7th Workshop on Large-Scale Distributed Systems for Information Retrieval (LSDS-IR'09)

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Abstract

Due to the dramatically increasing amount of available data, effective and scalable solutions for data organization and search are essential. Distributed solutions naturally provide promising alternatives to standard centralized approaches. With the computational power of thousands or millions of computers in clusters or peer-to-peer systems, the challenges that arise are manifold, ranging from efficient resource discovery to issues in load balancing and distributed query processing.

The 2009 edition of the Workshop on Large-Scale Distributed Systems for Information Retrieval (LSDS-IR'09) provided a forum for researchers to discuss these problems and to define new directions in research on Distributed Information Retrieval. The Workshop program featured research contributions in the areas of collection selection, similarity search, index compression, distributed indexing, query processing, distributed computing, and network formation. In addition, there were two industry talks on large scale Web search and distributed computing.

1 Introduction

The Web is continuously growing, currently containing more than 20 billion pages (some sources suggest more than 100 billion), compared with fewer than 1 billion in 1998. Traditionally, Web-scale search engines employ large and highly replicated systems, operating on computer clusters in one or more data centers. Coping with the increasing number of user requests and indexable pages requires adding more resources. However, data centers cannot grow indefinitely. Scalability problems in Information Retrieval (IR) have to be addressed in the near future, and new distributed applications are likely to drive the way in which people use the Web. Distributed IR is the point where these two directions converge.

The 7th Large-Scale Distributed Systems Workshop (LSDS-IR'09), held on July 23, 2009, and co-located with the 2009 ACM SIGIR Conference in Boston, provided a forum for researchers to discuss these problems and to define new research directions in the area. It brought together researchers from the domains of IR and Databases, working on distributed and peer-to-peer (P2P) information systems to foster closer collaboration that could have a large impact on the future of distributed and P2P IR.

The LSDS-IR'09 Workshop continued the efforts from previous workshops held in conjunction with leading conferences:

- CIKM'08: Workshop on Large-Scale Distributed Systems for Information Retrieval – LSDS-IR'08
- SIGIR'07: Workshop on Large-Scale Distributed Systems for Information Retrieval – LSDS-IR'07
- CIKM'06: Workshop on Information Retrieval in Peer-to-Peer Networks – P2PIR'06
- CIKM'05: Workshop on Information Retrieval in Peer-to-Peer Networks – P2PIR'05
- SIGIR'05: Workshop on Heterogeneous and Distributed Information Retrieval – HDIR'05
- SIGIR'04: Workshop on Information Retrieval in Peer-to-Peer Networks – P2PIR'04

In the remainder of this report, we present the Workshop program committee and the program. We then summarize the keynote speeches and the presented research papers. We finish with a discussion of the lessons learned.

2 Program Committee

The program committee for the Workshop included:

- Karl Aberer, EPFL, Switzerland
- Ricardo Baeza-Yates, Yahoo! Research Barcelona, Spain
- Gregory Buehrer, Microsoft Live Labs, USA
- Roi Blanco, University of A Coruna, Spain
- Fabrizio Falchi, ISTI-CNR, Italy
- Ophir Frieder, Illinois Institute of Technology, Chicago, USA
- Flavio Junqueira, Yahoo! Research Barcelona, Spain
- Claudio Lucchese, ISTI-CNR, Italy
- Sebastian Michel, EPFL, Switzerland
- Wolfgang Nejdl, University of Hannover, Germany
- Kjetil Norvag, Norwegian University of Science and Technology, Norway
- Salvatore Orlando, University of Venice, Italy
- Josiane Xavier Parreira, Max-Planck-Institut Informatik, Germany
- Raffaele Perego, ISTI-CNR, Italy
- Diego Puppin, Google, USA
- Martin Rajman, EPFL, Switzerland
- Fabrizio Silvestri, ISTI-CNR, Italy
- Gleb Skobeltsyn, EPFL & Google, Switzerland
- Torsten Suel, Polytechnic University, USA
- Christos Tryfonopoulos, Max-Planck-Institut Informatik, Germany
- Wai Gen Yee, Illinois Institute of Technology, USA
- Ivana Podnar Zarko, University of Zagreb, Croatia
- Pavel Zezula, Masaryk University of Brno, Czech Republic

3 Workshop Program

The Workshop program consisted of two invited keynote talks and nine technical presentations. The two keynote talks were:

1. Leonidas Kontothanassis (Google Inc.). "The YouTube Video Delivery System." [1]
2. Dennis Fetterly (Microsoft Research). "DryadLINQ: A System for General-Purpose Distributed Data-Parallel Computing Using a High-Level Language." [7]

Kontothanassis discussed access patterns and trends in video information systems pertaining to YouTube. Fetterly talked about experiences with using the DryadLINQ system, a programming environment for writing high performance parallel applications on PC clusters, for Information Retrieval experiments.

