Presenting Search Results of Meeting Documents

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ABSTRACT
Information plays an important role in organisations, allowing management to make sound decisions. Many organisations keep documents in electronic format, and as the number and volume of documents increases, search and retrieval become tedious and difficult. Effective presentation of search results is an important user interface issue for any search tool in this context. Search results can be composed of a number of different elements, including file details, text extracts and thumbnail images.

This study considered the effectiveness of several search result presentation elements in the context of a desktop search tool used to search for relevant meeting minute documents. Participants were presented with search results from two existing desktop search applications and one test application developed by the authors. The participants were then asked to evaluate the quality of different elements of the result presentation. Responses indicated that domain-specific presentation elements are valuable to users, allowing them to effectively determine the relevance of individual search result items. The results also suggest that other domain specific search tools would benefit from customised search result presentation.

Author Keywords
Document search; user interfaces, information access

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
In many organisations, formal meetings are conducted on a regular basis. Meeting outcomes – such as report presentations, project updates, decisions, actions and recommendations – are typically captured in a meeting minute document. A common process is for the document to be subsequently circulated for discussion and correction, with formal acceptance as an official record during the next meeting.

It is important for members in any organisation to be able to refer to the official record of decisions and recommendations that have been recorded in meeting minute documents. As time passes the chance of forgetting what was discussed and decided increases. Furthermore, as members of an organisation change, new members may need to read through past meeting documents to find relevant details, which can be a tedious and error prone process.

While many organisations store and organise electronic documents using chronological details, such as the date of a meeting as part of the file name, such schemes do not assist in searching through documents for relevant topic-specific information. Having effective tools to search and retrieve documents is therefore important.

Desktop search tools are applications that can be used to perform topic-specific searches on a collection of information, such as meeting minute documents. Similar to web search engines, a desktop search tool allows user to search for documents using a search query. The search results are displayed in a rank-ordered list according to a defined measure of search relevance. In this paper, we suggest that user perception of search tool effectiveness is directly based on two key aspects: (a) the correct *identification* of relevant documents, and (b) the quality of search result *presentation*.

In addressing the quality aspect of relevant document identification, an earlier work by Chua et al. (2011) presented a method of exploiting the domain specific nature of meeting minute documents to improve search results. Each document, in a collection of meeting minute documents, was pre-processed to create an index and cluster of related topic details. This was then used to enhance the search identification performance. Experiments, using a controlled set of search queries, showed that the most relevant documents were listed within the first ten documents. However the work did not consider in detail the quality of search result presentation as part of user interface concerns. Thus the focus of this paper is to identify how to best display search results in a way that allows users to quickly identify relevant information. Good search result presentation allows a user to accurately determine document relevance, and in part is a robust feature that can compensate for poor document identification or weak search query details.

The work presented in this paper considered the effectiveness of different search result presentation elements in the context of a desktop search tool used to search for relevant information contained within a collection of meeting minute documents.

As a case study example, a collection of meeting minute documents for the Council of Deans from a university had been used. All the documents conform to a standard structure. For example, each document starts with the

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meeting name, day, time, venue and the members attending the meeting, followed by the meeting minutes. Similarly, a decimal numbering system is used to number the topics discussed in the meeting, and details related to a topic are blocked in paragraphs. Some topics and details may run across several meetings, and therefore may be recorded within several documents.

This paper begins by considering background work and related studies, including the specific presentation approach used by two desktop search tools. The features and limitations of search result presentation by the existing tools, with respect to search within meeting minute documents, are then noted. A new domain-specific result presentation template is then proposed, and results presented from surveys conducted evaluate the usefulness of different result presentation elements.

BACKGROUND AND RELATED STUDIES

According to Jansen (2001), search engine users typically only look at the top ten items from the first page of search results. Numerous works had been conducted in categorising search results (Cutting et al. 1992; Zamir et al. 1999; Chen et al. 2000; Dumais et al. 2000; Dumais et al. 2001; Ozinski et al. 2005; Ren et al. 2009).

Many desktop search tools display each search result item using contracted text as shown in Figures 1 and 2. Search query keywords are often presented with emphasis in the excerpt to assist users in determining result relevance. Contracted text excerpts provide a brief clipped summary for search result items. By nature, excerpts will at times lack details needed for the user to determine its relevance to their search.

