Groupwise Analytics via Adaptive MapReduce

Liping Peng, Kai Zeng, Andrey Balmin, Vuk Ercegovac, Peter J. Haas, Yannis Sismanis

**Groupwise Set-Valued Analytics**
- Micromarketing, fraudulent transaction detection, etc.
- **SELECT** `synopsis(k)` **FROM** dataset **GROUP** **BY** strata:
  - Stratified top-k
  - Stratified bottom-k
  - Stratified sampling

**Groupwise Analytics Running on Adaptive MapReduce**
- Global threshold \( w_{(k)} \): The \( k \)-th smallest weight for all records in group \( G \).
- Each mapper maintains the set of records with weights no larger than \( w_{(k)} \).
- The number of shuffled records can be reduced from \( O(gkm) \) to \( O(gk) \).

**Buffered MapReduce for Bottom-k Query**
- **Mapper**: run bottom-k algorithm and emit a local synopsis of \( k \) records per group
- **Reducer**: collect all synopses of the same group and merge into a global synopsis

**Asynchronous Coordination with DMDS**
- Each mapper periodically sends equi-depth histogram of group values to coordinator
- Coordinator periodically merges mapper histograms to estimate global threshold

**Top-r Stratified Sampling**
- In micro-marketing applications, focus on the \( r \) largest (age, zip code) customer groups due to resource or time limitation.
- **SELECT** `sample(k)` **FROM** dataset **GROUP** **BY** strata **ORDER** **BY** `count(*)`
  - LIMIT \( r \);`
- **Key idea**: GARAM + approximate thresholding

**Evaluation: Stratified Sampling**
- **Data**:
  - A table in SDSS
  - 245 columns
  - 586 million records
  - 2.4TB in HDFS
- **Cluster**:
  - 12 nodes with 10Gbs Ethernet
  - 12-core Intel Xeon 64-bit CPU @2.2GHz, 96GB RAM and 12 SATA disks per node
  - Hadoop v1.1.2
  - 1 node for Hadoop JobTracker for HDFS
  - 1 node for ZooKeeper Server
  - 10 workers, each with 8 map slots and 4 reduce slots

- **GARAM** is close to Buffered for small \( gk \) and performs the best when \( gk \) is large
- **GARAM** shuffles the least in all cases due to the much more aggressive pre-filtering in the mappers based on the coordination

- Significantly outperforms GARAM in the case of 13961 strata: 20x less data, 2x faster
- Does not improve much over GARAM in the case of 854 strata, but shorter duration indicates little overhead relative to GARAM