Apache Cassandra

Outlines

- ***Query language***
- ***Connect Python to Apache Cassandra***

“ I don’t always use Cassandra but when I do, I denormalize

- Meme.

Apache Cassendra

- A distributed NoSQL database system for managing large amounts of data across many commodity servers, while providing highly available service and no single point of failure.

Key features

- Distributed and decentralized
- Fault tolerance
- Tunable consistency
- Column oriented
- CQL query
- High performance

Distributed and decentralized

- Distributed: capable of running on multiple machines
- Decentralized: No single point of failure.
- No master-slave issues due to peer-to-peer architecture

Elastic Scalability

- Cassandra scales horizontally adding more machines that have all or some of the data on
- Adding of nodes increase performance throughput linearly
- Decreasing and increasing the node count happen seamlessly.

High availability and fault tolerance

- Multiple networked computers operating in a cluster
- Facility for recognizing node failures
- Forward failing over requests to another part of the system

Column oriented Key-Value Store

- Data is stored in sparse multidimensional hash tables
- A row can have multiple columns not necessarily the same amount of columns for each row
- Each row has a unique key, which also determines partitioning

Cassandra Query Language

- "COL 3 is the default and primary interface into the Cassandra DBMS“
- Familiar SQL-like syntax that maps to Cassandras storage engine and simplifies data modelling

Cassandra Query Language

```
CRETE TABLE songs (
        Id uuid PRIMARY KEY, title text,
        Album text, Artist text,
        data blob );
```

```
SELECT * FROM songs
WHERE id = 'a3e64f8f...';
```

```
SELECT *  FROM songs ;
```

```
INSERT INTO songs (id, title, album, artist)
VALUES( 'a3e64f8f...', 'Hazim ra3d', 'Spacetoon', 'Tarkan' );
```

Cassandra Query Language

```
INSERT INTO songs (id, title)
VALUES( 'a3e64f8f...', 'Al Kanas');
```

This is Possible With Cassandra

Cassandra Query Language

The resulting table in RDMBS is this:

id	title	artist	album	data
a3e64f8f...	Hazim Ra3d	Tarkan	Spacetoon	*null*
g617Dd23...	Al Kanas	*null*	*null*	*null*

Cassandra Query Language

The resulting table in Cassandra is this:

id	title	artist	album	data
a3e64f8f...	Hazim Ra3d	Tarkan	Spacetoon	
g617Dd23...	Al Kanas			

MySQL Comparison

Statistics based on 50 GB Data

	Cassandra	MySQL
Average Write	**0.12 ms**	**~300 ms**
Average Read	**15 ms**	**~350 ms**

Stats provided by Authors using Facebook data.

Data Model

Cluster:

Cassandra database is distributed over several machines that operate together. The outermost container is known as the Cluster. For failure handling, every node contains a replica, and in case of a failure, the replica takes charge. Cassandra arranges the nodes in a cluster, in a ring format, and assigns data to them.

Data Model

Keyspace

Outermost container for data (one or more column families), like database in RDBMS.

