
NoSQL

The NoSQL DBMS

NoSQL:

- A fast, portable, open-source RDBMS
- A derivative of the RDB database system
- Based on the “operator/stream paradigm”

- One common interpretation of NoSQL is “not only SQL” or like “non-relational”

NoSQL

- NoSQL is a non-relational database management systems, different from traditional relational database management systems in some significant ways.
- It is designed for distributed data stores where very large scale of data storing needs (for example Google or Facebook which collects terabits of data every day for their users).
- These type of data storing may not require fixed schema, avoid join operations and typically scale horizontally.

RDBMS

- Structured and organized data
- Structured query language (SQL)
- Data and its relationships are stored in separate tables.
- Data Manipulation Language, Data Definition Language
- Tight Consistency

NoSQL

- Stands for Not Only SQL
- No declarative query language
- No predefined schema
- Key-Value pair storage, Column Store, Document Store, Graph databases
- Eventual consistency rather ACID property
- Unstructured and unpredictable data
- Prioritizes high performance, high availability and scalability

NoSQL Examples

Hbase Cassandra Hypertable Accumulo Amazon SimpleDB SciDB Stratosphere flare
Cloudata BigTable QD Technology SmartFocus KDI Alterian Cloudera C-Store
Vertica Qbase-MetaCarta OpenNeptune HPCC Mongo DB CouchDB Clusterpoint ServerTerrastore
Jackrabbit OrientDB Perservere CoudKit Djondb SchemaFreeDB SDB JasDB
RaptorDB ThruDB RavenDB DynamoDB Azure Table Storage Couchbase Server Riak
LevelDB Chordless GenieDB Scalaris Tokyo Kyoto Cabinet Tyrant Scalien
Berkeley DB Voldemort Dynomite KAI MemcacheDB Faircom C-Tree HamsterDB STSdb
Tarantool/Box Maxtable Pincaster RaptorDB TIBCO Active Spaces allegro-C nessDBHyperDex
Mnesia LightCloud Hibari BangDB OpenLDAP/MDB/Lightning Scality Redis
KaTree TomP2P Kumofs TreapDB NMDB luxio actord Keyspace
schema-free RAMCloud SubRecord Mo8onDb Dovetaildb JDBM Neo4 InfiniteGraph
Sones InfoGrid HyperGraphDB DEX GraphBase Trinity AllegroGraph BrightstarDB
Bigdata Meronymy OpenLink Virtuoso VertexDB FlockDB Execom IOG Java Univ Netwrk/Graph Framework
OpenRDF/Sesame Filament OWLim NetworkX iGraph Jena SPARQL OrientDb
ArangoDB AlchemyDB Soft NoSQL Systems Db4o Versant Objectivity Starcounter
ZODB Magma NEO PicoList siaqodb Sterling Morantex EyeDB
HSS Database FramerD Ninja Database Pro StupidDB KiokuDB Perl solution Durus
GigaSpaces Infinispan Queplix Hazelcast GridGain Galaxy SpaceBase JoafipCoherence
eXtremeScale MarkLogic Server EMC Documentum xDB eXist Sedna BaseX Qizx
Berkeley DB XML Xindice Tamino Globals Intersystems Cache GT.M EGTM
U2 OpenInsight Reality OpenQM ESENT jBASE MultiValue Lotus/Domino
eXtremeDB RDM Embedded ISIS Family Prevayler Yserial Vmware vFabric GemFire Btrieve
KirbyBase Tokutek Recutils FileDB Armadillo illuminate Correlation Database FluidDB
Fleet DB Twisted Storage Rindo Sherpa tin Dryad SkyNet Disco
MUMPS Adabas XAP In-Memory Grid eXtreme Scale MckoiDDB Mckoi SQL Database
Oracle Big Data Appliance Innostore FleetDB No-List KDI Perst IODB

Primary NoSQL Categories

General Categories of NoSQL Systems:

- Key/value store
- (wide) Column store
- Graph store
- Document store

Compared to the relational model:

- Query models are not as developed.
- Distinction between abstraction & implementation is not as clear.

Key/Value Store

The basic data model:

- Database is a collection of key/value pairs
- The key for each pair is unique

No requirement for normalization (and consequently dependency preservation or lossless join)

Primary operations:

- insert(key,value)
- delete(key)
- update(key,value)
- lookup(key)

Additional operations:

- variations on the above, e.g., reverse lookup
- iterators

DynamoDB
Azure Table Storage
Riak
Rdis
Aerospike
FoundationDB
LevelDB
Berkeley DB
Oracle NoSQL Database
GenieDb
BangDB
Chordless
Scalaris
Tokyo Cabinet/Tyrant
Scalien
Voldemort
Dynomite
KAI
MemcacheDB
Faircom C-Tree
LSM
KitaroDB
HamsterDB
STSdb
TarantoolBox
Maxtable
Quasardb
Pincaster
RaptorDB
TIBCO Active Spaces
Allegro-C
nessDB
HyperDex
SharedHashFile
Symas LMDB
Sophia
PickleDB
Mnesia
LightCloud
Hibari
OpenLDAP
Genomu
BinaryRage
Elliptics
Dbreeze
RocksDB
TreodeDB
(www.nosql-database.org
www.db-engines.com
www.wikipedia.com)

Wide Column Store

The basic data model:

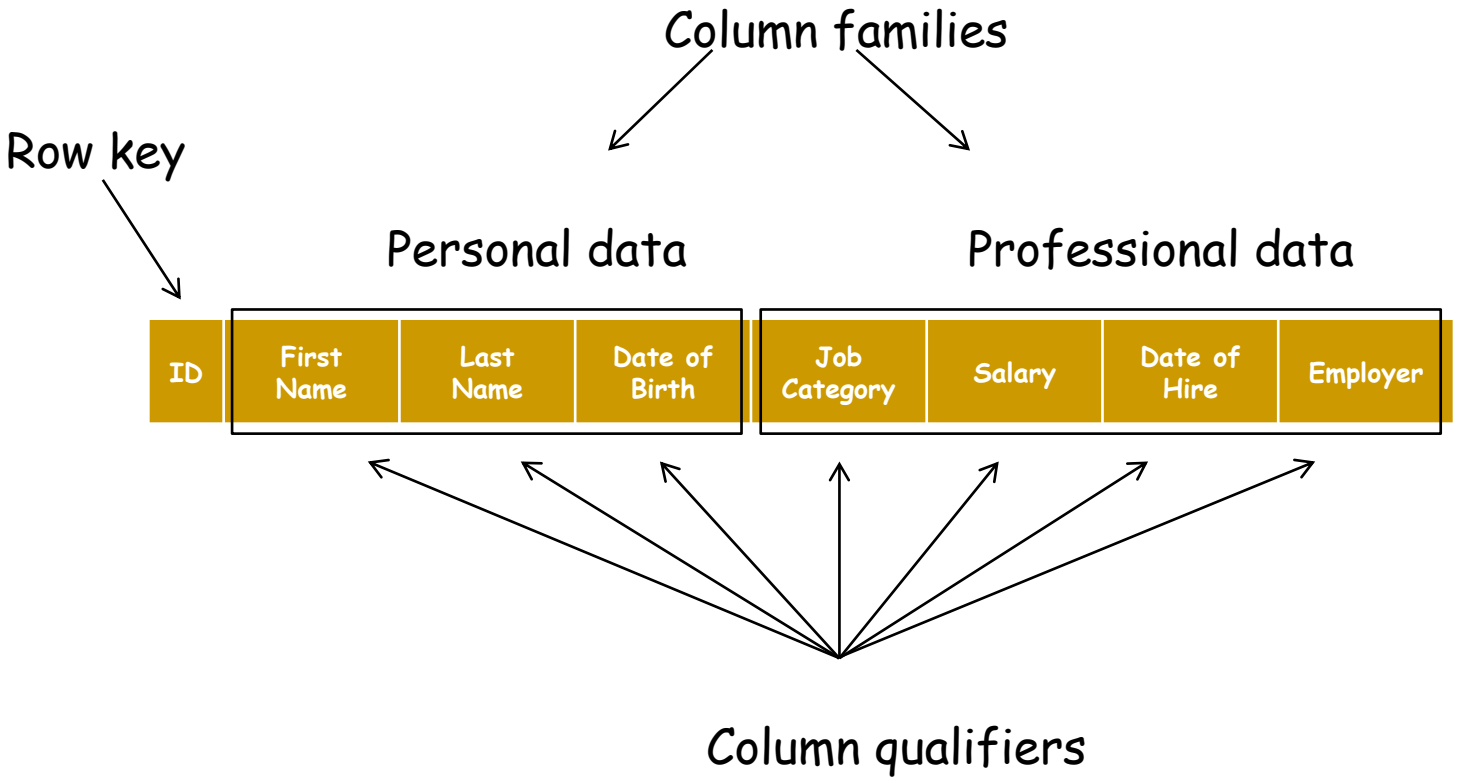
- Database is a collection of key/value pairs
- Key consists of 3 parts – a row key, a column key, and a time-stamp (i.e., the version)
- Flexible schema - the set of columns is not fixed, and may differ from row-to-row

One last column detail:

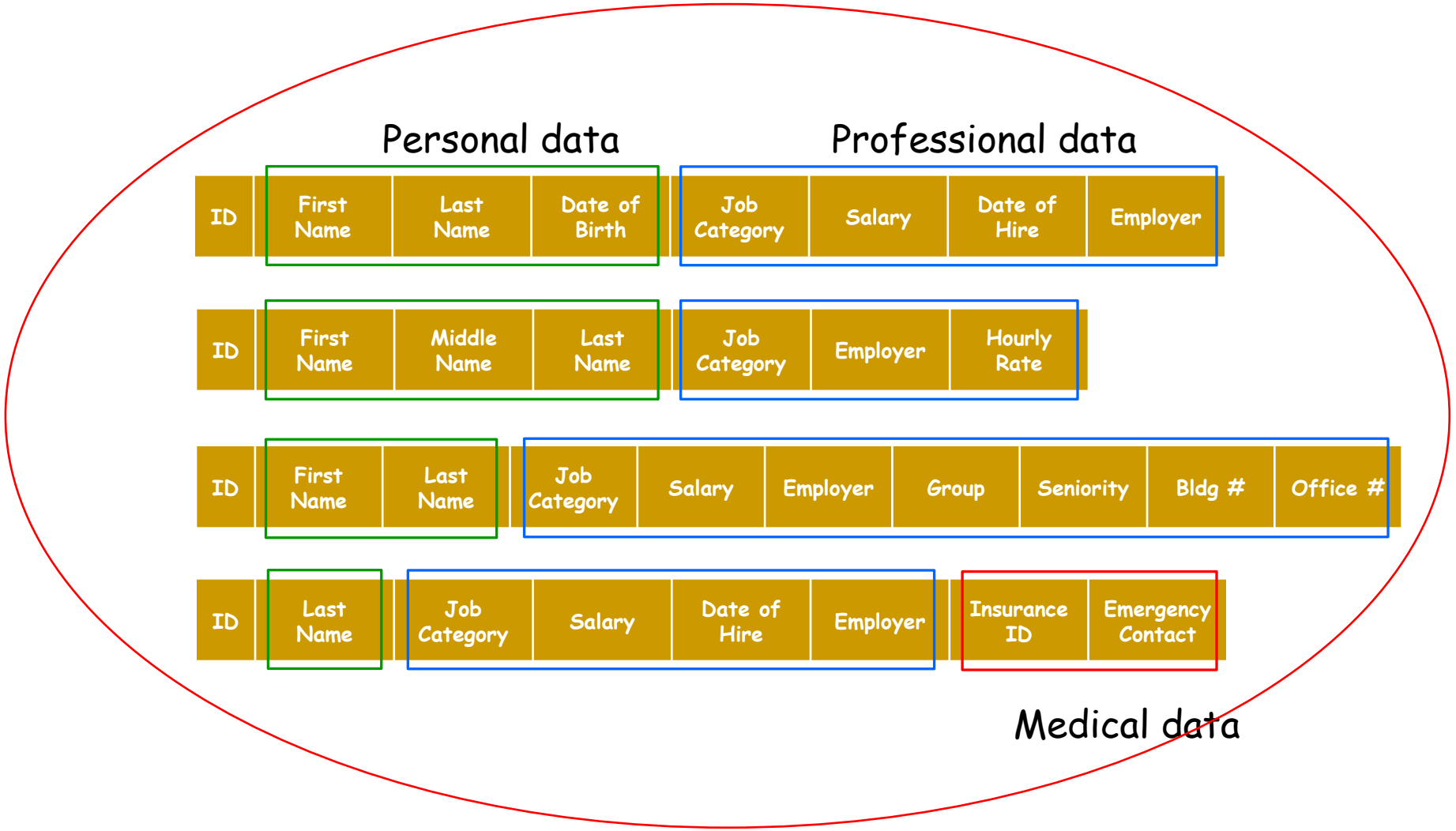
- Column key consists of two parts – a column family, and a qualifier

Accumulo
Amazon SimpleDB
BigTable
Cassandra
Cloudata
Cloudera
Druid
Flink
Hbase
Hortonworks
HPCC
Hyupertable
KAI
KDI
MapR
MonetDB
OpenNeptune
Qbase
Splice Machine
Sqrrl
(www.nosql-database.org
www.db-engines.com
www.wikipedia.com)

Wide Column Store

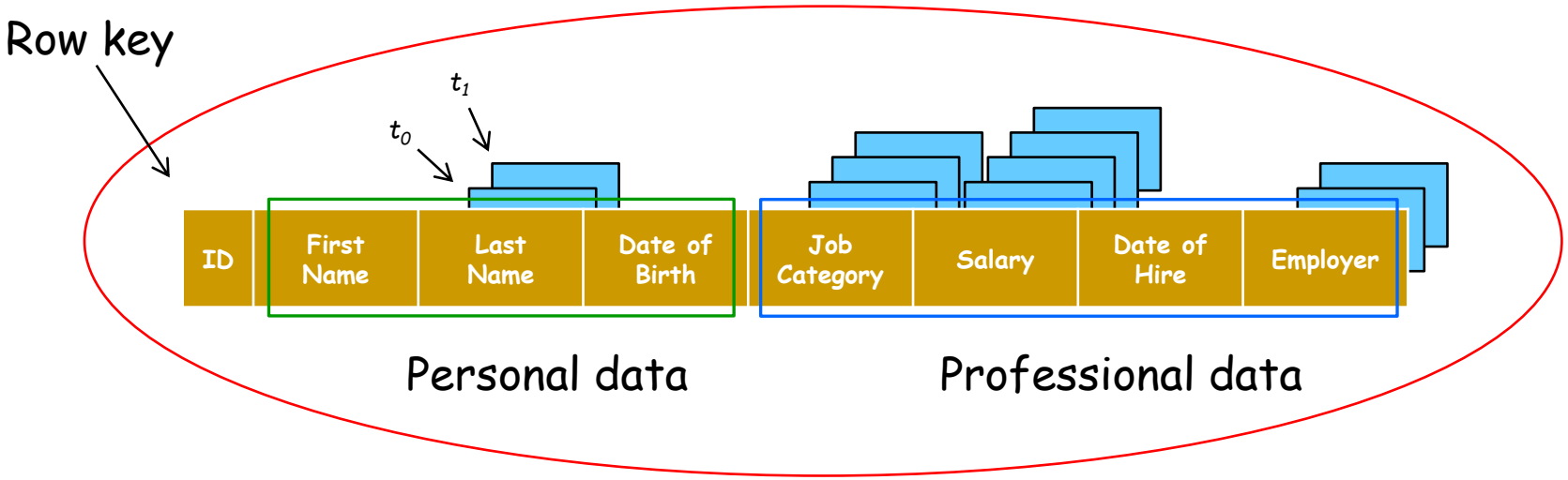


Wide Column Store



One "table"

