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BAHRIA UNIVERSITY (KARACHI CAMPUS)

Assignment-03

(Big Data Analytics)

Class: **BSE [4]-7 (B)**

Course Instructor: **Dr. Salahuddin Shaikh**

Date: **12/12/2024)**

**(Morning)**

Submission Date: **23/12/2024**

Max Marks**: 10 M (CLO2-3)**

Student’s Name: **Muhammad Shoaib Akhter Qadri**

Reg. No: **79290**

# MongoDB Task: Advanced Student Management System

Consider a MongoDB collection named **"students"** that stores information about students enrolled in a university. Each document represents a student and contains the following fields:

* **\_id**: Unique identifier for the student.
* **name**: Full name of the student.
* **age**: Age of the student.
* **department**: Department the student belongs to (e.g., Computer Science, Business, Engineering).
* **gpa**: Current GPA of the student.
* **courses**: An array containing the list of courses the student is enrolled in. Each course includes:
  + **course\_name**: Name of the course.
  + **grade**: Grade obtained in the course.

# Tasks for Applying Advanced MongoDB Queries:

1. Insert five new student documents, ensuring at least one student has a GPA of exactly

4.0 and at least three courses. Verify the insertions by retrieving the students with the highest GPA.

**Solution:**

db.students.insertMany([

{

name: "Shoaib Akhter",

age: 21,

department: "Computer Science",

gpa: 3.2,

courses: [

{ course\_name: "Algorithms", grade: "B" },

{ course\_name: "Data Structures", grade: "B" }

]

},

{

name: "Emily Davis",

age: 23,

department: "Business",

gpa: 3.8,

courses: [

{ course\_name: "Marketing 101", grade: "A" },

{ course\_name: "Accounting Basics", grade: "B" }

]

},

{

name: "Michael Smith",

age: 24,

department: "Engineering",

gpa: 3.7,

courses: [

{ course\_name: "Thermodynamics", grade: "A" },

{ course\_name: "Fluid Mechanics", grade: "B" },

{ course\_name: "Calculus II", grade: "B" }

]

},

{

name: "Aisha Ali",

age: 22,

department: "Mathematics",

gpa: 4.0, // exactly 4.0

courses: [

{ course\_name: "Linear Algebra", grade: "A" },

{ course\_name: "Real Analysis", grade: "A" },

{ course\_name: "Complex Analysis", grade: "A" }

]

},

{

name: "David Kim",

age: 20,

department: "Computer Science",

gpa: 3.8,

courses: [

{ course\_name: "Intro to Programming", grade: "B" },

{ course\_name: "Operating Systems", grade: "C" },

{ course\_name: "Computer Architecture", grade: "B" }

]

}

]);

db.students.find().sort({ gpa: -1 }).limit(1);

**Output:**

**A screenshot of a computer code

Description automatically generated**

**A screenshot of a computer code

Description automatically generated**

1. Retrieve all students from the "Computer Science" department who have taken more than two courses and a GPA greater than 3.5.

**Solution:**

db.students.find({

department: "Computer Science",

gpa: { $gt: 3.5 },

$expr: { $gt: [{ $size: "$courses" }, 2] }

});

**Output:**

A screenshot of a computer code

Description automatically generated

1. Update all students aged 22 or below by increasing their GPA by 0.3 **and** adding a new course titled "Ethics" with a grade of "A".

**Solution:**

db.students.updateMany(

{ age: { $lte: 22 } },

{

$inc: { gpa: 0.3 },

$push: { courses: { course\_name: "Ethics", grade: "A" } }

}

);

**Output:**

A screen shot of a computer

Description automatically generated

1. Remove the lowest grade from the courses array **and** reduce the GPA by 0.1 for students who have more than three courses.