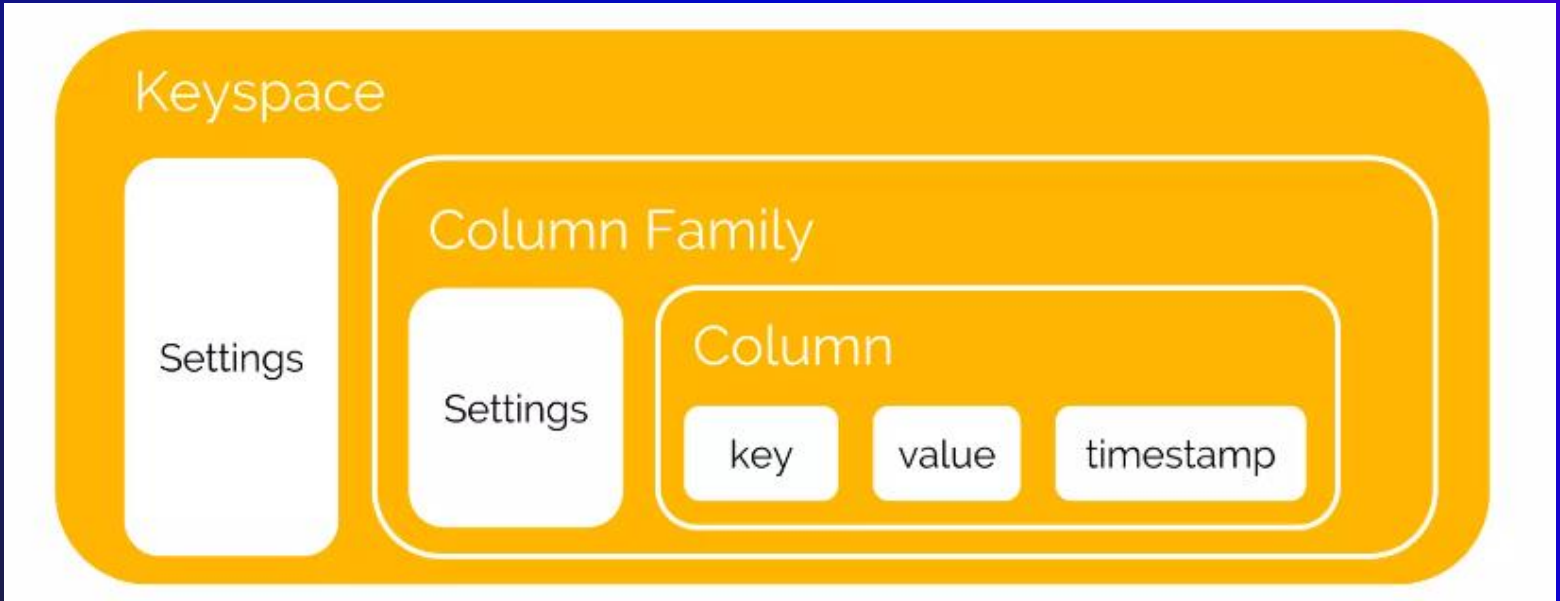
Column family

Contains Super columns or Columns (but not both).

Column

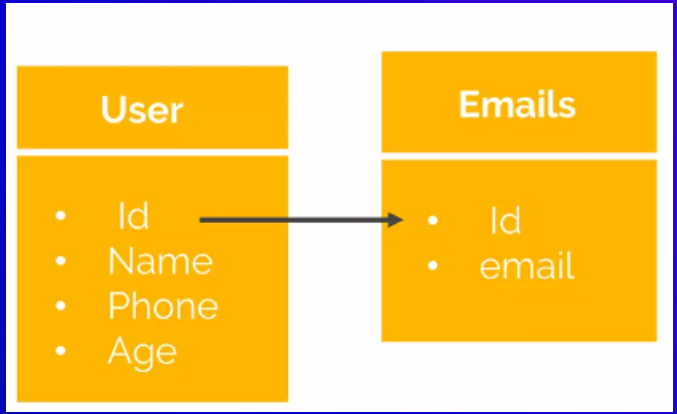
Basic data structures with: key, value, timestamp

Data Model


Keyspace
Settings
Column Family
Settings
Column
key
value
timestamp

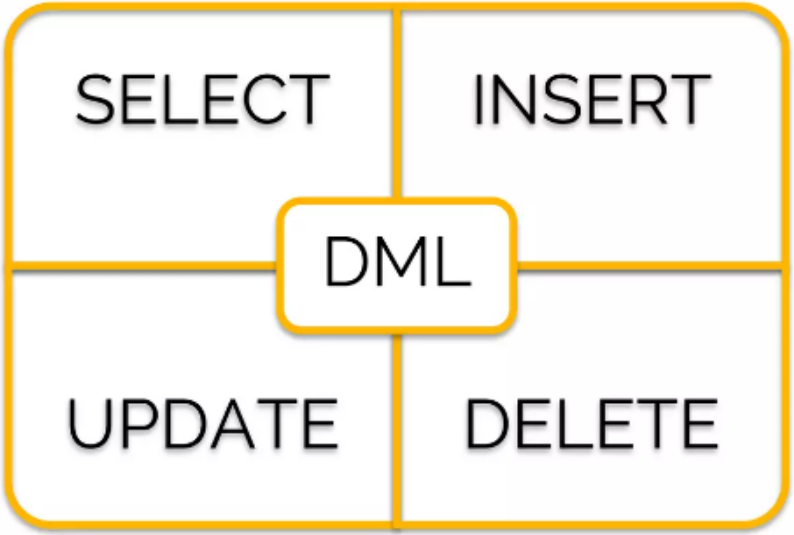
Example using CQL

- The Following Slides will demonstrate different cases with different CQL interfaces like DDL, DML etc..



Interface DML

The DML Interface is the Same With Normal SQL DML



Interface DDL

Same as SQL, but with keyspaces and types option added.

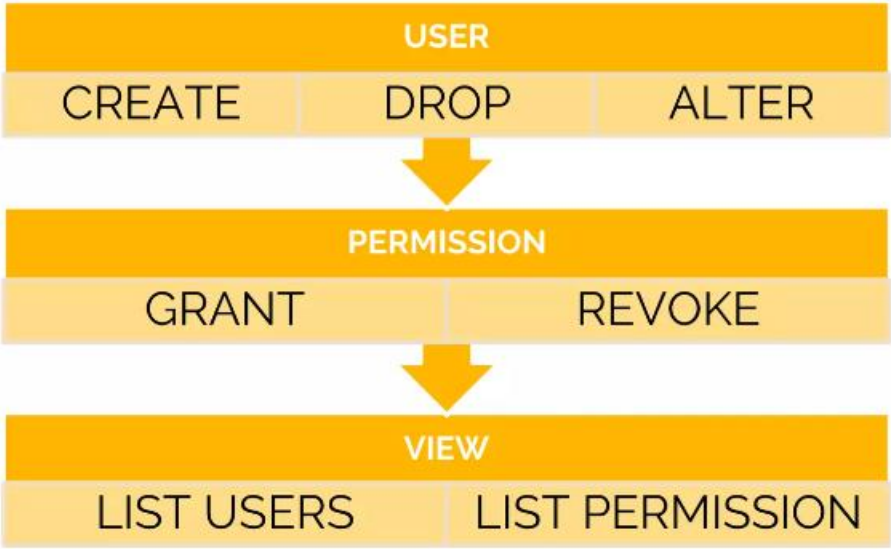
DROP
- Type
- Keyspace , Table
- Index , Trigger

