Dynamaps: Dynamic Queries on a Health Statistics Atlas

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ABSTRACT
Dynamic queries are user-controlled animated displays of visual or textual data. On an application developed for the National Center for Health Statistics and running on their ordinary staff equipment, a thematic map of the United States is animated by moving a time slider to illustrate trends of mortality rates. Other sliders filter parts of the maps interactively according to parameters such as demographics. During the filtering possible correlations can be observed as they create color patterns in the "dissapearance" of the states. This application has been received with enthusiasm by the user community and will be distributed with selected new datasets.

BACKGROUND

Dynamic queries
Dynamic queries (DQs) are user-controlled animated displays of visual or textual data. Several experiments have demonstrated that dynamic queries help users find trends and exception conditions [1, 2]. The National Center for Health Statistics (NCHS) proposed to investigate the use of dynamic queries as a health statistics exploration tool. The resulting application will be made available to researchers and epidemiologists with the release of selected new datasets.

This tool can be used to browse unexplored data and also to illustrate findings. For this application [4] the benefits of dynamic queries for exploring time trends and providing dynamic filtering in the search for correlations are demonstrated. The feasability of dynamic queries on thematic maps, even on a 386 PC (the only equipment widely available to the potential user community) is also seen.

Displaying spatio-temporal statistics
Traditionally, health statistics—like many other statistics—are made available through tables of averages, graphs and pages of detail data. Printed maps and atlases are used but access to detail is lost since all values are split by only a few categories used for the color coding; users still must refer to tables. Geographical Information Systems are now reaching the desktop world but they remain aimed at the *production* of maps rather than the exploration and rapid browsing of maps.

Showing time trends
For maps, time trends are traditionally shown as a series of small maps. Some software packages allow canned animations to be prepared and shown to illustrate findings. Real-time animation is repeatedly cited in the literature (e.g. [3]) but only as a desirable future development or reserved for high-end equipment. We believe that giving users control of the animation is a determining factor of the application's success. (Actually the video itself cannot quite convey the sense of control since it is the equivalent of a canned animation program.)

GENERAL DESCRIPTION OF THE INTERFACES
After the selection of a cause of death and of three parameters representing possible demographic confounders, a map of the US is displayed with the chosen mortality rate color coded for each state (e.g. the Cervix Uteri cancer rate [figure 1]). The states where the cancer rate is high are red (dark on the figure), the states where the rates are low appear blue and the other states are gray. On the right of the screen four sliders provide control over the map animation.

Showing time trends
When the year slider is moved from 1950 to 1970 the color of each state changes in real time, reflecting each state's rate change. Our example shows the overall decline in cervix uteri cancer rates over the years as well as geographical clusters.

Querying
In our example the three chosen query parameters for each state are the percentage of the population who went to college, the per-capita income and the percentage of

smokers. The user may set upper and lower bounds on the range sliders. States with values that fall outside the boundaries are set to the background color (black) while states with values within all the boundaries are set to a color determined by their corresponding mortality rate. For example, users could look at states having a college education percentage between 15 and 20%, an average per-capita income greater than $12,000 and a high percentage of smokers. This technique allows even first-time users to specify queries easily and with no errors.

Interactive filtering

When the college slider is slid from 28% (the maximum) to 10% (the minimum), the states will progressively disappear (turn black) from the map under user control. States with a high percentage of college educated residents will be turned off first while the states with a lower percentage will remain on the map longer. In the case of cervix cancer it can be seen that the low cancer rate states tend to disappear first and mainly "reddish" high rate states persist, suggesting a possible correlation. Because of the direct control, the animation can be easily replayed at will and at any speed until a suspected pattern can be isolated.

Access to details

Finally, an obvious but greatly appreciated benefit (compared to the traditional atlases) is the immediate access to all the detail data which appears on a form when an area is selected.

FAST ANIMATION

For dynamic queries real-time is essential, which means that changing the colors on the map must be instantaneous. The traditional technique of flood-filling regions is known to be too slow; the "states" version of our system illustrates that the simple but powerful palette manipulation technique allows dynamic queries to be used on common machines (e.g., on a 386 PC).

With a greater number of irregularly shaped areas, it is the display update speed which becomes the challenge for low-power PCs and not the data access. For example our 800 "county-like" areas version will not refresh fast enough

without efficient animation algorithms or the replacement of the irregular shapes by small regular shapes which can be processed faster. Of course zooming on a section of the map is always possible, making the real time animation feasible again.

CONCLUSIONS

This application has been very well-received by the user community. It is a compelling tool for both novices and experts. These methods hold much promise for improving access to large data sets because they utilize the remarkable human capabilities for visual pattern recognition. We want to encourage designers and developers to consider the use of dynamic queries as there are many practical applications today which can be implemented on ordinary equipment.

ACKNOWLEDGEMENTS

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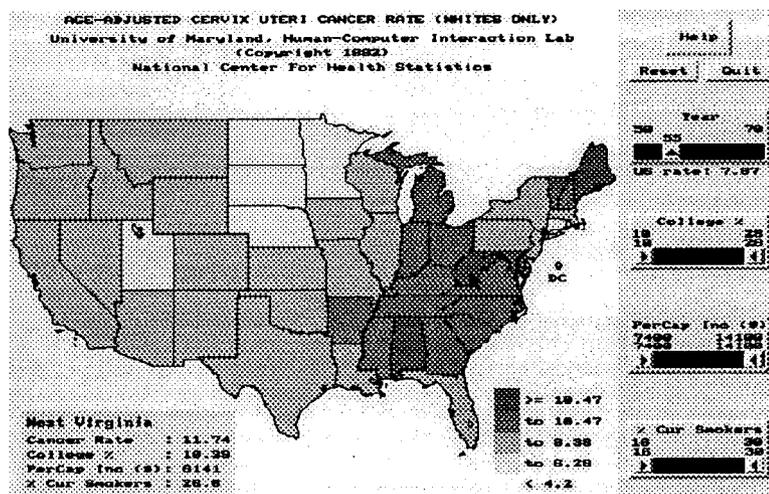
Figure 1:
Cervix cancer rates are color coded on the map. The year slider shows time trends. The other sliders allow interactive filtering of the map according to the three chosen demographic parameters.