Learn MongoDB in 1 Day

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Chapter 1: What is MongoDB? Introduction, Architecture, Features & Example

What is MongoDB?

MongoDB is a document-oriented NoSQL database used for high volume data storage. MongoDB is a database which came into light around the mid-2000s. It falls under the category of a NoSQL database.

MongoDB Features

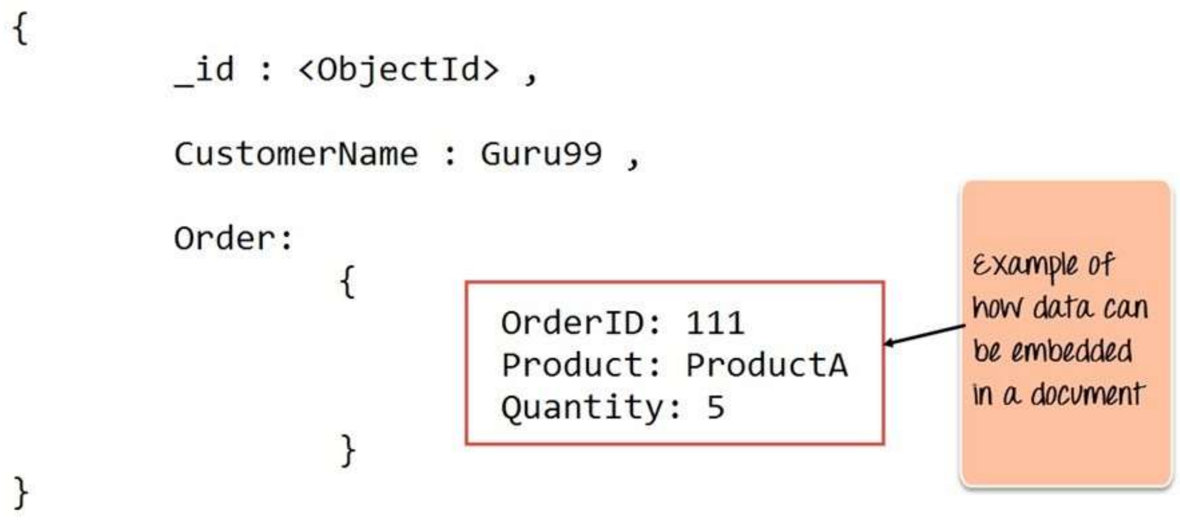
1. Each database contains collections which in turn contains documents. Each document can be different with a varying number of fields. The size and content of each document can be different from each other.
2. The document structure is more in line with how developers construct their classes and objects in their respective programming languages. Developers will often say that their classes are not rows and columns but have a clear structure with key-value pairs.
3. As seen in the introduction with NoSQL databases, the rows (or documents as called in MongoDB) doesn’t need to have a schema defined beforehand. Instead, the fields can be created on the fly.
4. The data model available within MongoDB allows you to represent hierarchical relationships, to store arrays, and other more complex structures more easily.
5. Scalability – The MongoDB environments are very scalable. Companies across the world have defined clusters with some of them running 100+ nodes with around millions of documents

within the database

MongoDB Example

The below example shows how a document can be modeled in MongoDB.

1. The _id field is added by MongoDB to uniquely identify the document in the collection.
2. What you can note is that the Order Data (OrderID, Product, and Quantity) which in RDBMS will normally be stored in a separate table, while in MongoDB it is actually stored as an embedded document in the collection itself. This is one of the key differences in how data is modeled in MongoDB.



```
{
        _id : <ObjectId> ,

        CustomerName : Guru99 ,

        Order:
                {
                        OrderID: 111
                        Product: ProductA
                        Quantity: 5
                }
}
```

Key Components of MongoDB Architecture

Below are a few of the common terms used in MongoDB

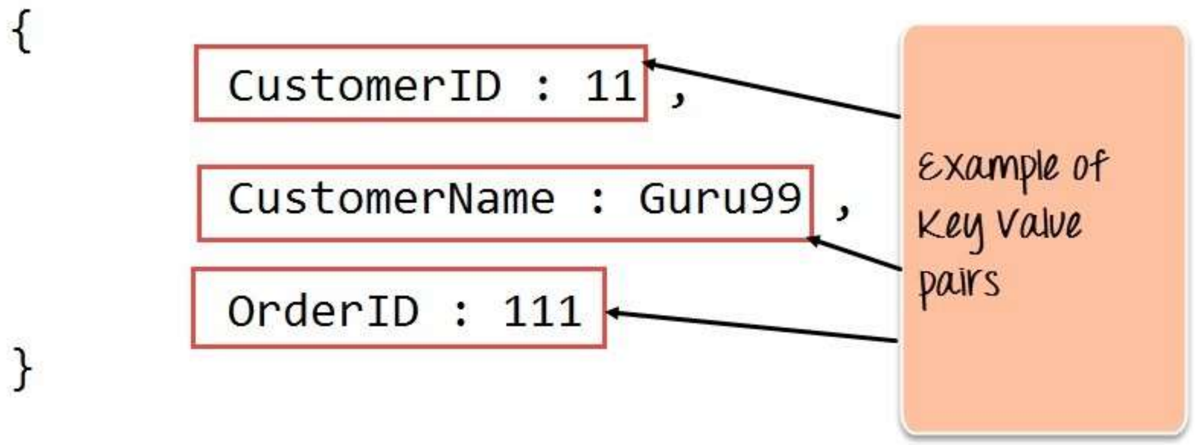
1. **_id** – This is a field required in every MongoDB document. The _id field represents a unique value in the MongoDB document. The _id field is like the document's primary key. If you create a

new document without an _id field, MongoDB will automatically create the field. So for example, if we see the example of the above customer table, Mongo DB will add a 24 digit unique identifier to each document in the collection.