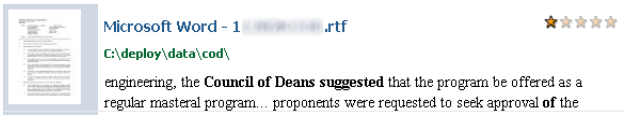


Figure 1. Search result item presentation showing file type, file name, location, contracted text excerpt (with keyword emphasis), rank and thumbnail image.

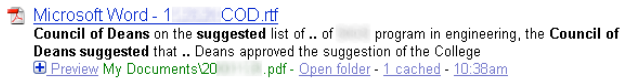


Figure 2. Search result item presentation showing file type, file name, contracted text excerpt, and links to additional features (preview, open etc).

Other desktop search tools list each file by name, and allow users to open each document using an integrated document viewer (where possible) as shown in Figure 3. While this approach provides additional functionality, it also poses additional challenges to the user. For example, as the result presentation page does not provide enough information to allow the user to evaluate each result item, users are forced to do secondary searches to locate where in the document the keywords are. This problem is compounded if more than one keyword are used in the search and if keywords are not consecutive in target documents.

Search engines have also used thumbnail images as part of search result presentation. Ideally such thumbnail images represent a useful visual summary of target, supporting the user to quickly discriminate among results.

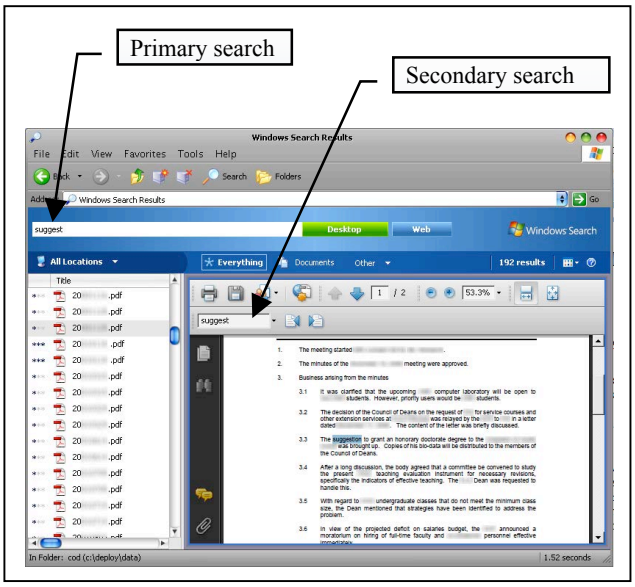


Figure 3. Windows Desktop Search example showing primary search results, integrated document viewing and secondary document search features.

In using image excerpts, Li et al. (2008) showed that images are very helpful in accelerating user's relevance judgment to web search results. Similarly, experiments conducted by Xue et al. (2008) showed that using image snippets in interactive web search helps users to identify those web pages they expect and to reformulate their initial query more effectively and efficiently.

In the study of various summarization approaches using thumbnails, Jiao et al. (2010) showed that each approach had respective advantages on different types of web pages and for different tasks. For example, thumbnail images are effective for web pages with simple distinct structure. A web page can be summarised well if it includes dominant images, while external images are a useful source for those web pages without dominant images, and it can be regarded as a valuable complement to internal images. It also pointed out that visual snippets are extremely effective in helping users identify the visited web pages in a re-finding task.

Aula et al. (2010) also conducted a study that focused on the accuracy of users' evaluation of web page helpfulness based on different kinds of page previews; thumbnails of different sizes and zoom levels (showing either details of a page or more of the page layout) with text summaries, thumbnails combined with key textual information, and the positioning of the key information elements. They mentioned that based on their work and other researches, Google released a thumbnail preview extension for the Chrome browser named 'Google Similar Pages' in December 2009.

In text summarisation, Woodruff et al. (2001) showed that thumbnails combined with text summaries are better than plain thumbnails. Studies by Buyukkokten (2001) and Borodin (2007) also demonstrated that text summarisation enable user to see the whole in parts when

browsing with a device having a small screen. Furthermore, automatic text summarisation had been widely studied as described in literature surveys by Das et al. (2007) and Gupta et al. (2010). Teevan et al. (2009) also showed the positive value of having both a thumbnail and text summary with respect to a user's search and browse experience.

