No. 18-422

IN THE

Supreme Court of the United States

ROBERT A. RUCHO, ET AL.,

Appellants,

v.

COMMON CAUSE, ET AL.,

Appellees.

ON APPEAL FROM THE
UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF NORTH CAROLINA

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

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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 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 standard that would (i) enable courts to evaluate claims of excessive partisan gerrymandering by determining the extent to which a redistricting plan is an extreme outlier—at either the statewide level or individual district level—compared to the universe of possible redistricting plans compatible with the State's declared goals; (ii) provide guidance and reasonable leeway to States; and (iii) protect voters' constitutional rights.

Dr. Lander filed an *amicus curiae* brief in *Gill v. Whitford,* No.16-1161, that described how, in principle, extreme outlier analysis could provide a foundation for assessing claims of excessive partisan gerrymandering.

Understanding extreme outlier analysis is even more important here, because the plaintiffs in this case presented expert testimony applying extreme outlier analysis, and the District Court relied upon that testimony as part of the basis for its findings.

This brief explains the principles underlying the application of extreme outlier tests at both the statewide and district levels and the results of applying them to North Carolina's 2016 plan, as presented at trial.

SUMMARY OF THE ARGUMENT

This case presents the question of whether there exists any judicially manageable standard that would enable courts to determine when the partisan bias of a statewide redistricting plan, or any individual district within that plan, is so excessive as to render it unconstitutional.

There is no dispute that "excessive" partisan gerrymandering is both harmful and unconstitutional. In *Vieth v. Jubelirer,* 541 U.S. 267 (2004), all nine Justices of this Court agreed that, while *some* partisanship is permitted in redistricting, *excessive* partisan gerrymanders are incompatible with democratic principles and violate the Constitution.

The open question has been whether there exists any "judicially discoverable and manageable standards" for *recognizing* excessive partisan gerrymanders. *Vieth v. Jubelirer,* 541 U.S. 267, 277-278 (2004) (plurality opinion), quoting *Baker v. Carr,* 369 U.S. 186, 217 (1962). This Court has waited to see if such a standard might emerge from a deeper understanding of the process of gerrymandering.

In the past decade, advances in computer technology have now finally made it possible to apply a straightforward, objective and judicially manageable test—termed an 'extreme outlier test.' An extreme outlier standard is based on a simple principle: Just as political parties use computers to *create* excessive partisan gerrymanders by searching the universe of possible redistricting plans to find ones that impose an extreme burden on citizens who previously voted for an opposing party, one can use computers to *recognize* an excessive partisan gerrymander by seeing if its partisan impact is extreme *relative to the universe of possible plans*.

With modern computer technology, it is now straightforward to (i) generate a large collection of redistricting plans that are representative of all possible plans that meet the State's declared goals (e.g., compactness and contiguity); (ii) calculate the partisan outcome that would occur under each such plan, based upon actual precinct-level votes in one or more recent elections; (iii) display the distribution of the outcomes across these plans; and (iv) situate the State's chosen plan along that continuum to reveal the degree to which that plan is an outlier. One can analyze outcomes for a statewide plan as a whole, or for an individual district within a plan.

In this way, it is now straightforward to measure the *quantitative degree* to which a partisan gerrymander is *excessive.* For example, one can readily determine whether a redistricting plan is more extremely partisan (at a statewide level or for any individual district) than, say, 80%, 90%, 95%, or 99% of the possible plans from which the State might have chosen.

Notably, the Federal Government relies upon the same approach (testing whether a particular outcome is an extreme outlier among the distribution of all possible outcomes) in many critical real-world situations, including national defense, public safety, finance and health. Specific examples include the design of nuclear weapons, safety of nuclear weapons in storage, safety of nuclear power plants, hurricane storm track prediction, and stress testing of large banks, among others.

An extreme outlier standard avoids the criticisms that have been leveled at many previously proposed approaches. Specifically, it (i) is judicially discoverable, in that the test is inherent in the constitutional principle (to test whether a redistricting plan is *excessive*, determine the fraction of possible alternative plans that it *exceeds* with respect to its electoral outcome); (ii) is judicially manageable, in that it is an objective mathematical method that has a *right* answer; (iii) accounts for a State's natural political geography, including "natural packing"; and (iv) does not expect or enforce proportional representation.

An extreme outlier standard can be applied to statewide maps or to any individual district—making it applicable both to claims of associational harm under the First Amendment and to claims of vote dilution under the Fourteenth Amendment or Article I, § 2.

An extreme outlier standard would also provide guidance to the States about the degree to which a proposed redistricting plan is excessive and thus would be likely to minimize litigation.

This appeal is the first case in which this Court has had the opportunity to review a district court decision that incorporates an extreme outlier standard.