_Id	CustomerID	CustomerName	OrderID
563479cc8a8a4246bd27d784	11	Guru99	111
563479cc7a8a4246bd47d784	22	Trevor Smith	222
563479cc9a8a4246bd57d784	33	Nicole	333

2. **Collection** – This is a grouping of MongoDB documents. A collection is the equivalent of a table which is created in any other RDMS such as Oracle or MS SQL. A collection exists within a single database. As seen from the introduction collections don't enforce any sort of structure.
3. **Cursor** – This is a pointer to the result set of a query. Clients can iterate through a cursor to retrieve results.
4. **Database** – This is a container for collections like in RDMS wherein it is a container for tables. Each database gets its own set of files on the file system. A MongoDB server can store multiple databases.
5. **Document** - A record in a MongoDB collection is basically called a document. The document, in turn, will consist of field name and values.
6. **Field** - A name-value pair in a document. A document has zero or more fields. Fields are analogous to columns in relational databases.

   The following diagram shows an example of Fields with Key value pairs. So in the example below CustomerID and 11 is one of the key value pair's defined in the document.



7. **JSON** – This is known as JavaScript Object Notation. This is a human-readable, plain text format for expressing structured data. JSON is currently supported in many programming languages.

Just a quick note on the key difference between the _id field and a normal collection field. The _id field is used to uniquely identify the documents in a collection and is automatically added by MongoDB when the collection is created.

Why Use MongoDB?

Below are the few of the reasons as to why one should start using MongoDB

1. Document-oriented – Since MongoDB is a NoSQL type database, instead of having data in a relational type format, it stores the data in documents. This makes MongoDB very flexible and adaptable to real business world situation and requirements.
2. Ad hoc queries - MongoDB supports searching by field, range queries, and regular expression searches. Queries can be made to return specific fields within documents.
3. Indexing - Indexes can be created to improve the performance of searches within MongoDB. Any field in a MongoDB document can be indexed.
4. Replication - MongoDB can provide high availability with replica

sets. A replica set consists of two or more mongo DB instances. Each replica set member may act in the role of the primary or secondary replica at any time. The primary replica is the main server which interacts with the client and performs all the read/write operations. The Secondary replicas maintain a copy of the data of the primary using built-in replication. When a primary replica fails, the replica set automatically switches over to the secondary and then it becomes the primary server.

5. Load balancing - MongoDB uses the concept of sharding to scale horizontally by splitting data across multiple MongoDB instances. MongoDB can run over multiple servers, balancing the load and/or duplicating data to keep the system up and running in case of hardware failure.

Data Modelling in MongoDB

As we have seen from the Introduction section, the data in MongoDB has a flexible schema. Unlike in SQL databases, where you must have a table’s schema declared before inserting data, MongoDB’s collections do not enforce document structure. This sort of flexibility is what makes MongoDB so powerful.

When modeling data in Mongo, keep the following things in mind

1. What are the needs of the application – Look at the business needs of the application and see what data and the type of data needed for the application. Based on this, ensure that the structure of the document is decided accordingly.
2. What are data retrieval patterns – If you foresee a heavy query usage then consider the use of indexes in your data model to improve the efficiency of queries.
3. Are frequent insert’s, updates and removals happening in the database – Reconsider the use of indexes or incorporate sharding if required in your data modeling design to improve the efficiency of your overall MongoDB environment.

Difference between MongoDB & RDBMS

Below are some of the key term differences between MongoDB and RDBMS

RDBMS	**MongoDB**	**Difference**
Table	Collection	In RDBMS, the table contains the columns and rows which are used to store the data whereas, in MongoDB, this same structure is known as a collection. The collection contains documents which in turn contains Fields, which in turn are key-value pairs.
Row	Document	In RDBMS, the row represents a single, implicitly structured data item in a table. In MongoDB, the data is stored in documents.
Column	Field	In RDBMS, the column denotes a set of data values. These in MongoDB are known as Fields.
Joins	Embedded documents	In RDBMS, data is sometimes spread across various tables and in order to show a complete view of all data, a join is sometimes formed across tables to get the data. In MongoDB, the data is normally stored in a single collection, but separated by using Embedded documents. So there is no concept of joins in MongoDB.

Apart from the terms differences, a few other differences are shown below

1. Relational databases are known for enforcing data integrity. This is not an explicit requirement in MongoDB.
2. RDBMS requires that data be normalized first so that it can prevent orphan records and duplicates Normalizing data then has the requirement of more tables, which will then result in more table joins, thus requiring more keys and indexes.

   As databases start to grow, performance can start becoming an issue. Again this is not an explicit requirement in MongoDB. MongoDB is flexible and does not need the data to be normalized first.

