Game-y Information Graphics

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Abstract
In this paper we explore the application of formal elements of games such as goals and scores to information graphics—so called "game-y" information graphics. In order to study how game-y aspects could engender exploration of a dataset, we built two versions of an information graphic, one without game elements and the other incorporating aspects of trivia games. Preliminary results based on a real world deployment of the graphics on a newspaper website suggest that the trivia game information graphic engendered increased exploration of the data space by users as compared to the regular version of the graphic.

Keywords
Information graphics, games, computational journalism, storytelling

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

Introduction
Information visualizations typically present large quantities of information to users with the goal of helping those users make sense of the information

space. Part of the sensemaking process relates to maintaining a *situational awareness* [6] of the space which involves perceiving, comprehending, and predicting based on the current state of the information space. In particular elements of the perception and comprehension of the information space relate to how easily the user can navigate and explore the space.

Prior work [1, 3, 8] has looked at using storytelling and narrative structures to structure and communicate via information visualization. However, there is an absence of research that looks at *interactive* narrative interfaces such as games as ways of structuring activity in information visualizations. Games can be seen as an alternative method of structuring a story, which are less bound by linear structure but which still conform to rules or mechanics of play. In this work we explore the potential of applying aspects of games to information graphics and in particular how that affects users' exploration of the information space.

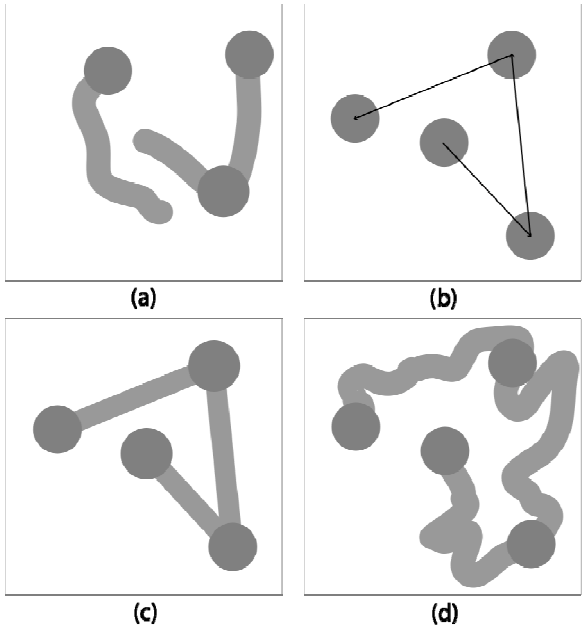

Figure 1. A conceptual diagram showing different possibilities for the amount of the data space explored by the user (projected to a 2D area in gray, landmarks in darker gray); (a) undirected, (b) landmark narrative, (c) flexible narrative, (d) directed with questions.

Storytelling with Information Graphics

The notion of telling a story through information graphics has been explored both in the research literature as well as in media contexts such as journalism. Narrative is oftentimes well structured whereas traditional information visualization is built around mostly undirected exploratory activity. We hypothesize that how a story is presented to a user and the flexibility of the interactions afforded with the graphic will impact the extent of the exploration of the dataset by users (see Figure 1). Here we cover some of the related work that spans this range of narrative possibilities.

Perhaps the most interaction limited form of information graphic storytelling is theatrical performance around graphics. For instance, John King has used the "Magic Wall", a large touch-screen display, on CNN to depict voting results during elections by walking viewers through different visuals and scenarios with the data. Another well-known example of this is Al Gore's narrated traversal of information graphics in the movie *An Inconvenient Truth*. The Economist magazine also routinely produces *videographics,* narrated walkthroughs of some of their information graphics[1]. We refer to this mode of storytelling as the *landmark narrative* (Figure 1b) since the user is guided between some pre-selected set of landmarks in the dataset.

At the other end of the spectrum are *undirected* information visualizations (Figure 1a) which allow the user to freely explore the data space according to whatever is of most interest to them. Such systems may be difficult for users to delve into if they are initially too complex or disorienting. Visualization systems like sense.us [4] or the Baby Name Wizard [7] are also unstructured but can provide some social direction by allowing people to mark or share points in the data space that are interesting.

[1] http://audiovideo.economist.com/

Gershon and Page [3] have argued that stories are an effective mechanism to structure and communicate complex information in an appealing and compelling way. Storytelling has also been examined in the context of volume visualization [8] and in geo-spatial intelligence applications [1]. These approaches are built on traditional notions of the story as a trajectory or path through some narrative space. We refer to these stories as *flexible narratives* (Figure 1c) since particular landmarks are selected and the user is transitioned between them in a way that allows them to stop and look at the dataset at points in-between landmarks.