On a different approach in text summarisation, Hassan-Monteroa et al. (2006) worked on using tag clouds as visual interface for information retrieval. Kuo et al. (2007) also proposed the use of tag clouds to summarise web results.

In this paper, we explore several strategies that can be used to assist in the presentation of search results for meeting documents. Interestingly, because of the structural similarity of each meeting minute document, visual thumbnails are not distinctive and provide little benefit.

EXISTING SYSTEMS AND THEIR LIMITATIONS

Existing web and desktop search tools are limited in their ability to recognise and capitalise on the context of a document. They, therefore, present search results in simple lists using standard formats for each item. The format of each item is typically a summary of the retrieved document with other generic details. For instance, the search result returned by a tool such as Google Desktop displays:

- the document title (if available) or file name,
- the file type (format) of the file,
- a text snippet containing the search keyword(s) with the keyword(s) emphasised, and
- a link to the document.

Figure 4 is a search result item where the title of the document is unavailable and the file name is used instead.

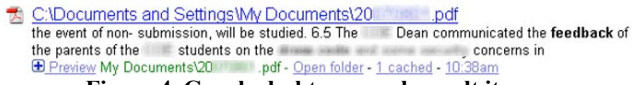


Figure 4. Google desktop search result item

Another desktop search system, Puggle, displays each search result items with:

- a thumbnail image (of the first page),
- the title of the file,
- a link to the document,
- a text snippet containing the search keyword(s) with the keyword(s) emphasised, and
- a rating image (five "star" levels of relevance).

Figure 5 shows the thumbnail and related document information from a Puggle search query result.

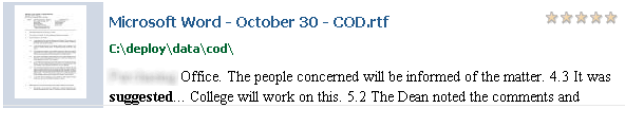


Figure 5. Puggle search result item with thumbnail and star rating details added to file name and text details

Despite a number of very useful information elements in standard search result presentations, there are limitations for specific domains of document content. For meeting minute documents, this includes the problem of extracting an appropriate title, difficulty for a user in obtaining context from a contracted text excerpt, and similarity of all thumbnail images. Consider the collection of thumbnail images from eight different meeting minute documents as shown in Figure 6. It shows that they all look quite similar.

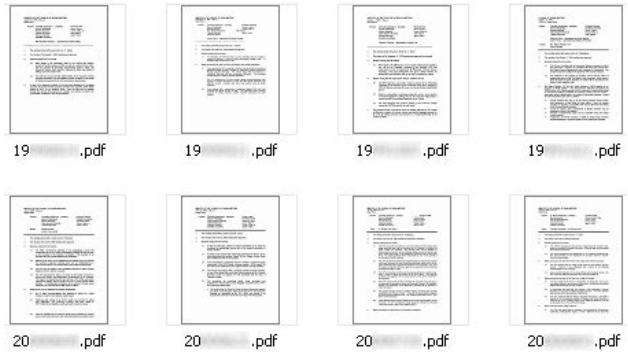


Figure 6. Meeting minute document thumbnails showing the similarity that reduces usefulness for this domain

SYSTEM

The presentation module is built on top of a domain-specific search application by Chua et al. (2011) returned a list of search results pertaining to specific sections of a meeting document. In presenting the search result, the study examined the three-level hierarchical tree for displaying of the search results by Drori (2000) as shown in Figure 7.