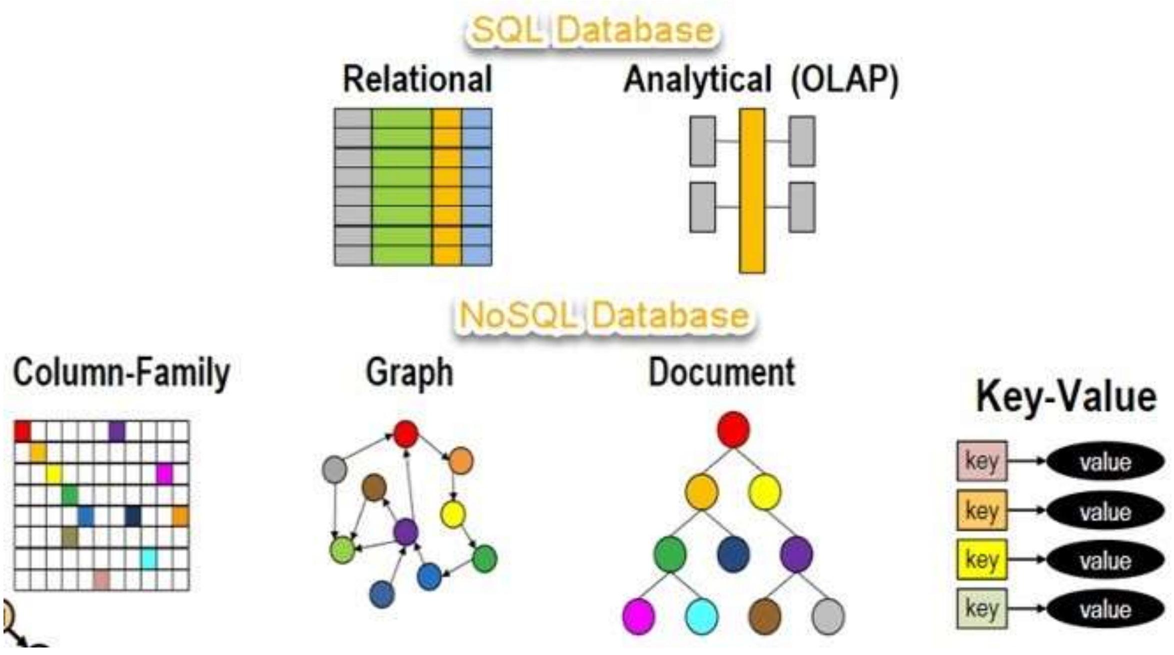
Chapter 2: NoSQL Tutorial: Learn NoSQL Features, Types, What is, Advantages

What is NoSQL?

NoSQL is a non-relational DMS, that does not require a fixed schema, avoids joins, and is easy to scale. NoSQL database is used for distributed data stores with humongous data storage needs. NoSQL is used for Big data and real-time web apps. For example, companies like Twitter, Facebook, Google that collect terabytes of user data every single day.

NoSQL database stands for "Not Only SQL" or "Not SQL." Though a better term would NoREL NoSQL caught on. Carl Strozz introduced the NoSQL concept in 1998.

Traditional RDBMS uses SQL syntax to store and retrieve data for further insights. Instead, a NoSQL database system encompasses a wide range of database technologies that can store structured, semi- structured, unstructured and polymorphic data.

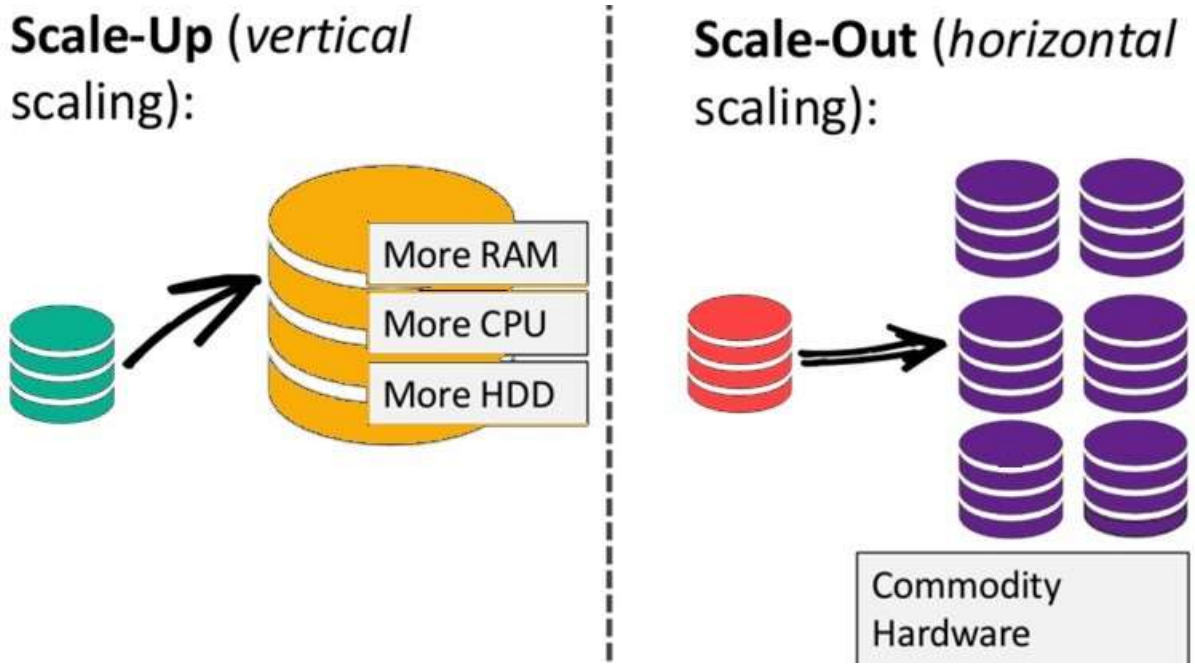


Why NoSQL?