CREATE
- Type
- Keyspace , Table
- Index , Trigger

ALTER
- Type
- Keyspace , Table
- Index , Trigger

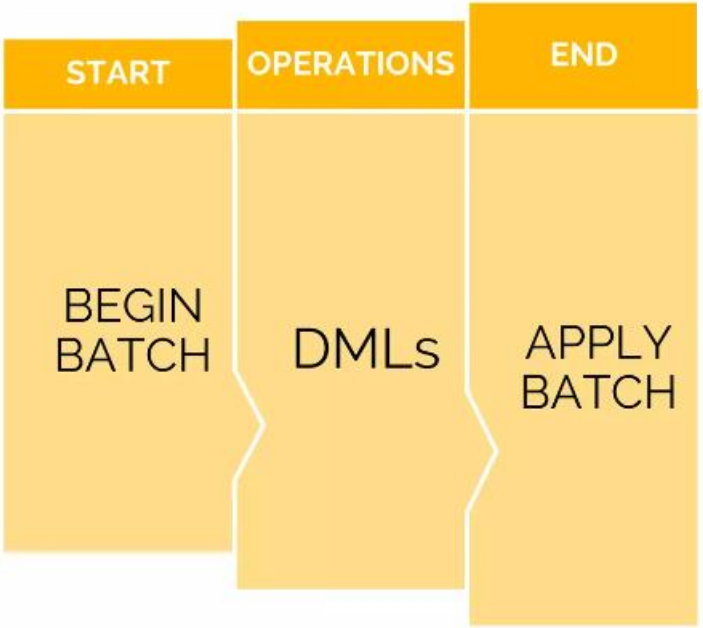
Interface DCL

Create users (Roles), give them permission, and start using them.



Interface TCL

For multiple operations use the BATCH command



Metadata using describe

keyspace	Describe keyspace name
Table	Describe table keyspace_name .table_name
Others	Describe keyspaces, tables, schema

Metadata Keys space

Query the defined key spaces using the SELECT statement.

```
SELECT * FROM
system_schema.keyspaces
```

keyspace_name	durable_writes	replication
test	True	{'class': 'org.apache'}....
.....	.....	.....

Metadata Table

Getting information about tables in the test keyspace.

```
SELECT * FROM system_schema.tables
WHERE keyspace_name = test';
```

keyspace_name	table_name	.....
test	users	.....
.....	.....	.....

Metadata Columns

Getting information about columns in the users tables.

```
SELECT * FROM system_schema.columns
WHERE keyspace_name = test' AND table_name = 'users';
```

table_name	column_name	kind	type	.....
users	age	regular	int	.....
.....	.....	.....	.....	.....

Logging with System.log

To see what is happening in the database, you can use the system.log file in the Cassandra home to directory to track creational query.

{CASSANDRA HOME}/utils/cassandra.logdirISUNDEFINED/

Here is an Example

{CASSANDRA HOME}/utils/cassandra.logdirISUNDEFINED/

Logging with System.log

Here is an Example

```
INFO  [main] 2018-11-08 23:48:36,960
MigrationManager.java:302 - Create new Keyspace:
KeyspaceMetadata {name=system_traces,
params=KeyspaceParams {durable_writes=true,
replication=ReplicationParams
{class=org.apache.cassandra.locator.SimpleStrategy,
replication_factor=2 }
```

Logging with Tracing

It's an option to activate in the Cassandra database

```
TRACING [ ON | OFF]
```

The result will be on different keyspace called system_traces. In a table called events

```
USE system_traces;
SELECT * FROM events;
```

Logging with Tracing

Example:

```
INSERT INTO product(id , name) VALUES (UUID(), 'Hello');
```

Result:

```
Execute CQL3 query
Parsing insert into product(id , name) values(UUID(), 'Hello');
Preparing statement
......
```

Strengths

- ***Linear scale performance*** The ability to add nodes without failures leads to predictable Increases in performance
- ***Supports multiple languages*** Python, C#/.NET, C++, Ruby, Java, Go, and many more..
- ***Operational and developmental simplicity*** There are no complex software tiers to be managed, so administration duties are greatly simplified.

