NoSQL and MongoDB

Agenda

- Opsamling: Node.js og ORM
- NoSQL og MongoDB
- Collections og Documents
- Implementering af MongoDB CRUD-operationer og andre queries
- Relationer og datamodellering i MongoDB
- Evt. indeksering, søgning og optimering af queries

Types

There are various types of databases, including relational databases (such as MySQL, PostgreSQL, and Oracle), NoSQL databases (like MongoDB and Cassandra), and other specialized databases tailored to specific use cases.


MySQL™


mongoDB

Most Popular Databases

https://survey.stackoverflow.co/2023/#section-most-popular-technologies-databases

Most Popular Databases

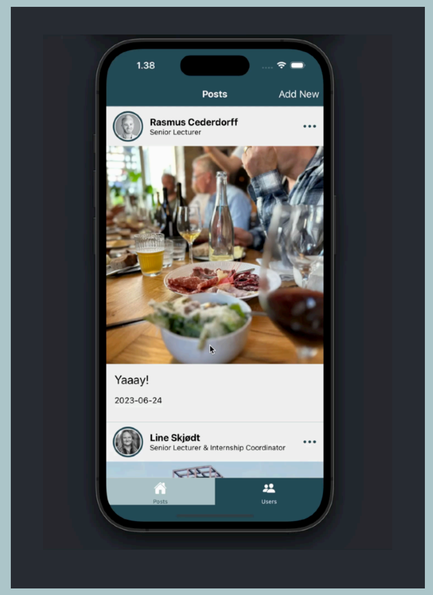
https://survey.stackoverflow.co/2023/#section-most-popular-technologies-databases

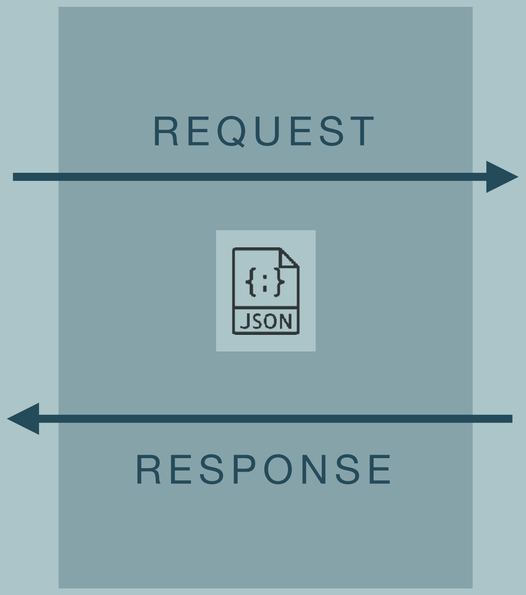
Web Dev Architecture

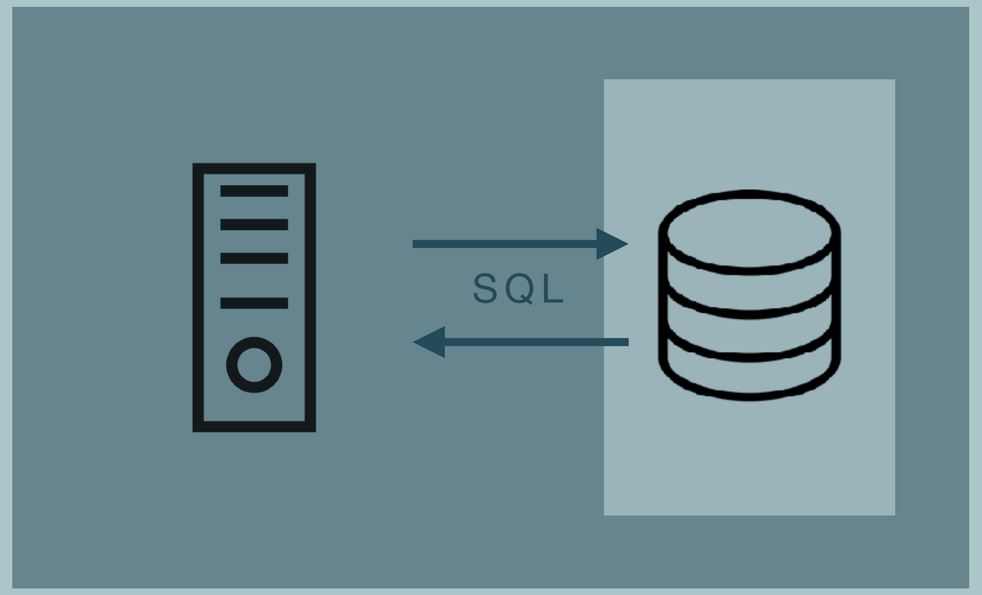
FRONTEND

REST API

BACKEND







CLIENT

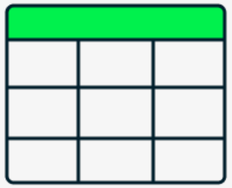
SERVER

https://www.youtube.com/watch?v=-bt_y4Loofg

Non-Relational Databases

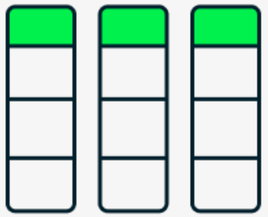
Where it Began: Relational

Key features of relational databases



Related data is stored in rows and columns in one table.

SQL (Structured Query Language)



A table uses columns to define the information being stored and rows for the actual data.

Filling in the Gap

1970s

Relational Databases

SQL was developed by IBM as a way to interact with the new relational databases

1990s

World Wide Web

Need for data storage explodes

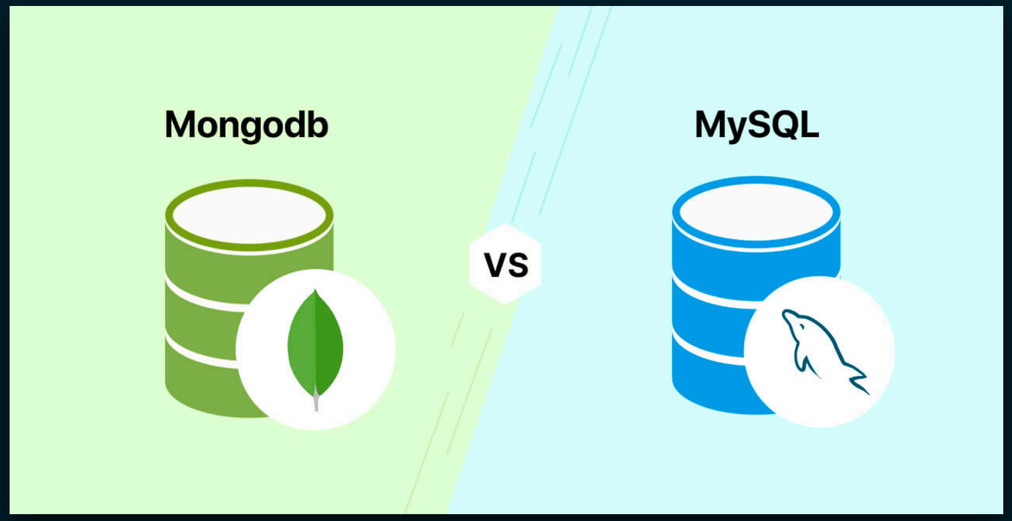
2000s

NoSQL

Unstructured data storage to mitigate costs and increase efficiency

Relational Model: Challenges

- Issues with scalability and flexibility
- Not all data is structured
- Object-oriented, tables and columns?



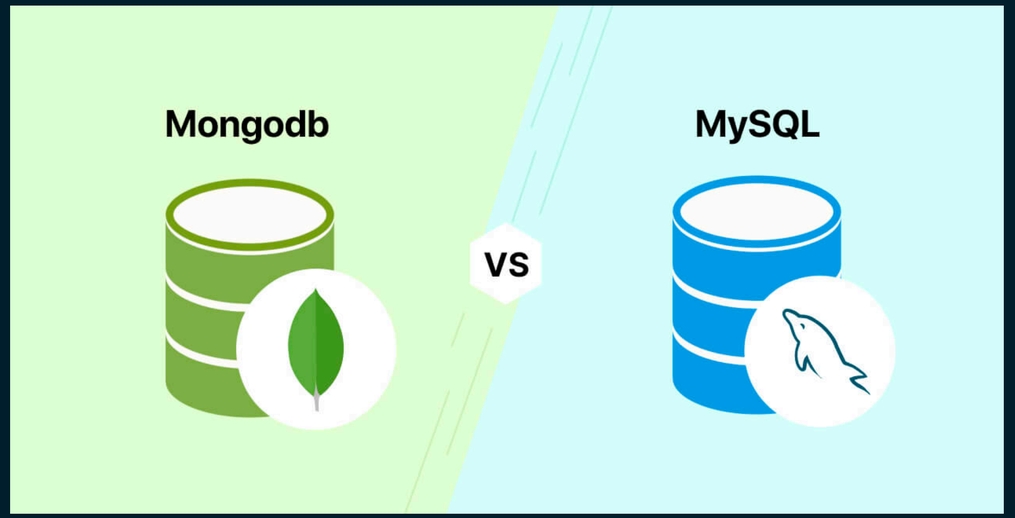
```
const user = {
    id: 6,
    name: "Murat Kilic",
    mail: "mki@eaaa.dk",
    title: "Senior Lecturer",
    image: "https://www.eaaa.dk/media/llyavasj/murat-kilic.jpg"
};
```

id	name	mail	title	image
1	Peter Lind	petl@kea.dk	Senior Lecturer	https://share.cederdorff.com/i
2	Rasmus Cederdorff	race@dev.dk	Senior Lecturer	https://share.cederdorff.com/i
3	Lars Bogetoft	larb@eaaa.dk	Head of Education	https://kea.dk/slir/w200-c1x1/
4	Edith Terte	edan@kea.dk	Lecturer	https://media.licdn.com/dms/im
5	Frederikke Bender	fbe@kea.dk	Head of Education	https://kea.dk/slir/w200-c1x1/
6	Murat Kilic	mki@eaaa.dk	Senior Lecturer	https://www.eaaa.dk/media/llya
7	Anne Kirketerp	anki@eaaa.dk	Head of Education	https://www.eaaa.dk/media/5buh

From object to database table? WTF!1!

But Why?

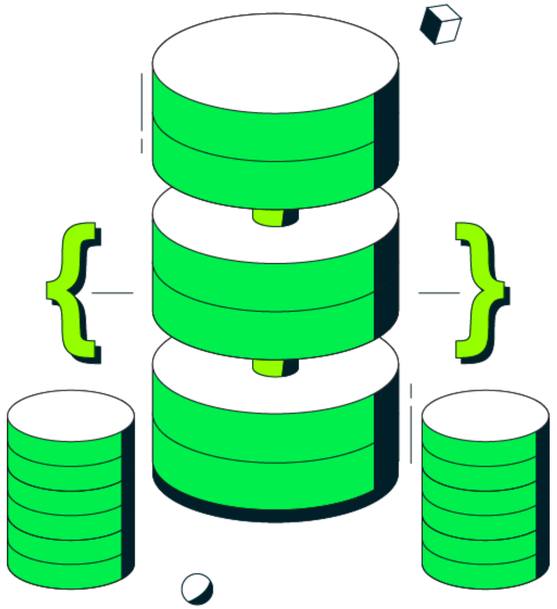
- **Data Flexibility**: MongoDB handles unstructured data well, while MySQL is structured.
- **Schema**: MongoDB is schema-less, allowing for dynamic data, while MySQL requires a predefined schema.
- **Scalability**: MongoDB is horizontally scalable, beneficial for large datasets and high traffic.MySQL may face challenges with horizontal scalability.
- **Use Cases**: MongoDB suits document-oriented and complex data structures. MySQL is often preferred for traditional relational data.
- **Development Speed**: MongoDB's flexibility can accelerate development for evolving applications.
- **Specific Application Needs**: Choose based on project requirements, considering data complexity and scalability.



To fix the problem, various technology and software companies introduced new databases referred to as NoSQL or non-relational.

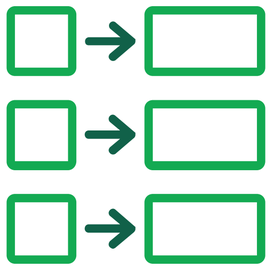
- Polymorphic data structures
- Flexible schemas
- Easy to scale large workloads

What is a non-relational database?