The concept of NoSQL databases became popular with Internet giants like Google, Facebook, Amazon, etc. who deal with huge volumes of data. The system response time becomes slow when you use RDBMS for massive volumes of data.

To resolve this problem, we could “scale up” our systems by upgrading our existing hardware. This process is expensive.

The alternative for this issue is to distribute database load on multiple hosts whenever the load increases. This method is known as “scaling out.”


Scale-Up (*vertical* scaling):
More RAM
More CPU
More HDD
Scale-Out (*horizontal* scaling):
Commodity Hardware

NoSQL database is non-relational, so it scales out better than relational databases as they are designed with web applications in mind.

Brief History of NoSQL Databases

- 1998- Carlo Strozzi use the term NoSQL for his lightweight, open- source relational database
- 2000- Graph database Neo4j is launched
- 2004- Google BigTable is launched
- 2005- CouchDB is launched
- 2007- The research paper on Amazon Dynamo is released
- 2008- Facebooks open sources the Cassandra project 2009-
- The term NoSQL was reintroduced

Features of NoSQL

Non-relational

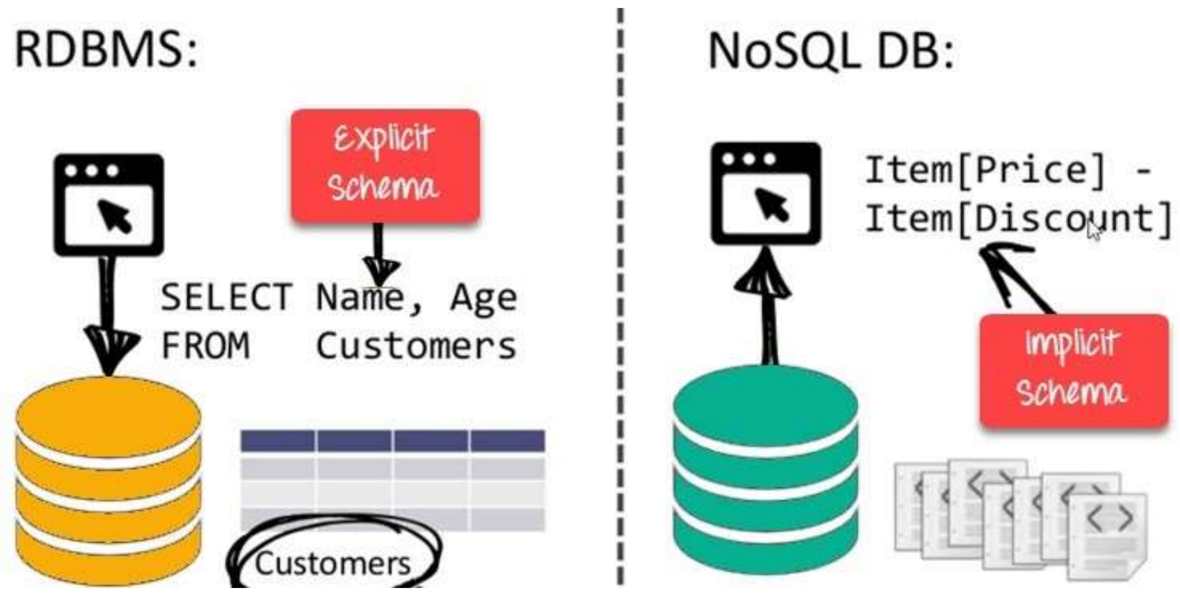
- NoSQL databases never follow the relational model
- Never provide tables with flat fixed-column records

- Work with self-contained aggregates or BLOBs
- Doesn’t require object-relational mapping and data normalization No
- complex features like query languages, query planners,

  referential integrity joins, ACID

Schema-free

- NoSQL databases are either schema-free or have relaxed schemas Do
- not require any sort of definition of the schema of the data Offers
- heterogeneous structures of data in the same domain