The nine technical talks – in order of presentation – were:

1. Wai Gen Yee, Andrew Yates, Shizhu Liu, and Ophir Frider (Illinois Institute of Technology). "Are Web User Comments Useful for Search?" [2]
2. Andrea Esuli (ISTI-CNR, Italy). "PP-Index: Using Permutation Prefixes for Efficient and Scalable Approximate Similarity Search." [4]
3. Sander Bockting (Avanade) and Djoerd Hiemstra (University of Twente). "Collection Selection with Highly Discriminative Keys." [5]
4. Patrizio Dazzi, Matteo Mordacchini, Raffaele Perego (ISTI-CNR, Italy), Pascal Felber, Lorenzo Leonini (University of Neuchatel), Le Bao Anh, Martin Rajman (Ecole Polytechnique Federale de Lausanne, Switzerland), and Etienne Riviere (NTNU, Norway). "Peer-to-Peer Clustering of Web-browsing Users." [6]
5. Weimao Ke and Javed Mostafa (University of North Carolina). "Strong Ties vs. Weak Ties: Studying the Clustering Paradox for Decentralized Search." [8]
6. Gabriele Capannini, Fabrizio Silvestri, Ranieri Baraglia, and Franco Maria Nardini (ISTI-CNR, Italy). "Sorting using BItonic netwoRk wIth CUDA." [9]
7. Linh Thai Nguyen (Orbitz Inc. and Illinois Institute of Technology). "Static Index Pruning for Information Retrieval Systems: A Posting-Based Approach." [10]
8. Richard McCreadie, Craig Macdonald, and Iadh Ounis (University of Glasgow). "Comparing Distributed Indexing: To MapReduce or Not?" [11]
9. Jimmy Lin (University of Maryland). "The Curse of Zipf and Limits to Parallelization: A Look at the Stragglers Problem in MapReduce" [12]

As in the past years, the Workshop features several papers on P2P-IR. Bockting et al. present an approach for collection selection based on indexing of popular term combinations. Ke et al. study the clustering paradox for decentralized search. Finally, Dazzi et al. discuss the clustering of users in a P2P network for sharing browsing interests.

Another cluster of papers deals with efficiency of large scale infrastructures for information retrieval. Esuli suggests using permutation prefix indexes for similarity search. Nguyen proposes a new static index pruning approach. Capannini et al. propose a sorting algorithm that uses CUDA. McCreadie et al. discuss how suitable the MapReduce paradigm is for efficient indexing. Lin addresses the load-balancing issue with MapReduce. Finally, on the search quality side, Yee et al. study the benefits of using user comments for improving search in social Web sites.

4 Presentations

Konthothanassis began the workshop discussing the challenges that YouTube faces, streaming in and out so much data [1]. Already, YouTube is one of the five most popular Web sites with millions of unique visitors per month [17] and 10 hours of video uploaded per minute [18]. This puts large strain on their infrastructure, requiring novel techniques for managing physical problems like cooling and power consumption, and software problems, like working sets and security. YouTube continues to grow, and to maintain quality of service, it maintains a global network of replicated server sites, which require regular updating to maintain consistency.

Yee et al. continued the discussion on YouTube, illustrating ways of increasing the accuracy of search on content-sharing Web sites [2]. Current practice is to search for videos based on their (publisher-defined) titles, descriptions, and keywords. The problem with this approach is that this associated metadata is quite sparse and based on the perspective of a single user. Yee et al. show that by incorporating the top comment terms into the index processing can improve search accuracy by over 10%. These results are corroborated by similar analyses conducted in [3].

Esuli presented the Permutation Prefix Index (PP-Index), a novel data structure for efficient approximate similarity search [4], and its application to content-based image retrieval on a collection of 100M images [19]. The idea is to represent an object by its view of the surrounding world, i.e. a list reference objects sorted by their distance. Objects represented by similar lists are likely to be similar to each other. Such lists of objects can be stored in a compact prefix tree (about 6 MB for indexing 100M objects), which is used to select a small set of candidate results. The PP-Index provides good performance in terms of precision and speed, which can be further improved with parallel queries and data replication.