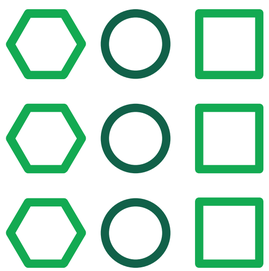
Non-Relational Database Types

Non-Relational Database Types

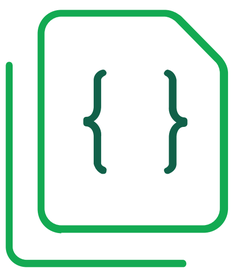


Key/Value

Graph



Column



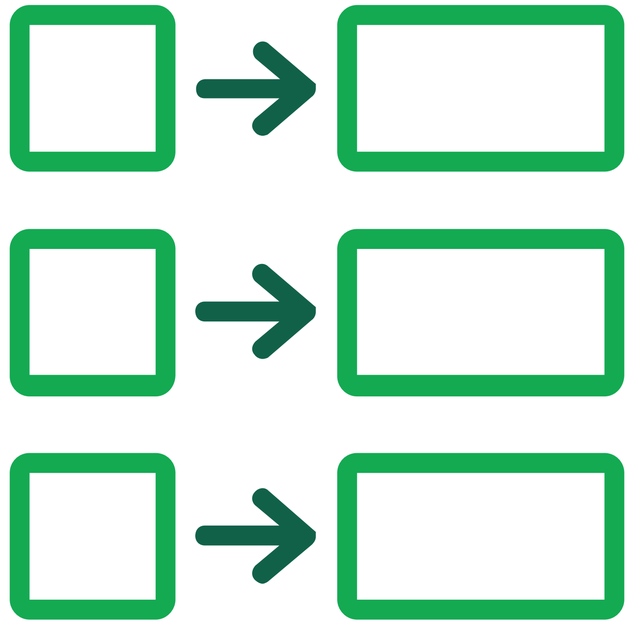
Document

Structure

- A unique key is paired with a collection of values, where the values can be anything from a string to a large binary object

Strength

- Simple data model



Key/Value Database

Key/Value: Example

Key	Value
Name	Sherlock Holmes
Age	40
Address	221B Baker Street

Structure

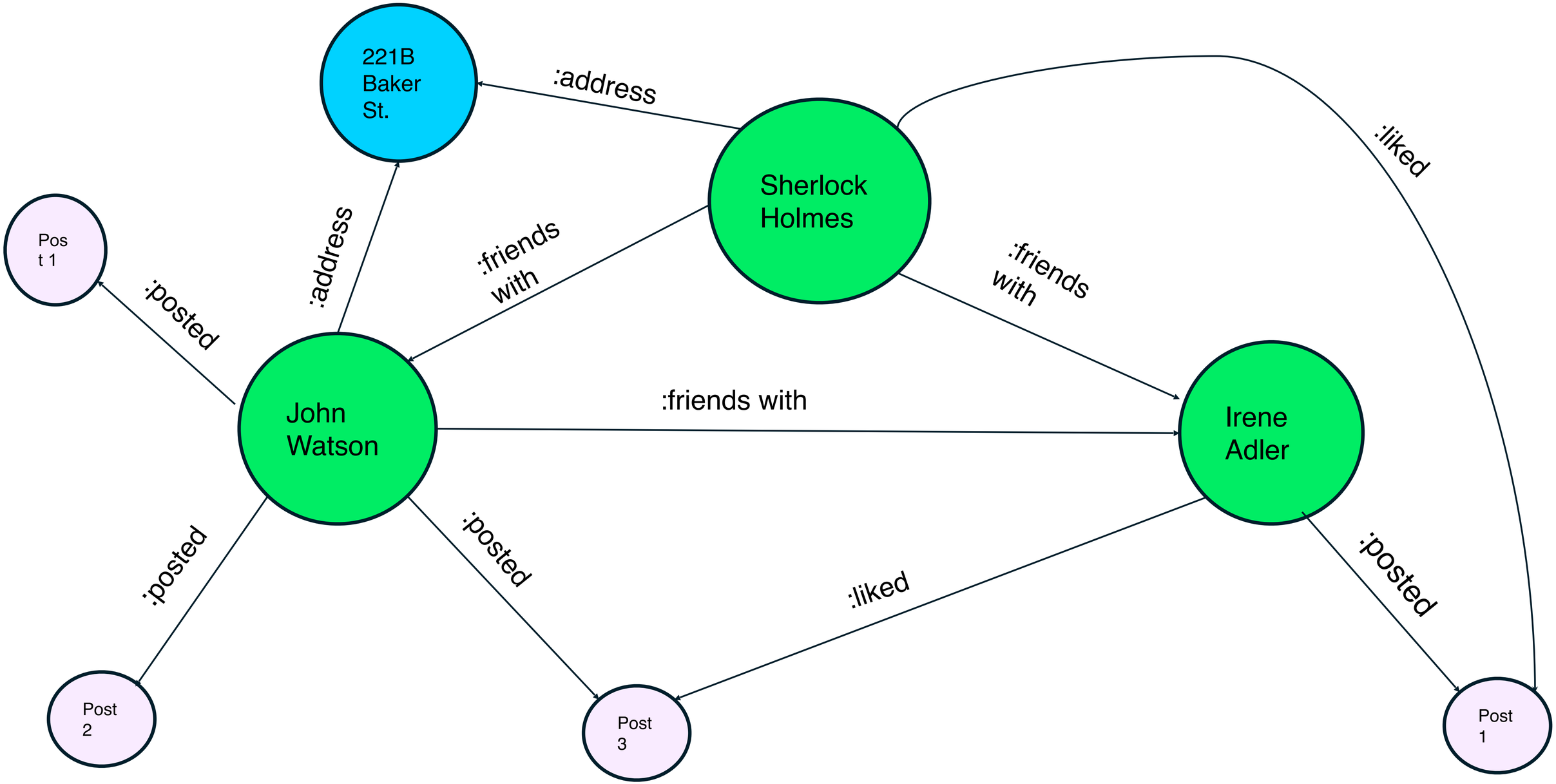
- Captures connected data
- Each element is stored as a node
- Connections between nodes are called links or relationships

Strength

- Traverses the connections between data rapidly

Graph Database

Graph: Example

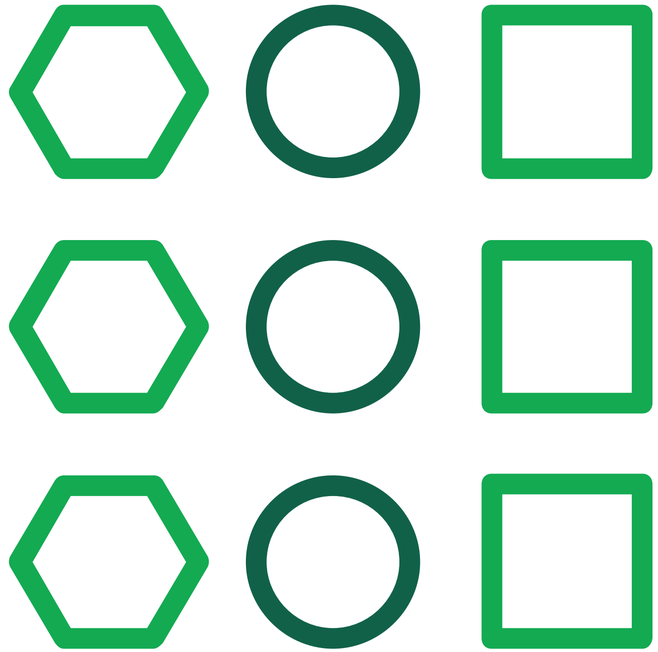


Structure

- Data is stored using key rows that can be associated with one or more dynamic columns

Strengths

- Highly performant queries
- Designed for analytics



Column Oriented or Wide Column

Column Oriented Example

Name	ID
Sherlock	001
John	002
Irene	003

Age	ID
40	001
45	002
43	003

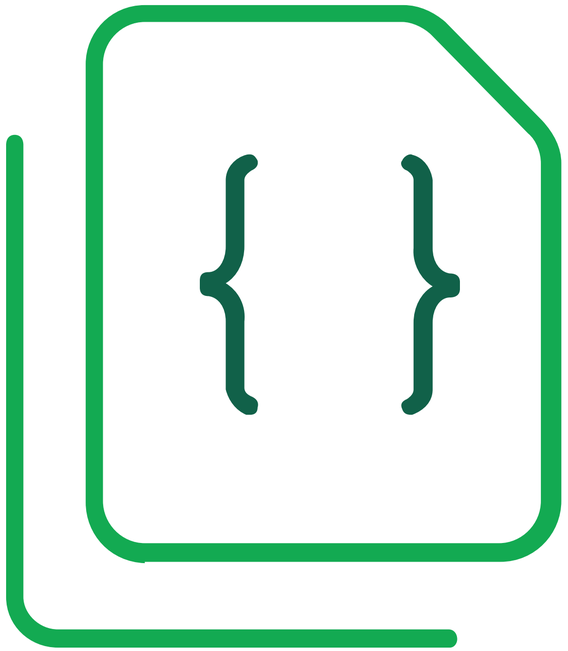
Height	ID
6’2	001
5’9	002
5’7	003

Structure

- Polymorphic data models
- Each document contains markup that identifies fields and values

Strengths

- Obvious relationships using embedded arrays and documents
- No complex mapping



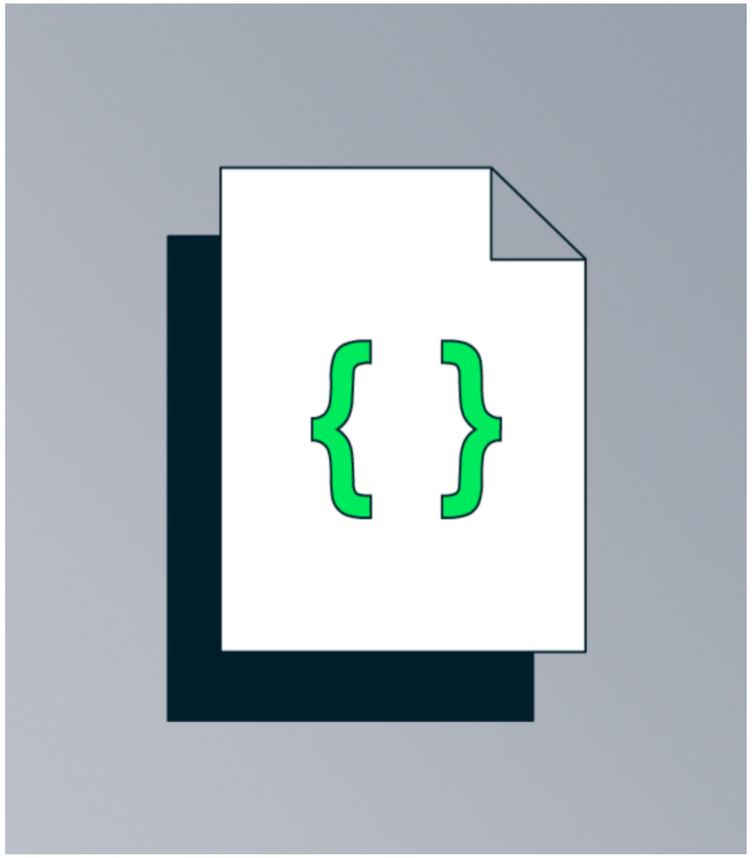
Document Database

Document Model Example

```
{
  "_id":
ObjectId("5ef2d4b45b7f11b6d7a
"),
  "user_id": "Sherlock
Holmes",
  "age": 40,
  "address":
     {
    “Country: “England”
    “City”: “London”,
    “Street”: “221B Baker St.”
  },
  “Hobbies”:[ violin, crime-
solving ]
}
```

```
{
  "_id":
ObjectId("6ef8d4b32c9f12b6d4a")
,
  "user_id": "John Watson",
  "age": 45,
  "address":
     {
    “Country: “England”
    “City”: “London”,
    “Street”: “221B Baker St.”
  },
  “Medical license”: “Active”
}
```

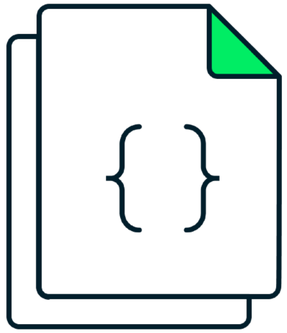
The Document Model



For general purpose use, the document model prevails as the preferred model by developers and database administrators.