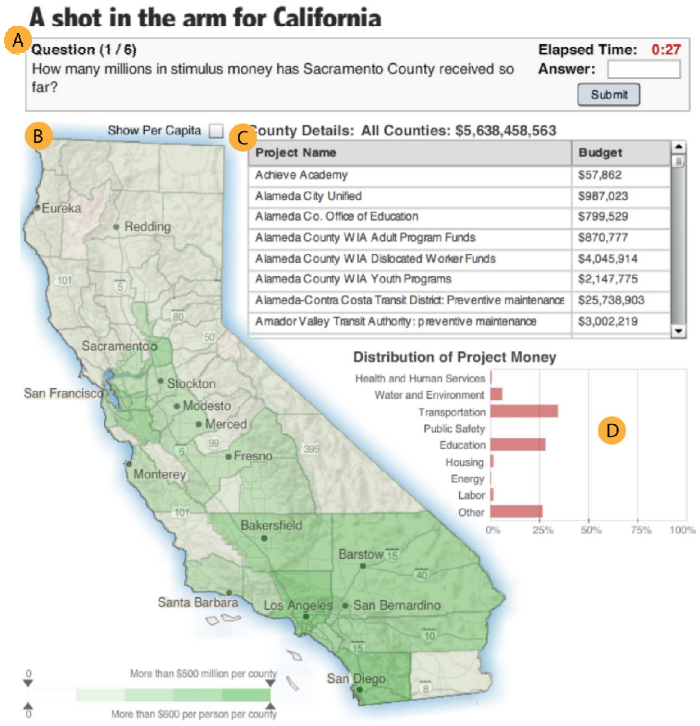

Figure 2. The California Stimulus Map (trivia version). Section (a) is absent in the non-trivia version.

A Gaming Approach

Games can be seen as an alternative method of structuring a story, which are less bound by linear structure but yet still conform to rules or mechanics of play. They are related to both traditional forms of narrative storytelling as well as to mechanisms for structuring simulated realities [2, 5].

An information graphic is in essence a simulated reality insofar as it is a rendering of an abstract data model into a visual space. Games then are a good candidate for helping to structure the interaction within the representation created by an information graphic. It should be noted that games sometimes incorporate graphics which help players navigate or give feedback on game stats or goals. Here we consider the graphic as the dominant frame and the game elements as subservient to the graphic itself. There are several formal elements of games that can be incorporated into information graphics including goals, rules, scores, competition, advancement, and the notion of "winning". From a storytelling point of view, selecting the goals, rules, and criteria for scoring would then form the editorial core of building an effective information graphic game.

Here we consider a specific subset of game, which has already gained a degree of acceptability within news organizations, but which has not been applied before in the space of information graphics: the trivia game. The core mechanic of trivia games is relatively simple and involves successfully answering questions, potentially under some constraints such as requiring that questions be answered within some time-frame or with some point premium for difficulty [2].

Question answering provides structure to the interaction with the graphic (without forcefully constraining it) while at the same time allowing journalists to select and guide the experience of the graphic by focusing attention (Figure 1d). This stands in contrast to other forms of storytelling with information graphics, which either highly constrain interaction or leave the user to potentially flounder under the absence of any guidance to interesting landmarks.

The California Stimulus Map

In order to explore the differences between a trivia game information graphic and a regular information graphic we built two versions of the California Stimulus Map. The graphic visualizes the federal stimulus funds from the American Recovery and Reinvestment Act (ARRA) which were allocated to different counties and projects throughout the state of California.

The main map graphic shows the distribution of the stimulus money to different counties based on the shade of green (Figure 2b). Shading can also be normalized to a per capita basis. Hovering over a county reveals more information about exactly how much money that county received. Clicking a county filters the list of projects shown in Figure 2c. and updates the distribution of project money graph in Figure 2d to show how the funds are allocated across different categories such as "Transportation" or "Energy". Projects in Figure 2c. can also be clicked on for more detailed information about the project such as start date and budget. Also, hovering over the bars in Figure 2d. shows the total amount of money allocated to that project category.

Table 1. Questions used in the experimental (trivia game) version of the California Stimulus Map

Questions
1. How many millions in stimulus money has Sacramento County received so far?
2. On a per capita basis, which county has received the most stimulus money for projects so far?
3. How many millions in stimulus money has Sutter county received for "Water and Environment" projects so far?
4. In Sacramento County, what is the category of the project that received the most money so far?
5. What is the name of the air force base that received the lion's share of the stimulus money in Yuba County so far?
6. How many counties statewide have received more than $100 million dollars for projects so far?

