



Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

Introduction to Database Systems: CS305 Intro to MongoDB

Oliver Bonham-Carter
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7 November 2023

The Problem with SQL

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

firstName	lastName	primaryAddr

- Let's say that we have a (perfectly) working SQL table
- The schema has been designed and coded for *current data requirements*

Table Update (i)

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

firstName	lastName	primaryAddr	secondAddr

- The data we collect has changed.
- We need to update our schema for the *new data requirements*

Table Update (ii)

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

firstName	lastName	primaryAddr	secondAddr	thirdAddr

- Our needs have changed again and the SQL table must be updated.
- The schema is reprogrammed

Expectations

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

firstName	lastName	primaryAddr	secondAddr	thirdAddr
Smiley Face	Yellow Box	Yellow Diamond	Yellow Star	Yellow Triangle
Smiley Face	Blue Box	Blue Diamond	Blue Star	Blue Triangle
Smiley Face	Teal Box	Teal Diamond	Teal Star	Teal Triangle
Smiley Face	Red Box	Red Diamond	Red Star	Red Triangle

- We expect that the table will be full when in use
- Expectations are not always fulfilled...

In Reality, Much Data is Missing

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Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

firstName	lastName	primaryAddr	secondAddr	thirdAddr
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- But, in reality, much of the table is empty!
- The table can easily get huge and be hard to manage.

We Might Stop and Ask Ourselves...

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Systems:
CS305
Intro to
MongoDB

Oliver
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The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example



- What can we do to stop having to redesign our database schema with our changing data?
- Is SQL the right type of database management system for our changing data requirements?

A NoSQL Database Management System

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example



mongoDB®

- NoSQL: *Not Only SQL* database systems that support SQL-like query languages, but are used increasingly in big data applications and real-time web applications.
 - The stored data is allowed to change
-
- <https://www.mongodb.com/>

Philosophy of MongoDB

Non-relational DB

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to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

- Document Identifiers (`_id`) will be created for each document, field name reserved by system
- Application tracks the schema and mapping
- Uses JSON, BSON (*B* for binary inputs)
- Written in C++
- Supports APIs (drivers) in many computer languages
 - JavaScript, Python, Golang, Ruby, Perl, Java, Java Scala, C#, C++, Haskell, Erlang

Database Language Guide

SQL systems versus NoSQL

Introduction
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Systems:
CS305
Intro to
MongoDB

Oliver
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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

RDBMS		MongoDB
Database	➡	Database
Table, View	➡	Collection
Row	➡	Document (BSON)
Column	➡	Field
Index	➡	Index
Join	➡	Embedded Document
Foreign Key	➡	Reference
Partition	➡	Shard

- The terms are different but their meanings are similar
- *Schema-less*, collections (like tables) are populated by any data
- *Documents* are similar to the *tuples* of Sqlite3 programming

Schema Free

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Systems:
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Intro to
MongoDB

Oliver
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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example



Collection

- No pre-defined data schema
 - Data may be entered in absence of a defined schema
- **Documents** (*rows*) of **collections** (*DB's*) may have different types of data

Schema Free

Mostly similar documents

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Systems:
CS305
Intro to
MongoDB

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Carter
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The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

```
{name: "will",  
eyes: "blue",  
birthplace: "NY",  
aliases: ["bill", "la ciacco"],  
loc: [32.7, 63.4],  
boss: "ben"}
```

```
{name: "jeff",  
eyes: "blue",  
loc: [40.7, 73.4],  
boss: "ben"}
```

```
{name: "brendan",  
aliases: ["el diablo"]}
```

```
{name: "ben",  
hat: "yes"}
```

```
{name: "matt",  
pizza: "DiGiorno",  
height: 72,  
loc: [44.6, 71.3]}
```

- Sometimes not all the data is available to create a document.
- The query *interprets* missing data as NULL entries

Styles of Storing Data

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to Database
Systems:
CS305
Intro to
MongoDB

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The Problem
With SQL

About Mongo
Schema

Language
JSON

Collections

Inventory
Example

Relational Database

Student_Id	Student_Name	Age	College
1001	Chaitanya	30	Beginnersbook
1002	Steve	29	Beginnersbook
1003	Negan	28	Beginnersbook

MongoDB

```
{
  "_id": ObjectId("....."),
  "Student_Id": 1001,
  "Student_Name": "Chaitanya",
  "Age": 30,
  "College": "Beginnersbook"
}
{
  "_id": ObjectId("....."),
  "Student_Id": 1002,
  "Student_Name": "Steve",
  "Age": 29,
  "College": "Beginnersbook"
}
{
  "_id": ObjectId("....."),
  "Student_Id": 1003,
  "Student_Name": "Negan",
  "Age": 28,
  "College": "Beginnersbook"
}
```

JSON and MongoDB Code

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
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Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

- **Data is in name / value pairs**
- A name/value pair consists of a field name followed by a colon, followed by a value:
 - Example: { "name": "R2-D2" }
- **Data is separated by commas**
- Example: { "name": "R2-D2", race : "Droid" }
- **Curly braces hold objects**
- Example: {"name": "R2-D2", race : "Droid", affiliation: "rebels"}
- **An array is stored in brackets []**
- Example [{ "name": "R2-D2", race : "Droid", affiliation: "rebels"}, { "name": "Yoda", affiliation: "rebels" }]



CRUD Operations

Create, Read, Update and Delete

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

We will see more of these commands later!