Collections and Documents

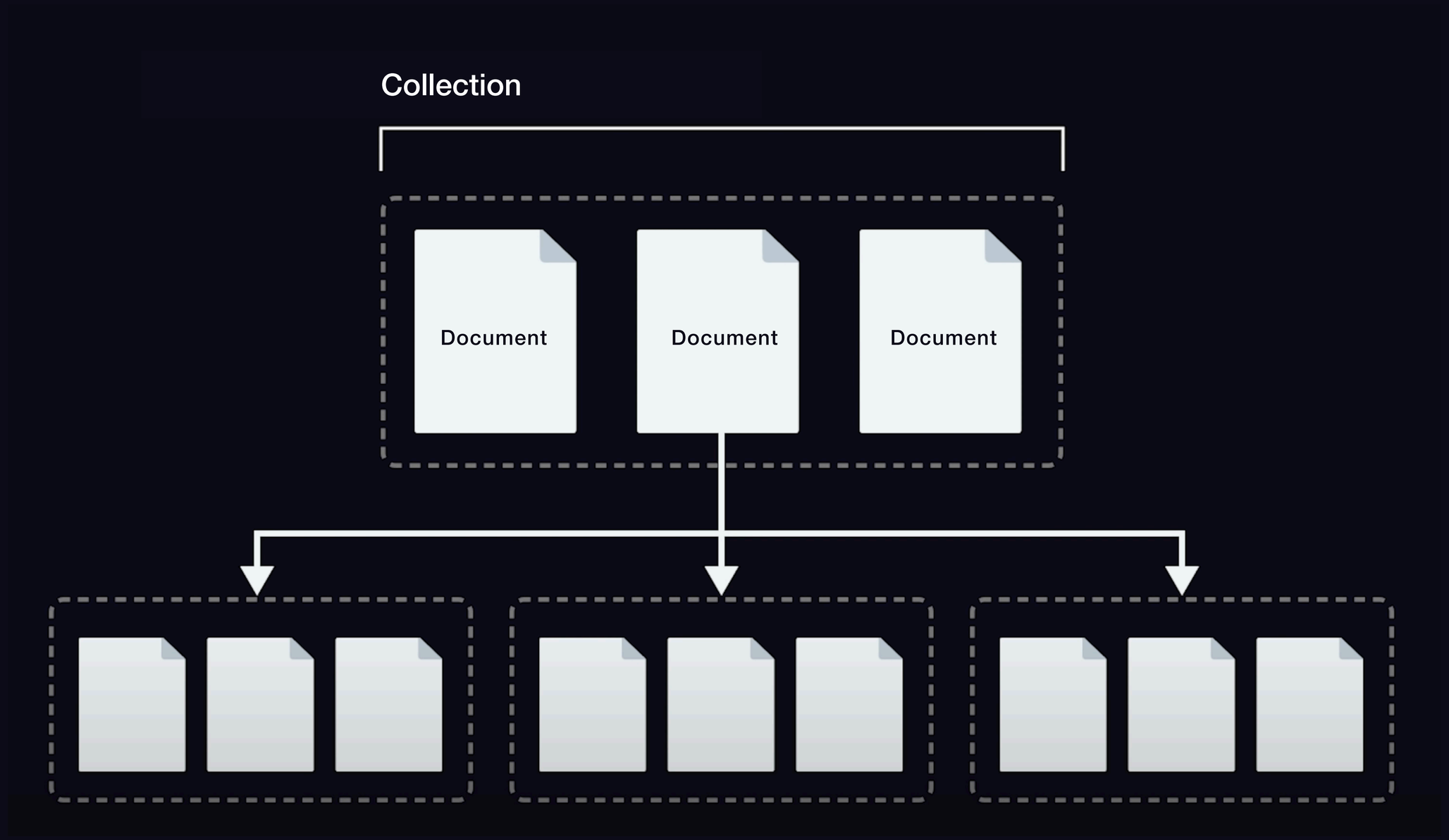
Document



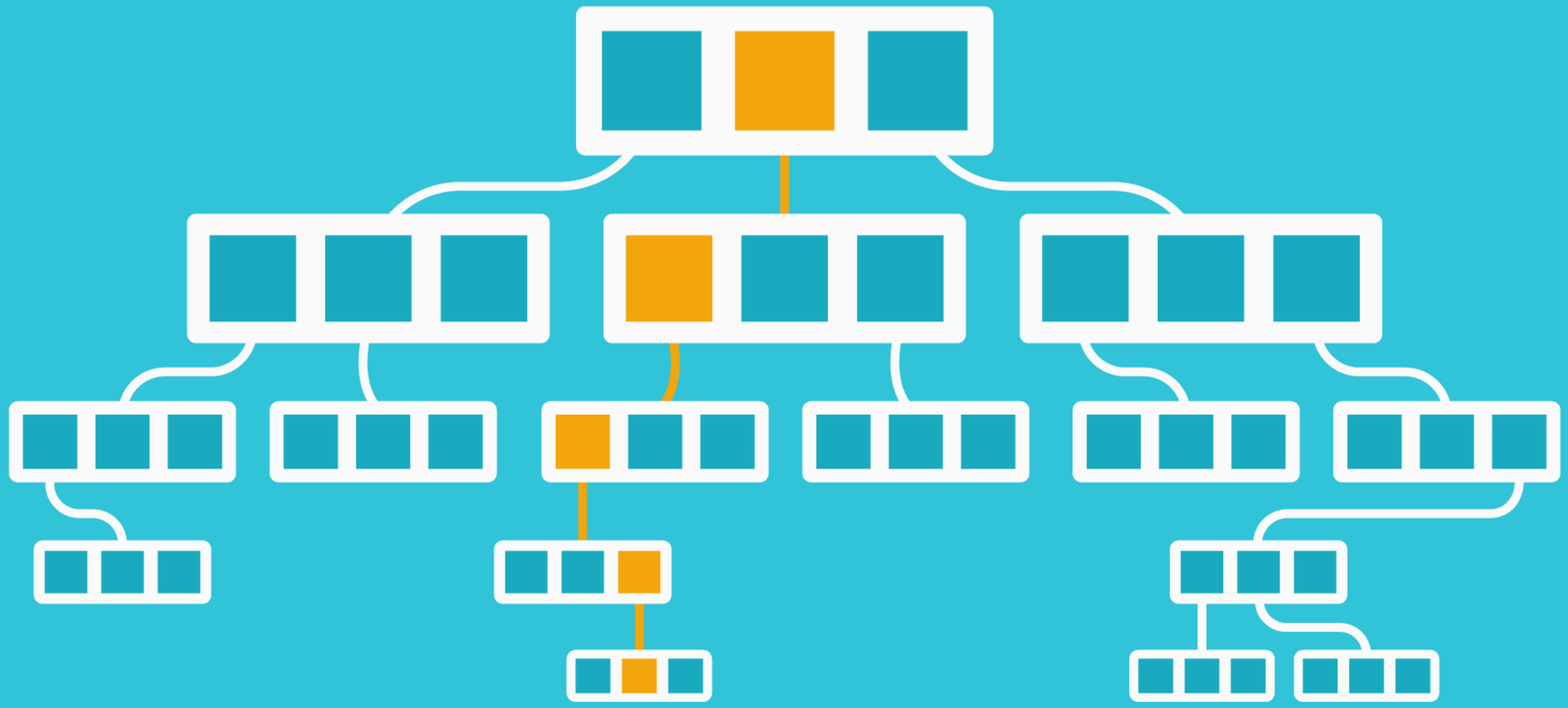
A way to organize and store data as a set of field-value pairs in MongoDB.

Collection

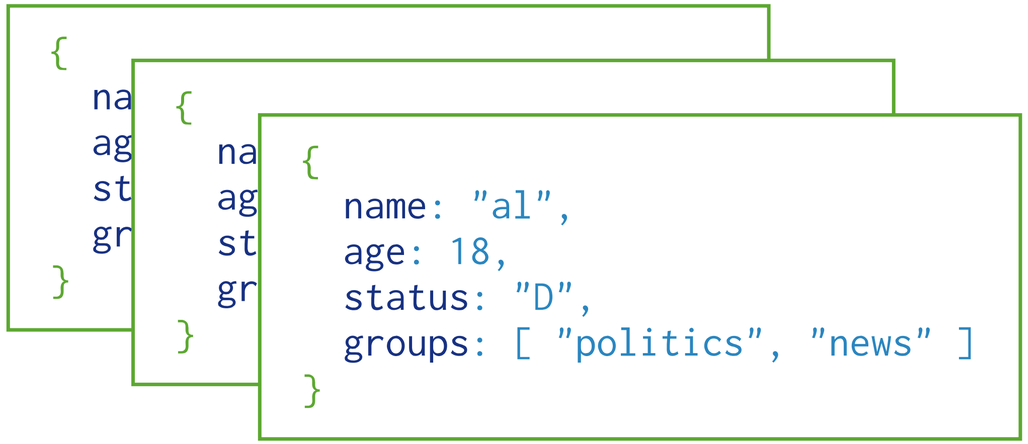
An organized store of documents in MongoDB, usually with common fields between documents


Collection
Document
Document
Document

Collections and Documents



Collections and Documents

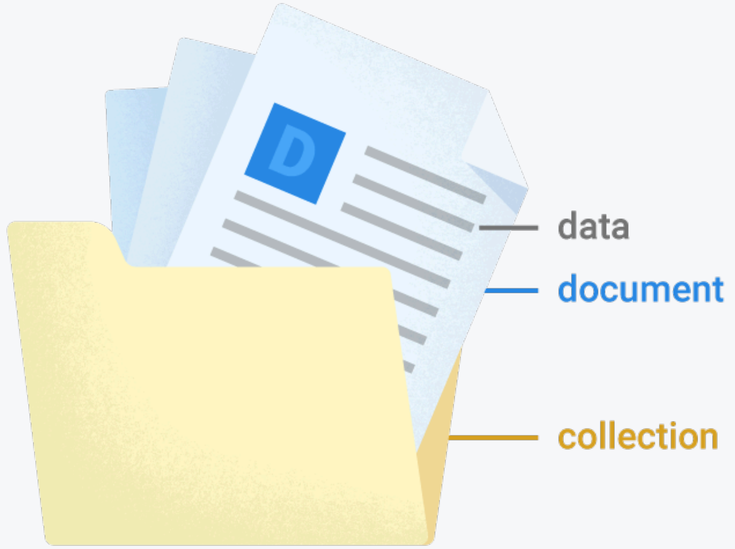


Collection

```
{
  name: "sue",
  age: 26,
  status: "A",
  groups: [ "news", "sports" ]
}
```

field: value
field: value
field: value
field: value

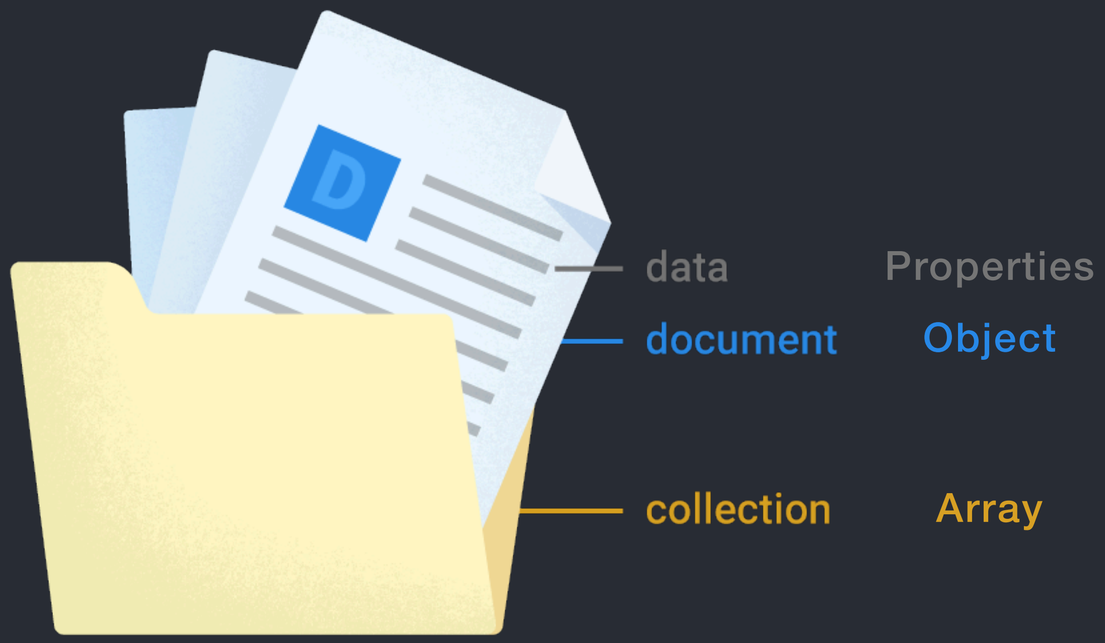
Document



users > seme0qoWIzQh...

mdu-e18front	users	seme0qoWIzQhZDfI1m0L
+ Start collection	+ Add document	+ Start collection
users >	IS35ivFQOBBYrObwZX7k	+ Add field
	cNzvoH8XSRib6XXiUYuX	mail: "bki@eaaa.dk"
	seme0qoWIzQhZDfI1m0L >	name: "Birgitte"

Collection & document vs array & object

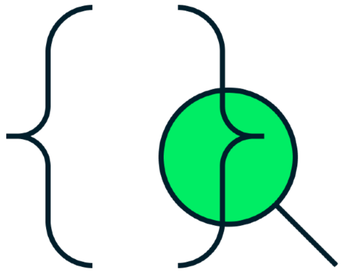



```
const users = [
    {
        id: 1,
        name: "Rasmus Cederdorff",
        title: "Senior Lecturer",
        mail: "race@eaaa.dk",
        image: "https://share.cederdorff.com/images/race.jpg"
    },
    {
        id: 2,
        name: "Anne Kirketerp",
        title: "Head of Department",
        mail: "anki@eaaa.dk",
        image: "https://www.eaaa.dk/media/5buh1xeo/anne-kirke
    },
    {
        id: 3,
        name: "Murat Kilic",
        title: "Senior Lecturer",
        mail: "mki@eaaa.dk",
        image: "https://www.eaaa.dk/media/llyavasj/murat-kili
    }
];
```

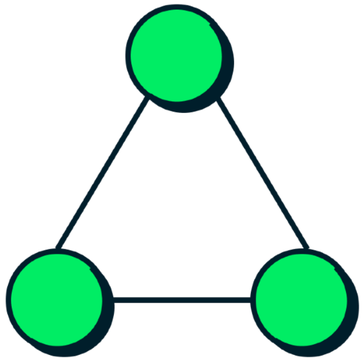
```
{
    "first_name": "Paul",
    "surname": "Miller",
    "cell": "447557505611",
    "city": "London",
    "location": [45.123, 47.232],
    "profession": ["banking", "finance", "trader"],
    "cars": [
        {
            "model": "Bentley",
            "year": 1973
        },
        {
            "model": "Rolls Royce",
            "year": 1965
        }
    ]
}
```

The Document Model and MongoDB

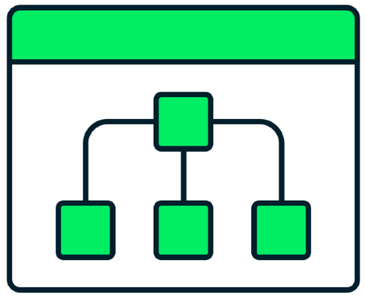
Key Features



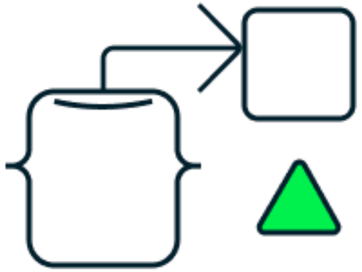
API query or query language



Distributed and resilient



Flexible schema



Object mapping

```
{
  "_id": ObjectId(
   "5f4f7fef2d4b45b7f11b6d7a"),
  "user_id": "Sean",
  "age": 29,
  "Status": "A"
}
```

The Document Model: Structure and Syntax

- To the left is an example of a document representing a user details including `user_id`, `age`, and a `status` category.

```
{
  "_id": ObjectId(
   "5f4f7fef2d4b45b7f11b6d7a"),
  "user_id": "Sean",
  "age": 29,
  "Status": "A"
}
```

The Document Model: Structure and Syntax

- A document in MongoDB uses the JavaScript Object Notation (JSON) format.
- This format uses curly brackets to mark the start and the end of the document.

```
{
  "_id": ObjectId(
   "5f4f7fef2d4b45b7f11b6d7a"),
  "user_id": "Sean",
  "age": 29,
  "Status": "A"
}
```

The Document Model: Structure and Syntax

- MongoDB refers to keys as fields.
- The field-values within a pair in a document are separated by colons (:).

```
{
  "_id": ObjectId(
   "5f4f7fef2d4b45b7f11b6d7a"),
  "user_id": "Sean",
  "age": 29,
  "Status": "A"
}
```

The Document Model: Structure and Syntax

- Each field must be enclosed within quotation marks. String values are often quoted as good practice.

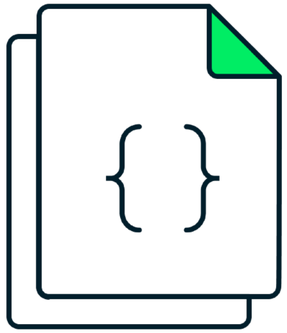
```
{
  "_id": ObjectId(
   "5f4f7fef2d4b45b7f11b6d7a"),
  "user_id": "Sean",
  "age": 29,
  "Status": "A"
}
```

The Document Model: Structure and Syntax

- Each field-value pair is separated within the document by commas.

Collections in the Document Model

Document



A way to organize and store data as a set of field-value pairs in MongoDB.

Collection

An organized store of documents in MongoDB, usually with common fields between documents

Example

Two documents in the same collection
but with different fields...

```
{
  "_id": ObjectId(
 "5f4f7fef2d4b45b7f11b6d7a"),
  "user_id": "Sean",
  "age": 29,
  "Status": "A"
}
```

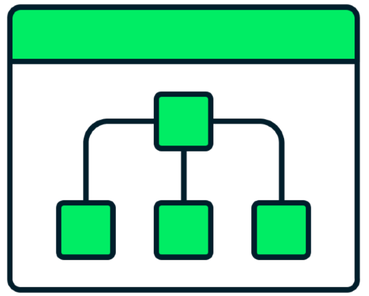
```
{
  "_id": ObjectId(
"5f4f7fef2d4b45b7f11b6d7a"),
  "user_id": "Daniel",
  "age": 25,
  "Status": "A",
  "Country": "USA"
}
```

Collections and Schema Validation

The document model used by MongoDB can enforce a schema if required, the recommended approach is to do so using JSON Schema.

