Google Dremel: SQL-Like Query for Big Data

JIMMY ARDIANSYAH[1,*]

[1] School of Informatics and Computing, Bloomington, IN 47408, U.S.A.
[*] jardians@indiana.edu - S17-IR-2002

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Dremel is a scalable, interactive ad-hoc query system for analysis of read-only nested data. By combining multi-level execution trees and columnar data layout, it is capable of running aggregation queries over trillion-row tables in seconds.

Keywords: Google Dremel, Big Data Query

https://github.com/jardians/sp17-i524/tree/master/paper1/S17-IR-2002/report.pdf

This review document is provided for you to achieve your best. We have listed a number of obvious opportunities for improvement. When improving it, please keep this copy untouched and instead focus on improving report.tex. The review does not include all possible improvement suggestions and for each comment you may want to check if it applies elsewhere in the document.

Please, use 80 character lines in the LaTeX source. Makes reading the paper easier.

Abstract: Good. It can be expanded with another sentence or two with examples of tasks it has been used for.

Overall, you do a good job of explaining what Dremel is and how it works. However, the parts of the paper that have to give a more general idea about Dremel (intro and conclusion for example) need to be written in a more neutral voice. That is, you need to tone down some of the superlative words you are using like "drastically", "super", "unprecedented" and so on. The goal of the paper is to inform about specific qualities of Dremel in a neutral way, and backing up claims with citations. The use of words like these is not appropriate for a paper like this, even in sections that are aimed at providing a broader view of Dremel.

Assessment: Some revisions recommended. Please address the notes below by end of March.

INTRODUCTION

Big data analytics nowadays has become more common across industries and government agencies partly due to fast and affordable commodity storage to keep pace with data and business growth.

Not clear. Data sense?

Make the data sense at the fingertips of data scientists and analysts has become increasingly essential to compete in the business world. Having interactive tool with fast response times often make

Grammar

a difference in data exploration, rapid prototyping as well as designing

Term

of data pipelines. Performing interactive data analysis at scale demands a high degree of parallelism. That's where Dremel comes into play.

Dremel is a scalable, interactive ad-hoc query system for analysis of read-only nested data. By combining multi-level execution trees and columnar data layout, it is capable of running aggregation queries over trillion-row tables in seconds. The system scales to thousands of CPUs and petabytes of data. With Dremel, you get to write a declarative SQL-like query against data stored in a very efficient for analysis read-only columnar format. It's also possible to write queries that analyze billions of rows, terabytes of data, and trillions of records in seconds [1].

HISTORY DEVELOPMENT

This section mixes the historical development with elements from the architecture of Dremel (column store, definition and repetition levels, reconstructing a record, etc.). This will better serve as the first two paragraph of the architecture section.

When Google published the Dremel paper in 2010, it explained how this structure is preserved within column store. Every column, in addition to its value, also stores two numbers — definition and repetition levels.

This encoding ensures that the full or partial structure of the record can be reconstructed by reading only requested columns, and never requires reading parent columns (which is the case with alternative encoding). That same paper gives an exact algorithm for both encoding the data and reconstructing the record.

In 2014, Google published another paper — Storing and Querying tree-structured records in Dremel

Please use a citation. You don't need to include the title of the paper in the text if you cite it.

— which lays theoretical foundation and proves correctness of algorithms for filtering and aggregation operators, which take advantage of the above encoding. [2].

WHY DREMEL

Needs question mark.

This observation report discusses some characteristics of Dremel; a system that supports interactive analysis of very large datasets over shared clusters of commodity machines.

This first sentence is not necessary. You've already discussed what Dremel is at a high level, and you should try to avoid focusing on the paper (e.g. "This observation report discusses...") and focus on Dremel itself.

Dremel can even execute a complex regular expression text matching on a huge logging table that consists of about 35 billion rows and 20 TB, in merely tens of seconds.

This is a very specific statement that needs a reference. Also, why focus on something so specific in a general "Why Dremel?" section?

This is the power of Dremel; it has super high

"super high" is subjective and too conversational for a paper like this

scalability and most of the time it returns results within seconds or tens of seconds no matter how big the queried dataset is. Why Dremel can be as drastically

"drastically" is subjective

fast as the examples show?