**Solution:**

const studentsWithManyCourses = db.students.find({

$expr: { $gt: [{ $size: "$courses" }, 3] }

}).toArray();

const gradeMap = { A: 4, B: 3, C: 2, D: 1, F: 0 };

studentsWithManyCourses.forEach(student => {

let lowestCourse = null;

let lowestScore = Infinity;

student.courses.forEach(crs => {

const score = gradeMap[crs.grade] ?? 0;

if (score < lowestScore) {

lowestScore = score;

lowestCourse = crs;

}

});

if (lowestCourse) {

db.students.updateOne(

{ \_id: student.\_id },

{

$pull: { courses: { course\_name: lowestCourse.course\_name, grade: lowestCourse.grade } },

$inc: { gpa: -0.1 }

}

);

}

});

**Output:**

A screenshot of a computer code

Description automatically generated

A screenshot of a computer program

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A screenshot of a computer program

Description automatically generated

1. Find the student with the highest total grades across all courses **and** add a new course titled "Leadership" with a grade of "A".

**Solution:**

const pipeline = [

{

$addFields: {

totalGradePoints: {

$sum: {

$map: {

input: "$courses",

as: "crs",

in: {

$switch: {

branches: [

{ case: { $eq: ["$$crs.grade", "A"] }, then: 4 },

{ case: { $eq: ["$$crs.grade", "B"] }, then: 3 },

{ case: { $eq: ["$$crs.grade", "C"] }, then: 2 },

{ case: { $eq: ["$$crs.grade", "D"] }, then: 1 },

],

default: 0

}

}

}

}

}

}

},

{ $sort: { totalGradePoints: -1 } },

{ $limit: 1 }

];

const topStudent = db.students.aggregate(pipeline).toArray()[0];

if (topStudent) {

db.students.updateOne(

{ \_id: topStudent.\_id },

{

$push: { courses: { course\_name: "Leadership", grade: "A" } }

}

);

}

**Output:**

A screenshot of a computer code

Description automatically generated

1. Calculate the average GPA of students grouped by their department **and** include the total number of students in each department.

**Solution:**

db.students.aggregate([

{

$group: {

\_id: "$department",

averageGPA: { $avg: "$gpa" },

totalStudents: { $sum: 1 }

}

}

]);

**Output:**

A screenshot of a computer screen

Description automatically generated

1. Retrieve the names of students enrolled in exactly two courses **and** sort them by GPA in descending order.

**Solution:**

db.students.find(

{

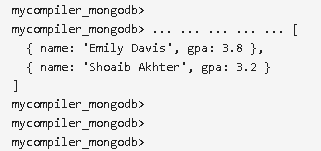
$expr: { $eq: [{ $size: "$courses" }, 2] }

},

{ name: 1, gpa: 1, \_id: 0 }

).sort({ gpa: -1 });

**Output:**

****

1. Find and update the student with the lowest GPA by adding a new course titled "Programming Basics" with a grade of "A" **and** setting their GPA to at least 2.5 if it's currently below that.

**Solution:**

const lowestGPAStudent = db.students.find().sort({ gpa: 1 }).limit(1).toArray()[0];

if (lowestGPAStudent) {

db.students.updateOne(

{ \_id: lowestGPAStudent.\_id },

{

$push: { courses: { course\_name: "Programming Basics", grade: "A" } },

$set: {

gpa: Math.max(lowestGPAStudent.gpa, 2.5)

}

}

);

}

**Output:**

A screenshot of a computer code

Description automatically generated

1. Delete students from the "Business" department whose average course grade is below "C" **and** have fewer than three courses.