JSON Schema:

- Allows a prescribed document structure to be configured on a per collection basis.
- Can tune schema validation according to use case.
- Can be used by any query to inspect document structure and content.



Schema Validation

This example creates a users collection with validation rules:

- The document must be an object.
- It must have the required fields: `image`, `mail`, `name`, and `title`.
- The `_id` must be a unique `objectId`.
- The `image` must be a string.
- The `mail` must be a string and follow the pattern of a valid email address.
- The `name` and `title` must be strings.

You can customize the validation rules based on your specific requirements. Adjust the properties, types, and patterns as needed.

https://www.mongodb.com/docs/manual/core/schema-validation/

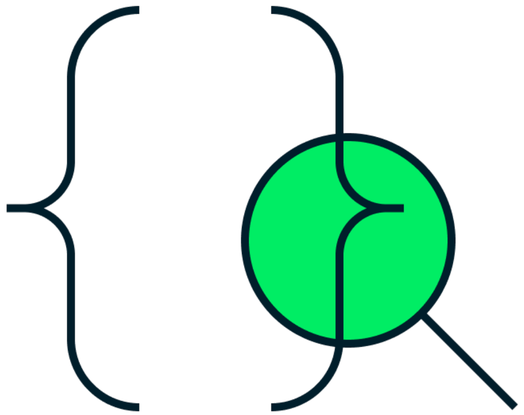
```
db.createCollection("users", {
   validator: {
      $jsonSchema: {
         bsonType: "object",
         required: ["image", "mail", "name", "title"],
         properties: {
            _id: {
               bsonType: "objectId",
               description: "must be a unique ObjectId"
            },
            image: {
               bsonType: "string",
               description: "must be a string and is required"
            },
            mail: {
               bsonType: "string",
               pattern: "^[a-zA-Z0-9._%+-]+@[a-zA-Z0-9.-]+\\.[a-zA-Z]{2,}$",
               description: "must be a valid email address and is required"
            },
            name: {
               bsonType: "string",
               description: "must be a string and is required"
            },
            title: {
               bsonType: "string",
               description: "must be a string and is required"
            }
            // Add more properties as needed
         }
      }
   }
});
```

MongoDB Query Language

Simple syntax

Designed to query documents

Only queries a single collection



MongoDB Query Language

MongoDB Query Language

MQL is designed for single collection queries and it is typically used for creating, reading, updating, or deletion (CRUD) operations.

MQL query operators:

- Comparison
- Logical
- Element
- Array
- Evaluation
- Bitwise
- Comment
- Geospatial
- Projection, Update and Update Modifiers

MQL Find()

MQL Find()

db.<collection>.find()

Query filter document

db.collection.find({ <field1>: <value1>, ... })

Specifying query operators

db.<collection>.find({ <field1>: { <operator1>: <value1> }, ... })

MQL Find()

db.<collection>.find()

Query filter document

db.collection.find({ <field1>: <value1>, ... })

Specifying query operators

db.<collection>.find({ <field1>: { <operator1>: <value1> }, ... })

MQL Find()

db.<collection>.find()

Query filter document

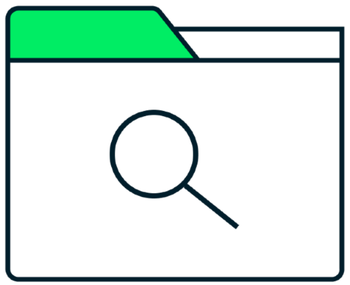
db.collection.find({ <field1>: <value1>, ... })

Specifying query operators

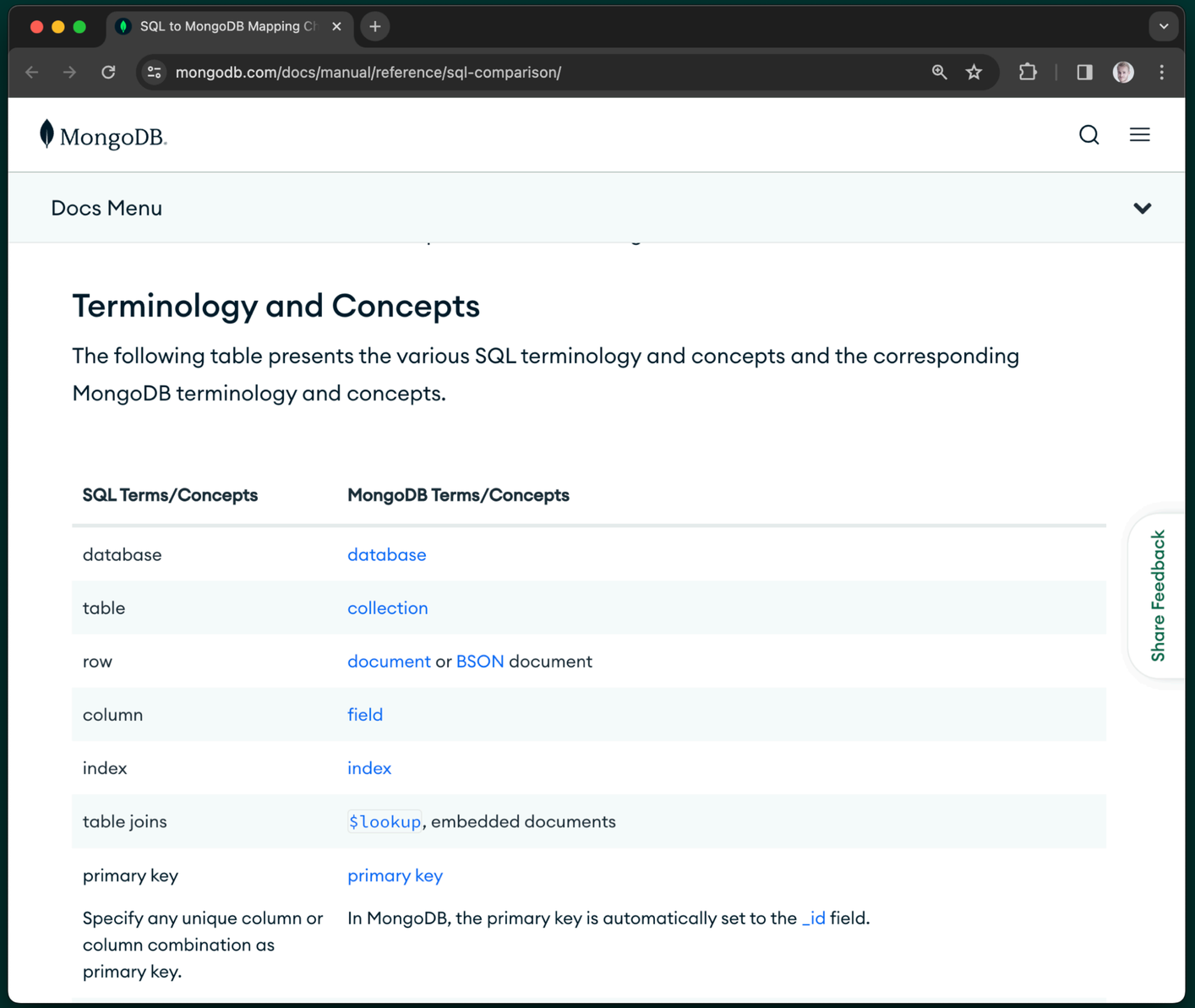
db.<collection>.find({ <field1>: { <operator1>: <value1> }, ... })

MQL Find(): Important Note

The collection is implicit in MQL based on the query’s criteria.



SQL vs MongoDB



https://www.mongodb.com/docs/manual/reference/sql-comparison/

SQL Schema Statements

```
CREATE TABLE people (
    id MEDIUMINT NOT NULL
        AUTO_INCREMENT,
    user_id Varchar(30),
    age Number,
    status char(1),
    PRIMARY KEY (id)
)
```

MongoDB Schema Statements

Implicitly created on first `insertOne()` or `insertMany()` operation. The primary key `_id` is automatically added if `_id` field is not specified.

```
db.people.insertOne( {
    user_id: "abc123",
    age: 55,
    status: "A"
} )
```

https://www.mongodb.com/docs/manual/reference/sql-comparison/

SQL INSERT Statements	MongoDB insertOne() Statements

```
INSERT INTO people(user_id,
                   age,
                   status)
VALUES ("bcd001",
        45,
        "A")
```

```
db.people.insertOne(
   { user_id: "bcd001", age: 45, status: "A"
)
```

https://www.mongodb.com/docs/manual/reference/sql-comparison/

SQL SELECT Statements	MongoDB find() Statements
`SELECT *` `FROM people`	`db.people.find()`

`SELECT id,`
`user_id,`
`status`
`FROM people`
	`db.people.find(`
	`{ },`
	`{ user_id: 1, status: 1 }`
	`)`

`SELECT user_id, status`
`FROM people`
	`db.people.find(`
	`{ },`
	`{ user_id: 1, status: 1, _id: 0 }`
	`)`

`SELECT *`
`FROM people`
`WHERE status = "A"`
	`db.people.find(`
	`{ status: "A" }`
	`)`

SQL Update Statements	MongoDB updateMany() Statements

```
UPDATE people
SET status = "C"
WHERE age > 25
```

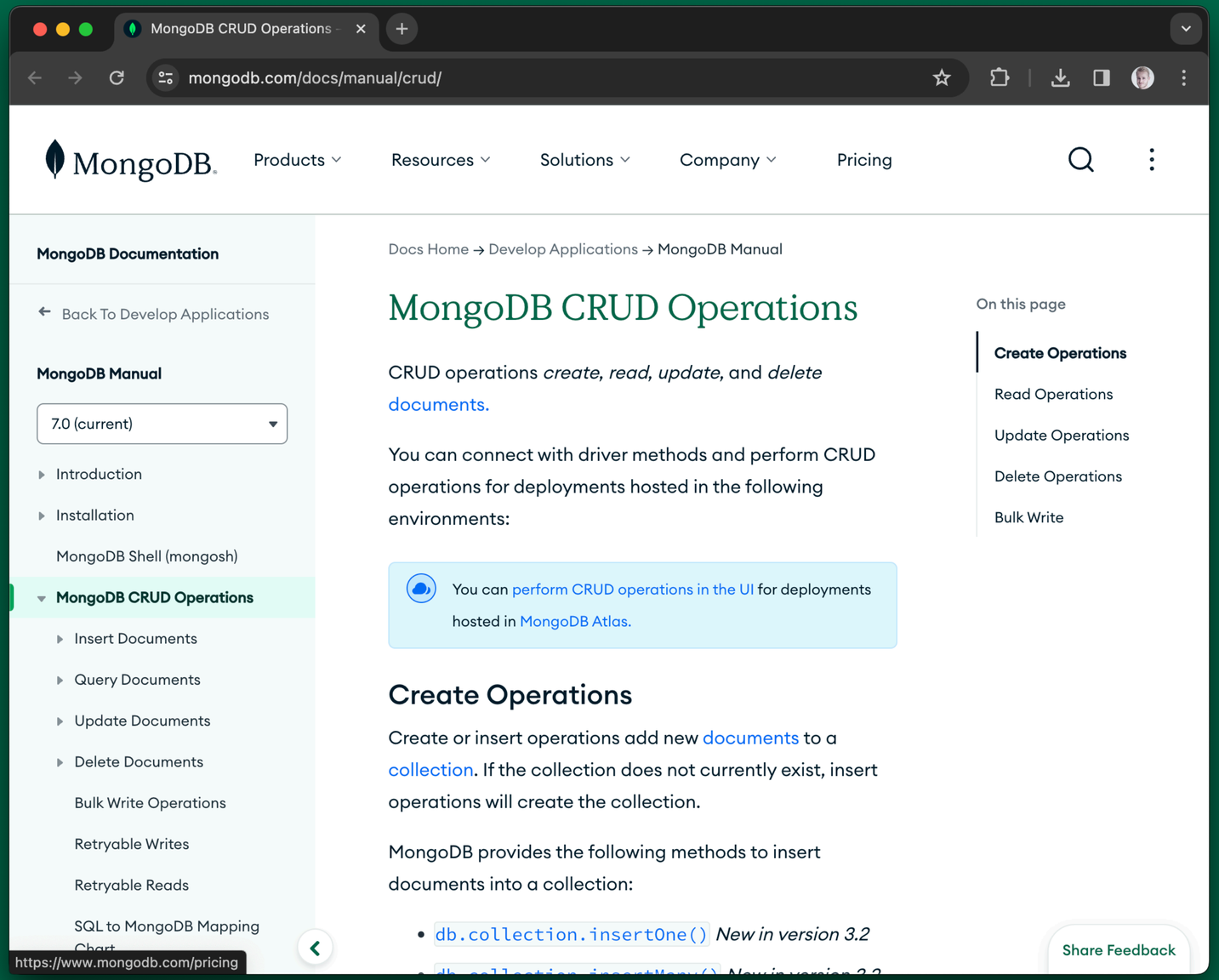
```
db.people.updateMany(
   { age: { $gt: 25 } },
   { $set: { status: "C" } }
)
```

```
UPDATE people
SET age = age + 3
WHERE status = "A"
```

```
db.people.updateMany(
   { status: "A" } ,
   { $inc: { age: 3 } }
)
```

https://www.mongodb.com/docs/manual/reference/sql-comparison/

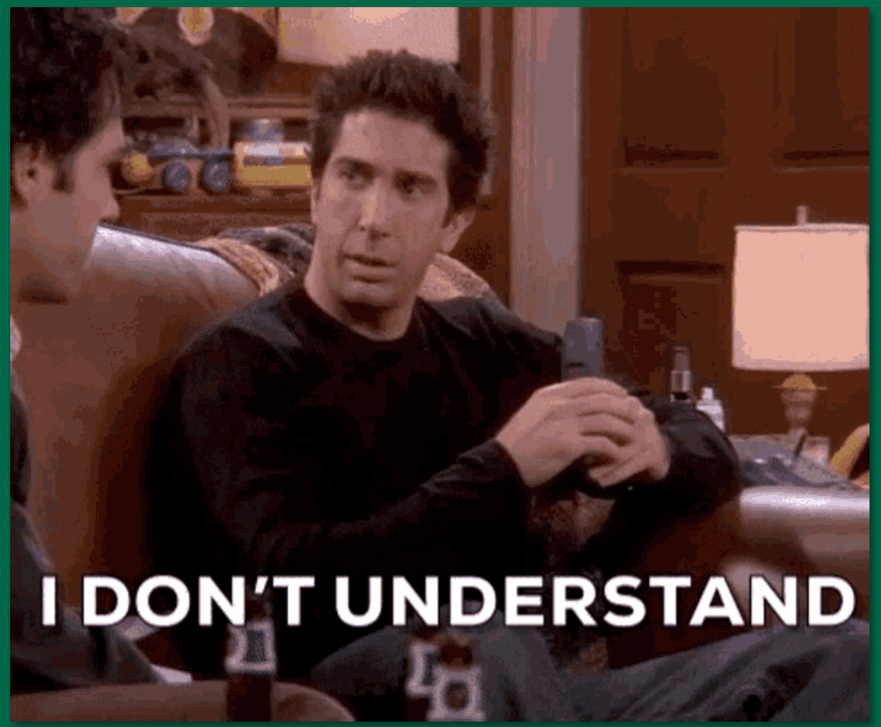
MongoDB CRUD Operations



https://www.mongodb.com/docs/manual/crud/

The Docs and Articles

- MongoDB, Inc. 2023. Introduction to MongoDB: https://www.mongodb.com/docs/manual/introduction/
- MongoDB, Inc. 2023. Databases and Collections: https://www.mongodb.com/docs/manual/core/databases-and-collections/
- MongoDB, Inc. 2023. MongoDB CRUD Operations: https://www.mongodb.com/docs/manual/crud/
- MongoDB, Inc. 2023. Data Modeling Introduction: https://www.mongodb.com/docs/manual/core/data-modeling-introduction/
- MongoDB, Inc. 2023. Indexes: https://www.mongodb.com/docs/manual/indexes/
- Beugnet, M. 2023. MongoDB Cheat Sheet: https://www.mongodb.com/developer/products/mongodb/cheat-sheet/
- Karlsson, j. 2023. MongoDB Schema Design Best Practices: https://www.mongodb.com/developer/products/mongodb/mongodb-schema-design-best-practices/



