

Session-based search with Querium

Gene Golovchinsky
FX Palo Alto Lab
Palo Alto, CA, USA
gene@fxpal.com

Abdigani Diriye
University College London
London, UK
a.diriye@ucl.ac.uk

ABSTRACT

We illustrate the use of Querium, a novel search system designed to support people's collaborative and multi-session search tasks, in the context of the HCIR 2011 Search Challenge. This report demonstrates how a Querium's interface and search engine can be used to search for documents in an open-ended, exploratory task. We illustrate the use of relevance feedback, faceted search, query fusion, and the search history, as well as commenting and overview functions.

Author Keywords

Multi-session search, search interface.

ACM Classification Keywords

H5.3. Information interfaces and presentation: Group and organizational work.

INTRODUCTION

One important characteristic of many collaborative search systems is the notion that search activity spans multiple sessions. Examples of this include carrying out a background literature review, planning a holiday, and gathering information about a product to purchase [5]. Multi-session search tasks comprise a significant portion of most web search activity [5][9][6]; searchers undertaking multi-session search tasks tend to make heavy use of bookmarking features, re-searching to relocate previously seen content, printing, emailing and saving pages to tackle these search tasks [1]. A number of system features exist within experimental search systems and browsers to support such tasks, although studies (e.g., [6][2]) suggest that such features are rarely found in the wild, where people rely on bookmarks and email to manage their found information.

We based the design loosely on SACK [4], borrowing some of its querying ideas, but extend it with a number of communication options and a more streamlined interface. In the following section, we introduce the essential interface features of Querium, and then illustrate how the system was used to try to find an answer to the example task given on the HCIR 2011 web site.

THE QUERIUM SEARCH INTERFACE

Querium is designed to leverage the familiar style of interaction with web search engines while extending that interaction in important ways. The system includes a text entry field through which queries can be typed, a list of matching results is displayed for each query, and a left-hand sidebar displays additional controls and information.

Beyond these traditional interface components, Querium organizes search activities into tasks, and augments the search view by adding a resizable embedded document pane (but documents could also be opened in a separate window), rich query history displays, additional controls on the search results, a variety of filters, and a notepad/chat window (see Figure 1). In addition, a summary view is used to organize a team's activities with respect to some task.



Figure 1. Querium interface: (1) top area for new queries, (2) navigation sidebar, (3) main results, and (4) document view.

Querium uses the notion of a task as an organizing principle for managing search and collaborative activity. A task consists of one or more queries, and may involve one or more collaborators. A person may create as many tasks as necessary. Queries, comments, judgments of relevance, and other interactions with information are localized to a task; the same document retrieved in different tasks will have different assessments, and will be shared (or not shared) with different collaborators.

THE TASK

The HCIR 2011 search challenge sample task involved finding documents in support of the following information need using the CiteSeer collection [3] (CC BY-NC-SA 3.0):

Latent Semantic Indexing (LSI) is an indexing and retrieval method that uses a mathematical technique called Singular Value Decomposition (SVD) to identify patterns in the relationships between the terms and concepts contained in an unstructured collection of text. Deerwester et al. published seminal papers on LSI in 1988. Is there earlier work that anticipates some or part of this approach?

In the following section, we will describe the search process we used to explore the collection; novel interface features will be explained as they are used.

We started with a simple query “deerwester lsi” Querium retrieved the top 99 matching documents, as shown below.

The screenshot shows the Querium Beta search interface. The search bar contains the query "deerwester lsi". The results are sorted by Rank, with the top result being "Searching Information Servers Based on Customized Profiles" by Shih-Hao Li and Peter B. Dawley. The interface includes a sidebar with filters and a right-hand panel for document comments.

We now filtered the results to documents that were published prior to 1999, and sorted them by ascending date:

The screenshot shows the Querium Beta search interface with the same query "deerwester lsi". The results are now filtered to documents published prior to 1999 and sorted by ascending date. The top result is "Indexing by Latent Semantic Analysis" by Scott Deerwester et al. The interface includes a sidebar with filters and a right-hand panel for document comments.