The District Court heard undisputed testimony from two experts who demonstrated that North Carolina's 2016 Plan is more extreme—at *both* the statewide level and the individual district level—than more than 99% of all possible plans that the State could have chosen.

Based in part on this and related testimony (as well as direct evidence of intent), the District Court properly found North Carolina's 2016 Plan and most of its districts to be unconstitutional as an excessive partisan gerrymander.

With technology having finally provided a straightforward, judicially discoverable and manageable standard for assessing excessiveness in partisan gerrymandering cases, the remaining question is: How extreme is *too* extreme?

This Court faced this same question in its legislative redistricting cases after *Baker v. Carr*, 369 U.S. 186 (1962): With respect to the population of legislative districts, how extreme a difference is too extreme?

There is, of course, no mathematically or constitutionally 'ordained' threshold—in either context.

In the 'one person, one vote' context, this Court adopted a presumptive threshold of 10% for allowable population differences among state legislative districts.

This Court may similarly someday choose to provide a presumptive threshold for how extreme a redistricting plan may be (say, not more extreme than 80%, or 90%, or 95% of all possible plans).

However, there is no need to do so at this time, because the redistricting plan in this case is *so extreme* as to exceed any plausible threshold.

ARGUMENT

I. ADVANCES IN TECHNOLOGY NOW PROVIDE A STRAIGHTFORWARD, JUDICIALLY MANAGEABLE STANDARD FOR RECOGNIZING EXCESSIVE PARTISAN GERRYMANDERS

There is no dispute that "excessive" partisan gerrymandering is both harmful and unconstitutional. Indeed, all nine Justices of this Court in *Vieth v. Jubelirer,* 541 U.S. 267 (2004), agreed that, while *some* partisanship is permitted in redistricting, *excessive* partisan gerrymandering is incompatible with democratic principles and violates the Constitution.

The open question has been whether the issue is justiciable — that is, whether there exist "judicially discoverable and manageable standards" for *recognizing* excessive partisan gerrymanders. *Vieth v. Jubelirer,* 541 U.S. 267, 277-278 (2004) (plurality opinion), quoting *Baker v. Carr,* 369 U.S. 186, 217 (1962).

This Court has waited to see if such a standard might emerge from a deeper understanding of the process of partisan gerrymandering.

Justice Kennedy, in *Vieth*, expressed hope that new technologies "may produce new methods of analysis that make more evident the precise nature of the burdens 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 313 (Kennedy, J., concurring in the judgment).

In the past decade, advances in computer technology have now made it possible to apply a straightforward, objective and judicially manageable test—termed an 'extreme outlier test'—to enable courts to decide when a statewide redistricting plan or an individual district is so excessively partisan as to be unconstitutional.

An extreme outlier standard is based on a simple principle: Just as political parties use computers to *create* excessive partisan gerrymanders by searching the universe of possible redistricting plans to find ones that impose an extreme burden on citizens who previously voted for an opposing party, one can use computers to *recognize* an excessive partisan gerrymander by seeing if its partisan impact is extreme *relative to the universe of possible plans*.

While the principle is simple, it has not been feasible to apply it in practice—until recently. In the past decade, however, advances in computer technology have made it straightforward to *measure the quantitative degree to which a partisan gerrymander is excessive.* For example, one can readily determine whether a redistricting plan is more extremely partisan than, say, 80%, 90%, 95%, or 99% of the possible plans from which the State might have chosen.

In effect, computer technology has finally caught up with the electoral problem it created.

Importantly, an extreme outlier standard can be applied to statewide maps or to any individual district—making it applicable both to claims of associational harm under the First Amendment and to claims of vote dilution under the Fourteenth Amendment or Article I, § 2.

II. EXCESSIVELY PARTISAN GERRYMANDERS ARE CREATED BY USING COMPUTER TECHNOLOGY TO FIND EXTREME OUTLIERS

Partisan gerrymandering seeks to draw voting districts to "subordinate adherents of one political party and entrench a rival party in power." *Ariz. State Leg. v. Ariz. Indep. Redistricting Comm'n*, 135 S. Ct. 2652, 2658 (2015).

To do so, parties use information about voters' political affiliations based on their political expression in recent elections. Typically, the approach involves two steps:

(i) for each voting precinct, examine the partisan outcomes in one or more recent elections (that is, the number of voters who supported each party); and

(ii) based on these data, aggregate the precincts into new districts to create a redistricting plan with a number of 'packed' districts, in which the proportion of voters who previously supported an opposing party is unusually high, and a larger number of 'cracked' districts, in which the proportion of voters who previously supported the opposing party is unusually low.

