

# Maps and cartograms of the 2004 US presidential election results

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Conventional maps of election results can give a misleading picture of the popular support that candidates have because population is highly non-uniform and equal areas on a map may not correspond to equal numbers of voters. Taking the example of the 2004 United States presidential election, we show how this problem can be corrected using a cartogram—a map in which the sizes of regions such as states are rescaled according to population or some other variable of interest.

On November 2, 2004, the day of the United States presidential election, and in the months since then, many of us will have seen maps of the election results in which each state is colored (conventionally) red or blue to indicate whether more of their voters voted for the Republican presidential candidate (George W. Bush) or for the Democratic candidate (John F. Kerry) respectively. We show such a map in Fig. 1 [1]. The map gives the superficial impression that the “red states” dominate the country, since they cover far more area than the blue ones. However, as has frequently been pointed out, this is misleading because the red states tend to have small populations, whereas many of the blue states have large ones. The blue may be small in area, but they are large in terms of numbers of people, which is what matters in an election.

We can correct for this by making use of a *cartogram*, a map in which the sizes of states have been rescaled according to their population. That is, states are drawn with a size proportional not to their sheer topographic acreage—which has little to do with politics—but to the

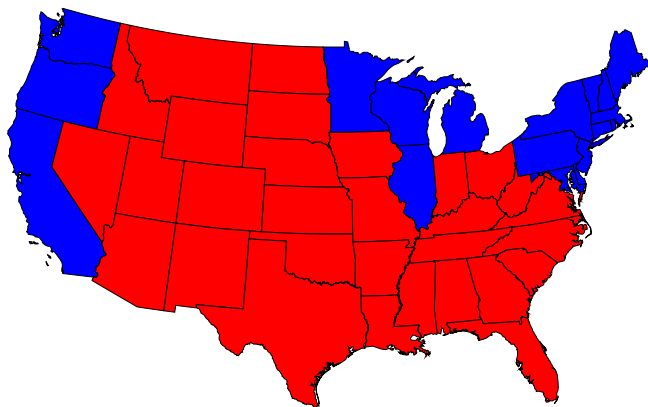


FIG. 1: The standard red and blue map of the results of the 2004 US Presidential election. The (lower 48) states are colored red if more voters voted for the Republican candidate than any other, and blue if more voters voted for the Democratic candidate than any other. (Because a small percentage of votes were taken by third-party candidates, this is not quite the same as saying a majority of voters voted Republican or Democrat.)

number of their inhabitants, states with more people appearing larger than states with fewer, regardless of their actual area on the ground. Thus, on such a map, the state of Rhode Island, which has about a million inhabitants, would appear twice the size of Wyoming, which has half a million, even though Wyoming has 60 times the acreage of Rhode Island.

Figure 2 shows the presidential election results on a cartogram of this type. The cartogram was made using the diffusion-based method of Gastner and Newman [2] with a grid resolution of  $4096 \times 2048$  points. Population data were taken from the 2000 US Census.

The cartogram reveals what we know already from the news: that the country was quite evenly divided by the vote, rather than being dominated by one side or the other.

The presidential election is not decided on the basis of the number of people who vote for each candidate, however, but on the basis of the electoral college. Each state contributes a certain number of electors to the electoral college, who vote according to the majority in their state [3]. The candidate receiving a majority of the votes in the electoral college wins the election. The electoral votes are apportioned among the states roughly according to population, as measured by the census, but with a small but deliberate bias in favor of less populous states.

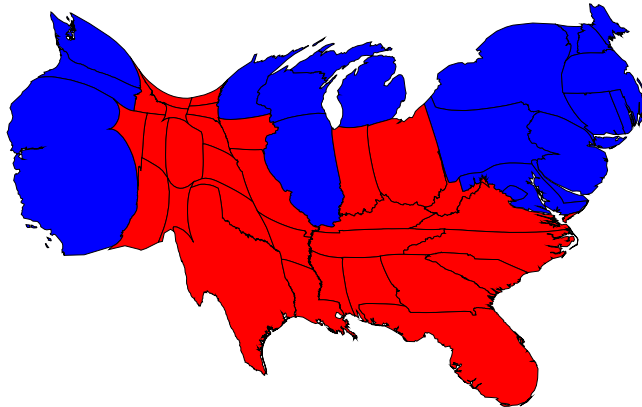


FIG. 2: A cartogram in which the sizes of states are proportional to the states’ populations.