NoSQL is Schema-Free

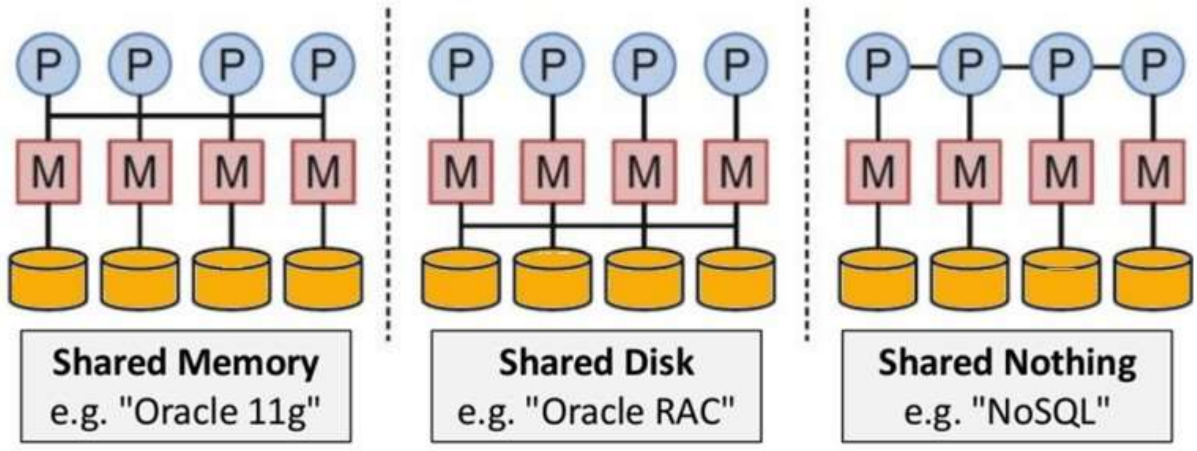
Simple API

- Offers easy to use interfaces for storage and querying data provided
- APIs allow low-level data manipulation & selection methods Text-
- based protocols mostly used with HTTP REST with JSON Mostly used
- no standard based query language
- Web-enabled databases running as internet-facing services

Distributed

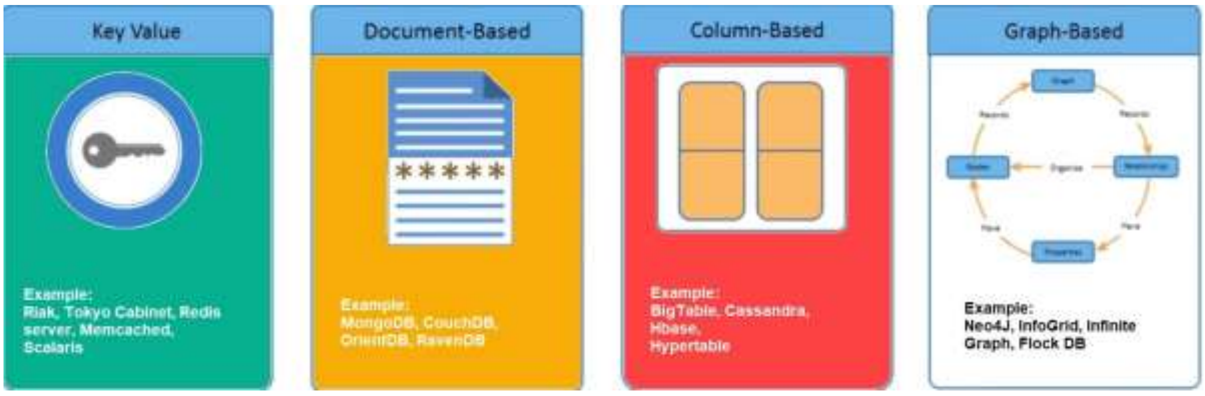
- Multiple NoSQL databases can be executed in a distributed fashion

- Offers auto-scaling and fail-over capabilities
- Often ACID concept can be sacrificed for scalability and throughput
- Mostly no synchronous replication between distributed nodes Asynchronous Multi-Master Replication, peer-to-peer, HDFS Replication
- Only providing eventual consistency
- Shared Nothing Architecture. This enables less coordination and higher distribution.



NoSQL is Shared Nothing.

Types of NoSQL Databases


Key Value
Example:
Riak, Tokyo Cabinet, Redis server, Memcached, Scalaris
Document-Based
*****
Example:
MongoDB, CouchDB, OrientDB, RavenDB
Column-Based
Example:
BigTable, Cassandra, Hbase, Hypertable
Graph-Based
Example:
Neo4J, InfoGrid, Infinite Graph, Flock DB

There are mainly four categories of NoSQL databases. Each of these categories has its unique attributes and limitations. No specific database is better to solve all problems. You should select a database based on your product needs. Let

see all of them:

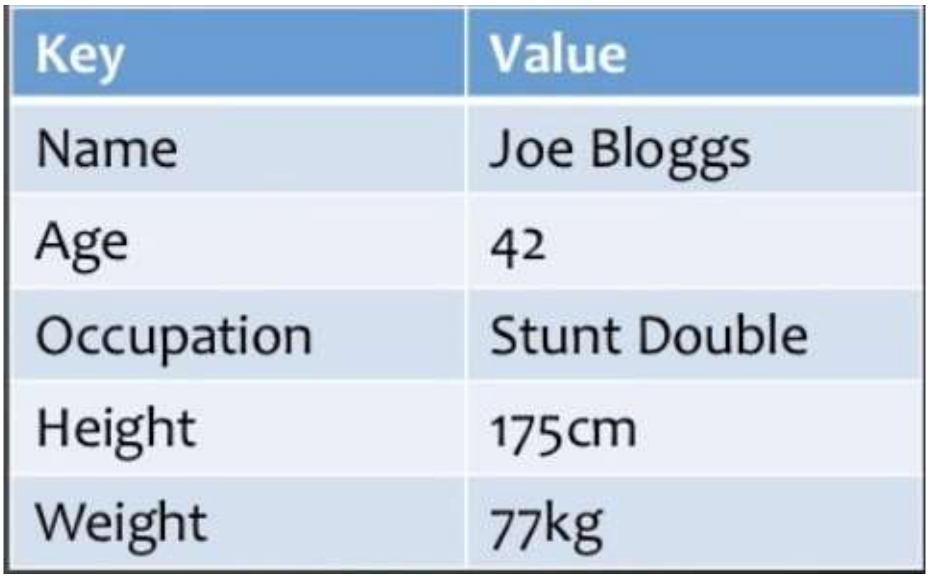
- Key-value Pair Based
- Column-oriented Graph
- Graphs based Document-
- oriented

Key Value Pair Based

Data is stored in key/value pairs. It is designed in such a way to handle lots of data and heavy load.