Compared to the vast majority of possible redistricting plans compatible with a State's declared objectives (such as compactness and contiguity), the resulting plan is chosen to be an extreme outlier at both the district level and the statewide level.

At the district level, cracking aims to burden political opponents by assigning many of them to districts in which their proportion—and thus their chance of electing a representative from their preferred party—is much lower than would be the case under the vast majority of possible redistricting plans.

At the statewide level, cracking and packing aim to burden political opponents by creating a redistricting plan under which they are assigned to legislative districts designed to ensure that they elect as few representatives as possible.

Currently, partisan gerrymandering uses precinct-level data from recent elections because it is readily available and, empirically, tends to be predictive of future political outcomes.[1]

Increasingly, it is becoming simple to profile *individual voters*—based on website usage, search queries, social media and purchasing decisions—to predict their partisan associations with even greater accuracy than previously possible. In the future, political parties will thus increasingly have data that

[1] For example, the Legislature's expert mapping consultant, Dr. Thomas Hofeller, testified that past voting behavior, as reflected in past election results, is the best predictor of future election success. Ex. 2037. Past election data have become the industry standard for predicting the partisan performance of a districting plan. JS App-11-12; *see also* JS App-175-177.

would allow them to discriminate against their opponents not just at the level of precincts, but at the level of city blocks, houses, apartments and individual persons.

If this Court finds that claims of excessive partisan gerrymandering are non-justiciable, partisan gerrymandering will likely become even more sophisticated, extreme and targeted.

III. IN ITS 2016 PLAN, NORTH CAROLINA SOUGHT TO CREATE AN EXTREME PARTISAN GERRYMANDER

There is no dispute among the parties that, in creating its 2016 Plan, North Carolina sought to create an extreme partisan gerrymander.

As the District Court found, the North Carolina General Assembly set the following criteria for its mapmakers:

(i) use population data and election results from the 2010 and 2014 mid-term elections;

(ii) aim to create districts with equal population, compactness and contiguity; and

(iii) aim to create districts that ensure that the congressional delegation will have 10 Republicans and 3 Democrats.

When asked about the third criterion, Representative David Lewis, co-chair of the General Assembly's Joint Select Committee on Congressional Redistricting, said that he "propose[d] that [the Committee] draw the maps to give a partisan advantage to 10 Republicans and 3 Democrats because [he] d[id] not believe it [would be] possible to draw a map with 11 Republicans and 2 Democrats." Ex. 1005. at 50:7–10.

To follow these instructions, the General Assembly's expert mapping consultant examined a wide range of possible redistricting plans to find one that was as extreme as possible.

The 2016 Plan achieved the stated goal. While Republican candidates received 53% of the statewide vote, they prevailed in 10 of the 13 (77%) congressional districts.

The question is thus not whether North Carolina *sought* to adopt an extreme partisan gerrymander. Appellants have effectively conceded that they did.[2]

Rather, the issue is whether there is a judicially manageable standard that courts can use to *objectively determine* whether North Carolina adopted an extreme partisan gerrymander.

As described in the next section, there now is such a standard.

IV. AN EXTREME OUTLIER TEST CAN RECOGNIZE EXCESSIVELY PARTISAN GERRYMANDERS BY APPLYING THE SAME TECHNOLOGY USED TO CREATE THEM

Just as extreme partisan gerrymanders are *created* by examining a large number of possible redistricting plans to find an extreme outlier, an extreme partisan gerrymander can now be *recognized* by determining how extreme the plan is when

[2] *See also* JS App-157-159.

compared to a large collection of plans sampled at random from the universe of all possible plans consistent with a State's declared redistricting goals (e.g., compactness and contiguity).

With modern computer technology, it is straightforward to (i) generate a large collection of redistricting plans that are representative of all possible plans that meet the State's declared goals (e.g., compactness and contiguity); (ii) calculate the partisan outcome that would occur under each such plan, based upon actual precinct-level votes in one or more recent elections; (iii) display the distribution of the outcomes across these plans; and (iv) situate the State's chosen plan along that continuum to reveal the degree to which that plan is an outlier. One can analyze outcomes for a statewide plan as a whole, or for an individual district within a plan.

As described in Section VII *infra*, the approach of randomly sampling from a universe of outcomes to identify extreme outliers is routinely used by the Federal Government for a wide range of critical national needs, including national defense, the safety of nuclear power plants and hurricane storm track predictions.

To illustrate the concept: A State's plan might be compared to a collection of 10,000 plans sampled randomly from the universe of all possible plans that meet the State's redistricting criteria.[3,4]

For each district in each of those 10,000 plans, one can calculate the total number of Republican and Democratic votes that would have been cast in that district if the plan had been used in any recent election—by simply adding up the votes that were cast in each precinct assigned to the district under the plan.

