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Specifying Big Data Benchmarks

First Workshop, WBDB 2012
San Jose, CA, USA, May 8-9, 2012
and Second Workshop, WBDB 2012
Pune, India, December 17-18, 2012
Revised Selected Papers

Springer

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Preface

Punctuated by the rapid growth in the use of the Internet, both in the number of devices connected globally and the amount of data per device, the world has been in the midst of an extraordinary information explosion over the past decade. As a consequence, society is experiencing a rate of change in dealing with information that is faster than at any other point throughout history. The data originating from social media, enterprise applications, and computer devices in general, commonly referred to as big data, continue to grow exponentially establishing enormous potential for extracting very detailed information. Big data are often differentiated from traditional large databases using the three Vs: volume, variety, and velocity. Some also include a fourth V, namely, value. With new systems, techniques, and algorithms being developed that can deal with these new database characteristics, emerges the need for a standardized methodology for their performance evaluation.

This sparked the idea among a small group of industry and academic experts to establish a series of workshops explicitly with the intention of defining a set of benchmarks for providing objective measures of the effectiveness of hardware and software systems dealing with big data applications. Chaitanya Baru, Tilmann Rabl, Meikel Poess, Milind Bhandarkar, and Raghunath Nambiar formed a Steering Committee to organize these workshops – the Workshop on Big Data Benchmarking series (WBDB) was born. Everybody on the Steering Committee agreed that big data benchmarks, once established in the industry, will facilitate evaluation of alternative solutions and provide for comparisons among different solution approaches. The benchmarks need to characterize the new feature sets, enormous data sizes, large-scale and evolving system configurations, shifting loads, and heterogeneous technologies of big data and cloud platforms. There are new challenges and options in software for big data such as SQL, NoSQL, and the Hadoop software ecosystem; different modalities of big data, including graphs, streams, scientific data, and document collections, etc; new options in hardware including, HDD vs. SSD, different types of HDD, SSD, and main memory, and large-memory systems; and, new platform options that include dedicated commodity clusters and cloud platforms.

WBDB workshops enable invited attendees to extend their view of big data benchmarking as well as communicate their own ideas. This is accomplished through an open forum of discussions on a number of issues related to big data benchmarking – including definitions of big data terms, benchmark processes and auditing. Each attendee was asked to submit an abstract about an interesting topic, related to big data benchmarking and to give a 5-minute "lightening talk" during the first half of the workshop. After that the workshop attendees, who covered the core big data benchmark issues, which were identified in the workshops, were invited to submit a full paper to be included in these

proceedings. This turned out to be a great structure for the first two workshops, because it brought a lot of ideas into the open and, since many workshop attendees did not know each other, served as an introduction of the workshop attendees. During social time, individuals were able to follow up on ideas that were sparked by the lightening talks.

The First Workshop on Big Data Benchmarking (WBDB 2012), held during May 8–9, 2012, in San Jose, CA, in the Brocade facilities, was attended by over 60 invitees representing 45 different organizations, including industry and academia. It was funded by the NSF and sponsored by Mellanox, Seagate, Brocade, and Greenplum. The topics discussed at the first workshop can be grouped into four topic areas: (1) Benchmark Context; (2) Benchmark Design Principles for a Big Data Benchmark; (3) Objectives of Big Data Benchmarking; and (4) Big Data Benchmark Design.

As far as benchmark context is concerned, the consensus of the benchmark attendees was that a big data benchmarking activity should begin at the application level, by attempting to characterize the end-to-end needs and requirements of big data analytic pipelines. While isolating individual steps in such pipelines, e.g., sorting, is indeed of interest, it should be done in the context of the broader application scenario. Furthermore, a wide range of data genres should be considered including, for example, structured, semi-structured, and unstructured data; graphs (including different types of graphs that might occur in different types of application domains, e.g., social networking versus biological networks); streams; geospatial data; array-based data; and special data types such as genomic data. The core set of operations need to be identified, modeled, and benchmarked for each genre, while also seeking similarities across genres.

