

VISUALIZING BACKCHANNEL FOR LARGE-SCALE EVENTS

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ABSTRACT

The concept of a Visual Backchannel as a novel way of following and exploring online conversations about large-scale events. Micro blogging communities, such as Twitter, are increasingly used as digital backchannels for timely exchange of brief comments and impressions during political speeches, sport competitions, natural disasters, and other large events. Currently, shared updates are typically displayed in the form of a simple list, making it difficult to get a summary of the fast-paced discussions as it happens in the moment and how it evolves over time. In distinction, proposed Visual Backchannel design provides an evolving, interactive, and multi-faceted visual overview of large-scale ongoing conversations on Twitter. To visualize a continuously updating information stream, visual saliency for what is happening now and what has just happened, set in the context of the evolving conversation is included. As part of a fully web-based coordinated-view system, Topic Streams, a temporally adjustable stacked graph visualizing topics over time, a People Spiral representing participants and their activity, and an Image Cloud encoding the popularity of event photos by size are included. Together with a post listing, discuss our design considerations, in particular with respect to evolving visualizations of dynamically changing data.

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INTRODUCTION

Digital backchannels are an emerging social phenomenon. As people are watching political debates, attending educational events, or even coping with natural disasters, they increasingly share brief and timely pieces of information in digital backchannels, which create persistent conversations about events of social significance [1]. Digital backchannels have become an intriguing communication medium, over which more and more people exchange impressions, suggestions, and comments during events [2]. Such backchannels not only enable participants to share their experience and shape how observers perceive an event, they are also used to help participants' influence the unfolding of an event and its outcome.

As these digital backchannels rise in importance as social imitation spaces, in which people complement and co-create large-scale events, significant limitations with current methods of displaying information are seen. The widespread chronologically ordered lists alone are not sufficient for large-scale backchannels in that they are not able to adequately represent the scale and dynamics of real-time conversations. This has the unintended but well-known consequence that participants get distracted from the main event, have difficulties focusing, and lack an overview of what the backchannel contains.

To explore these issues, Visual Backchannel, an evolving, interactive, and multi-faceted interface that integrates three visualizations with a list of backchannel

posts via linking, brushing and filtering are introduced. In order to give new perspectives on backchannel conversations [3]. This is accompanied by two compact visualizations, People Spiral and an Image Cloud, presenting visual aggregates of active participants and shared images. These visualizations offer a visual sense of the conversation at the moment, using visual accentuations that make the present visible, in the context of the topical development. This way Visual Backchannel provides saliency and visual evidence of what is happening now, and what is recent within the ongoing temporal context of how backchannel conversations unfold over time. The four views, which are linked via highlighting, brushing, and filtering are designed to provide organically evolving representations of a constantly changing data set, and interactive access to the temporal distribution of topics, the most active participants, salient photographic impressions.

In this work, there are two main contributions:

- The notion of evolving visualizations that integrate representations of current activity and recent development in continuous information streams, such as digital backchannels are proposed.
- Three novel interactive visualizations that summarize the main facets of large-scale backchannels and provide exploratory interactivity along time, topics, and people in the context of a Visual Backchannel interface are introduced.

TOWARDS DIGITAL BACKCHANNELS

The problem space around digital backchannels as socially significant information spaces during events, and to summarize, there has been some promising research on visualizing the development of topics over time. While existing stacked graph techniques focus on static datasets with fixed temporal and topical granularities, a highly dynamic and interactive stacked graph technique. Visualizations of news, tags, and tweets use primarily motion to represent data change are introduced. To our knowledge, there has been no work on evolving views combining both current and past changes of topics over time. In this work, to integrate current, recent, and past topic changes using visual and interactive representations design goals for a Visual Backchannel interface is needed [4].

A. Problem Space and Scope

At the beginning of this work, brainstorming session was held with about 10 colleagues to gather initial feedback on the type of events they wanted better backchannel support for and the problems—in particular with regard to participation—they experienced at such events. Based on their feedback, a broad range of events and a selection of the main problems with existing event backchannels have been identified. The collected problems centre on following the main topics being discussed, knowing the people participating, and managing attention between the main event and the backchannel.

