Blogscape: Cartography on Social Networks

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ABSTRACT
In this paper we describe a visualization system for enabling location-based navigation of a social blog network. Our visualization has three parts: a map, tabular, and matrix display, to facilitate several selected user tasks. We use coordinated visualizations with an interface based on the principles of overview, zoom and filter, and details-on-demand to enable users to explore the information in a flexible way. In addition, we suggest future directions for extending our prototype visualization into more general functionality.

Author Keywords
Information visualization, Geographic visualization, Social networks, Coordinated views

INTRODUCTION
People are represented by large quantities of data. We have names, interests, experiences, friends, and family, to name a few. We also have a location (where we are) and a home (where we live), though those may not be the same place. Location figures largely in our lives and affects us in visible and invisible ways; however, in visualizing online relationships and interactions, place is usually ignored.

It is easy to underestimate the importance of place, but moving from city to city is often a stressful event, and it is increasingly common in today's mobile society. Friendships can become strained over distance. The growth in recent years of social networking software and blogs has enabled more people to keep in touch than seemed possible in the past, though virtual contact is no substitute for face-to-face interaction. They appear to have largely supplanted group email in some situations and have a much lower entry cost than sending a paper newsletter. Online social facilitation and the growth of virtual communities are two of the great success stories of the World Wide Web, acting to bring people together in the virtual sense.

These social networks exist in several different forms. One form is the dating service (Friendster [8], OkCupid [25], etc.). Sites designed to facilitate dating provide distance metrics in both the virtual (graph of social relationships) and physical (geo-spatial) senses, but the visualization focus is on seeing pictures of prospective friends or dates, rather than exploring the tens of thousands of people in each user's "friend space", which is defined by Friendster as *six degrees of separation* [19]. This number is not arbitrary, but rather based on the hypothesis put forward by Milgram in 1967 [8] and based on the writings of Hungarian writer Frigyes Karinthy from the 1920s [30], that people could be connected through mutual acquaintances such that there were no more than six degrees of separation between any two people in the world.

Another form of social network provides facilities for meeting people, with less focus on face-to-face meeting and more focus on self-defined communities (Orkut, etc.) [26]. Such networks provide a sense of community, but they are difficult to keep up with, as there is not always a sense of urgency in updating a profile or visiting the site. Once all of one's friends have joined a social networking site, and if visitors chose not to use the site for networking purposes, there is little point in following the site's updates.

A third type of social networking software is based on communities of web log (commonly referred to as blog) authors. Users of blogs use the software to facilitate social interaction [9]. Because of the quick updating and low overhead required for a blog or journal, these networks are quick means of communication — unlike static web sites, which may be difficult to update. These blog communities also offer constantly changing content, which keeps users interested in reading the site and revisiting it. Friendships formed and explored in these networks tend to be based more on shared interests and shared backgrounds than on physical appearance or location — in fact, many users do not even include a picture of themselves in their user profiles. Concomitantly, these networks emphasize virtual relationships more than other online social networks, and are used less to arrange face-to-face meetings.

Motivation
While communities of blog users are happy to interact virtually and independently of geographical location, exploring the relationship between geographic or regional location and ideas, beliefs, and interests is a rich sociological endeavor. From a practical standpoint this information can be used to develop goods and services, as well as provide a mechanism for understanding the development and propagation of ideas (sometimes referred

to as memes). A meme, under the definition proposed by Richard Dawkins in 1976, is a unit of cultural content that can be transmitted from mind to mind [5].

While there are a variety of tools that attempt to track ideas through the web (memepool [23], technorati [27], del.icio.us [18], blogdex [16], etc.), these tools neither attempt to map the propagation of ideas and interests geo-spatially, nor do they explore the social relationship between the meme holders. Tools that explore the mechanisms of meme propagation (direct physical contact or virtual idea sharing) would lend insight into the nature of the underlying thoughts and ideas.

Our goal is not to provide a mechanism for discovering memes, but to visualize their propagation through networks of virtually connected users. While we have narrowed Blogscape's focus to examine blogs based on interest instead of meme to avoid having to solve a large-scale text analysis problem, we believe our research tool provides a basis for more generalized inquiry into ideas in the form of interests. Some interests, such as "setting people's hair on fire with my mind," show propagation between users, which is slow-scale meme generation.