Key-value pair storage databases store data as a hash table where each key is unique, and the value can be a JSON, BLOB(Binary Large Objects), string, etc.

For example, a key-value pair may contain a key like "Website" associated with a value like "Guru99".



Key	Value
Name	Joe Bloggs
Age	42
Occupation	Stunt Double
Height	175cm
Weight	77kg

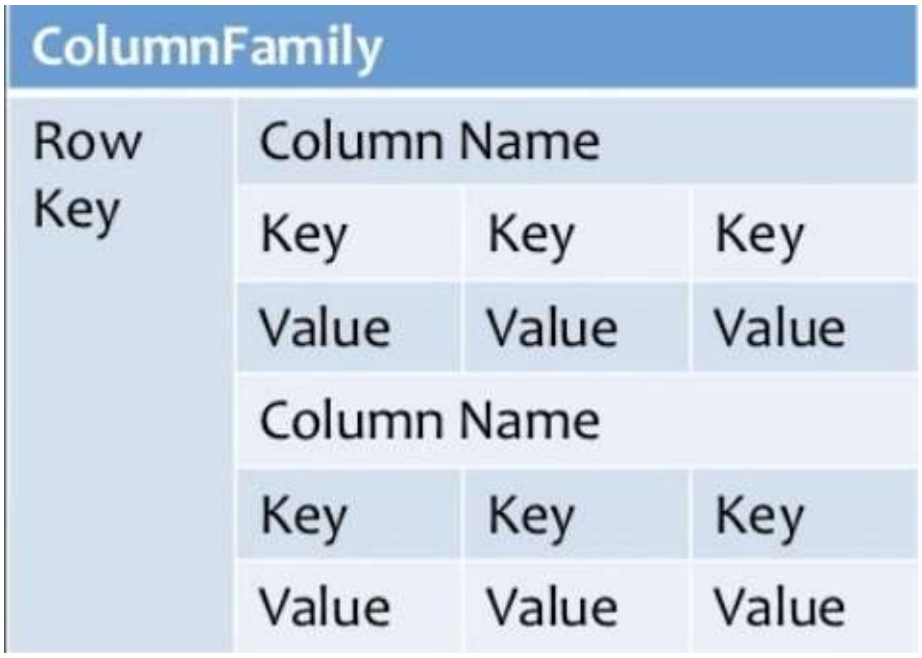
It is one of the most basic types of NoSQL databases. This kind of NoSQL database is used as a collection, dictionaries, associative arrays, etc. Key value stores help the developer to store schema-less data. They work best for shopping cart contents.

Redis, Dynamo, Riak are some examples of key-value store DataBases.

They are all based on Amazon’s Dynamo paper.

Column-based

Column-oriented databases work on columns and are based on BigTable paper by Google. Every column is treated separately. Values of single column databases are stored contiguously.



ColumnFamily			
Row Key	Column Name		
	Key	Key	Key
	Value	Value	Value
	Column Name		
	Key	Key	Key
	Value	Value	Value

Column based NoSQLdatabase

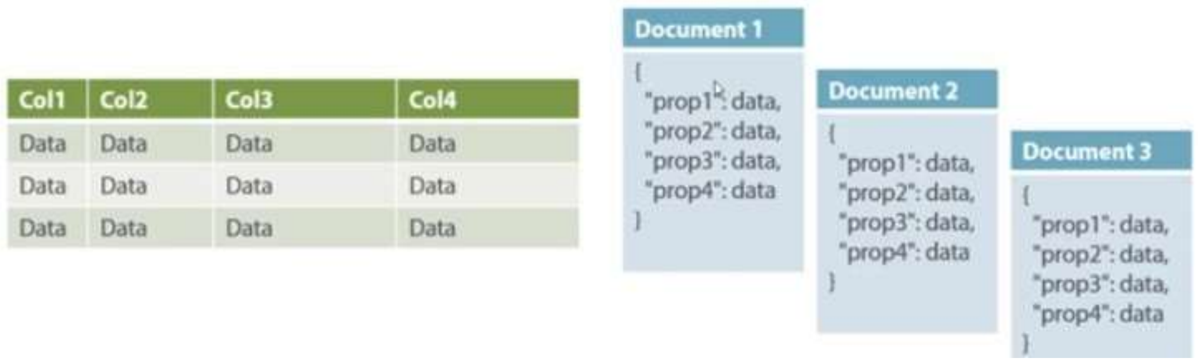
They deliver high performance on aggregation queries like SUM, COUNT, AVG, MIN etc. as the data is readily available in a column.

