No. 16-1161

IN THE

Supreme Court of the United States

BEVERLY R. GILL, ET AL.,

Appellants,

v.

WILLIAM WHITFORD, ET AL.,

Appellees.

ON APPEAL FROM THE
UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF WISCONSIN

BRIEF FOR *AMICUS CURIAE* ERIC S. LANDER IN SUPPORT OF APPELLEES

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Dated: August 31, 2017

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INTEREST OF *AMICUS CURIAE*[*]

Amicus Curiae **Eric S. Lander** is an expert in the scientific analysis of large datasets, who has served as an advisor to the Federal Government on matters of science and technology.

A mathematician and geneticist, Dr. Lander was one of the principal leaders of the Human Genome Project and led the analysis of its vast dataset. Dr. Lander serves as President and Founding Director of the Broad Institute of Harvard and MIT, a nonprofit research institution focused on genomic medicine. He is also a professor on the faculties of Harvard and MIT.

Dr. Lander served from 2009 to 2017 as Co-Chair of the President's Council of Advisors on Science and Technology (PCAST), an advisory group that directly advised the President of the United States on a wide range of matters, including information technology. He currently serves on the Defense Innovation Board (DIB), which advises the Secretary of Defense on innovative uses of technology for national defense.

Dr. Lander was elected to the U.S. National Academy of Sciences in 1997 and to the U.S. National Academy of Medicine in 1999. He has received numerous major awards for his research, including for his work analyzing large datasets.

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[*] Counsel for all parties have filed with the Clerk of this Court letters granting blanket consent to the timely filing of *amicus curiae* briefs. No counsel for any party authored this brief in whole or in part, and no person other than the named *amicus curiae* and his counsel has made any monetary contribution intended to fund the preparation or submission of this brief.

Dr. Lander wishes to emphasize that this brief represents his own personal views. It is in no way intended as a statement of policy or position by the United States Government, the Broad Institute, Harvard, MIT, or any other entity.

At the heart of this case is the question of whether there exists a judicially manageable standard for recognizing extreme partisan gerrymanders. As a leading researcher in the analysis of large datasets, Dr. Lander has a strong interest in alerting this Court to recent technological advances that now enable the adoption of a judicially manageable, computer-based, objective mathematical standard that would (i) enable courts to evaluate claims of excessive partisan gerrymandering by comparing the degree of partisan bias in a State's plan to the bias in all other comparable plans that achieve the State's declared goals; (ii) provide guidance and reasonable leeway to States; and (iii) protect voters' constitutional rights.

SUMMARY OF THE ARGUMENT

This case hinges on the question of whether there is a judicially manageable standard that would enable courts to determine when the partisan bias of a redistricting plan is so excessive as to render the plan unconstitutional.

This question has grown in importance, as recent technological advances have made it ever easier for a political party in power to design redistricting plans that entrench itself—even when its voters constitute a minority of the electorate.

In *Vieth v. Jubelirer,* 541 U.S. 267 (2004), all nine Justices of this Court agreed that extreme partisan gerrymanders are incompatible with democratic principles and violate the Constitution. This Court, however, has not yet agreed upon a standard for determining when the partisan bias of a redistricting plan is so extreme as to be unconstitutional. Rather, it has taken a patient approach.

Justice Kennedy presciently observed that "technology is both a threat and a promise," noting that the same advances that enable increasingly extreme partisan gerrymandering might also provide a solution. *Vieth,* 541 U.S. at 312 (Kennedy, J., concurring in the judgment).

Technology has now delivered on that promise. Due to progress over the past decade, it is now possible for this Court to adopt an objective, judicially manageable standard that asks:

> *Is the State's chosen redistricting plan an 'extreme outlier'—that is, is its expected partisan outcome more extreme than that of the great majority*

> *of all possible plans that accomplish the State's declared goals as well as the State's chosen plan?*

If so, the plan is not plausibly explained by the State's declared goals. Rather, it *prima facie* constitutes excessive partisanship.

An *extreme outlier standard* would properly (i) respect the State's declared objectives (e.g., population equality, minority voting rights, compactness, contiguity, and preservation of political subdivision boundaries); (ii) reflect the State's political geography (including any 'natural packing' of political parties); (iii) provide clear guidance to States; (iv) protect voters' constitutional rights and (v) minimize litigation. Moreover, it provides capacious room for political considerations, and neither requires nor expects proportionality in the result.

The extreme outlier standard would divide a court's analysis into three distinct steps:

(1) Legal analysis: The court would examine whether a State's declared goals are consistent with Federal law and the U.S. Constitution, as well as any applicable state constitutional or statutory requirements. This is a purely legal analysis of the sort that courts routinely undertake.

(2) Quantitative evidence: The parties would present evidence identifying the quantitative degree to which the State's plan is an outlier with respect to its expected partisan outcome. Computers now make it possible to answer this question by (i) sampling thousands or even millions of possible redistricting plans that meet the State's declared goals for redistricting comparably to the State's

chosen plan; (ii) measuring the expected partisan outcome for each such plan; (iii) displaying the *distribution* of the expected partisan outcomes across these plans; and (iv) situating the State's chosen plan along that continuum (that is, its percentile along the distribution; see Figure 1), to reveal the degree to which it is an outlier. (Here, *partisan outcome* can be defined by any suitable metric. The simplest—and arguably most relevant—is the number of seats that a given political party would be expected to win under the plan. But courts could also choose to consider other metrics, such as the efficiency gap.)

This is a *mathematical* question to which there is a *right* answer. With improvements in technology, it is feasible to calculate that answer with good accuracy. Thus, even opposing parties in a case should obtain highly similar results.

Notably, the Federal Government relies on analogous calculations (involving the analysis of distributions of outcomes) for national defense and public safety—including, for example, assessing whether a nuclear weapon will detonate properly, and whether Miami is safely out of the path of a hurricane. In the past decade, scholars have also increasingly used such computational methods to calculate the distribution of outcomes for possible redistricting plans.

