ASTER

Do more.

SQL/MR

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ASTER BACKGROUND

Our Founders

3 PhD students from Stanford C.S.

- Cool ideas…
- … but no funding, no product, no clients!

OK, they had $ 10,000…

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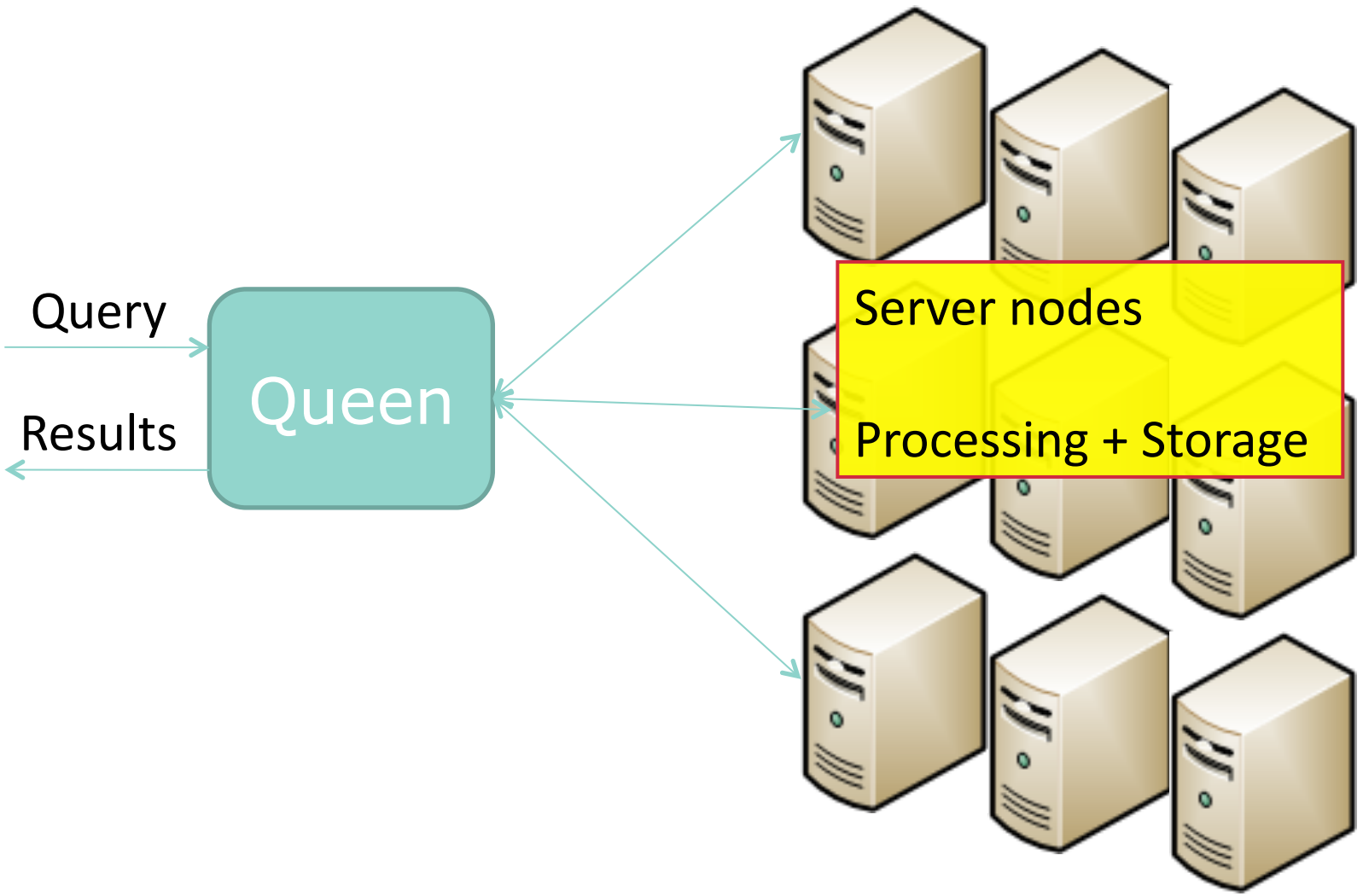
Our Product: *n*Cluster

- A massively scalable database designed for analytics.
- Runs on a cluster of commodity nodes.
- Scales from GBs to 100s of TBs and beyond.
- Standard SQL interface (via a command line tool, JDBC, ODBC, etc).
- Support MR-like functionality via user-defined SQL/MR functions.

Our Approach: Commodity Nodes



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SQL/MR

What are SQL/MR functions?

SQL/MR functions:

- Are Java functions meeting a particular API.
- Are compiled outside the database, installed via a command line tool, and then invoked via SQL.
- Take a database table of one schema as input and output rows back into the database.
- Are polymorphic. During initialization, a function is told the schema of its input (for example, (key, value)) and needs to return its output schema.
- Accept zero or more argument clauses (parameters), which can modify their behavior.
- Are designed to run on a massively parallel system by allowing the user to specify which slice of the data a particular instance of the function sees.

First Example: Word Count

Problem: Count the word frequency distribution across a set of documents.

Input: A database table containing the documents in question.

Map Phase: For each word in each document, outputs a row of the form (word, 1).

Shuffle Phase: Brings all rows with the same value for word together.

Reduce Phase: Count the number of rows for each word about output (word, <total-count>).