**Solution:**

db.students.insertMany([

{

name: "Shoaib Akhter",

age: 21,

department: "Computer Science",

gpa: 3.2,

courses: [

{ course\_name: "Algorithms", grade: "B" },

{ course\_name: "Data Structures", grade: "B" }

]

},

{

name: "Emily Davis",

age: 23,

department: "Business",

gpa: 3.8,

courses: [

{ course\_name: "Marketing 101", grade: "C" },

{ course\_name: "Accounting Basics", grade: "C" }

]

},

{

name: "Michael Smith",

age: 35,

department: "Engineering",

gpa: 4.0,

courses: [

{ course\_name: "Thermodynamics", grade: "A" },

{ course\_name: "Fluid Mechanics", grade: "A" },

{ course\_name: "Calculus II", grade: "A" },

{ course\_name: "Material Science", grade: "B" }

]

},

{

name: "Aisha Ali",

age: 22,

department: "Mathematics",

gpa: 4.0,

courses: [

{ course\_name: "Linear Algebra", grade: "A" },

{ course\_name: "Real Analysis", grade: "A" },

{ course\_name: "Complex Analysis", grade: "A" }

]

},

{

name: "David Kim",

age: 25,

department: "Computer Science",

gpa: 3.8,

courses: [

{ course\_name: "Intro to Programming", grade: "A" },

{ course\_name: "Math", grade: "C" },

{ course\_name: "Computer Architecture", grade: "B" }

]

},

{

name: "Sarah Lee",

age: 22,

department: "Business",

gpa: 2.9,

courses: [

{ course\_name: "Business Law", grade: "F" },

{ course\_name: "Business Ethics", grade: "D" }

]

}

]);

const gradeMap = { A: 4, B: 3, C: 2, D: 1, F: 0 };

const studentsToDelete = db.students.aggregate([

{ $match: { department: "Business" } },

{

$addFields: {

numericGrades: {

$map: {

input: "$courses",

as: "course",

in: {

$switch: {

branches: [

{ case: { $eq: ["$$course.grade", "A"] }, then: 4 },

{ case: { $eq: ["$$course.grade", "B"] }, then: 3 },

{ case: { $eq: ["$$course.grade", "C"] }, then: 2 },

{ case: { $eq: ["$$course.grade", "D"] }, then: 1 },

{ case: { $eq: ["$$course.grade", "F"] }, then: 0 }

],

default: 0

}

}

}

},

courseCount: { $size: "$courses" }

}

},

{

$addFields: {

avgNumericGrade: { $avg: "$numericGrades" }

}

},

{

$match: {

avgNumericGrade: { $lt: 2 },

courseCount: { $lt: 3 }

}

}

]).toArray(); // Convert the result to an array for processing

// Step 3: Delete the matching students

studentsToDelete.forEach(student => {

db.students.deleteOne({ \_id: student.\_id });

});

**Output:**

A line of small dots

Description automatically generated

1. Retrieve students aged between 20 and 25 who have taken at least one course containing the word "Math" in its name, sorted by age in ascending order.

**Solution:**

db.students.find(

{

age: { $gte: 20, $lte: 25 },

"courses.course\_name": /Math/i // regex to match "Math" (case-insensitive)

}

).sort({ age: 1 });

**Output:**

A screenshot of a computer code

Description automatically generated

A computer code with black text

Description automatically generated

1. Update all students in the "Engineering" department by increasing their GPA by 0.2

**and** removing any courses with grades below "B".

**Solution:**

db.students.updateMany(

{ department: "Engineering" },

[

{

$set: {

gpa: { $add: ["$gpa", 0.2] },

courses: {

$filter: {

input: "$courses",

as: "crs",

cond: {

$or: [

{ $eq: ["$$crs.grade", "A"] },

{ $eq: ["$$crs.grade", "B"] }

]

}

}

}

}

}

]

);

**Output:**

A screenshot of a computer code

Description automatically generated

1. Calculate the total number of courses taken by all students grouped by department **and**

find the department with the maximum courses.

**Solution:**

db.students.aggregate([

{

$group: {

\_id: "$department",

totalCourses: { $sum: { $size: "$courses" } }

}

},

{

$sort: { totalCourses: -1 }

},

]);

**Output:**

A screenshot of a computer program

Description automatically generated

1. Retrieve the top three students with the highest GPA **and** display their names, GPAs, and the total number of courses they are enrolled in.

