ISIT312 Big Data Management

HBase Data Model

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HBase Data Model

Outline

Background

Logical view of data

Design fundamentals

Physical implementation

Background

Hbase is open source distributed database based on a data model of Google's BigTable

HBase provides a BigTable view of data stored in HDFS

HBase is also called as Hadoop DataBase

HBase still provides a tabular view of data however it is also very different from the traditional relational data model

HBase data model is a sparse, distributed, persistent multidimensional sorted map

It is indexed by a row key, column key, and timestamp

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HBase organizes data into tables

HBase table consists of rows

Each row is uniquely identified by a row key

Data within a row is grouped by a column family

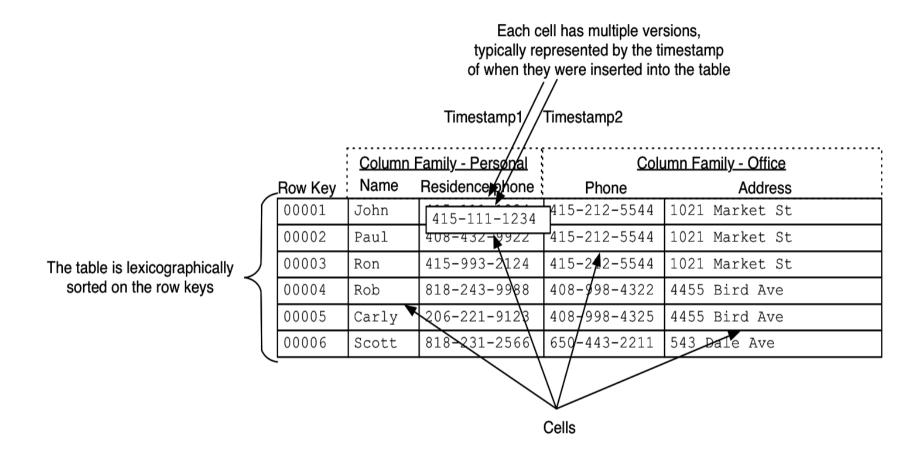
Column families have an important impact on the physical implementation of HBase table

Every row has the same column families although some of them can be empty

Data within a column family is addressed via its column qualifier, or simply, column name

Hence, a combination of row key, column family, and column qualifier uniquely identifies a cell

Values in cells do not have a data type and are always treated as sequences of bytes



Values within a cell have multiple versions

Versions are identified by their version number, which by default is a timestamp when the cell was written that the cell was written that the cell was being bata Management, SIM S2 2024

If a timestamp is not determined at write time, then the current timestamp is used

If a timestamp is not determined during a read, the latest one is returned

The maximum allowed number of cell value versions is determined for each column family

The default number of cell versions is three

A view of HBase table as a nested structure

```
{"Row-0001":
                                                                          HBase Table
            {"Home":
                    {"Name":
                             {"timestamp-1":"James"}
                     "Phones":
                               {"timestamp-1":"2 42 214339"
                                "timestamp-2":"2 42 213456"
                                "timestamp-3":"+61 2 4567890"}
             "Office":
                       {"Phone":
                                {"timestamp-4":"+64 345678"}
                        "Address":
                                  {"timestamp-5":"10 Ellenborough Pl"}
}
```

A view of HBase table as a nested structure

```
{"Row-0002":
                                                                           HBase Table
            {"Home":
                     {"Name":
                             {"timestamp-6":"Harry"}
                      "Phones":
                               {"timestamp-7":"2 42 214234"}
             "Office":
                       {"Phone":
                                {"timepstamp-8":"+64 345678"}
                        "Address":
                                  {"timestamp-9":"10 Bong Bong Rd"
                                   "timestamp-10":"23 Victoria Rd"}
}
```

A key can be row key or a combination of a row key, column family, qualifier, and timestamp depending on what supposed to be retrieved

If all the cells in a row are of interest then a key is a row key

If only specific cells are of interest, the appropriate column families and qualifiers are a part of a key

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When designing Hbase table we have to consider the following questions:

- What should be a row key and what should it contain?
- How many column families should a table have?
- What columns (qualifiers) should be included in each column family?
- What information should go into the cells?
- How many versions should be stored for each cell?