Too Many Voices: - Active events and backchannels attended by many participants make it difficult to follow the conversation or even engage meaningfully, as there are “too many voices” and “too many people to listen to”. Instead it would be ideal to be able to “hear the ‘voice of thousands’”.

Sea of Strangers: - During large-scale events participants may feel “lost in a sea of strangers” as it is difficult to know who else is in the meeting” or event. For example, it can be hard to “find like minded people” or to “find my tribe”. Experiencing a large-scale event often gives the opportunity for meeting new people and “not just talking to the people you come with”. A requirement for this is for oneself to be “seen as attending” as well, which means that a person’s participation and presence at the event is visible to other participants. Losing focus and distraction is a critical problem provoked by the competitive nature of the main event and the backchannel. With many people and posts to follow, participants have difficulties deciding “what to focus on”, which often coincide with a “lack of attention to meeting itself”.

B. Goals for a Visual Backchannel

When considering large-scale backchannel conversations, there is a growing need to consider fragmented awareness and the shifting attention of participants [5]. In order to explore these issues of switching between the main event and the backchannel, to represent the “now” in the context of the “recent” are attempted. By aligning the visual variables for current activity with the representations for recent developments.

Summarize the conversation:- A Visual Backchannel should include views that summarize the topical, social, and pictorial aspects of backchannel conversations, decreasing the cognitive effort required to follow a backchannel. The main topics, most active participants, and most popular images of a conversation should be visualized indicating both activity and development.

Integrate the ‘now’ and the ‘recent’:- Visualizations should capture how a backchannel conversation is unfolding at the current moment and in the context of its recent development. These way participants should be assisted in making sense of current activity by being able to review recent developments. For example, when briefly switching attention away from the event toward the backchannel, it should require little effort to recover awareness and focus.

Extend presence of the present: - As the ‘now’ really does not take any time, there should be visual accentuations for current activity such as incoming posts and subsequent changes in the visualizations. This way current backchannel activity should become more comprehensible. Ideally, the half-life of visual highlights representing the present should bridge the gap to the visualization of the recent past.

TWEETS AS DATA

To approach the aforementioned goals for a Visual Backchannel, the turn is to microblog community. Twitter as a widely used backchannel platform. In exploring new visual interfaces for backchannel communication than creating a new backchannel platform, to build on Twitter, which already has a large and active audience is decided. Besides the wide adoption of Twitter, the choice was also influenced by Twitter’s open API that allows for relatively simple and automatic access to its publicly shared posts.

A. Short Live Updates

Tweets are limited to 140-character length, initially in order to work with SMS texts, but this limit could also be seen today as an attempt to manage attention. For the purpose of Visual Backchannel we focus on a tweet’s author, timestamp, and text. The author and time information of a post is easy to obtain and essential for indicating the activity of backchannel participants and visualizing temporal development.

A tweet’s text holds a wealth of valuable additional information. The text in a tweet holds the words that can be used in aggregate form to give a broad sense of what a conversation is about and, in combination with the timestamp, to indicate its topical evolution. A tweet may also contain links to images, possibly taken using a mobile phone during an event, which we can use to provide live pictorial impressions from event participants. Furthermore, there is a convention among Twitter members to indicate whether a tweet is a quotation by somebody else, namely a re-tweet, by prefacing the tweet with the original tweet’s author and the letters RT.

B. Text Analysis

The processing of tweets is different from previous work on text visualizations of email archives, blog posts, and news articles. Our ‘documents’ are at most 140 characters long and typically do not contain explicit keywords, subject headings, or tags except perhaps for hash tags [6]. We believe that using re-occurring words used by participants as topics for the Visual Backchannel results in a truthful representation of what a backchannel conversation is about. The challenge with using freeform text instead of pre-selected categories is that the resulting topic dimension will have a higher degree of noise and variance. The goals of the following processing steps are to reduce noise and variance and extract meaningful topics that are rooted in the actual tweets.