General class of problem

Visualizing blogs is difficult because there are many relationships possible in a blog database. Each person has many entries, many interests, and many friends. In this case, we have inferred a social network from a social blogging tool. We deal only with the publicly available personal information, recency of a person's entries, and the frequency of her updates, rather than doing a textual analysis on blog content.

LiveJournal, the social blogging tool that is the source of our data, is properly a network of users and their friends, but in order to visualize it more comprehensibly and concisely, we are looking at it as a tree [10]. In order to see if a person appears in a friends list other than the one that currently has focus, one would need to visualize that friends list instead.

We followed the guidelines set out in Shneiderman's 1996 paper [13], designing a visualization with Overview (general data visualization), Zoom and Filter (query functionality), and Details on Demand (information available for each node) functionality. This set of features allows users to interact with the interface and the visualization in a fairly consistent and natural way. Overview functionality allows users a way to see where the general trends in the data lie – do all of my friends live in the Northeast? Do all of the skateboarders live in Florida? Zoom and filter widgets allow users to specify particular criteria, like distance from themselves or depth in their friends structure, to pick particular friends or acquaintances out of the visualized data set. Details-on-demand

functionality allows the user to see what characteristics a given person has besides the filtered characteristics.

Our visualization includes several coordinated components. The first is a common set of UI elements, which provide Zoom and Filter functionality on several attributes, including both physical distance in miles and virtual distance in steps of separation. These visualizations also have a common Details on Demand section, which provides extended information about the selected individual. The visualization proper includes a one-dimensional tabular view sortable by attribute, a two-dimensional matrix (which may show additional dimensions with color and shape), and a geographic visualization that shows the location of friends and potential friends, with zooming capability provided by Piccolo [1].

The superimposition of the physical onto the virtual environment does not just facilitate off-line conversation. Knowing where someone lives can also be a clue to what sort of activities they enjoy, and in what form. Someone from upstate New York has a different experience of skiing than a Coloradoan, and neither one of them means the same thing as a Montanan.

LiveJournal

The social blog tool that we have chosen for this project is LiveJournal, which describes itself as "an online journal service with features that allow interaction between users" [21]. LiveJournal's user base included, at the time of this writing, 2,651,345 active users, posting 25,000 times per minute.

LiveJournal users provide personal information, to which they control the access. The only pieces of information that are always public are the user's username, her public biography area, her listed interests, and her listed friends, all of which are available from the user info page. Users are not required to list interests, but most users do. Optional personal information includes geographic location, in the form of City, State, and Country, which we find to be of interest. A user may also allow the list of people who have befriended her to be displayed, but this occurs at the user's discretion.

A friend is a very specific relationship within LiveJournal. A person's friends may read any of her journal entries that they are not specifically banned from reading. Befriending someone means that you intend to read her journal entries, and makes her journal entries appear in your default friends view.

User posts in LiveJournal may be locked to specific user-defined groups, usually simply the person's friends list. Blogscape does not use this information, unfortunately, as there is no way to tell from the public files when the last public post a user made was, but only the last post overall (which may or may not be publicly readable) and how

many posts total the user has made over the lifetime of her current LiveJournal account.

There are two classes of LiveJournal account: free accounts and paid accounts. As the names suggest, the free accounts are provided free of charge but have limited functionality, while paid accounts are full-featured. Certain types of search, such as a search on interest or location, require a paid account, though the information those searches are based on is publicly available. This lack of functionality means that certain types of search are more feasible for paid account holders than the general population.

LiveJournal specifically also includes a self-selected community feature, centered around interests or location. A user may belong to an interest-based community for several reasons -- because they are interested in the topic of the community, are good at performing or analyzing it, want to communicate a particular opinion, or because they would like to become good at performing or analyzing it. Some communities exist only to assist novices (non-members), while others may even be gossip forums for a particular real-life group. Though users may belong to location-based communities, one cannot assume either that everyone in a particular location reads a particular community, or that everyone who reads a particular community lives in a particular location. A person may belong to the Pittsburgh community because they live in Pittsburgh, because they used to live in Pittsburgh, or because they would like to live in Pittsburgh. Users are also given the option to provide location information, but a search on a particular location requires a paid account and returns a list of the 1000 most-recently-updated journals, displayed with user icon.

LiveJournal provides a large amount of functionality, but the interface to connect users is inefficient and limited by account type. We hope to extend LiveJournal's functionality by providing location and two-dimensional relationship information in the form of a set of visualizations.

