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MongoDB Querying & Aggregation

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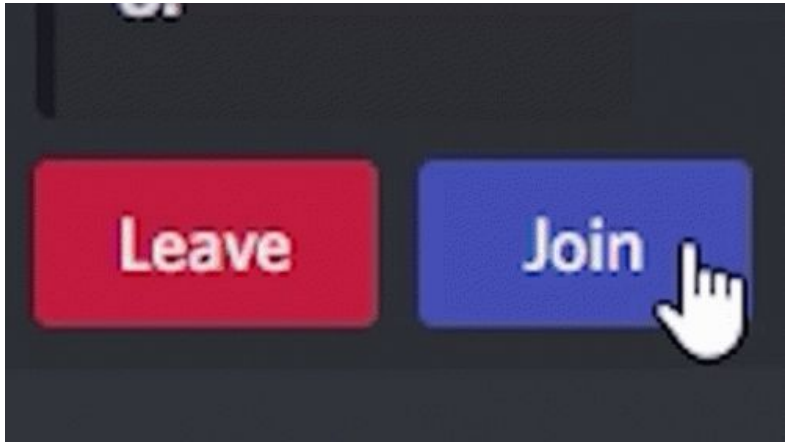

Dataset Overview

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Collection Name: students

Each document includes:

- name, age, major
- subjects (array)
- scores (array of embedded documents)
- Optional graduation_Date

Ideal for demonstrating:

- Array queries
- Embedded document queries
- Aggregation analytics

Dataset

Querying Related Documents

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MongoDB allows querying:

- Simple fields
- Array values
- Embedded documents
- Nested conditions
- Existence of fields

Designed to retrieve related information without joins.

Querying Simple Fields

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Example: Students majoring in Computer Science

```
db.students.find({ major: "Computer Science" })
```

Fetches all documents where `major` matches exactly.

Querying Array Fields

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Example: Students studying “Math”

```
db.students.find({ subjects: "Math" })
```

Matches array elements automatically.

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Simple Field Query vs Array Field Query

Short Summary Difference

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Feature	Simple Field Query	Array Field Query
Data type	Single value	Multiple values (array)
Example field	`major: "CS"`	`subjects: ["Math", "AI"]`
Query	`{ major: "CS" }`	`{ subjects: "Math" }`
Matching	Exact equality	Matches any element inside array
Behavior	Straight comparison	MongoDB searches inside array automatically

Querying Embedded Documents

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Example: Students scoring 95 in Math

```
db.students.find({
  scores: { $elemMatch: { subject: "Math", score: 95 } }
})
```

`$elemMatch` ensures both conditions match the same embedded document.

Comparison & Logical Queries

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Comparison:

```
db.students.find({ age: { $gt: 22 } })
```

Logical:

```
db.students.find({
  $or: [
    { major: "Computer Science" },
    { major: "Information Technology" }
  ]
})
```

Aggregation Overview

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Aggregation performs:

- Summaries
- Analytics
- Grouping
- Calculations
- Data transformation

Uses multiple stages in a pipeline.

Key Aggregation Operators

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- `$match` – Filter
- `$group` – Aggregate
- `$project` – Select/reshape fields
- `$sort` – Sorting
- `$unwind` – Flatten arrays
- `$count` – Counts
- `$avg`, `$sum`, `$min`, `$max` – Computations

Counting Documents

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Find total number of documents in students collection.

```
db.studentdetails.aggregate([
  { $count: "Total Students" }
])
```

Result: Number of documents in students collection.

Grouping by Major

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Find how many students are there in each Department

```
db.studentdetails.aggregate(
[
  { $group:
        { _id: "$department",
        total: { $sum: 1 } } }
]
)
```

This pipeline groups students by their Department and uses $sum: 1

to count how many students belong to each Department.

We can also use $count:{} to count all students in each department.

Average Score in each subject

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Find the average score for in each subject

```
db.studentdetails.aggregate([
  { $unwind: "$subjects" },
  {
    $group: {
      _id: "$subjects.name",
      avgMarks: { $avg: "$subjects.marks" }
    }
  }
])
```

Average Score in DBMS

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Find the average score for all students in DBMS subject and round it off to two decimal places.

```
db.studentdetails.aggregate([
  { $unwind: "$subjects" },
  { $match: { "subjects.name": "DBMS" } },
  { $group: { _id: "DBMS", avgScore: { $avg: "$subjects.marks" } } },
  {$project:{_id:1,avgScore:{$round:["$avgScore",2]}}}
])
```

This pipeline calculates the average “DBMS” score by unwinding(separating) all scores, filtering only DBMS entries, and then grouping them to compute the average using $avg & further rounding off using $round operator in $project.