- Images and re-tweets. First, we extract event photos that are typically associated with tweets as links to image

services, such as Twitpic9. We determine whether a post is a re-tweet quoted from somebody else by looking for substrings of RT. This is done before the subsequent processing steps, since links and re-tweets are not considered in the Topic Streams.

- **String cleaning.** Noise becomes negligible as we aggregate large numbers of tweets, remove special characters and URLs, and make the text lowercase. The resulting string consists now only of letters and numerals. Then we split the string at white space characters in order to get individual words.
- **Stop word removal.** To reduce the number of less expressive words, we remove 120 stop words, common words (such as “a”, “is” and “can”) that typically do not carry meaning. We also consider the search term we use to aggregate the posts from Twitter as a stop word and remove it, since it would be associated with all tweets across all times thus not adding any information.
- **Stemming.** We reduce the number of words further by collapsing those words that carry similar meaning using a basic Porter stemmer algorithm. For example, singular and plural versions of the same word, or noun, adjective, and verb versions of the same stem are collapsed together into single stems. We display the most frequent word per stem as a label, which worked well in our experience.
- **Associations.** We associate the extracted aspects with the original posts and store them in a relational database. In summary we now have the following information for each backchannel post: time of publication, full original text, extracted topics (word stems), author name, image link, and whether it is a re-tweet.

This information allows us to visualize several dimensions of a backchannel conversation [7].

DESIGNING A VISUAL BACKCHANNEL

The design and implementation of Visual Backchannel as a coordinated-view interface provides interactive and visual access to the current activity and ongoing development of backchannel conversations. Besides featuring a conventional list of backchannel posts, the Visual Backchannel interface consists of three novel visualizations that are linked in order to support cross-filtering and brushing. The primary visualization using the most screen real estate is Topic Streams, a stacked graph visualization of conversation topics, below which there is a People Spiral, a helical view of the most active participants, and an Image Cloud featuring photographs taken during an event.

While being designed to create aesthetic aggregations that summarize topical, social, and pictorial aspects of a backchannel over a given time period, these visualizations also accentuate current activity in on-going backchannels using ‘half-lived’ highlights in the context of recent developments. The visualizations provide ways for interactive and responsive cross-filtering along time, topics, and participants. Furthermore, the interface features interactive representations of currently set filters, including text search, and a conventional list of backchannel posts giving rapid access to the data being visualized.

A. Topic Streams

The primary view of our Visual Backchannel is used by Topic Streams, an interactive stacked graph that visualizes live-changing textual data across time and supports interactive exploration by temporal zooming and

panning, and topical filtering. In contrast to previous stacked graph techniques that relied on fixed time intervals and pre-defined categories, such as news topics, movie titles, and artist names, our Topic Streams support multiple levels of temporal zoom and are based on the changing textual contents of tweets.

B. Representing Conversation Development

The visualization uses an integrated set of visual variables and arrangements to encode topical development:

Position. The x-axis of the visualization is used for the time dimension. Depending on the time window, there are date and/or time labels on the top. The present is positioned at the far right edge of the view, unless the viewer changes the temporal selection to a past time window. Analogous to previous stacked graph techniques, the y-axis is used to encode relative frequency of topics by the vertical width of the stream corresponding to a topic at a particular time point.

Ordering. Recent work on stacked graphs suggested novel methods for finding ideal stream orderings in order to reduce ‘wiggle’ between time intervals. One of the suggestions is to arrange arriving streams on the outside (both top and bottom) and streams that have arrived earlier close to the middle of the stacked graph. We experimented with many ordering techniques, however, we experienced very unstable orderings of streams for different time spans leading to abrupt re-orderings when zooming or panning along the time dimension. To avoid excessive visual activity through reordering, yet still use the order of streams in a meaningful but more stable way, we decided to order by general newness of a topic from top to bottom of the streams. The choice of newness as an ordering measure over time of first occurrence is based on the observation that the first occurrence of a word in an individual tweet alone does not make it a conversation topic, but only when it is picked up by multiple participants.