RELATED WORK

Social network visualization is not a trivial task in information visualization. In many ways, the problem may not be definitively solvable because social network visualization is extremely task-dependent and because solutions may not scale well.

Location information is paramount for mobile-device-based social facilitation. Burak and Sharon [2] found that users of mobile devices were willing to use Instant Messaging clients to contact others in their immediate area. Location information in this case provided a basis for conversation. The survey associated with this project also found that privacy concerns were secondary in the minds of users to the willingness to meet new people, which Nardi and her colleagues corroborate [9].

Erickson and Kellogg [6] describe a method of designing systems to support social interaction, including allowing visibility, awareness, and accountability in online interactions. They suggest as well that there is some tension between privacy and translucence, which is why complete transparency is not the goal of online presence systems. Their concept of awareness depends more on online activities than personal characteristics, however Danis [4] suggests that the concept of awareness should be extended to include not only interactive behavior, but also personal characteristics, including tastes and location. This information allows users to choose whom to interact with based on similarity or aspirational similarity, bringing online social interaction closer to face-to-face interaction.

In their design for a location-aware event-planning system, Pousman et al [11] attempted to facilitate informal, quickly planned events based on location information provided by mobile devices.

Mobile devices are located based on their proximity to cellular towers or by internal GPS units. Web-based journaling software, however, does not automatically add location information to entries. McCurley [7] explored various ways to geoparse (parse for location information) and geocode (convert that location information to a spot on a map) websites. Though each user provides LiveJournal location information, it still needs to be converted to a machine-usable location for that information to be useful.

A map by itself is not enough to turn location data into information, and the tasks a system is designed for are not the only tasks it will be used for. Just knowing that a certain set of people live in various locations does not lead automatically to insight. Roth et al [12] provide strategies for coordinating multiple views to allow freer data exploration on large data sets.

A similar coordinated visualization for map data exists in DynaMaps, a way of visualizing Census data with yoked maps, scatter plots, and tables [3]. These maps use double-ended sliders for filtering, and sortable column views for choropleth maps. Like many specifically geographic visualizations, DynaMaps use a choropleth map to show a value per area – they look for patterns among groups of demographically related people, rather than individuals.

There is also a tradition in LiveJournal, which is an open source, constantly changing project, of adding interesting tools to visualize the LiveJournal data set. These tools are most popular when they allow users to find out something about themselves or their friends, like the popular tool LiveJournal Connect, which provides a path between any two given users' friends [22].

The social network visualizations that exist for LiveJournal tend to use large node-link diagrams to show relationships. One that provides an intersection of friends and interests in a node-link diagram is the Touchgraph LiveJournal

Browser [29], but it does not scale to large numbers of users, and it is unclear which interests are shared with which people. Location and attributes other than interests are not handled at all in this tool.

USER TASKS

We address the general problem of making connections with other social blog tool users based on durable personal characteristics, such as location.

In the current LiveJournal interface, these tasks are made more difficult by the disconnected user information areas. Each user has a profile, or information page, which uses hyperlinks to connect to the users on her friends list.

Users may want to find particular users that share their interests. In the current LiveJournal interface, this is possible for paid account users: they can enter an interest or click on an interest in a profile (often their own) to search for other users that share that interest. The result set returned, however, is capped at a thousand, spread over several linked pages, which include each of those thousand users' icons.

A similar process will currently allow users to search by geographic location. Users can either enter a location or click on a City, State, or Country to see the journals from that location. However, this only allows the search of a specifically designated location, such as College Park, MD. It does not allow for locations like "Downtown College Park, MD" and, as above, returns a set of at most a thousand user pictures. These limits make sense for a sequential display of user names and pictures, but they limit search to the thousand most recently updated journals in a particular area.

For the problem of finding other users in a particular area that share a particular interest, the only solution that currently exists is to follow one of the strategies described above on one dimension, then check each individual user to see if they fit on the other dimension. This process will be time-consuming for any interest or location that encompasses more than ten or twenty users. To keep this in perspective, there are over a million users who list "music," the most popular interest, and for another example, over 70,000 who list "politics." The task of finding a particular user and interest may seem abstract, but the simplest example would be starting a sewing circle or sailing club, or discovering who to invite to a wine tasting. In these cases, finding like-minded individuals in one's immediate area would be paramount.