(3) *Threshold analysis*: The court would use this quantitative assessment in reaching a decision about the ultimate question: *Is the plan so extreme that it constitutes excessive partisanship?* This previously unavailable information (concerning how far out on the distribution the State's chosen plan lies relative to all other comparable plans) uniquely

sheds light on whether the plan "(1) is intended to place a severe impediment on the effectiveness of the votes of individual citizens on the basis of their political affiliation, (2) has that effect, and (3) cannot be justified on other, legitimate legislative grounds." *Whitford v. Gill,* 218 F. Supp. 3d 837, 884 (W.D. Wis. 2016); App. J.S. 109a-110a. This objective information can be combined with other evidence regarding intent, effect, and justification.

In the case before this Court, Wisconsin's redistricting plan enacted in 2010 under Act 43 is clearly an extreme outlier. Scholars who have used computational methods to calculate the distribution of outcomes have found Wisconsin's plan has greater partisan bias than 99% of all possible comparable plans.

While States have considerable latitude in redistricting, there is a limit as to how far they properly may go to disadvantage their citizens on the basis of political affiliation or beliefs.

An extreme outlier standard would provide courts with an objective and quantifiable benchmark to evaluate whether a State's plan has gone so far as to undermine democratic principles and violate the Constitution. It also would minimize litigation by providing objective guidance both to States and to potential challengers. Ultimately, it would bolster public confidence in the courts, by enabling them to strike down extreme partisan gerrymanders, but only on the basis of an objective, quantitative standard.

ARGUMENT

I. A JUDICIALLY MANAGEABLE STANDARD FOR RECOGNIZING EXCESSIVELY PARTISAN GERRYMANDERS REQUIRES SOME QUANTITATIVE FOUNDATION.

The key issue on this appeal is whether claims of excessively partisan redistricting are justiciable.

This Court has recognized that the right to vote is "fundamental . . . in a free and democratic society," as it is "preservative of other basic civil and political rights," *Reynolds v. Sims*, 377 U.S. 533, 561-62 (1964), and that the "basic aim" of redistricting is to provide "fair and effective representation for all citizens." *Id.* at 565-566.

Moreover, all nine Justices of this Court in *Vieth v. Jubelirer,* 541 U.S. 267 (2004), agreed that excessively partisan redistricting is inimical to our democratic form of government and violates the U.S. Constitution.[1]

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[1] *See* 541 U.S. at 292 (plurality opinion) ("[w]e do not disagree" that severe partisan gerrymanders are incompatible with democratic principles); *id.* at 293 ("an *excessive* injection of politics is *un*lawful") (emphasis in original); *id.* at 311-12 (Kennedy, J., concurring in the judgment) ("Allegations of unconstitutional bias in apportionment are most serious claims"); *id.* at 316 ("I do not understand the plurality to conclude that partisan gerrymandering that disfavors one party is permissible. Indeed, the plurality seems to acknowledge it is not."); *id.* at 326 (Stevens, J., dissenting) (plurality's opinion "seems to agree that if the State goes 'too far'—if it engages in 'political gerrymandering for politics' sake'— it violates the Constitution"); *id.* at 343 (Souter, J., joined by Ginsburg, J.) ("if unfairness is sufficiently demonstrable, the guarantee of equal protection condemns it as a denial of substantial equality"); *id.* at 361 (Breyer, J., dissenting) ("the democratic harm of unjustified entrenchment is obvious").

But this Court has struggled to articulate and agree upon "judicially discoverable and manageable standards," *Vieth v. Jubelirer,* 541 U.S. 267, 277-278 (2004) (plurality opinion), *quoting Baker v. Carr,* 369 U.S. 186, 217 (1962), for recognizing when a particular redistricting plan unconstitutionally interferes with fair and effective representation for all citizens. *Id.*; *Davis v. Bandemer,* 478 U.S. 109 (1986).

A major reason for this difficulty, *amicus* submits, is that this Court has sought to define excessiveness based solely upon qualitative, verbal criteria. Excessiveness is a quantitative concept that requires some quantitative underpinning.

Recent advances in technology have made it possible to provide clear guidance about the quantitative degree to which the partisan bias of a redistricting plan is (or is not) extreme. Such objective guidance can now provide the foundation for a readily manageable judicial standard.

Justice Kennedy presaged this development in *Vieth,* where he wrote that "[t]echnology is a threat and a promise" for the future of partisan gerrymandering. 541 U.S. at 312. The following sections address the threat, and then the promise.

II. TECHNOLOGY IS A THREAT THAT WILL GROW INEXORABLY IF COURTS REFUSE TO ENTERTAIN ANY CLAIMS OF PARTISAN GERRYMANDERING.

Justice Kennedy warned in *Vieth* that "if courts refuse to entertain any claims of partisan gerrymandering, the temptation to use partisan favoritism in districting in an unconstitutional manner will grow." 541 U.S. at 312.

Technology poses this growing threat because it makes it increasingly feasible to:

(i) collect or buy information about individuals (including party affiliation; voting frequency; past election results for their neighborhood; political donations; religious affiliation; ethnicity; online social network activity; income and spending habits; music preferences; and much more);

(ii) apply sophisticated computational methods (such as machine learning) to the aggregated information to build powerful predictive models of each individual's party preferences;

(iii) map the predicted preferences and voting habits onto a State's geography, using geographic information systems (GIS);

(iv) generate vast numbers of possible redistricting plans and evaluate their likely partisan outcomes (based on precinct-level results in recent elections, as well as other personal information noted above); and

(v) among those redistricting plans, choose extreme outliers that impose the greatest partisan bias.

If courts refuse to entertain *any* claims of partisan gerrymandering, political parties predictably will draw on rapidly accelerating technology to more effectively entrench themselves in power, by imposing extreme redistricting plans that disadvantage citizens holding opposing political affiliations or beliefs.

The risk to democracy of unfettered partisan gerrymandering is clear. If completely unchecked, a party that temporarily gains control of a State's redistricting process could draw districts that assure itself of legislative control (and potentially legislative supermajorities) even with only minority support of the voters, and could lock in the advantage by refreshing the gerrymanders as needed.

