A System for Interleaving Discussion and Summarization in Collaborative Document Writing

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ABSTRACT

In many instances of online collaboration, ideation and deliberation about what to write happen separately from the synthesis of the deliberation into a cohesive document. However, this may result in a final document that has little connection to the discussion that came before. In this work, we present *interleaved discussion and summarization*, a process where discussion and summarization are woven together in a single space, and collaborators can switch back and forth between discussing ideas and summarizing discussion until it results in a final document that incorporates and references all discussion points. We implement this process into a tool called Wikum+ that allows groups working together on a project to create *living summaries*—artifacts that can grow as new collaborators, ideas, and feedback arise and shrink as collaborators come to consensus.

INTRODUCTION

Cooperation and the sharing of ideas in team production have been shown to have social benefits for groups as well as better and more innovative outcomes [4]. Furthermore, the perceived quality of collaboratively written documents is higher [1], and overall productivity increases [3]. Although online discussion platforms provide a liberating medium for groups to collectively deliberate across time and distance, a major challenge that is exacerbated in the online setting is refining and combining the mountain of ideas into something meaningful [2]. Interesting comments and the outcome of deliberations can be buried deep in lengthy online discussion threads, whereas other comments may be lower quality, worsening creativity and productivity.

While many online collective deliberation systems rely on filtering, voting [6, 7], or moderation [8], these can reveal biases and suppress minority opinions, due to reliance on moderators or underprovision of votes [5]. In addition, voting systems have no capability for more sophisticated *refinement* to improve an idea or *synthesis* of multiple ideas. The lack of synthesizing capabilities on common online discussion platforms results in users having to migrate away to document-writing software. As a result, users lose the ability to directly reference conversation or easily incorporate what people said. Some software such as Wikipedia have space for discussion but it lives on a separate page and cannot be referenced in the main document. Additionally, collaborative document-writing tools like Google Docs have features for chatting and in-line commenting. However, there is no easy way to connect chat messages to document edits, or to start from a discussion and build to a document section.

In this work, we propose an *interleaved discussion and summarization* process to scaffold the entire collaboration life cycle. Instead of separate discussion and synthesis stages, we represent collaboration as an interleaved process, where different ideas can go back and forth between *discussion* periods, when more comments are created, and *summarization* periods, when comments are condensed into summaries. We build this workflow into a tool called Wikum+—a hybrid between an online discussion tool and a collaborative writing tool. Wikum+ allows groups to create a *living summary* artifact that simultaneously condenses as people come to consensus and refine down ideas, and expands as new users arrive and new ideas get posed.

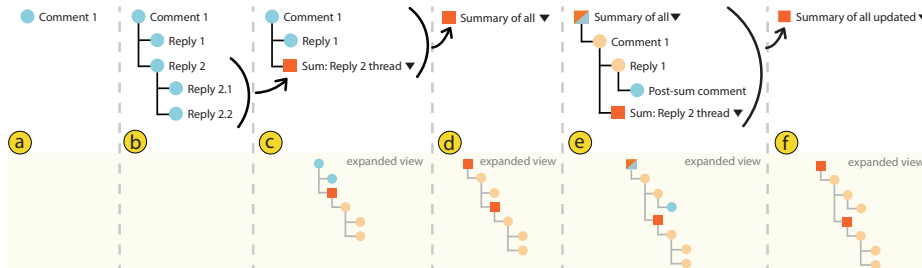## INTERLEAVED DISCUSSION AND SUMMARIZATION

Figure 1: Wikum+ discussions grow with discussion and shrink with summarization. By default (top row), only summary nodes and unsummarized comments are shown, unless summaries are clicked-to-expand (second row). A typical workflow is as follows:

- **a–b** Users can contribute comments and replies.
- **b–c** Users can summarize select comments. This adds an orange summary node and changes the blue (unsummarized) comments to yellow (summarized). Collapsed summaries can be expanded to show contents.
- **c–d** Summaries can be added at higher levels to include other summaries recursively.
- **d–e** New comments can be added at any point. Summaries above turn half-blue, half-orange, signifying partial summarization.
- **e–f** Users can edit the partial summary to incorporate new comments. Stages d through f loop until the summary reaches a stable state.
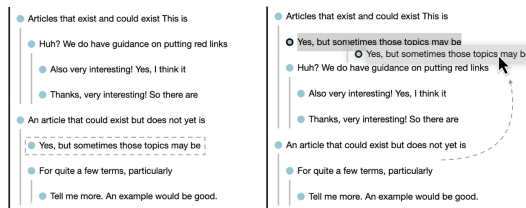

Figure 2: Dragging and dropping a comment from one thread to another.

[1]http://wikum.org/

Users start by deliberating through comments, much as they would in a typical forum (Figure 1 (a–b)), freely exchanging ideas and opinions without requiring any synthesis. During the discussion, a user can at any point take a subset or subthread of the comments and summarize it (Figure 1 (b–c)). Summaries can also contain other summaries, allowing users to break up the task of summarizing a large discussion into recursive steps (Figure 1 (c–d)). Steps (b) through (d) replicate the capabilities of recursive summarization studied previously [9], building up to the top-level summary, which acts as the final document. However, unlike previously, users can leave additional comments to threads or start new threads, allowing fluid interleaving of commenting and summarizing.

Furthermore, any user can also add a *post-summary comment* as a direct reply to a summary or to continues discussing a previously summarized thread (Figure 1 (d–e)). For instance, one may have some feedback on the summary, feel that the discussion was not actually concluded, or have new input to provide.

