COLLABORATIVE EDUCATIONAL GEOANALYTICS APPLIED TO LARGE STATISTICS TEMPORAL DATA

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Abstract: Recent advances in Web 2.0 graphics technologies have the potential to make a dramatic impact on developing collaborative geovisual analytics that analyse, visualize, communicate and present official statistics. In this paper, we introduce novel "storytelling" means for the experts to first explore large, temporal and multidimensional statistical data, then collaborate with colleagues and finally embed dynamic visualization into Web documents e.g. HTML, Blogs or MediaWiki to communicate essential gained insight and knowledge. The aim is to let the analyst (author) explore data and simultaneously save important discoveries and thus enable sharing of gained insights over the Internet. Through the story mechanism facilitating descriptive metatext, textual annotations hyperlinked through the snapshot mechanism and integrated with interactive visualization, the author can let the reader follow the analyst's way of logical reasoning. This emerging technology could in many ways change the terms and structures for learning.

1 INTRODUCTION

The major tenets of Web 2.0 are creating a revolution in the way in which information is produced and shared among different interest groups and individuals. Concepts like "collective intelligence" has become undisputed linked with developments such as blogs, wikis, social networking and collaborative software development. Web 2.0 can make dramatic impact on developing interactive and collaborative geovisual analytics tools for the Internet. Tools are needed that advances humans ability to exchange gained knowledge and develop a shared understanding with other people. Stimulate brainstorming and problem-solving through creative and incremental discovery and develop a contextual collaborative understanding - commonly referred to as geospatial "analytics reasoning" are important tasks to solve.

While the benefits of geovisual analytics tools (Andrienko 2003 and 2005) are many, it remains a challenge to adapt these tools to the Internet and reach a broader user community. In this context, we introduce a web-enabled tool Geovisual Analytics Visualization "GAV Flash" for analysing and communicating knowledge explored in large volumes of statistical data. This tool and associate applications OECD Factbook (OECD 2009b) and Regional eXplorer (OECD 2009a) facilitate a broad collection of dynamic visualization methods integrated with the Adobe© Flash© and Flex© development platform. The eXplorer platform focuses on the analytics reasoning aspects enabling statisticians to explore spatial, temporal and multivariate data from multiple perspectives simultaneously using dynamically linked views, views (Brodbeck 2003) discover interesting relationships, share their incremental discoveries with colleagues and finally communicate selected relevant knowledge to the public.

In this paper, we introduce novel "storytelling" means for the analyst to 1) select any spatial-temporal and multidimensional national or sub-national statistical data, 2) explore and discern trends and patterns, 3) then orchestrate and describe metadata, 4) collaborate with colleagues to confirm and 5) finally publish essential gained insight and knowledge embedded as dynamic visualization "Vislet" in blogs or wikis with associate metadata. The main features can be summarized:

- Interactions, dynamic time animation and state-changes in an analytical reasoning process, such as visual inquiries or highlighted outliers but also linked, can be saved during an explorative process through "memorized interactive views".

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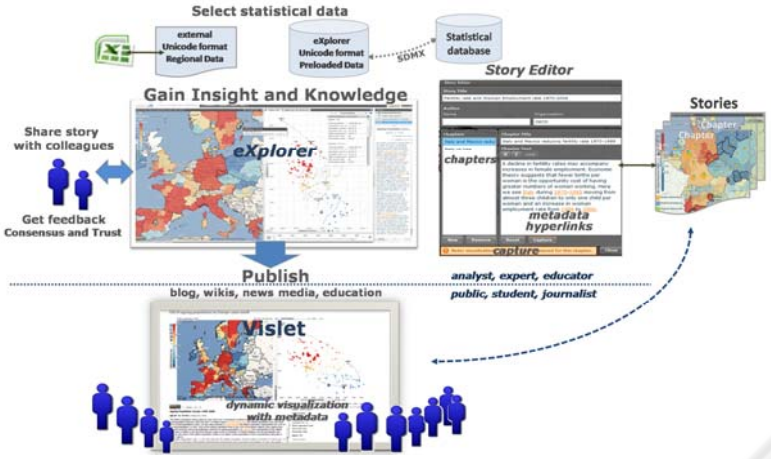

Figure 1: The analyst (author) uses eXplorer to1) import any national or sub-national statistical data, 2) explore and make discoveries through trends and patterns and derive insight. Gained knowledge is the foundation for 3) creating a story that can be 4) shared with colleagues and reach consensus and trust. The visual discoveries are captured into snapshots together with descriptive metadata and hyperlinks in relation to the analytics reasoning. The author gets feedback from colleagues, adopts the story and 5) finally publishes "tell-a-story" to the community using a "Vislet" that is embedded in blogs or wikis.