This produced a list of 35 documents, including some of the work by Deerwester’s team. We marked that document as potentially useful by clicking on the “thumbs up” button, and then ran a relevance feedback search for documents

similar to the selected one. Relevance feedback was implemented using reverted indexing [7]. The figure below shows the results, filtered and sorted by date

querium Beta

deerwester lsi

SEARCH HELP NOTES/CHAT Collaborators: None

Welcome to Querium

VIEW Summary Search Results

FILTER BY

Normal [100]

All Docs [100]

Useful Docs [1]

Seen Docs [1]

Docs Not Seen [99]

All years [100]

2007 - [3]

2000 - 2006 [25]

- 1999 [36]

Unknown [36]

FIND MORE

Similar to "liked" docs

By combining queries

RECENT QUERIES

deerwester lsi with 1 doc(s)

deerwester lsi

2 Indexing by Latent Semantic Analysis

Scott Deerwester, Susan T. Dumais, George W. Furnas, Thomas K. Landauer, Richard Harshman [1990] *Journal of the American Society for Information Science*
superbook.bellcore.com/~std/papers/JASIS90.ps
 The particular technique used is singular-value decomposition, in which a large term by document matrix is decomposed into a set of ca 100 orthogonal factors from which the original matrix can be approximated by linear combination....
[Show related terms](#)

1 Indexing by Latent Semantic Analysis

Scott Deerwester Graduate, Scott Deerwester, Susan T. Dumais, George W. Furnas, Thomas K. Landauer, Richard Harshman [1990] *Journal of the American Society for Information Science*
www.si.umich.edu/~furnas/POSTSCRIPTS/LSI.JASIS.paper.ps
 The particular technique used is singular-value decomposition, in which a large term by document matrix is decomposed into a set of ca 100 orthogonal factors from which the original matrix can be approximated by linear combination....
[Show related terms](#)

6 Enhancing Performance in Latent Semantic Indexing (LSI) Retrieval

Susan T. Dumais [1992]
superbook.bellcore.com/~std/papers/BRMIC91.ps
 Introduction We have developed a method called Latent Semantic Indexing (LSI) that can improve people's access to electronically available textual information (Deerwester, et al., 1990; Dumais, et al., 1988; Furnas, et al.,...)
[Show related terms](#)

14 LSI meets TREC: A Status Report

Susan T. Dumais [1993] In: D. Harman (Ed.), *The First Text Retrieval Conference (TREC1)*, National Institute of Standards and Technology Special Publication
santana.uni-muenster.de/Library/InformationRetrieval/lsi.papers.trec1.ps
 A description of terms, documents and user queries based on the underlying, "latent semantic", structure (rather than surface level word choice) is used for representing and retrieving information. Latent Semantic Indexing....
[Show related terms](#)

22 Improving text retrieval for the routing problem using latent semantic indexing

David Hull [1994] In *Proc. of the 17th ACM-SIGIR Conference*
www.cis.temple.edu/~vasilis/Courses/CIS750/Papers/p282-hull.pdf
 Improving Text Retrieval for the Routing Problem using Latent Semantic Indexing David Hull Xerox PARC and Stanford University 3333 Coyote Hill Rd. Palo Alto, CA 94304 Internet: hull@parc.xerox.com Abstract Latent Semantic....
[Show related terms](#)

39 SUPRA-RPC: Subprogram PaRAMeters in Remote Procedure Calls

Alexander D. Stoyenko [1994] University of Geneva, Switzerland
www.cs.ubc.ca/local/reading/proceedings/spe91-95/spe1/vol24/issue1/spe870.pdf

Enter your document comments here... POST

Browsing through these documents did not identify any obvious clues to answering the posed question, so we tried

a new query "Singular value decomposition factors terms" The filtered, sorted results are shown below:

querium Beta

singular value decomposition factors terms

SEARCH HELP NOTES/CHAT Collaborators: None

Welcome to Querium

VIEW Summary Search Results

FILTER BY

Normal [100]

All Docs [100]

Docs Not Seen [100]

All years [100]

2007 - [6]

2000 - 2006 [29]

- 1999 [32]

Unknown [33]

FIND MORE

By combining queries

RECENT QUERIES

singular value decomposition factors terms

deerwester lsi with 1 doc(s)

deerwester lsi

69 Generalizations Of The Singular Value And Or Decomposition

Bart De Moor, Paul Van Dooren [1995] *SIAM Matr. Anal. S. Applic.*
ftp.auto.ucl.ac.be/pub/vandooren/DemoorVD92.ps.Z
 GENERALIZATIONS OF THE SINGULAR VALUE AND OR DECOMPOSITION BART DE MOOR Y AND PAUL VAN DOOREN z We dedicate this paper to Gene Golub, a true source of inspiration for our work, but also a genuine friend, at the occasion....
[Show related terms](#)

