



CPRE/SE 419 Software Tools for Large Scale Data Analytics

Spring 2023

Homework 1

Due: Thursday, February 23, 11:59PM

Preamble:

The purpose of this homework is for you to review and get some practice on the material that was covered in class so far. It has three main parts: (I) General questions, to be answered very concisely; (II) Actual problem-settings/discussion; (III) A problem to be solved via pseudocode (plus – since you are great younger colleagues, you get a bonus in Part III: a reading assignment (just reading, nothing to report in this homework¹))

Part I:

1. (8 pts.) Would you say that a Namenode machine should be on the same machine as a DataNode in terms of hardware?
2. (8 pts) Would you say that a Secondary node is a substitute/back up node for the NameNode?
3. (8 pts.) Briefly describe at least one advantage of YARN over Hadoop.
4. (8 pts.) What is a heartbeat in HDFS?
5. (8 pts.) Can you change the block size of HDFS files? What would be the immediate consequence of doing so?

Part II:

1. Consider the setting of a machine with a single disk, with the following properties:
 - i. The throughput is 256MB/sec.
 - ii. There is a file of size 500GB
 - (a) (10 pts.) How long does it take to read the entire file into the main memory?
 - (b) (13 pts.) Now, consider distributed setting, where the cluster has the following properties:
 - i. Each node has the same throughput (256MB/sec.).
 - ii. There is a file of size 500GB which is split into blocks, and each block is 128MB.
 - iii. There are a total of 20000 nodes.What would be the best-case scenario of distributing the blocks among the nodes, for the purpose of optimizing the throughput (in terms of making sure that the entire file is read (i.e., each portion is read from disk -> main memory)? What is the speed-up with respect to (a)?

¹ Of course, the future is unpredictable... one could always use an extra question (along with Rachmaninoff's piano concertos) on a pop-quiz, no?



- (c) (13 pts.) For the final variant, consider settings (almost) same as in problem (b) – the only difference being that now the cluster has only 100 nodes. What is the time to read the file (best-case scenario in terms of blocks distribution)?

Part III:

1. (24 pts.) Write MapReduce algorithm (i.e., pseudocode for the map and reduce methods) for the following problem:

Given two square-matrices A and B , each with dimension $n \times n$, compute the product $A \times B$.

Please address the fundamental aspects like, for example:

- How the input is (assumed) to be represented as a file in HDFS.
- Assuming that there were M mappers (map tasks) and R reducers (reduce tasks), analyze the per-mapper CPU cost, per-reducer CPU cost, and the communication costs between mappers and reducers.

2. Reading assignment: <https://www.usenix.org/system/files/conference/atc13/atc13-cidon.pdf>

What to turnin: Typed solutions are strongly preferred. If, for whatever reason, you are prevented from using any editor, then we may accept hand-written solution – only if they are extremely legible.

You can work in teams of two students for this assignment (of course, individual submissions will be honored too). If you are working in a team – please make sure to put the names of the team members in the beginning of the document. You have plenty of time to complete the assignment – however, it would be wise to start planning the time/activities asap.