Once new comments are added under a summary, the original summary that was written is now no longer comprehensive and is marked incomplete. A user can then edit the incomplete summary to incorporate the new comments (Figure 1 (e–f)), returning the view to how it was in step (d). Steps (d) through (f) can then loop indefinitely, forming *summarization and discussion cycles* that grow and shrink the discussion, until no one has any new comments to add, all comments are summarized, and users are left with a document that covers the entire discussion. Summaries thus synthesize the current state of the discussion and can then be iteratively refined as new comments come in. Because unsummarized discussions and incomplete summaries are marked, users can easily see what areas of the discussion still require synthesis.

WIKUM+ SYSTEM

We present the Wikum+ system (Figure 3) for supporting collaboration via interleaved discussion and summarization[1]. The interface contains a threaded outline view on the left showing unsummarized comments (blue), summarized comments (light orange), and summaries (dark orange). This view allows users to select, expand and collapse, and move comments and summaries. On the right are the full comments and summaries selected by the user from the outline.

Permissions. The creator of a Wikum+ instance can set commenter-only roles and editor-only roles (e.g., ability to summarize, move, hide, or tag comments) for users, allowing various permissions levels. They can also set the entire instance to be publicly commentable, publicly editable, or both (Figure 3 (3)).
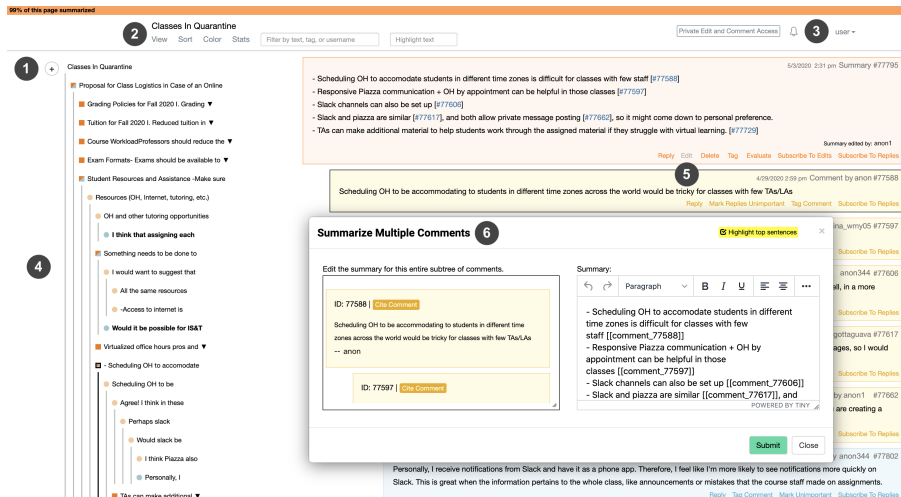
Figure 3: The Wikum+ UI. (1) New comment button. (2) Drop-down menus. (3) Access Levels and Notifications. (4) Outline View, bold unread indicators; The thread selected in the outline view is displayed on the right. (5) Locking to prevent race conditions. (6) Summarization modal with content on the left and the summary text in a rich-editing input box on the right.
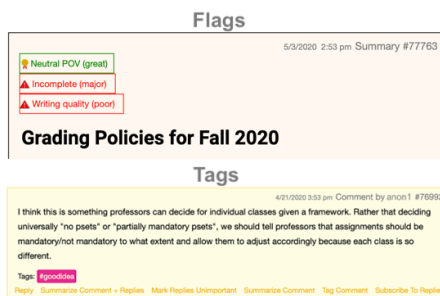

Figure 4: Flags and tags in Wikum+.

Real-time updates. Wikum+ also updates in real-time for all actions, allowing for synchronous discussions. Locks prevent race conditions in moving and summarizing threads.

Notifications & Unread markers. For asynchronous work, Wikum+ allows users to receive customized email notifications, @-mention others (Figure 3 (3)), and find unread or newly added comments since the user's last visit to the page through the outline view (in bold).

Summarization. Users can summarize a discussion subthread or select group of comments, lower-level summaries, or subthreads, and then summarize them. They can also summarize a single comment. Wikum+ provides a rich text editor that allows users to see the content they are trying to summarize or edit. Users can directly *quote* part of the content verbatim or *cite* the text they reference, allowing readers to jump to the referenced discussion point.

Organization, Flagging, & Deletion. To organize the discussion, users can tag (Figure 4), filter, sort temporarily, drag-and-drop (Figure 2), and cluster similar comments and summaries (Figure 3 (2)). Summaries can also be flagged (Figure 4) to indicate that further work is needed. Both summaries and comments can be deleted.

Out-of-date Indicators & Iterative Refinement. An out-of-date indicator—shown as a half-blue, half-orange square—can appear on a summary if a post-summary comment is added under it, or if a user moves a summary, comment, or subthread from elsewhere to under the summary. The contents expand under the out-of-date summary until the unsummarized comment in blue appears. The summary can return back to fully summarized (dark orange) once a user edits the summary and checks off that newly-added comments have now been incorporated. The summary update, incorporating the post-summary discussion, completes a summary-discussion cycle, which can then loop again. Flags allow users to evaluate summaries on their neutrality, comprehensiveness, and writing quality, also allowing for iterative refinement (Figure 4).

DEMO GOALS AND CONCLUSION

Our goal in demonstrating Wikum+ at CSCW is to receive feedback on existing and potential features. We would like to invite CSCW attendees to use Wikum+ over the course of the conference and hopefully beyond in collaborative discussion contexts. A special Wikum+ page will be created where attendees can join to add notes taken from the conference, allowing users to create an overarching summary of the conference in real-time for the members of the CSCW community. By using Wikum+, attendees can discuss interesting ideas, provide suggestions, increase their engagement, and create a community during and beyond the conference.

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