Because LiveJournal is a blogging service as well as a social network, on top of meeting people one would like to get to know, a system should support finding people whose journals a user would want to read – people who have interesting experiences but who may not reciprocate the user's interest. This task includes finding people who pursue a particular interest in a particular area – for instance, one who was interested in skateboarding on the California coast might seek out skateboarders in California. This task could be accomplished in a similar fashion to the above task, though one would need to search for a particular state or city, then check through each user on that list for a particular interest.

In addition to locating people in a particular area who pursue a given interest, one might also like to be able to find users that resemble oneself in different parts of the country. This search would entail determining which of one's interests were most important or most distinctive, then seeing what people who shared those interests had to say. Searching for similar users would involve searching on one's most diagnostic or important interests, then looking for location information in those selected users' profiles. This sort of search would be useful, for instance, if a user were planning on moving and needed to know what the academic communities were like in particular cities.

The most abstract sort of task would be to find out whether particular interests correlate with particular areas. Do skateboarders congregate in California? Do people in Maryland really like turtles exceptionally much? Do people who like to raft move to the Pacific Northwest? Finding the intersection of interests and location is almost impossible in LiveJournal. This sort of search may, however, be misleading because of the previously mentioned disparities in how interests are realized in different parts of the world.

KEY VISUALIZATION DATA

Physical

The location where a user identifies herself as residing is represented within LiveJournal as a triple of City, State, and Country. We geoparse that information into a location that can be plotted on a map using the US Census Bureau's TIGER system [28].

From that location information and the location information of the root user, we can compute a spherical distance metric, which is used to filter users on the map view, and to color users in the matrix view.

Virtual

The similarity of interests can be defined as the proportion of the root user's interests shared by the target user. For a given user, this could be represented by the following equation:

$$similarity = i_{common} / i_{root}$$

where i_{common} is the number of shared interests, and i_{root} is the number of interests that the root user lists.

The path distance, also called virtual distance or depth, is the number of hops required to get from the root user to the target user following the path above.
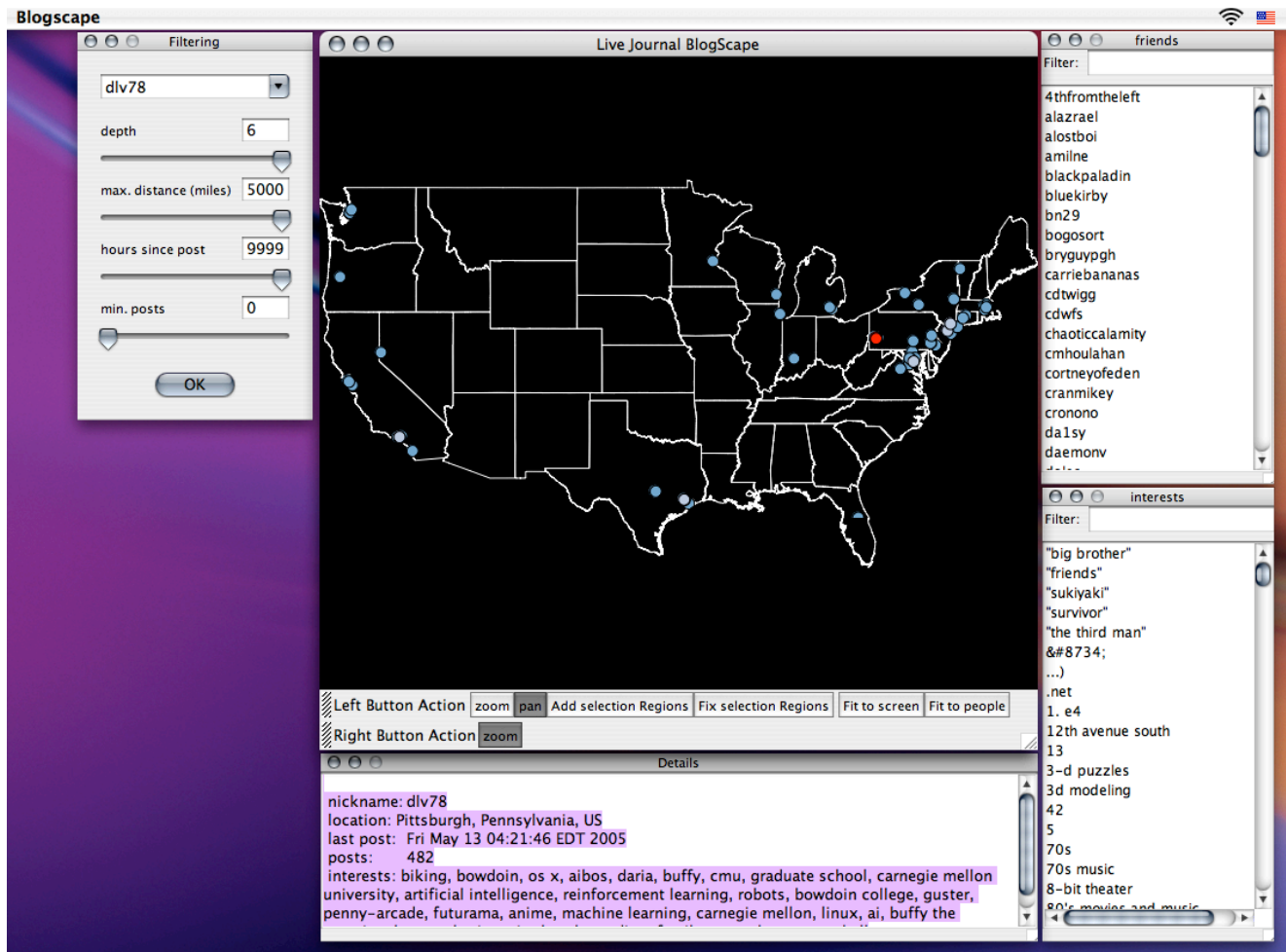
Figure 1: Map view and User Interface.