Bockting et al. presented a P2P text search solution called Sophos [5]. Sophos is a collection selection system that leverages highly-discriminative keys [14] in peer indices to construct a broker index. The broker index contains keys that are good discriminators to select collections (peers). Additionally, in order to reduce the number of keys transferred to the broker, the authors employ query-driven indexing [15].

Dazzi et al. outlined the architecture of a P2P information system, identifying the many design issues [6]. They focus on the clustering of similar users, with the goal of reducing the querying cost; if similar users are topologically close to each other, then queries, logically, have a shorter distance to travel to find relevant results. The problems with user clustering include designing ways to represent collections, designing the right collection similarity metrics, handling unbalanced loads, and handling malicious peers. Such problems are fundamental to the design of P2P information systems.

The second part of the workshop devoted to Large-Scale systems started from a keynote by **Dennis Fetterly**. Fetterly talked about DryadLINQ [20] - a system for general-purpose distributed data-parallel computing using a high-level language. The talk covered architecture of Dryad - an infrastructure for parallel and distributed programming from Microsoft Research which models dataflow of the application using DAG, and basics of LINQ (Language INtegrated Query) - a general purpose language that adds native data querying capabilities to .NET languages. The talk finished with several examples of using DryadLINQ in practice and lessons learned. More information about DeyadLINQ is available at http://research.microsoft.com/projects/dryadlinq.

Ke presented a study on decentralized search in P2P environments [8]. Typically, search is supported by a semantic overlay network, where two peers are linked by a neighborhood relationship with high probability if they own similar content. Such probability is controlled by the so called clustering exponent: a large clustering exponent boosts links among very similar pages, while a small clustering exponent allows connections between less similar neighbors that speed up the search process. Ke showed that for each dataset there exists a best tuning of the clustering exponent that allows for improved precision and speed in search.

Capannini et al. discussed the possible advantages in using recent "many-core" architectures, and in particular GPUs, for the basic task of sorting [9], which is a building block for many important problems, such as indexing in IR. Further, Capannini illustrated an efficient implementation of a bitonic sorting network for GPUs. The main challenge is to reshape the bitonic sort computation according to a stream programming model, which organizes data as streams and expresses all computation as kernels. The proposed implementation provides significant speed-ups, especially with large amounts of data.

Nguyen showed a way of static index pruning, trying to combine the benefits of both document-centric and term-centric pruning [10]. The intuition of his work is that document-centric pruning incorrectly allows all documents to stay in a collection and term-centric pruning allows all terms to stay in an index. The problem is that not all documents and not all terms are equally popular, so some of each should be removed. Experimental results are impressive for a low pruning level, outperforming both document- and term-centric pruning. However, as the pruning level increases, document-centric pruning outperforms his approach. His work would be improved with a better cost function so that his approach would work at least as well as the better of document-centric and term-centric pruning.

McCreadie et al. discussed efficient ways to implement distributed indexing of a large-scale textual collection [11]. They implemented and compared three approaches: 1) baseline indexing with map-reduce as outlined in [16], 2) distributed indexing without map-reduce, and 3) an optimized indexing algorithm based on map-reduce. The map phase of the optimized algorithm does more local processing of the input and uses compression to emit less intermediate data which positively affects performance. The authors performed extensive experiments demonstrating that the proposed optimized indexing with map-reduce scales well and achieves a noticeable speed up while indexing a large corpus of 25M documents on 19 machines.

Lin showed one of the limiting factors of Map Reduce – that it can only run as quickly as the slowest process [12]. His claim is that, in practice, data sets cannot be partitioned evenly. This is demonstrated by works such as [13], who showed that a power law distribution exists in many real-world phenemona. Workload processing times will reflect these skewed data set sizes by skewed computation times. Future work includes new ways of partitioning workload for better load balancing.

5 Final Remarks

The presented work represents a cross-section of today's distributed and P2P information search and processing problems. Large-scale, distributed systems [1, 2] with sparse descriptions require a great amount of resources to allow speedy and accurate search. Other techniques that can improve the efficiency or speed of distributed data search are novel indexing techniques based on approximations, selective keys and specialized topologies [4, 5, 6, 8]. Modern approaches to solving the problems of handling large scale distributed data include the use of map-reduce-like technologies [7, 11]. Such approaches are not without peril, however, as partitioned workloads will tend to have skewed sizes [12].

We plan for the next edition of the Large Scale Distributed Systems for Information Retrieval Workshop to be held next year in the ACM SIGIR Conference. At that conference, we expect to see greater development on the handling of large data sets by data partitioning and distribution. For more information on this year's Workshop, please see http://lsdsir09.isti.cnr.it/.

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