Justice O'Connor, *in Davis v. Bandemer*, 478 U.S. 109 (1986), suggested that political gerrymandering might turn out to be a "self-limiting enterprise," because an aggressive gerrymander would run the risk of cutting the margins too fine, 478 U.S. at 152 (O'Connor, J., concurring in the judgment). But history has shown otherwise. In the present case, the Wisconsin legislature used modern technology (especially its expert's ability to run a wide range of hypothetical election scenarios) specifically to confirm that its gerrymander, despite its aggressive nature, was indeed robust enough to withstand numerous electoral variations. App. J.S. 21a-27a, 41a-42a, 148a.

Indeed, there is clear evidence that extreme partisan gerrymandering has become more common and effective as a tool to entrench a party in power. The academic literature has found a steady trend to greater partisan gerrymandering in the 21st century, compared to the late 20th century.[2] Moreover, the number of extreme partisan gerrymanders post-2010 is larger, by any reasonable assessment, than in any previous redistricting cycle.[3] Indeed, lawsuits alleging partisan gerrymandering post-2010 have

[2] Note, *An Interstate Process Perspective on Political Gerrymandering*, 119 Harv. L. Rev. 1576, 1576 (2006); Nicholas O. Stephanopoulos, *Our Electoral Exceptionalism*, 80 U. Chi. L. Rev. 769, 819 (2013).

[3] Nicholas O. Stephanopoulos & Eric M. McGhee, *Partisan Gerrymandering and the Efficiency Gap*, 82 U. Chi. L. Rev. 831, 836-838 (2015).

been filed in Illinois,[4] Georgia,[5] Maryland,[6] North Carolina,[7] Pennsylvania,[8] and Texas,[9] in addition to the instant case from Wisconsin. Notably, such claims have been made against both Republicans and Democrats.

III. TECHNOLOGY NOW ALSO PROVIDES A STRAIGHTFORWARD AND OBJECTIVE WAY TO RECOGNIZE WHEN A STATE HAS CHOSEN A REDISTRICTING PLAN THAT IS EXCESSIVELY PARTISAN.

Justice Kennedy, in *Vieth*, also saw the promise of technology. "These new technologies may produce new methods of analysis that make more evident the precise nature of the burdens that gerrymanders impose on the representational rights of voters and parties. That would facilitate court efforts to identify and remedy the burdens, with judicial intervention limited by the derived standards." 541 U.S. at 312.

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[4] *Committee for a Fair and Balanced Map v. Ill. State Bd. of Elec.*, 835 F. Supp. 2d 563 (N.D. Ill. 2011).

[5] *Georgia State Conf. of NAACP v. Georgia,* U.S.D.C. (N.D. Ga.), Civil Action No. 17cv01427.

[6] *Benisek v. Lamone,* U.S.D.C. (D. Md.), Civil Action No. 13-cv-03233.

[7] *Common Cause v. Rucho,* U.S.D.C. (M.D.N.C.), Civil Action No. 16-cv-1026*; League of Women Voters v. Rucho,* U.S.D.C. (M.D.N.C.), Civil Action No. 16-cv-1164.

[8] *League of Women Voters v. Pennsylvania,* Commonwealth Court of Pennsylvania, Civil Action No. 261 MD 2017.

[9] *Perez v. Abbott,* U.S.D.C. (W.D. Tx.), Civil Action No. 11-cv-00360.

Thus, while technology now enables political parties to impose excessive disadvantages on citizens holding opposing political affiliations or beliefs, technology can now also be used to determine objectively whether a State's chosen plan goes too far—i.e., is an extreme outlier with respect to its degree of partisanship.

It is now possible, through the use of computers to examine extremely large representative samples, to employ a straightforward and objective *extreme outlier standard*:

> *A State's chosen plan is an extreme outlier if its partisan bias exceeds that of the great majority of all possible plans that accomplish the State's declared goals comparably to the State's plan.*

If so, the plan is not plausibly explained by the State's declared goals. Rather, it *prima facie* constitutes excessive partisanship.

To apply an extreme outlier standard, a court would undertake a three-part analysis:

(1) Legal analysis: The court would examine whether a State's declared goals are consistent with Federal law and the U.S. Constitution, as well as any applicable state constitutional or statutory requirements. This is a purely legal analysis of the sort that courts routinely undertake.

(2) Quantitative evidence: The parties would present evidence about the *quantitative degree* to which the State's plan is an outlier in its expected partisan outcome, relative to all redistricting plans that meet the State's declared goals comparably to

the State's chosen plan. This is a *mathematical* question to which there is a *right* answer.

(3) *Threshold analysis*: The court would then weigh (i) this objective, quantitative assessment of the degree to which the State's plan is an extreme outlier and (ii) other relevant information bearing on intent, effect, and justification, to determine whether the plan represents unconstitutionally excessive partisanship.

The following sections elaborate on the second component.

A. The excessiveness of a redistricting plan may be determined by comparing it to the *distribution of outcomes* for all possible plans that satisfy the State's declared goals.

This section describes how excessiveness can be determined by examining all possible redistricting plans. Because examining *all* plans is not computationally feasible, the next section notes that modern technology makes it possible to accomplish the same goal by examining a very large, representative sample of such plans.

The fundamental idea is straightforward: compare the partisan outcome expected for the State's plan to the distribution of expected partisan outcomes across all possible plans that comparably satisfy the State's declared goals. The concept of the distribution of outcomes is shown in Figure 1.

