

Drawing Data on Maps: Sketch-Based Spatiotemporal Visualization

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ABSTRACT

Spatial data is frequently used in urban planning contexts to support decision-making. This data can be used to plan routes through the city for public transportation or to designate zones for planning new businesses and residences. Unfortunately, few tools exist that allow non-programmers to rapidly utilize spatial data to create such plans. In this poster, we present SpaceSketch, a tool for rapidly constructing map-based visualizations using spatial data. SpaceSketch utilizes a sketch-based approach to visualization specification in which hand-drawn trajectories and regions are encoded using a user-specified model. Using SpaceSketch, map-based plans can be rapidly constructed, compared, and altered on a multitouch canvas.

1 INTRODUCTION

Cities grow and change as a consequence of new technology, environmental factors, and the evolving requirements of their citizenry. Major metropolitan areas now have departments dedicated to analyzing and mapping important data. Crime, for example, is recorded by major cities and published frequently for review by the public. Crime data can be aggregated on a map to give a relative sense of how many occur in each neighborhood. While many tools exist for representing spatiotemporal data, they are primarily oriented towards creating static representations of general trends and patterns.

Unfortunately, these tools do not typically offer interactive methods for dynamically creating and comparing courses of action that are based upon an analysis of that data. In this poster, we describe ongoing research to discern effective representation and interaction methods that allow a user to rapidly sketch and erase trajectories and bounded regions on a map. The visual encoding of these sketched features are directly linked to an underlying data model, supporting a number of planning scenarios.

2 RELATED WORK

Geospatial representation has long been an important focus in the field of information visualization, and civic data of many forms have caught the interest of researchers. Rarely, however, does this include representing the predicted effects of a course of action or intervention that will subsequently change the underlying data. Some promising work in this area suggests that representation and interaction methods for a course of action within a data set vary greatly from a static analysis of an existing data set. In one such example, multivariate census data is presented along a trajectory plotted by the user[5]. The attribute signature, or route taken through the area, represents one potential path through the data that could be taken rather than data that has been collected from a route that was taken. One key difference from our approach, however, is that the system demonstrated by Turkay allows for exploration of a single trajectory rather than the direct comparison and manipulation of several potential trajectories concurrently. This also varies substantially from

other visualizations of trajectories which attempt to find meaningful patterns and trends in routes that were taken in the past[1, 2].

Previous research has also indicated that rapid, sketch-based prototyping of user interfaces can facilitate a more free-form exploration of alternatives[4]. Further, hand-drawn materials can often improve collaboration by facilitating conscription and by serving as boundary objects between different stakeholders [3]. Both aspects can substantially improve the value of an illustration as an artifact that promotes distributed cognition, allowing users to rapidly externalize and share mental models within a team. Finally, a “sketchy” rendering style can be used in information visualization to encourage annotation and to convey the unfinished quality of uncertain data [6].

3 SPACESKETCH

In this section, we present the details of SpaceSketch, an initial prototype for sketch-based spatiotemporal visualization. SpaceSketch is designed for use on a multitouch-enabled display with a stylus. The stylus is used to draw data sketches on the map, while touch controls are used for navigation within the display. There are two underlying data sets in the SpaceSketch prototype: spatial events and traversable roads. The spatial events consist of any type of an event that has a fixed location and point in time, such as a crime or a traffic collision. A traversable roads dataset is used by SpaceSketch to snap drawn paths to the location of actual roads that allow people to move around the city.

3.1 Sketching Paths

Using a stylus, a path can be drawn from one location to another on the map. The interface supports three modes of path sketching: (1) shortest path; (2) user-specified path; and (3) radial exploration. In the first mode, the system generates the shortest path between the endpoints using the traversable road dataset and ignores the shape of the path drawn by the user. This mode is useful when a user wants to quickly establish an initial guideline for getting from one place to another. The shortest path mode can also be used to extend a path indefinitely, moving between different waypoints as the user draws each leg of the trip on the map.

Each path consists of a sequence of path segments connecting the traversable intersections within the city. Once a path segment is constructed, its location is compared to the spatial events to determine how many events each segment is in proximity to. A kernel score is then derived for this path segment, which is used to determine the rendering characteristics of the path segment. Path segments with a higher score are encoded with increased salience through higher saturation and line width, though we are currently experimenting with other visual designs to convey this.

In the user-specified path mode, the user traces a path from a location. The system follows the traced line to construct a path that follows it, even if another shorter path exists. The system optimizes the route to try and find the shortest path that follows the one sketched by the user. When the user lifts the stylus from the screen, the system connects the path with the endpoint at the location the stylus was lifted from, finishing the path.

