Public Participation GIS for the General Public?

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1 Introduction

Public participation is a critical step toward to a democratic process of decision making (Pløger, 2001). The last two decades have seen the development of public participatory geographical information systems (PPGIS) (see, for example, Carver 2001; Craig et al. 2002; Sieber 2006). Though much progress has been made, a wide use of PPGIS, especially by the general public, is yet to come. Reasons for the lack of "public" in PPGIS include the esoteric features of available GIS (and PPGIS) packages that require intensive technical training and perhaps nontrivial financial resources.

The purpose of this paper is to discuss the possibility of developing PPGIS that can be made available to the general public. We start with proposing a PPGIS requirement model and then discuss a conceptual PPGIS framework and its applications.

2 Requirements of PPGIS

We examine the fundamental requirements of a PPGIS from three dimensions.

- *Interaction.* A PPGIS must allow straightforward interaction between a user and a computer (including the front-end computer used by the user and the server that provides critical services to the user). More specifically, the user must be able to store, modify, and display spatial and aspatial information related to a decision making process. The majority of such interaction is carried out through a user-friendly graphic interface.

- *Sharing*. For many public decision making problems, it is important to consider the preferences of stakeholders who often have different ethnic, political, cultural, and social backgrounds. Even for the cases when a group of people with similar interests, they may still have different backgrounds that require a common language to communicate. An effective PPGIS must be able to accommodate these differences and to allow different opinions be expressed and represented.

- *Computation*. Many decision problems require intensive computation to evaluate a large number of potential alternatives. It is reasonable to require that a PPGIS provide a "starting" point to its users, who can then derive new alternatives to reflect their own preferences. To

reduce the bias produced by providing a single starting alternative, a more useful option is for the PPGIS to provide a diverse set of alternatives and the user can focus on those that are close to their preference. Generating a diverse set of alternatives requires intensive computation.

In addition to these requirements, freedom or accessibility to software should also be considered. A PPGIS based on commercial software packages *may* provide relatively stable performance (though no guarantee), while a public domain PPGIS may allow grandmas to go to public libraries and participate.

3 Enabling Technologies

Among the above requirements, interactivity has been typically implemented in current PPGIS applications, while other requirements are less commonly available. To support public spatial decision making, the PPGIS requirements can be fulfilled with the help of a number of recent advances in computational and information techniques.

- *The semantic web*. As an extension of the World Wide Web, the semantic web is a formal knowledge management method that can be used to represent the meaning of web contents in conceptual spaces, allowing for human-friendly retrieval of information adapted to individual preferences (Antoniou and van Harmelen, 2004). The World Wide Web Consortium has recommended the Resource Description Framework (RDF) and the Web Ontology Language (OWL) to represent and share web resources and their semantic structures, enabling knowledge based searches and situated understanding (Gahegan and Pike, 2006).

- *AJAX (Asynchronous JavaScript and XML)*. AJAX is critical in creating "rich" interactive, dynamic Internet applications that contains responsive features such as allowing refreshing a portion of a web site without reloading the entire page. Here, JavaScript is used to render the user interface and to communicate between the web user and web server. XML (Extensible Markup Language) is used to design efficient data structures to help data exchange between the user and server sides. A variety of Hypertext Transfer Protocol (HTTP) servers such as PHP can be used to provide server-side services and work with an AJAX framework.

- *Web-based interactive computer graphics*. A number of languages and software products have been widely used to support user-friendly web interfaces. Among them, SWF (Small World Format and ShockWave Flash) is a proprietary product that has been popularly used by web sites such as Yahoo and the New York Times for interactive mapping. Google has created its own product called Google Widget Toolkit (GWT) that is freely available (for now) and supports not only maps but also general user interface widgets. Scalable Vector Graphics (SVG) is relatively less popular on commercial web sites but is gaining momentum in the public domain (Geroimenko and Chen, 2005). SVG has also been used to display vector-based maps (Peng and Zhang, 2004). GWT also has a component to support SVG.

- *Evolutionary computation*. A fundamental challenge to public participation in spatial decision making is the difficulty of providing a set of good decision alternatives for the participants to choose and work on. Recent development in evolutionary computation has demonstrated that it is possible to create a diverse set of alternatives for decision makers (here,

including everybody who participates) to examine the tradeoffs and make their final decisions (see, for example, Xiao et al., 2007).

We note that other techniques (e.g., JAVA) have also been identified as an essential part of the PPGIS in the literature. We focus on more recent developments that can be utilised to achieve the requirement we deem to be critical for a successful PPGIS for the general public.

4 A Conceptual PPGIS Framework

Based on the above discussion, we propose a conceptual framework for the purpose of public participation in decision process. The components of this framework are illustrated in Figure 1. The function of each component is described below.