Column-based NoSQL databases are widely used to manage data warehouses, business intelligence, CRM, Library card catalogs,

HBase, Cassandra, HBase, Hypertable are examples of column based database.

Document-Oriented:

Document-Oriented NoSQL DB stores and retrieves data as a key value pair but the value part is stored as a document. The document is stored in JSON or XML formats. The value is understood by the DB and can be queried.



Relational Vs. Document

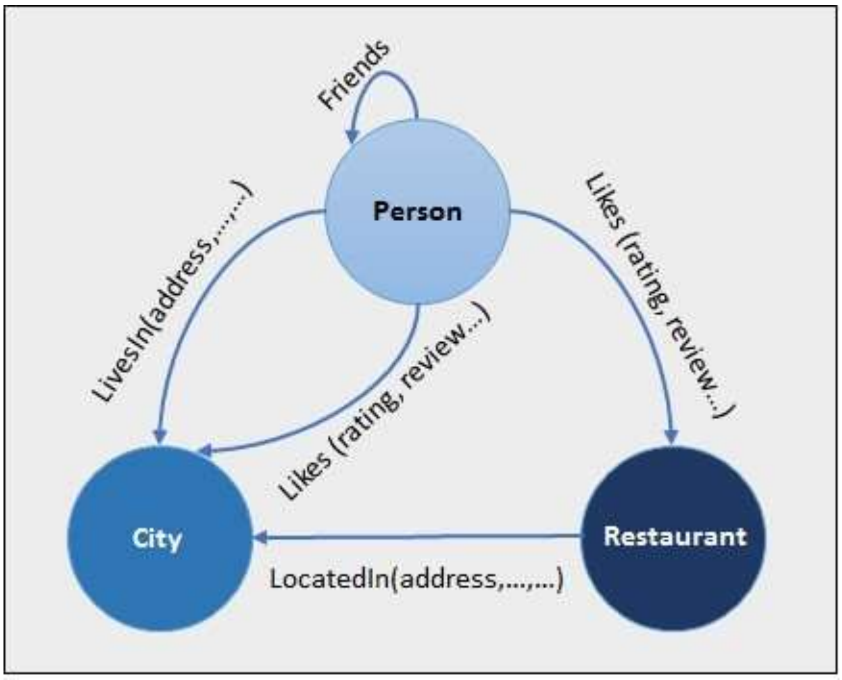
In this diagram on your left you can see we have rows and columns, and in the right, we have a document database which has a similar structure to JSON. Now for the relational database, you have to know what columns you have and so on. However, for a document database, you have data store like JSON object. You do not require to define which make it flexible.

The document type is mostly used for CMS systems, blogging platforms, real-time analytics & e-commerce applications. It should not use for complex transactions which require multiple operations or queries against varying aggregate structures.

Amazon SimpleDB, CouchDB, MongoDB, Riak, Lotus Notes, MongoDB, are popular Document originated DBMS systems.

Graph-Based

A graph type database stores entities as well the relations amongst those entities. The entity is stored as a node with the relationship as edges. An edge gives a relationship between nodes. Every node and edge has a unique identifier.


Friends
Person
LivesIn(address,.....)
Likes (rating, review...)
Likes (rating, review...)
City
Restaurant
LocatedIn(address,...,...)

Compared to a relational database where tables are loosely connected, a Graph database is a multi-relational in nature. Traversing relationship is fast as they are already captured into the DB, and there is no need to calculate them.

Graph base database mostly used for social networks, logistics, spatial data.

Neo4J, Infinite Graph, OrientDB, FlockDB are some popular graph- based databases.

Query Mechanism tools for NoSQL

The most common data retrieval mechanism is the REST-based retrieval of a value based on its key/ID with GET resource

Document store Database offers more difficult queries as they understand the value in a key-value pair. For example, CouchDB allows defining views with MapReduce

What is the CAP Theorem?

CAP theorem is also called brewer’s theorem. It states that is impossible for a distributed data store to offer more than two out of three guarantees

1. Consistency
2. Availability
3. Partition Tolerance

Consistency:

The data should remain consistent even after the execution of an operation. This means once data is written, any future read request should contain that data. For example, after updating the order status, all the clients should be able to see the same data.

Availability:

The database should always be available and responsive. It should not have any downtime.

Partition Tolerance:

Partition Tolerance means that the system should continue to function even if the communication among the servers is not stable. For example, the servers can be partitioned into multiple groups which may not communicate with each other. Here, if part of the database is unavailable, other parts are always unaffected.

