A scalable sparse matrix-vector multiplication architecture with Accumulo and D4M

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***Abstract*—The increasing volume and velocity of large unstructured datasets have been calling for new technologies to store, query, and analyse data of interest. Such datasets can be represented as a large graph. This paper presents a scalable architecture for analysing massive graphs, with a focus on computing sparse matrix-vector multiplication (SpMV). In this paper, we describe the architecture consisting of Accumulo, D4M and pMatlab. We store the data in Dynamic Distributed Dimensional Data Model(D4M) format for easy extraction from Accumulo database while pMatlab serves as a parallel computation engine using MPI. The principal analysis algorithm is Lanczos-SO for calculating top k eigenvalues and eigenvectors of a matrix. Experiments on Graph500 benchmark datasets demonstrate the scalability and efficiency of our architecture.**

I. Introduction

Typical data analytics normally include the following pipeline: collecting data, querying data, analysing data and report. Nowadays Hadoop plays a fundamental role in tackling the challenges caused by increasing volume and velocity of unstructured data. The success of Hadoop relies on its two components: Hadoop Distributed File System (HDFS) for storing massive amount of data with redundancy for failure tolerance and MapReduce for batch processing.

In many applications it is intuitive to represent data as a graph to discover patterns hidden underneath. Graph representation has a wide range of applications from social sciences to physics and bio-informatics . Take social media for example, a sparse adjacent matrix for all Twitter users can be built to reflect their relationships. Construction of such a matrix, however, requires complicated operations. Moreover, to find users of similar interests, we need apply linear algebra operations to this matrix. Recent work has focused on constructing graphs from the data stored in the D4M format and applying eigendecomposition to the modularity matrix. "[**?**]".

Sparse matrix-vector multiplication (SpMV) is of great importance in sparse linear algebra given the fact that they represent the dominant cost in many iterative methods for solving large-scale linear systems and eigenvalue problems that arise in a wide variety of scientific and engineering applications. "[**?**]" For example, SpMV is the most expensive operation in Lanczos-SO algorithm employed in HEIGEN which is an eigensolver for billion-scale graphs based on Hadoop. "[**?**]"

In this paper, we introduce a scalable massive graph analysis architecture integrating D4M and Accumulo with the focus on SpMV. This architecture encompasses the entire data analytics pipeline, from data collection to data extraction of relational structure to data analysis of the resulting graph. In addition, we present and compare our experimental results on implementing Lanczos-SO algorithm to HEIGEN. Our platform shows almost twice speed-up and great scalability.

The rest of the paper is organized as follows. Section 2 describes the architecture, discusses the data storage format and the graph construction procedure. Section 3 explains Lanczos-SO algorithm. Section 4 focuses on D4M and Accumulo. Section 5 demonstrates our implementation of eigensolver using D4M and Accumulo. Section 6 is for experimental results and discussion and section 7 comes to a conclusion.

II. Discussion

To be completed after getting experimental results

III. Relevant work

To be completed

IV. Conclusion

To be completed

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