- **Db.collection** specifies the collection or the *table* in which to store the document (*tuple*)
- **Create**
 - db.collection.insert()
 - db.collection.save()
 - db.collection.update()
- **Read**
 - db.collection.find()
 - db.collection.findOne()
- **Update**
 - db.collection.update()
- **Delete**
 - db.collection.remove()



Let's code

Online coding to test the new DB

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to Database
Systems:

CS305

Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example





Let's code

Online MongoDB

Introduction
to Database

Systems:

CS305

Intro to

MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

The screenshot shows a web-based MongoDB compiler interface. At the top, there's a browser-style header with tabs, a search bar containing 'mycompiler.io/new/mongodb', and various icons. Below the header, the title 'myCompiler' is displayed next to its logo. The main area contains a text input field labeled 'Enter a title...', a dropdown menu set to 'MongoDB', and two buttons: a green 'Run' button and a blue 'Copy' button. A code editor window shows the following MongoDB script:

```
1 db.students.insertMany([  
2   { id: 1, name: 'Ryan', gender: 'M' },  
3   { id: 2, name: 'Joanna', gender: 'F' }  
4 ]);  
5 db.students.find({ gender: 'F' });
```

<https://www.mycompiler.io/new/mongodb>



Let's code

Output

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

▶ Run

Save

Output

```
mycompiler_mongodb> ... . . . . {
  acknowledged: true,
  insertedIds: {
    '0': ObjectId("6549a9c5f525983ea1427d26"),
    '1': ObjectId("6549a9c5f525983ea1427d27")
  }
}
mycompiler_mongodb> [
  {
    _id: ObjectId("6549a9c5f525983ea1427d27"),
    id: 2,
    name: 'Joanna',
    gender: 'F'
}
```

Simple Collections

Enter data as JSON code

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

Insert each document individually into the *Furniture* collection

```
db.Furniture.drop()  
db.Furniture.insertOne({chair:"wood"})  
db.Furniture.insertOne({chair:"metal"})  
db.Furniture.insertOne({chair:"plastic"})  
db.Furniture.insertOne({table:"glass"})  
db.Furniture.insertOne({table:"wood"})  
db.Furniture.insertOne({table:"metal"})  
db.Furniture.insertOne({lamp:"brass"})  
db.Furniture.insertOne({lamp:"glass"})  
db.Furniture.insertOne({lamp:"silver"})
```

```
db.Furniture.find({searchSpace},{showAttrib:1})
```

Find everything

```
db.Furniture.find({},{})
```



Let's code

Output

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

MongoDB ▾



```
1 db.Furniture.drop()  
2 db.Furniture.insertOne({chair:"wood"})  
3 db.Furniture.insertOne({chair:"metal"})  
4 db.Furniture.insertOne({chair:"plastic"})  
5 db.Furniture.insertOne({table:"glass"})  
6 db.Furniture.insertOne({table:"wood"})  
7 db.Furniture.insertOne({table:"metal"})  
8 db.Furniture.insertOne({lamp:"brass"})  
9 db.Furniture.insertOne({lamp:"glass"})  
10 db.Furniture.insertOne({lamp:"silver"})  
11  
12 db.Furniture.find({}, {lamp:1})  
13
```

Find all lamps

```
db.Furniture.find({}, {lamp:1})
```



Let's code

Output

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo
Schema

Language
JSON

Collections

Inventory
Example

Output

```
mycompiler_mongodb>
mycompiler_mongodb> [
  { _id: ObjectId("6549ad8be57e3cf501f4fe5a") },
  { _id: ObjectId("6549ad8be57e3cf501f4fe5b") },
  { _id: ObjectId("6549ad8be57e3cf501f4fe5c") },
  { _id: ObjectId("6549ad8be57e3cf501f4fe5d") },
  { _id: ObjectId("6549ad8be57e3cf501f4fe5e") },
  { _id: ObjectId("6549ad8be57e3cf501f4fe5f") },
  { _id: ObjectId("6549ad8be57e3cf501f4fe60"), lamp: 'brass' },
  { _id: ObjectId("6549ad8ce57e3cf501f4fe61"), lamp: 'glass' },
  { _id: ObjectId("6549ad8ce57e3cf501f4fe62"), lamp: 'silver' }
]
mycompiler_mongodb>

[Execution complete with exit code 0]
```

Find all lamps

```
db.Furniture.find({}, {lamp:1})
```



Let's code

Output

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example



A screenshot of a MongoDB shell interface. The title bar says "MongoDB". The code area contains the following numbered lines:

```
1 db.Furniture.drop()
2 db.Furniture.insertOne({chair:"wood"})
3 db.Furniture.insertOne({chair:"metal"})
4 db.Furniture.insertOne({chair:"plastic"})
5 db.Furniture.insertOne({table:"glass"})
6 db.Furniture.insertOne({table:"wood"})
7 db.Furniture.insertOne({table:"metal"})
8 db.Furniture.insertOne({lamp:"brass"})
9 db.Furniture.insertOne({lamp:"glass"})
10 db.Furniture.insertOne({lamp:"silver"})
11
12 db.Furniture.find({}, {lamp:1}).pretty()
13
```

The line "db.Furniture.find({}, {lamp:1}).pretty()" is highlighted with a light blue background.