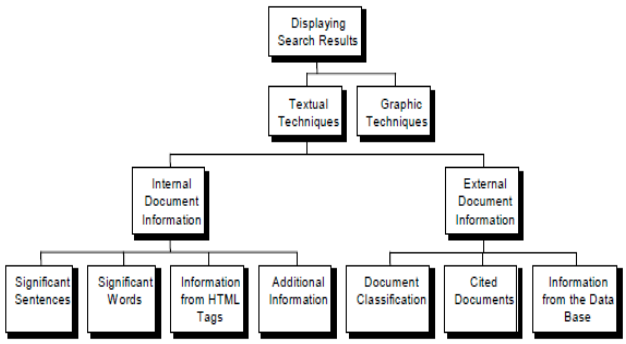


Figure 7. Display techniques for search results (Drori 2000)

The study considered only the internal document as its textual technique focusing on significant sentences, significant words and additional information. These represent the key items that are recorded in a meeting document. These are:

- the purpose of the meeting,
- the date and time of the meeting,
- the meeting lead or chair person's name,
- assigned action items, and
- decisions made.

Given the availability of these details, we designed a search result item template as shown in Figure 8.

Purpose of the meeting	Members
Date and time of the meeting	
Related sub-sections in the meeting document	
Discussion containing either • Assigned action items • Decisions made	

Figure 8. Search result item template

When the search application processes documents for later search queries, various minute meeting specific details are extracted. This includes meeting details such as the title of the meeting, the date and time, venue and attending members. Furthermore, topic numbers in the meeting document were also identified. Figure 9 shows how a search result is presented in the search result item template.

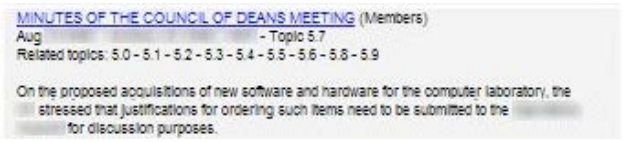


Figure 9. Search result

When search results are presented as a list to the user, there is a practical limit to the amount of information that can be included. In order for the user to remain on the same result page, the "members" and "related topics" details are initially hidden, and then displayed using a standard "pop up" box technique when the mouse is positioned over the key word.

Examples of the visible "pop up" boxes for "member" details and "related topics" details are shown in Figures 10 and 11 respectively. The related topics details provide a method for the user to quickly preview specific sections of a meeting document without opening the document.

Each search result is also enclosed in a light shaded box, and is highlighted when the mouse is within the shaded box. This provides the user with a visual cue as to which search result is being viewed with interest.

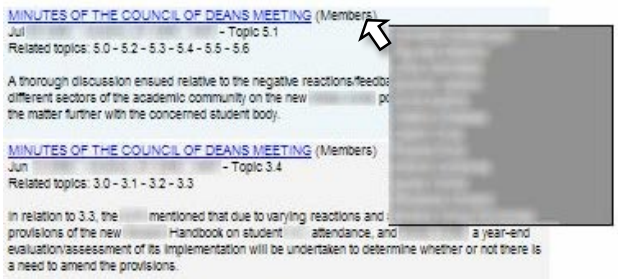


Figure 10. A list of meeting members presented is using a pop up box when a mouse is positioned over "Members"

Note that other visuals techniques were considered but not included in the search result item template. For instance, a thumbnail was not included in the presentation due to fact that all meeting documents will result to almost similar image.

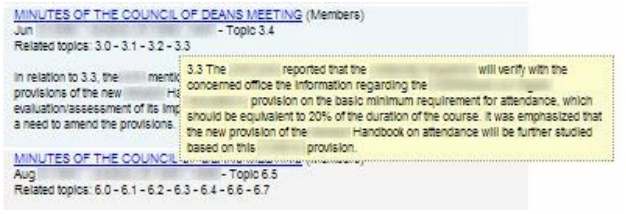


Figure 11. Related topic details are displayed with the mouse is position over a particular topic number

Text summarisation (contraction) was considered in the search result item template. However, due to the need to emphasise search keyword(s), a summarised result can result in useful keywords being removed. Furthermore, within the example documents used, the number of words in a section did not exceed 310. As a result all sections could easily be displayed within the space in the search result item template without contraction.

EXPERIMENTS

The aim of this study was to consider the effectiveness of different search result presentation elements within the specific context of a desktop search tool designed to support users in the search and retrieval of information from a collection of meeting minute documents. The notion of effectiveness here is an element of result presentation that typically allows users to evaluate results quickly and accurately. That is, as a result of good presentation, a user is more likely to quickly and correctly identify if a particular search result item from the list of results is relevant to them.