Numerous examples of successful benchmarking efforts can be leveraged, such as those from consortia as the Transaction Processing Council (TPC), Standard Performance Evaluation Corporation (SPEC), industry-driven efforts such as VMMark (VMWare) and Top500, and benchmarks like Terasort and Graph500. With respect to design principles, the workshop discussed whether those from existing TPC benchmarks, many of which experience an impressively long shelf life, can be adopted for a big data benchmark or whether new once should be developed. The conclusion was that some design principles should be adopted but that others such as scalability and elasticity seen in big data application require the development of new design principles. One of the more contentious topics was the questions of whether the goal of a big data benchmark should foster innovation or competition, i.e., whether it should serve as a technical and engineering or a marketing tool, which split the room into academic-focused attendees and those from industry. The goals of a technical benchmarking activity are primarily to test alternative technological solutions to a given problem. Such benchmarks focus more on collecting detailed technical information for use in system optimization, re-engineering, and re-design. A competitive benchmark focuses on comparing performance and price/performance (and, perhaps, other costs, such as start-up costs and total cost of ownership) among competing

products, and may require an audit as part of the benchmark process in order to ensure a fair competition.

Following the successful First Workshop on Big Data Benchmarking, the second workshop (WBDB 2012.in) was held in Pune, India, on December 16–17, 2012, where the facilities were provided by Persistent Systems and Infosys. Unlike the first workshop, an open call for papers was published for WBDB 2012.in. This was a good decision, since it attracted several submissions from international researchers. However, the participation was restricted to one person per company or institution. Each participant was requested to give a presentation. The Steering Committee and the Program Committee did a great job in inviting a balanced crowd of industrial and academic participants. About half of the 40 participants were local, while the other half came from all around the world. The two-day workshop was organized in four major blocks. The first day started with three longer presentations that showed matured research and results of collaborations that were seeded in the first workshop. The second half of the first day was used for discussing the BigData Top100 idea, a big data-related analogy of the Top500 list of the world's fastest super computers. The second day began with discussion of big data-related hardware solutions and ended with domain-specific topics in the big data landscape.

The major result from these two workshops is the definition of a big data analytics benchmark, BigBench. It extents the well-known decision support benchmark TPC-DS with semi-structured and unstructured data, very common in big data workloads. The two workshops also seeded the idea of forming a consortium for the BigData Top100 list and a biweekly Big Data Benchmarking Community call was established, where big data researchers and practitioners present novel use-cases, problems, and solutions.

In this book, the most mature and interesting contributions from the First and Second Workshop on Big Data Benchmarking were collected. We divided the contributions into four categories. Five papers cover benchmarking, foundations, and tools: "TPC's Benchmark Development Model: Making the First Industry Standard Benchmark on Big Data a Success" explains the methodology the TPC uses to develop benchmarks"; "Data Management: A Look Back and a Look Ahead" provides an overview of the TPC and why some benchmarks were successful and some failed; "Big Data Generation" covers how large amounts of data for large-scale factor big data benchmarks can be efficiently generated using The Parallel Data Generation Framework (PDGF); "From TPC-C to Big Data Benchmarks: A Functional Workload Model" describes how benchmark-relevant elements from an application domain can be used to define benchmarks; and "The Implications of Diverse Applications and Scalable Data Sets in Benchmarking Big Data Systems" explores the influence of experiment scale on performance.

The second category is about domain specific benchmarking. Six papers cover a broad range of specific big data domains. "Processing Big Events with Showers and Streams" discusses different categories of stream data and their use-cases. The paper "Big Data Provenance: Challenges and Implications for

Benchmarking" reviews big provenance solutions and explores strategies for benchmarking them. In the paper "Benchmarking Spatial Big Data," the domain of spatial data is explored and discussed. Scientific datasets and benchmarking of array databases are presented in the paper "Towards a Systematic Benchmark for Array Database Systems." "Unleashing Semantics of Research Data" presents challenges in retrieving big semantic data from research documents. This part of the book concludes with a discussion of graph data and its generation in the paper "Generating Large-Scale Heterogeneous Graphs for Benchmarking."

The third category covers hardware-specific approaches to measuring big data aspects. The paper "A Micro-Benchmark Suite for Evaluating HDFS Operations on Modern Clusters" presents storage benchmarks on HDFS and in "Assessing the Performance Impact of High-Speed Interconnects on MapReduce" different network interconnects are evaluated.

The last category presents a full end-to-end big data benchmark. "BigBench Specification V0.1" contains a detailed description of the big data analytics benchmark BigBench including the full set of queries and the data model with scripts to run the benchmark.

The 14 papers in this book were selected out of a total of 60 presentations at WBDB 2012 and WBDB 2012.in. All papers were reviewed in two rounds. We would like to thank all authors and presenters for making both workshops successful. We thank the reviewers for their commitment and our sponsors for helping to keep both workshops free of charge.

October 2013

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Table of Contents

Benchmarking, Foundations and Tools

Domain Specific Benchmarking

Benchmarking Hardware

End-to-End Big Data Benchmarks