We determine the total number of posts based on LiveJournal information provided in the user's profile.

Each user's LiveJournal profile also includes the time stamp of that user's last update to her journal.

VISUALIZATION TOOL

User interface

We used a common set of user interface elements and a common set of coordinated visualizations, including: a tabular interface, a map interface, and a matrix interface, to facilitate conclusions across visualizations, interface elements, and details.

Our user interface includes areas to enter the user name and interests of note, as well as sliders with text box entry to control the filter levels, such as distance and depth in the user's friend space.

The user interface also includes a details box, which gives the path to the target user that produced the depth rating, as well as common interests.

Our table view is a simple table of all the search results, sortable by any attribute, including tree depth, distance, and last update time.

By default, the Tabular view includes columns for username, distance from the root user, location, depth in the root user's friend space, and similarity to the root user, as measured by the number of common interests they share.

Map view

Our map view plots the locations of users on a map of the United States. Users at greater relational depth are rendered in a darker color, causing more peripheral users to appear to recede into the background. Those peripheral users are still selectable, however, because they may be the people of interest in a particular search – sometimes one is not looking to explore information about close friends, but rather about potential friends.

Each level of depth in the relationship graph is a rendered in a different graphical layer, so that changes in tree depth selection can be filtered quickly enough to remain responsive to users' input.
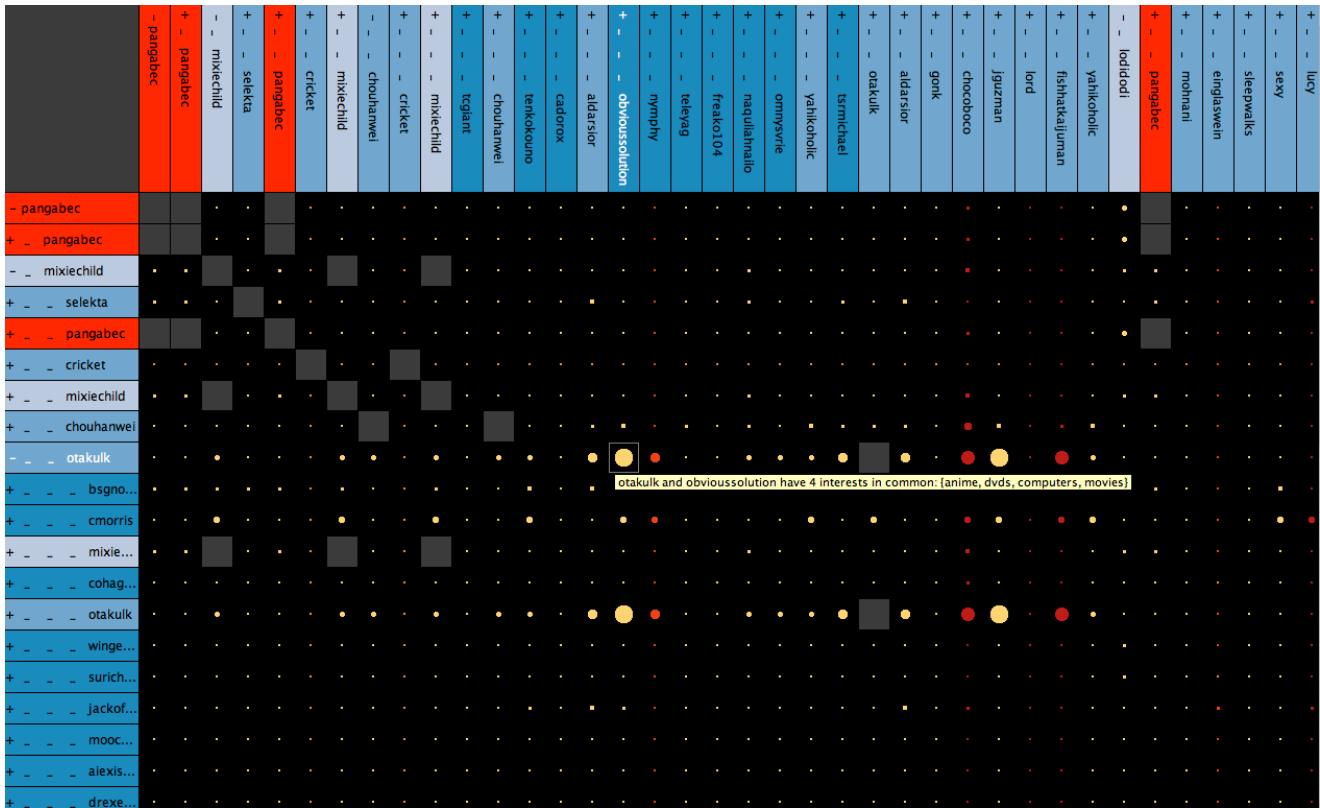
Figure 2: Matrix view.

Users in close geo-spatial proximity, such as a set of users in the same city or metropolitan area, are rendered with slight alpha values and randomly displaced a small amount graphically to mitigate occlusion issues in densely populated areas.