This information can then be used to analyze the State's plan at the statewide or individual district level. making it applicable both to claims of associational harm under the First Amendment and to claims of vote dilution under the Fourteenth Amendment or Article I, § 2.

(i) Statewide analysis. A statewide analysis asks: Is the State's plan an extreme outlier with respect to the *overall number of representatives* elected by voters associated with a given political party?

To answer the question, one compares the overall electoral outcome (the total number of districts won by the party) under the State's plan to the outcome under each of the 10,000 plans.

Suppose, for example, that the State's plan resulted in 3 Democratic representatives, but only 20 of the 10,000 randomly sampled plans resulted in an

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[3] The precise size does not matter provided that it is large enough, which one can confirm by checking that results remain essentially the same when the size is increased.

[4] Methods for drawing random samples, representative of a large distribution of outcomes, are well developed in computational analysis; see Section VII *infra*.

outcome this low. Then, the State's plan would be more extremely partisan than 99.8% of all possible redistricting plans.

(ii) District analysis. A district-level analysis asks: Is a *particular district* in the State's plan an extreme outlier with respect to the proportion of voters associated with a given political party? The proportion may be either extremely high (packing) or low (cracking).

One can answer the question for a particular district by comparing the proportion of voters associated with the party in the district in the State's plan to the proportion in the corresponding district in each of the 10,000 plans.[5,6]

Suppose, for example, a particular district in the State's plan has the fourth highest proportion of Democrats, with the proportion being, say, 46%. If the proportion of Democrats in the fourth highest district was 46% or less in 50 of the 10,000 plans, then the State's plan would impose a burden (in terms of vote dilution of Democratic voters in this district) more extreme than in 99.5% of possible plans.

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[5] Here, the corresponding district means the district with the same rank in terms of proportion of voters associated with the party.

[6] The question can also be answered by considering the impact on each individual precinct within a district—by comparing the district containing the precinct in the State's plan to the district containing that precinct in each of the 10,000 sampled plans—to see if it is an extreme outlier with respect to the proportion of voters associated with a given political party (that is, packing and cracking).

V. THE DISTRICT COURT PROPERLY APPLIED AN EXTREME OUTLIER STANDARD TO NORTH CAROLINA'S 2016 PLAN

In a four-day trial held in October 2017, the District Court heard expert testimony by two computational scholars, Dr. Jonathan Mattingly of Duke University and Dr. Jowei Chen of the University of Michigan, who had each published extensively on the use of computational analysis to determine the extent to which redistricting plans are extreme outliers. Both experts applied extreme outlier tests to North Carolina's 2016 Plan, and each reached effectively identical conclusions.

The discussion below focuses on the analyses performed by Dr. Mattingly, who examined a sample of 24,518 plans. The work was described in his deposition and testimony at trial—as well as in his expert's report and an academic article,[7] about both of which he testified in deposition and at trial.[8]

Dr. Chen performed similar analyses, using a sample of 3,000 plans, and reached the same conclusions concerning the extent to which North Carolina's 2016 Plan is an extreme outlier.

(i) Statewide analysis. Dr. Mattingly compared the number of Democratic representatives that would have been elected under North Carolina's 2016 Plan

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[7] Sachet Bangia et al., *Redistricting: Drawing the Line*, arXiv:1704.03360v2 (arXiv preprint 2017), available at: https://arxiv.org/pdf/1704.03360.pdf (last visited Feb. 25, 2019).

[8] JA-345-362 (Excerpts from Jonathan Mattingly PowerPoint Demonstrative), 364-392 (Excerpts from Transcript of Bench Trial, Direct Examination of Dr. Jonathan Mattingly).

versus under each of the 24,518 sampled plans. The analyses were performed using precinct-level results from both the 2016 and 2012 elections.

The results, shown in Figure 1, clearly demonstrate that North Carolina's 2016 Plan is an extreme outlier.

Based on data from the 2016 election, the outcome of the State's Plan (only three Democrats elected in a plan with 13 districts, despite Democrats receiving 47% of votes statewide) was more extreme than for 99.3% of the 24,518 sampled plans.

Based on data from the 2012 election, the outcome of the State's Plan (in that case, four Democrats elected in a plan with 13 districts[9]) was more extreme than for 99.7% of the 24,518 sampled plans.

Interestingly, Dr. Mattingly also applied the extreme outlier test to a redistricting plan that had been drawn by a bipartisan panel of retired North Carolina justices and judges in August 2016 ("Judges' Plan").[10] In contrast to North Carolina's Plan, the Judges' Plan was not an extreme outlier. To the

[9] The statewide Democratic vote in the 2012 House election was higher than in 2016 (51% vs. 47%).