Colour. The newness of topics with their stream colors, as the stream ordering only represents a ranking and not a distribution of values. The mapping from newness to colour is done in the HSV (hue, saturation, value) colour space. A subset of the hue spectrum between blue and green, with the newest topics represented by green and the oldest in blue is chosen. To make the streams of newer topics appear brighter and more saturated we map greater newness to higher saturation and higher value.

Scaling. While the vertical width of an individual stream at a specific time interval is determined by the relative number of topic occurrences in tweets during this time bin, the overall sum of the stream widths per time interval corresponds to the sum of occurrences of these most popular topics. We scale the topic visualization so that the time bin with the most topics uses the full height of the topic view in the interface. This has the effect that the Topic Streams are rescaled between filter explorations. While this carries the danger of impeding comparability, we indicate the rescaling through animated transitions.

Labels. The topic visualization is also accompanied by textual labels. For each topic there is a label positioned at its widest section of the corresponding stream. The label that is used is the most used word instance of the particular stem. The font size of the label is correlated with the overall number of occurrences of the topic in this time window and its colour is a darker tone of the colour of the stream. There

are date and time labels at the top of the visualization for temporal intervals. Faint vertical lines demarcate the different time bins.

C. Representing Current Activity

Complementing the visualization of topics changing over time, we see a need for representing current activity in the backchannel in the context of recent developments. We want to represent data change in ways that are comprehensible and not lost when following the visualization only peripherally or sporadically, which is likely during events. To encode current activity we are focusing on three main visual variables: colour, position, and motion. These variables are not in conflict when used for representing topical development, as they can be seen as extensions from the present into the recent past.

Position. We position the present at a clear location, namely the far right of the topic visualization. This way the viewer can expect the most change in a particular region of the interface. Similar to the temporary use of colour, the position of the now gradually slides to the left of the visualization as the previous now becomes the recent.

Motion. Data change leads to animated transitions in the visualizations. The Topic Streams grow or shrink relatively with current activity. The extent of the animations represents the extent of the change in the backchannel conversation. When the animated transitions terminate, the result of the previous now becomes the shape of the recent. By using multiple connected visual variables to represent the continuum between current activity (the now) and prior development (the recent), the Visual Backchannel offers a novel visual representation with yellow highlights indicating current activity in the backchannel. that is designed to help with getting a sense of 'what is happening' in the context of 'what just happened'. While we have focused here on the Topic Streams an analogous approach for visualizing the data for the People Spiral, Image Cloud, and post list are followed.

A. Interactivity

The Topic Streams support three topic filter interactions: temporal zoom, temporal sliding, and topical selection. All these interactions result in animated transitions of the Topic Streams and the other views, reducing the cognitive cost of following the change.

Temporal zooming. The zoom level specifies the basic unit for each time interval. A range between ten seconds and a month per interval, with seven steps in between, was chosen to represent a wide spectrum of events and allowing viewers to set their time span of choice. The viewer can change the level of temporal zoom by scrolling with the mouse wheel; similar to how zooming works in web-based mapping services, or clicking on the corresponding button above the Topic Streams. This zoom event is acknowledged by an animation of the grid representing the time intervals. As soon as the data for the new time window of the topic visualization has been transmitted to the browser, the Topic Streams are updated through animated transitions.

Temporal sliding. The viewer can also change the current time window by sliding it to an earlier or later period. Also similar to web based mapping tools, the viewer can simply drag the topic view either to the left or to the right or select corresponding buttons to move the time window to a later or earlier time point. By dragging with the mouse pointer, the streams, time grid, and time labels will follow its movement, and after releasing the mouse button they will

snap into the chosen place. When the viewer drags the topic visualizations, there will be pre-rendered parts of the streams with the length of the current time window in each direction. This technique is known in computer graphics as off-screen rendering, and here it allows us to provide a smoother user experience.

Topical selection. Besides changing the temporal granularity or position of the Topic Streams, the viewer can also change their topical composition by selecting a topic itself as a filter. This has the effect that only those Topic Streams that coincide with the selected topic will be shown. The selected topic will be removed from the Topic Streams, as it is implicitly present in all selected tweets and thus will not change the visual representation of the Topic Streams. Instead the topic filter will be represented as an interactive button above the topic visualization that allows its cancellation by simply clicking it.

