Data storing and data access

Plan

- Basic Java API for HBase
  - demo
- Bulk data loading
- Hands-on
  - Distributed storage for user files
- SQL on noSQL
- Summary

Basic Java API for HBase

import org.apache.hadoop.hbase.*

Data modification operations

- Storing the data
  - Put – it inserts or updates a new cell (s)
  - Append – it updates a cell
  - Bulk loading – loads the data directly to store files
- Reading
  - Get – single row lookup (one or many cells)
  - Scan – rows range scanning
- Deleting data
  - delete (column families, rows, cells)
  - truncate…

Adding a row with Java API

1. Configuration creation

```
Configuration config = HBaseConfiguration.create();
```

2. Establishing connection

```
Connection connection = ConnectionFactory.createConnection(config);
```

3. Table opening

```
Table table = connection.getTable(TableName.valueOf(table_name));
```

4. Create a put object

```
Put p = new Put(key);
```

5. Set values for columns

```
p.addColumn(family, col_name, value);….
```

6. Push the data to the table

```
table.put(p);
```

Getting data with Java API

1. Open a connection and instantiate a table object

2. Create a get object

```
Get g = new Get(key);
```

3. (optional) specify certain family or column only

```
g.addColumn(family_name, col_name); //or
g.addFamily(family_name);
```

4. Get the data from the table

```
Result result= table.get(g);
```

5. Get values from the result object

```
byte [] value = result.getValue(family, col_name); //….
```

Scanning the data with Java API

1. Open a connection and instantiate a table object

2. Create a Scan object
```
Scan s = new Scan(start_row,stop_row);
```

3. (optional) Set columns to be retrieved
```
s.addColumn(family,col_name)
```

4. Get a result scanner object
```
ResultScanner scanner = table.getScanner(s);
```

5. Iterate through results
```
for (Result row : scanner) {
 // do something with the row
}
```

Filtering scan results

- will not prevent from reading the data set -> will reduce the network utilization only!
- there are many filters available for column names, values etc.
- …and can be combained

```
scan.setFilter(new ValueFilter(GREATER_OR_EQUAL,1500);

scan.setFilter(new PageFilter(25));
```

Demo

- Lets store persons data in HBase
- Description of a person:
  - `id`
  - `first_name`
  - `last_name`
  - `data of brith`
  - `profession`
  - `….?`
- Additional requirement
  - Fast records lookup by Last Name

Demo – source data in CSV

```
1232323,Zbigniew,Baranowski,M,1983-11-20,Poland,IT,CERN
1254542,Kacper,Surdy,M,1989-12-12,Poland,IT,CERN
6565655,Michel,Jackson,M,1966-12-12,USA,Music,None
7633242,Barack,Obama,M,1954-12-22,USA,President,USA
5323425,Andrzej,Duda,M,1966-01-23,Poland,President,Poland
5432411,Ewa,Kopacz,F,1956-02-23,Poland,Prime Minister,Poland
3243255,Rolf,Heuer,M,1950-03-26,Germany,DG,CERN
6554322,Fabiola,Gianotti,F,1962-10-29,Italy,Particle Physici
1232323,Lionel,Messi,M,1984-06-24,Argentina,Football Player,
```

Demo - designing

- Generate a new id when inserting a person
  - Has to be unique
    - sequence of incremented numbers
    - incrementing has to be an atomic operation
  - Recent value for id has to be stored (in a table)
- Row key = id ?
  - maybe row key = “last_name+id”?
  - Lets keep: row key = id
- Fast last_name lookups
  - Additional indexing table

Demo - Tables

- Users – with users data
  - row_key = userID
- Counters – for userID generation
  - row_key = main_table_name
- usersIndex – for indexing users table
  - row_key = last_name+userID ?
  - row_key = column_name+value+userID

Demo – Java classes

- UsersLoader – loading the data
  - generates userID – from “counters” table
  - loads the users data into “users” table
  - updates “usersIndex” table
- UsersScanner – performs range scans
  - scans the “usersIndex” table – ranges provided by a caller
  - gets the details of given records from the “users” table

Hands on

- Get the scripts

```
wget cern.ch/zbaranow/hbase.zip
unzip hbase.zip
cd hbase/part1
```

- Preview: `UsersLoader.java , UsersScanner.java`
- Create tables

```
hbase shell -n tables.txt
```

- Compile and run

```
javac –cp `hbase classpath` *.java
java –cp `hbase classpath` UserLoader users.csv 2>/dev/null
java –cp `hbase classpath` UsersScanner last_name
  Baranowski Baranowskj 2>/dev/null
```

Schema design consideration

Key values

- Is the most important aspect in designing
  - fast data reading vs fast data storing
- Fast data access (range scans)
  - keep in mind the right order of row key parts
    - “username+timestamp” vs “timestamp+username”
  - for fast recent data retrievals it is better to insert new rows into the first regions of the table
    - Example: key=10000000000-timestamp
- Fast data storing
  - distribute rows across regions
    - Salting
    - Hashing

Tables

- Two options
  - **Wide** - large number of columns

Region 1

Key	F1:COL1	F1:COL2	F2:COL3	F2:COL4
r1	r1v1	r1v2	r1v3	r1v4
r2	r2v1	r2v2	r2v3	r2v4
r3	r3v1	r3v2	r3v3	r3v4

