

BASES DE DADOS

Módulo III

NoSQL

TECNOLOGIAS E SISTEMAS DE INFORMAÇÃO PARA A
WEB

Agenda

- ❖ NoSQL
- ❖ SQL vs NoSQL
- ❖ *MongoBD*
 - ❖ *Introduction*
 - ❖ *GUI tools*

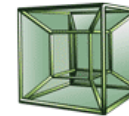
APACHE
HBASE

 **Cassandra**


CouchDB
relax



riak



mongoDB

HYPERTABLE INC



Neo4j



redis

NoSQL

- ❖ NoSQL is similar to “Non SQL” or “Not only SQL”

- ❖ Non-relational databases

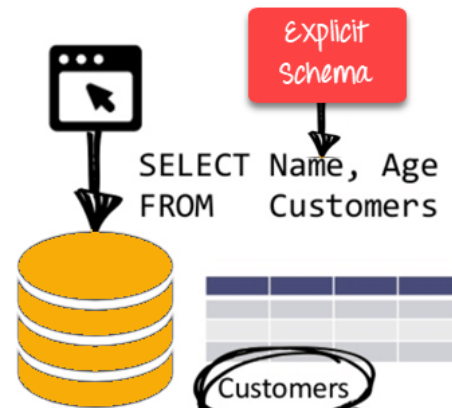
doesn't require object-relational mapping and data normalization. So, they avoid joins!

- ❖ No complex features like query languages, query planners, referential integrity

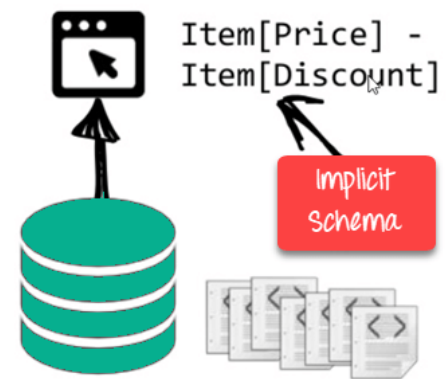
- ❖ Easy to scale, because they not require a fixed schema. Flexible structure

- ❖ Used mainly for Big data and real-time web apps

RDBMS:



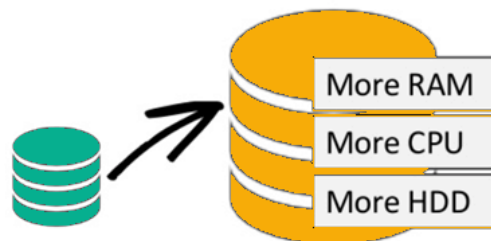
NoSQL DB:



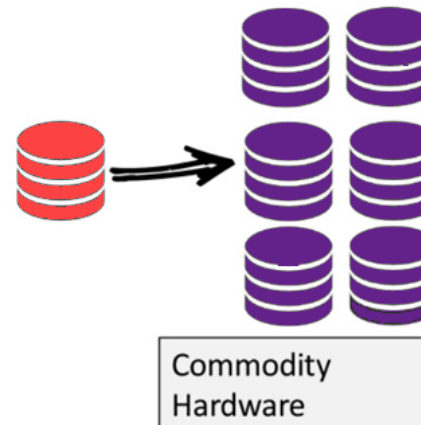
NoSQL

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

Scale-Up (*vertical scaling*):



Scale-Out (*horizontal scaling*):



"scale up" our systems by upgrading our existing hardware

"scaling out", distribute database load on multiple hosts whenever the load increases

NoSQL | Evolution perspective

- ❖ 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
- ❖ 2009- MongoDB is launched (probably the most popular NoSQL Database)

