes different laws than a legislature with huge Democratic majorities in both chambers. Both make different laws than a legislature with thin majorities for the same party in both chambers or a legislature in which Republicans control one chamber and Democrats control the other. By contrast, there is little or no evidence that statewide policymaking is affected solely by the compactness of the districts, number of municipalities or counties that are split, or core retention in the legislative map.

Hence, this Court should conclude that fairness in redistricting means political fairness. But which measure of political fairness—proportionality, efficiency gap, seats bias, votes bias, declination, mean-median, etc.—should it use? The answer is *proportionality*.

There are three reasons why proportionality is the only measure of political fairness the Court should use. First, proportionality is the most direct measure and easiest to understand. *A proportional map is one in which the predicted percentage of districts won by each party is as close as possible to the percentage of the statewide (two-party) vote it has received.* For example, if 51.5% of the statewide, two-party vote is cast for Democrats, then a proportional map is one in which 51.5% of the seats in each chamber—51 of 99 in the assembly and 17 of 33 in the senate—are predicted to be won by Democrats.

Second, for a swing state like Wisconsin, all measures of political fairness are generally consistent. John F. Nagle & Alec Ramsay, *On Measuring Two-Party Partisan Bias In Unbalanced States*, 20 Election Law Journal 116 (2021). For example, *FastMap1* exhibits the best performance among all maps in the WIMAP study for all measures of political fairness considered in the study, including proportionality.

Third, proportionality is the most conceptually sound measure of political fairness. The idea of representative democracy is that a small group of legislators represents a large group of people; the small group reflects, embodies, and stands for the large group. This is exactly the idea of proportionality; the small group is proportional to the large group. If a large group is 48.5% Republican and 51.5% Democratic, the best representation of it is a small group with the same percentages.

Political fairness is rooted in the idea that "all voters have 'an equal opportunity to translate their votes into representation'" *Carter v. Chapman*, 270 A.3d 444, 470 (Pa. 2022), *cert. denied,* 143 S.Ct. 102 (2022). Since the percentage of each party's voters will vary, this equal opportunity can only mean that voters should have the opportunity to elect numbers of representatives that are *proportional* to their percentage of the electorate.

In fact, proportionality is already built into our understanding of the word "representation" in many contexts, including politics. Proportionality is the key to good representation in polls, marketing surveys, clinical studies, maps, and architectural models. In these contexts, the term "representative sample" literally means "proportional sample." Other measures of political fairness use elaborate concepts like "wasted votes" and "seats-votes

curves" that, unlike proportionality, are only weakly connected to the idea of fair representation.

The Court should therefore endeavor to select a legislative map that is as proportional as possible. This will maximize the likelihood of proportional election results in the future. *If future elections are proportional, then the predominant factor determining which state laws are made in Wisconsin will be not only the political party makeup of the Wisconsin legislature but also the political party makeup of the Wisconsin electorate.* This is exactly what fairness in redistricting means.

2. The Court should use composite data from six recent statewide elections to judge the political fairness of remedial maps.

All measures of political fairness, including proportionality, use past election results at the ward level to serve as mock elections for predicting future election results in proposed districts. When assessing political fairness, the Court should follow the recommendations of Judge Adelman: use the average results of at least five recent statewide elections. Hon. Lynn Adelman, *Political Fairness In Redistricting: What Wisconsin's Experience Teaches*, 49 University of Memphis Law Review 1083, 1105 (2019). Results from legislative and Congressional elections should be ignored; they are sensitive to local issues and may involve unopposed candidates, skewing the results. The more elections considered, the better, so Petering recommends six statewide elections be used. The average number of voters supporting each party in each ward can be computed as described in Note 1 of Petering (2023). Once proposed districts are created, constituent ward totals yield district totals. District totals then predict the number of districts won by each party.

3. The Court should not use "past-the-post" accounting to analyze political fairness but should use a more nuanced, "fractional seats" approach.

