Adaptive Online Aggregation with Randomness Detection

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Approximate Query Processing

<table>
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<th>Advantages</th>
<th>Disadvantages</th>
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<td>Faster execution</td>
<td>Inaccurate</td>
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<tr>
<td>Non-blocking</td>
<td>Heavy preprocessing</td>
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Many application can tolerate some errors.
Block-level sampling reduces preprocessing but increase errors.

Online Aggregation

![Diagram showing online aggregation with estimate and result over time.]

Sampling and Estimation

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<th>Sampling</th>
<th>Estimation</th>
<th>Aggregates</th>
<th>Preprocessing</th>
<th>Bound</th>
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<td>Tuple-level</td>
<td>Shuffling</td>
<td>Closed-form</td>
<td>Limited</td>
<td>Tight</td>
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<td>Block-level</td>
<td>None</td>
<td>Bootstrap</td>
<td>Extended</td>
<td>Wide</td>
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Existing solutions: we cannot get no preprocessing and tight bounds at the same time.
Ideal: no preprocessing + tight bounds + extended aggregates.

Randomness Detection

- Is data shuffling necessary for all queries?
- Is it possible to treat a block-level sample as a tuple-level sample?
- Can we identify when is it possible?

Observation 1: Some attributes are not clustered in the original dataset.
Observation 2: After we have a "large enough" block-level sample, it is safe to treat it as a tuple-level sample.

Heuristic:
- Monitor the difference among distributions of each iteration.
- kullback-leibler divergence, earth mover's distance.
- Fast to convert → No statistical guarantee.

Statistical:
- Are two sample distributions extracted from the same population?
- Chi-squared test, Kolmogorov-Smirnov test.
- Slow to convert → Statistical guarantee.

Spark Implementation

![Diagram showing Spark implementation with various components: SparkSQL Compiler, Online Query Rewriter, SQL query, SparkSQL Engine, Online Operator, Spark Engine, HDFS, and more.]

Experiments

Spark 2.1.0, Hadoop 2.8.2.
9 node cluster, 1 coordinator and 8 working nodes. Each node has 16 cores, 28 GB of memory, and 4 TB of HDD storage.

TPC-H: 1 TB

Q3: SELECT SUM(L_EXTENDEDPRICE * (1 - L_DISCOUNT)) FROM lineitem,orders,customer WHERE L_ORDERKEY = O_ORDERKEY AND O_CUSTKEY = C_CUSTKEY

Sorted

Random

K-S test

Earth mower's distance

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