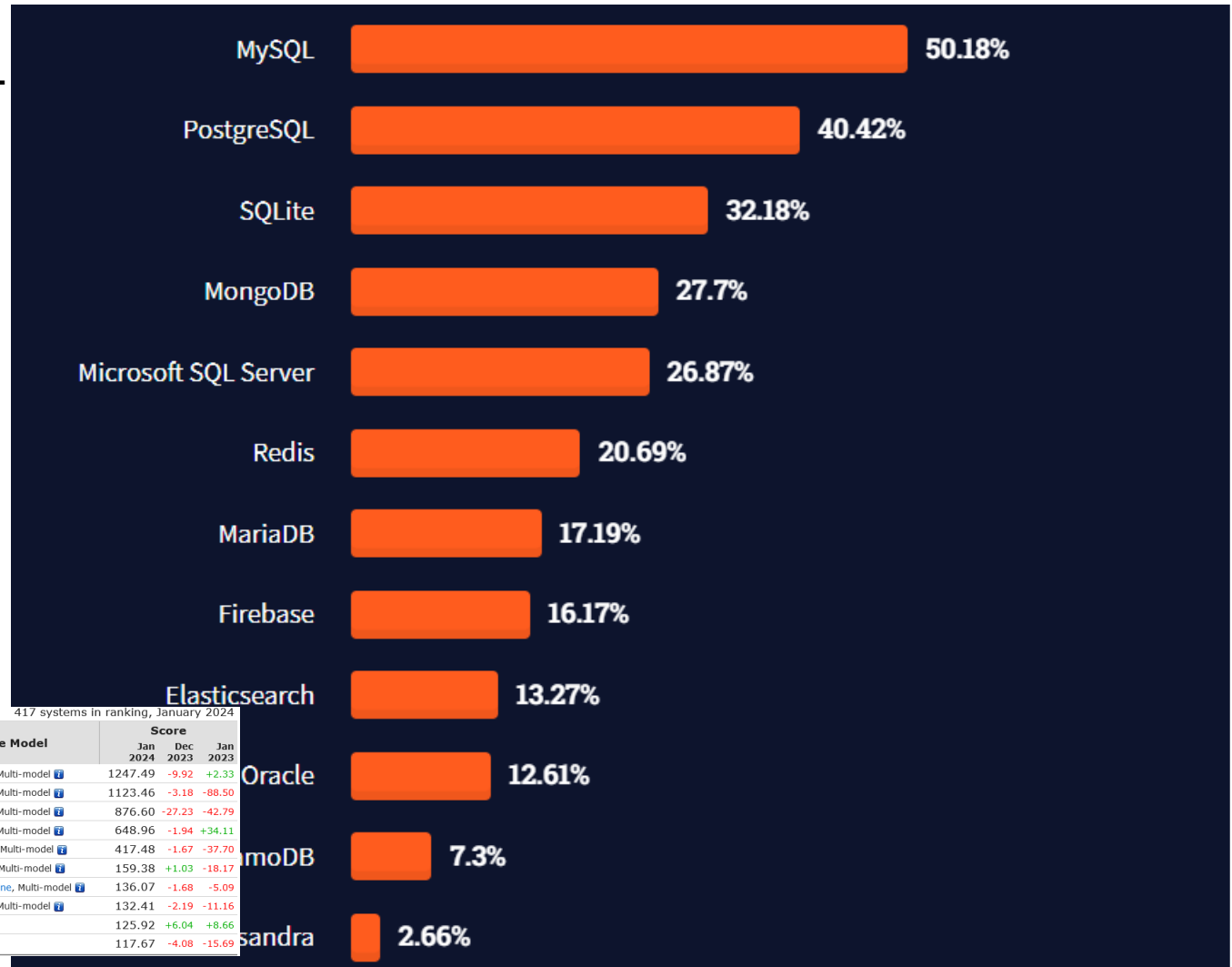
2010- Redis, a key-value store that supports various data structures, is released as an open source project

2011- **Apache HBase**, a distributed column-oriented database modeled after Google BigTable, becomes a top-level Apache project

2012- Datomic, a distributed database that supports transactions, queries, and joins, is launched by Rich Hickey, the creator of Clojure

<https://www.youtube.com/watch?v=hfKnFvv9vRU>

SQL vs NoSQL



Rank			DBMS	Database Model	Score		
Jan 2024	Dec 2023	Jan 2023			Jan 2024	Dec 2023	Jan 2023
1.	1.	1.	Oracle 🚩	Relational, Multi-model ⓘ	1247.49	-9.92	+2.33
2.	2.	2.	MySQL 🚩	Relational, Multi-model ⓘ	1123.46	-3.18	-88.50
3.	3.	3.	Microsoft SQL Server 🚩	Relational, Multi-model ⓘ	876.60	-27.23	-42.79
4.	4.	4.	PostgreSQL 🚩	Relational, Multi-model ⓘ	648.96	-1.94	+34.11
5.	5.	5.	MongoDB 🚩	Document, Multi-model ⓘ	417.48	-1.67	-37.70
6.	6.	6.	Redis 🚩	Key-value, Multi-model ⓘ	159.38	+1.03	-18.17
7.	7.	📈 8.	Elasticsearch	Search engine, Multi-model ⓘ	136.07	-1.68	-5.09
8.	8.	📉 7.	IBM Db2	Relational, Multi-model ⓘ	132.41	-2.19	-11.16
9.	📈 10.	📈 11.	Snowflake 🚩	Relational	125.92	+6.04	+8.66
10.	📉 9.	📉 9.	Microsoft Access	Relational	117.67	-4.08	-15.69

Fonte: StackOverflow, 2021 survey: <https://insights.stackoverflow.com/survey/2021#technology>