68 Computing the polar decomposition—with applications

Nicholas J. Higham, Mims E. G. [1996] *SIAM J. Sci. Stat. Comput.*
eprints.ma.man.ac.uk/694/01/covered/MIMS_ep2007_9.pdf
 In view of the properties possessed by the polar factors of a matrix, techniques for computing the polar decomposition are of interest. While U and can be obtained in view of the singular value decomposition (see 3.1), this approach....
[Show related terms](#)

45 Accurate Singular Values of Bidiagonal Matrices

James Demmel, W. Kahan [1990] *SIAM J. Sci. Stat. Comput.*
ftp.inria.fr/pub/mirrors/netlib/lapack/lawns/lawn03.ps
 Comput., v. 11, n. 5, pp. 873-912, 1990 C James Demmel W. Kahan ouran t Institute Compu ter Science Division N 251 Mercer Str. University of California ew York, NY 10012 Berkeley, CA 94720 C Abstract computing the singular....
[Show related terms](#)

46 Accurate Singular Values of Bidiagonal Matrices

James Demmel, W. Kahan [1990] *SIAM J. Sci. Stat. Comput.*
phys.kookmin.ac.kr/lapack/lawns/lawn03.ps
 Comput., v. 11, n. 5, pp. 873-912, 1990 C James Demmel W. Kahan ouran t Institute Compu ter Science Division N 251 Mercer Str. University of California ew York, NY 10012 Berkeley, CA 94720 C Abstract computing the singular....
[Show related terms](#)

17 Perturbation Theory for the Singular Value Decomposition

G. W. Stewart, G. W. Stewart [1990] in *SVD and Signal Processing, II: Algorithms, Analysis and Applications*
www.cs.umd.edu/Library/TRs/CS-TR-2539/CS-TR-2539.ps.Z
 UMACS-TR-90-124 September 1990 CS-TR 2539 Perturbation Theory for the Singular Value Decomposition G. W. Stewart abstract The singular value decomposition has a number of applications in digital signal processing.
[Show related terms](#)

18 Perturbation Theory for the Singular Value Decomposition

Stewart The, G. W. Stewart, G. W. Stewart [1991] in *SVD and Signal Processing, II: Algorithms, Analysis and Applications*
thales.cs.umd.edu/pub/reports/ptsvd.ps
 UMACS-TR-90-124 September 1990 CS-TR 2539 Perturbation Theory for the Singular Value Decomposition G. W. Stewart abstract The singular value decomposition has a number of applications in digital signal processing.
[Show related terms](#)

Enter your document comments here... POST

The top document seemed promising, so it was saved (marked with a "thumbs up") and a comment was added to the document. The second document, even though it

preceded the Deerwester et al paper, did not address any issues related to information retrieval.

querium Beta

singular value decomposition factors terms

SEARCH HELP NOTES/CHAT Collaborators: None

hcir

"Generalizations Of The Singular Value And Qr Decomposition" marked as useful

VIEW Summary Search Results

FILTER BY

Normal [100]

All Docs [100]

Seen Docs [2]

Docs Not Seen [98]

All years [100]

2007 - [6]

2000 - 2006 [29]

- 1999 [32]

Unknown [33]

FIND MORE

Similar to "liked" docs

By combining queries

RECENT QUERIES

singular value decomposition factors terms

deerwester lsi with 1 doc(s)

deerwester lsi

69 Generalizations Of The Singular Value And Qr Decomposition
Bart De Moor, Paul Van Dooren [1985] SIAM Matr. Anal. & Applic.
<ftp://auto.ucl.ac.be/pub/vandooren/DemoorVD92.ps.Z>
GENERALIZATIONS OF THE SINGULAR VALUE AND QR DECOMPOSITION BART DE MOOR y AND PAUL VAN DOOREN z We dedicate this paper to Gene Golub, a true source of inspiration for our work, but also a genuine friend, at the occasion...
[Show related terms](#)

68 Computing the polar decomposition—with applications
Nicholas J. Higham, Mims Eprint, Nicholas J. Higham [1986] SIAM J. Sci. Stat. Comput
eprints.ma.man.ac.uk/694/01/covered/MIMS_ep2007_9.pdf
In view of the properties possessed by the polar factors of a matrix, techniques for computing the polar decomposition are of interest. While U and Σ can be obtained via the singular value decomposition (see 3.1), this approach...
[Show related terms](#)