Create

```
db.users.insertOne(
  {
    name: "sue",
    age: 26,
    status: "pending"
  }
)
```

collection

field: value

field: value

field: value

document

```
db.createCollection("posts")

db.posts.insertOne(
    {
      caption: "Beautiful sunset at the beach",
      createdAt: new Date("2023-04-05T15:27:14Z"),
      image: "https://images.unsplash.com/photo-1566241832378-917a0f30db2c?ixlib=r
      uid: ObjectId("ZfPTVEMQKf9v")
    }
)

db.posts.insertMany(
[
    {
      caption: "Beautiful sunset at the beach",
      createdAt: new Date("2023-04-05T15:27:14Z"),
      image: "https://images.unsplash.com/photo-1566241832378-917a0f30db2c?ixlib=r
      uid: ObjectId("ZfPTVEMQKf9v")
    },
    {
      caption: "Exploring the city streets of Aarhus",
      createdAt: new Date("2023-04-06T10:45:30Z"),
      image: "https://images.unsplash.com/photo-1559070169-a3077159ee16?ixlib=rb-4
      uid: ObjectId("fTs84KRoYw5p")
    },
    {
      caption: "Delicious food at the restaurant",
      createdAt: new Date("2023-04-04T20:57:24Z"),
      image: "https://images.unsplash.com/photo-1548940740-204726a19be3?ixlib=rb-4
      uid: ObjectId("fjpRTRTjZHwr")
    },
    //...
  ]
)
```

Read

```
db.users.find(
    { age: { $gt: 18 } },
    { name: 1, address: 1 }
).limit(5)
```

- collection
- query criteria
- projection
- cursor modifier

```
// find all
db.posts.find()
 // find all - to array
db.posts.find().toArray()

// posts with specific user
db.posts.find({uid: ObjectId("ZfPTVEMQKf9v")})
// all users with title: "Senior Lecturer"
db.users.find({title:"Senior Lecturer"})

// find and then sort
//  1 for ascending or -1 for descending
db.users.find().sort({name:1})
db.posts.find().sort({createdAt:1})

db.posts.find().count() // count docs
```

Update

```
db.users.updateMany(
   { age: { $lt: 18 } },
   { $set: { status: "reject" } }
)
```

collection

update filter

update action

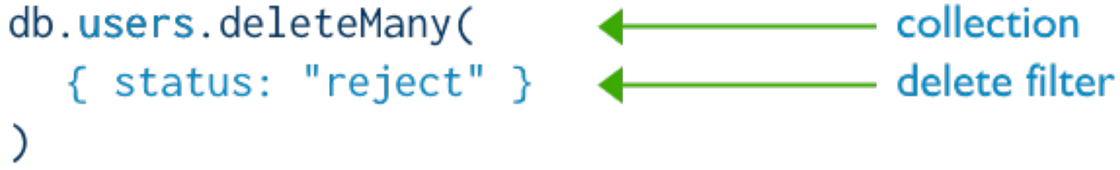
```
db.users.updateOne(
    // Specify the user you want to update
    { _id: ObjectId("ZfPTVEMQKf9v") },
    {
        $set: {
            // Update the name field with the new value
            name: "New Name",
            // Update the title field with the new value
            title: "New Title"
            // Add more fields to update as needed
        }
    }
);

db.users.updateMany(
    // Specify the criteria for the documents you want to update
    { title: "Senior Lecturer" },
    {
        $set: {
            // Update the title field with the new value
            title: "Updated Title",
            // Add more fields to update as needed
        }
    }
);
```

Update

- If you want to completely replace a document

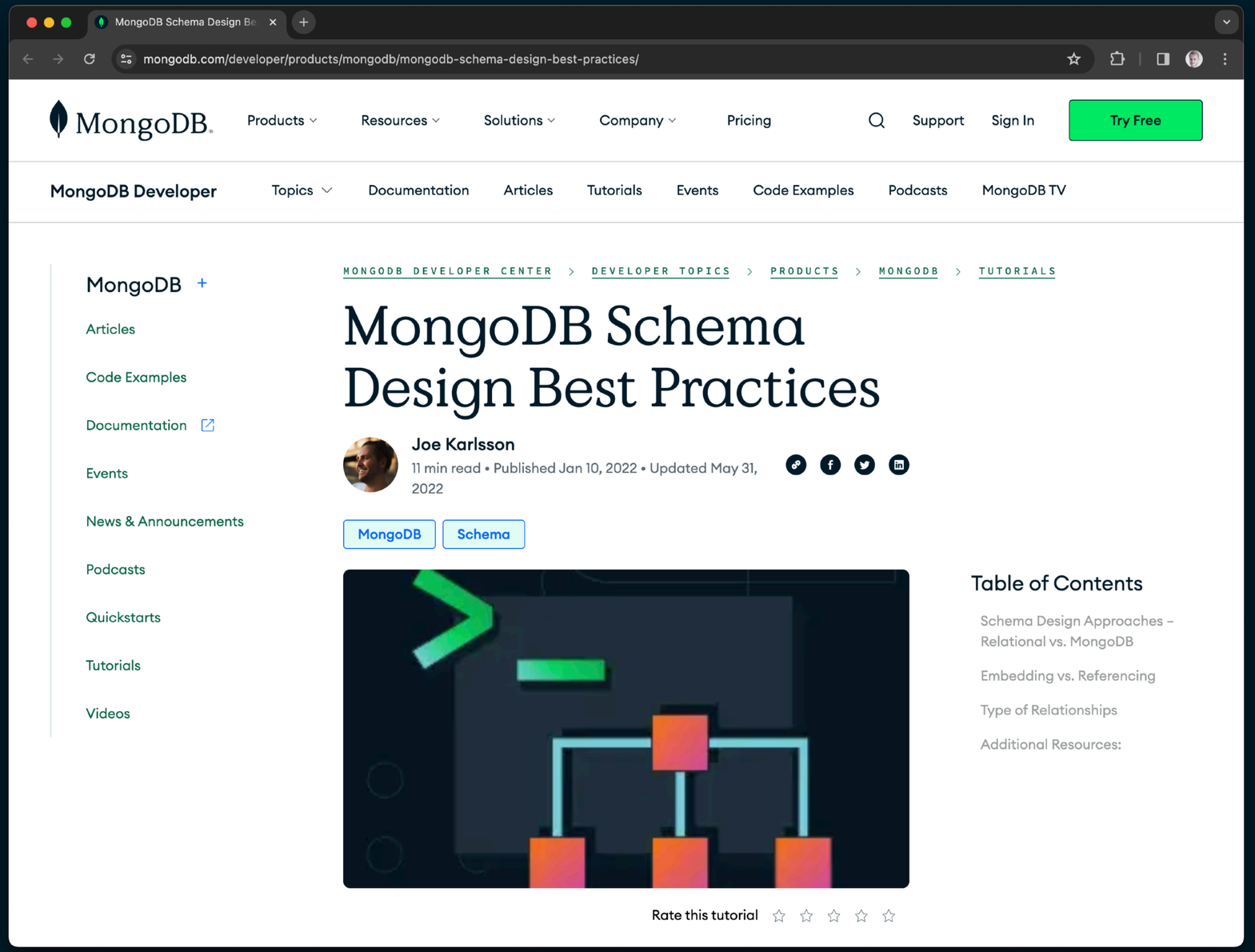
```
db.users.replaceOne(
    // Specify the user you want to replace
    { _id: ObjectId("ZfPTVEMQKf9v") },
    {
        _id: ObjectId("ZfPTVEMQKf9v"),
        image: "https://new-image-url.com",
        mail: "new-email@example.com",
        // Add more fields as needed
    }
);
```

Delete




```
db.users.deleteOne(
    // Specify the user you want to delete
    { _id: ObjectId("ZfPTVEMQKf9v") }
);

db.users.deleteMany(
    // Specify the criteria for the
    // documents you want to delete
    { title: "Senior Lecturer" }
);
```

Data Modeling and Schema Design



https://www.mongodb.com/developer/products/mongodb/mongodb-schema-design-best-practices/

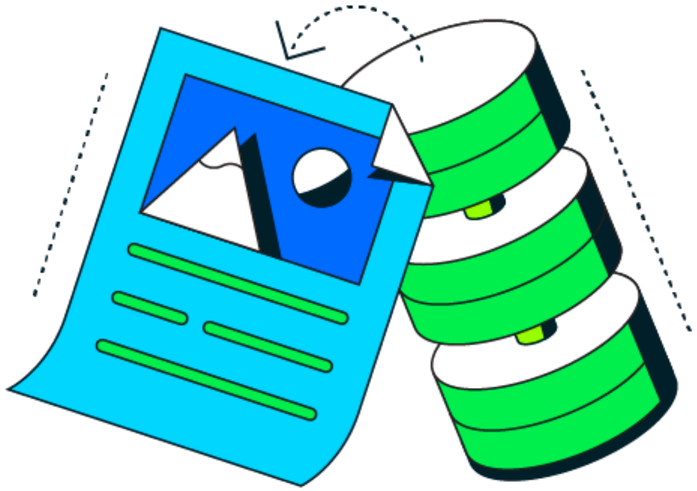
MongoDB Schema Design

- No formal process
- No algorithms
- No rules

Schema Design

The design comes from the needs of the application first.

Therefore, the schema should evolve as the application changes.

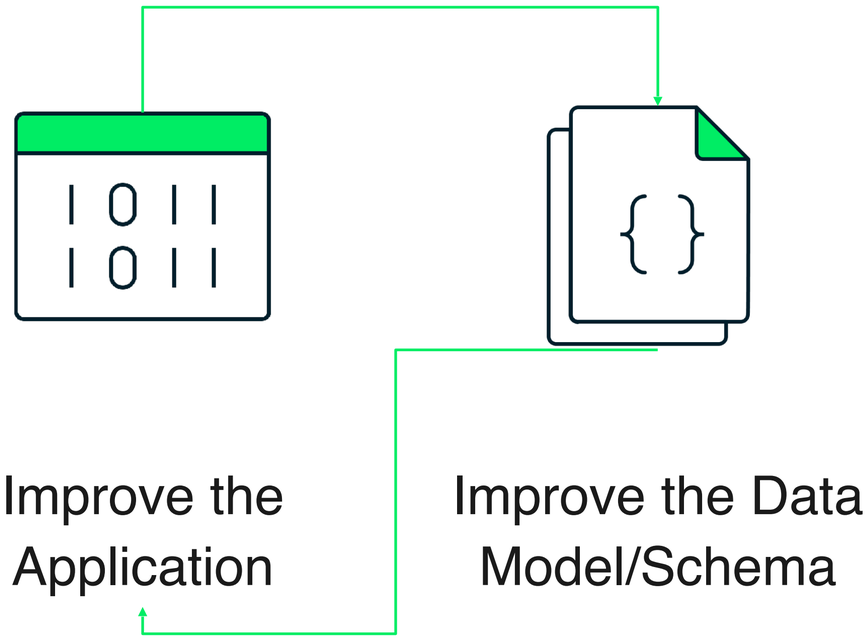


Data Modeling and the Document Model

The core of data modeling in the document model is to understand what data is needed by your queries. Once that information is known, can you begin designing the schema.