[10] *See Nonpartisan Redistricting Panel Reveals Unofficial NC Congressional Voting Map,* available at: https://sanford.duke.edu/articles/nonpartisan-redistricting-panel-reveals-unofficial-nc-congressional-voting-map (last visited Feb. 25, 2019).

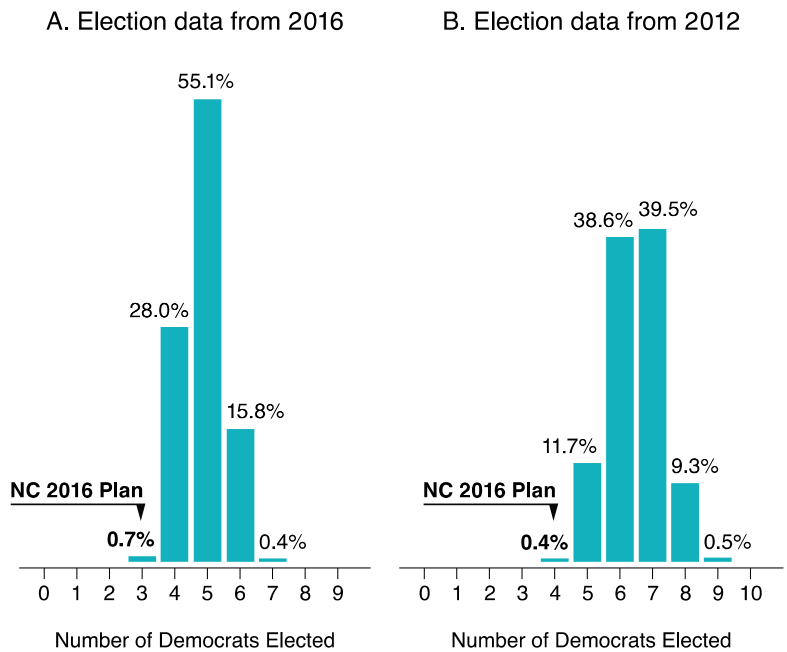

Figure 1. Extreme Outlier Test: Statewide. The figure compares the total number of Democrats elected statewide under North Carolina's 2016 Plan to the total number that would be elected under each of the 24,518 plans sampled from the universe of possible redistricting plans. (Panels A and B show results based on the precinct-level results for the 2016 and 2012 election, respectively.)

Panel A, for example, shows that 0.7%, 28%, 55.1%, 15.8% and 0.4% of the 24,518 plans result in 3, 4, 5, 6, and 7 Democratic districts, respectively. North Carolina's 2016 Plan resulted in 3 Democratic districts.

(The figure has been redrawn, for clarity, from the data in Common Cause Plaintiffs' Exh. 3040, JA-353 and JA-345.)

contrary, it was squarely in the middle of the distribution.[11]

(ii) District-level analysis. Dr. Mattingly sorted North Carolina's 13 districts in increasing order of the proportion of Democratic voters. He then compared these proportions in each district to the proportion in the comparably ranked district in each of the 24,518 sampled plans.

Based on data from the 2016 election, the results, shown in Figure 2, clearly demonstrate that North Carolina's Plan is an extreme outlier at the district level for at least six districts.

The top three districts (NC-1, NC-4, NC-12) show *extreme packing*. The proportion of Democratic voters in these districts is *higher* than in, respectively, 99.7%, 100% and 100% of the 24,518 sampled plans.[12]

The next three districts (NC-13, NC-2, NC-9) show *extreme cracking*. The proportion of Democratic voters in these districts is *lower* than in, respectively, 100%, 99.9% and 99.8% of the 24,518 sampled plans.[13] The State's plan thus imposed more extreme vote dilution on the Democratic voters in these districts than in virtually all other alternative plans.

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[11] For the Judges' Plan, the result was equal to the median of the distribution based on data from the 2012 election and differed by one from the median of the distribution based on data from the 2016 election. JA-341.

[12] The aggregate proportion of Democratic voters in these three districts is *higher* than in *all* of the 24,518 sampled plans—showing extreme packing.

[13] The aggregate proportion of Democratic voters in these three districts is *lower* than in *all* of the 24,518 sampled plans—showing extreme cracking.