45 Accurate Singular Values of Bidiagonal Matrices
Appeared In The, James Demmel, W. Kahan [1990] SIAM J. Sci. Stat. Comput
<ftp://iris.su.se/pub/mirrors/netlib/lapack/lawns/lawn03.ps>
Comput., v. 11, n. 5, pp. 873-912, 1990. C James Demmel W. Kahan ouran t Institute Compu ter Science Division N 251 Mercer Str. University of California ew York, NY 10012 Berkeley, CA 94720 C Abstract omputing the singular...
[Show related terms](#)

46 Accurate Singular Values of Bidiagonal Matrices
James Demmel, W. Kahan [1990] SIAM J. Sci. Stat. Comput
<phys.kookmin.ac.kr/lapack/lawns/lawn03.ps>
Comput., v. 11, n. 5, pp. 873-912, 1990. C James Demmel W. Kahan ouran t Institute Compu ter Science Division N 251 Mercer Str. University of California ew York, NY 10012 Berkeley, CA 94720 C Abstract omputing the singular...
[Show related terms](#)

17 Perturbation Theory for the Singular Value Decomposition
G. W. Stewart, G. W. Stewart [1990] in SVD and Signal Processing, II: Algorithms, Analysis and Applications
<www.cs.umd.edu/library/TR/CS-TR-2539/CS-TR-2539.ps.Z>
UMACS-TR-90-124 September 1990 CS-TR 2539 Perturbation Theory for the Singular Value Decomposition G. W. Stewart abstract The singular value decomposition has a number of applications in digital signal processing.
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18 Perturbation Theory for the Singular Value Decomposition
Stewart The, G. W. Stewart, G. W. Stewart [1991] in SVD and Signal Processing, II: Algorithms, Analysis and Applications
<thales.cs.umd.edu/pub/reports/ptsvd.ps>
UMACS-TR-90-124 September 1990 CS-TR 2539 Perturbation Theory for the Singular Value Decomposition G. W. Stewart

Gene

Talks about some applications of SVD

MANCHESTER 1824

Computing the Polar Decomposition—with Applications

Nicholas J. Higham

1986

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ISSN 1740-9007

Next we tried “term factorization” and “factorization”, but these queries were too general. At this point, we performed a query fusion step. Query fusion combines the ranked lists of documents retrieved by the queries in the selected task;

we used the same algorithm as described by Pickens et al. [8]. The combined results, filtered and sorted by date, are shown below:

querium Beta

factorization

SEARCH HELP NOTES/CHAT Collaborators: None

hcir

"Generalizations Of The Singular Value And Qr Decomposition" marked as useful

VIEW Summary Search Results

FILTER BY

Normal [96]

All Docs [96]

Useful Docs [2]

Seen Docs [6]

Docs Not Seen [90]

All years [96]

2007 - [2]

2000 - 2006 [25]

- 1999 [37]

Unknown [32]

FIND MORE

Similar to "liked" docs

By combining queries

RECENT QUERIES

factorization

singular value decomposition factors terms

deerwester lsi with 1 doc(s)

deerwester lsi

Generalizations Of The Singular Value And Qr Decomposition
Bart De Moor, Paul Van Dooren [1985] SIAM Matr. Anal. & Applic.
<ftp://auto.ucl.ac.be/pub/vandooren/DemoorVD92.ps.Z>
[Show related terms](#)

Computing the polar decomposition—with applications
Nicholas J. Higham, Mims Eprint, Nicholas J. Higham [1986] SIAM J. Sci. Stat. Comput
eprints.ma.man.ac.uk/694/01/covered/MIMS_ep2007_9.pdf
[Show related terms](#)

Indexing by Latent Semantic Analysis
Scott Deerwester Graduate, Scott Deerwester, Susan T. Dumais, George W. Furnas, Thomas K. Landauer, Richard Harshman [1990] Journal of the American Society for Information Science
<www.su.umd.edu/~furnas/POSTSCRIPTS/LSI.JASIS.paper.ps>
[Show related terms](#)

Indexing by Latent Semantic Analysis
Scott Deerwester, Susan T. Dumais, George W. Furnas, Thomas K. Landauer, Richard Harshman [1990] Journal of the American Society for Information Science
<superbook.bellcore.com/~std/papers/JASIS90.ps>
[Show related terms](#)

