Real-time GDA

ABSTRACT

ACM Reference format:
. 2016. Real-time GDA. In *Proceedings of ACM Conference, Washington, DC, USA, July 2017 (Conference'17),* 1 pages.
DOI: 10.475/123_4

1 MODEL

Let $\mathcal{L}$ be the set of sites that holds data and runs tasks. For each inter-site WAN link, let $B_{l_1}^{l_2}$ be the bandwidth from site $l_1 \in \mathcal{L}$ to site $l_2 \in \mathcal{L}$. We assume that the bandwidths are stable within the time frame of doing real-time data analytics.

1.1 Single MapReduce Query

We perform the map tasks at the sites that contain the associated data and denote D_{l_1} as the output data from all of the map tasks at site l_1. The fraction of reduce tasks assigned to site l_2 is denoted as r_{l_2} which is also the fraction of all other sites' data that must be transfered through the WAN to l_2. This means that the total WAN usage is for a given task distribution r is:

$$\sum_{l_1} \sum_{l_2 \neq l_1} D_{l_1} r_{l_2} \tag{1}$$

If we are given a start time s after the map steps are all completed and a data shuffle deadline t for the reduce tasks, then the completion time is bounded as such:

$$s + \max_{(l_1, l_2): l_2 \neq l_1} \left\{ \frac{D_{l_1} r_{l_2}}{B_{l_1}^{l_2}} \right\} \leq t \tag{2}$$

which is caused by the heterogeneous WAN bandwidth and has a bottlenecking link(s).

2 PROBLEM FORMULATIONS

2.1 Single MapReduce Query

Minimize WAN usage. When minimizing WAN usage for a MapReduce data shuffle we have the following optimization problem:

$$\min_{r} \quad \sum_{l_1} \sum_{l_2 \neq l_1} D_{l_1} r_{l_2} \tag{3a}$$

$$\text{s.t.} \quad \sum_{l_2} r_{l_2} = 1 \tag{3b}$$

$$r_{l_2} \geq 0 \quad \forall l_2 \tag{3c}$$

Feasibility to meet deadline. We want to find a feasible r so that the data shuffle finishes at or before t:

$$\text{find } r \text{ s.t.} \quad \frac{D_{l_1} r_{l_2}}{B_{l_1}^{l_2}} \leq t - s \quad \forall (l_1, l_2) : l_2 \neq l_1 \tag{4a}$$

$$\sum_{l_2} r_{l_2} = 1 \tag{4b}$$

$$r_{l_2} \geq 0 \quad \forall l_2 \tag{4c}$$

Minimize WAN usage given a shuffle deadline. When minimizing WAN usage for a MapReduce data shuffle for a given deadline t we have the following optimization problem:

$$\min_{r} \quad \sum_{l_1} \sum_{l_2 \neq l_1} D_{l_1} r_{l_2} \tag{5a}$$

$$\text{s.t.} \quad \frac{D_{l_1} r_{l_2}}{B_{l_1}^{l_2}} \leq t - s \quad \forall (l_1, l_2) : l_2 \neq l_1 \tag{5b}$$

$$\sum_{l_2} r_{l_2} = 1 \tag{5c}$$

$$r_{l_2} \geq 0 \quad \forall l_2 \tag{5d}$$

APPENDIX

Conference'17, Washington, DC, USA

DOI: 10.475/123_4