There are two ways to assess the proportionality (or other political fairness measure) of a map: *past-the-post* and *fractional seats*. In *past-the-post* accounting, the predicted number of seats won by Party A equals the number of districts where Party A voters outnumber Party B voters. In *fractional seats* accounting, Party A's share of the (two-party) vote in each district is converted to a fractional value between 0 and 1 which is both the predicted number of seats Party A wins in the district and the chance that Party A wins the district (Figure 2). These "fractional seat" values are summed over all districts to give the predicted number of seats won by Party A. Note 2 of Petering (2023) gives a detailed explanation of these approaches.

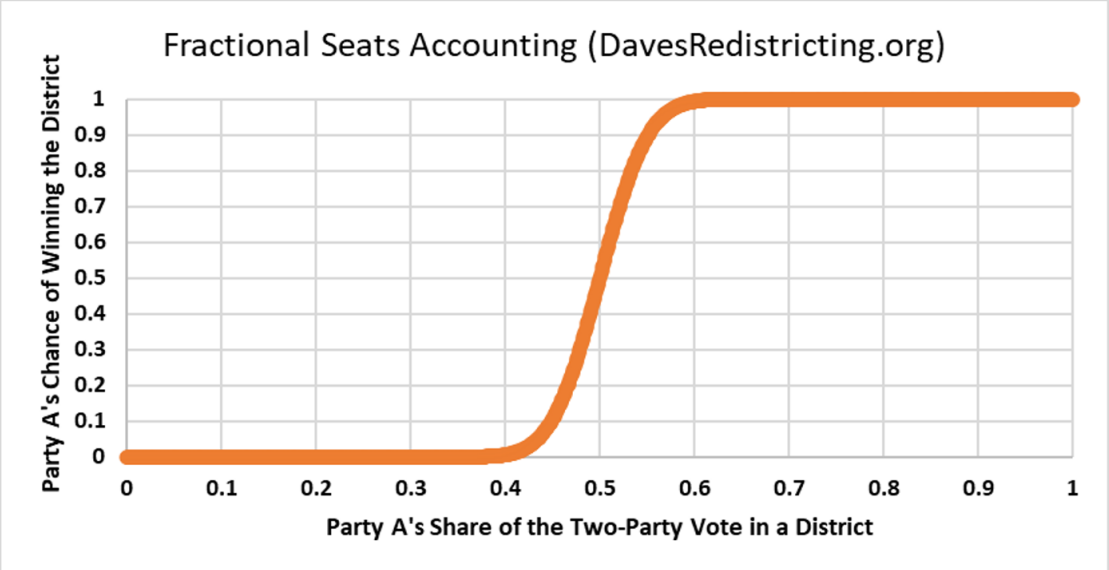

Figure 2. In fractional seats accounting, a district is assumed to be a complete win or loss only if it is lopsided. If a district is competitive, each party is assumed to have a fractional, non-zero probability of winning it (i.e., a fractional, non-zero predicted number of seats it wins in the district).

Table 2 below illustrates the difference between these approaches. Consider a 50-50 state like Wisconsin with eight districts in which the parties' shares of the two-party

vote in each district are shown in columns 2-3. Note that each party has exactly 50% of the statewide vote. *Past-the-post* accounting treats closely contested and lopsided districts equally and predicts both parties will win 4 districts. Using this method, the map seems perfectly proportional. In contrast, *fractional seats* accounting recognizes that Districts 1-2 are nearly toss-ups and gives Party A a 60% chance of winning each (i.e., an expected 0.6 victories in each). Therefore, the fractional seats approach predicts that Party A (B) will win 3.2 (4.8) districts, i.e., 40% (60%) of the districts. A seat share of 40% for Party A is not close to Party A's statewide vote share (50%), so, using a fractional seats approach, one concludes that the map is not close to being proportional. This example shows that *fractional seats* accounting is more reasonable than *past-the-post* accounting because it considers the uncertainty inherent in campaigns and elections.

Table 2. Example of a 50-50 state with eight districts. *Past-the-post* accounting treats closely contested and lopsided districts equally and predicts both parties will win 4 districts. *Fractional seats* accounting treats them differently and predicts that Party A (B) will win 3.2 (4.8) districts.