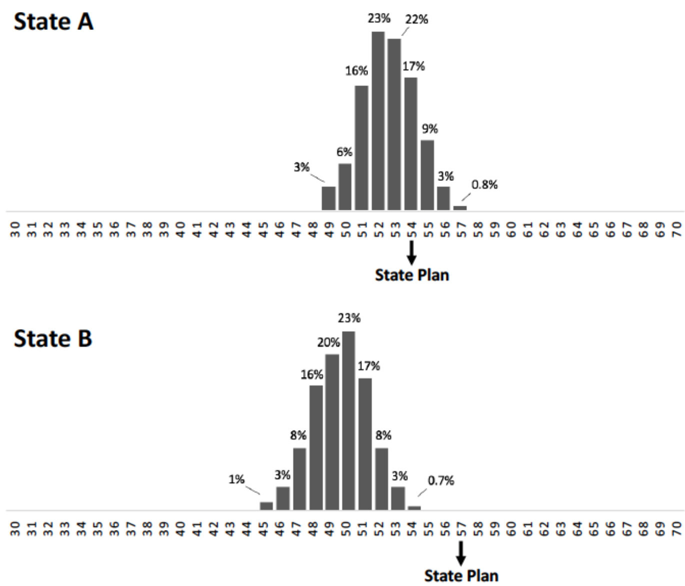

Figure 1. This conceptual figure illustrates the evaluation of a State's redistricting plan for an Assembly in two different States, labelled State A and State B. (Actual results for Wisconsin's plan are shown in Figure 2.)

Each panel shows the hypothetical results of using a computer to (i) generate a large and representative sample of redistricting plans that satisfy the State's declared goals comparably to the State's chosen plan; (ii) determine the expected outcome for each plan (that is, the number of districts in which Republicans would have been expected to have had a majority of votes, if the plan had been in effect for a past election); (iii) aggregate the results; and (iv) display them on the bar chart.

The horizontal axis shows possible numbers of districts won. The height of each bar shows the proportion of redistricting plans with the corresponding outcome. (The frequencies add up to slightly less than 100%, because outcomes with frequencies below 0.1% are not shown.) The arrow indicates the expected outcome for each State's plan.

State A's chosen plan, with an expected outcome of 54 seats, is *not* an extreme outlier: it exceeds only 70% of the distribution for comparable plans. By contrast, State B's State's chosen plan, with an expected outcome of 57 seats, clearly *is* an extreme outlier: it exceeds 99% of all comparable plans.

To calculate the distribution of outcomes, one would proceed as follows:

(i) *Generate a list containing every possible redistricting plan*. Each plan would define precise district boundaries on the State's actual geographic and population map, subject to the requirement that the plan properly satisfies the one person, one vote principle.

(ii) *Discard all plans that fail to meet the State's declared goals*. A State is entitled to adopt various goals, provided that they bear a rational relationship to a legitimate governmental purpose and do not interfere with Federal constitutional and statutory requirements. Traditional examples include compactness, contiguity, and respect for political subdivision boundaries.[10] In each case, it is possible to measure the degree to which each plan

[10] *See Shaw v. Reno,* 509 U.S. 630, 647 (1993) (identifying those as traditional redistricting principles).

accomplishes each of the goals.[11] One would then discard any plan that does not satisfy those goals comparably to the State's chosen plan.

(iii) *Discard all remaining plans that fail to satisfy requirements in Federal law or the Constitution, or, if applicable, the State's constitution and laws*. For example, the Voting Rights Act forbids a redistricting plan that "results in the denial or abridgement of the right of any citizen of the United States to vote on account of race or color" or membership in a language minority group.[12] For each plan, one could measure whether the plan produces majority-minority districts and/or minority opportunity districts comparably to the State's chosen plan.[13] One would then discard any plan that fails to do so.

(iv) *Designate as 'comparable plans' those plans that have not been discarded.*

(v) *For each comparable plan, calculate its expected 'partisan outcome.'* For the sake of illustration, partisan outcome might be defined in

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[11] For example, there are various commonly accepted measures of compactness, such as Polsby-Popper, Reock, and Convex Hull scores. Multiple measures may be used in conjunction.

[12] Section 2 of the Voting Rights Act of 1965, as amended, now codified at 52 U.S.C. § 10301; see also *id.* § 10303(f)(2).

[13] This Court has developed a legal framework for the adjudication of minority vote dilution claims. See, e.g., *League of United Latin Am. Citizens v. Perry*, 548 U.S. 399, 425-426 (2006) (setting forth the elements of a minority vote dilution claim under § 2). The issue here is simply to evaluate whether a potential redistricting plan has comparable properties—such as majority-minority districts or minority opportunity districts—as the State's chosen plan.

terms of the total number of seats that Republicans would have won, if the plan had been in effect in a specific recent election—that is, the number of districts in which the vote count for Republicans would have exceeded the vote count for Democrats.[14]

(vi) *Summarize the distribution of outcomes across all comparable plans.* The distribution is typically displayed as a simple bar chart showing the frequency of each outcome (or group of outcomes). The bar chart typically resembles a 'bell curve.' Figure 1 illustrates two hypothetical examples.

(vii) *Compare the State's chosen plan to the distribution of outcomes across all comparable plans to determine the extent to which it is an outlier.* To be precise, the degree to which a plan is an outlier means how far out on the 'tail' of the distribution it lies (e.g., 55th vs. 90th percentile).

In the hypothetical examples in Figure 1, the redistricting plan for State A is well within the typical range of the distribution of comparable plans for the State, while the redistricting plan for State B is clearly an extreme outlier (it is more extreme than 99% of comparable plans for the State—that is, in the 99th percentile).

Based on how extreme the State's plan is relative to all comparable plans (i.e., where along the continuum of all comparable plans it lies), a court would decide whether or not the plan *prima facie* reflects excessive and unconstitutional partisanship. It could then consider this finding along with other

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[14] For any potential district, one can infer the vote total that would have occurred in a recent election by adding up the results for the individual precincts (or voting tabulation districts) within it. (If precincts are partially contained, results can be reasonably prorated or interpolated.)

information concerning intent, effect, and justification to reach a judgment concerning the permissibility of the plan.

B. Although it is not feasible to enumerate *every* possible redistricting plan, computers may be used to calculate the distribution of possible outcomes with good accuracy by examining a large, representative sample of such plans.

In the previous section, the first step in calculating the distribution of possible outcomes involved enumerating every possible redistricting plan for the State. In fact, the number of such redistricting plans is too large to explicitly enumerate each one.

Fortunately, there is no need to enumerate every plan. It is enough to determine the frequency of each bar in the bar graph to good accuracy. With technological advances, it is now possible to do so by drawing a large representative sample of such plans.