In the radial exploration mode, a user investigates the area around a central waypoint by dragging the stylus from that location to any distance around it. While the stylus remains down, a circle is drawn with the radius of the distance from the starting point to

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the stylus. When the stylus is lifted from the display, the system identifies all traversable locations within the circle from the central waypoint and creates a path to them (Figure 1). This can be useful if a user wants to explore the neighborhood within a certain walking distance around a central location. Multiple radial explorations can be constructed on the map at the same time, and can be connected by lines using any of the path sketching methods.

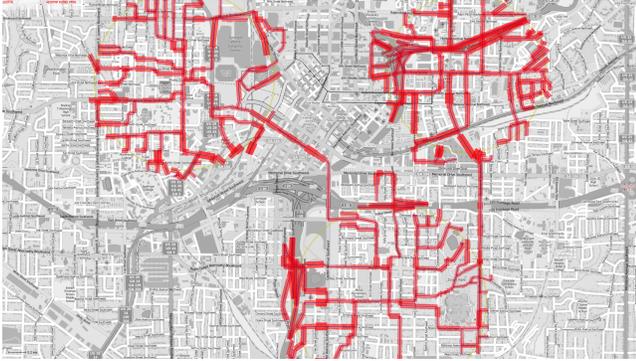


Figure 1: A user is investigating the area around three locations using the radial exploration mode, which constructs all paths within a certain distance from a central point. These locations have then been connected by drawing a path between them.

3.2 Sketching Regions

SpaceSketch also provides the capability to define regions on the map. A user drags the stylus around the defined area that is automatically closed when it is lifted from the display. The shading of the region is mapped to the number of spatial events (e.g., crimes) that occur within that region (Figure 2). The current rendering could be adapted to highlight the deviation of each area from the median number of internal crimes, distance of contained crimes from the shape centroid, and more.

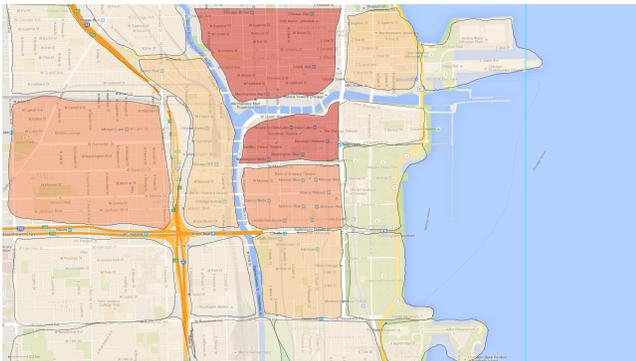


Figure 2: The area around downtown has been divided into a set of sketched regions. Each region is shaded by the number of spatial events that have occurred within it.

An additional feature of the bounded regions is that they can be used to “paint” paths that pass through the defined area. If, for example, a user specifies a radial exploration with a long distance, the number of paths constructed will be quite high. By examining the rendering style of the paths, the user can identify areas with a higher number of spatial events along each path, and draw a bounded region around those area. The paths that move through that area will then be shaded with a different hue, allowing the user to determine if alternate paths are available to reach the affected destinations

(Figure 3). If a new path is drawn as a branch from an existing path on the map, it inherits the coloring of the original path.



Figure 3: Regions have been drawn on the map to “paint” the paths that pass through them. Paths passing through the regions are encoded with a red hue, as are all paths that branch from them.

4 CONCLUSION

In this paper, we presented the details of SpaceSketch, an initial prototype for sketch-based spatiotemporal visualization. To allow city officials and citizens to more effectively make plans based on civic data, additional research is needed to discern effective representation and interaction methods that allow a user to compare courses of action within the context of spatiotemporal data. We plan to continue our exploration of sketch-based interaction methods, as the techniques described in this paper lend themselves to a number of potential applications. First, we will explore how sketch-based line drawing affects exploration of a city during routing tasks and subsequent effects on the internalization of spatial details. Second, we will work to apply sketch-based interactions to a design study to develop updated police zones and beats for the city of Atlanta. Finally, we will work within a participatory design study to collect novel interaction and annotation techniques and to understand the potential for sketch-based interaction methods in collecting public opinions on proposed changes to urban infrastructure.

ACKNOWLEDGEMENTS

The authors wish to the Atlanta Police Department for providing the open data sources used in the case studies. Support for the research is provided by the DHS VACCINE Center of Excellence.

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