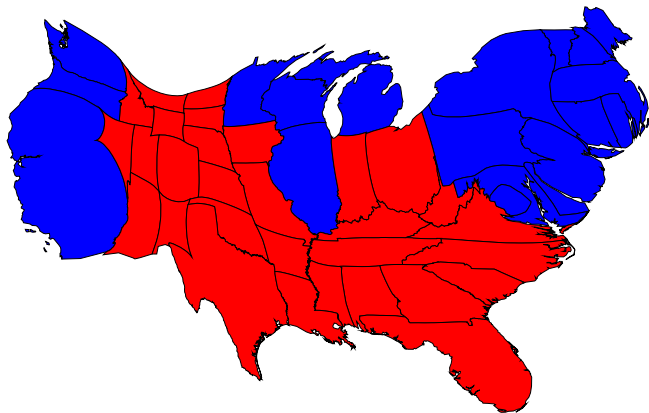


FIG. 3: A cartogram in which the sizes of states are proportional to the number of votes they have in the electoral college.

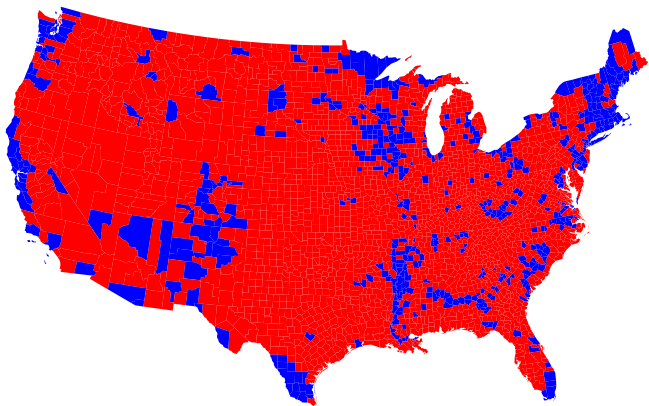


FIG. 4: A map of the counties of the United States, again colored red and blue to indicate Republican or Democratic pluralities.

We can represent the effects of the electoral college by scaling the sizes of states to be proportional to their number of electoral votes. The result is shown in Fig. 3. This figure looks similar to Fig. 2, but it is not identical. Wyoming, for instance, has approximately doubled its size, precisely because of the bias in favor of states with smaller populations.

The areas of red and blue on the cartogram are now proportional to the actual numbers of electoral votes won by each candidate. Thus this map shows simultaneously which states went to which candidate and also which candidate won more votes—something that you cannot tell easily from the normal election-night red and blue map.

But we can go further. We can do the same thing also with the county-level election results and the images are even more striking. Figure 4 shows a map of US counties, again colored red and blue to indicate Republican and Democratic pluralities. Similar maps have appeared in the press and have been cited as evidence that the Re-

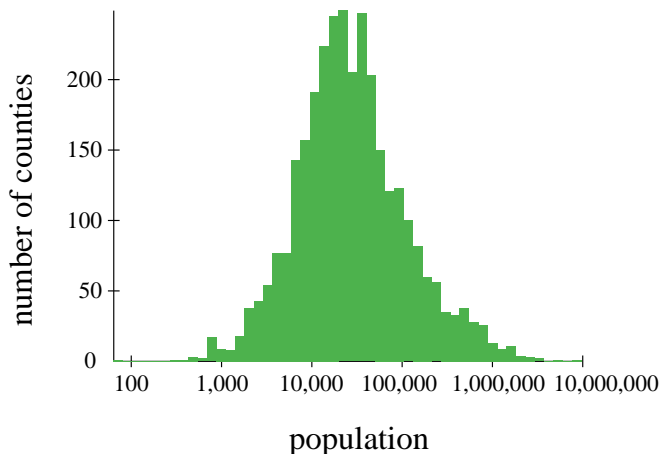


FIG. 5: Histogram of the populations of US counties.

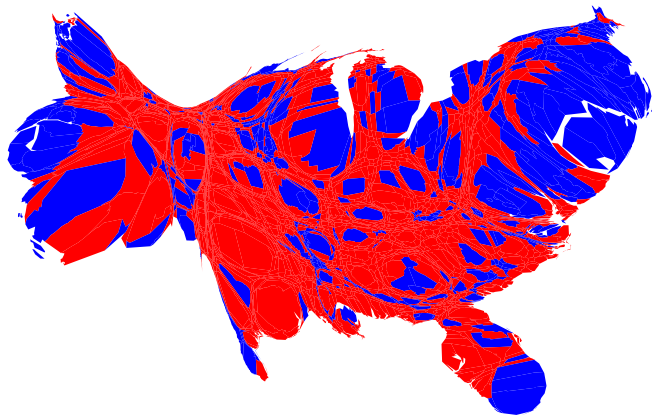


FIG. 6: The counties of the United States redrawn using a population cartogram.

publican party has overwhelming support. Again, however, the populations of counties vary significantly. The most populous county in the United States is Los Angeles County, CA, with over 9.5 million inhabitants, while the least populous is Loving County, TX, with just 67, so there are more than five orders of magnitude variation between the two extremes. The distribution of populations appears to be roughly log-normal: a histogram is shown in Fig. 5.