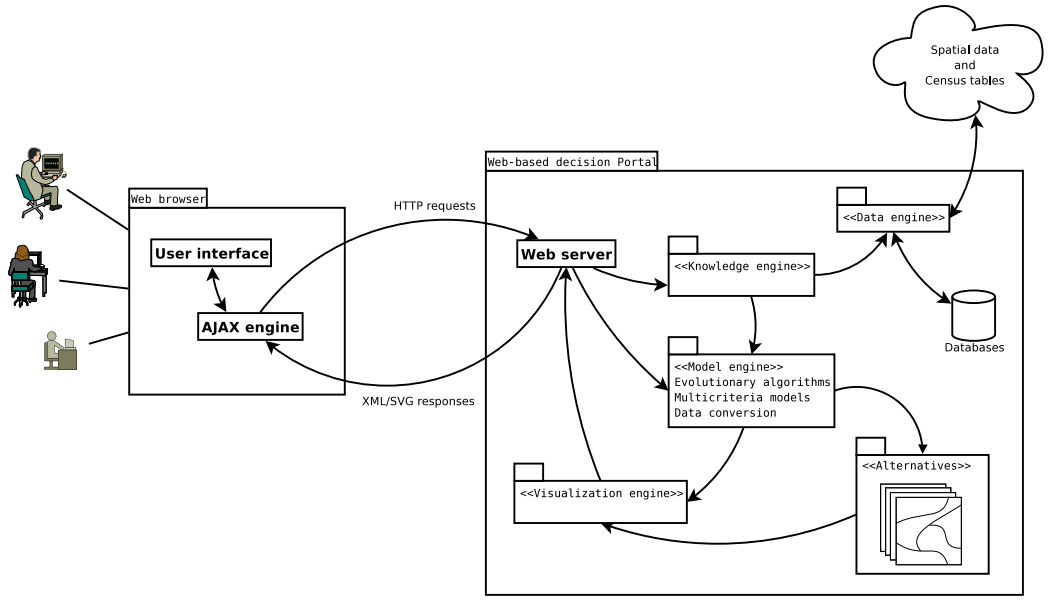

Figure 1: A conceptual PPGIS framework for the general public.

- The *User interface* provides the tools to help users specify their requirements that are necessary for a particular spatial decision problem.
- The requirements and inputs specified by the users are processed by the *AJAX engine* that construct and send HTTP requests.
- The *Web server* receives the requests from the AJAX engine and starts the *knowledge engine*, which "understands" the meaning of the user requests and calls appropriate data and model to create visual responses and send back to the AJAX engine, which, in turn, displays the results on the user interface.
- The *Data engine* is used to manage a variety of data sources, including the *Database* stored on the server side, as well as other data sources available on the Internet (e.g., the census tables).

- The server side also contains a *Model Engine* that manages computational models that can be used to generate interesting *alternatives* for the problem being addressed by the user.
- The *Visualisation engine* is used to prepare data that will be transferred to the AJAX engine for visual display. SVG, for example, can be used here.

5 Applications

We will discuss the use of this theoretical framework in political redistricting where the general public can be involved in the process of generating plans that reflect different perspectives. We then discuss how this framework can be used to investigate patterns and trends of racial and economic segregation for six Ohio urban communities. We will also explore how a participatory approach can be used in risk assessment for disaster preparation and mitigation.

6 Conclusions and Discussion

In this paper, we propose a three-dimensional requirement model for PPGIS. We argue that enabling techniques have matured to support the development of PPGIS that are accessible to the general public. We also develop a conceptual PPGIS framework and discuss its possible applications.

7 References

Antoniou, G. and F. van Harmelen (2004). *A Semantic Web Primer*. Cambridge, MA: The MIT Press.

Carver, S. (2001). Guest editorial: public participation using web-based GIS. *Environment and Planning B 28*(6), 803–804.

Craig, W. J., T. M. Harris, and D. Weiner (2002). *Community Participation and Geographic Information Systems*. London: Taylor & Francis.

Gahegan, M. and W. Pike (2006). A situated knowledge representation of geographical information. *Transactions in GIS 10*(5), 727–749.

Geroimenko, V. and C. Chen (Eds.) (2005). *Visualizing Information Using SVG and X3D*. London: Springer.

Peng, Z. R. and C. Zhang (2004). The roles of geography markup language (GML), scalable vector graphics (SVG), and web feature service (WFS) specifications in the development of internet geographic information systems (GIS). *Journal of Geographical Systems 6*(2), 95–116.

Pløger, J. (2001). Public participation and the art of governance. *Environment and Planning B 28*(2), 219–241.

Sieber, R. (2006). Public participation geographic information systems: a literature review and framework. *Annals of the Association of American Geographers 96*(3), 491–507.

Xiao, N., D. A. Bennett, and M. P. Armstrong (2007). Interactive evolutionary approaches to multiobjective spatial decision making: A synthetic review. *Computers, Environment and Urban Systems*, forthcoming.