SQL vs NoSQL

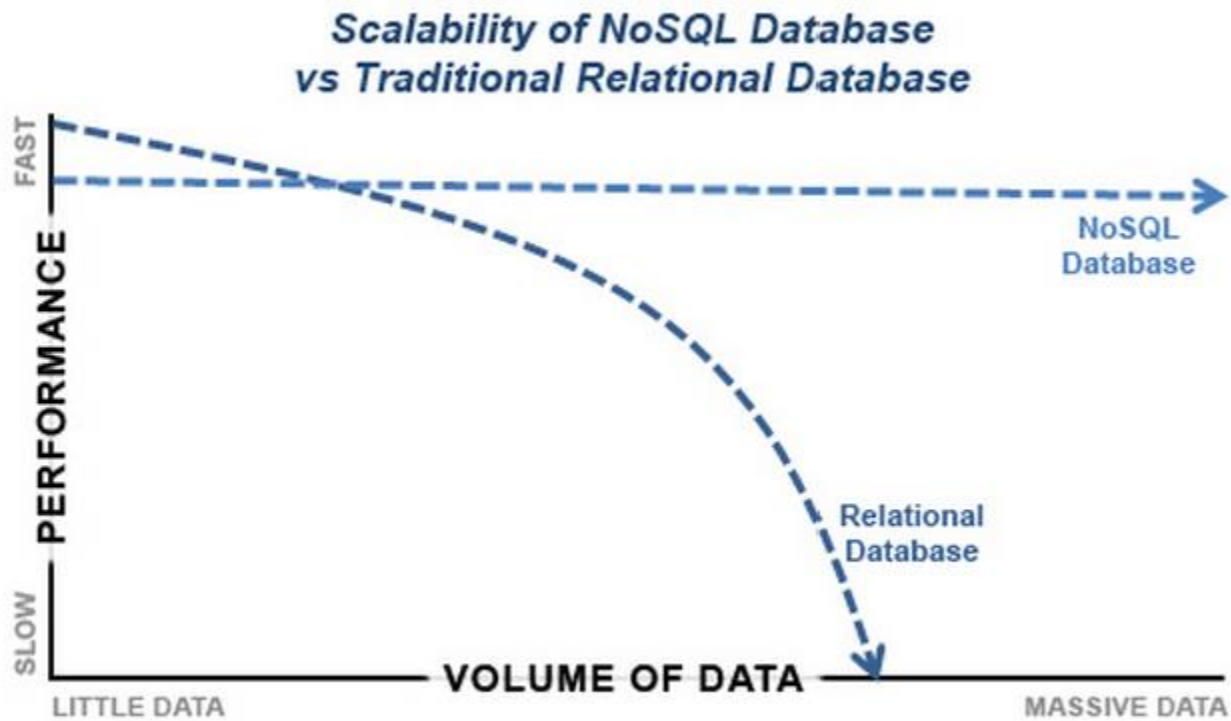
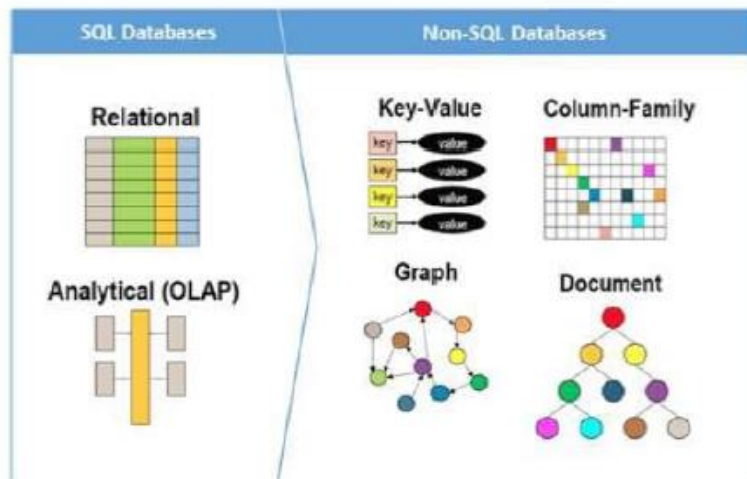


Image Credit: DataJobs.com

SQL vs NoSQL

noSQL: “Not Only SQL”



SQL vs NoSQL

- ▶ **NoSQL** databases have existed since the late 1960s, but were only recognized as NoSQL at the beginning of the 21st century, with the emergence of web 2.0 applications such as Facebook, Amazon or Google.
- ▶ **NoSQL** databases are increasingly used to store large volumes of data and support Web applications
- ▶ Current NoSQL databases are more mature and ready for action. The adoption of NoSQL technology is largely being driven by three co-related trends:
 - ▶ cloud computing
 - ▶ large number of users (millions to billions)
 - ▶ big data

SQL vs NoSQL

	SQL	NoSQL
Type	Relational	Non-Relational
Data	Structured Data stored in Tables	Un-structured stored in JSON files but the graph database does supports relationship
Schema	Static	Dynamic
Scalability	Vertical	Horizontal
Language	Structured Query Language	Un-structured Query Language
Joins	Helpful to design complex queries	No joins, Don't have the powerful interface to prepare complex query
OLTP	Recommended and best suited for OLTP systems	Less likely to be considered for OLTP system
Support	Great support	community depedent, they are expanding the support model
Integrated Caching	Supports In-line memory(SQL2014 and SQL 2016)	Supports integrated caching
flexible	rigid schema bound to relationship	Non-rigid schema and flexible
Transaction	ACID	CAP theorem
Auto elasticity	Requires downtime in most cases	Automatic, No outage required

ACID: Atomicidade, Consistência, Isolamento e Durabilidade (*Atomicity, Consistency, Isolation, Durability*)

CAP theorem: Consistency (every read receives the most recent write or an error), Availability, Partition tolerance:

SQL vs NoSQL

Relational Model



Document Model

Collection ("Things")



MySQL pros

- Atomic transactions support
- JOIN support
- Mature solution
- Privilege and password security system