			Past-The-Post Accounting		Fractional Seats Accounting	
District	Party A Composite Vote Share	Party B Composite Vote Share	No. Party A Seats	No. Party B Seats	No. Party A Seats	No. Party B Seats
1	51%	49%	1	0	0.6	0.4
2	51%	49%	1	0	0.6	0.4
3	71%	29%	1	0	1	0
4	71%	29%	1	0	1	0
5	39%	61%	0	1	0	1
6	39%	61%	0	1	0	1
7	39%	61%	0	1	0	1
8	39%	61%	0	1	0	1
Overall	50%	50%	4	4	3.2	4.8

Is *fractional seats* accounting better than *past-the-post* accounting at predicting actual election results? Yes, according to a recent study of state legislative elections (Note 3, Petering, 2023). Therefore, it is critical that the Court adopt the fractional seats approach used by DavesRedistricting.org and many leading redistricting

scholars when evaluating the proportionality, or other measure of political fairness, of proposed maps.[3] Otherwise, it runs the risk of declaring a map to be fair when in fact it is not.

II. The Court Should Invite Maps From *Amici* and Establish an Unambiguous Mathematical Procedure for Selecting the Best Remedial Map that Strongly Emphasizes Proportionality and Considers 9 Criteria.

Mirror, mirror on the wall, which is the fairest map of all?

The Court must remain politically neutral and transparent when identifying a remedial map. The best way to do this is to accept proposed maps from *Amici* as a part of any remedial process, along with any other submissions from the parties. The Court should also establish an unambiguous mathematical procedure by which one map can be selected.

Below, Petering makes specific recommendations for this procedure. Proportionality should be a major consideration, but it should not be pursued at all costs. Rather, it should be part of a holistic redistricting methodology that considers many redistricting criteria.

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[3] *See* Andrew Gelman and Gary King, *A Unified Method Of Evaluating Electoral Systems And Redistricting Plans*, 38 American Journal of Political Science No. 2, 514 (1994); David Cottrell, *Using Computer Simulations To Measure The Effect Of Gerrymandering On Electoral Competition In The U.S. Congress,* 44 Legislative Studies Quarterly, 487 (2019); John F. Nagle, *What Criteria Should Be Used For Redistricting Reform?* 18 Election Law Journal 63 (2019); John F. Nagle & Alec Ramsay, *On Measuring Two-Party Partisan Bias In Unbalanced States*, 20 Election Law Journal 116 (2021).

In a multi-criteria problem, the best way to avoid ambiguity is to establish well-defined *metrics* called *penalty scores* for each redistricting criterion and a *weighting scheme* that specifies how penalty scores for individual criteria are aggregated into a single number that is the *total penalty score* of a map. Among all maps meeting the strict legal requirements, the Court should select the one with the minimum total penalty score. This approach, detailed below, minimizes subjectivity and maximizes transparency.

Petering recommends that the Court consider Criteria 1-9 when evaluating possible remedies (Table 1). These criteria account for all language in the Wisconsin and U.S. Constitutions and three criteria commonly associated with the term "gerrymandering": proportionality, compactness, and competitiveness.

It would be thorny for the Court to decide which communities of interest are worthier than others (Criterion 10). Criterion 11 is unnecessary because Criterion 2 already imposes a strict 2% population deviation requirement. Criteria 12-14 measure "least change." Therefore, Criteria 10-14 should be ignored.

Criteria 1-9 should be considered as follows.

A. Criteria 1-4 are strict legal requirements

Criterion 1: Nesting and numbering

Three consecutively numbered assembly districts must be nested in each senate district. Maps failing to satisfy this criterion should be eliminated.

Criterion 2: Population deviation

Any map with an overall range in population deviation of more than 2% in the assembly or senate should be discarded.

Criterion 3: Compliance with the Voting Rights Act and Equal Protection Clause

The map must not disenfranchise minority voters. Any map that does not satisfy this criterion should be eliminated.

Criterion 4: Contiguity

Once the Court decides on a contiguity standard, any map with a noncontiguous assembly or senate district must be discarded.

B. Evaluating Criteria 5-9

Surviving maps should then be evaluated using *penalty scores* for Criteria 5-9 as described below.