You need to clarify what examples or remove this sentence. Are these related to something you've discussed in the paper so far, or of the references? It is not clear.

The answer can be found in two core technologies which gives Dremel this unprecedented

"unprecedented" is subjective;

performance:

1. Columnar Storage. Data is stored in a columnar storage fashion which makes possible to achieve very

   try to avoid using adverbs like "very"

   high compression ratio and scan throughput.

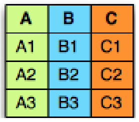
2. Tree Architecture is used for dispatching queries and aggregating results across thousands of machines in a few seconds [1].

This is more the tone and wording the whole paper should use. Still, "across thousands of machines in a few seconds" is not very specific so you should see if you can make this a little more concrete based on what the paper reports

Columnar Storage.

Dremel stores data in its columnar storage, which means it separates a record into column values and stores each value on different storage volume, whereas traditional databases normally store the whole record on one volume; this is efficient for cases where many columns of the records need to be fetched. For example, if one analysis heavily relied on fetching all fields for records that belong to a particular time ranged, row-oriented storage would make sense.

To illustrate what columnar storage is all about, here is an example with three columns

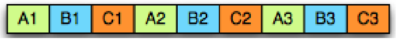


A	B	C
A1	B1	C1
A2	B2	C2
A3	B3	C3

Fig. 1. Typical row-oriented storage

In a row-oriented storage, the data is laid out one row at a time as follows:

When you write a paper like this, it is best not to assume where a figure will be placed on the page. Thus, don't use a colon, but say "In Figure ref{...}, ...". This is for two reasons: 1) Paper formats differ between different conferences and journals, so you're not guaranteed where a figure will be placed. 2) LaTeX itself doesn't always guarantee exact placement on the page.

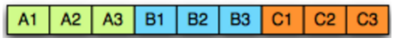


A1	B1	C1	A2	B2	C2	A3	B3	C3

Fig. 2. Transform row to column-oriented format

Whereas in a column-oriented storage, it is laid out one column at a time:

See above about using the colon/assuming where the figure will appear on the page.



A1	A2	A3	B1	B2	B3	C1	C2	C3

Fig. 3. Laid out the column

Dremel has introduced columnar storage, which provides several advantages over row-oriented system:

- Is generally very efficient in term

  Grammar

  of compression on columns because entropy within a column is lower that entropy within a block of rows. in other words, data is more similar within the same column, than it is in a block of rows. This can make a huge

  "huge" is subjective, just use "big"

difference especially when the column has few distinct value.

Grammar

- Work well for queries that only access a small subset of columns.
- I/O will be reduced as we can efficiently scan only a subset of the columns while reading the data. Better compression also reduces the bandwidth required to read the input.
- Is often well suited for data-werehousing applications where users want to aggregate certain columns over a large collection of records.
- As we store data of the same type in each column, we can use encoding better suited to the modern processors' pipeline by making instruction branching more predictable [3].

This is a nice list of advantages, but please try to provide references about some of the assertions in the first four bullet points.

Tree Architecture

Dremel builds on ideas from web search and parallel DBMSs. First, its architecture borrows the concept of a serving tree used in distributed search engines.

This will be difficult to understand for someone who doesn't know what a serving tree is. Either provide a little more explanation, or include a reference.

Just like a web search request, a query gets pushed down the tree and is rewritten at each step. The result of the query is assembled by aggregating the replies received from lower levels of the tree. Tree Architecture has enable Dremel to dispatch queries and collect results across tens of thousands of machines in a matter of seconds by using the Tree architecture.

This is a specific empirical claim so it needs a reference.

The architecture forms a massively parallel distributed tree for pushing down a query to the tree and then aggregating the results from the leaves at a blazing fast

"blazing fast" is subjective and better suited to an advertisment than a paper like this

speed [4]. Consider a simple aggregation query below:

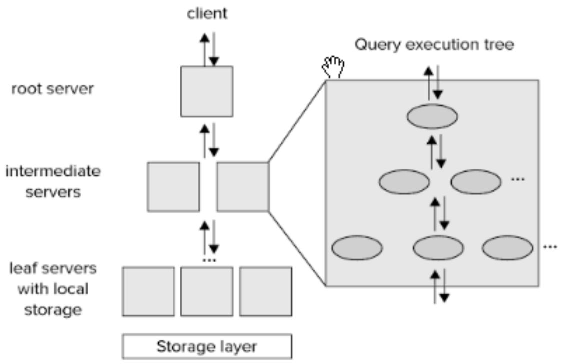


Fig. 4. Typical Tree Architecture [5]

A root server receives incoming queries, reads metadata from the tables, and routes the queries to the next level intermediate servers in the serving tree. The leaf servers communicate with the storage layer (based on the columnar model described earlier) to read data which is bubbling up for the aggregation and final result is return to the user or access the data on local disk.