MongoDB pros

- Document validation
- Integrated storage engines
- Shortened time between primary failure and recovery

MySQL cons

- Tough scaling
- Stability concerns
- Isn't community-driven development

MongoDB cons

- Not the best option for apps with complex transactions
- Not a snap-in replacement for legacy solutions
- Young solution


SQL vs NoSQL | Overview

- ▶ SQL databases are relational, NoSQL are non-relational
- ▶ SQL databases use structured query language and have a predefined schema. NoSQL databases have dynamic schemas for unstructured data
- ▶ SQL databases are vertically scalable, NoSQL databases are horizontally scalable
- ▶ SQL databases are table based, while NoSQL databases are document, key-value, graph or column based
- ▶ SQL databases are better for multi-row transactions. NoSQL are better for unstructured data like JSON documents

Types of NoSQL databases

- ▶ NoSQL databases can be divided into four distinct groups:

Key Value



Example:
Riak, Tokyo Cabinet, Redis
server, Memcached,
Scalaris

Document-Based



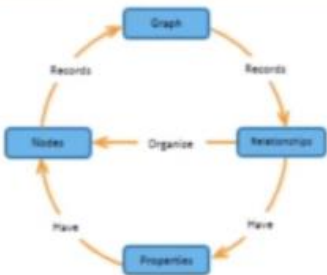
Example:
MongoDB, CouchDB,
OrientDB, RavenDB

Column-Based



Example:
BigTable, Cassandra,
Hbase,
Hypertable

Graph-Based



Example:
Neo4J, InfoGrid, Infinite
Graph, Flock DB

Types of NoSQL databases

- ▶ NoSQL databases can be divided into four distinct groups.
 - ▶ **Key/value based:** These databases work by matching key with specific values, similar to a map or dictionary. They are efficient, extremely performant, and easily scalable.
 - ▶ 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

Key	Value
194252165973	MacBook Pro 13"
42406659611	USB Microphone
36000341362	Hand Sanitizer
36196308002	Toilet paper

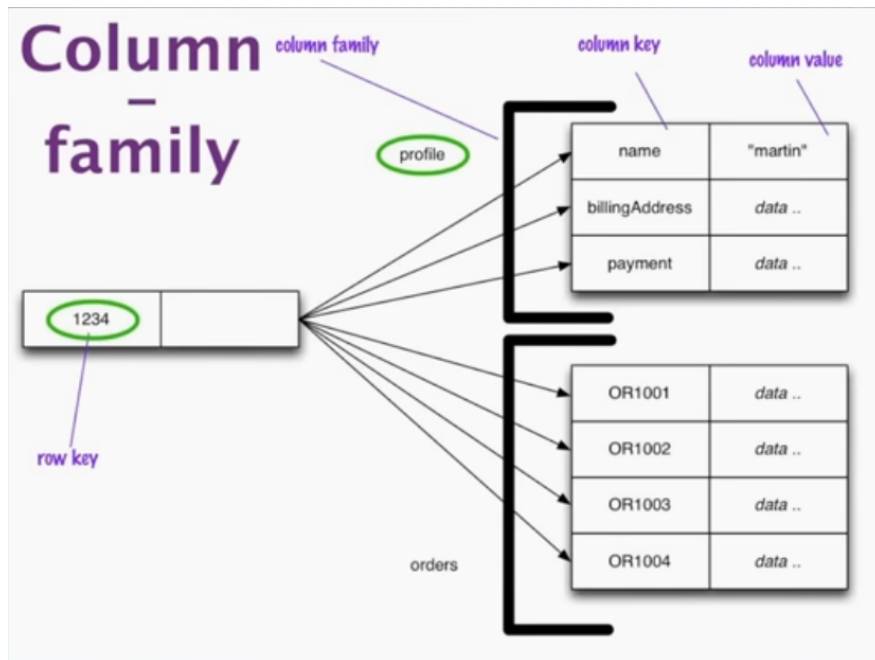


Key	Value
194252165973	{ name: "MacBook Pro 13", price: \$1032.21, description: "laptop" }
42406659611	USB Microphone
36000341362	Hand Sanitizer
36196308002	Toilet paper

Types of NoSQL databases



- ▶ NoSQL databases can be divided into four distinct groups.
 - ▶ **Column based:** These databases work by creating collections of one or more key/value pairs that match a specific record. They are also referred to as extensible record stores, wide columnar stores, or column oriented stores.



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

Types of NoSQL databases

- ▶ NoSQL databases can be divided into four distinct groups.
 - ▶ **Document based:** Key value pairs are encapsulated in JSON like documents. The keys within each document have to be unique. Unlike key based, the values are not opaque to the system and can be queried.