Setup

A group of 13 participants contributed to the study results. Each participant had at least a bachelor's degree, was aged within the range of 20 to 45, with 77% of the participants being male. 85% of all participants considered themselves well versed in the use of search engines.

Participants were given four tasks, each designed to measure the effectiveness of result presentation formats or elements.

Three result presentation formats were used for the tasks; two from existing general-purpose desktop search tools and one domain-specific application developed by the authors. We refer to these presentation formats as:

(a) Contracted text + Thumbnail (Figure 1),

(b) Contracted text + File Information (Figure 2), and

(c) Full section text + Meeting Information (Figure 9).

The four tasks were used to gather participant responses regarding preference to the three presentation formats, the perceived value of different presentation elements and finally the value of an overall composition of elements.

Task 1: Comparing

In this task, participants were asked to compare search results from the three different search queries, presented using the three different result formats. As a baseline result, each search query was performed using one of the desktop search tools and the first search result selected for

comparison. The query result item was then obtained from the two other desktop search applications for comparison. Thus for each search query a single selected document is presented with three different formats shown in randomised order.

Participants were asked to rank, according to their preference from best to worst, the three different presentations formats for each query example.

Task 2: Understanding

In this task, participants were presented with a single search result from six different search queries; two search queries were performed using each of the three desktop search applications. For each single query result, participants were asked if they would need to open the document to determine if it was relevant to the query, or if they were confident that it was relevant based on the details shown.

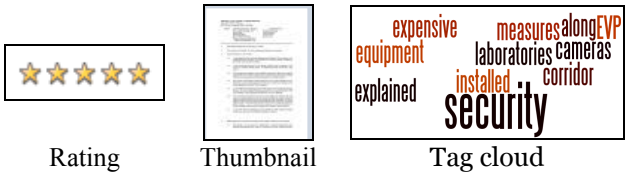
While presenting contracted text has the advantage of reducing the details shown to the user, the nature of partial and fragmented excerpts can also have the effect of forcing users to open documents to determine its true relevance. The expectation for this task was that presenting a full section text excerpt, which is typically quite suitable for meeting minute documents, could reduce the need for users to open a document to determine search relevance.

Task 3: Evaluating

In this task, the participants were asked to evaluate the importance of information elements that can be part of individual search result items. The purpose of the task was to gauge how strongly users valued each element, in particular additional domain-specific elements such as a "members" list and "related topics" links.

Participants were presented nine different elements, each element is shown visually in the context of a sample search result. A Likert-scale was used to ask participants what they thought in terms of importance for each element in the presented search result. Specifically, a scale with values from 1 to 5 was used to indicate if the participant felt that an element "must be omitted", "can be omitted", was "neutral", "it helps" and "must be present" respectively.

Six of the additional information elements are text details, while three are images used in various search applications. Examples of the three image elements are rating images, thumbnails and tag clouds as shown in Figure 12.



Rating Thumbnail Tag cloud

Figure 12. Visual image elements used in Task 3

Task 4: Recommending

In this task, participants were shown five different presentation formats for a single search result item. Participants were asked to rank the different formats according to their personal preference. The three existing formats (a), (b) and (c) from Task 2 and 3 were used, as well as two additional formats:

(d) Full section text + Meeting Information + Tag Cloud

(e) Full section text + Meeting Information + Thumbnail

The purpose of this task was to determine if users perceive additional value from either tag clouds or thumbnail images with the domain-specific format.

Results

Task 1: Comparing

Survey results, presented in Table 1, indicate that the majority of participants (59%) ranked the Full section text + Meeting Information format (c) as best. The remaining 41% of first preferences for formats (a) and (b) suggest that many participants are comfortable with an excerpt style of contracted text presentation. Given that popular web search engines use contracted text formats, it would be reasonable to suggest that participant familiarity with contracted text has some influence on this result away from the full section text presentation.

Table 1: Rank permutation results for Task 1. Rows indicate rank order and columns show responses.