Find all lamps, use formatting

```
db.Furniture.find({}, {lamp:1}).pretty()
```



Let's code

Output

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo
Schema

Language
JSON

Collections

Inventory
Example

Output

```
mycompiler_mongodb>
mycompiler_mongodb> [
  { _id: ObjectId("6549ad1c0589be4c15b50581") },
  { _id: ObjectId("6549ad1c0589be4c15b50582") },
  { _id: ObjectId("6549ad1c0589be4c15b50583") },
  { _id: ObjectId("6549ad1c0589be4c15b50584") },
  { _id: ObjectId("6549ad1d0589be4c15b50585") },
  { _id: ObjectId("6549ad1d0589be4c15b50586") },
  { _id: ObjectId("6549ad1d0589be4c15b50587") }, lamp: 'brass' },
  { _id: ObjectId("6549ad1d0589be4c15b50588") }, lamp: 'glass' },
  { _id: ObjectId("6549ad1d0589be4c15b50589") }, lamp: 'silver' }
]
mycompiler_mongodb>

[Execution complete with exit code 0]
```

Find all lamps, use formatting

```
db.Furniture.find({}, {lamp:1}).pretty()
```

What is going on here?

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
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Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

Let's reflect ...



Simple Collections

Simple Example of Queries

Introduction
to Database
Systems:

CS305

Intro to

MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example

Query all documents in the *Furniture* collection

```
db.Furniture.find({}, {})
```

Query all *Lamp* types across all collections

```
// SELECT * FROM Furniture WHERE lamp == ``brass``;
```

```
db.Furniture.find({}, {lamp: 1})
```

```
db.Furniture.find({}, {lamp: 1, _id: 0})
```

Query *Lamp* types from the *Furniture* collection

```
// SELECT lamp FROM Furniture WHERE lamp == ``brass``;
```

```
db.Furniture.find({lamp: "brass"})
```

```
db.Furniture.find({lamp: "glass"})
```

```
db.Furniture.find({lamp: "silver"})
```

```
// do not show object id's
```

```
db.Furniture.find({lamp: "silver"}, {_id: 0})
```

Insert many documents into the *Inventory* collection

Introduction
to Database
Systems:

CS305

Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo
Schema

Language
JSON

Collections

Inventory
Example

Inserting

```
db.inventory.insertMany([  
    { item: "journal", qty: 25, size: { h: 14, w: 21, uom: "cm" }, status: "A" },  
    { item: "notebook", qty: 50, size: { h: 8.5, w: 11, uom: "in" }, status: "A" },  
    { item: "paper", qty: 100, size: { h: 8.5, w: 11, uom: "in" }, status: "D" },  
    { item: "planner", qty: 75, size: { h: 22.85, w: 30, uom: "cm" }, status: "D" },  
    { item: "postcard", qty: 45, size: { h: 10, w: 15.25, uom: "cm" }, status: "A" }  
]);
```

SELECT * FROM inventory

```
db.inventory.find( {},{} )  
db.inventory.find( {},{} ).pretty()
```

SELECT item FROM inventory

```
db.inventory.find({},{ "item":1 }).pretty()
```

SELECT * FROM inventory WHERE item == "postcard"

```
db.inventory.find({ "item": "postcard"},{})  
db.inventory.find({ "item": "postcard"},{}).pretty()
```

Queries from the *Inventory* collection

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo
Schema

Language
JSON

Collections

Inventory
Example

SELECT * FROM inventory WHERE status = "D"

```
db.inventory.find( { status: "D" } )
```

SELECT * FROM inventory WHERE status in ("A", "D")

```
db.inventory.find({status:{ $in: [ "A", "D" ]}})
```

SELECT * FROM inventory WHERE status == "D")

```
db.inventory.find({ status: "D" },{})
```

Show me where the *size* = "h" and *size* = 10)

```
db.inventory.find( {"size.h":10} ).pretty()
```

See more on this at ...

<https://www.mongodb.com/docs/manual/tutorial/query-documents/>

Consider this...

Introduction
to Database
Systems:
CS305
Intro to
MongoDB

Oliver
Bonham-
Carter
Hang Zhao

The Problem
With SQL

About Mongo

Schema

Language
JSON

Collections

Inventory
Example



THINK

The logo consists of the word "THINK" in a bold, black, sans-serif font. It is centered on a white rectangular background, which is itself centered within a larger orange rounded rectangle.

- Can you go back to the above examples to query other fascinating information?
- Can you create and populate a new Mongo database?
- Can you write sophisticated queries in your database?