Matrix view

Our matrix view follows closely on principles learned from Matrix Browser [15]. We present a 2-dimensional view of a user's immediate social network, where each row and column represents a user in the relationship graph. Both dimensions of the matrix are visualized as a hierarchical, visually foldable, list of users. At the intersection of each row and column two pieces of information are visualized: the similarity of interests (indicated by a circle with radius proportional to the similarity metric) and the physical distance (represented by the color of each circle).

For this visualization we use an asymmetric computation for the similarity of interest that leads to the need for a complete matrix (as opposed to a upper or lower right-triangle view). Our similarity metric is the same as the one we mentioned above, with the difference that the root user is not necessarily the user for whose interests we are computing the similarity, but rather the user selected in the row heading:

$$similarity = i_{row} \cap i_{col} / i_{row}$$

Thus each row shows the similarity of the users listed in columns to the user listed in the row. To find out how similar to other users a given user is, one can follow that user's row to find out how many of her interests other users in the matrix share, and follow her column to find out how many of her friends' interests she shares. A tool tip available at the intersection provides a list of what interests those two users share.

The advantage of a matrix view over a node-link diagram is that a matrix takes up less space and can be collapsed hierarchically in a more intuitive way. In addition, the color landscape should provide a good overview of interesting locations in the abstract friend space at the intersection of low distance and high similarity.

Details Views

Complete details for the currently selected user are provided in a dedicated window. For each user we list: username, location, number of posts, time of last post, and all of her interests.