**Solution:**

db.students.aggregate([

{

$project: {

name: 1,

gpa: 1,

totalCourses: { $size: "$courses" }

}

},

{ $sort: { gpa: -1 } },

{ $limit: 3 }

]);

**Output:**

A screenshot of a computer code

Description automatically generated

A screenshot of a computer code

Description automatically generated

1. Remove students who are not enrolled in any courses **and** sort the remaining students by age in descending order.

**Solution:**

db.students.deleteMany({

$expr: { $eq: [{ $size: "$courses" }, 0] }

});

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

**Output:**

A screenshot of a computer code

Description automatically generated

A computer code on a white background

Description automatically generated

A screenshot of a computer code

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A screenshot of a computer code

Description automatically generated

A screenshot of a computer program

Description automatically generated

1. Find students with "Ali" in their name who are in the "Mathematics" department **and**

have taken at least one course, then update their age to 21.

**Solution:**

db.students.updateMany(

{

name: /Ali/i,

department: "Mathematics",

$expr: { $gt: [{ $size: "$courses" }, 0] }

},

{ $set: { age: 21 } }

);

**Output:**

A screen shot of a computer code

Description automatically generated

1. Calculate the average GPA **and** the average number of courses taken by students in each department.

**Solution:**

db.students.aggregate([

{

$group: {

\_id: "$department",

averageGPA: { $avg: "$gpa" },

averageCourses: { $avg: { $size: "$courses" } }

}

}

]);

**Output:**

A screenshot of a computer

Description automatically generated

1. Find and delete the course with the lowest grade for the student with the highest number of courses **and** update their GPA by decreasing it by 0.2.

**Solution:**

db.students.insertMany([

{

name: "Shoaib Akhter",

age: 21,

department: "Computer Science",

gpa: 3.2,

courses: [

{ course\_name: "Algorithms", grade: "B" },

{ course\_name: "Data Structures", grade: "B" }

]

},

{

name: "Emily Davis",

age: 23,

department: "Business",

gpa: 3.8,

courses: [

{ course\_name: "Marketing 101", grade: "A" },

{ course\_name: "Accounting Basics", grade: "B" }

]

},

{

name: "Michael Smith",

age: 35,

department: "Engineering",

gpa: 4.0,

courses: [

{ course\_name: "Thermodynamics", grade: "A" },

{ course\_name: "Fluid Mechanics", grade: "A" },

{ course\_name: "Calculus II", grade: "A" },

{ course\_name: "Material Science", grade: "B" }

]

},

{

name: "Aisha Ali",

age: 22,

department: "Mathematics",

gpa: 4.0,

courses: [

{ course\_name: "Linear Algebra", grade: "A" },

{ course\_name: "Real Analysis", grade: "A" },

{ course\_name: "Complex Analysis", grade: "A" }

]

},

{

name: "David Kim",

age: 25,

department: "Computer Science",

gpa: 3.8,

courses: [

{ course\_name: "Intro to Programming", grade: "A" },

{ course\_name: "Math", grade: "C" },

{ course\_name: "Computer Architecture", grade: "B" }

]

}

]);

const studentWithMaxCourses = db.students.aggregate([

{

$addFields: {

courseCount: { $size: "$courses" }

}

},

{

$sort: { courseCount: -1 }

},

{

$limit: 1

}

]).toArray()[0]; // Get the first document

if (studentWithMaxCourses) {

const gradeMap = { A: 4, B: 3, C: 2, D: 1, F: 0 };

let lowestCourse = null;

let lowestGradeValue = Infinity;

studentWithMaxCourses.courses.forEach(course => {

const gradeValue = gradeMap[course.grade] || 0;

if (gradeValue < lowestGradeValue) {

lowestGradeValue = gradeValue;

lowestCourse = course;

}

});

if (lowestCourse) {

db.students.updateOne(

{ \_id: studentWithMaxCourses.\_id },

{

$pull: { courses: { course\_name: lowestCourse.course\_name, grade: lowestCourse.grade } },

$inc: { gpa: -0.2 } // Step 4: Decrease GPA by 0.2

}

);

}

}

**Output:**

A screenshot of a computer program

Description automatically generated

1. Retrieve the names and GPAs of students aged 20 or above who have a total GPA greater than 10 when summed across all their courses.

