

Chapter 57

Application of Geographical Information System and Interactive Data Visualization in Healthcare Decision Making

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ABSTRACT

This paper focuses on two techniques and their applications in healthcare systems: geographic information system (GIS) and interactive data visualization. GIS is a type of technique applied to manipulate, analyze and display spatial information. It is a useful tool tackling location related problems. GIS applications in healthcare include evaluation of accessibility to healthcare facilities, site planning of new healthcare services and analysis of risks and spreads of infectious diseases. Interactive data visualization is a collection of techniques translating data from its numeric format to graphic presentation dynamically for easy understanding and visual impact. Compared to conventional static data visualization techniques, interactive data visualization techniques allow user to self-explore the entire data set by instant slice and dice, quick switching among multiple data sources. Adjustable granularity of interactive data visualization allows for both detailed micro information and aggregated macro information displayed in a single chart. Animated transition adds extra visual impact that describes how system transits from one state to another. When applied to healthcare system, interactive visualization techniques are useful in areas such as information integration, flow or trajectory presentation and location related visualization, etc. One area both techniques intersect is location analysis. In this paper, real life case studies will be given to illustrate how these two techniques, when combined together, help in solving quantitative or qualitative location related problem, visualizing geographical information and accelerating decision making procedures.

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1. BACKGROUND

We access all types of location related information through different map service providers. For instance, querying driving direction from home to working place, looking for the fastest travelling options from hotel to attractions. Mapping services are becoming more and more an indispensable part in everyone's daily work and life. Compared to traditional paper-based map, modern map services integrate seamlessly with Internet and social network and provide a much more powerful yet accessible platform to explore, query and share valuable or interesting location information. In healthcare context, map services provide valuable information for both patients and healthcare service providers. From patients' perspective, map services may help answer the following questions:

1. What are the services available around my place?
2. Where is the near location for this service?
3. How can I get there?

From healthcare service providers' perspective, map services can be used as an analytical tool for in-depth location analysis. It may help to understand patients better and make better decisions. Some typical questions are listed as below:

1. Where are my patients living?
2. What is the accessibility of this service?
3. What is the catchment of this service?
4. Do I have enough capacity in this area?
5. What will the workload look like if I set up a new service at this location?
6. Where are the hotspots of this disease?

Geographic information system (GIS) is one of techniques behind modern map services. GIS is a collection of techniques focused on capturing, storing, checking, manipulating, analyzing, managing, and displaying all types of geographical data and spatial information (Grimshaw, 2000). GIS is widely applied in many areas including transportation, land planning, waste management, real estate, environment, agriculture, forestry and so on (Malczewski, 2006). Sufficient GIS applications can also be found in healthcare. Popular topics include conversion and management of health information in spatial databases, analysis of risks and spreads of infectious diseases, evaluation of accessibility to healthcare facilities, site planning of new healthcare services, community healthcare awareness and so on (Cromley & McLafferty, 2012).

One possible limitation of traditional GIS application is that it usually generates static maps, hence lacks flexibility when there is a requirement of interaction. Such limitation could be complemented by interactive data visualization. Interactive data visualization is a collection of techniques translating data from its numeric format to graphic presentation dynamically for easy understanding and visual impact (Few & Perceptual, 2007). It gains more popularity as it provides more flexibility and visual impact over traditional static visualization. Compared to the widely applied static chart types such as bar chart, pie chart or scatter plot, interactive data visualization opens possibility of conveying information in a more flexible and customized way (Ward, Grinstein, Keim, & more, 2010). Interactive data visualization techniques demonstrate the following advantages:

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