In fact HBase table is a four level hierarchical structure where a table consists of rows, rows consists of column families, column families consist of columns and columns consists of versions

If cells contain the keys then HBase table becomes a network/graph structure

Important facts to remember:

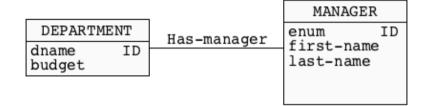
- Indexing is performed only for a row key
- Hbase tables are sorted based on a row key
- Everything in Hbase tables is stored as untyped sequence of bytes
- Atomicity is guaranteed only at a row level and there are no multi-row transactions
- Column families must be defined at Hbase table creation time
- Column qualifiers are dynamic and can be defined at write time
- Column qualifiers are stored as sequences of bytes such that they can represent data

Implementation of Entity type

```
CUSTOMER
cnumber ID
first-name
last-name
phone
email
```

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Implementation of one-to-one relationship

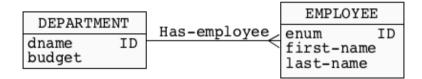


Implementation of one-to-many relationship

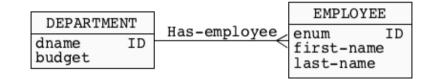
```
DEPARTMENT
dname ID
budget

Has-employee
enum ID
first-name
last-name
```

Another implementation of one-to-many relationship



Yet another implementation of one-to-many relationship



Implementation of many-to-many relationship

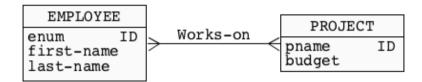
```
EMPLOYEE

enum ID
first-name last-name last-name

EMPLOYEE

Works-on
pname ID
budget
```

Another implementation of many-to-many relationship



Another implementation of many-to-many relationship

```
EMPLOYEE

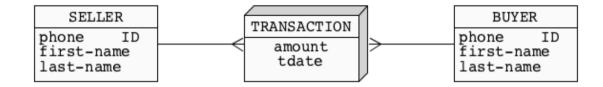
enum ID
first-name last-name | Works-on | PROJECT |
pname ID | budget | ID |
```

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Note, that it is possible to group in one Hbase table rows of different types

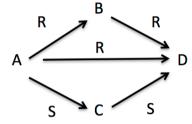
```
{"employee-007":
                                                                                            HBase Table
                {"EMPLOYEE":
                            {"enumber": {"timestamp-1":"007"},
                             "first-name": {"timestamp-2":"James"},
                             "last-name": {"timestamp-3":"Bond"}
{"project-1":
             {"PROJECT":
                        {"pnumber": {"timestamp-4":"1"},
                         "budget": {"timestamp-5":"12345.25"}
{"participation-2":
                   {"PARTICIPATION":
                                    {"pnumber": {"timestamp-1":"project-1"},
                                     "employee": {"timestamp-2":"employee-007"}
                               ISIT312 Big Data Management, SIM S2 2024
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```

Implementation of fact with dimensions

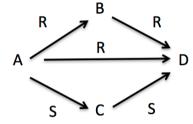


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Implementation of graph structure



Implementation of graph structure



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HBase is a database built on top of HDFS

HBase tables can scale up to billions of rows and millions of columns

Because Hbase tables can grow up to terabytes or even petabytes, Hbase tables are split into smaller chunks of data that are distributed across multiple servers

Chunks of data are called as regions and servers that host regions are called as region servers

Region servers are usually collocated with data nodes of HDFS

The splits of Hbase tables are usually horizontal, however, it is also possible to benefit from vertical splits separating column families

Region assignments happen when Hbase table grows in size or when a region server is malfunctioning or when a new region server is added

References

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