Wide Column Store



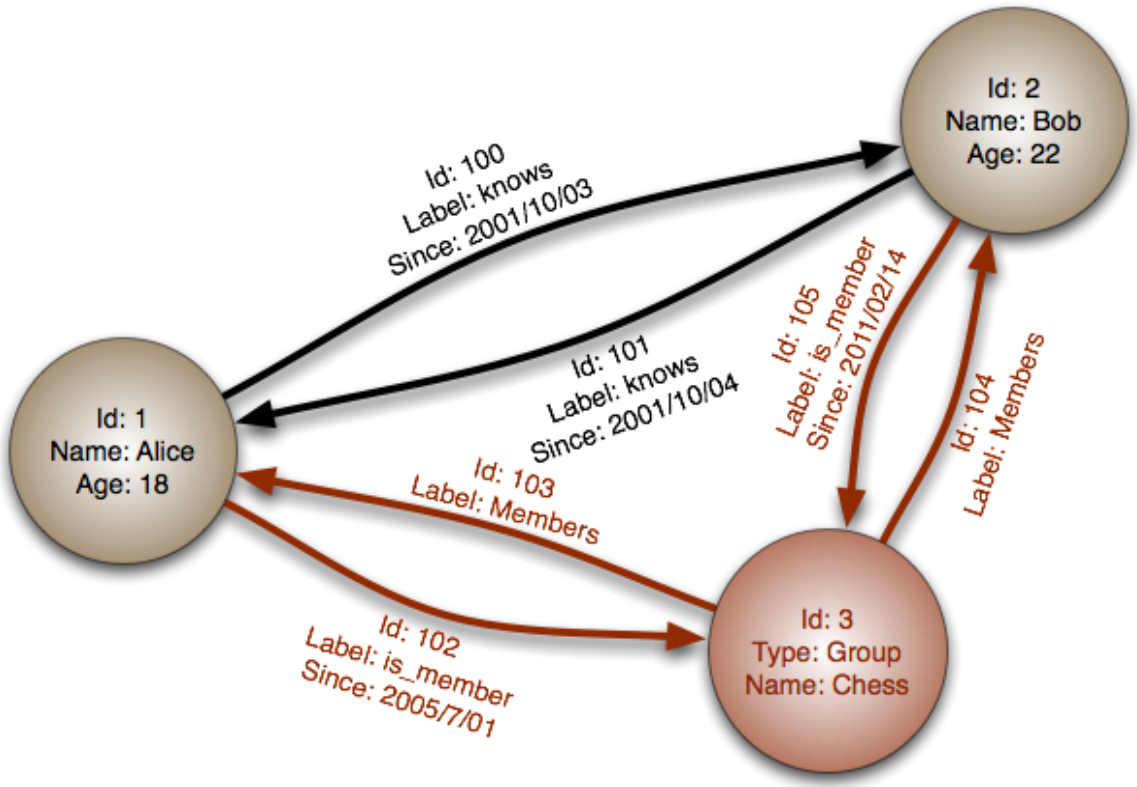
One "row"

One "row" in a wide-column NoSQL database table
=
Many rows in several relations/tables in a relational database

Graph Store

The basic data model:

- Directed graphs
- Nodes & edges, with properties, i.e., "labels"



AllegroGraph
ArangoDB
Bigdata
Bitsy
BrightstarDB
DEX/Sparksee
Execom IOG
Fallen *
Filament
FlockDB
GraphBase
Graphd
Horton
HyperGraphDB
IBM System G Native Store
InfiniteGraph
InfoGrid
jCoreDB Graph
MapGraph
Meronymy
Neo4j
Orly
OpenLink virtuoso
Oracle Spatial and Graph
Oracle NoSQL Datbase
OrientDB
OQGraph
Ontotext OWLIM
R2DF
ROIS
Sones GraphDB
SPARQLCity
Sqrrl Enterprise
Stardog
Teradata Aster
Titan
Trinity
TripleBit
VelocityGraph
VertexDB
WhiteDB
(www.nosql-database.org
www.db-engines.com
www.wikipedia.com)

Document Store

The basic data model:

- The general notion of a document – words, phrases, sentences, paragraphs, sections, subsections, footnotes, etc.
- Flexible schema – subcomponent structure may be nested, and vary from document-to-document.
- Metadata – title, author, date, embedded tags, etc.
- Key/identifier.

One implementation detail:

- Formats vary greatly – PDF, XML, JSON, BSON, plain text, various binary, scanned image.

AmisaDB
ArangoDB
BaseX
Cassandra
Cloudant
Clusterpoint
Couchbase
CouchDB
Densodb
Djondb
EJDB
Elasticsearch
eXist
FleetDB
iBoxDB
Inquire
JasDB
MarkLogic
MongoDB
MUMPS
NeDB
NoSQL embedded db
OrientDB
RaptorDB
RavenDB
RethinkDB
SDB
SisoDB
Terrastore
ThruDB
(www.nosql-database.org
www.db-engines.com
www.wikipedia.com)