Strengths (2)

- ***Ability to deploy across data centers*** Cassandra can be deployed across multiple, geographically dispersed data centers
- ***Cloud availability*** Installations in cloud environments
- ***Peer to peer architecture*** Cassandra follows a peer-to-peer architecture, instead ofmaster-slave architecture

Strengths (3)

- ***Flexible data model*** Supports modern data types with fast writes and reads
- ***Fault tolerance*** Nodes that fail can easily be restored or replaced
- ***High Performance*** Cassandra has demonstrated brilliant performance under large sets of data

Strengths (4)

- ***Schema-free/Schema-less*** In Cassandra, columns can be created at your will within the rows. Cassandra data model is also famously known as a schema-optional data model
- ***AP-CAP*** Cassandra is typically classified as an AP system, meaning that availability and partition tolerance are generally considered to be more important than consistency in Cassandra

Weaknesses (1)

Use Cases where is better to avoid using Cassandra:

- If there are too many joins required to retrieve the data
- To store configuration data
- During compaction, things slow down and throughput degrades
- Basic things like aggregation operators are not supported
- Range queries on partition key are not supported

Weaknesses (2)

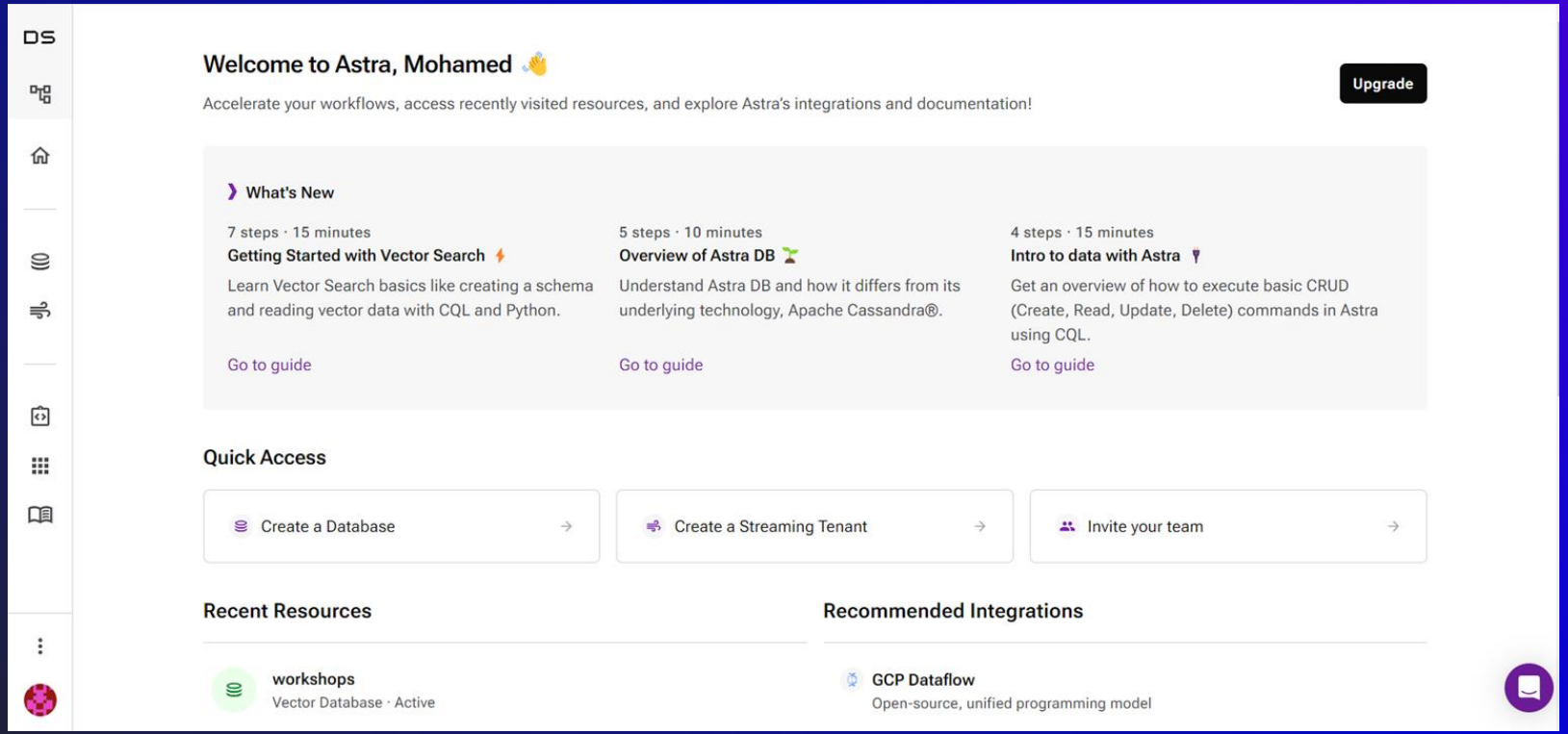
Use Cases where is better to avoid using Cassandra