LAPACK Working Note Generalized QR Factorization and its Applications (Work in Progress)
E. Anderson, Z. Bai, J. Dongarra [1991]
<www.netlib.org/lapack/lawnspdf/lawn31.pdf>
[Show related terms](#)

The Generalized QR Factorization and its Applications
E. Anderson, Z. Bai, J. Dongarra, A. Qr [1991]
<ftp.sun.ac.za/sites/ftp.netlib.org/tennessee/ut-cs-91-131.ps>
[Show related terms](#)

Enhancing Performance in Latent Semantic Indexing (LSI) Retrieval
Susan T. Dumais [1992]
<superbook.bellcore.com/~std/papers/BRMIC91.ps>
[Show related terms](#)

Gene

doesn't cite Deerwester at al. Not aware of IR applications?

The Generalized QR Decomposition

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The first document seemed promising, but although it was published after Deerwester et al., it did not cite that work.

At this point, we went back to the first query, to try a different filter. One of the “features” of the dataset we were

using is rather noisy metadata, which makes it worthwhile to explore records with incomplete metadata. We then performed another relevance feedback query using the

“Analysis of the values of the LSI Term-Term Matrix” document, as shown below:

The screenshot shows the Querium Beta search interface. The search bar contains 'deerwester lsi'. The results are sorted by Rank. The first result is 'Searching Information Servers Based on Customized Profiles' by Shih-Hao Li, Peter B. Danzig. The second result is 'Analysis of the values in the LSI Term-Term Matrix' by William Hill, April Kontostathis. The third result is 'Improving text retrieval for the routing problem using latent semantic indexing' by David Hull. The fourth result is 'Combining Content and Collaboration in Text Filtering' by Ian Soboroff, Charles Nicholas, Charles K. Nicholas. The fifth result is '1 Latent Semantic Indexing: An Overview' by Infospace Spring. The sixth result is 'Automatic Cross-Linguistic Information Retrieval using Latent Semantic Indexing' by Susan Dumais, Thomas K. Landauer, Michael L. Littman. The interface includes a sidebar with filters, a 'FIND MORE' section, and a 'RECENT QUERIES' section.

This produced the following results (filtered, sorted by date):

The screenshot shows the Querium Beta search interface with results sorted by date. The first result is 'Indexing by Latent Semantic Analysis' by Scott Deerwester, Susan T. Dumais, George W. Furnas, Thomas K. Landauer, Richard Harshman. The second result is 'Indexing by Latent Semantic Analysis' by Scott Deerwester Graduate, Scott Deerwester, Susan T. Dumais, George W. Furnas, Thomas K. Landauer, Richard Harshman. The third result is 'LAPACK Working Note Generalized OR Factorization and its Applications (Work in Progress)' by E. Anderson, Z. Bai, J. Dongarra. The fourth result is 'The Generalized OR Factorization and its Applications' by E. Anderson, Z. Bai, J. Dongarra, A. Qi. The fifth result is 'Enhancing Performance in Latent Semantic Indexing (LSI) Retrieval' by Susan T. Dumais. The sixth result is 'LSI meets TREC: A Status Report' by Susan T. Dumais. The seventh result is 'Improving text retrieval for the routing problem using latent semantic indexing' by David Hull. The interface includes a sidebar with filters, a 'FIND MORE' section, and a 'RECENT QUERIES' section.

This returned no new interesting documents, so we tried a couple of additional queries, “lsi applications,” “lsi history,” and “lsi history svd”. The first two queries were

not effective, but the third was more promising. The results are shown below:

SEARCH
HELP
NOTES/CHAT

Collaborators:
None

hcir

VIEW
 Summary
 Search Results

FILTER BY

- Normal [100]**
- All Docs [100]
- Seen Docs [2]
- Docs Not Seen [98]
- All years [100]
- 2007 - [2]
- 2000 - 2006 [27]
- 1999 [54]
- Unknown [17]

FIND MORE

- Similar to "liked" docs
- By combining queries

RECENT QUERIES

- Golub Kahan with 1 doc(s)
- +Golub+Kahan
- Golub Kahan
- Lsi history svd
- Lsi history
- Lsi applications
- deerwestar lsi with 1 doc(s)
- factorization
- base factorization