As discussed in Section IV below, analogous approaches are widely used in many important settings. For example, the United States Government routinely relies on such methods, including for national defense and homeland security. In the past decade, such methods have finally been applied to the evaluation of redistricting plans.

C. **This approach for assessing excessiveness can be applied to *any* suitable individual measure of partisan outcome—or to any *combination* of measures that a court wishes to consider.**

In the description above, *partisan outcome* was illustrated by a specific metric: the number of seats that a party predictably would have won if the plan had been in effect for a specific recent election.

A proper analysis of the expected partisan outcome of a redistricting plan, however, should not be based solely on results from a single election. Because partisan gerrymandering aims to entrench a party in power even when it loses popular support, it is important to consider the impact of a redistricting plan under multiple electoral circumstances. Specifically, the extreme-outlier analysis can and should be performed for the results from several recent elections, as well as for relevant variations around these results.[15] In this way, one can readily see whether a State's chosen plan is an extreme outlier with respect to relevant circumstances—e.g., whether it provides dramatically greater protection against loss of seats than the vast majority of comparable plans.

In addition to considering expected electoral outcomes, courts may also choose to consider whether the State's plan is an extreme outlier with respect to other measures of partisan outcome, such as the efficiency gap.

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[15] For example, one might perform the extreme outlier analysis for the results of two or three elections, as well as for the results obtained by shifting the vote shares in these elections within a relevant range (e.g., 5% in each direction).

D. An extreme outlier standard would address justiciability concerns raised by this Court.

Justice Kennedy, in *Vieth,* 541 U.S. at 307-308, expressed concern that the courts had "no basis on which to define clear, manageable and politically neutral standards for measuring the particular burden a given partisan classification imposes on representational rights."

The approach outlined above would address that concern, by locating the State's chosen plan along the continuum of all possible redistricting plans that comparably reflect the State's declared goals. The process uniquely isolates and quantifies the degree of partisan bias in the State's plan.

A fundamental difficulty in articulating a judicially manageable standard for determining whether a redistricting plan represents excessive partisanship has been that 'excessiveness' implicitly entails a comparison. It requires answering the question: "Excessive compared to *what*?"

The extreme outlier approach provides a clear, principled, and objective answer: "Excessive among all possible choices that comparably achieve the State's declared goals."

The approach further addresses justiciability concerns expressed by this Court as follows:

(i) The approach respects the State's declared goals, by restricting comparisons to plans that meet these goals comparably to the State's chosen plan.

(ii) The approach respects the State's political geography, by considering only plans based on the actual map of the State. Any 'natural' packing (e.g., the fact that Democratic voters are often more concentrated in urban areas) is automatically taken into account because the same condition applies to all of the possible plans to which the State's plan is compared.

(iii) The approach does not seek to ensure or even reward proportionality. Indeed, in view of the uneven partisan geography in the United States, it typically would not produce strict proportionality.

(iv) The approach employs a rational and objective principle (namely, comparison to all other options that achieve the State's declared objectives). It thus satisfies the test that "law pronounced by the courts must be principled, rational, and based upon reasoned distinctions." *Vieth*, 541 U.S. at 279 (plurality opinion).

(v) The approach does not ignore other relevant evidence. The extent to which the plan is an extreme outlier under this standard would be used in conjunction with other relevant evidence (e.g., evidence of legislative process and intent, and any asserted justifications).

(vi) The approach provides capacious room for partisan considerations. A State is not obliged to choose a redistricting plan that corresponds to the middle of the distribution. It can make many political choices, and even put a partisan finger on the scale to some reasonable degree. But, as *Vieth* confirms, if the balance becomes *too* extreme (that is, too far into the tail of the distribution), it creates an unconstitutional burden.

Under this approach, the court will still have to decide whether the partisan bias in the plan is so extreme as to impose an unconstitutional burden on voters based upon their political affiliations and beliefs. While mathematics provides no 'magic' threshold, the need for a court to draw a line *somewhere* does not render a standard judicially unmanageable.

In many cases, the answer will already be obvious: a plan located in the 55th percentile (near the center of the distribution) is clearly not excessively partisan; in contrast, a plan located in the 95th percentile is clearly extreme.

In all cases, moreover, the quantification of the degree of partisan bias provided by the extreme outlier standard will provide courts with a straightforward tool for assessing how far a plan goes. Previously, courts have had to rely upon necessarily imprecise verbal descriptions of a plan's allegedly partisan intent and effects.

Courts have experience drawing constitutional lines based upon mathematical data in the redistricting context. *See, e.g., Tennant v. Jefferson County Comm'n*, 567 U.S. 758 (2012); *Karcher v. Daggett*, 462 U.S. 725 (1983) (applying population data to population equality principles in congressional redistricting).

Eventually, this Court may choose to adopt a specific percentile threshold to define presumptively invalid levels of bias—much as it has done for population equality principles for state legislative redistricting. *See Brown v. Thomson,* 462 U.S. 835, 843-843 (1983) (applying a 10% threshold for presumptive violations). However, there is no need to do so now.

IV. DETERMINING A DISTRIBUTION OF OUTCOMES FROM A LARGE SAMPLE IS A COMMONLY USED AND RELIABLE COMPUTATIONAL PROCEDURE.

The extreme outlier standard requires comparing a State's chosen plan to the distribution of outcomes across all comparable plans that meet the State's declared goals. As described in this section, recent technological advances have finally made it feasible to perform such comparisons.

Indeed, modern computational methods make it possible, in a wide variety of settings, to determine the distribution of outcomes with good accuracy by obtaining and examining a large representative sample. Such methods are routinely used to solve critical national challenges. *See* Section IV.A, *infra.*

Further, in the past decade, various scholars have applied these methods to the evaluation of redistricting plans. *See* Section IV.B, *infra*.

A. The United States relies on computational analyses of distributions of outcomes for critical national needs, including national defense.

Almost immediately after computers were developed, scientists realized that they could be used to make accurate inferences about distributions of outcomes, even when the number of underlying possibilities is extremely large. In particular, these methods can be used to recognize whether an outcome is an extreme outlier.