Eventual Consistency

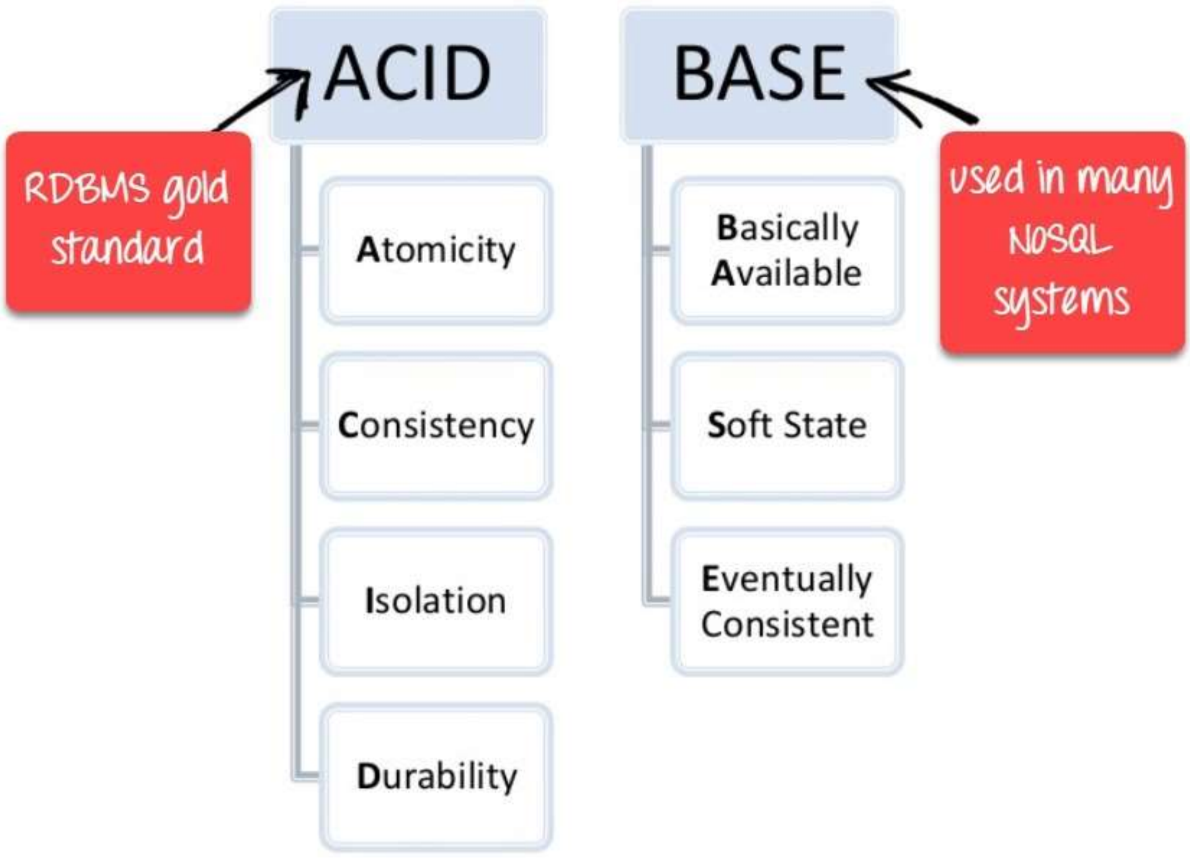
The term “eventual consistency” means to have copies of data on multiple machines to get high availability and scalability. Thus, changes made to any data item on one machine has to be propagated to other replicas.

Data replication may not be instantaneous as some copies will be updated immediately while others in due course of time. These copies may be mutually, but in due course of time, they become consistent.

Hence, the name eventual consistency.

BASE: **B**asically **A**vailable, **S**oft state, **E**ventual consistency

- Basically, available means DB is available all the time as per CAP theorem
- Soft state means even without an input; the system state may change
- Eventual consistency means that the system will become consistent over time



Advantages of NoSQL

- Can be used as Primary or Analytic Data Source Big
- Data Capability
- No Single Point of Failure Easy
- Replication
- No Need for Separate Caching Layer

- It provides fast performance and horizontal scalability.
- Can handle structured, semi-structured, and unstructured data with equal effect
- Object-oriented programming which is easy to use and flexible NoSQL
- databases don’t need a dedicated high-performance server Support
- Key Developer Languages and Platforms
- Simple to implement than using RDBMS
- It can serve as the primary data source for online applications.
- Handles big data which manages data velocity, variety, volume, and complexity
- Excels at distributed database and multi-data center operations
- Eliminates the need for a specific caching layer to store data Offers a
- flexible schema design which can easily be altered without downtime or service disruption

Disadvantages of NoSQL

- No standardization rules
- Limited query capabilities
- RDBMS databases and tools are comparatively mature
- It does not offer any traditional database capabilities, like consistency when multiple transactions are performed simultaneously.
- When the volume of data increases it is difficult to maintain unique values as keys become difficult
- Doesn’t work as well with relational data The
- learning curve is stiff for new developers
- Open source options so not so popular for enterprises.

Summary

- NoSQL is a non-relational DMS, that does not require a fixed schema, avoids joins, and is easy to scale

- The concept of NoSQL databases beccame popular with Internet giants like Google, Facebook, Amazon, etc. who deal with huge volumes of data
- In the year 1998- Carlo Strozzi use the term NoSQL for his lightweight, open-source relational database
- NoSQL databases never follow the relational model it is either schema-free or has relaxed schemas
- Four types of NoSQL Database are 1).Key-value Pair Based 2).Column-oriented Graph 3).Graphs based 4).Document-oriented
- NOSQL can handle structured, semi-structured, and unstructured data with equal effect
- CAP theorem consists of three words Consistency, Availability, and Partition Tolerance
- BASE stands for **B**asically **A**vailable, **S**oft state, **E**ventual consistency
- The term “eventual consistency” means to have copies of data on multiple machines to get high availability and scalability NOSQL offer
- limited query capabilities