  - **Tall** - large number of rows

Region 1
Region 2
Region 3
Region 4

Key	F1:V
r1_col1	r1v1
r1_col2	r1v1
r1_col3	r1v3
r1_col4	r1v4
r2_col1	r2v1
r2_col2	r2v2
r2_col3	r2v3
r2_col4	r2v4
r3_col1	r3v1

Bulk data loading

Bulk loading

- Why?
  - For loading big data sets already available on HDFS
  - Faster – direct data writing to HBase store files
  - No footprint on region servers
- How?
  1. Load the data into HDFS
  2. Generate a hfiles with the data using MapReduce
     - write your own
     - or use importtsv – has some limitations
  3. Embed generated files into HBase

Bulk load – demo

1. Create a target table
2. Load the CSV file to HDFS
3. Run ImportTsv
4. Run LoadIncrementalHFiles

All commands in:

`bulkLoading.txt`

Part 2: Distributed storage (hands –on)

Hands on: distributed storage

- Let's imagine we need to provide a backend storage system for a large scale application
  - e.g. for a mail service, for a cloud drive
- We want the storage to be
  - distributed
  - content addressed
- In the following hands on we'll see how Hbase can do this

Distributed storage: insert client

- The application will be able to upload a file from a local file system and save a reference to it in ‘users’ table
- A file will be reference by its SHA-1 fingerprint
- General steps:
  - read a file and calculate a fingerprint
  - check for file existence
  - save in ‘files’ table if not exists
  - add a reference in ‘users’ table in ‘media’ column family

Distributed storage: download client

- The application will be able to download a file given an user ID and a file (media) name
- General steps:
  - retrieve a fingerprint from ‘users’ table
  - get the file data from ‘files’ table
  - save the data to a local file system

Distributed storage: exercise location

- Get to the source files

```
cd ../part2
```

- Fill the TODOs
  - support with docs and previous examples
- Compile with

```
javac -cp `hbase classpath` InsertFile.java
javac -cp `hbase classpath` GetMedia.java
```

SQL on HBase

Running SQL on HBase

- From Hive or Impala
- HTable mapped to an external table
- Some DMLs are supported
  - insert (but not overwrite)
  - updates are available by duplicating a row with *insert* statement

Use cases for SQL on HBase

- Data warehouses
  - facts table : big data scanning -> impala + parquet
  - dimensional table: random lookups -> hbase
- Read – write storage
  - Metadata
  - counters

How to?

- Create an external table with hive
  - Provide column names and types (key column should be always a string)
  - `STORED BY 'org.apache.hadoop.hive.hbase.HBaseStorageHandler'`
  - `WITH SERDEPROPERTIES "hbase.columns.mapping” = ":key,main:first_name,main:last_name….”`
  - `TBLPROPERTIES ("hbase.table.name" = "users”);`
- Try it out !

```
hive –f ./part2/SQLonHBase.txt
```

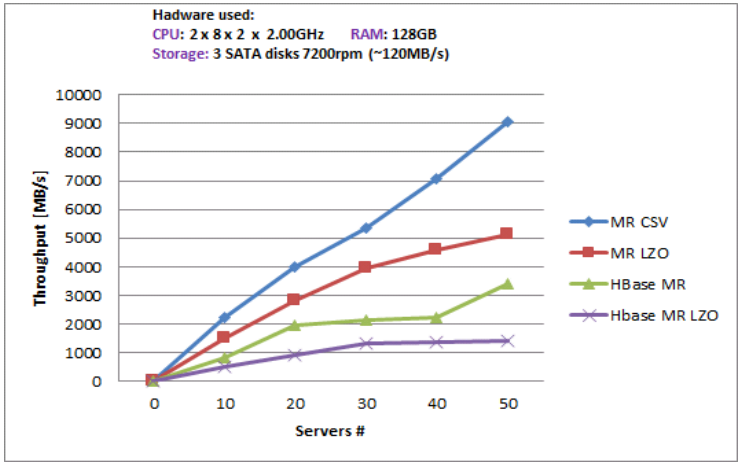
Summary

What was not covered

- Writing co-processors - stored procedures
- HBase table permissions
- Filtering of data scanner results
- Using map reduce for data storing and retrieving
- Bulk data loading with custom map reduce
- Using different APIs - Thrift

Summary

- Hbase is a key-value, wide-columnar store
  - Horizontal (regions) + Vertical (col. Families) partitioning
  - Row Key values are indexed within regions
  - Data typefree – data stored in bytes arrays
  - Tables are semi structured
- Fast random data access by key
- Not for massive parallel data processing!



- Stored data can be modified (updated, deleted)

Other similar NoSQL engines

- Apache Cassandra
- MongoDB
- Apache Accumulo (on Hadoop)
- Hypertable (on Hadoop)
- HyperDex
- BerkleyDB / Oracle NoSQL

Announcement: Hadoop users forum

- Why?
  - Exchange knowledge and experience about
    - The technology itself
    - Current successful projects on Hadoop@CERN
  - Service requirements
- Who?
  - Everyone how is interested in Hadoop (and not only)
- How?
  - e-group: it-analytics-wg@cern.ch
- When?
  - Every 2-4 weeks
  - Starting from 7th of October