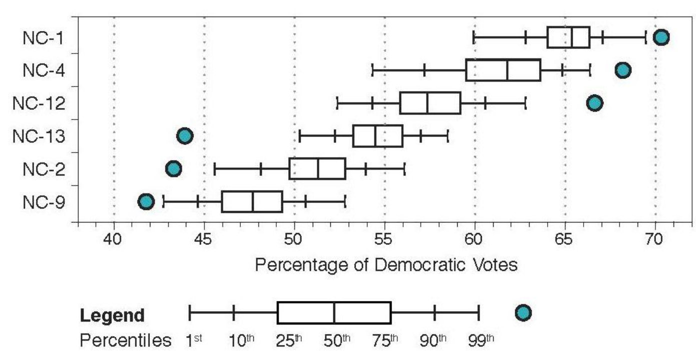

Figure 2. Extreme Outlier Test: Individual districts. The figure shows an extreme outlier test applied to the six districts with the highest proportion of Democratic voters (*NC-1, NC-4, NC-12, NC-13, NC-2, NC-9).*

For each of the individual districts, the plot shows the proportion of Democratic voters under North Carolina's 2016 Plan (blue circle) and the percentiles for the corresponding districts in each of the 24,518 plans sampled from the universe of possible redistricting plans. (The leftmost and rightmost bars indicate the 1^{st} and 99^{th} percentiles.)

For North Carolina's 2016 Plan, the first three districts are in the highest 1% of plans (extreme *packing*). The proportion is *higher* than in, respectively, 99.7%, 100%, and 100% of the sampled plans. The next three districts are in the lowest 1% of plans (extreme *cracking*). The proportion is *lower* than in, respectively, 100%, 99.9% and 99.8% of the sampled plans.

(The figure is redrawn, for clarity, from the data in Common Cause Plaintiffs' Exh. 3040, JA-357. The figure has been rotated, and bars at the 0^{th} and 100^{th} percentiles have been replaced by bars at the 1^{st} and 99^{th} percentiles.)

Dr. Mattingly obtained similar results based on data from the 2012 election, with seven districts being more extreme than 99% of the sampled plans.[14]

The same conclusions are reached when districts are analyzed at the level of the individual precincts contained within them.[15]

The General Assembly did not dispute that its intention was to produce a partisan gerrymander designed to ensure that 10 Republicans would be elected. Nor did it dispute the experts' analysis that the 2016 Plan was more extreme than more than 99% of all possible plans.

The District Court carefully considered and explicitly cited the analysis of the expert witnesses showing that North Carolina's 2016 Plan is an extreme outlier, as part of reaching its conclusion that the plan—at both the statewide level[16] and at the

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[14] JA-349.

[15] Dr. Mattingly subsequently published an extreme outlier analysis based on considering the individual precincts within each district, as described in footnote 6. It similarly shows that the 2016 Plan is an extreme outlier: In that plan, 233 of the 2,692 precincts are subject to packing or cracking more extreme than in more than 99% of the 24,518 sampled plans. (In most of the sampled plans, the number of such precincts does not exceed four.) *See* Jonathan Mattingly, *Localized view of Quantifying Gerrymandering*, Quantifying Gerrymandering (2019) available at https://sites.duke.edu/quantifyinggerrymandering/2019/03/04/localized-view-of-quantifying-gerrymandering/ (last visited Mar. 4, 2019).

[16] *See* JS App-120-121; 127-129; 131-132; 159-171; 181-187; 209-211.

level of many individual districts[17]—is an extreme partisan gerrymander that violates the Constitution.

VI. AN EXTREME OUTLIER STANDARD IS NOT SUSCEPTIBLE TO CRITICISMS THAT HAVE BEEN LEVELLED AT SOME PREVIOUSLY PROPOSED APPROACHES

An extreme outlier standard is not susceptible to criticisms that have been levelled at some approaches that have been used in partisan gerrymandering cases.[18] In particular, an extreme outlier standard (i) is judicially discoverable and manageable, (ii) employs an objective, well-established mathematical method, with a *right* answer, (iii) accounts for a State's actual political geography, and (iv) does not expect or enforce proportional representation.

A. An extreme outlier standard is judicially discoverable and manageable.

An extreme outlier standard is judicially discoverable in the sense that it flows directly from the constitutional principle at issue.

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[17] *See* JS App-230; 235-236; 240-241; 247-248; 254-255 and 258-259; 269; 272-273.

[18] Chief Justice Roberts has expressed concern that some approaches involving political-science metrics were of questionable relevance or reliability ("sociological gobbledygook"). Transcript of Oral Argument, *Gill v. Whitford*, No. 16-1161 (Oct. 3, 2017) at 40. Such concerns would not apply to an extreme outlier test, which directly measures excessiveness and which the Federal Government and others have successfully relied upon in critical situations for many decades.

In *Baker v. Carr*, 369 U.S. 186 (1962), for example, this Court found that claims of excessive population differences between legislative districts are justiciable, and in *Reynolds v. Sims,* 377 U.S. 533 (1964), this Court held that the Constitution requires substantially equal legislative representation for all citizens in a State regardless of where they reside. 377 U.S. at 565.