- If there are transactional data which require 100% consistency
- Cassandra can update and delete data but it is not designed to do so

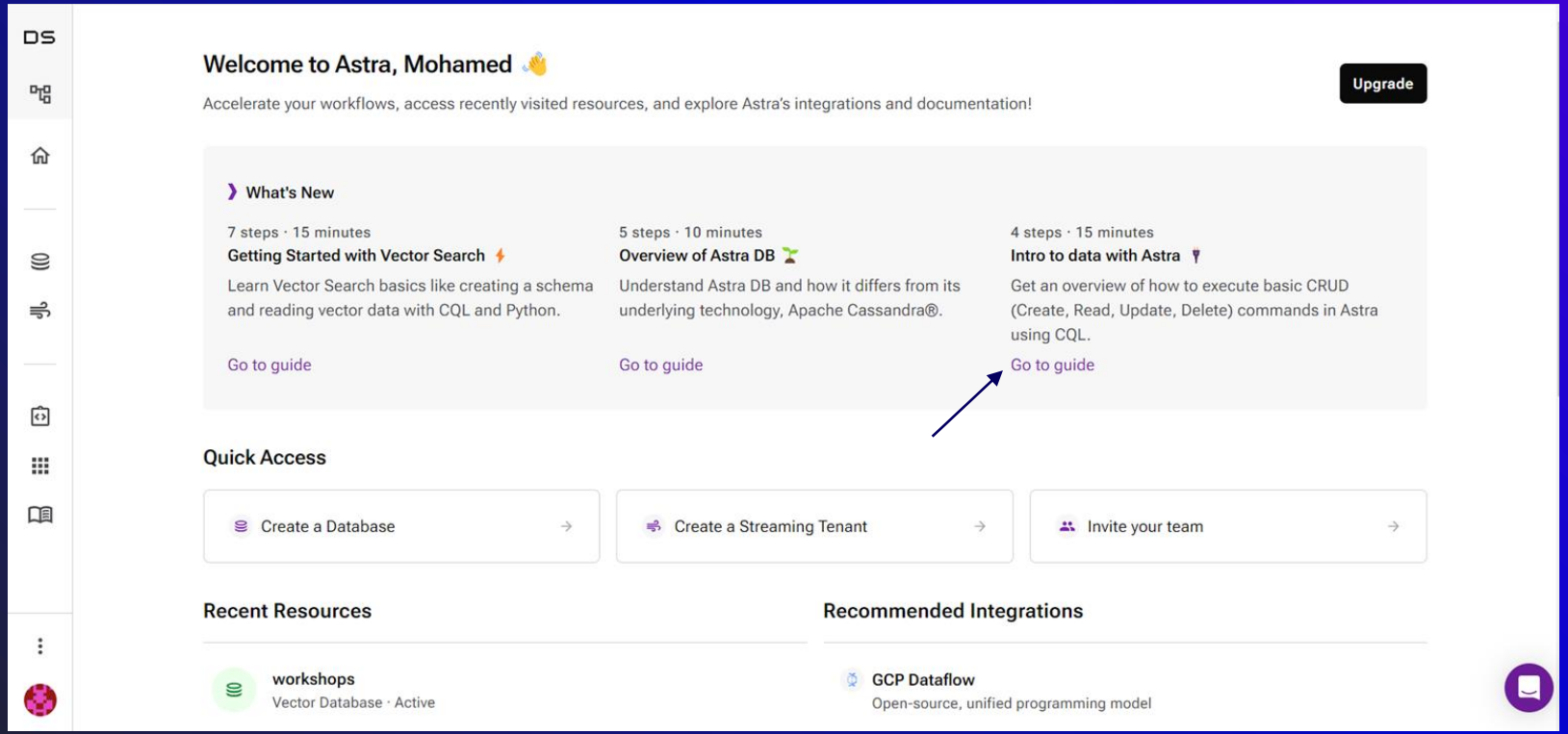
Use DataStax to try Cassandra

DATASTAX

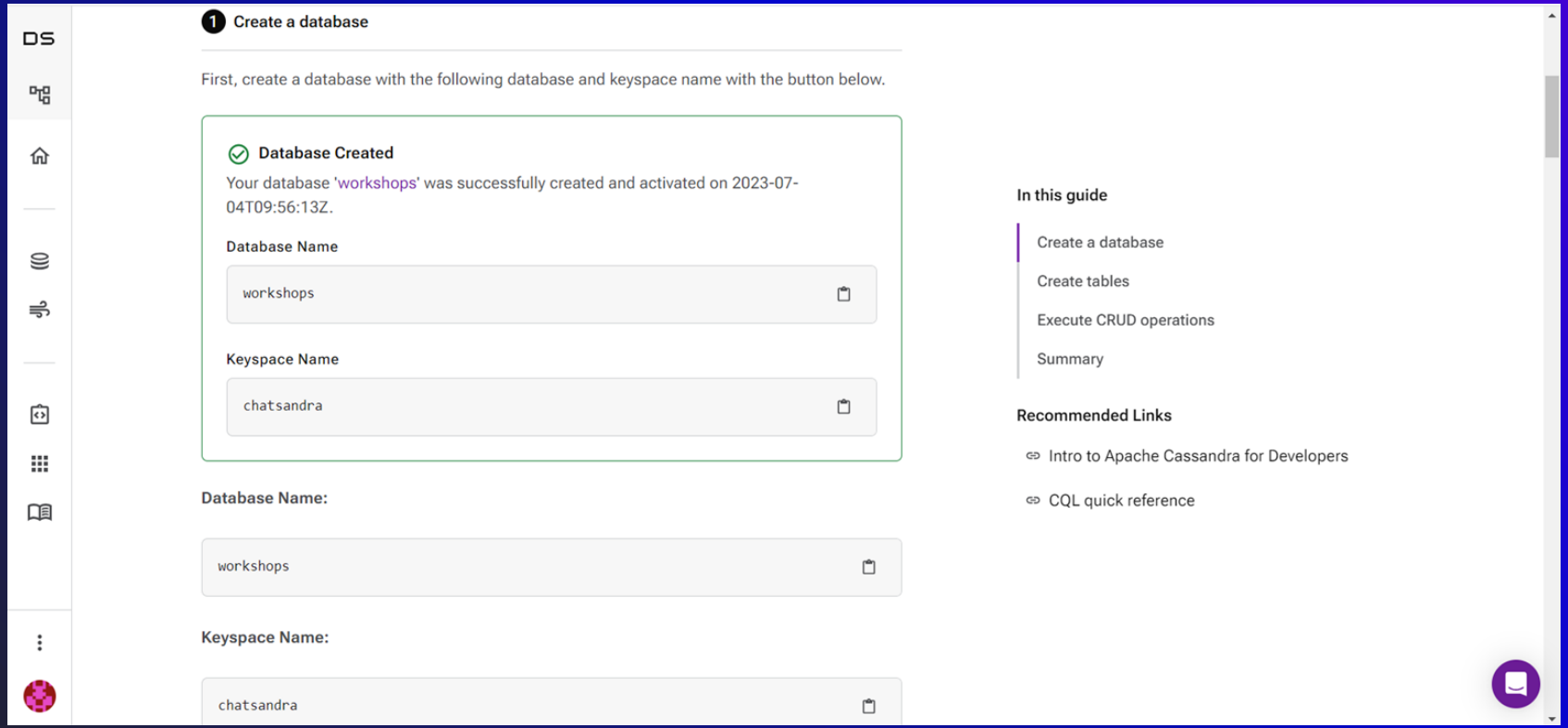
Let’s find out how to use datastax



Go to guide to learn how to use it



Creating database on datastax cloud



To write create a table you have to use CQL console

DS

2 Create tables

The next step is to create tables.

2a Launch the CQL Console and login to the database

Open the CQL Console using the button below.

You may want to put the console and this guide side by side for easy copying.

Launch CQL Console

2b Describe keyspaces and set keypsace context to chatsandra

Now you're ready to rock. Creating tables is easy, but before we create one, we need to tell the database which keyspace to use.

First, ***DESCRIBE*** all the keyspaces in the database. This gives you a list of the available keyspaces.

Command to execute

```
DESC KEYSPACES;
```

In this guide

Recommended Links

- Intro to Apache Cassandra for Developers
- CQL quick reference

You will write every command here

```
Connected as melhaddad308@gmail.com.
Connected to cndb at cassandra.ingress:9042.
[cqlsh 6.8.0 | Cassandra 4.0.0.6816 | CQL spec 3.4.5 | Native protocol v4 | TLS]
Use HELP for help.
token@cqlsh> CREATE TABLE IF NOT EXISTS users (
   ...   email       TEXT,
   ...   name        TEXT,
   ...   password    TEXT,
   ...   user_id     UUID,
   ...   PRIMARY KEY (( email ))
   ... );
```

Region: us-east1

You will write every command here

```
token@cqlsh> USE chatsandra;
token@cqlsh:chatsandra> CREATE TABLE IF NOT EXISTS users (
                   ...   email       TEXT,
                   ...   name        TEXT,
                   ...   password    TEXT,
                   ...   user_id     UUID,
                   ...   PRIMARY KEY (( email ))
                   ... );
token@cqlsh:chatsandra> DESC TABLES;

users

token@cqlsh:chatsandra>
```

Region: us-east1

Then we can make crud operation

3 Execute CRUD operations

CRUD stands for "**create, read, update, and delete**". They are the basic types of commands you need to work with ANY database to maintain data for your applications.

3a (C)RUD = create = insert data

We created the ***users*** table in the step above. Add data to this table with the **INSERT** statement. Begin by inserting three rows into the ***users*** table.