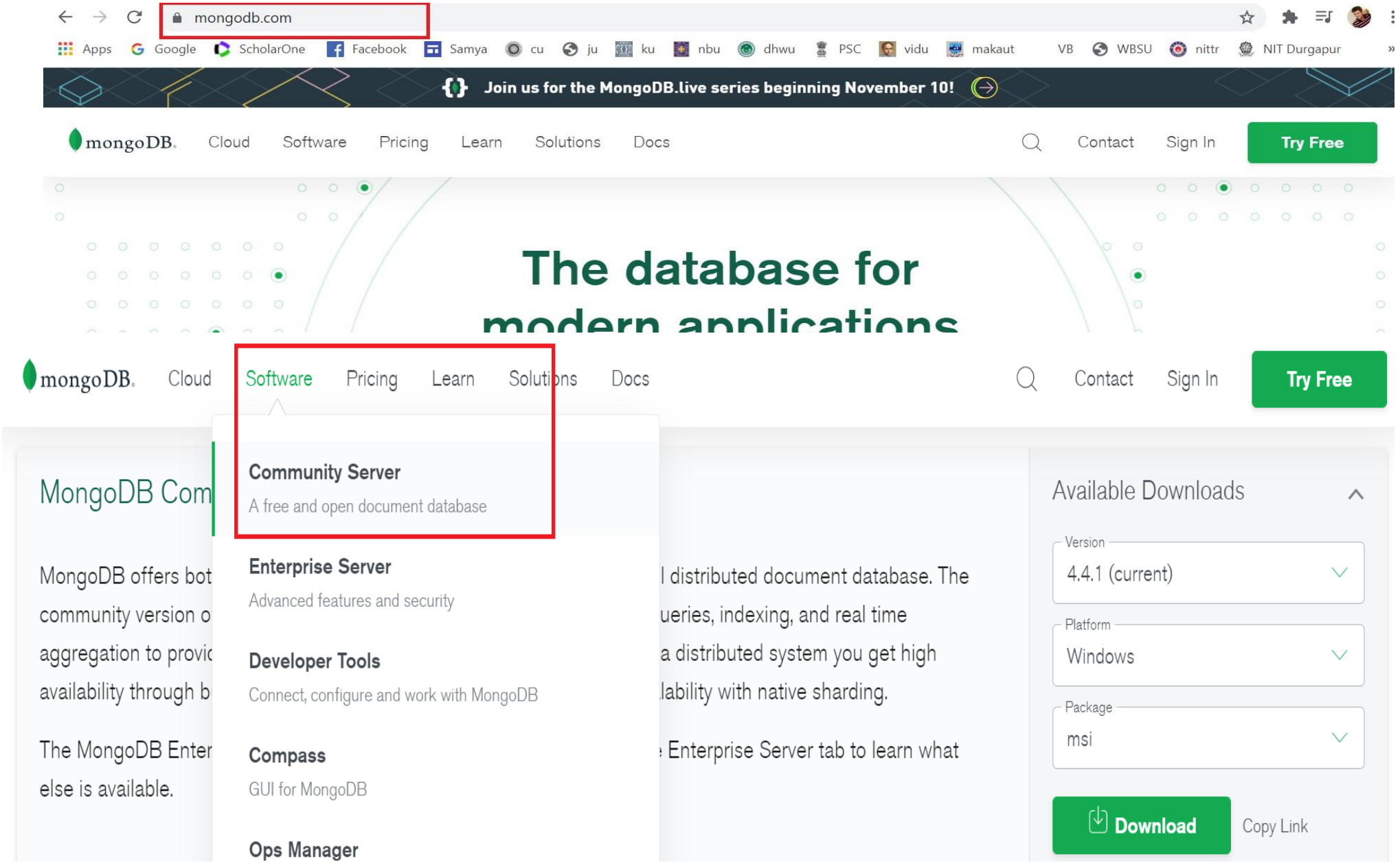
MongoDB

- MongoDB is a document database designed for ease of development and scaling.
- MongoDB offers both a *Community* and an *Enterprise* version of the database.

- A record in MongoDB is a document, which is a data structure composed of field and value pairs.
- MongoDB documents are similar to JSON objects.
- The values of fields may include other documents, arrays, and arrays of documents.

The advantages of using document database are:
•Documents (i.e. objects) correspond to native data types in many programming languages.
•Embedded documents and arrays reduce need for expensive joins.
•Dynamic schema supports fluent polymorphism.