The concept first arose in 1946 in the context of designing a hydrogen bomb.[16] As the power of modern computers has grown, a variety of computational methods have been developed for drawing a large sample that is representative of the entire universe of outcomes.[17]

The technology is now routinely applied to many critical real-world situations, including national defense, public safety, finance, and health. A few examples include:

• *Design of nuclear weapons, safety of nuclear weapons in storage, and safety of nuclear power plants*. As to weapons design, the computational analysis considers the vast number of paths that neutrons may take and assess the risk that 'criticality' will not occur. In the latter two cases, the analysis considers the risk that it *will* occur.[18]

• *Hurricane storm track prediction*. Methods called ensemble-based forecasting represent the distribution of possible outcomes in a 'cone of uncertainty;' this approach has enabled highly

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[16] Nicholas Metropolis, *The Beginning of the Monte Carlo Method*, 15 Los Alamos Sci. 125 (1987), available at http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-88-9067 (last visited Aug. 25, 2017).

[17] The initial techniques were called Monte Carlo methods, but many additional methods have been developed. See Christian Robert & George Casella, *Monte Carlo Statistical Methods* (2004); *Sequential Monte Carlo Methods in Practice*, (Arnaud Doucet, Nando de Freitas, & Neil Gordon eds., 2001); Andrew Gelman, et al., *Bayesian Data Analysis*, (3rd ed. 2013).

[18] Forrest B. Brown, *A Review of Best Practices for Monte Carlo Criticality Calculations*, Los Alamos Report LA-UR- 09-03136 (2009), available at https://mcnp.lanl.gov/pdf_files/la-ur-09-3136.pdf (last visited Aug. 25, 2017).

accurate assessments of which cities are safe and which are at risk.[19]

• *'Stress-testing' of large banks.* In the wake of the 2008 financial crisis, the Federal Reserve instituted its Supervisory Capital Assessment Program, which calculates the distribution of losses that can occur, to identify extreme outliers.[20]

Additional examples include conflict resolution in air traffic control,[21] safety of building structures under earthquake hazards,[22] and crashworthiness of automobiles.[23]

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[19] Thomas M. Hamill, et al., *NOAA's Future Ensemble-Based Hurricane Forecast Products*, 93 Bull. Amer. Meteor. Soc. 209 (2012); Jo Craven McGinty, *As Forecasts Go, You Can Bet on Monte Carlo*, Wall St. J., Aug. 12, 2016, available at https://www.wsj.com/articles/as-forecasts-go-you-can-bet-on-monte-carlo-1470994203 (last visited Aug. 25, 2017).

[20] Randy Heffernan, *Fed Uses Monte Carlo Simulation for Stress Test*, Risk & Decision Analysis News Blog, May 29, 2009, available at https://blog.palisade.com/2009/05/29/fed-uses-monte-carlo-simulation-for-stress-test/ (last visited Aug. 25, 2017); Board of Governors of the Federal Reserve System, *The Supervisory Capital Assessment Program: Design and Implementation*, Apr. 24, 2009, available at https://www.federalreserve.gov/newsevents/press/bcreg/bcreg20090424a1.pdf (last visited Aug. 25, 2017).

[21] Andrea Lecchini Visintini, et al., *Monte Carlo Optimization for Conflict Resolution in Air Traffic Control*, 7 IEEE Trans. Intell. Transp. Syst. 470 (2006).

[22] V. Bolotin, *Seismic Risk Assessment for Structures with the Monte Carlo Simulation*, 8 Probabilist. Eng. Mech. 169 (1993); Sinan Akkar & Yin Cheng, *Application of a Monte-Carlo Simulation Approach for the Probabilistic Assessment of Seismic Hazard for Geographically Distributed Portfolios*, 45 Earthq. Eng. Struct. D. 525 (2016).

[23] Stephen M. Summers & William T. Hollowell, *NHTSA's Crashworthiness Modeling Activities*, National

B. In the past decade, computational methods have been increasingly used to calculate the distribution of outcomes for possible redistricting plans.

For more than 50 years, scholars have recognized the wisdom of evaluating a proposed redistricting plan by comparing it to the universe of other possible plans. In 1967, Drs. James Thoreson and John Liittschwager programmed the University of Iowa's IBM 7044 digital computer to sample and evaluate 150 redistricting plans.[24] However, the computing power was so limited that their analysis could only be conducted at the level of counties, which is far above the level at which redistricting actually occurs. Various scholars sought to apply the approach in the 1970s and 1980s, but the technology was still inadequate to the task.[25]

The use of computers to *create* redistricting plans became a widespread practice in the 1990s and

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Highway Transportation Safety Administration, Paper #251 (2001), available at https://www-nrd.nhtsa.dot.gov/pdf/esv/esv17/proceed/00178.pdf (last visited Aug. 25, 2017).

[24] James D. Thoreson & John M. Liittschwager, *Computers in Behavioral Science: Legislative Districting by Computer Simulation*, 12 Syst. Res. Behav. Sci. 237 (1967).

[25] Yan Y. Liu, Wendy K. Tam Cho & Shaowen Wang, *PEAR: A Massively Parallel Evolutionary Computation Approach for Political Redistricting Optimization and Analysis*, 30 Swarm Evol. Comput. 78, 79 (2016); Wendy K. Tam Cho & Yan Y. Liu, *Toward a Talismanic Redistricting Tool: A Computational Method for Identifying Extreme Redistricting Plans*, 15 Election L.J. 351, 355-6 (2016); Micah Altman, Karin MacDonald & Michael McDonald, *From Crayons to Computers: The Evolution of Computer Use in Redistricting*, 23 Soc. Sci. Comput. Rev. 334, 335-7 (2005).

was ubiquitous in the 2000s—leading to the proliferation of extreme partisan gerrymandering.[26] But, the technology to *evaluate* redistricting plans lagged behind.