Highest Scorer in DBMS

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```
db.studentdetails.aggregate([
  { $unwind: "$subjects" },
  { $match: { "subjects.name": "DBMS" } },
  { $sort: { "subjects.marks": -1 } },
  { $limit: 1 }
])
```

This pipeline finds the highest DBMS score by unwinding all subjects, filtering only DBMS scores, sorting them from highest to lowest, and returning just the top result.

Aggregation Pipeline

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A MongoDB aggregation pipeline processes data step-by-step, where each stage performs a specific transformation and then passes the modified documents to the next stage.
Together, these stages form a pipeline that transforms raw data into meaningful analytical output.

Pipeline = series of stages

- Stage 1: `$match`
- Stage 2: `$unwind`
- Stage 3: `$group`
- Stage 4: `$sort`

Each stage transforms documents and passes them forward.

Total Score per Student

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```
db.studentdetails.aggregate([
  { $unwind: "$subjects" },
  { $group: {
      _id: "$name",
      totalScore: { $sum: "$subjects.marks" }
  }},
  { $sort: { totalScore: -1 } }
])
```

This pipeline expands each student's scores with **$unwind**, then **$group** sums all the score values to compute each student's **totalScore**, and finally **$sort** arranges them in descending order so the highest-scoring students appear first.

Average Score per Student

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```
db.studentdetails.aggregate([
  { $unwind: "$subjects" },
  { $group: {
      _id: { name: "$name" },
      avgScore: { $avg: "$subjects.marks" }
  }},
  { $sort: { avgScore: -1 } }
])
```

This pipeline uses **$unwind** to split each student's scores into separate documents, then **$group** (by name) to calculate each student's **average score** with **$avg**, and finally **$sort** orders them in descending order to show the highest-performing students first.

Highest Score per Student

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```
db.studentdetails.aggregate([
  { $unwind: "$subjects" },
  { $group: {
      _id: "$name",
      maxScore: { $max: "$subjects.marks" }
  }},
  { $sort: { maxScore: -1 } }
])
```

This pipeline uses **$unwind** to split each student's scores into individual entries, then **$group** (by name) to find each student's **highest score** using **$max**, and finally **$sort** arranges the students in descending order of their maxScore to show who achieved the highest single score.

$group

Count students per major

```
db.studentdetails.aggregate([
  {
    $group: {
      _id: "$major",
      totalStudents: { $sum: 1 }
    }
  }
]);
```

Counts how many students belong to each **major**.

How it works:

- **$group** groups all documents based on the value of **major**.
- **_id: "$major"** → Each unique major becomes one group.
- **$sum: 1** → Adds 1 for every student in that group → gives student count.

Result:

You get a list of majors with the **number of students** in each major.

$group — When to Use

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To group documents and perform aggregations like:

- sum
- count
- max
- min
- average

Use $group when:

- You want summary/aggregation results.
- You need student-wise, subject-wise, major-wise reports.
- You want counts, totals, highest score, lowest score etc.

$lookup — When to Use

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Purpose:

To join data from **another collection** into the current pipeline.

Use $lookup when:

- You have related data stored in **two different collections**.
- You need to **combine** or **merge** data (similar to SQL JOIN).
- Example: students + departments

Assume you have another collection:

```
db.departments.insertMany([
  { major: "Computer Science", hod: "Dr. Sharma" },
  { major: "Physics", hod: "Dr. Rao" },
  { major: "Math", hod: "Dr. Bose" }
]);
```

$lookup — Example

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Assume you have another collection:

```
db.studentdetails.aggregate([
  {
    $lookup: {
      from: "courses",
      localField: "course_ids",
      foreignField: "_id",
      as: "course_details"
    }
  }
]);
```

Performs a **LEFT JOIN** between `students` and `departments` based on the **major** field.

How it works:

- **localField: "major"** → Read the student's major
- **foreignField: "major"** → Match it with the department's major
- **from: "departments"** → Join with this collection
- **as: "major_details"** → Put matched department info into this new field

Result:

Each student gets an extra field **major_details** containing department info that matches their major

$lookup —

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Q. Count how many students are enrolled in each course.Display course name & count of students

```
db.studentdetails.aggregate([
  {
    $lookup: {
      from: "courses",
      localField: "course_ids",
      foreignField: "_id",
      as: "courseDetails" }
  },
  { $unwind: "$courseDetails" },
  { $group: {
      _id: "$courseDetails.name",
      totalStudents: { $sum: 1 }}}
])
```

$sort — When to Use

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Purpose:

To sort documents in **ascending** or **descending** order.

Use $sort when:

- You want **top scorers**, **youngest students**, **latest graduation year**, etc.
- You need ordering before or after grouping.

Sort students by age (descending)

```
db.studentdetails.find().sort({ age: -1 });
```

Sort students by highest score

```
db.studentdetails.aggregate([
  { $unwind: "$subjects" },
  {
    $group: {
      _id: "$name",
      maxScore: { $max: "$subjects.marks" }
    }
  },
  { $sort: { maxScore: -1 } }
]);
```

Summary – When to use

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Operator	Use When	Example Case (Your Dataset)
$lookup	Need to join 2 collections	Join `students` with `departments`
$group	Need aggregation/summaries	Find highest marks / student count
$sort	Need ordering	Top scorers, youngest students

Summary

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- MongoDB queries allow searching arrays, embedded docs, and conditions.
- Aggregation provides deep analytics using `$group`, `$unwind`, `$project`.
- Aggregation pipeline enables multi step data processing.
- Dataset helps demonstrate score analysis and graduation insights.
- **$group** → Groups documents by a field and performs operations like count, sum, avg, max.
- **$sort** → Arranges documents in ascending (1) or descending (-1) order.
- **$lookup** → Joins data from another collection based on matching fields.

Thank You !!

See You Guys in Next Session :)