In our current design, the focus is on the presentation of at most 100 image thumbnails with a square aspect ratio, however, this technique can be easily extended to arbitrary rectangles and larger displays. The positioning of images is based on an iterative force-directed layout algorithm that is seeded by initial positions with larger images positioned closer to the centre and smaller ones further at the periphery of the view. In order to make efficient use of the space devoted to the Image Cloud we need to adjust the maximum image size on the basis of the image frequencies and quantity. In our prototype, we set the maximum length of image thumbnails using the following formula:

$$l_{\max} = \frac{n A c_i}{c_{\max}}$$

$$c_i = \sum_{j=1}^n c_{ij}$$

with A for the screen area, n for number of images, c_i for occurrences of a particular image, c_{\max} for maximum occurrences among all images, and s as a spacing constant ranging between 1 and 2.5.

Depending on aesthetic intentions for creating customized backchannel displays, one could, for example, decrease s creating larger overlaps and images. Exploring these aesthetic considerations a little further, we have experimented with adding small, random rotations to images around the z-axis as a simple way of creating a more 'natural' appeal similar to the aesthetic of photo collages. By setting the range of rotation r and adjusting the spacing constant s , one gets a spectrum of visual layouts for an Image Cloud that ranges between a clean mosaic-like layout and a messy collage view with many overlaps. A relatively high spacing constant leads to open unused areas in the layout and relatively small images (see Figure 7, left). Reducing the spacing and adding rotation both increased the area used by shared images and also added an interesting visual pattern (right). The spacing and rotation constants provide the designer of a backchannel interface with more control over its visual appearance. While image spacing and rotation for aesthetic purposes may appear like visual clutter, we think that an appropriate balance between order and deviation in the layout can make the presentation both appealing and useful.

B. Interactive Exploration

In addition to seeing overviews and trends, the Visual Backchannel interface to allow the viewer to explore the different aspects of a backchannel and the linkage between them are designed. The Visual Backchannel is a coordinated-view system that provides interaction techniques to inspect the relationships of a backchannel

conversation with regard to its topics, time periods, participants, images, and posts. In our design there are two main types of exploratory interactivity: linked brushing and cross filtering. The former serves the temporary exploration of data relationships and the latter allows the viewer to select a subset of the conversation stream. These interaction types are designed to be as seamless and comprehensible as possible.

Linked brushing. With interactive brushing, the viewer can identify commonalities between multiple views. By hovering over a visual element in one view, related elements in other views are highlighted with a distinct colour, in our current design; it is a slightly matte tone of pink. For example, when moving the mouse pointer over the interface elements for participants, posts, or images, the Topic Streams visualization indicates the corresponding temporal distribution of a participant's activity or the publication time of the given post or photo. Similarly, the People Spiral highlights the author of a particular backchannel post or image, and vice versa the posts and images are highlighted.

Cross filtering. Besides displaying temporary relationships, the Visual Backchannel also provides functionality to slice and dice the conversation stream and the corresponding views by time, topic, and participant. The Topic Streams provide interactivity to change temporal granularity, time span, and topical selection and the People Spiral allows filtering by a participant of interest. Topic and participant filters become interactive controls displayed in the top right of the interface accompanying a search box and a button for filtering out re-tweets. In addition to these positive filters, we envision negative filters to hide particular participants or topics, for example, due to spam or different interests. The search box already allows negative filtering by preceding a search term with a minus sign.

FEEDBACK FROM POTENTIAL USERS

In an attempt to gain feedback on the usefulness and limitations of our Visual Backchannel interface from a wide range of potential users, an early prototype featuring the Topic Streams, a post list, and a people circle was demonstrated on a podium at a large corporate trade event attended by over 6000 people. The functional demo showed a live view of the tweets around the hashtag used for the conference.