Copy and paste the following in your CQL Console: *(We provided a few variations to get a feel for the syntax needed.)*

Commands to execute

```
INSERT INTO users (
  email,    // TEXT
  name,     // TEXT
  password, // TEXT
  user_id   // UUID: id of a user
)
VALUES (
  'otzi@mail.com',
  'Otzi Oney',
  '123456',
  11111111-1111-1111-1111-111111111111
);

INSERT INTO users (email, name, password, user_id) VALUES (
```

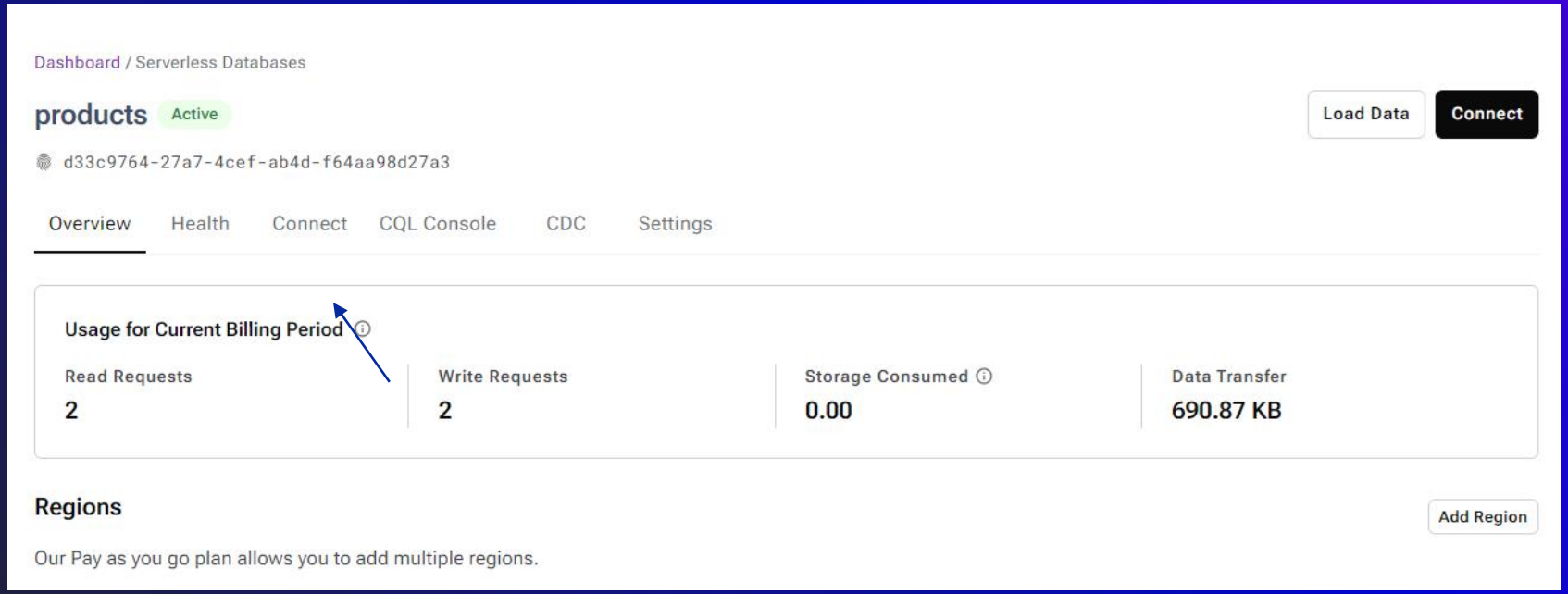
In this guide

Recommended Links

- Intro to Apache Cassandra for Developers
- CQL quick reference

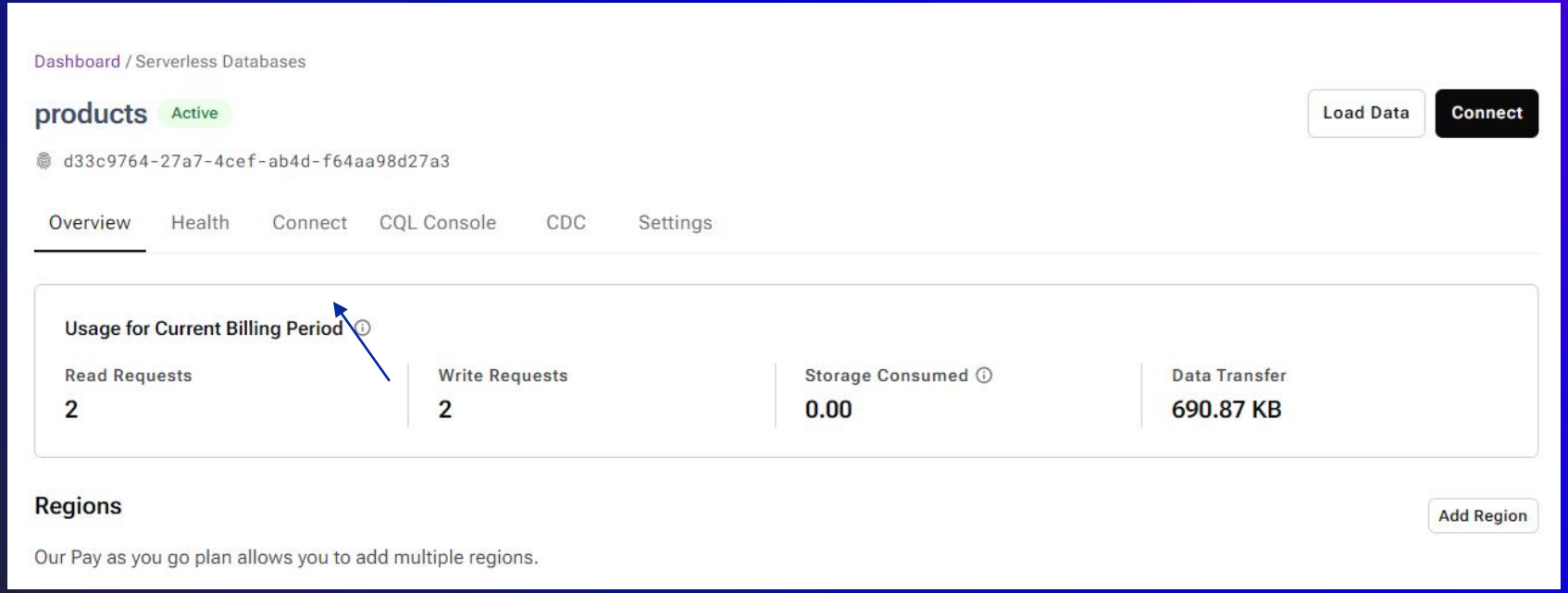
Connect DataStax with Python

Step1: after making a database you will have this dashboard, click on “Connect”



Connect DataStax with Python

Step 2: Download the application token and Secure Connect Bundle.



Now let’s go to our Editor….

Connect DataStax with Python

Step 3: Install Cassandra’s driver.

```
pip install cassandra-driver
```

Connect DataStax with Python

Step 4: Verify that the DataStax Python driver installed successfully:

```
python -c 'import cassandra; print (cassandra.__version__)'
```

Connect DataStax with Python

Step 5: make configurations, replace file name with your file

```python
from cassandra.cluster import Cluster
from cassandra.auth import PlainTextAuthProvider
import json

# This secure connect bundle is autogenerated when you donwload your SCB,
# if yours is different update the file name below
cloud_config= {
  'secure_connect_bundle': 'secure-connect-products.zip'
}
```

Connect DataStax with Python

Step 5: make configurations and connect to the database.

```
# This token json file is autogenerated when you donwload your token,
# if yours is different update the file name below
with open("                    .json") as f:
    secrets = json.load(f)

CLIENT_ID = secrets["clientId"]
