VISUAL DATA EXPLORATION USING SPACE-TIME CUBE

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In our software system CommonGIS (an upgraded version of the system Descartes described in Andrienko and Andrienko 1999) data about events (earthquakes etc.) may be explored using the "space-time cube" representation (MacEachren 1995, pp.252, 254). Here time is treated as the third (vertical) spatial dimension while two planar dimensions represent geographical space. Events are represented as circles placed vertically according to the time of their occurrence (Figure 1), the earliest events being at the bottom of the cube and the latest at the top. Variation of circle sizes or colors can additionally represent thematic characteristics of the events, for example, magnitudes of earthquakes.

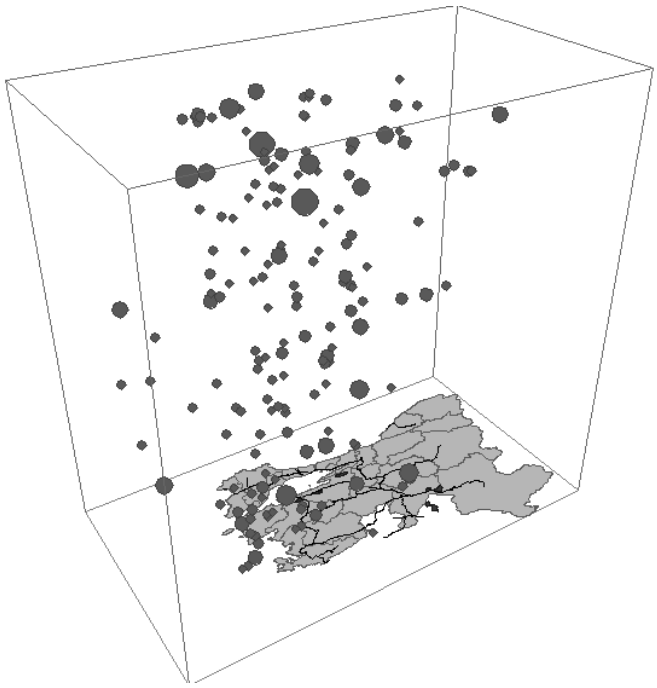

Figure 1. Data about events are represented in a "space-time cube". The vertical positions of the circles correspond to the times when the events occurred. Circle sizes or colors may reflect thematic characteristics of the events.

Data exploration using the space-time cube is supported by a number of interactive operations. Thus, the user can manipulate her/his viewing perspective into the cube. This gives an opportunity to check whether a bunch of circles really corresponds to a spatio-temporal cluster of events or this is merely a projection effect. It is possible to select a time subinterval and see only events that occurred during this time. The selected subinterval can be either stretched to the whole height of the cube or viewed as a "time slice" with the height of the cube corresponding to the entire period the data refer to. The subinterval can be shifted along the time axis. In response, the scene is dynamically redrawn thus producing an animation effect.

An important feature of the space-time cube presentation is its dynamic linking with a map as well as graphical displays of other types. This means that corresponding objects are identically marked in all displays when the user selects them with the mouse in one of the displays. This technique is illustrated in Figure 2: the user has selected a spatial cluster of events in the map and can see in the space-time cube how the events are distributed in time. In both the map and the cube these events are marked by circles with thick black borders.

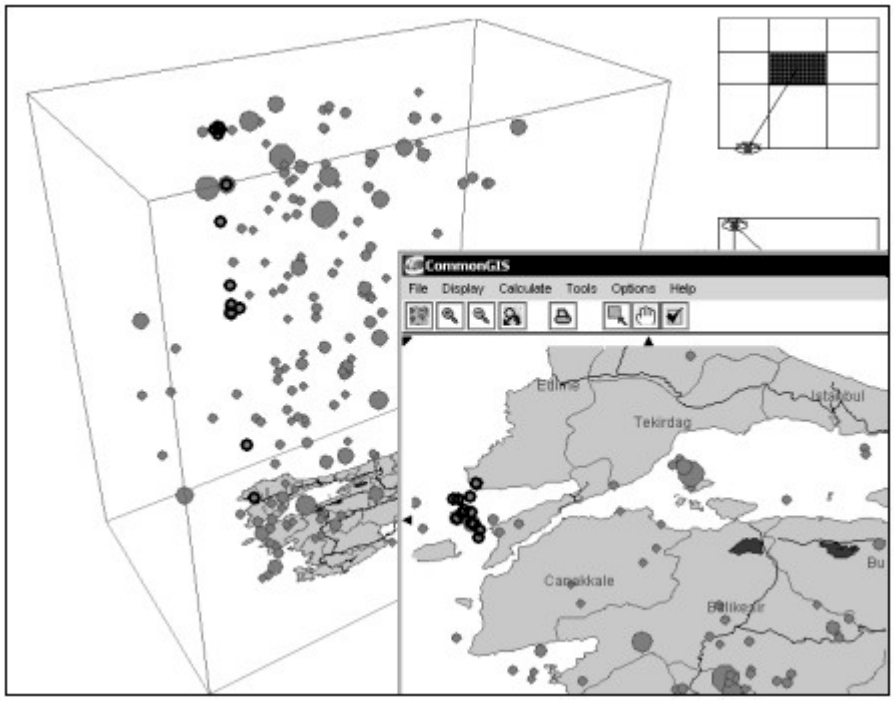

Figure 2. The “space-time cube” is dynamically linked to the map display by simultaneous highlighting of corresponding elements.

The space-time cube allows zooming in temporal dimension and in geographical space. In particular, the display reacts to zooming and panning of the map. Additionally, the space-time cube is linked to a dynamic query device that allows selecting events with specific characteristics (for example, only earthquakes with high magnitude).

The system will be demonstrated at the conference.

REFERENCES

[1] Andrienko, G., and Andrienko, N., 1999. Interactive maps for visual data exploration. *International Journal Geographical Information Science* 13, pp.355-374

[2] MacEachren, A.M., 1995. *How Maps Work: Representation, Visualization, and Design*. New York: The Guilford Press.

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Biography

Dr. Gennady Andrienko is manager of the SPADE team technology. He received his Master degrees in Computer Science from Kiev State University in 1986, and a Ph.D. equivalent in Computer Science from Moscow State University in 1992. He worked on knowledge-based systems at the Mathematics Institute of Moldavian Academy of Sciences (Kishinev, Moldova), then at the Institute on Mathematical Problems of Biology of Russian Academy of Science (Pushchino Research Center, Russia). Since 1997 Dr. Andrienko has research position at GMD (now Fraunhofer Institute AiS). He plays key roles in numerous international R&D projects, including EU-funded projects CommonGIS, SPIN!, and GIMMI. He is author of more than 100 refereed papers that have been published in international journals, books, and conference proceedings. He is active member of several commissions of the International Cartographic Association (Commission on Visualization and Virtual Reality, Commission on Maps and the Internet, and Commission on Theoretical Cartography). His research interests and experiences are interactive computer graphics, automated knowledge-based cartographic visualisation, information visualisation, spatial data mining, and visual geo-data exploration.