- A Story mechanism records the status of an explorative discovery including tasks, events, conditioning, dynamic linked views, region highlights, colour legend scale, results from filter or cluster operations and time animation;
- Combination of a descriptive and conceptual metatext with an interactive and guided discovery process could improve not only the educational aspect but also the credibility of the sharable understanding of analytical results;
- An eXplorer Story can be published on a HTML page, blog or wikis as a Vislet with integrated dynamic visualization and metatext;

A geovisual analytics framework and class library for web developers with integrated service for communicating and collaborating analytical assessments to remote team members and public; 2 related work.

2 RELATED WORK

The importance of providing explorative sessions in geovisualization and incorporated features to capture and reuse interactions and integrate them into electronic documents was early demonstrated by MacEachren (MacEachren and Brewer 2001) and Jern (Jern 2001, 2008). CCMaps presents a conditioned choropleth mapping tool that allows users to save snapshots and reuse them for presentation purpose. More recent efforts were made by Visual Inquiry Toolkit (Guo et al. 2006) that allows users to place pertinent clusters into a "pattern-basket" to be reused in the visualization process. Robinson describes a method they call "Re-Visualization" and a related tool ReVise that captures and re-uses analysis sessions (Robinson 2006); Keel describes a visual analytics system of computational agents that support the exchange of task-relevant information and incremental discoveries of relationships and knowledge among team members commonly referred to as sense-making (Keel 2006). Wohlfart describes a storytelling approach combined with interactive volume visualization and an annotated animation (Wohlfart and Hauser 2007).

Many capture and reuse approaches are limited to be used within the same application environment that may well require a license and are not always easily accessible to team members without installing external software. Increased computer security practices tend to limit this possibility. In this context, we introduce a web compliant layered component toolkit facilitating a snapshot mechanism that captures, re-uses and shares active properties for individual functional components. We demonstrate that such an implementation can provide a more open and collaborative geovisual analytics framework for public use (OECD 2009a).

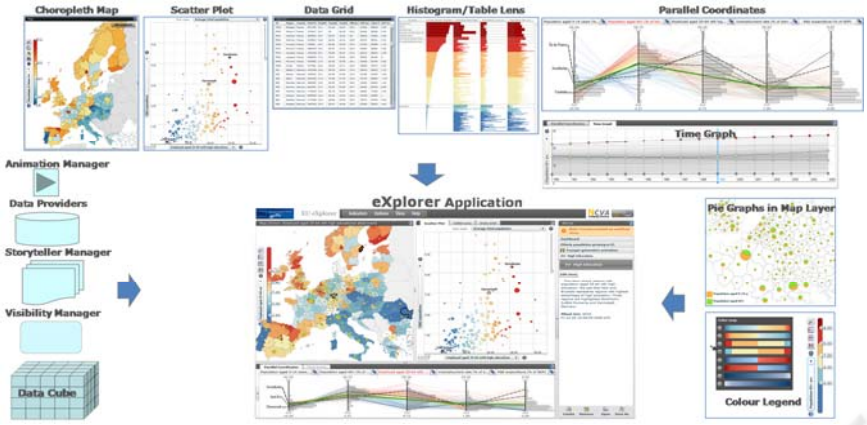

Figure 2: eXplorer is assembled from a collection of GAV Flash visualisation and administrative components.

3 SYSTEM IMPLEMENTATION

GeoAnalytics Visualisation GAV Flash is a toolkit and framework adapted for the Web 2.0 using Adobe's Flash basic graphics and Flex for user interfaces. Programmed in Adobe's object-oriented language ActionScript, GAV Flash facilitates 100% deployment to the Internet through Adobe Flash Player V10. GAV Flash includes a collection of common geovisualization and information visualization components, data analysis algorithms, tools that connect the components to each other and data providers that can load data from various sources (figure 2). Interactive features that support a spatial and temporal analytical reasoning process are exposed such as tooltips, brushing, highlight, data zoom, visual inquiry, conditioned statistics filter mechanisms that can discover outliers and methods supporting dynamically linked multiple views. A space-time-attribute data cube provides the interactive performance required for eXplorer's handling of massive statistical data.

As GAV Flash is built upon Adobe Flex, a developer has access to all Flex user interface functionalities. By combining buttons, panels and sliders with GAV data providers, managers and visual representations, applications can easily be customized. The open architecture, allows new or existing tools to be incorporated with the already existing components, e.g. statistical analysis tools or visual representations. By separating the data structure from the visual representations, applications are created that work regardless of input.