1st (Best)	(a)		(b)		(c)	
2nd	(b)	(c)	(a)	(c)	(a)	(b)
3rd	(c)	(b)	(c)	(a)	(b)	(a)
Count	8	4	2	0	7	13
Best count	12 (~29%)		2 (~12%)		20 (~59%)	

Task 2: Understanding

Summary results for Task 2 are shown in Table 2. The objective of this task was to validate the idea that full section text from meeting minute documents are of more value to a user than contracted text. Recall that format (c) includes a full section text excerpt, while formats (a) and (b) contain contracted text excerpts.

Table 2: Summary results for Task 2. The "Open" values indicate cases where participants did not understand if the document was relevant and would need to open it.

Presentation Format	Open?
(a) Contracted text + Thumbnail	~88%
(b) Contracted text + File Information	~81%
(c) Full section text + Meeting Information	~31%

As expected, participants indicated that they would want to open the related document for formats (a) and (b) examples (~88% and ~81% respectively), while format (c) examples provided sufficient details and only ~31% of cases did the participant want to open the document for more detail.

Task 3: Evaluating

In this task participants were asked to evaluate the importance of nine different information elements that can be used as part of result presentation. For analysis elements have been categorised into three groups; text on key items (four elements), text on additional items (two elements) and visual representation (three elements).

Figure 13 shows the participants rating of importance on the key text items. Specifically, these are: the "title of the meeting" (purpose), "date of the meeting", "members in the meeting" (including meeting lead) and the "topic content" (including action items or decisions made).

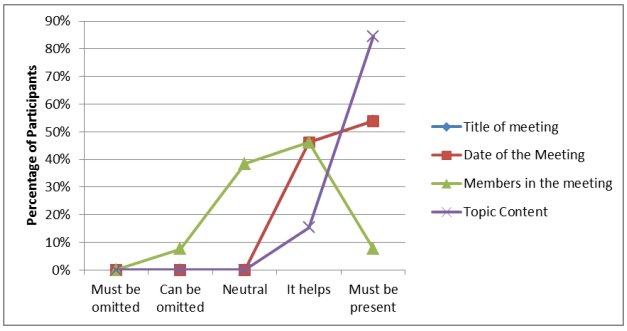


Figure 13: Importance of text on key items. Note that "Title of Meeting" is obscured by "Date of the Meeting" data.

Results show that participants rate almost all of the text on key items elements as information that "helps" or "must be present". Interestingly, the "members in the meeting" element is rated by most participants as "neutral" or "it helps". This seems reasonable for the case study domain, where most search queries would be concerning the "topic content" of meetings rather than member attendance.

The results presented in Figure 14 show that 70% of participants wanted to have the file name and file type displayed, whereas displaying information on related topic numbers is spread across all ratings except in "must be omitted".

The slightly bimodal form of results for file name and type details suggests that participants may perceive two distinct reasons or utility value. It would be interesting to determine if users have a genuine need for these details with respect to the search query, or if the dominant reason is simply user preference or familiarity.

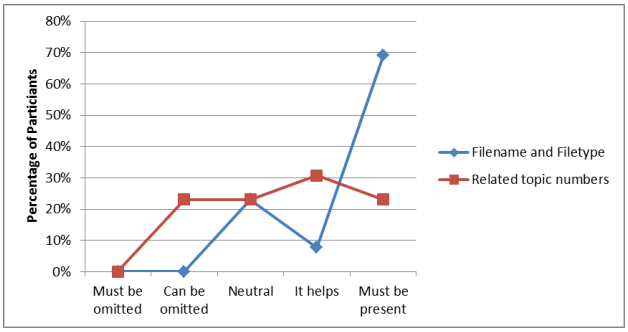


Figure 14: Importance of additional text key items

The last group of presentation elements to be evaluated are the visual enhancements provided by rating images ("stars" in this case), thumbnail images and tag clouds. Figure 15 shows the participants assessment of the importance of each visual element.