In those cases, the constitutional problem (excessive population differences between districts) implied a natural judicial standard for recognizing it (measuring how excessive the differences are).

The remaining issue was to decide, in any given case, whether the population difference between districts was *too* excessive.

No mathematically 'ordained' threshold is set forth or inherent in the Constitution concerning when population differences between districts are too excessive. However, this Court adopted a reasonable threshold to make the standard readily manageable.

With respect to state legislative districts, this Court held that, as a general matter, an apportionment plan with a maximum population range under 10% falls within the category of minor deviations, but a plan with larger disparities requires justification by the State. *See, e.g.*, *Voinovich v. Quilter,* 507 U.S. 146 (1993); *Gaffney v. Cummings,* 412 U.S. 735 (1973).[19]

[19] With respect to *congressional* districts, Art. I, § 2, provides that representatives be chosen "by the People of the several States," thus requiring population equality as nearly as is practicable; the State must demonstrate that any population deviations were necessary to achieve some legitimate state

Similarly, this Court has long agreed that *excessive* partisan gerrymandering violates the Constitution. The constitutional problem (excessive partisan gerrymandering) implies the natural judicial standard for recognizing it (measuring the *excessiveness* of a gerrymander).

To measure excessiveness, the extreme outlier test compares a putative gerrymander to all possible redistricting plans compatible with the State's declared goals. (This quantitative measure could, of course, be combined with other factors—such as direct evidence of legislative intent, as in this case.)

Concerning the degree of excessiveness, this Court might someday choose, after the benefit of some experience, to provide a presumptive threshold for excessive partisan gerrymandering—just as it did for legislative redistricting cases after *Baker v. Carr*.

As with the 'one-person, one-vote' standard, there is no constitutionally 'ordained' threshold for excessive partisan gerrymandering.

At present, however, there is no need for this Court to adopt a presumptive threshold, because North Carolina's 2016 Plan is *so extreme* in its partisan bias as to exceed any plausible threshold.

B. An extreme outlier standard employs an objective mathematical approach, with a *right* answer.

An extreme outlier standard concerns a straightforward, quantitative mathematical question

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objective. *See Tennant v. Jefferson Cty. Comm'n*, 567 U.S. 758, 763 (2012); *Karcher v. Daggett,* 462 U.S. 725 (1983).

to which there is a *right* answer: What fraction of redistricting plans are less extreme than the plan?

Extreme outlier analysis belongs to a well-established field and, as described in Section VII *infra*, the method is widely used by the Federal Government for a wide range of critical needs, including national defense and public safety.

If a redistricting plan were to be challenged, each interested party could run its own analysis, using readily available data, methods and cloud computing resources.

In the unlikely event that the parties reached meaningfully different answers, they could present testimony challenging and supporting the methodologies.

Given that extreme outlier tests are widely used throughout science—including for national defense and other critical national needs, the U.S. scientific community would rapidly become involved in resolving any methodological disagreement.

Indeed, the U.S. National Academy of Sciences has publicly announced that it would convene scientific experts to assist in helping the scientific community reach consensus with respect to the analysis of redistricting plans.[20]

Courts could rest assured that meaningful methodological disputes will not persist. The field will rapidly settle on standard and reliable methods.

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[20] *See Statement on Analysis of Voting Redistricting Plans*, available at: http://www.nasonline.org/about-nas/leadership/speeches-statements-interviews-mcnutt.html (last visited Feb. 19, 2019).

C. An extreme outlier standard accounts for a State's actual political geography.

An extreme outlier standard accounts for a State's actual political geography, because it compares a redistricting plan to the universe of all possible redistricting plans drawn on the same political geography.

If Democrats are overrepresented in cities, this condition will affect the universe of all possible redistricting plans—resulting in most plans having some degree of "natural" packing.

For a plan to be an extreme *outlier*, it must be extreme relative to the universe of all possible plans.

D. An extreme outlier standard does not expect or enforce proportional representation.

This Court has been clear that the Constitution does not require proportional representation.[21]

Notably, an extreme outlier standard does not consider in any way whether a plan achieves proportional representation.

To the contrary, an extreme outlier standard *expects* that representation will be non-proportional whenever there is "natural" packing.

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[21] "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." *Davis v. Bandemer,* 478 U.S. 109 (1986) at 130 (plurality opinion) (citations omitted).

VII. THE UNITED STATES RELIES ON AN EXTREME OUTLIER APPROACH FOR A WIDE RANGE OF CRITICAL NEEDS, INCLUDING NATIONAL DEFENSE

An extreme outlier standard for excessive partisan gerrymandering would be analogous to extreme outlier approaches used in many other settings.