Redrawing the county-by-county results on a cartogram, as shown in Fig. 6, again gives a more accurate picture of the election. Once more, the blue areas are much magnified and the total areas of blue and red are nearly equal. However, there is still more red than blue on this cartogram, even after allowing for population sizes, while the percentages of voters nationwide voting for either candidate were by contrast almost identical, so what is going on here?

The answer seems to be that the amount of red on the map is skewed because, of the larger counties that were won by the Republican candidate, many were won

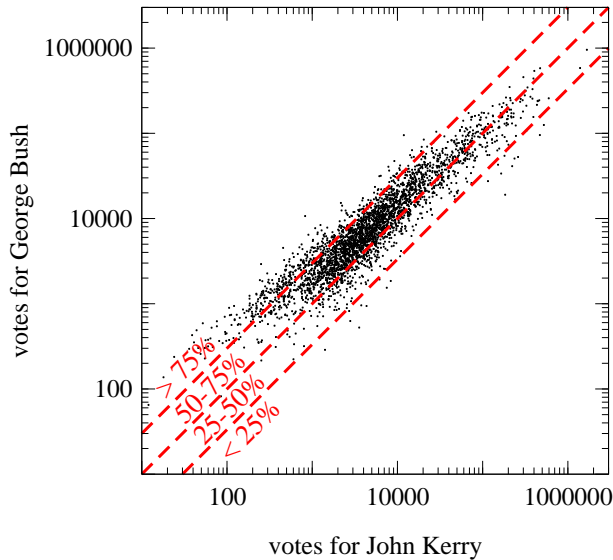


FIG. 7: Scatter plot of votes, county by county. Each point represents the vote counts for the two major candidates in one county in the conterminous United States.

by a relatively narrow margin. Figure 7 shows a scatter plot of the vote counts by county. Each point in this figure represents one county and the point’s position shows the number of votes cast for the two major candidates. The diagonal lines indicate where counties would fall with 25%, 50%, and 75% of votes cast for the Republican candidate. Most of the points in the plot fall above the 50% line, indicating a Republican majority, but most of the points representing substantial Republican majorities are for small counties with fewer votes in total. Counties of medium or larger size—which account for a large portion of the total area on our cartogram—tend to be won (or lost) by narrow margins and should therefore be considered neither purely Republican nor purely Democrat. Nonetheless in Fig. 6 these counties all appear purely red or blue, which gives rise to a misleading impression of the vote.

One way to allow for this, suggested by Vanderbei [4], is to use not just two colors on the map, red and blue, but a range from red to blue via various shades of purple for the different percentages of votes. In Fig. 8 we show

the normal map and the cartogram colored using this scheme. In the cartogram, it appears that only a rather small area is taken up by true red or blue counties, the rest being mostly shades of purple.

We believe that the cartograms presented here go a long way towards correcting some of the most glaring problems encountered with simple geographic representations of election results.

The authors thank the anonymous referees for helpful comments and the staff of the University of Michigan Library’s Numeric and Spatial Data Services for their help with the geographic data. The maps shown here, along with much of the accompanying text, were originally published by the authors on the worldwide web on November 6, 2004 and released under a Creative Commons license that allows for their free distribution, reproduction, and use in derivative works, subject to some conditions. Insofar as the images and text in this article reproduce those of the original web publication, that license applies to this article as well. In case of doubt, please contact the authors for permission to republish the material. Our software for making cartograms is freely available on the web at <http://www-personal.umich.edu/~mejn/cart>. This work was funded in part by the National Science Foundation under grant numbers DMS-0234188 and DMS-0405348 and by the James S. McDonnell Foundation.