Data Modeling with MongoDB

- Several design possibilities
- Design for the usage pattern
- Evolving the schema is easy
- No migrations or downtime required for a new version of the schema

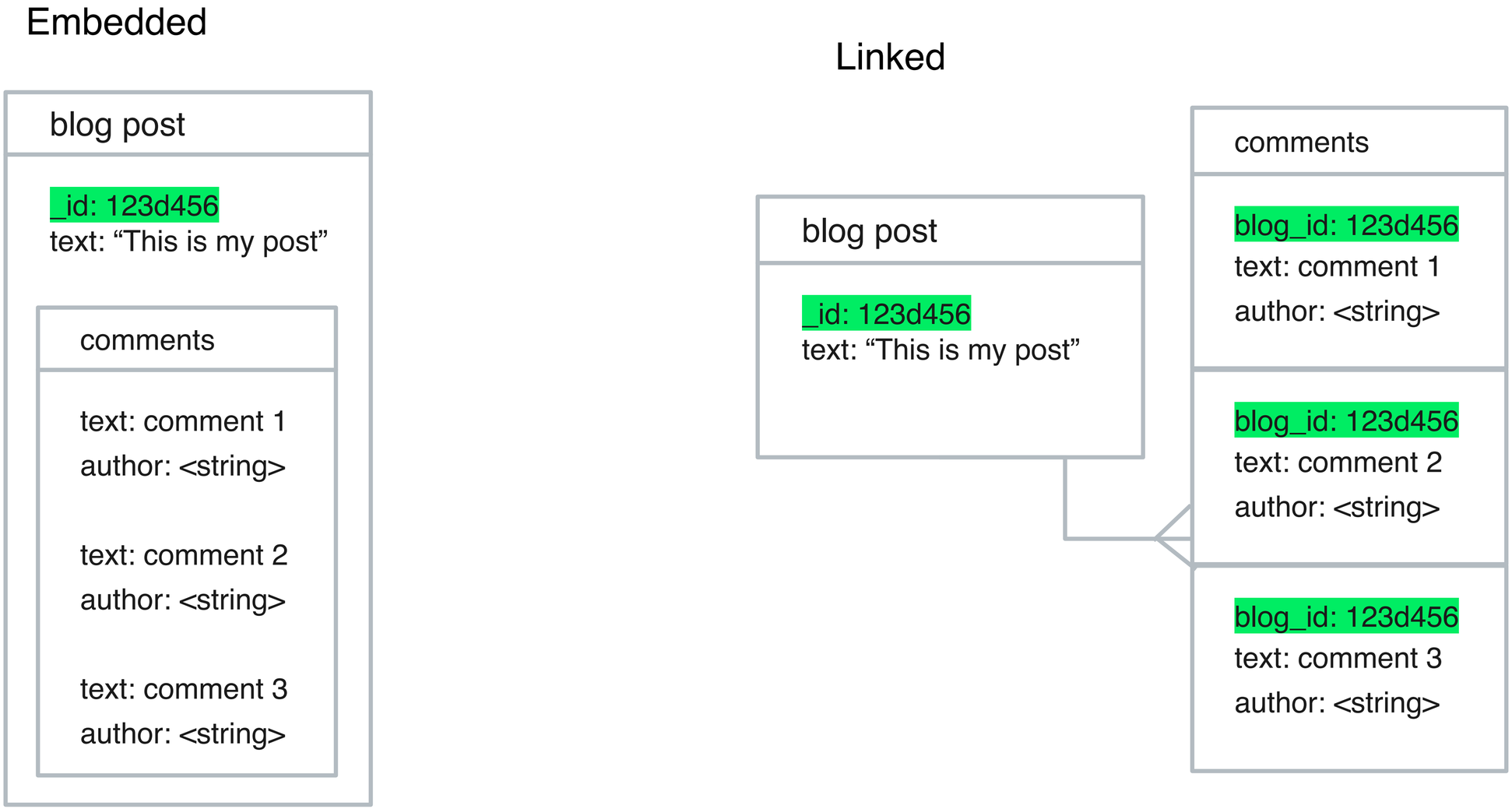


Schema Design: Considerations

- Your queries and the specific data your application requires.
- How your application reads the data (read patterns).
- How your application writes the data (write patterns).
- What are the relationships between your data (linked or embedded).

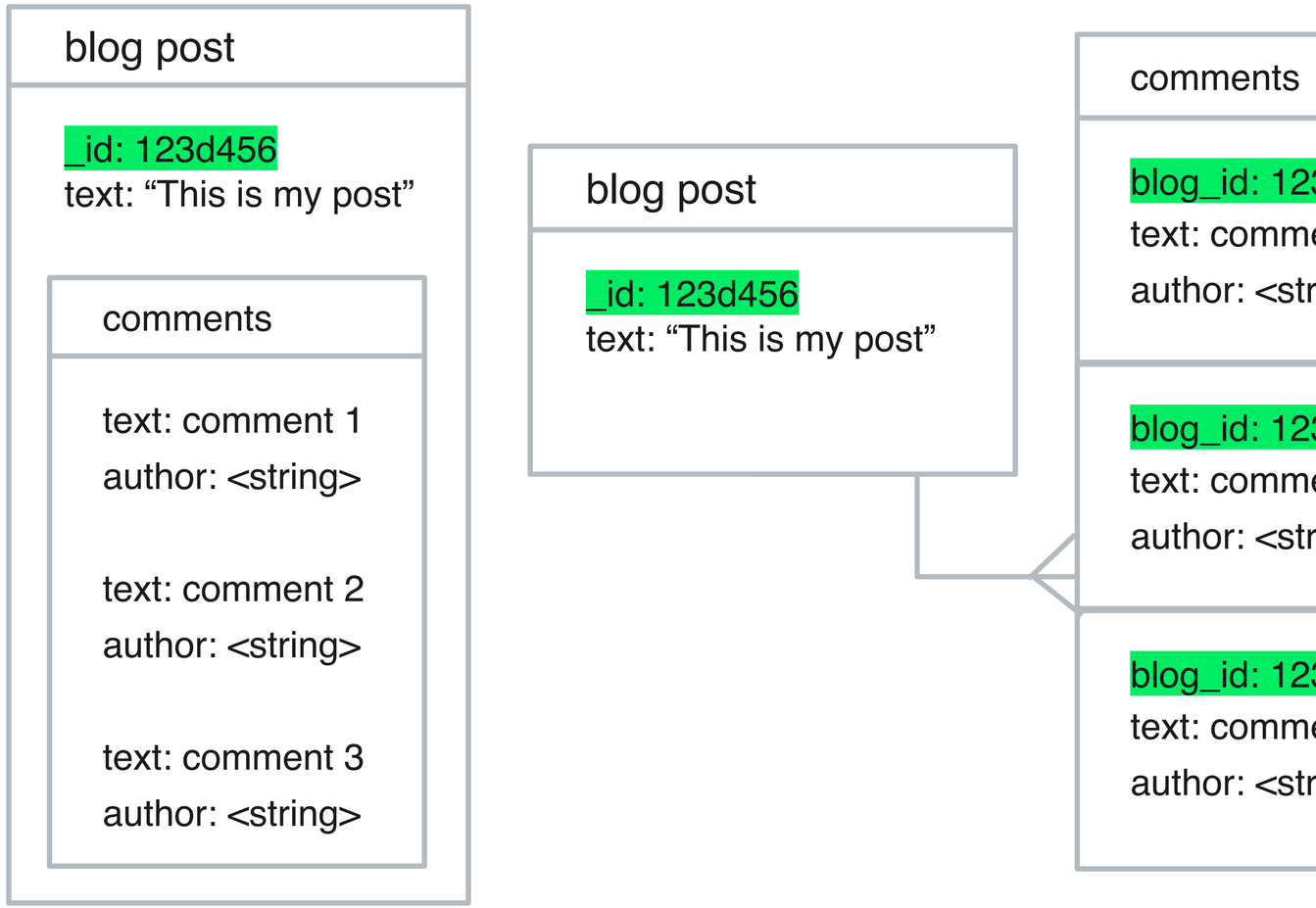
Schema Design - Link or Embed?

Embedded vs Linked relationship in the Post-Comment example



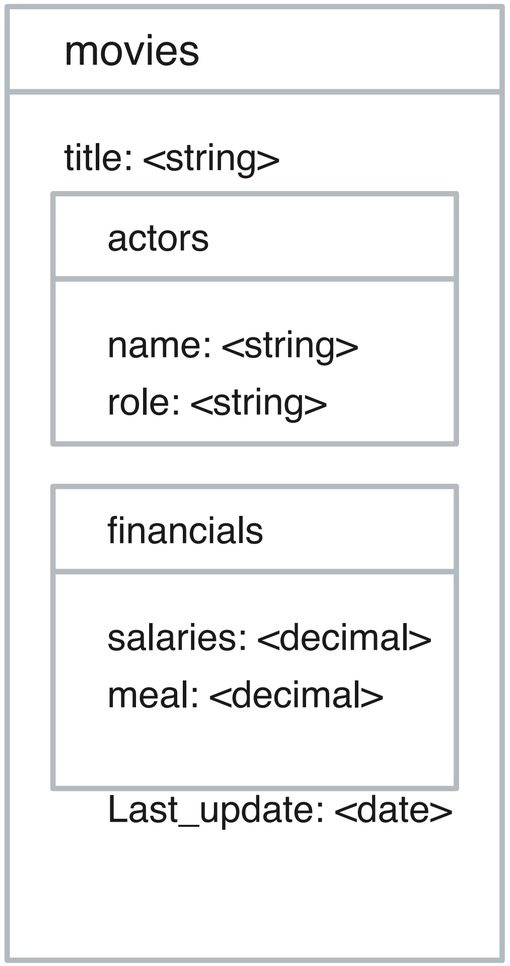
Schema Design - Link or Embed?

- Do I want most of the data's information embedded?
- Do I need to search within the embedded data?
- How frequently will the embedded data change?
- Is the embedded data shared or private?

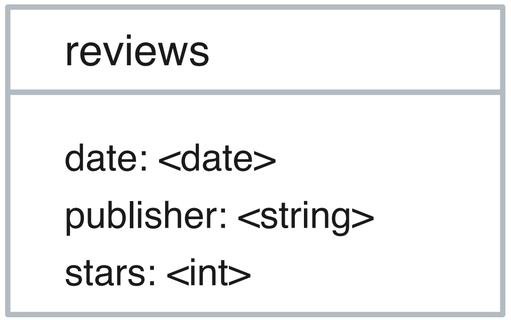


Example: Movies and Reviews

Embedded



Linked



Relationships

One to one (1-1)

One to many (1-N)

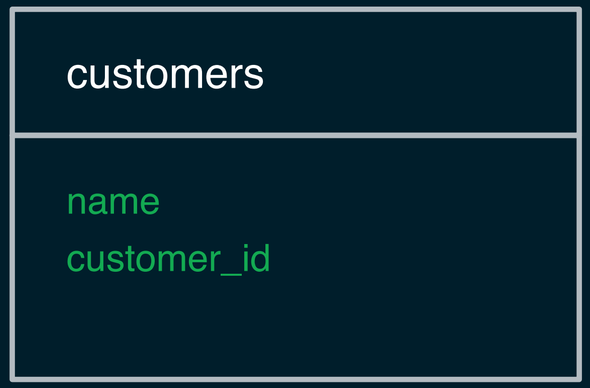
Many to many (N-N)

Relationships and Data Modeling

Relationships

One-to-One (1-1)

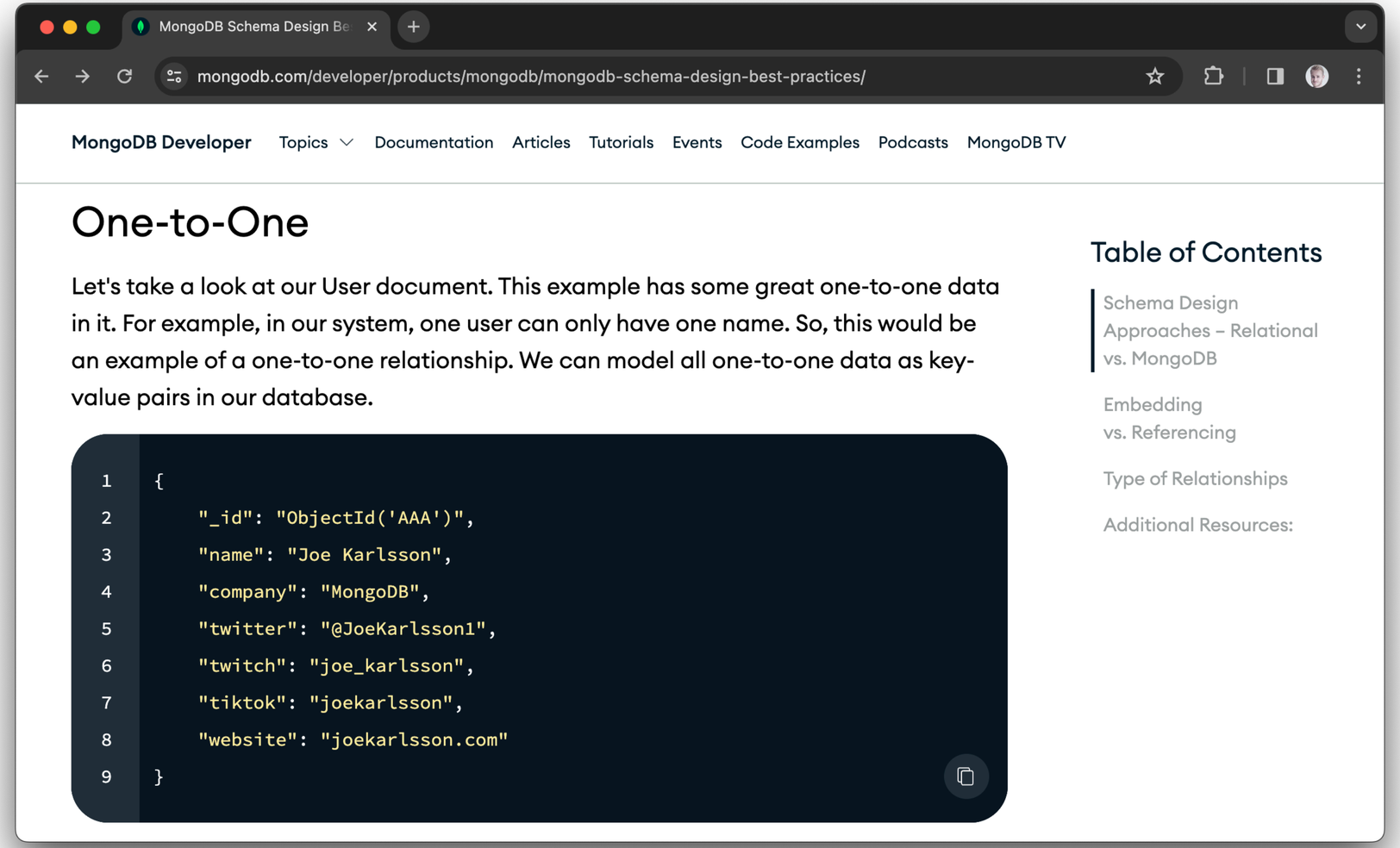
A one-to-one relationship is represented and stored in a single document, this would typically be data like a person's name and the customer id.