The situation has changed in the last decade, as computer technology has caught up with the problem that it spawned. The computing power available to professionals has increased by more than a million-fold in the past twenty-five years, owing to increases in processor speed and computer architectures that employ many processors in parallel.[27]

Multiple researchers have employed various computational methods to finally be able to evaluate redistricting plans by comparing them to a large sample of possible plans that respect a State's declared goals.

The field is maturing rapidly. There are many active scholars, including Dr. Wendy Cho of the University of Illinois;[28] Dr. Jonathan Mattingly of

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[26] Micah Altman, Karin MacDonald & Michael McDonald, *From Crayons to Computers: The Evolution of Computer Use in Redistricting*, 23 Soc. Sci. Comput. Rev. 334, 335-42 (2005); Micah Altman & Michael McDonald, *The Promise and Perils of Computers in Redistricting*, 5 Duke J. Const. L. & Pub. Pol'y 69, 78-9 (2010); Nicholas O. Stephanopoulos & Eric M. McGhee, *Partisan Gerrymandering and the Efficiency Gap*, 82 U. Chi. L. Rev. 831, 831 (2015).

[27] Peter J. Denning & Ted G. Lewis, *Exponential Laws of Computing Growth*, 60 Commun. ACM 54, 56 (2017).

[28] Wendy K. Tam Cho & Yan Y. Liu, *Toward a Talismanic Redistricting Tool: A Computational Method for Identifying Extreme Redistricting Plans*, 15 Election L.J. 351 (2016); Yan Y. Liu, Wendy K. Tam Cho & Shaowen Wang, *PEAR: A Massively Parallel Evolutionary Computation*

Duke University;[29] Drs. Jowei Chen of the University of Michigan, Dr. Jonathan Rodden of Stanford University, and Dr. David Cottrell of Dartmouth College;[30] and Dr. Michael McDonald of Binghamton University.[31] These experts have applied a wide range of computational algorithms and computer hardware to draw large, representative samples (containing hundreds to millions of plans), with consistent results. They have

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Approach for Political Redistricting Optimization and Analysis, 30 Swarm Evol. Comput. 78 (2016).

[29] Jonathan C. Mattingly & Christy Vaughn, *Redistricting and the Will of the People*, arXiv:1410.8796 (arXiv preprint 2014), available at: https://arxiv.org/pdf/1410.8796.pdf (last visited Aug, 28, 2017); Sachet Bangia, et al., *Redistricting: Drawing the Line*, arXiv:1704.03360 (arXiv preprint 2017), available at: https://arxiv.org/pdf/1704.03360.pdf (last visited Aug, 28, 2017).

[30] Jowei Chen & Jonathan Rodden, *Cutting Through the Thicket: Redistricting Simulations and the Detection of Partisan Gerrymanders*, 14 Election L. J. 331 (2015); Jowei Chen & David Cottrell, *Evaluating partisan gains from Congressional gerrymandering: Using computer simulations to estimate the effect of gerrymandering in the U.S. House*, 44 Elect. Stud. 329 (2016); Jowei Chen, *The Impact of Political Geography on Wisconsin Redistricting: An Analysis of Wisconsin's Act 43 Assembly Districting Plan*, 16 Election L. J. (forthcoming 2017), available at: http://www-personal.umich.edu/~jowei/Political_Geography_Wisconsin_Redistricting.pdf and https://doi.org/10.1089/elj.2017.0455 (last visited Aug, 28, 2017).

[31] Michael D. McDonald & Robin E. Best, *Unfair Partisan Gerrymanders in Politics and Law: A Diagnostic Applied to Six Cases*, 14 Election L. J. 312 (2015); Jonathan Krasno, et al., *Can Gerrymanders Be Measured? An Examination of Wisconsin's State Assembly* (forthcoming), available at SSRN: https://ssrn.com/abstract=2783144 (last visited Aug, 28, 2017).

applied their computer code to redistricting plans in various states—showing that some plans are comfortably within the normal range of plans, while others lie far outside the ordinary distribution of outcomes.

C. The use of computational analysis to compare a State's plan to the distribution of outcomes for comparable plans is practicable.

In the event of a court challenge to a particular redistricting plan, each party could run its own computational analysis. Computational methods have been published for determining the distribution of possible outcomes.[32] The relevant information is readily accessible.[33] So, too are computational resources, including through cloud computing.

Importantly, there is a *right* answer as to the degree of excessiveness of a State's chosen plan with respect to any metric, or set of metrics, of partisan outcome.

If the parties reached significantly different results concerning any metric of partisan outcome, they could present expert testimony challenging and

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[32] Yan Y. Liu, Wendy K. Tam Cho & Shaowen Wang, *PEAR: A Massively Parallel Evolutionary Computation Approach for Political Redistricting Optimization and Analysis*, 30 Swarm Evol. Comput. 78 (2016).

[33] Electronic maps of census geography and detailed population data from the latest decennial census are readily available. Precinct-level voting returns are public records. State legislatures often specify their goals before embarking upon redistricting, or at least in a report accompanying their redistricting plans. In some cases, those goals are contained in constitutional or statutory provisions.

supporting the premises and methodologies underlying any differences in constructing their various computer programs.

Moreover, the U.S. scientific community would predictably become involved, in the interest of assuring the accuracy and integrity of this quantitative approach. Indeed, the U.S. National Academy of Sciences has recently stated that it would convene scientific experts to assist in helping the scientific community reach consensus on performance measures.[34]

The process will provide a court with clear information concerning how far out on the distribution (i.e., in what percentile) the State's chosen plan lies.

V. WISCONSIN'S PLAN IN THIS CASE IS AN EXTREME OUTLIER.

Scholars have evaluated the Wisconsin redistricting plan, enacted in Act 43 in 2010, to determine whether it is an extreme outlier. This section briefly summarizes their findings.

In an article in the Election Law Journal, Dr. Jowei Chen of the University of Michigan compares Wisconsin's plan to the distribution of expected outcomes for a representative sample of 200 redistricting plans that accomplish Wisconsin's goals comparably to the State's own plan.[35] Specifically,

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[34] *See* National Academy of Sciences, *Statement on Analysis of Voting Redistricting Plans*, available at: http://www.nasonline.org/about-nas/leadership/speeches-statements-interviews-mcnutt.html (last visited Aug. 29, 2017).