The control version of the graphic contained no trivia questions (the user was left on their own to explore the data) whereas the experimental version of the graphic contained a series of six trivia questions which were selected to guide the user to different aspects of the data space (Figure 2a, also Table 1). In order to make the experience more game-like and add a sense of time pressure, an elapsed time indicator counted up as the user was answering the trivia questions. Also, a sense of competition was added by allowing the user to compare their completion speed to that of others and to see in what percentile they finished.

Experiment

We wanted to assess how the addition of trivia game elements to the California Stimulus Map would affect the exploration of the data space by users. In order to do this we instrumented both versions of the graphic to log how users were interacting with the different graphical elements. This included logging interactions such as "county hover", "county click", "project click", "graph hover", and "show per capita" toggle.

The control graphic was posted to the front page of the Sacramento Bee website (http://www.sacbee.com) on July 29th, 2009. Because the graphic was a real part of the news website we were unable to randomly assign users to either condition of the graphic or to assure that a given user didn't use both versions of the graphic at different times. Directly below the display of the control graphic was a link to the experimental version. The two versions were not afforded an equal chance of usage since the paper chose to promote the control version of the graphic more heavily. Thus, some interested people were exposed to both versions, with the control version more likely to have been seen first.

Another limitation of the logging methodology we employed is that we used IP addresses to try to identify

different users. In hindsight this was a mistake since routers can make different users' IP addresses from the same institution appear to be the same. Furthermore, without other data from users, such as from questionnaires, we are unable to control for possible covariates (e.g. age, interest level) or to measure perceived effects like frustration or enjoyment.

Results

The logging approach we used combined with the limitations of the deployment allow for only preliminary analysis of how trivia game elements affect the exploration of the data space. Again, due to the difference in the way the versions were promoted the control version garnered a lot more attention and was launched 17,327 times whereas the experimental version was launched only 597 times.

The results in Table 2 give an overview of how the number of different user interface operations varied between the two conditions. The counts have been normalized by the number of launches for each respective condition. They indicate the relative propensity for users to explore the graphics via hovering and clicking on different user interface elements. The frequency of "county hover", "county click", "graph hover", and "show per capita" operations are all higher for the experimental condition whereas the "project click" operation was lower in the experimental condition.

The results are generally consistent with the hypothesis that asking different kinds of questions can lead users to explore more of the data space. For instance, question 2 (see Table 1) can be answered by first toggling the per capita check box and then hovering over the counties with the darkest green in order to make a comparison of the actual greatest value. The frequency of toggling "show per capita" is much greater in the experimental version, likely because users needed this in order to answer the trivia question correctly.

Table 2. The count of user interface operations for each of the conditions normalized by the number of user launches of that condition.

UI Operation	No Trivia (control)	Trivia (experimental)
County Hover	46.64	93.62
County Click	1.99	2.23
Project Click	0.79	0.34
Graph Hover	2.19	2.69
Show per Capita	0.07	0.52

For the "project click" operation the trend is reversed, with a higher frequency of usage in the control condition. This may be a result of not asking a question in the experimental version that specifically required clicking on any particular project.

Discussion

Preliminary results indicate that users generally engaged and explored the data space more extensively in the experimental (trivia game) version of the information graphic. However, an alternate explanation for the higher frequencies of most UI operations in the experimental condition is that perhaps only people who were more interested in the graphic to begin with were the ones to launch the game version. Thus the people who used the experimental version may have already been more likely to engage the graphical elements.

Thus, while this work has excellent ecological validity, future work should be carried out in a controlled environment where better experimental design and logging procedures can help clarify these results.

A more controlled deployment would also allow for additional methods such as questionnaires or post-task interviews to get more at the experience of users. Furthermore it would allow for the investigation not just of the breadth of exploration via UI operation metrics but also the *quality* of the exploration and sensemaking process. This might be measured for instance via the number of insights or "interesting observations" that users report after using the graphic [6].

There are certainly limitations to combining trivia games with information graphics. Perhaps most significant is the authoring cost of having a journalist (or other sensemaker) go through the dataset to identifying interesting questions to ask. Since data is oftentimes updated in a news environment questions and answers also need to be rechecked for accuracy and relevancy after a dataset update. Another aspect of future work entails automatically generating questions and answers for a given dataset so as to minimize the authoring or re-authoring process. A potential weakness of an editorial process is that by selecting and emphasizing some things, other more subtle aspects of the dataset could be overlooked. We expect that a more rigorous future evaluation methodology will also help answer this question.

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