One to One (1-1)

Scenario:

You have to map patron and address relationships. In this example, you'll need to view one data entity in context of the other.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One-to-One
Let's take a look at our User document. This example has some great one-to-one data in it. For example, in our system, one user can only have one name. So, this would be an example of a one-to-one relationship. We can model all one-to-one data as key-value pairs in our database.
{
"_id": "ObjectId('AAA')",
"name": "Joe Karlsson",
"company": "MongoDB",
"twitter": "@JoeKarlsson1",
"twitch": "joe_karlsson",
"tiktok": "joekarlsson",
"website": "joekarlsson.com"
}
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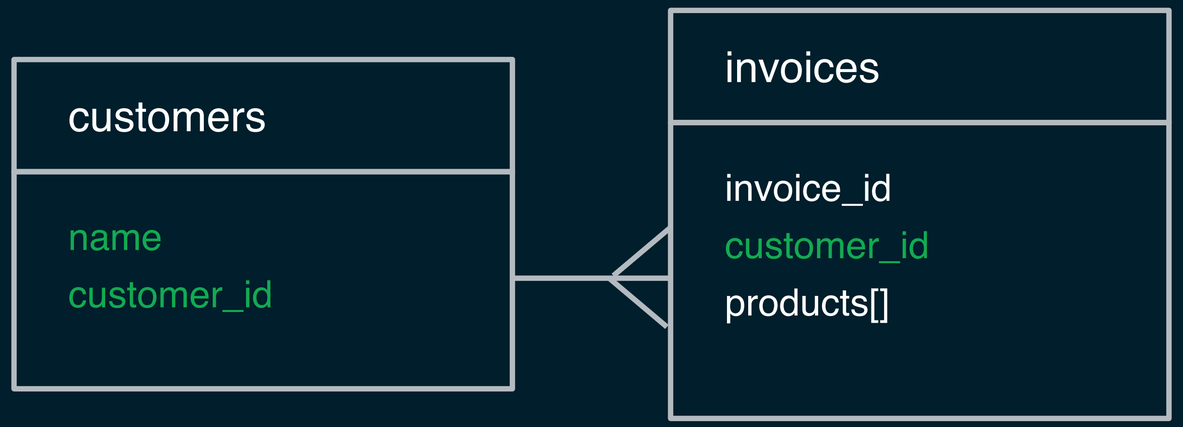
Relationships

One-to-Many (1-N)

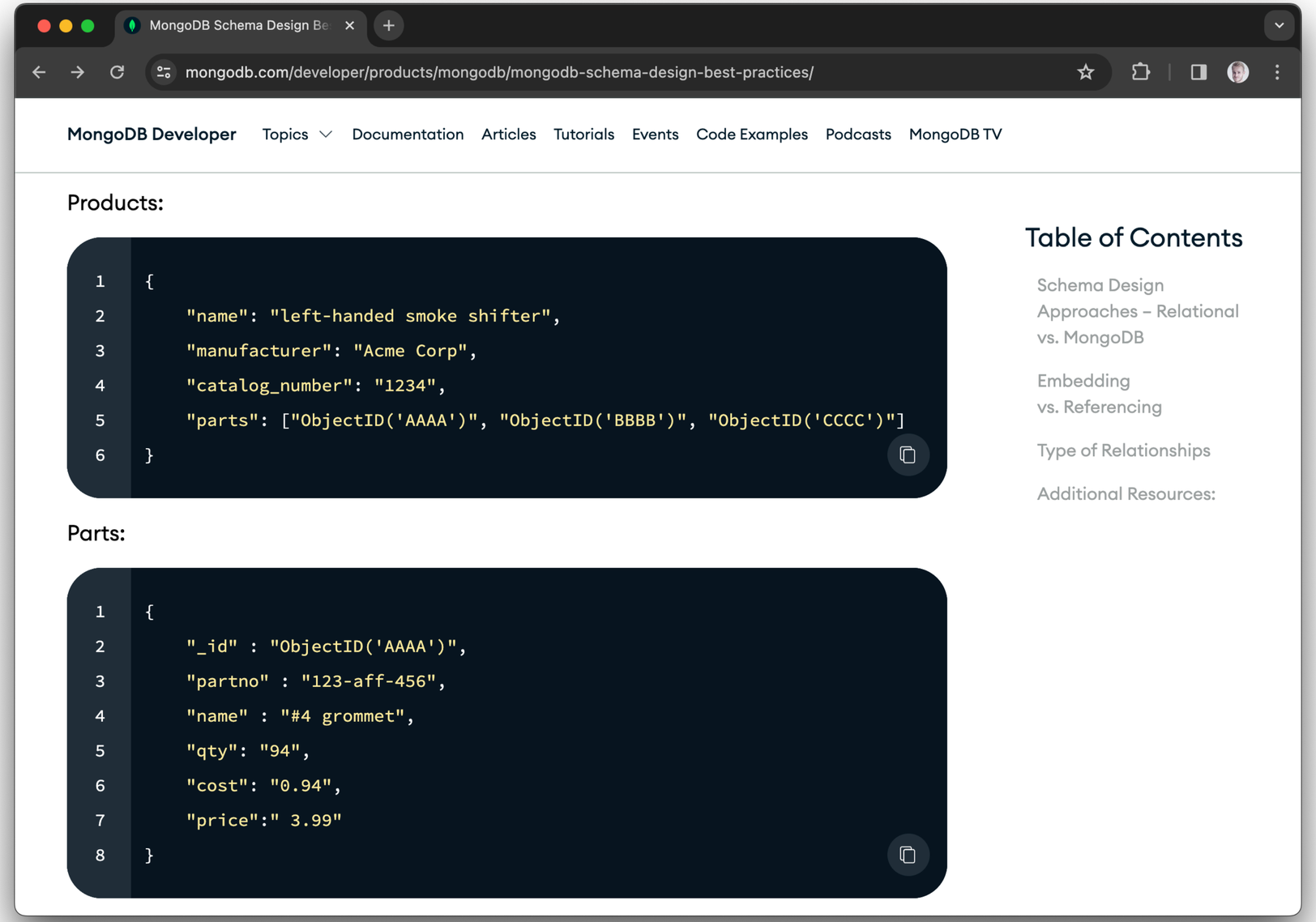
A one-to-many relationship can be considered when an object of a given type is associated with N objects of a second type.



One to Many (1-N)

Scenario (Link):

You have to map publisher and book relationships. Suppose you had the same publisher data for the same book. Embedding the [publisher] document inside the [book] document would lead to repetition of publisher information.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Products:
{
"name": "left-handed smoke shifter",
"manufacturer": "Acme Corp",
"catalog_number": "1234",
"parts": ["ObjectID('AAAA')", "ObjectID('BBBB')", "ObjectID('CCCC')"]
}
Parts:
{
"_id" : "ObjectID('AAAA')",
"partno" : "123-aff-456",
"name" : "#4 grommet",
"qty": "94",
"cost": "0.94",
"price":" 3.99"
}
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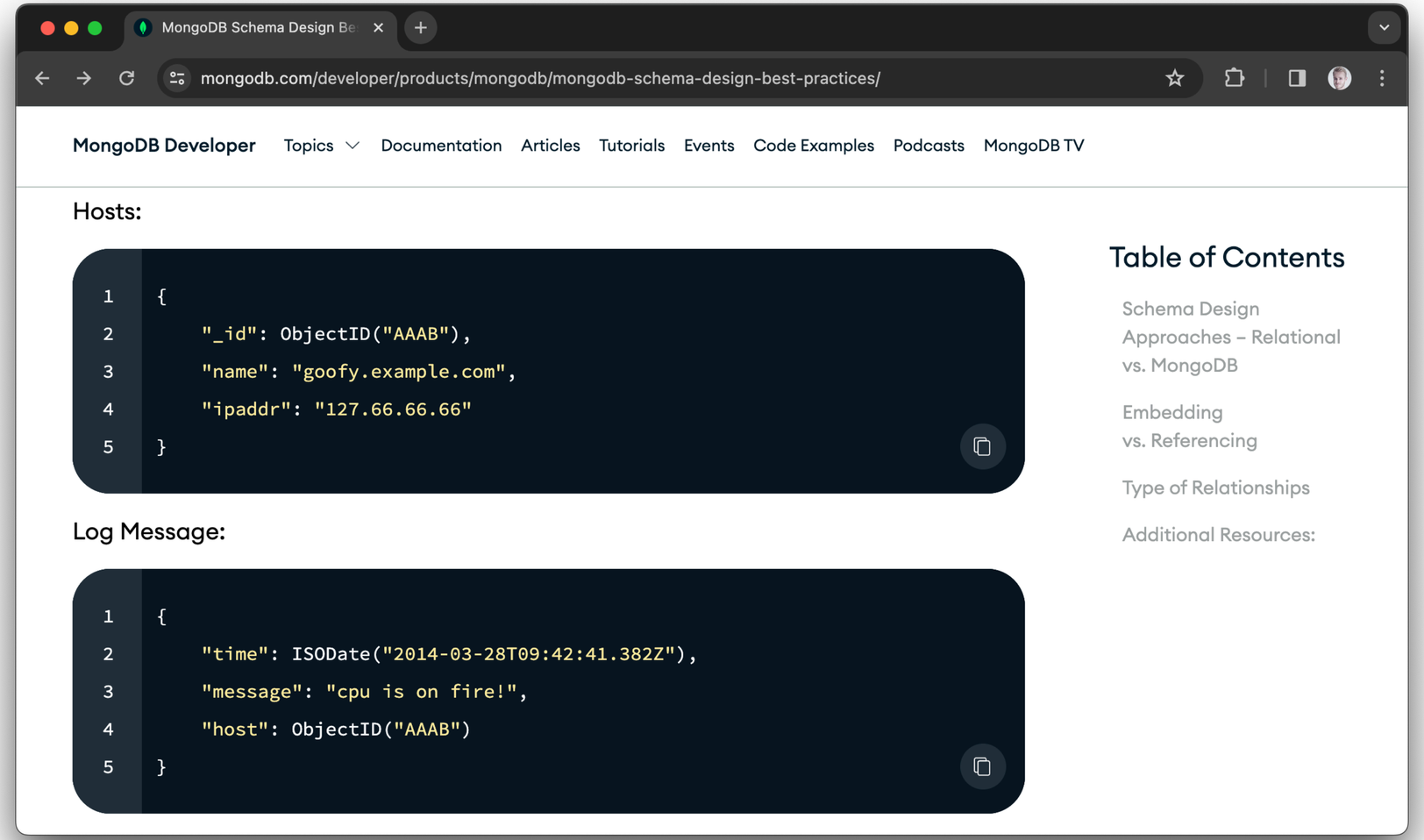
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Hosts:
{
"_id": ObjectID("AAAB"),
"name": "goofy.example.com",
"ipaddr": "127.66.66.66"
}
Log Message:
{
"time": ISODate("2014-03-28T09:42:41.382Z"),
"message": "cpu is on fire!",
"host": ObjectID("AAAB")
}
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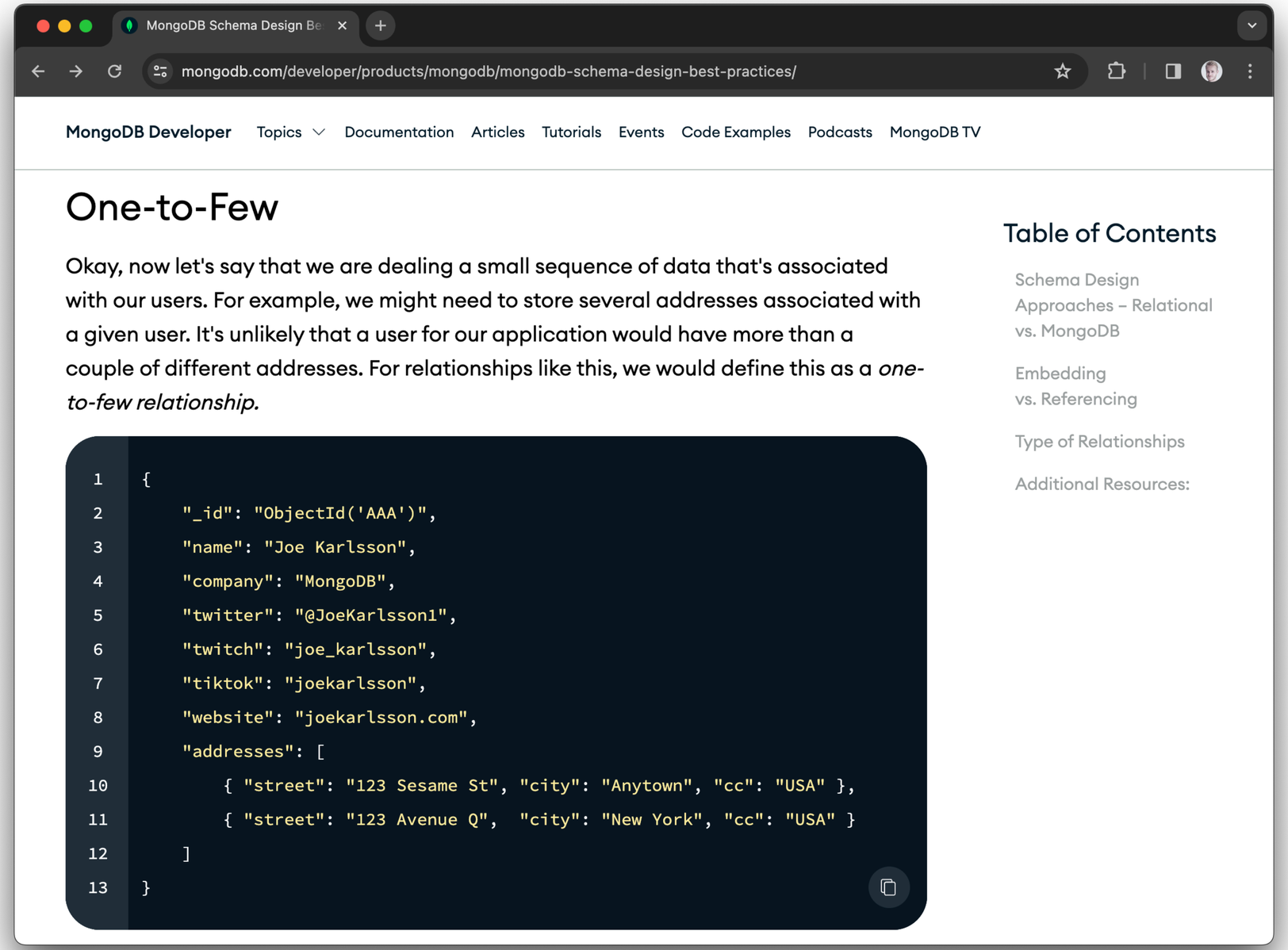
One to Many (1-N)

Scenario (Embed):