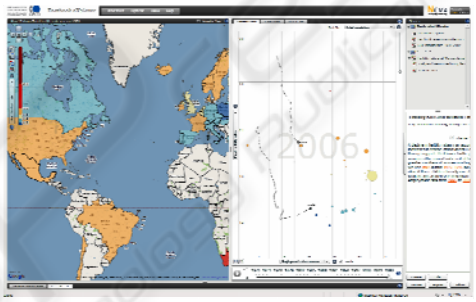

Figure 3: A story called "*Fertility rate and women employment rate*". Two countries Italy and Mexico are highlighted in two coordinated views. A decline in fertility rates may accompany increases in female employment. Economic theory suggests that fewer births per woman are the opportunity cost of having greater numbers of women working. Here we see Italy during 1970-1995 moving from almost three children to only one child per woman and an increase in woman employment rate from 1996 to 2006. The Story (right panel) shows the metatext for current story and a list of other associated stories.

4 COLLABORATIVE SPACE-TIME-ATTRIBUTE ANIMATION FOR STORYTELLING

Complex and collaborative geovisual analytics sense-making tasks require the external representation and visual organization of information. These methods could help sense-makers compare, organize, comprehend and reflect on what they know, to quickly access specific information when needed, to remember relevant thoughts and ideas, as well as to exchange

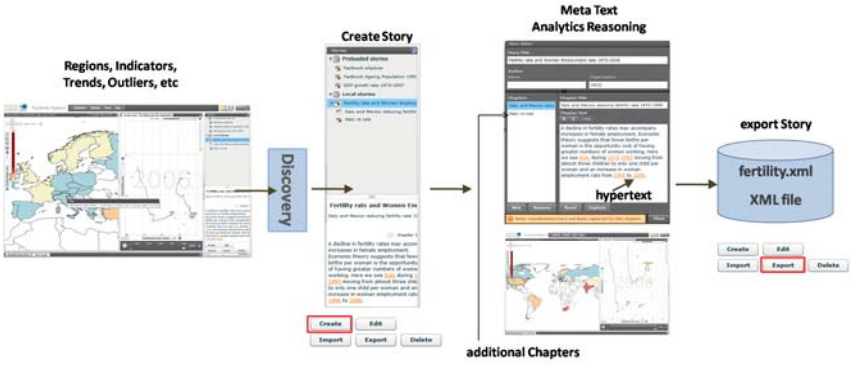

Figure 4: During an eXplorer session (figure 3), the analyst first selects regions to be analysed and associate indicators. Then a search for trends, outliers, discovers important observations, highlights regions to be compared etc. - a discovery is made! Secondly, open the Story Panel (right view), use button Create a Story, a Story Editor panel comes up, fill in the required information and associate reasoning text and finally press Capture , the entire current eXplorer scenario (all views and attributes) are saved together with selected indicators. The user can now start a second Chapter (New) and create a new scenario and repeat the process or Close and then use the button Export as, give the Story a name "my story nr 2".xml. The Story is now saved locally on your computer and can be reused Imported or sent to a colleague for review in eXplorer.

knowledge and develop a shared understanding with other people. Computer generated information visualizations usually explicitly state relationships among information items thus allowing for quick and non-ambiguous explorations of an information space. Human generated information arrangements are often vague in regards to relationships thus inviting more creative interpretations of an information space. The GAV Flash framework integrates tools for both collaborative interactive visualization and sense-making. A story indicates a successful suggestion and subsequently fosters additional suggestions based on similar considerations based on similar considerations. This learning mechanism allows our storytelling system to improve the accuracy of its suggestions as well as to dynamically adapt to particular users, tasks and circumstances. Colleagues can review a story arrangement and respond with suggestions and comments and subsequently fosters additional suggestions based on similar considerations.

The eXplorer platform facilitates the architecture to support means of capture, add descriptive text, save, packaging and sharing the discovery and results of a geovisual analytics process in a series of snapshots “Story” (figure 4 and 5). When the button “Capture” in the *Story Editor* is pressed, the state of each GAV Flash view in OECD Factbook eXplorer (figure 3) is saved together with user-defined metatext. Before closing the application, the user exports the story into a XML formatted file. Team members (figure 1) can through descriptive text combined with interactive visualization follow the analyst’s way of logical reasoning by loading selected stories. At any time a team member can access stories and apply them in eXplorer or any other GAV Flash application assembled from the same component. A comprehensive story in the context of a remote collaborative sense-making activity can thus be created by the analyst through a set of linked snapshots (chapters). Users will discuss relevant issues through storytelling based on solid evidence, thus raising awareness and increasing the common knowledge on a certain phenomenon.