There was significant tweeting activity during the event, followed both by people attending the event and those monitoring it from afar. The Visual Backchannel was a very popular, well-received demo, with many visitors commenting positively on the overall look and apparent simplicity of presentation. The reactions and comments from visitors suggested a set of possible uses for the Visual Backchannel interfaces that partly match our proposed goals and confirm earlier work on conversation and community visualization.

Audience response. Organizers and speakers at the conference were very interested to see what themes the audience took from specific sessions. This was particularly true for speakers at the large plenary sessions. They were curious both to see what the audience found interesting, and what the reactions were to specific announcements they made and demos they showed. For example, they could see reactions to the choice of a specific celebrity as keynote speaker, and more importantly to them, what people thought of a new project they announced.

Considering one. People using Twitter wanted to see their own posts and who else had re-tweeted or responded to them. Several tweeters asked to have screenshots taken and sent to them capturing their postings almost as a souvenir of their involvement in the community; this was not something we had anticipated. Two stated that they would show them to their managers as evidence of their efforts and impact.

Product discussions. Many attendees wanted to use the tool to follow tweets about their product or company, both in general and to show the effect of specific announcements, publicity campaigns, or news stories. A business partner from Australia said he would like to use it as a quick way to easily catch up and see what people had been saying in the rest of the world about a topic or product area while he was asleep overnight. He said it would "literally change my life".

Searching capability. Visitors wanted to locate postings around a specific topic within the event, and in some cases wanted to pull up a specific tweet they had seen before. The tested prototype version required them to locate the term in the visualization to select associated tweets. In some cases, the term was not shown as it had not appeared enough in the selected time window prompting some people to zoom into the display and scroll to different time periods in hopes of seeing the desired word. On the basis of this, we have integrated a search capability into the Visual Backchannel interface allowing full text search over post content and author names.

CONCLUSIONS

The Visual Backchannel, a novel medium for exploring large-scale conversations around events, making it possible as presented:

- 1) Get a visual sense of large backchannel conversations over time,
- 2) Follow evolving representations of a live, continually changing data set, and
- 3) Explore its temporal, topical, social, and pictorial facets.

In order to visually summarize what a backchannel conversation is about and how it changes, we have introduced Topic Streams, as temporally adjustable stacked graphs, and two lightweight visualizations, People Spiral and Image Cloud, that represent the authors and images of a backchannel. These three visualizations provide context for the continually updated post listing and are themselves continually updating and evolving. The viewer can engage in different types of interactive explorations to focus on the subset of a backchannel conversation by selecting a time span, participant, and/or topic of interest.

In a continual stream of information, there are interesting nuances in the temporal experience. For instance, the current moment or 'the now' is caught up in what is actively taking place in the posts. However, to understand the topics in the now, one needs the context of the immediately preceding, or 'the recent'. Further, both the now and the recent need the context of the on-going but slightly longer term focus of the event. By integrating decaying highlights that progress from the incoming yellow through the hue gradient of yellow through green to blue, the Visual Backchannel combines information about the now together with information about the recent into one visualization. Providing this temporarily fading highlight raises the possibility that one might be able to keep one's awareness of the backchannel in one's periphery. This possibility is certainly worth further exploration.

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A Visual Backchannel for Large-Scale Events

Marian Dörk, Daniel Gruen, Carey Williamson, and Sheelagh Carpendale

Abstract—We introduce the concept of a Visual Backchannel as a novel way of following and exploring online conversations about large-scale events. Microblogging communities, such as Twitter, are increasingly used as digital backchannels for timely exchange of brief comments and impressions during political speeches, sport competitions, natural disasters, and other large events. Currently, shared updates are typically displayed in the form of a simple list, making it difficult to get an overview of the fast-paced discussions as it happens in the moment and how it evolves over time. In contrast, our Visual Backchannel design provides an evolving, interactive, and multi-faceted visual overview of large-scale ongoing conversations on Twitter. To visualize a continuously updating information stream, we include visual saliency for what is happening now and what has just happened, set in the context of the evolving conversation. As part of a fully web-based coordinated-view system we introduce Topic Streams, a temporally adjustable stacked graph visualizing topics over time, a People Spiral representing participants and their activity, and an Image Cloud encoding the popularity of event photos by size. Together with a post listing, these mutually linked views support cross-filtering along topics, participants, and time ranges. We discuss our design considerations, in particular with respect to evolving visualizations of dynamically changing data. Initial feedback indicates significant interest and suggests several unanticipated uses.