Installing MongoDB



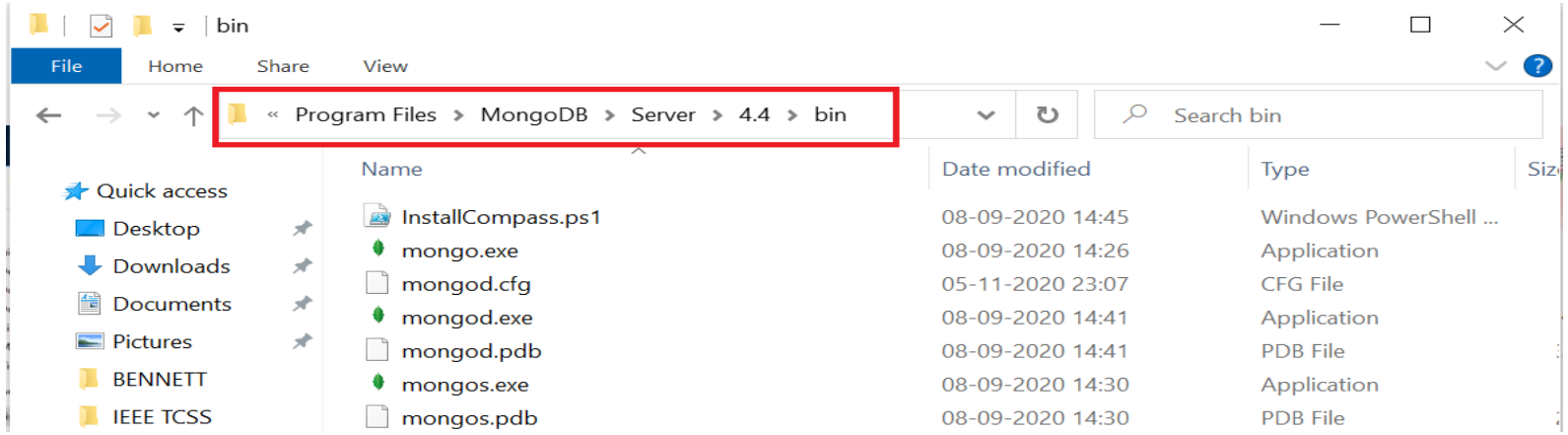
Go to: www.mongodb.com

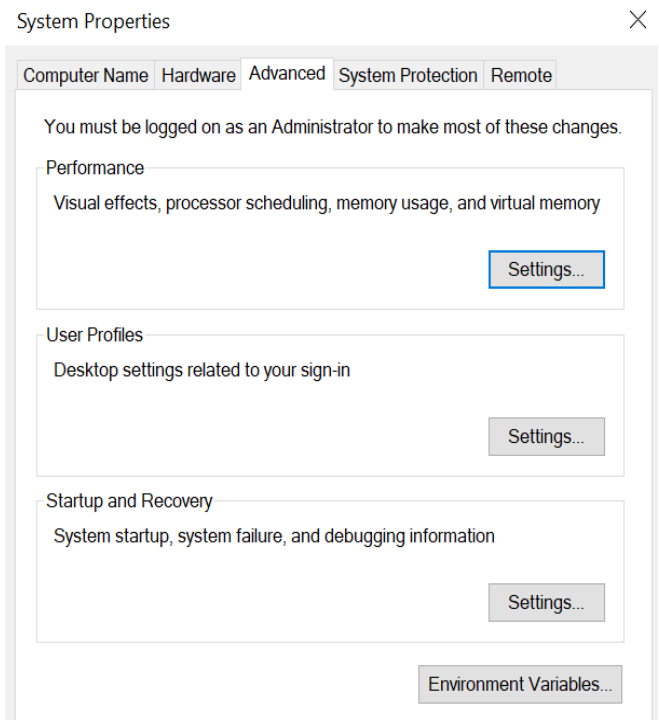
Then go to software -> Community Server

Then Click Download

Installing Steps

- Run downloaded .msi file
- Install complete version
- Install MongoDB as service (by default)
- Keep data directory and log directory as it is
- Install MongoDB compass
- Wait for installation to finish.





1. Copy the path 2. Click environment variables 3. System variable 4. Add path 5. Add the address (upto bin) 6. save this
2. A) Now go to C folder B) Create 'data' folder C) within data create 'db' folder

Run Command promt

Command Prompt

```
Microsoft Windows [Version 10.0.19041.572]
(c) 2020 Microsoft Corporation. All rights reserved.

C:\Users\smuhu>cd C:\Program Files\MongoDB\Server\4.4\bin

C:\Program Files\MongoDB\Server\4.4\bin>
```

Go to the bin folder

Command Prompt - mongod

```
Microsoft Windows [Version 10.0.19041.572]
(c) 2020 Microsoft Corporation. All rights reserved.

C:\Users\smuhu>cd C:\Program Files\MongoDB\Server\4.4\bin

C:\Program Files\MongoDB\Server\4.4\bin>mongod
{"t":{"$date":"2020-11-05T23:28:30.447+05:30"},"s":"I",  "c":"CONTROL",  "id":23285,   "ctx":"main","msg":"Automatically
 disabling TLS 1.0, to force-enable TLS 1.0 specify --sslDisabledProtocols 'none'"}
{"t":{"$date":"2020-11-05T23:28:30.449+05:30"},"s":"W",  "c":"ASIO",     "id":22601,   "ctx":"main","msg":"No TransportL
ayer configured during NetworkInterface startup"}
{"t":{"$date":"2020-11-05T23:28:30.450+05:30"},"s":"I",  "c":"NETWORK",  "id":4648602, "ctx":"main","msg":"Implicit TCP
FastOpen in use."}
{"t":{"$date":"2020-11-05T23:28:30.451+05:30"},"s":"I",  "c":"STORAGE",  "id":4615611, "ctx":"initandlisten","msg":"Mong
oDB starting","attr":{"pid":6424,"port":27017,"dbPath":"C:/data/db/","architecture":"64-bit","host":"LAPTOP-Q7UL5R16"}}
{"t":{"$date":"2020-11-05T23:28:30.452+05:30"},"s":"I",  "c":"CONTROL",  "id":23398,   "ctx":"initandlisten","msg":"Targ
et operating system minimum version","attr":{"targetMinOS":"Windows 7/Windows Server 2008 R2"}}
{"t":{"$date":"2020-11-05T23:28:30.452+05:30"},"s":"I",  "c":"CONTROL",  "id":23403,   "ctx":"initandlisten","msg":"Buil
d Info","attr":{"buildInfo":{"version":"4.4.1","gitVersion":"ad91a93a5a31e175f5cbf8c69561e788bbc55ce1","modules":[],"all
ocator":"tcmalloc","environment":{"distmod":"windows","distarch":"x86_64","target_arch":"x86_64"}}}}
{"t":{"$date":"2020-11-05T23:28:30.452+05:30"},"s":"I",  "c":"CONTROL",  "id":51765,   "ctx":"initandlisten","msg":"Oper
```

Open command prompt. Command is mongod. It will start the mongo demon

Command Prompt - mongo

```
C:\Users\smuhu>cd C:\Program Files\MongoDB\Server\4.4\bin

C:\Program Files\MongoDB\Server\4.4\bin>mongo
MongoDB shell version v4.4.1
connecting to: mongodb://127.0.0.1:27017/?compressors=disabled&gssapiServiceName=mongodb
Implicit session: session { "id" : UUID("9ff8a1c3-6b58-4641-ab8f-89cb35f40b77") }
MongoDB server version: 4.4.1
Welcome to the MongoDB shell.
For interactive help, type "help".
For more comprehensive documentation, see
        https://docs.mongodb.com/
Questions? Try the MongoDB Developer Community Forums
        https://community.mongodb.com
---
```

Open another command prompt. Command is "mongo". It will start the mongo shell. Now you can write programs of NoSQL.