You have to map a patron with multiple address relationships. In this one-to-many relationship between [patron] and [address] data, the [patron] has multiple [address] entities.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One-to-Few
Okay, now let's say that we are dealing a small sequence of data that's associated with our users. For example, we might need to store several addresses associated with a given user. It's unlikely that a user for our application would have more than a couple of different addresses. For relationships like this, we would define this as a *one-to-few relationship.*
{
"_id": "ObjectId('AAA')",
"name": "Joe Karlsson",
"company": "MongoDB",
"twitter": "@JoeKarlsson1",
"twitch": "joe_karlsson",
"tiktok": "joekarlsson",
"website": "joekarlsson.com",
"addresses": [
{ "street": "123 Sesame St", "city": "Anytown", "cc": "USA" },
{ "street": "123 Avenue Q", "city": "New York", "cc": "USA" }
]
}
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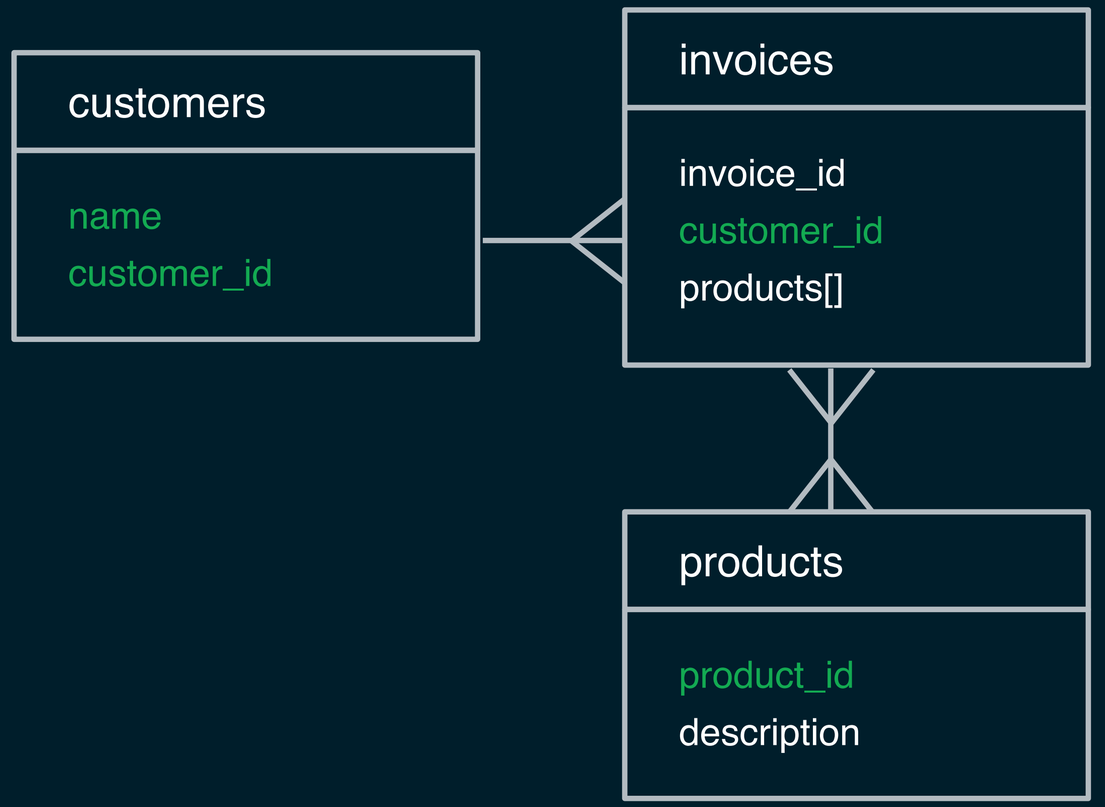
Relationships

Many-to-Many (N-N)

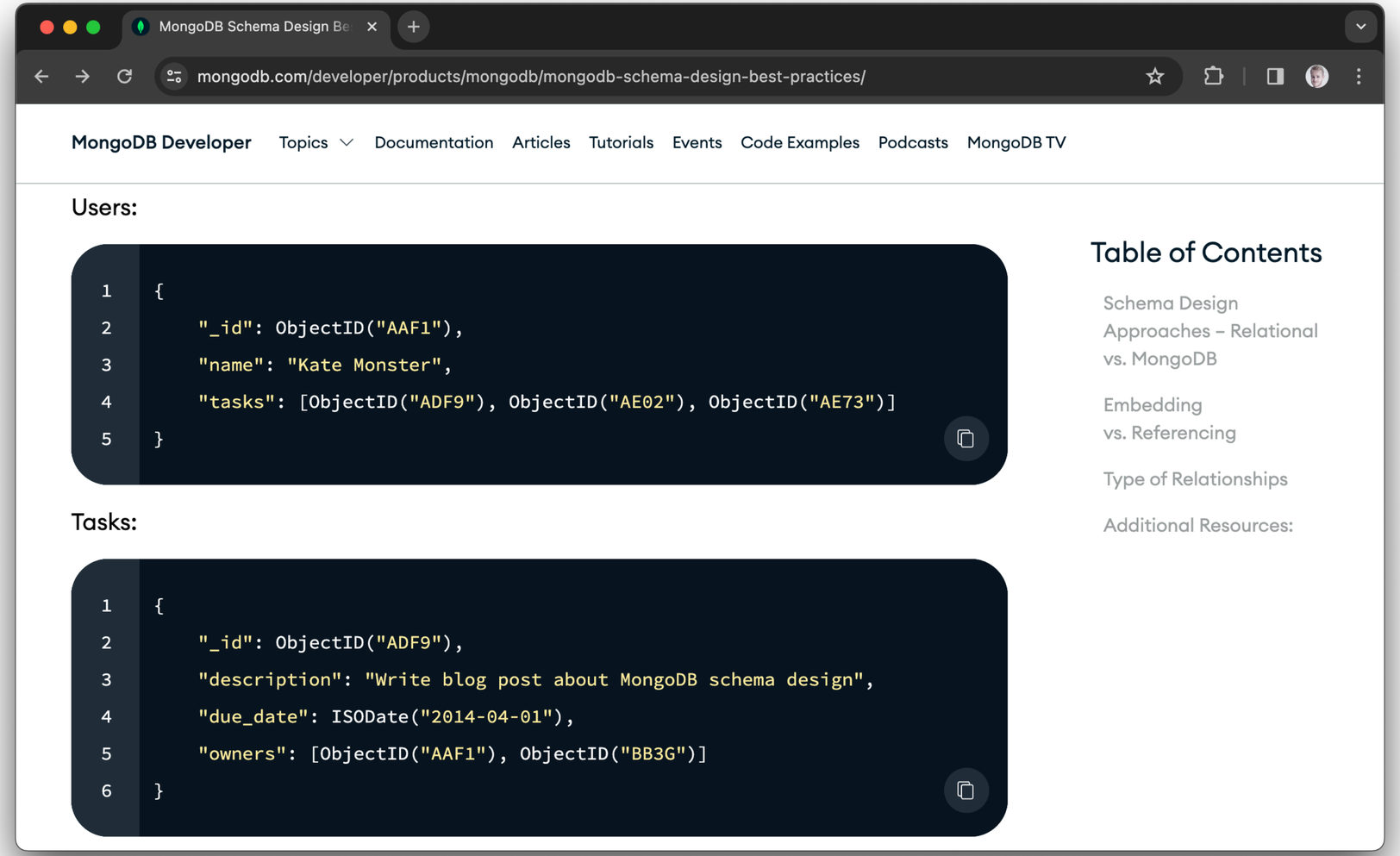
A Many-to-Many relationship between two entities where they both might have many relationships between each other.



Many to Many (N-N)

Scenario:

Consider a scenario where a book was written by multiple authors and similarly, one of the authors has written multiple books. How would we go about mapping these relationships?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Users:
{
"_id": ObjectID("AAF1"),
"name": "Kate Monster",
"tasks": [ObjectID("ADF9"), ObjectID("AE02"), ObjectID("AE73")]
}
Tasks:
{
"_id": ObjectID("ADF9"),
"description": "Write blog post about MongoDB schema design",
"due_date": ISODate("2014-04-01"),
"owners": [ObjectID("AAF1"), ObjectID("BB3G")]
}
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- One-to-One - Prefer key value pairs within the document
- One-to-Few - Prefer embedding
- One-to-Many - Prefer embedding
- One-to-Squillions - Prefer Referencing
- Many-to-Many - Prefer Referencing

Embed or Link

Embed

- For integrity with read operations
- For integrity with write operations
- On one-to-one and one-to-many
- For data that is deleted together by default

Link

- When the "many" side is a huge number
- For integrity on write operations on many-to-many
- When a piece is frequently used, but not the other and memory is an issue

General Rules for MongoDB Schema Design

- Rule 1: Favor embedding unless there is a compelling reason not to.
- Rule 2: Needing to access an object on its own is a compelling reason not to embed it.
- Rule 3: Avoid joins and lookups if possible, but don't be afraid if they can provide a better schema design.
- Rule 4: Arrays should not grow without bound. If there are more than a couple of hundred documents on the many side, don't embed them; if there are more than a few thousand documents on the many side, don't use an array of ObjectID references. High-cardinality arrays are a compelling reason not to embed.
- Rule 5: As always, with MongoDB, how you model your data depends entirely on your particular application's data access patterns. You want to structure your data to match the ways that your application queries and updates it.

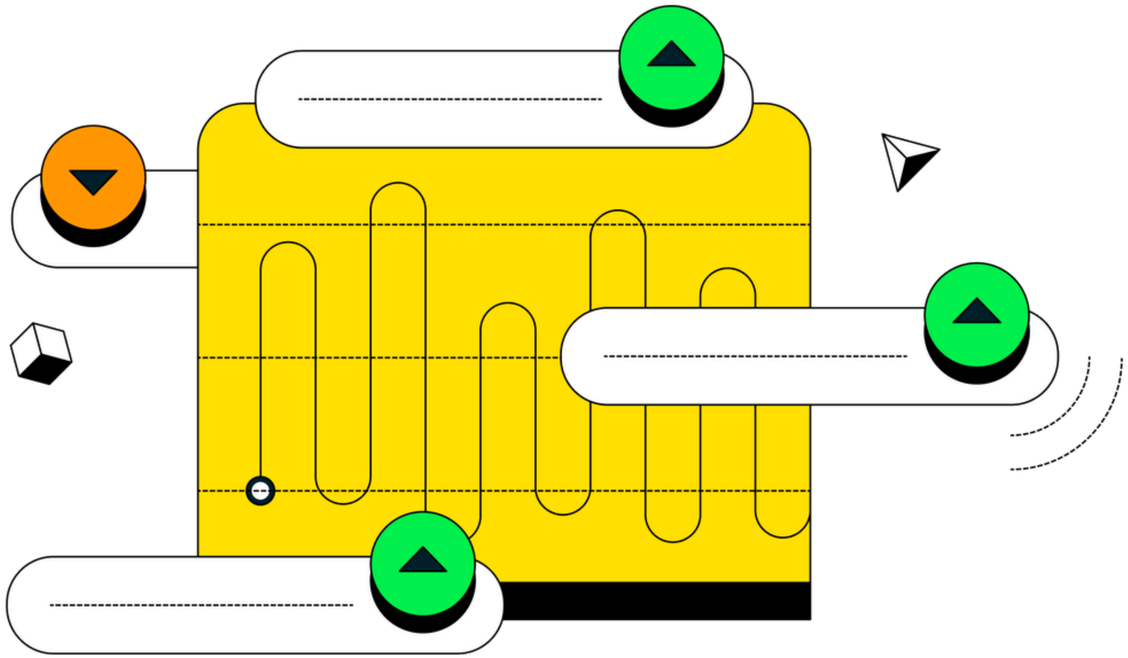
https://www.mongodb.com/developer/products/mongodb/mongodb-schema-design-best-practices/

Indexes and search

What is an Index in MongoDB?

Indexes hold a small portion of the collection's data in a form that's easy to traverse. They are used to:

- Speed up queries and updates
- Avoid disk I/O as queries eliminating the need for slow collection scans
- Reduce overall computation

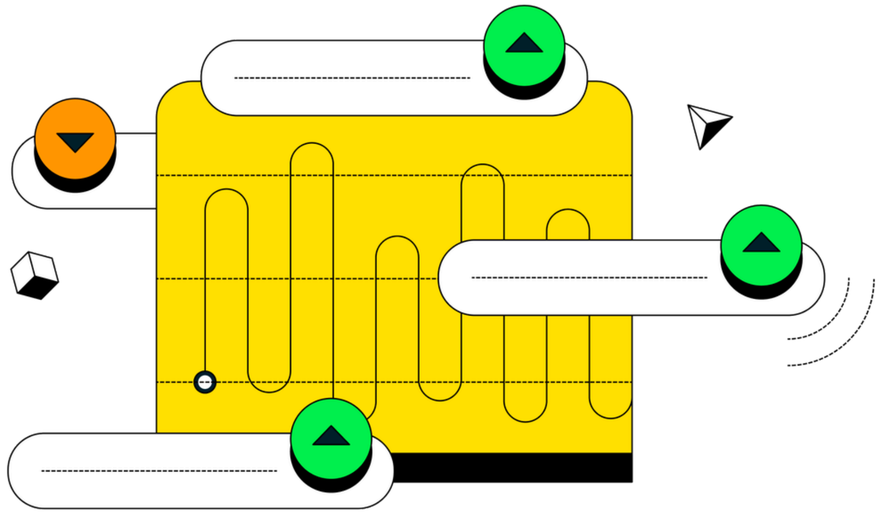


When to Use Indexes

Developers should use an index when querying data in a collection, especially for frequently run queries.

When determining if an index should be used, consider:

- Four indexes is a good rule of thumb for the ideal number for a given collection.
- Sixty-four indexes are the maximum per collection, however, above 20 and performances renders the system almost unusable for workloads.



Considerations When Using Indexes

Indexes require RAM.

Avoid unnecessary indexes at all cost, otherwise the write. performance will suffer. Each index adds 10% overhead.

When does an index entry get modified?

- Data is inserted (applies to all indexes).
- Data is deleted (applies to all indexes).
- Data is updated in such a way that its indexed field changes.

Most common indexes:

- Single Field
- Compound Index

Other types of specialized indexes including:

- Multikey Index
- Geospatial Index
- Text Index
- Hashed Index
- Time-To-Live (TTL) Index
- Hidden Index
- Partial Index
- Wildcard Index