

CHAPTER I

INTRODUCTION

The area cartogram has become an increasingly popular tool in visualizing the distribution of data. Through the spatial transformation of map regions relative to the data, the cartogram prominently emphasizes *data distribution* instead of territorial size. According to Dorling [4], “whatever you choose to use cartograms for, from studying participation in elections, to the spread of a disease, or the social structure of a country, the very different perspectives they show are likely to alter the way you imagine the processes behind these patterns to be operating”.

The results of the popular vote in the 1996 U.S. presidential race are visualized in Figure 1.1a using traditional thematic mapping. Each state is colored either a shade of red or a shade of blue, denoting the majority winner of each state as Clinton or Dole, respectively. The color saturation indicates the magnitude of the winning percentage, with full saturation indicating a secured win of 50% or more and light saturation possibly indicating a very close win due to third party candidates, for example.

There is a significant problem with this visualization. Without prior knowledge of population density across the country, the viewer has no clear indicator as to who actually won the election. In fact, if you tally up the state areas you find that Dole actually captured 21,000 more square miles of territory than Clinton, the victor. While this map provides a medium of familiarity, it produces an intrinsic distortion of the very data we are trying to analyze.

Since elections are not won on square miles, it stands to reason that the results would be better visualized on a map more representative of population. These same election results are shown in Figure 1.1b on a 1996 equal population cartogram, where the size of each state is proportional to its population. Since the cartogram is based on a unit measurement of population, not square miles, it provides a clear indicator of Clinton’s defeat of Dole. This cartogram, generated using the *Constraint-Based Method*

