Assignment 3- cloud computing

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Assignment3–Spark-on-gcp

This report is to test the computations of SVD and PCA on the matrix evaluated by pyspark on google cloud.

set-up. Throughtout this report, the dense square matrices are randomly generated by normal distribution with zero mean and unit variance. In addition, we use `RowMatrix` to distributed the matrix partitions among the machines within the cluster. Then, we use SVD and PCA computations available in `pyspark` to evaluate their performance among two different clusters.

Requirements

This section introduces the requirements so that pyspark can be run on your personal local machine as shown below:

- Java JDK
- Scala
- Spark 2.3.3 with Hadoop 2.7
- Anaconda 3 with the following installed package `numpy`

In addition, you have to export SPARK_HOME (for your current spark directory), PYSPARK_PYTHON (for your current python directory), and HADOOP_HOME (for your current hadoop directory) to be able to run the python scipt on spark.

Run the code in the personal Windows machine

After all the installations, we can run the SVD and PCA computations by the python scipt `Spark-test-svd-and-pca.py` on your personal machine with spark 2.3.3 and hadoop 2.7 by using the following command:

```
directory/to/spark-2.3.3-bin-hadoop2.7/bin/spark-submit Spark-test-svd-and-pca.py
```

Run the code on GCP

This section introduces how to test the SVD and PCA computations by the script `Spark-test-svd-and-pca.py` on GCP. We follow the detailed steps which can be found in the following site.

To be able to run the python scripts on top of spark in the google cloud platform, we need to

1. Enable Cloud Dataproc API which can be found in the API library in your console.
2. Create the Bucket which can be found in Web Console. Here, you upload necessary python scipts and data matrices.
3. Create the clusters to make the numerical evaluations using Dataproc. Here, you can easily deploy the clusters which are already installed spark and python.
4. You can submit the job into the cluster easily from your console.

Numerical Results for GCP

We randomly generated the dense matrix with dimension 2000×2000, 2100×2100, and 2200×2200 to evaluate the performance of distributed computations of SVD and PCA when we use two different types of clusters: one consists of one master and another consists of one master and two workers. Throughout the simulations, we set 2 virtual CPUs and 500 GB memory storage for a master and each worker.

Cluster type	Matrix Dimension	Running Time
1 M 0 W	2000×2000	2 min 22 sec
	2100×2100	8 min 32 sec
	2200×2200	out of memory
1 M 2 W	2000×2000	1 min 45 sec
	2100×2100	1 min 54 sec
	2200×2200	2 min 0 sec

Table 1 and Figure 1 illustrate that the cluster with high number of workers outperforms that with low number of workers in terms of computation time when we increase the matrix size gradually. Also, if the matrix size is not high enough, then the compuation time between these clusters can be comparable. In addition, we can see the sub-linear speedup and faster-than-linear speedup when the benchmarking matrices with size 2000×2000 and 2100×2100 are used from Figure 2. Here, the relative speedup of the algorithm on p processors is defined as $S(p) = t_1/t_p$, where t_1 and t_p are the time it takes to finish the compuations

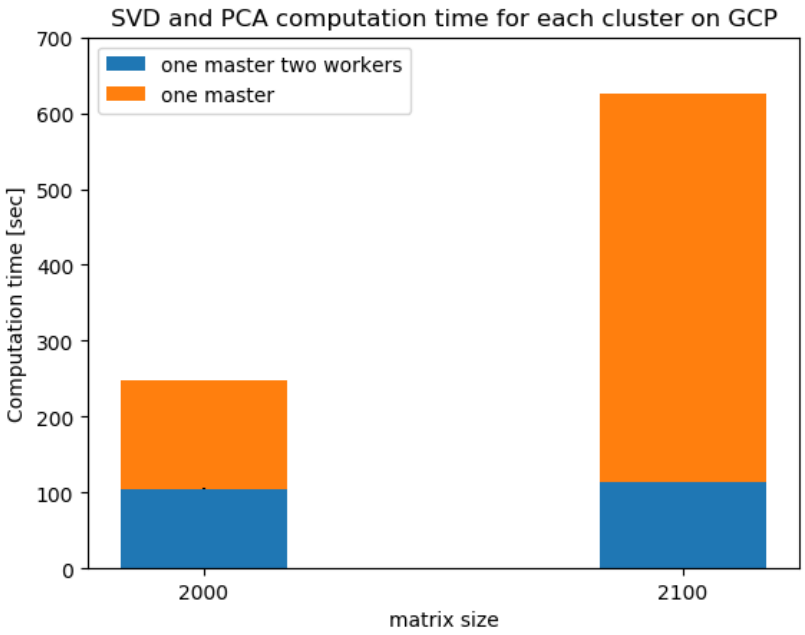
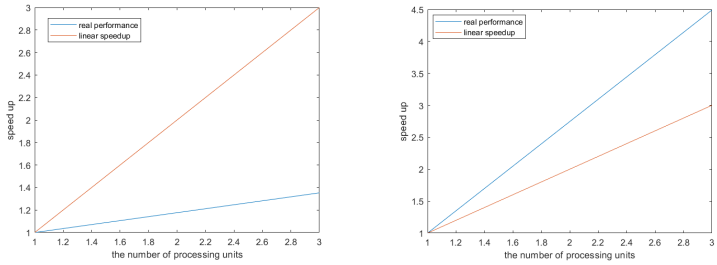


Figure 1: SVD and PCA computation for each cluster on GCP

on 1 and p processing units, respectively.



(a) 2000×2000 (b) 2100×2100

Figure 2: Speedup for different matrix size

Reflections

This assignment enables us to explore how to deploy the codes utilizing the computer clusters on available cloud platforms, e.g. google and amazon clouds. It helps us see the better performance of current parallelism frameworks available in many programming languages to handle computations over large-scale data.

One complaint would be the installations of `pyspark` are quite tricky since they require many software packages. However, it is quite convenient to deploy on the google cloud platform using `dataprocs` which enables us to get the clusters with already installed packages.

Github respository

All the results and python scripts can be found in the following link:

https://github.com/KhiriratSarit/-Assignment3--Spark-on-gcp.