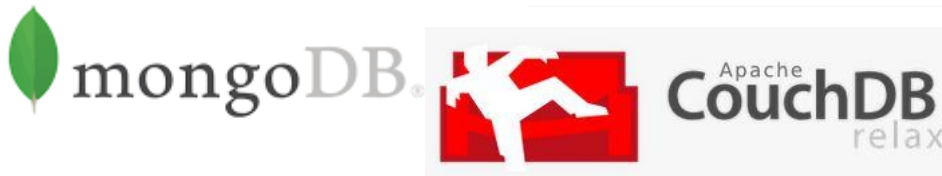
Collection

A collection can have multiple documents



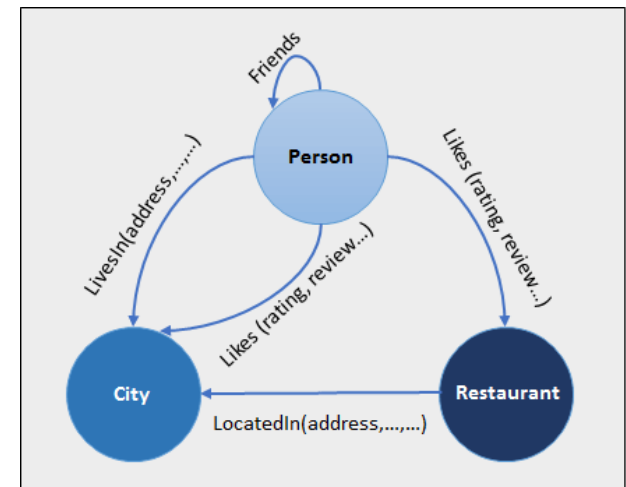
Edit document [\(view keyboard shortcuts\)](#)

```
1 {  
2   "_id": {  
3     "$oid": "5c2e5568e7179a49f40bee8a"  
4   },  
5   "employee_id": "1",  
6   "employee_name": "Eduardo Albuquerque",  
7   "employee_salary": "1950",  
8   "employee_nif": "234567890",  
9   "employee_department": "production"  
10 }
```



Types of NoSQL databases

- ▶ NoSQL databases can be divided into four distinct groups.
 - ▶ **Graph based:** These databases are specialized in efficient management of heavily linked data.
 - ▶ 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.



MongoDB



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MongoDB

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MongoDB

latest s

Overview

Download

Compass

Update

Compa

Atlas →

Multi-cloud database platform

Database

Search

Data Lake

Charts

Enterprise Advanced →

Enterprise software and support

Enterprise Server

Ops Manager

Enterprise Kubernetes

Operator

Community Edition →

Free software used by millions

Community Server

Cloud Manager

Community Kubernetes

Operator

Realm →

Data services for mobile & web

Edge-to-Cloud Sync

Functions, APIs, and more

Tools →

Build faster

Compass

Shell

VS Code Plugin

Atlas CLI

Database Connectors

<https://www.mongodb.com/>

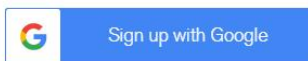
MongoDB Atlas

- ▶ MongoDB as a Service
- ▶ Cloud Hosting Services AWS (Amazon Web Services)



MongoDB Atlas

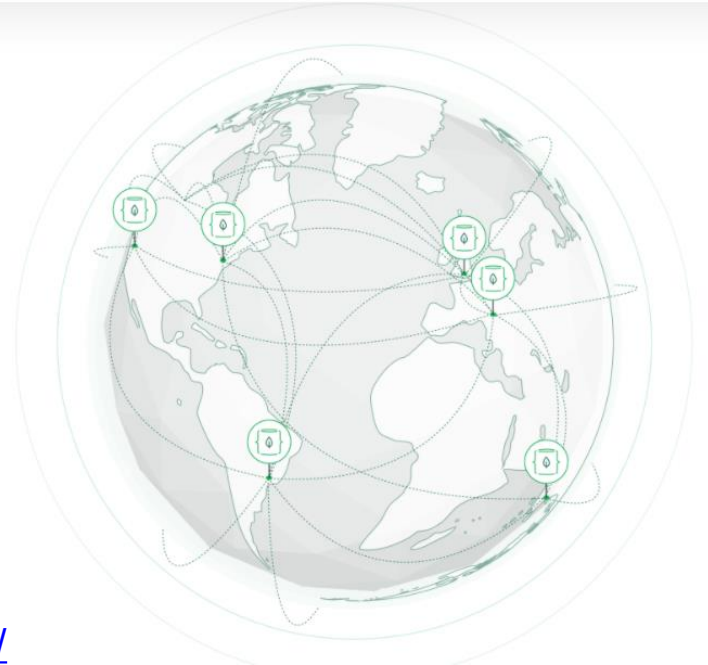
Cloud-hosted MongoDB service on AWS, Azure and Google Cloud. Deploy, operate, and scale a MongoDB database in just a few clicks



or



<https://www.mongodb.com/>



MongoDB Atlas

- ▶ MongoDB as a Service
- ▶ Cloud Hosting Services AWS (Amazon Web Services)

Already have an account? [Sign in](#).

Get started free

No credit card required



☐ I agree to the [terms of service](#) and [privacy policy](#).