However, after data is processed, one will be running aggregate queries and analysis on large chunks of data at a time, most probably only on a subsets of columns. Because many analytical queries only select a subsets of columns at a time for storing that will be analyzed later [5].

Overall, Dremel combine

Spelling

parallel query execution with the columnar format that supporting

Term

performance data access and also capable of operating on in situ

Use
emph{} to show you are introducing a term.

nested data. In situ refers to the ability to access data 'in place', e.g., in a distributed file system like Veritas Cluster File System, General Parallel File System (GPFS), and Global File System (GFS).

Why not simply use "in place" to avoid having to explain a new term? Does using "in situ" help understanding in any way?

IMPLEMENTATION OF GOOGLE DREMEL

Apache Drill is the open source version of Google's Dremel system which is available as an infrastructure service called Google BigQuery. One explicitly stated design goal

Needs reference. Where is it stated?

is that Drill is able to scale to 10,000 servers or more and to be able to process petabytes of data and trillions of records in seconds.

Specific quantitative claim, needs reference.

Drill is an Apache top-level project.

Explain briefly what that means (top level project)?

Drill supports a variety of NoSQL databases and file systems. In addition, Drill supports data locality, so it's a good idea to co-locate Drill and the datastore on the same nodes [6].

CONCLUSION

Although query and process

Grammar

large volute of data in any system is a challenging task, especially in the big data ecosystem due to vast expense of option available, Dremel has been standing out as the right model

"standing out as the right model" is subjective

for process and storing data with a lot of benefits as well as fitting as part of an entire big data stack which can be used against raw data, like log data. Choosing the right tool for your data is one of the most important decision one will make in the application, and everyone need to spend the appropriate amount of time and effort to get it right the first time.

This sentence is unnecessary.

Because of it, I believed

Don't use "I believe", "I think", etc. The paper should have a neutral voice.

Dremel will be the future of interactive ad-hoc query system for analysis that require fast result.

Subjective statement.

ACKNOWLEDGEMENTS

this

Spelling

work was done as part of the course "I524: Big Data and Open Source Software Projects" at Indiana University during Spring 2017

REFERENCES

[1] S. Melnik, A. Gubarev, J. J. Long, G. Romer, S. Shivakumar, M. Tolton, and T. Vassilakis, "Dremel: Interactive analysis of web-scale datasets," *Communications of the ACM*, vol. 54, pp. 114–123, Jun. 2011. [Online]. Available: http://cacm.acm.org/magazines/2011/6/108648-dremel-interactive-analysis-of-web-scale-datasets/fulltext

[2] Google, "Dinside capacitor, bigquery's next-generation columnar storage format," Web Page, Feb. 2017, accessed: 2017-02-20. [Online]. Available: https://cloud.google.com/blog/big-data/2016/04/inside-capacitor-bigqueys-next-generation-columnar-storage-format

[3] M. Grover, T. Malaska, J. Seidman, and G. Shapira, *Hadoop Application Architectures*. Sebastopol, California: O'Reilly Media Inc, 2015.

[4] Twittter, "Dremel made simple with parquet," Web Page, Feb. 2017, accessed: 2017-02-15. [Online]. Available: https://blog.twitter.com/2013/dremel-made-simple-with-parquet

[5] B. Lublinsky, K. T. Smith, and A. Yakubovich, *Professional Hadoop Solutions*. Indianapoli, Indiana: Wiley Publishing, 2013.

[6] wikipedia, "Apache drill," Web Page, Feb. 2017, accessed: 2017-02-20. [Online]. Available: https://en.wikipedia.org/wiki/Apache_Drill