Criterion 5: Political fairness

As argued in Section I.C, *proportionality* should be used to evaluate the map's political fairness. The six elections utilized at DavesRedistricting.org ("DRA") should be used to measure proportionality: 2022 governor, 2022 U.S. Senate, 2022 attorney general, 2020 president, 2018 U.S. Senate, and 2016 president. Results from these elections should be equally weighted to compute the composite data. Petering further urges the Court to adopt the *fractional seats* approach used by DRA when evaluating proportionality (Section I.C.3).

Specifically, the Court should use the penalty score *"number of fractional seats away from perfect proportionality"* to measure political fairness in the assembly and senate. This equals the difference between the fractional seats Party A is predicted to win and the fractional seats that Party A would win in a perfectly proportional map. Both values are computed by DavesRedistricting.org. For example, according to composite voting data, Democrats have 51.49% of the statewide vote in Wisconsin. The number of assembly seats in perfect proportion to this is (.5149)*(99) = 50.98. If Democrats are predicted to win 47.44 fractional seats, the number of seats away from perfect proportionality is 50.98-47.44 = 3.54. This would be the penalty score for Subcriterion 5A in Table 1. A separate score would be computed for Subcriterion 5S.

Criterion 6: Compactness

There are two main measures of compactness: *Reock* and *Polsby-Popper*. The former measures how dispersed district shapes are; the latter measures how indented they are. Both have values between 0 and 1 with bigger values being better. Reock is more appropriate because it ignores small indentations, so Petering recommends that the Court use *"1 – (overall Reock score computed by DRA)"* as the penalty score for this criterion.

Criterion 7: Competitiveness

Composite data from the six elections used to evaluate proportionality should also be used to evaluate competitiveness. Specifically, the Court should use *"number of noncompetitive districts outside the 45%-55% range"* as the penalty score.

Criterion 8: Keeping counties intact

County splitting can be measured as either: (i) the number of counties that are not kept wholly intact within one district; or (ii) the total number of county splits in the map. The former measure has a limited range. Therefore, the Court should use *"total number of county splits"* as the penalty score.

Criterion 9: Keeping municipalities intact

The Court should use *"number of municipalities whose population is not kept wholly intact within one district"* as the penalty score.

C. The method for computing total penalty scores should strongly prioritize proportionality.

Once the penalty scores for Criteria 5-9 are computed, the Court should aggregate the scores for each map into a *total penalty score* using a *weighting scheme* (Table 3). This weighting scheme would be one of the few subjective components of the Court's analysis. After the weights are decided, the map with the smallest total penalty score should be selected as the remedy.

Importantly, *proportionality should be strongly prioritized in the weighting scheme* to encourage the creation of *strictly proportional* maps, i.e., maps that are (nearly) perfectly proportional. This is because, in a swing state like Wisconsin, there is a world of difference between a map that is somewhat proportional and one that is strictly proportional. According to a recent simulation study, increasing a party's (fractional) predicted seat total in the Wisconsin Assembly from 49 to 50 increases its chances of controlling the chamber from about 40% to 60%. Also,

increasing its predicted seat total from 48 to 51 increases its chances of controlling the chamber from about 25% to 75% (Note 4, Petering, 2023). Thus, the stakes are incredibly high in the effort to achieve strict proportionality.

Petering's recommended weights for Subcriteria 5A-9A and 5S-9S are shown in Table 3. These weights express mapping priorities in precise mathematical terms. Consider the weights for the assembly. Here, weights of 50 for proportionality and 1 for municipality splitting mean that moving one seat closer to perfect proportionality and reducing the number of split municipalities by 50 are equally good because the map's total penalty score decreases by 50 in both cases. Improving the Reock compactness score by 0.05 (which is a major improvement) or increasing the number of competitive districts by 10 are two other equally desirable cases.

There are three times more assembly districts than senate districts, so the weights for proportionality and competitiveness in the senate are three times higher than in the assembly. Thus, moving three seats closer to proportionality in the assembly and one seat closer to proportionality in the senate are equally good. Overall, the weighting scheme prioritizes subcriteria which appear higher in the table.