Create account

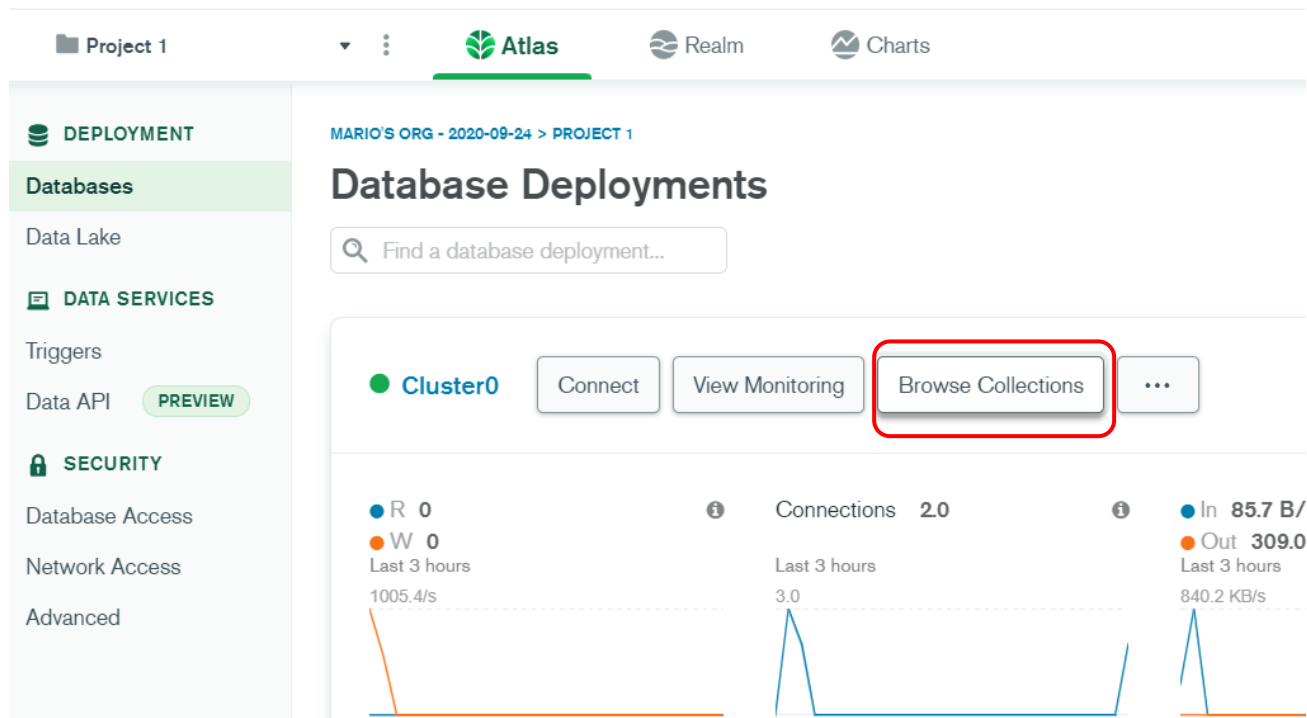
Or

 Sign up with Google

<https://www.mongodb.com/atlas/database>

MongoDB Atlas

- MongoDB Cloud Hosting Services AWS (Amazon Web Services)



MongoDB Atlas

The screenshot displays the MongoDB Atlas web interface. On the left, a sidebar contains navigation links: 'DEPLOYMENT', 'Databases', 'Data Lake', 'DATA SERVICES', 'Triggers', 'Data API' (with a 'PREVIEW' badge), 'SECURITY', 'Database Access', 'Network Access', and 'Advanced'. A red arrow points from the 'Databases & Collections' text to the 'Databases' link. The main content area shows the 'MyBusiness' database with 10 databases and 23 collections. The 'employees' collection is selected, showing a collection size of 2.64KB, 11 total documents, and a total index size of 20KB. The 'Find' tab is active, displaying a filter bar with the query `{ field: 'value' }` and buttons for 'FILTER', 'OPTIONS', 'Apply', and 'Reset'. The 'INSERT DOCUMENT' button is also visible. Below the filter bar, the 'QUERY RESULTS 1-11 OF 11' are shown, with the first two documents visible: `{ '_id': ObjectId('5ffc3687cf724c5863ca5444'), 'employee_id': '01', 'employee_name': 'Eduardo Albuquerque', 'employee_salary': '2150', 'employee_depart': Array, 'employee_adress': Object }` and `{ '_id': ObjectId('5ffc385ecf724c5863ca5445'), 'employee_id': '02' }`.