[35] Jowei Chen, *The Impact of Political Geography on Wisconsin Redistricting: An Analysis of Wisconsin's Act 43*

the article shows that each of these plans scores higher than Wisconsin's chosen plan with respect to (i) compactness, (ii) number of counties preserved intact, and (iii) number of municipalities preserved intact.[36]

Yet, the number of Republican-leaning districts under the State's plan is much greater than under each of the 200 comparable plans. These data place Wisconsin's plan in the 99th percentile of the distribution.

The article also evaluates Wisconsin's plan with respect to the efficiency gap metric. It similarly shows that the plan has a more extreme efficiency gap than all of the 200 comparable plans.

In a recent technical report, Drs. Jonathan Mattingly and Gregory Herschlag also report an evaluation of Wisconsin's plan.[37] Their methodology differs in its details (with respect to the algorithms for drawing a representative sample, the size of the sample, and the electoral data used), but their conclusion is the same: Wisconsin's plan is an extreme outlier, lying in the 99th percentile of the distribution of comparable plans.

Assembly Districting Plan, 16 Election L. J. (in press, 2017), available at: http://www-personal.umich.edu/~jowei/Political_Geography_Wisconsin_Redistricting.pdf and https://doi.org/10.1089/elj.2017.0455 (last visited Aug, 28, 2017).

[36] The analysis in this paper is based on data from the 2012 election.

[37] Jonathan C. Mattingly & Gregory Herschlag, *Evaluating Partisan Gerrymandering in Wisconsin*, available at: https://services.math.duke.edu/~jonm/Redistricting/ (last visited Aug, 28, 2017).

These scholars analyzed a much larger sample, consisting of 19,184 redistricting plans. Figure 2 shows the distribution of expected partisan outcomes based on precinct-level data from the Wisconsin State Assembly election in 2012. Wisconsin's chosen plan is an extreme outlier, yielding a result that is more extreme than 99.4% of comparable plans—that is, it lies at the 99.4th percentile.

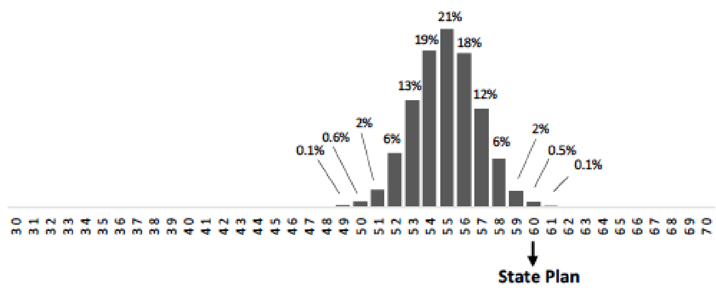

Figure 2. This figure shows results from an evaluation of Wisconsin's redistricting plan in this case, performed by Drs. Mattingly and Herschlag (see Section V). These scholars generated 19,184 representative plans that are comparable to Wisconsin's plan enacted under Act 43 in 2010. For each plan, they calculated the number of seats expected to be won by Republicans had the plan been used in the next State Assembly election, in 2012. The bars indicate the frequency of each outcome (with frequencies below 0.1% not shown). The State's plan, with an outcome of 60 seats, is an extreme outlier: it is more extreme than 99.4% of redistricting plans that accomplish Wisconsin's declared goals comparably to the State's plan.

The technical report does not only analyze the data for a single electoral outcome. It performs an extreme outlier analysis using data for the Wisconsin State Assembly elections in 2012, 2014 and 2016. For each election, it determines the expected partisan outcome for each of the 19,184 redistricting plans for the election result and for shifts around the result of up to 7.5%.

In each case, Wisconsin's chosen plan is an extreme outlier: its outcomes are more extreme than at least 99% of the comparable plans for each of 2012, 2014, and 2016.

VI. AN EXTREME OUTLIER STANDARD WOULD PROVIDE GUIDANCE TO THE PARTIES AND BOLSTER CONFIDENCE IN THE COURTS.

As argued in Section III.D, above, an extreme outlier standard would provide the courts with a previously unavailable basis "upon which to define clear, manageable and politically neutral standards for measuring the particular burden a given partisan classification imposes on representational rights." *Vieth,* 541 U.S. at 307-308 (Kennedy, J., concurring in the judgment).

In doing so, an extreme outlier standard would provide practical guidance to States with respect to the degree to which the pursuit of partisan bias in redistricting plans is constitutionally permissible.

Today, it is standard for redistricting software to generate population equality statistics for different plans as they are constructed. States' drafters use such information to be sure that a draft plan will comply with applicable population variance standards.

Similarly, many States would respond to an extreme outlier standard for partisan bias by evaluating draft redistricting plans while they were under consideration. In this way, these States would ensure that their enacted plans would be shielded from a successful court challenge. Moreover, potential challengers could also run their own evaluations to assess whether a plan would likely withstand challenge under this objective, quantitative standard. In both ways, the adoption of the proposed approach is likely to have the salutary effect of reducing partisan gerrymandering litigation.

Where such litigation was brought, the extreme outlier approach would tend to bolster public confidence in the courts.

In those cases where a court found that a plan *was* unconstitutionally partisan, the extreme outlier standard would help communicate the legitimacy of the decision and help to shield the court from claims of judicial activism. For example, the public could readily understand the legitimacy of court action striking down an extreme gerrymander that was objectively more partisan than, say, 90% of all possible plans that the State could have chosen and that comparably achieved the State's declared goals.

In short, an extreme outlier standard, by providing clear, objective and reliable quantitative information about the degree of partisan bias of a restricting plan, would bolster the perceived neutrality and legitimacy of the court's judgment.

CONCLUSION

For the reasons set forth above, this Court should endorse an extreme outlier standard, outlined above, as a judicially manageable standard for resolving claims of excessive partisan gerrymandering, and should hold that such claims, in light of that standard, are justiciable.

Respectfully submitted,

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Dated: August 31, 2017