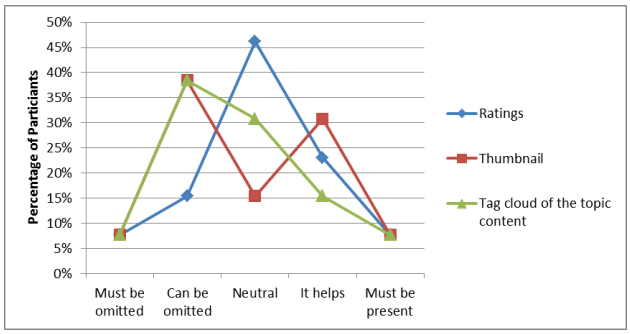


Figure 15: Importance of visual elements

It can be seen that the perceived value of a rating image is leaning towards being helpful with majority neutral. The perceived value of a thumbnail image is another interesting bimodal distribution, again suggesting different qualitative value assessment by participants. Finally, most participants considered tag clouds as neutral value or less. Tag clouds were perceived as having little value in this application. Results from Task 2 indicated that most participants found full section text excerpts of more value than a contracted summary. As tag clouds represent a visual summary of topic content, the weak value of this visual element is a consistent result. However, this result does not suggest a limit on the value of tag clouds for other applications.

Task 4: Recommending

In this task, participants ranked various presentation formats from best to worst. Only 12 participants provided responses, and all were unique rank permutations. The summary of best and worst rank allocation for each of the formats is presented in Table 3.

Interpretation of the worst rank results is somewhat clearer than for the best results. However, the small sample size and clear evidence of split opinions indicate that only suggestions can be made from the data collected.

Table 3: Best and worst rank summary for Task 4

Presentation Format	Best	Worst
(a) Contracted text + Thumbnail	~8%	50%
(b) Contracted text + File Information	25%	~8%
(c) Full section text + Meeting Information	~17%	0%
(d) Full + Meeting Information +Tag Cloud	~33%	25%
(e) Full + Meeting Information +Thumbnail	~17%	~17%

For the worst rank results, simple contracted text with thumbnail presentation of format (a) was considered by 50% of the responses as worst, followed by 25% for format (d) using a tag cloud and ~17% for format (e) which included a thumbnail image. Format (c) (0%) was not ranked as worst in any responses, which suggests that may be generally considered a good format, or that is does not contain elements participants did not like.

Interestingly, best rank results showed the strongest value of ~33% for format (d) which contains a tag cloud. This is counter to the Task 3 results which suggested tags clouds were not perceived by most users as valuable. However, if formats (c), (d) and (e) are considered as a group, they represent ~67%. This suggests that most users preferred formats specific to the test domain of meeting minute documents. Format (a) was only considered by ~8% of responses to be the best format, which is also supported by the ~50% of responses that considered it the worst.

CONCLUSION

In comparing different search result presentation formats and elements, results showed that full section text excerpts were preferred. Given that topics in a meeting document are fairly short, this is possible without contracting any text. If contraction is required, it will be minimal. This also means that with full section text available in the search result presentation, the need to open the actual meeting document is not necessary. This cuts down the time it takes for a user to evaluate the relevance of the search. More specifically, eliminate any secondary searches within the document and the meeting document is opened.

The perception on introducing visual representation as part of the search result may be affected by the prior knowledge or conception of the participants. Participants may have a different perception of tag clouds, given that it was rated both as most and least preferred in the choice of presentation. Similarly, the result of introducing a thumbnail showed a clear split between omitting it and finding it helpful.

Overall, full section text excerpt appears to be the choice in presenting search result for meeting documents. This can be enhanced to a certain extent by a visual representation. In future work, interactive visual representation will be explored. The work of Turetken (2005) showed that while search tasks are completed faster with visual interfaces than with textual interface, interactive visual interfaces such as zoomable interface works better. In addition, the experimental results by Joho (2008) suggested increasing the level of document representation in the search results can facilitate users' interaction with a search interface.

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REFERENCES

Aula, A., Khan, R. Guan, Z., Fontes, P. and Hong, P. A comparison of visual and textual page previews in judging the helpfulness of web pages. Proceedings of the 19th international conference on World wide web. ACM Press (2010), 51-59.

Borodin, Y., Mahmud, J. and Ramakrishnan, I.V. Context browsing with mobiles - when less is more. Proceedings of the 5th international conference on Mobile systems, applications and services (MobiSys '07). ACM Press (2007), 3-15.

Buyukkokten, O., Garcia-Molina, H. and Paepcke, A. Seeing the whole in parts: text summarization for web browsing on handheld devices. Proceedings of the 10th international conference on World Wide Web (WWW '01). ACM Press (2001), 652-662.