Input: The Documents Table

```
BEGIN;

CREATE FACT TABLE documents (body varchar,
  PARTITION KEY(body));

INSERT INTO documents VALUES ('this is a single
  test document. it is simple to count the words
  in this single document by hand. do we need a
  cluster?');

END;

SELECT body FROM documents;
```

Map Function: tokenize

```
public class tokenize implements RowFunction {
   ...

   public void operateOnSomeRows(RowIterator inputIterator,
         RowEmitter outputEmitter)
   {
      while ( inputIterator.advanceToNextRow() ) {
         String[] parts =
            splitPattern_.split( inputIterator.getStringAt(0) );

         for (String part : parts) {
            outputEmitter.addString(part);
            outputEmitter.addInt(1);
            outputEmitter.emitRow();
         }
      }
   }
}
```

Reduce Function: count_tokens

```
public class count_tokens implements PartitionFunction {
   ...

   public void operateOnPartition(
      PartitionDefinition partitionDefinition,
      RowIterator inputIterator, RowEmitter outputEmitter)
   {
      int count = 0;
      String word = inputIterator.getStringAt(0);

      while ( inputIterator.advanceToNextRow() )
         count++;

      outputEmitter.addString(word);
      outputEmitter.addInt(count);
      outputEmitter.emitRow();
   }
}
```

Invoking the Functions

```
BEGIN;

\install tokenize.jar
\install count_tokens.jar

SELECT word, count FROM count_tokens (
    ON ( SELECT word, count
         FROM tokenize(ON documents))
    PARTITION BY word
) ORDER BY word DESC;

ABORT;
```

Even Better: Forget the Reduce

```
BEGIN;

\install tokenize.jar

SELECT word, sum(count)
FROM tokenize(ON documents)
GROUP BY word
ORDER BY word;

ABORT;
```

Types of SQL/MR Functions

RowFunction

- Corresponds to a *map* function.
- Must implement the *operateOnSomeRows* method.
- Must be invoked without a PARTITION BY.
- "Sees" all the appropriate rows on a particular worker.

PartitionFunction

- Corresponds to a *reduce* function.
- Must implement the *operateOnPartition* method.
- Must be invoked with a PARTITION BY, which specifies how rows are reshuffled.
- "Sees" all the appropriate rows in a partition.

Requirements of a SQL/MR Function

- Must implement either `RowFunction` or `PartitionFunction`.
- Must have a single-argument constructor which takes a single `RuntimeContract` as a parameter.
- Class name must be all lowercase.
- Name of jar file must be the same as the SQL/MR function name.
- Note: can also upload a <functionname>.zip file, containing multiple jars. The jar with the SQL/MR function must have same name as the function, but other jars can be included. Useful for including libraries.

The Constructor

```
public tokenize(RuntimeContract contract)
{
   ArrayList<ColumnDefinition> output =
         new ArrayList<ColumnDefinition>();

   outputColumns.add(
       new ColumnDefinition("word", SqlType.varchar()));
   outputColumns.add(
       new ColumnDefinition("count", SqlType.bigint()));

   contract.setOutputInfo(new OutputInfo(outputColumns));
   contract.complete();
}
```

The Constructor

- The constructor can throw exceptions. If the exception is a subclass of `ClientVisibleException`, the user sees a descriptive message on the command line tool. Otherwise, they see a generic error message.
- A full stack trace of the exception can be viewed via the AMC.

Full Syntax

```
SELECT ...
FROM FunctionName(
  ON {tablename | (subquery)}
  [PARTITION BY ...]
  [ORDER BY ...]
  ARGCLAUSE1 (..., ...)
  MYCLAUSE (...)
  ...
);
```

Tip 1: CTAS

```
BEGIN;

\install tokeninze.jar

CREATE FACT TABLE counts (PARTITION
KEY(word)) AS
SELECT word, sum(count)
FROM tokenize(ON documents)
GROUP BY word;
ORDER BY word;

END;
```

Tip 2: Use Transactions

```
BEGIN;

\install tokeninze.jar

CREATE FACT TABLE counts (PARTITION
KEY(word)) AS
SELECT word, sum(count)
FROM tokenize(ON documents)
GROUP BY word;
ORDER BY word;

END;
```

Tip 3: PARTITION BY *c*

```
BEGIN;

\install exact_percentile.jar

SELECT *
FROM exact_percentile(
    ON source_data
    PARTITION BY 1
    PERCENTILE(25, 50, 75)
);

ABORT;
```

Tip 4: Using act

To connect to the cluster, use the command line tool **act**.

```
bash$ act -h <ip-address> -d <databasename> -U <username>
```

Useful commands

\d	List all tables.
\d <table name>	Show table details.
\dF	List installed SQL/MR files.
\?	More detailed help.
\timing	Enable query timing.

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Beyond Java: Stream

```
BEGIN;
\install tokeninze.py

SELECT word, sum(count)
FROM STREAM(
  ON documents
  SCRIPT('tokenize.py')
  OUTPUTS('word varchar', 'count int')
)
GROUP BY word
ORDER BY word;
ABORT;
```

Netflix Data Schema

movie_titles. Stores movie id, year, and titles.

training_set. Main training dataset. Stores (customerid, movieid, viewdate, and rating).

probe_set. A random sample of (customerid, movieid) pairs from the training set. Designed to be used for testing your classifier.

qualifying_set. A set of (customerid, movieid, viewdate) rows *not* in the training set. To enter the contest, submit your classifier's ratings for these movies.

Netflix Data Notes

- Both the probe and qualifying sets are ordered. The file you submit to Netflix needs to be in that same order. Therefore, the *probe_set* and *qualifying_set* tables have an extra *entryid* column.
- See www.netflixprize.com for more details about the dataset and on entering the contest.