An eXplorer story hyperlink (figure 5) is a reference in the story metatext to an external web site or another eXplorer discovery (view). A text item in the current story is highlighted so that when clicked, the story automatically displays in eXplorer, for example, a zoom to a certain region, change of indicator etc. or shows some referenced external content. This highlighted word(s) is known as a hyperlink and makes a logical connection to an eXplorer state or external reference. Hyperlinks are the basic building block of hypertexts. For example, some key words in a story such as Italy are highlighted, and provide links to explanations of those words in the same eXplorer story.

To insert a hyperlink in the metatext that links to a chapter or an external URL is often simply called to "link" (figure 5). Hypertext (meaning "more than just text") is a form of text that provides a richer functionality than simple metatext by allowing the reader to learn about topics within the story by clicking on key words. Typically the link anchor will be descriptive of the target's content (e.g. Italy), for example NCVA home page. Highlight the text to become a Hypertext, choose New Capture or External URL. New Chapter allows you to create a new eXplorer snapshot (e.g. zoom, highlight regions). When the Hypertext is initiated, eXplorer will display the state-of-the-snapshot.

Figure 5: The Story Editor includes metatext with hyperlinks and describes a discovery in an exploration scenario here called "*fertility rate and women employment rate for 1970-2006*" (figure 1). The story has two chapters.

5 CONCLUSIONS AND FUTURE DEVELOPMENT

We expect that the web-enabled and collaborative nature of the eXplorer platform will enhance the use and understanding of statistics, thus adding to sound, evidence-based policy decisions and transformed into shared knowledge. At the same time, it will encourage the practical use of advanced, collaborative geovisual analytics technologies because of its easy accessibility on the Internet. It will enable the analyst to take a more active role in the discovery process of exploring regional indicators, for example, to identify those regional areas that outperform other regions of their country or mean values. The tool will increase the interest in and knowledge of regional structures and development patterns among specialist as well as non-specialist users. The patterns of development may differ widely in urban and rural areas and regions may lag behind even when the national economy is performing well. Comments from our NCVA partners who have evaluated the tool highlights the following features:

- eXplorer is free available;
- Easy-to-use external statistical data access;
- Ability to have dynamic time-link views and see the multi-dimensionality of regional development;
- Possibility to capture, save and open discoveries (snapshots) with attached analytics reasoning metadata;
- IT expertise is not required to publish interactive visualization embedded in blogs and wikis;
- Important tool to publish statistics news on the Web;
- Increased expectations in terms of user experience;
- Will encourage more educational use of official statistics;

NCVA is an associated partner to the OECD Global Project on "Measuring the Progress of Societies". This "WikiProgress" project should represent the catalyst of initiatives existing around the world on the measurement of progress, as well as their use for raising awareness amongst stakeholders, informing them through statistical indicators describing economic, social and environmental trends and allowing them to discuss relevant issues through storytelling based on solid evidence. WikiProgress represents **the** place where both experts and public share their analysis practices on indicators, about the data that underlies our knowledge and hence our action. OECD eXplorer has demonstrated that geovisual analytics could represent a fundamental tool in developing knowledge, thus making better evidence based decisions possible and will provide answers to questions like:

- Who is developing initiatives on measuring progress (well-being, quality of life, etc.)?
- What type of classification do these initiatives use?
- Which indicators are being used to measure the different dimensions of progress?
- How is my country/region/community achieving over time and in comparison to other similar territories?

Our latest research includes a "Vislet". A standalone Flash application (widget) that is assembled from the GAV Flash class library and Flex GUI tools (figure 6) and integrates selected statistical indicators supported by highly interactive visualization with descriptive metadata embedded into blogs, wikis or any HTML document.

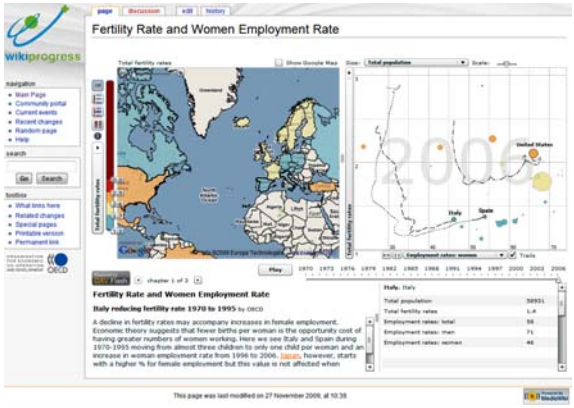

Figure 6: A proof-of-concept – A Story created in OECD Factbook (figure 3) and here published in MediaWiki. A vislet with two dynamic time-linked visualization views choropleth map and scatter plot are embedded in a wikiprogress article.

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