Shell script will show ">" sign

Commands

Show Databases

> Show dbs

```
---
> show dbs
admin    0.000GB
config   0.000GB
local    0.000GB
>
```

Create new database

> Use database_name

> Use bennett

```
> use bennett
switched to db bennett
>
```

Create collection

Here collection represents table

>db.createCollection("table_name")

>db.createCollection("testable")

```
> db.createCollection("testtable")
{ "ok" : 1 }
>
```

```
> use another
switched to db another
> show dbs
admin    0.000GB
bennett  0.000GB
config   0.000GB
local    0.000GB
> db.createCollection("Extra")
{ "ok" : 1 }
> show dbs
admin    0.000GB
another  0.000GB
bennett  0.000GB
config   0.000GB
local    0.000GB
> db.dropDatabase()
{ "dropped" : "another", "ok" : 1 }
> show dbs
admin    0.000GB
bennett  0.000GB
config   0.000GB
local    0.000GB
>
```

Lets create another database named "another"

Show databases
It will not show "another" as no table or collection is created

Insert a collection "Extra"

Now show databases will show "another"

For delete database use >db.dropDatabase()

Show the databases again

"another" database is deleted

Commands

Go to the database
See all the collection
Presents using
>show collections
For delete
>db.collection_name.drop()

```
> use bennett
switched to db bennett
> show collections
testtable
> db.testtable.drop()
true
>
```

```
> db.testtable.insertOne({"id":1, "name":"ABC","dept":"CSE"})
{
        "acknowledged" : true,
        "insertedId" : ObjectId("5fa4514a8bda3bca99bae594")
}
>
```

Insert 1 data into the collection/table using "insertOne" operation

```
@(shell):1:1
> db.testtable.insertMany([{"id":1, "name":"ABC","dept":"CSE"},{"id":2,"name":"PQR","dept":"CSE"}])
{
        "acknowledged" : true,
        "insertedIds" : [
                ObjectId("5fa452e68bda3bca99bae595"),
                ObjectId("5fa452e68bda3bca99bae596")
        ]
}
>
```

Insert many data into the collection using "insertManyOne" operation

Db.tablename.insertMany([{ }, { }, { }])

Commands

Retrieve data
>db.table_name.find();

```
> db.testtable.find()
{ "_id" : ObjectId("5fa452e68bda3bca99bae595"), "id" : 1, "name" : "ABC", "dept" : "CSE" }
{ "_id" : ObjectId("5fa452e68bda3bca99bae596"), "id" : 2, "name" : "PQR", "dept" : "CSE" }
```

Select some particular value
>db.table_name.find({attribute: {$option: value}})

```
> db.testtable.find({id:{$eq:2}})
{ "_id" : ObjectId("5fa452e68bda3bca99bae596"), "id" : 2, "name" : "PQR", "dept" : "CSE" }
>
```

You can find details in the following website:
https://docs.mongodb.com/manual/tutorial/query-documents/
https://docs.mongodb.com/manual/reference/operator/query/

List of options available

Name	Description
$eq	Matches values that are equal to a specified value.
$gt	Matches values that are greater than a specified value.
$gte	Matches values that are greater than or equal to a specified value.
$in	Matches any of the values specified in an array.
$lt	Matches values that are less than a specified value.
$lte	Matches values that are less than or equal to a specified value.
$ne	Matches all values that are not equal to a specified value.
$nin	Matches none of the values specified in an array.

Commands

Delete row
>db.table_name.deleteMany({attribute:value})

```
> db.testtable.deleteMany({ name : "ABC" })
{ "acknowledged" : true, "deletedCount" : 1 }
```