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- [1] This map and the others in the paper do not include the states of Alaska and Hawaii, because of some technical problems with non-contiguous cartograms.
  - [2] M. T. Gastner and M. E. J. Newman, Diffusion-based method for producing density equalizing maps. *Proc. Natl. Acad. Sci. USA* **101**, 7499–7504 (2004).
  - [3] In theory there are two exceptions: Nebraska and Maine have laws that allow them to divide up their electoral votes between the candidates. In practice, however, neither of them has ever done this.
  - [4] P. A. Klinkner, Red and blue scare: The continuing diversity of the American electoral landscape. *The Forum* **2**(2), Art. 2 (2004).

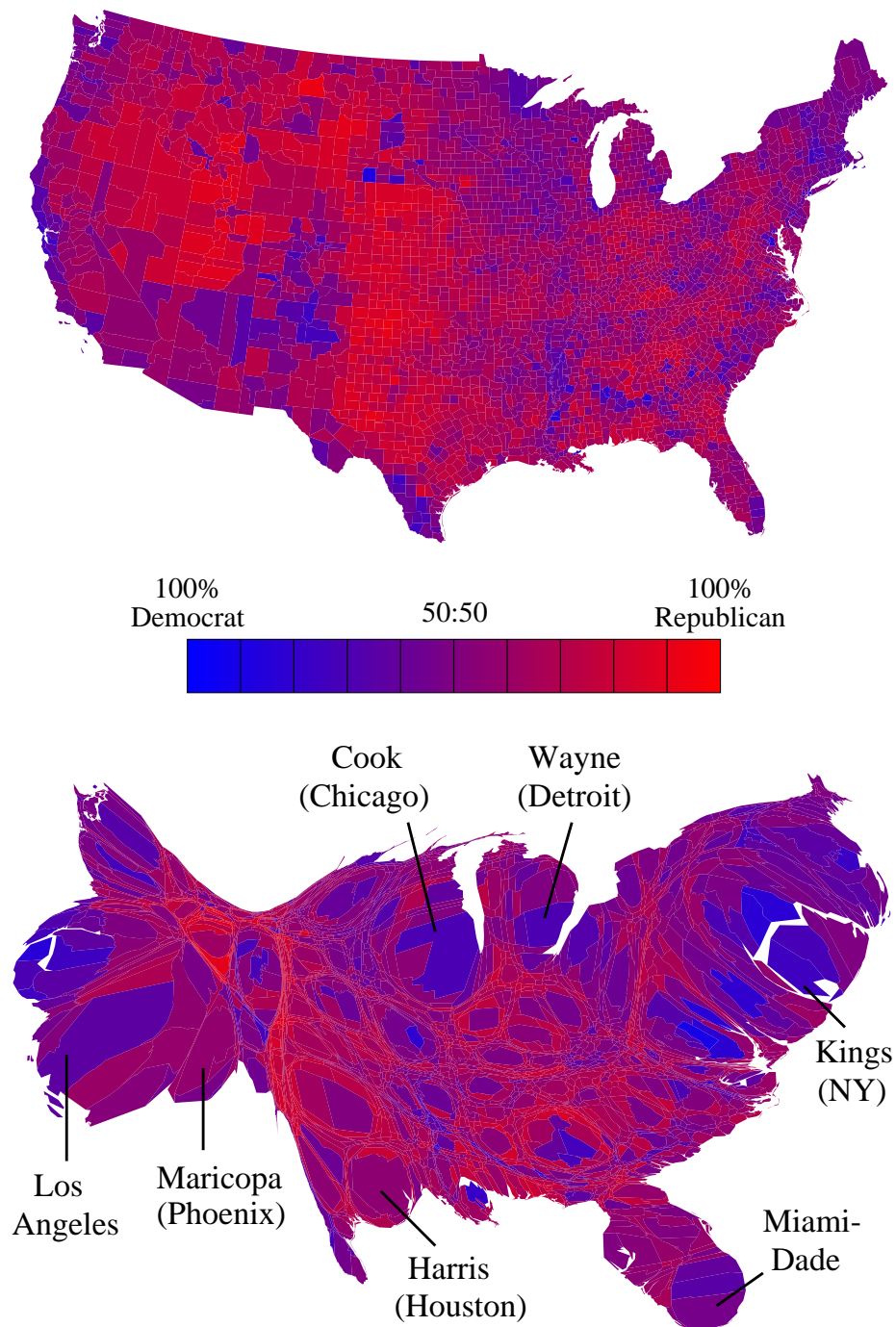


FIG. 8: Map (top) and cartogram (bottom) showing the election results on the blue–purple–red scale in which the amount of blue or red in the color of each county is proportional to the fraction of votes going to the corresponding candidate (excluding votes for third-party candidates).