Index Terms—Backchannel, information visualization, events, multiple views, microblogging, information retrieval, World Wide Web.

1 INTRODUCTION

Digital backchannels are an emerging social phenomenon. As people are watching political debates [34], attending educational events [17], or even coping with natural disasters [36], they increasingly share brief and timely pieces of information in digital backchannels, which create persistent conversations about events of social significance. Digital backchannels have become an intriguing communication medium, over which more and more people exchange impressions, suggestions, and comments during events. Such backchannels not only enable participants to share their experience and shape how observers perceive an event [7, 33], they are also used to help participants influence the unfolding of an event and its outcome [6, 19].

As these digital backchannels rise in importance as social information spaces, in which people complement and co-create large-scale events, we see significant limitations with current methods of displaying information. The widespread chronologically ordered lists alone are not sufficient for large-scale backchannels in that they are not able to adequately represent the scale and dynamics of real-time conversations. This has the unintended but well-known consequence that participants get distracted from the main event, have difficulties focusing, and lack an overview of what the backchannel contains [10, 19, 27].

To explore these issues, we introduce Visual Backchannel, an evolving, interactive, and multi-faceted interface that integrates three visualizations with a list of backchannel posts via linking, brushing and filtering (see Figure 1). In order to give new perspectives on backchannel conversations, we introduce *Topic Streams*, a temporally and topically adjustable stacked graph that visualizes topics extracted from digital backchannel conversations. This is accompanied by two compact visualizations, *People Spiral* and an *Image Cloud*, presenting visual aggregates of active participants and shared images. These visualizations offer a visual sense of the conversation at the moment, using visual accentuations that make the present visible, in the context of the topical development. This way Visual Backchannel provides saliency and visual evidence of what is happening now, and what is recent within the ongoing temporal context of how backchannel conversations unfold

over time. The four views, which are linked via highlighting, brushing, and filtering are designed to provide organically evolving representations of a constantly changing data set, and interactive access to the temporal distribution of topics, the most active participants, and salient photographic impressions.

With this work, we make two main contributions:

- We propose the notion of evolving visualizations that integrate representations of current activity and recent development in continuous information streams, such as digital backchannels.
- We introduce three novel interactive visualizations that summarize the main facets of large-scale backchannels and provide exploratory interactivity along time, topics, and people in the context of a Visual Backchannel interface.

The rest of this paper is organized as follows. Section 2 provides a brief overview of prior related work. Section 3 motivates the need for better digital backchannels, and provides design goals for our Visual Backchannel system. Section 4 identifies the challenges and opportunities of dealing with dynamic, evolving data. Section 5 describes the realization of our Visual Backchannel, while Section 6 discusses initial feedback on the system. Section 7 outlines limitations of this work and future research directions, while Section 8 concludes the paper.

2 RELATED WORK

Our work can be situated in the context of visualizing persistent conversations, experiencing digital backchannels during a wide range of events, and representing topics over time.

2.1 Visualizing Persistent Conversations

Much of the previous research on visualizing human communication considered its social and expressive aspects. For example, on a low level, artistic visualizations of typing patterns, corrections, and pauses between responses can enrich otherwise ordinary text-based messages [29, 37]. On a higher level, visualizing the identity and presence of people participating in chats and Usenet discussions, as well as their temporal activity and structure, can lead to increased social awareness [13, 14]. Visualizations of short-term [38] and long-term discussions [40, 42] can provide valuable cues about conversation activity and community patterns. Further research focuses on conversation threads. For example, the extent of forum discussions and the distribution of a given search term therein can be visualized in a bird's-eye view of forum threads [12]. Email exchanges can be visualized as thread arcs representing reply structure and temporal order [25]. While nesting and time provide suitable mechanisms for structuring and ordering the display of exchanged messages, we are interested in providing overviews of the main topics being discussed.

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