CLIENT_SECRET = secrets["secret"]

auth_provider = PlainTextAuthProvider(CLIENT_ID, CLIENT_SECRET)
cluster = Cluster(cloud=cloud_config, auth_provider=auth_provider)
session = cluster.connect()
```

Token file name

Connect DataStax with Python

Step 6: Check the connection.

```
row = session.execute("select release_version from system.local").one()
if row:
  print(row[0])
else:
  print("An error occurred.")
```

Connect DataStax with Python

Step 7: Close connection.

```
session.shutdown()
cluster.shutdown()
```

“ Let’s practice on real use Case

Use case : Analyzing Product Data

Create database.

```
# Create Product Table
create_table_query = '''
    CREATE TABLE IF NOT EXISTS supermarket_products.products (
        product_id UUID PRIMARY KEY,
        name TEXT,
        price DECIMAL,
        category TEXT
    )
'''

session.execute(create_table_query)
```

Use case : Analyzing Product Data

Insert data.

```python
import uuid

data_to_insert = [
    (uuid.UUID("1e34567a-6dcd-11ec-8d3d-0242ac130003"), "Product A", 25.99, "Electronics"),
    (uuid.UUID("2f45678b-6dcd-11ec-8d3d-0242ac130003"), "Product B", 39.99, "Clothing")
]

for values in data_to_insert:
    session.execute(
        """
        INSERT INTO supermarket_products.products (product_id, name, price, category)
        VALUES (%s, %s, %s, %s)
        """,
        values
    )
```

Use case : Analyzing Product Data

Do your analysis.

```python
import pandas as pd

query = 'SELECT * FROM supermarket_products.products'
result = session.execute(query)

data_list = []
for row in result:
    data_list.append(row)

# Create a pandas DataFrame from the retrieved data
df = pd.DataFrame(data_list, columns=['product_id', 'category' ,'name', 'price' ])

# Perform analysis on the DataFrame
average_price_by_category = df.groupby('category')['price'].mean()
```

Thank You!