Project 1

Atlas Realm Charts

DEPLOYMENT

Databases

Data Lake

DATA SERVICES

Triggers

Data API PREVIEW

SECURITY

Database Access

Network Access

Advanced

DATABASES: 10 COLLECTIONS: 23

+ Create Database

NAMESPACES

MyBusiness

employees

sample_airbnb

sample_analytics

sample_geospatial

sample_mflix

sample_restaurants

sample_supplies

sample_training

sample_weatherdata

teste

MyBusiness.employees

COLLECTION SIZE: 2.64KB TOTAL DOCUMENTS: 11 INDEXES TOTAL SIZE: 20KB

Find Indexes Schema Anti-Patterns 0 Aggregation Search Indexes

INSERT DOCUMENT

FILTER { field: 'value' } OPTIONS Apply Reset

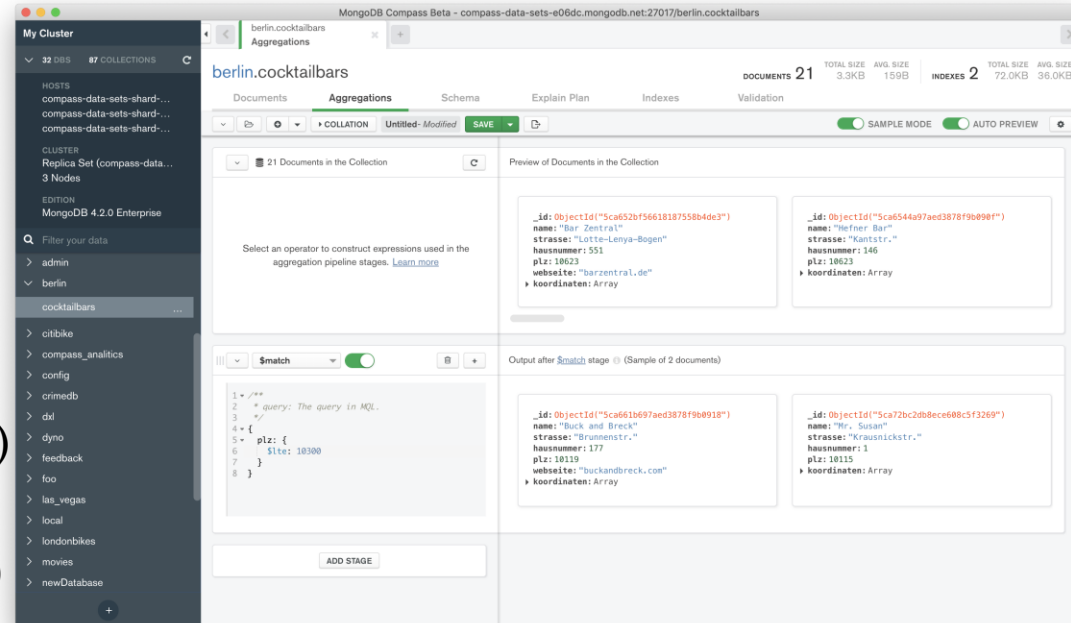
QUERY RESULTS 1-11 OF 11

```
{
  "_id": ObjectId("5ffc3687cf724c5863ca5444"),
  "employee_id": "01",
  "employee_name": "Eduardo Albuquerque",
  "employee_salary": "2150",
  "employee_depart": Array,
  "employee_adress": Object
}
```

```
{
  "_id": ObjectId("5ffc385ecf724c5863ca5445"),
  "employee_id": "02"
}
```

Mongo BD GUI Tools:

- ▶ MongoDB Compass
- ▶ Robo 3T (formely Robomongo)
- ▶ Studio 3T (formely MongoChef)
- ▶ Table Plus (GUI tool for relational databases like MySQL, PostgreSQL, SQLite, and NoSQL databases like MongoDB)



MongoDB Compass



► Install Compass ...



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MongoDB Compass

latest stable ▼


Overview

Download and Install Compass

Update MongoDB
Compass

Download Compass

To download Compass, you can use your preferred web browser.

1. Open the [downloads page](#) .
2. Select the installer you prefer. The MongoDB Compass installer is available as a `.exe` or `.msi` package or a `.zip` archive.
3. Download the latest version of MongoDB Compass for Windows.

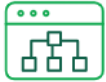
Install Compass

1. Double-click the installer file.
2. Follow the prompts to install Compass. You can select the destination of the Compass installation.
3. Once installed, Compass launches and prompts you to configure privacy settings and specify update preferences.

<https://docs.mongodb.com/compass/current/install/>



► MongoDB Compass: GUI Tool



Visualize and explore

Visualize, understand, and work with your data through an intuitive GUI.



Insert, modify, and delete

Modify your data with a powerful visual editing tool.



Debug and optimize

Understand performance issues with visual explain plans, view utilization and manage your indices.

Connecting Compass to Atlas

1 Setp I – MongoDB Atlas – click on **Connect**

The screenshot displays the MongoDB Atlas interface. At the top, there's a navigation bar with 'Project 1', 'Atlas', 'Realm', and 'Charts'. The left sidebar shows 'DATA STORAGE' with 'Clusters' selected, and 'SECURITY' with 'Database Access', 'Network Access', and 'Advanced'. The main content area is titled 'Clusters' and shows a search bar 'Find a cluster...'. A green banner at the top of the cluster list states: 'Sample dataset successfully loaded. Access it in Data Explorer by clicking the Collections button, or with'. Below this, the first cluster 'Cluster0' is listed with 'Version 4.2.11'. The 'CONNECT' button for Cluster0 is highlighted with a red box. Other buttons shown are 'METRICS', 'COLLECTIONS', and a three-dot menu. To the right of the cluster list, there's a graph titled 'Operations' showing 'R: 0.007 W: 0' over the 'Last 6 Hours'. Below the graph, it shows 'Connections 3'.

Project 1

Atlas

Realm

Charts

DATA STORAGE

Clusters

Triggers

Data Lake

SECURITY

Database Access

Network Access

Advanced

MARIO'S ORG - 2020-09-24 > PROJECT 1

Clusters

Find a cluster...