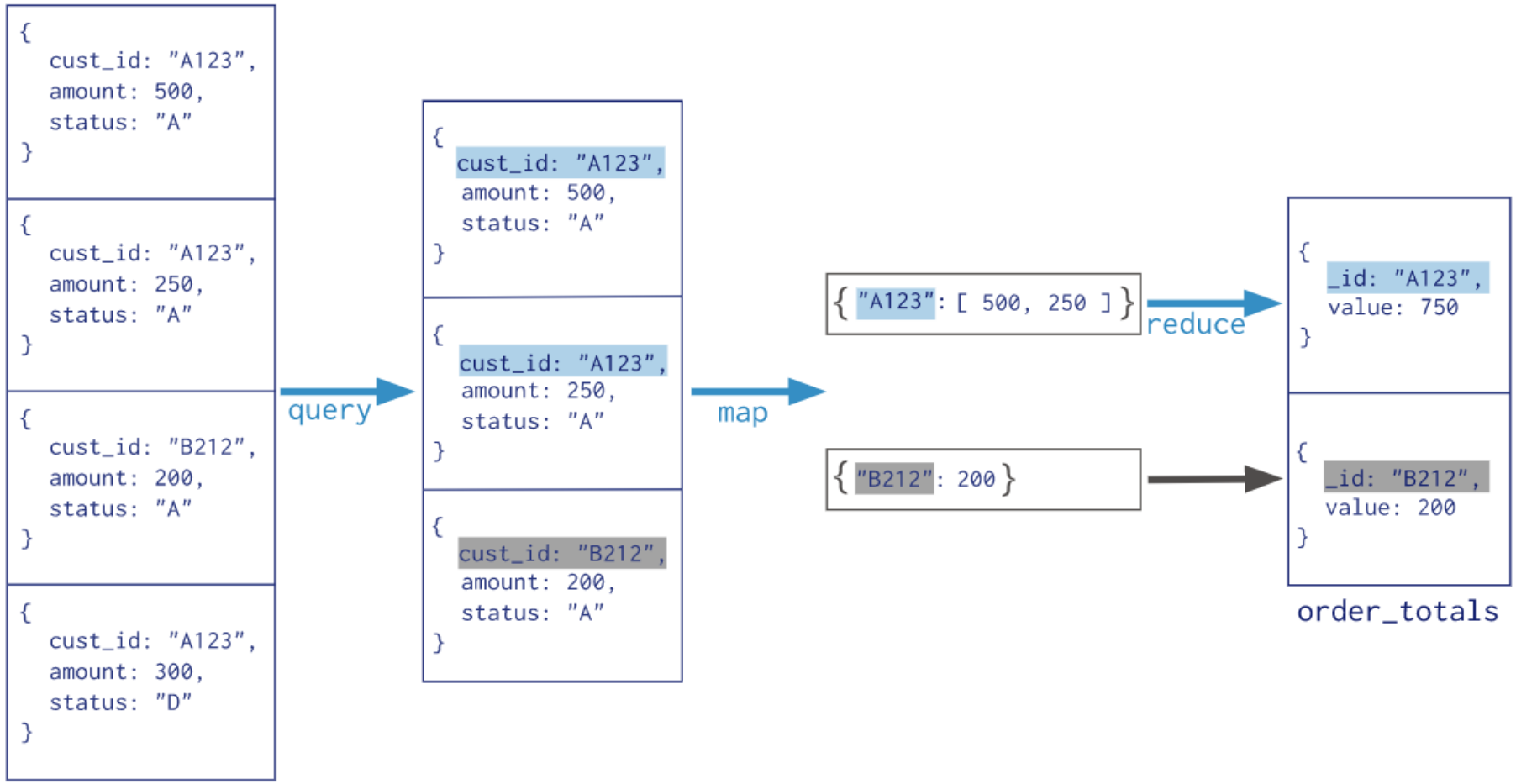
Again show the records
>db.table_name.find()
the record with the name "ABC" has been deleted.

```
> db.testtable.find()
{ "_id" : ObjectId("5fa452e68bda3bca99bae596"), "id" : 2, "name" : "PQR", "dept" : "CSE" }
>
```

`db.collection.updateOne()`	Updates at most a single document that match a specified filter even though multiple documents may match the specified filter. *New in version 3.2.*
`db.collection.updateMany()`	Update all documents that match a specified filter. *New in version 3.2.*
`db.collection.replaceOne()`	Replaces at most a single document that match a specified filter even though multiple documents may match the specified filter.

Different types of update options available

MapReduce Example

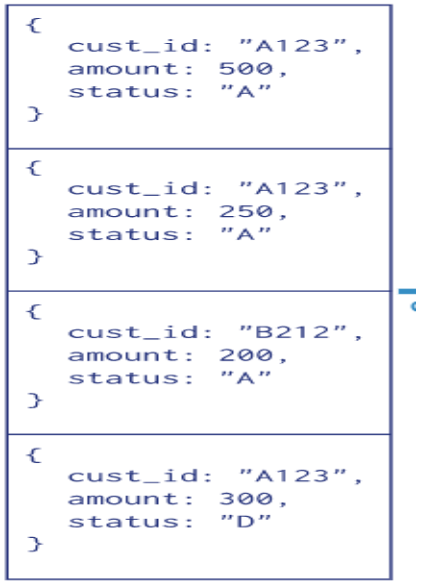


Source: https://docs.mongodb.com/manual/aggregation/

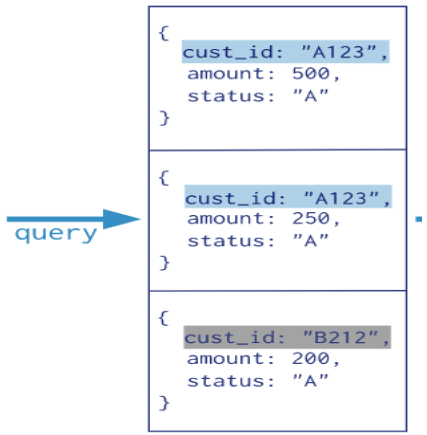
MapReduce Example

Create a database

Create collection "cust"




```
> use mapdb
switched to db mapdb
> db.createCollection("cust")
{ "ok" : 1 }
> db.cust.insertMany([{"id":"A123","amount":500,"status":"A"},{"id":"A123","amount":250,"status":"A"},{"id":"B212",
"amount":200,"status":"A"},{"id":"A123","amount":300,"status":"D"}])
{
        "acknowledged" : true,
        "insertedIds" : [
                ObjectId("5fa501d9bfc8ebf4554384ce"),
                ObjectId("5fa501d9bfc8ebf4554384cf"),
                ObjectId("5fa501d9bfc8ebf4554384d0"),
                ObjectId("5fa501d9bfc8ebf4554384d1")
        ]
}
>
```



Use aggregate function. Take the data of "A" and sum the amount based on "id"

```
> db.cust.aggregate([{$match:{status:"A"}},{$group:{_id:"$id",total:{$sum:"$amount"}}}])
{ "_id" : "A123", "total" : 750 }
{ "_id" : "B212", "total" : 200 }
>
```

Reference

http://www.strozzi.it/cgi-bin/CSA/tw7/I/en_US/nosql/Home%20Page

Manual: https://docs.mongodb.com/manual