Table 3. Recommended weighting scheme for deciding which map is the best

Assembly Subcriterion	Description	Weight	Senate Subcriterion	Description	Weight
5A	Proportionality	50	5S	Proportionality	150
6A	Compactness	1000	6S	Compactness	1000
7A	Competitiveness	5	7S	Competitiveness	15
8A	Keeping counties intact	1	8S	Keeping counties intact	1
9A	Keeping municipalities intact	1	9S	Keeping municipalities intact	1

As a concrete example, compare a map named *155#176* (see Section II.D) to the current map (SB621). Table 4 shows the scoring of each map. Note that *155#176*

outperforms SB621 for Criteria 4, 5, 6, 7, and 8, but not Criterion 9. Overall, *155#176* has a total penalty score of 2227.4 whereas SB621's score is 3453.9. Thus, *155#176* should be preferred by the Court.

Table 4. Detailed scoring of maps *155#176* and SB621

		155#176 **(strictly contiguous)**		**SB 621 (not contiguous)**	
Subcriterion	**Weight**	**Penalty Score**	**Weighted Penalty Score**	**Penalty Score**	**Weighted Penalty Score**
5A	50	0.02	1.0	9.80	490
6A	1000	0.5447	544.7	0.6418	641.8
7A	5	70	350	83	415
8A	1	142	142	156	156
9A	1	98	98	51	51
5S	150	0.07	10.5	4.05	607.5
6S	1000	0.5792	579.2	0.6316	631.6
7S	15	25	375	24	360
8S	1	65	65	71	71
9S	1	62	62	30	30
		Total Penalty Score = 2227.4		**Total Penalty Score = 3453.9**	

D. The Court should consider map *155#176* and additional maps made by *FastMap* as possible remedies.

It is one thing to talk about fair maps. It is another to create them. Petering has created a rigorously fair map generated by the *FastMap* algorithm. The .csv files can be downloaded at DistrictSolutions.net/wisconsin-maps.html, below the entry dated Nov. 8, 2023.

This map, named *155#176*, satisfies the core legal requirements. It has exceptional proportionality, outstanding compactness, excellent competitiveness, very good county splitting performance, and good municipality splitting performance. All its districts are strictly contiguous. Additional details are provided in the following sections. All metrics are computed by DRA.

1. District numbering and nesting.

Three consecutively numbered assembly districts comprise each senate district.

2. Population deviation.

Wisconsin traditionally adopts maps with an overall range in population deviation of 2% or less. Map *155#176* has a 1.98% (1.52%) range in population deviation in the assembly (senate), so it meets this standard (Note 5, Petering, 2023).

3. Voting Rights Act (VRA) compliance.

Assembly districts 7-9, 10-12, and 16-18 (and senate districts 3, 4, and 6) are identical to their counterparts in SB 621, so *155#176* should comply with the VRA.

4. Contiguity.

All assembly and senate districts are strictly contiguous.

5. Proportionality (political fairness).

Based on 2016-2022 composite voting data, DRA gives the map a proportionality rating of 100 of 100 for the assembly and 100 of 100 for the senate. In the assembly, (Democrats, Republicans) are predicted to win (50.96, 48.04) fractional seats, which is nearly identical to the number they would win in a perfectly proportional map: (50.98, 48.02). In the senate, (Democrats, Republicans) are predicted to win (17.06, 15.94) fractional seats, which is close to a perfectly proportional map: (16.99, 16.01). Overall, the assembly (senate) map is 0.02 (0.07) seats away from perfect proportionality. For all intents and purposes, *the map is strictly proportional.*

6. Compactness.

DRA gives the map a compactness rating of 78 of 100 for the assembly and 65 of 100 for the senate. According to DRA, the overall (*Reock*, *Polsby-Popper*) score in the assembly is (0.4553, 0.3944) and senate is (0.4208, 0.3421). These are exceptional scores.

7. Competitiveness.

In the assembly, 32 (38) districts are at least 55% Democratic (Republican) and 29 districts are in the 45%-55% competitive range. In the senate, 12 (13) districts are at least 55% Democratic (Republican) and 8 districts are competitive. The map exhibits excellent competitiveness.