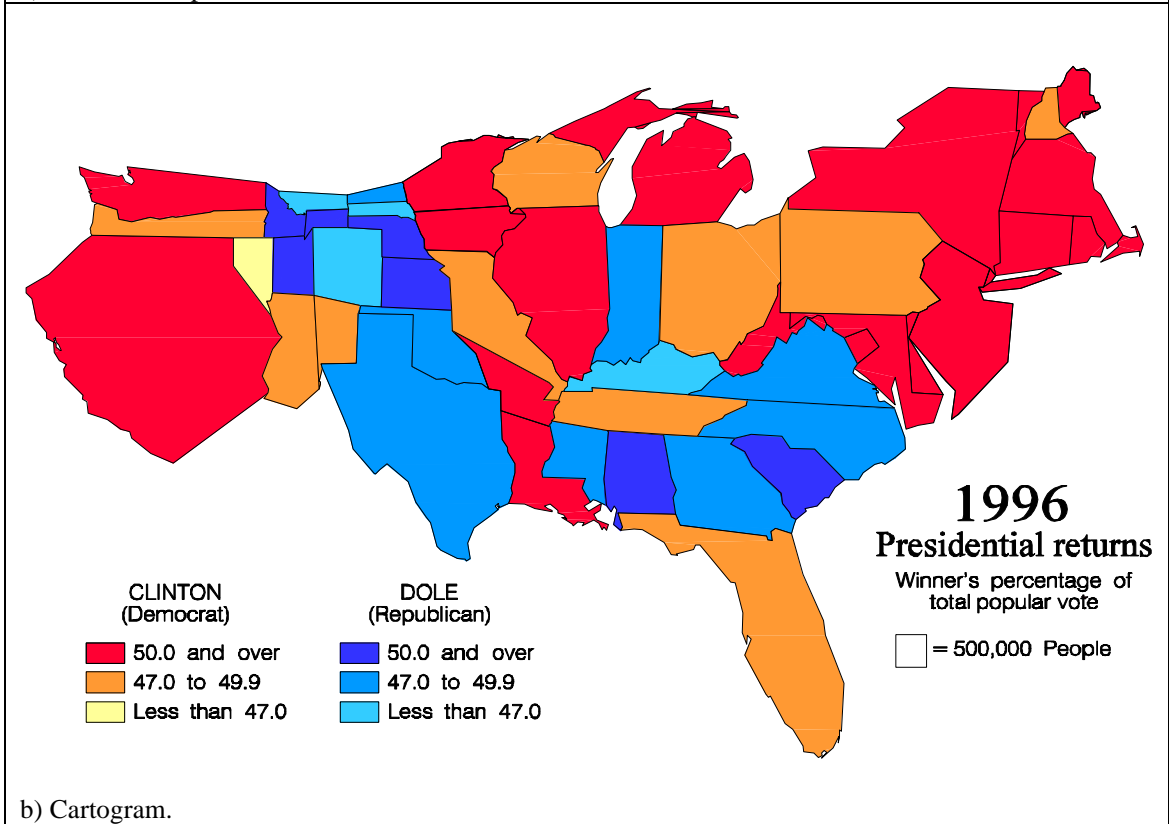
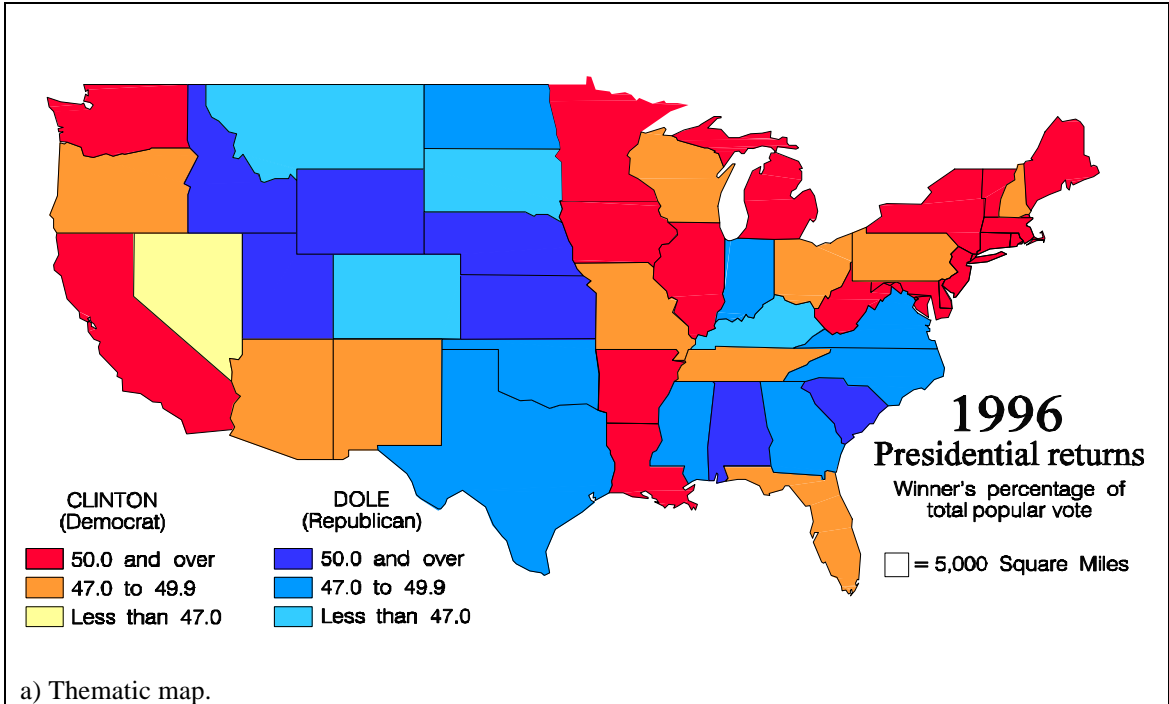


Figure 1.1: Visualizations of the 1996 U.S. presidential returns (Data Source: Federal Election Commission)

described in this thesis, clearly conveys the relative voting significance of each state while retaining significant shape cues to enable their recognition.

Several computer algorithms have been developed to construct *continuous* area cartograms [4, 6, 9, 20, 23, 25, 26], where the topology, or connectivity, of the map regions is retained. Accurately resizing regions relative to a data variable while maintaining continuity and region recognition has proved to be a challenging task [22]. One could argue, based on the lack of widespread use of cartograms in conventional fields, that this problem has not been solved effectively to date.

This paper presents a new method for constructing cartograms. We demonstrate that it overcomes many of the shortcomings of existing methods, and contend that it provides an effective tool for cartogram visualization that is heretofore unparalleled in its functionality, versatility, and shape preservation.

In the construction of cartograms there are two distinct and conflicting goals: adjusting region sizes and retaining region shapes. Our *Constraint-Based Method* utilizes three foundational mechanisms to achieve these goals: alternating relaxation, constrained dynamics, and hierarchical resolution. We converge upon each goal in an alternating relaxation fashion, by achieving desired areas without regard to shape, and then utilizing constrained dynamics to hold the areas fixed while shape is restored. Through hierarchical resolution, we perform gross adjustments initially upon a coarsely resampled map and refinements later at progressively higher levels of detail.