In separate windows, we provide a complete list of the currently selected user's friends (to a depth selected by the filtering interface), and a complete list of their interests. Each of these lists is automatically kept sorted in an alphabetic fashion.
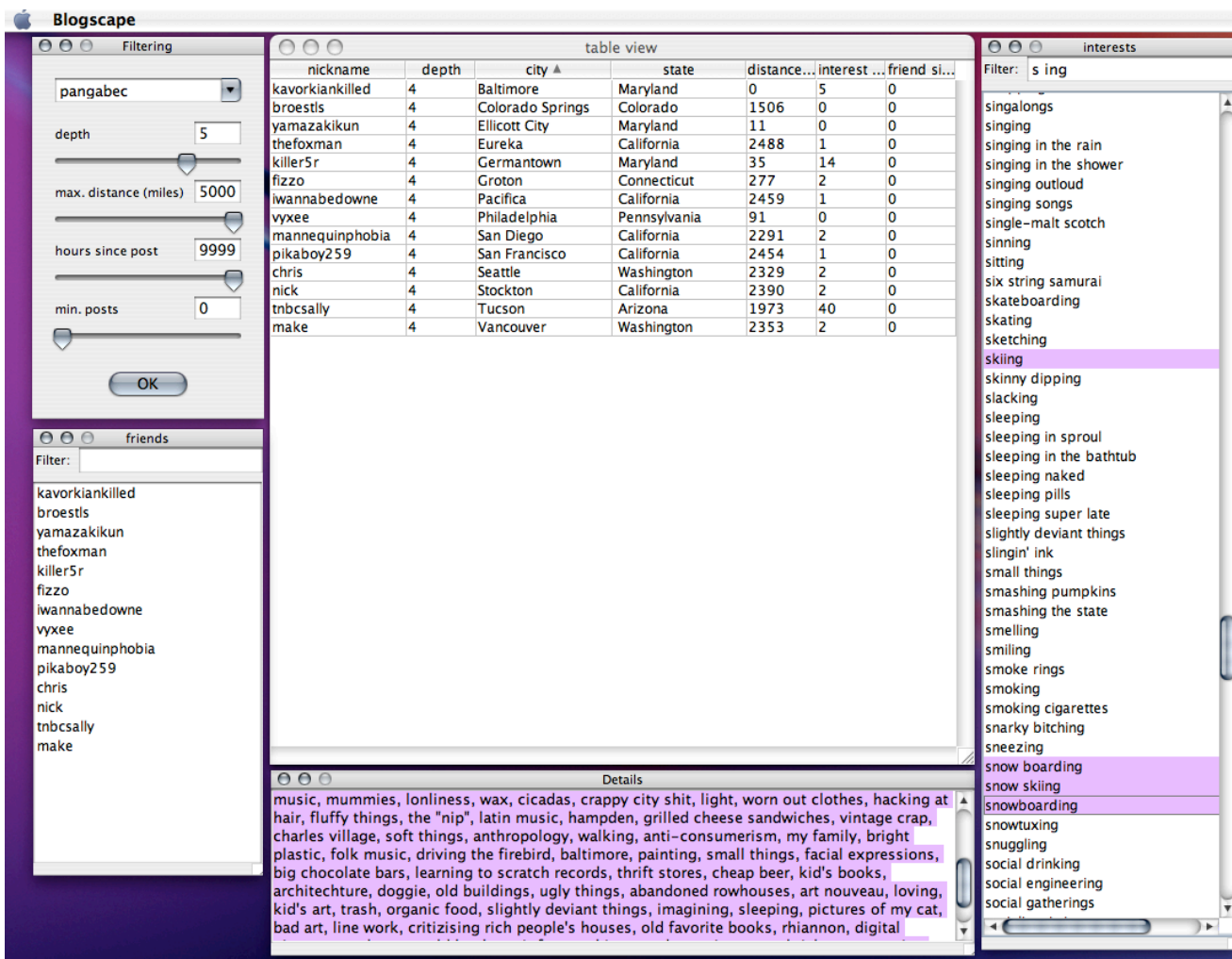
6

Figure 3: Table view showing filtering.

Filtering Interface

Throughout Blogscape we provide common filtering tools that affect each view simultaneously. These tools allow the user to focus the visualizations on criteria they are most interested in examining. We also use a type of dynamic filtering called Glazed Lists [20] in which a user can type in a partial name to match within either the friends or interests view. When a particular set of users is selected, their common interests are highlighted as well; when a particular set of interests is highlighted, the users that have those interests are shown in the friends list.

We provide tools to filter on a set of interests, distance from the currently selected user, path length to the selected user, number of posts, and time of last post. Our goal is to provide a quick way for the user to reduce the density of our visualizations while still allowing them to focus on interesting data.

