Redistricting is the process of redrawing boundaries of electoral or school districts in response to new census data or projected demographic changes. The practices of redistricting are regularly carried out at various administrative levels to construct different types of districts, such as Congressional Districts, State Legislative Districts, County Council Districts, and School Districts. Redistricting is a critical issue that has far-reaching impact on many aspects of our social, political, and legal systems and is thus of great interest not only to scientists and politicians, but also, more importantly, to the general public and individual citizens.

Meanwhile, redistricting is a challenging problem that spans across multiple disciplines, such as geography (Morrill 1981, Rush 2000), political science (Gelman et al. 1994, Barkan et al. 2006), law (Silverberg 1996), computer science (Puppe et al. 2008), mathematics and statistics (Chou et al. 2006). In this paper, I will focus on political redistricting but the general idea is applicable to other types of redistricting. For the past 40 years, particularly since 1990, political redistricting practices have been continually involved with controversies, lawsuits, court rulings, public debates, and reform calls. At the center of these problems is the practice of gerrymandering—a deliberate manipulation of district boundaries to change the outcome of elections in favor of a political party (a.k.a. political gerrymanders) or to dilute the election power of minorities (a.k.a. racial gerrymanders).

The generally accepted principles for political redistricting include: (1) equal population for all districts; (2) each district being geographically contiguous; (3) each district of a compact shape; (4) preserve community of interest; (5) respect existing political boundaries; (6) increase political competitiveness; and (7) protect the voting power of minority by creating minority-majority districts. However, these rules are often difficult to implement in practice, particularly because some of them are up to subjective interpretation and difficult to define, such as “political competitiveness” and “community of interest”. There are also inherent conflicts among some principles, which demand compromises and delicate balancing (Forest 2005). To achieve more acceptable solutions, redistricting laws and practices in most states have mandatory procedures to engage the public in the process through independent commissions, public hearings, and allowing individual citizens to submit their own redistricting plans.

However, it is extremely difficult for any individual or citizen group to participate in redistricting. To be able to participate and contribute feasible redistricting plans, one needs necessary data, software tools, skills to work with the data/software, and significant amount of time. Indeed, redistricting in each state usually requires one or more full-time technicians and months of work to generate several alternative plans. Although with specifically designed GIS software tools it has become easier for a technical person to devise plans, the general public does not have access to such tools, which are expensive and demand considerable skills and time to use. Foster (2005) argues that, political parties can actually exploit the advancement in software tools to do precise gerrymandering since they have vastly more power, expertise, and resources than citizen’s groups.
To truly empower the public for redistricting, cyberinfrastructure has a tremendous role to play. An innovative cyber-based platform is needed to connect data, computing power, and people in the redistricting decision making process. More powerful and accessible tools are needed to allow individuals to: (1) devise redistricting plans based on their own preferences and criteria; (2) examine, analyze, comment on, or even merge (negotiate) plans contributed by others; and (3) ultimately influence the decision making process with collective wisdom and consensus. Such a platform not only brings power to the people, but also, more importantly, relies on the power of the people to address complex problems. The public will not only provide opinions but also contribute viable solutions (plans). A repository of such contributed solutions can help reach a more acceptable plan and help block potential gerrymanders. Currently it is difficult to tell if a plan is a gerrymander or not due to the lack alternative plans.

There are many challenges in developing such a cyber-based framework, including its overall architecture, data management, data integration, computational optimization, visualization, user interface, and other related information processing services over the Internet to help the public participate in the decision-making process. Below, I will briefly elaborate on two of these challenges.

First, powerful, user-friendly, and easy-to-access redistricting tools are critical. If needed, these tools should be able to deliver the high-performance computing power to the public in a transparent manner. Existing GIS-based redistricting software tools are neither accessible nor powerful enough for an individual citizen to design a plan without a significant investment of time and effort. There are two types of existing tools: (1) those using computational algorithms to automatically derive districts based on specified objectives; and (2) those relying on the user to manually put together a plan while the tool helps check its validity. However, given the complexity and challenges for a redistricting task, neither the automatic nor the manual approach can adequately help a novice user quickly construct a plan that incorporates her/his unique preferences and simultaneously meets all other requirements. Computational power and interactive controls (with novel visualization techniques) need to be integrated to provide powerful, flexible, and yet easy-to-use tools for the public.

Second, novel data mining and visualization techniques are needed to synthesize and understand a large number of different plans (which are collected through public participation). Although there are already numerous measures to evaluate districts and plans, it remains an interesting and open research question to design informative metrics to quantify the overall quality and inherent characteristics of plans, based on which plans can be compared, grouped, and even merged. Various plans should be analyzed and visualized simultaneously across multiple dimensions, such as spatial arrangements, demographic characteristics, compliance with rules, political implications, etc. This will facilitate a holistic understanding of public choices and opinions, which are useful for the experts to derive new theories and knowledge and for the public to understand problems and make valuable contributions.

To summarize, redistricting is a critical and challenging problem that demands the collaboration of multiple disciplines, the integration of computing powerful and human interactions, and the participation of both experts and citizens. A cyberinfrastructure-based approach will no only help achieve better solutions in practice but also enable the derivation of novel scientific theories and knowledge from the novel data that are otherwise impossible to obtain. GIS-based public participation has been used in many applications (Nyerges et al. 2006, Armstrong et al. 2008, Wright et al. 2009) but redistricting presents unique challenges and requires specialized designs and techniques.
References:


Rush, M.E., 2000, Redistricting and partisan fluidity: do we really know a gerrymander when we see one? Political Geography, 19, pp. 249-260.