SORT BY	Rank ↑	Title ↑	Authors ↑	Date ↑			
		1	2	3	4	5	6
6		Computing the Complete CS Decomposition ?	Brian D. Sutton [707] arxiv.org/pdf/0707.1838.pdf				
28		A differential equation approach to the singular value decomposition of bidiagonal m...	Meady T. Chu [1986] Linear Algebra and Its Applications www4.ncsu.edu/~mtchu/Research/Papers/svd_flow.pdf				
61		Block Reduction of Matrices to Condensed Forms for Eigenvalue Computations	Sven J. Hammarling, Danny C. Sorensen, Jack J. Dongarra, Jack J. Dongarra [1987] J. Comput. Appl. Math netlib.uow.edu.au/lapack/laws/lawn02.ps				
60		LAPACK Working Note 2 Block Reduction of Matrices to Condensed Forms for Eigen...	Sven J. Hammarling, Danny C. Sorensen, Jack Dongarra Sven, Jack J. Dongarra [1989] J. Comput. Appl. Math ftp.irisa.fr/pub/mirrors/netlib/lapack/laws/lawn02.ps				
19		Accurate Singular Values of Bidiagonal Matrices	James Demmel, W. Kahan [1990] SIAM J. Sci. Stat. Comput phys.kodmin.ac.kr/lapack/laws/lawn02.ps				

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SINGULAR VALUE DECOMPOSITION

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Received 12 March 1985; revised 31 July 1985

Reviewing the summary of the session, we ran a number of queries:

VIEW	gene's research	abdi's research	null test	hcir	EDIT	+ TASK
Summary	Query using selected docs	Golub Kahan +(10.1.1.46.4404)			me	7 mins ago
Search Results	Keyword query	+Golub +Kahan			me	21 mins ago
PERSON	Keyword query	Golub Kahan			me	21 mins ago
All	Keyword query	Isi history svd			me	24 mins ago
FILTER BY	Keyword query	Isi history			me	25 mins ago
All	Keyword query	Isi applications			me	25 mins ago
Shared	Keyword query	term factorization			me	49 mins ago
Queries	Query using selected docs	deerwester Isi +(10.1.1.58.9897)			me	29 mins ago
Docs	Keyword query	factorization			me	48 mins ago
Comments	Keyword query	deerwester Isi			me	1 hour ago
	Keyword query	singular value decomposition factors terms			me	59 mins ago
	Query using "Liked" docs	deerwester Isi +(10.1.1.41.4380)			me	1 hour ago

And we looked at a bunch of documents, commented on some, and marked some as useful (liked).

VIEW	gene's research	abdi's research	null test	hcir	EDIT	+ TASK
Summary	Opened doc	LAPACK Working Note 2 Block Reduction of Matrices to Condensed Forms for Eigenvalue Computations			me	5 mins ago
Search Results	Liked doc	A differential equation approach to the singular value decomposition of bidiagonal matrices			me	6 mins ago
PERSON	Liked doc	Latent Semantic Indexing (LSI) A Fast Track Tutorial			me	24 mins ago
All	Opened doc	The Generalized QR Factorization and its Applications			me	26 mins ago
FILTER BY	Opened doc	LAPACK Working Note Generalized QR Factorization and its Applications (Work in Progress)			me	45 mins ago
All	Opened doc	References			me	36 mins ago
Shared	Opened doc	In memory of			me	37 mins ago
Queries	Opened doc	Analysis of the values in the LSI Term-Term Matrix			me	40 mins ago
Docs	Liked doc	Indexing by Latent Semantic Analysis			me	1 hour ago
Comments	Opened doc	Using Matrix Decompositions in Formal Concept Analysis			me	51 mins ago
	Opened doc	Singular Value Decomposition - p.3/37 Vector Space			me	51 mins ago
	Opened doc	Computing the polar decomposition—with applications			me	57 mins ago
	Liked doc	Generalizations Of The Singular Value And Qr Decomposition			me	58 mins ago

In the end, we concluded that the work of Golub and Kahan foreshadowed and may have informed the work of Deerwester, et al. We arrived at this result through a combination of keyword and relevance feedback queries, by filtering and sorting on facets of metadata, by looking at aggregate results for the entire session, and by exploiting different kinds of overviews. In performing this task, we did not exhaust the capabilities of Querium: query overviews, more direct use of histograms, and collaborative features were not used in this example. We expect to demonstrate them in the workshop.

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