INTERNAL ARCHITECTURE

Blogscape includes several components written in Java that are linked together. The map view uses a map that is loaded into Piccolo [1] for added zooming flexibility. The friends list and interests list use a tool called Glazed Lists [20] which allows dynamic filtering and sorting of a list. Some parts of the interface were designed using the Macintosh interface development tool, InterfaceBuilder, in conjunction with the Nib4J Java Library [24]. We used ColorBrewer to pick the colors in all views [17].

The data is dynamically downloaded from LiveJournal as the tool runs the first time, and then cached into local files to speed up later runs of the visualization. We have also locally cached the TIGER Census data [28] to provide a simpler query for location based on city name.

TASK FACILITIATION

The question that comes to mind, then, is whether the tool we have described will enable users to perform the tasks we have described. Do these two pieces mesh together?

Finding a user based on particular interest in our visualization involves entering that interest. Unfortunately, we currently do not have the computing power to search all of LiveJournal for every user with a particular interest, but we can find all of the users within a user's friend space (multiple degrees of separation) that list a given interest.

Finding a user in a particular geographic region with our visualization is even simpler – one can plot all of the users within a friend space on the map, and then see which appear in a particular geographic region. The depth slider allows scaling back of the number of users displayed, reducing the possibility of information overload.

The problem of finding other users in a particular area that share a particular interest in our interface involves entering the interest as a filter, then looking to see what appears on the map.

Finding users whose blogs one would like to read based on personal characteristics like location and interest is similarly well supported.

Finding models for oneself in other areas of the country would involve looking for high numbers in the similarity metric that we provide in a search based on location.

The abstract task of finding out where people interested in a particular thing live would also involve filtering an overview map based on the particular interest listed.

CONCLUSION
In this paper, we have described a system for bringing together personal information like location to allow users to select what people to meet and what blogs to read. Our system enables users to find others with certain interests in certain parts of the United States.

The location information we use is publicly available. It is always a good idea for users to monitor what information they provide that will be displayed on the World Wide Web if they are concerned about privacy.

Coordinated visualizations with comprehensive and common user interfaces like the one we describe seem to be the future of information visualization; flexibility and the freedom to create a customized visualization are more useful to more users than a completely static display which requires serious tweaking to provide a useful visualization of the information. Forcing users to think about how the tool works breaks the fourth wall and thus increases cognitive load, as the user must mentally model both the tool and the data to understand the results.

FUTURE DIRECTIONS
Many of the authors whose work we looked at used location information to find others on mobile devices. Our interface, because of the problem of fitting large maps onto small devices, would probably not be well suited to high temporal granularity, small device interaction. Higher

temporal granularity is a laudable goal however – knowing that someone is traveling would allow for unscheduled interactions along the way. If I am in Boston, my location should be Boston, regardless of whether I actually live in San Francisco. This tweak could allow for more spontaneous, informal interaction with other users who normally live in different parts of the country. Currently our visualization is static, in that it only describes one point in time.

Being able to index individual posts rather than individual users based on automatically-parsed location information would also be useful, in that it would allow users to discover how others have, for instance, found rafting in central Texas. Travelogues and reviews of particular places could be tagged, automatically or manually, with location and interest information. The opinion of someone whose main concern is the linens in a particular hotel would not matter as much to someone else who was more interested in its proximity to good whitewater rafting.

A minor improvement to allow for more geographic awareness would be to allow users to select a set of points on a map, which would represent users within their friends space. The table view and detail view should then display information about the selected users, extending the way the interface components are coupled together.

As on many social network tools, duplication of users is a significant problem, and visualizing people who do not have a direct connection to the root user in matrix view is difficult. A de-duplication utility would be useful to remove redundant information from the matrix view, and glazing (filtering as one types) on the matrix view would allow for a more extensible matrix visualization.

Our map type of visualization can also be extended to the entire world, rather than just a map of the United States, as we have done in this pilot. International extensions would require language as well as location information. Many LiveJournal users live in Russia, and not only use a different language from the American user base, but a different alphabet, making automatic translation even more difficult.

The map we are using is an accurate visualization of location information, but distance is a one-dimensional attribute. Our visualization should also be customizable, like TreeMap [14], to allow the user to choose what colors and what attributes should be displayed in each view (particularly the matrix view) at any given time.

The addition of personal context information, provided the user is willing to release such information, allows for richer online interactions. Adding a location component to social network visualizations can add a face-to-face component as well that would enrich personal relationships.

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