Chen, H. and Dumais, S. Bringing Order to the Web: Automatically Categorizing Search Results. Proceedings of CHI 2000, ACM Press (2000), 145-152.

Chua, C. and Woodward, C. Preprocessing minutes of the meeting documents for search and retrieval. Proceedings of the International Association for Development of the Information Society European Conference on Data Mining, IADIS Press (2011), 51-58.

Cutting, D., Karger, D., Pedersen, J. and Tukey, J. Scatter/Gather: A cluster-based approach to browsing large document collections. Proceedings of SIGIR 1992, ACM Press (1992), 318-329.

Das, D. and Martins, A. A Survey on Automatic Text Summarization. Literature Survey for the Language and Statistics II course at CMU (2007).

Drori, O. The benefits of displaying additional internal document information on textual database search result lists, In J. Borbinha and T. Baker (Eds.): ECDL 2000, LNCS 1923, Springer-Verlag Berlin Heidelberg (2000), 69–82.

Dumais, S. and Chen, H. Hierarchical classification of web content. Proceedings of SIGIR 2000, ACM Press (2000), 256-263.

Dumais, S., Cutrell, E. and Chen, H. Optimizing search by showing results in context. Proceedings of CHI 2001, ACM Press (2001), 277-284.

Gupta, V. and Lehal, G. S. A survey of text summarization extractive techniques, Journal of Emerging Technologies in Web Intelligence, 2, 3, Academy Publisher (2010), 258-268.

Hassan-Monteroa, Y. and Herrero-Solana, V. Improving tag-clouds as visual information retrieval interfaces. International Conference on Multidisciplinary Information Sciences and Technologies (October 2006)

Jansen, B. and Pooch, U. A review web searching studies and a framework for future research. Journal of the American Society for Information Science and Technology 52, 3 (2001), 235-246.

Jiao, B., Yang, L., Xu, J. and Wu, F. Visual summarization of web pages. Proceeding of the 33rd international ACM SIGIR conference on Research and development in information retrieval, ACM Press (2010). 499-506.

Joho, H. and Jose, J. Effectiveness of additional representations for the search result presentation on the web, Information Processing and Management, 44, Science Direct (2008) 226–241.

Kuo, B., Hentrich, T., Good, B. and Wilkinson, M. Tag clouds for summarizing web search results.

Proceedings of the 16th international conference on World Wide Web (WWW '07). ACM Press (2007), 1203-1204.

Li, Z., Shi, S. and Zhang, L. Improving relevance judgment of web search results with image excerpts. Proceeding of the 17th international conference on World Wide Web, ACM Press (2008), 21-30.

Ozinski, S. and Weiss, D. A concept-driven algorithm for clustering search results. IEEE Intelligent Systems. IEEE Computer Society 20 (2005), 48-54.

Ren, A., Du, X. and Wang, P. Ontology-based categorization of web search results using YAGO, 2009 International Joint Conference on Computational Sciences and Optimization. IEEE Computer Society (2009), 800-804.

Teevan, J., Cutrell, E., Fisher, D., Drucker, S., Ramos, G., André, P. and Hu, C. Visual snippets summarizing web pages for search and revisitation. Proceedings of CHI 2009, ACM Press (2009), 2023-2032.

Turetken, O. and Sharda, R. Clustering-based visual interfaces for presentation of web search results: An empirical investigation. Information Systems Frontiers 7, 3, Springer Science (2005), 273–297.

Woodruff, A. Rosenholtz, R., Morrison, J., Faulring, A. and Pirolli, P. A comparison of the use of text summaries, plain thumbnails, and enhanced thumbnails for web search tasks. Journal of the American Society for Information Science and Technology, 53, 2, 2002, 175-185.

Xue, X., Zhou, Z. and Zhang, Z., improving web search using image snippets. ACM Transactions on Internet Technology, 8, 4, 21, ACM Press (2008), 21-59.

Zamir, O. and Etzioni, O. Grouper: A dynamic clustering interface to web search results. Proceedings of the 8th International World Wide Web Conference, Elsevier Science (1999), 1361-1374.