Sample dataset successfully loaded. Access it in Data Explorer by clicking the Collections button, or with

Cluster0

Version 4.2.11

CONNECT METRICS COLLECTIONS ...

CLUSTER TIER

M0 Sandbox (General)

REGION

GCP / Iowa (us-central1)

TYPE

Replica Set - 3 nodes

Operations R: 0.007 W: 0

Last 6 Hours

Connections 3

Connecting Compass to Atlas

2

Setp 2 – MongoDB Atlas – Connect using MongoDB Compass

✓ Setup connection security

Choose a connection method

Connect

Choose a connection method [View documentation](#)

Get your pre-formatted connection string by selecting your tool below.



Connect with the mongo shell

Interact with your cluster using MongoDB's interactive Javascript interface



Connect your application

Connect your application to your cluster using MongoDB's native drivers



Connect using MongoDB Compass

Explore, modify, and visualize your data with MongoDB's GUI



GUI for
MongoDB



Connecting Compass to Atlas

3

Step 3 – MongoDB Atlas – copy the connection string

Connect to Cluster0

✓ Setup connection security ✓ Choose a connection method Connect

I do not have MongoDB Compass

I have MongoDB Compass

1 Choose your version of Compass:

1.12 or later

See your Compass version in "About Compass"

2 Copy the connection string, then open MongoDB Compass.


```
mongodb+srv://<username>:<password>@cluster0.7iyuz.gcp.mongodb.net/test
```

You will be prompted for the password for the **<username>** user's (Database User) username.
When entering your password, make sure that any special characters are [URL encoded](#).


Connecting Compass to Atlas

4

Setp 4 – MongoDB Compass: **New Connection** & paste de string connection

 MongoDB Compass - Connect

Connect View Help

 **New Connection**

★ **Favorites**

JAN 20, 2021 10:11 AM
cluster0.7iyuz.gcp.mongodb.net

↺ **Recents**

JAN 20, 2021 7:15 PM
localhost:27017

JAN 19, 2021 7:01 PM
localhost:27017

JAN 19, 2021 6:40 PM
cluster0.7iyuz.gcp.mongodb.net

New Connection ☆ FAVORITE

Fill in connection fields individually

Paste your connection string (SRV or Standard ⓘ)

mongodb+srv://<username>:<password>@cluster0.7iyuz.gcp.mongodb.net/test|

Connect

MongoDB Compass

The screenshot displays the MongoDB Compass web interface. On the left sidebar, the 'Local' connection is selected, showing 'localhost:27017' and 'MongoDB 4.4.3 Community'. The main panel shows the 'MyBusiness.employees' collection with 11 documents, a total size of 2.7KB, and an average size of 246B. The 'Documents' tab is active, displaying a list of documents with a filter bar and a 'FIND' button. The first document is expanded, showing its structure: `{ '_id': ObjectId('5ffc3687cf724c5863ca5444'), 'employee_id': '01', 'employee_name': 'Eduardo Albuquerque', 'employee_salary': '2150', 'employee_depart': ['sales', 'Accounting'], 'employee_address': { 'street': 'Rua da Bela Vista', 'number': '180', 'city': 'Porto' } }`. The second document is also expanded, showing: `{ '_id': ObjectId('5ffc385ecf724c5863ca5445'), 'employee_id': '02', 'employee_name': 'Liliana Ferreira', 'employee_salary': '1850', 'employee_depart': ['sales', 'Production'], 'employee_address': { 'street': 'Rua das Marinhas', 'number': '180', 'city': 'Vila do Conde' } }`.

Local

4 DBS 2 COLLECTIONS

☆ FAVORITE

HOST
localhost:27017

CLUSTER
Standalone

EDITION
MongoDB 4.4.3 Community

Filter your data

MyBusiness

employees

admin

config

local

Documents

MyBusiness.employees

DOCUMENTS 11 TOTAL SIZE 2.7KB AVG. SIZE 246B INDEXES 1 TOTAL SIZE 32.8KB AVG. SIZE 32.8KB

Documents Aggregations Schema Explain Plan Indexes Validation

FILTER { field: 'value' }

OPTIONS FIND RESET ↺ ...

ADD DATA VIEW {}

Displaying documents 1 - 11 of 11 < > REFRESH

```
{
  "_id": ObjectId("5ffc3687cf724c5863ca5444"),
  "employee_id": "01",
  "employee_name": "Eduardo Albuquerque",
  "employee_salary": "2150",
  "employee_depart": Array
    0: "sales"
    1: "Accounting"
  "employee_address": Object
    street: "Rua da Bela Vista"
    number: "180"
    city: "Porto"
}
```

```
{
  "_id": ObjectId("5ffc385ecf724c5863ca5445"),
  "employee_id": "02",
  "employee_name": "Liliana Ferreira",
  "employee_salary": "1850",
  "employee_depart": Array
    0: "sales"
    1: "Production"
  "employee_address": Object
    street: "Rua das Marinhas"
    number: "180"
    city: "Vila do Conde"
}
```