8. Split counties.

The assembly map splits 53 counties a total of 142 times. The senate map splits 43 counties a total of 65 times. This is very good performance.

9. Split municipalities.

The assembly map splits 98 of Wisconsin's 1850 municipalities and the senate map splits 62 municipalities. This is good performance.

10. Map image.

Figure 3 shows the assembly districts in *155#176*. For more details, visit the Nov. 8, 2023 entry at www.DistrictSolutions.net/wisconsin-maps.html.

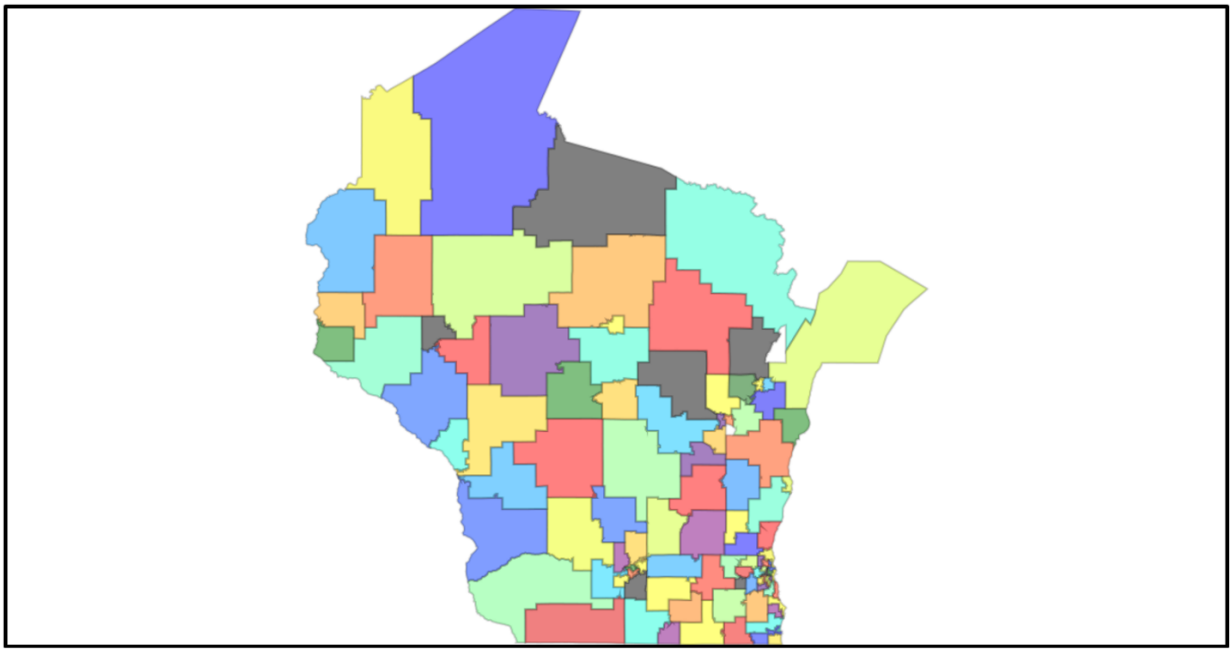

Figure 3. Image of the assembly districts in map *155#176*

CONCLUSION

Legislative redistricting in Wisconsin is a challenging endeavor. The Court's best option for a remedy to replace unconstitutional maps is to consider maps made by an objective computer algorithm such as *FastMap* and to set unambiguous mathematical standards by which a remedial map will be selected. The Court should acknowledge that fairness in redistricting means proportionality, so proportionality should play a major role in these standards.

Dated: November 8, 2023

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FORM AND LENGTH CERTIFICATION

I certify that the foregoing amicus brief conforms to the rules contained in Wis. Stat. § (Rule) 809.19(8)(b) and (c)3 (as modified by the Court's October 6, 2023 Order) for a brief produced with a proportional serif font. The length of the foregoing brief, exclusive of the caption, Table of Contents, Table of Authorities, and Interest of Amicus, is 4,397 words.

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