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.[22] 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 an entire universe of outcomes.[23]

The technology is now routinely applied to many critical real-world situations, including

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[22] 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 Feb. 19, 2019).

[23] 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).

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 fail to occur. In the latter two cases, the analysis considers the risk that it *will* occur.[24]

• *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 accurate assessments of which cities are safe and which are at risk.[25]

• *'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

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[24] 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 Feb. 19, 2019).

[25] 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 Feb. 19, 2019).

that can occur, to identify extreme outliers.[26] Stress tests continue to be applied.[27]

Additional examples include conflict resolution in air traffic control,[28] safety of building structures under earthquake hazards,[29] and crashworthiness of automobiles.[30]

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[26] 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 Feb. 19, 2019); 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 Feb. 19, 2019).

[27] *See OCC Releases Dodd-Frank Act Stress Test Scenarios for 2019*, available at: https://www.occ.treas.gov/news-issuances/news-releases/2019/nr-occ-2019-13.html (last visited Feb. 25, 2019).

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

[29] 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).

[30] Stephen M. Summers & William T. Hollowell, *NHTSA's Crashworthiness Modeling Activities*, National Highway Transportation Safety Administration, Paper #251 (2001), available at https://www-nrd.nhtsa.dot.gov/pdf/esv/esv17/proceed/00178.pdf (last visited Feb. 19, 2019).

VIII. OVER THE PAST DECADE, EXTREME OUTLIER APPROACHES HAVE BECOME INCREASINGLY APPLIED TO ASSESS 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.[31] 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.[32]

The use of computers to *create* redistricting plans became a widespread practice in the 1990s and was ubiquitous in the 2000s—leading to the

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

[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, 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).

proliferation of extreme partisan gerrymandering.[33] 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.[34]

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.

Over the past decade, the field has matured rapidly. There are many distinguished computational scientists actively applying extreme outlier methods, including Dr. Jonathan Mattingly of Duke University;[35] Dr. Jowei Chen of the University of

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[33] 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).

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

[35] 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 Feb. 19, 2019); Sachet Bangia, et al., *Redistricting:*

Michigan, Dr. Wendy Cho of the University of Illinois; [36] Dr. Jonathan Rodden of Stanford University, and Dr. David Cottrell of Dartmouth College; [37] and Dr. Michael McDonald of Binghamton

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Drawing the Line, arXiv:1704.03360 (arXiv preprint 2017), available at: https://arxiv.org/pdf/1704.03360.pdf (last visited Feb. 19, 2019); Gregory Herschlag, Robert Raviera, and Jonathan C. Mattingly, *Evaluating Partisan Gerrymandering in Wisconsin*, arXiv:1709.01596v1 (arXiv preprint 2017), available at: https://arxiv.org/pdf/1709.01596.pdf (last visited Feb. 25, 2019); Sachet Bangia, et al., *Quantifying Gerrymandering in North Carolina*, arXiv:1801.03783v1 (arXiv preprint 2018), available at: https://arxiv.org/pdf/1801.03783.pdf (last visited Feb. 25, 2019)

[36] 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 Approach for Political Redistricting Optimization and Analysis*, 30 Swarm Evol. Comput. 78 (2016); Wendy K. Tam Cho & Yan Y. Liu, *Sampling from complicated and unknown distributions: Monte Carlo and Markov Chain Monte Carlo methods for redistricting*, 506 *Physica A* 170 (2018.

[37] 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. (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 Feb. 19, 2019).

University.[38] As noted above, the first two of these experts testified in the case before this Court.

These scientists have 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.

Notably, the results have been consistent even when experts use different computational algorithms and computer hardware to draw large, representative samples—exactly as one would expect for a mathematical analysis when properly performed.

While the extreme outlier methodology has become firmly established over the past decade, this case is the first in which the Court has had the opportunity to consider its application to partisan gerrymandering.

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

An extreme outlier standard would provide practical guidance to States with respect to whether they have overstepped the bounds in pursuit of partisan advantage.

Many States would routinely evaluate draft plans under consideration to assess the degree to

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[38] 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 Detected? An Examination of Wisconsin's State Assembly*, Am. Polit. Res. (2018).

which they are excessive. In this way, States could ensure that their enacted plans would be shielded from a successful court challenge.

Similarly, potential challengers could 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 would likely have the salutary effect of reducing litigation.

Where such litigation was brought, the objective nature of 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 clear, impartial and reliable nature of the extreme outlier standard could help communicate the legitimacy of the decision and thus 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 biased 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, at either the statewide or district level, 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 as a judicially manageable standard for resolving claims of excessive partisan gerrymandering, and should hold that, in light of that standard, such claims are justiciable.

Respectfully submitted,

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