**Solution:**

db.students.insertMany([

{

name: "Shoaib Akhter",

age: 21,

department: "Computer Science",

gpa: 3.2,

courses: [

{ course\_name: "Algorithms", grade: "B" },

{ course\_name: "Data Structures", grade: "B" }

]

},

{

name: "Emily Davis",

age: 23,

department: "Business",

gpa: 3.8,

courses: [

{ course\_name: "Marketing 101", grade: "A" },

{ course\_name: "Accounting Basics", grade: "B" }

]

},

{

name: "Michael Smith",

age: 35,

department: "Engineering",

gpa: 4,

courses: [

{ course\_name: "Thermodynamics", grade: "A" },

{ course\_name: "Fluid Mechanics", grade: "A" },

{ course\_name: "Calculus II", grade: "A" }

]

},

{

name: "Aisha Ali",

age: 22,

department: "Mathematics",

gpa: 4.0,

courses: [

{ course\_name: "Linear Algebra", grade: "A" },

{ course\_name: "Math", grade: "A" },

{ course\_name: "Complex Analysis", grade: "A" }

]

},

{

name: "David Kim",

age: 25,

department: "Computer Science",

gpa: 3.8,

courses: [

{ course\_name: "Intro to Programming", grade: "A" },

{ course\_name: "Math", grade: "C" },

{ course\_name: "Computer Architecture", grade: "B" }

]

}

]);

db.students.aggregate([

{

$match: {

age: { $gte: 20 }

}

},

{

$addFields: {

totalCourseGPA: {

$sum: {

$map: {

input: "$courses",

as: "crs",

in: {

$switch: {

branches: [

{ case: { $eq: ["$$crs.grade", "A"] }, then: 4 },

{ case: { $eq: ["$$crs.grade", "B"] }, then: 3 },

{ case: { $eq: ["$$crs.grade", "C"] }, then: 2 },

{ case: { $eq: ["$$crs.grade", "D"] }, then: 1 }

],

default: 0

}

}

}

}

}

}

},

{

$match: {

totalCourseGPA: { $gt: 10 }

}

},

{

$project: {

\_id: 0,

name: 1,

gpa: 1,

totalCourseGPA: 1

}

}

]);

**Output:**

A computer screen shot of a computer code

Description automatically generated

1. Add a new student named "Sara Khan" to the "Mathematics" department, aged 22, with a GPA of 3.7 and three courses. Then, retrieve all students sorted by their total number of courses in ascending order.

**Solution:**

db.students.insertOne({

name: "Sara Khan",

age: 22,

department: "Mathematics",

gpa: 3.7,

courses: [

{ course\_name: "Calculus III", grade: "A" },

{ course\_name: "Statistics", grade: "B" },

{ course\_name: "Discrete Math", grade: "B" }

]

});

db.students.aggregate([

{

$project: {

name: 1,

age: 1,

department: 1,

gpa: 1,

totalCourses: { $size: "$courses" }

}

},

{ $sort: { totalCourses: 1 } }

]);

**Output:**

A screenshot of a computer code

Description automatically generated

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Description automatically generated

1. Retrieve students, grouping them by department, and calculate the **maximum GPA** and

**total number of students** within each department.

**Solution:**

db.students.aggregate([

{

$group: {

\_id: "$department",

maxGPA: { $max: "$gpa" },

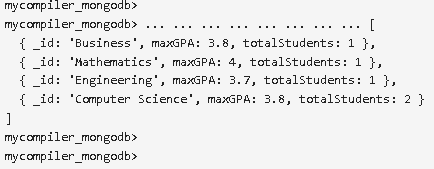
totalStudents: { $sum: 1 }

}

}

]);

**Output:**



**Submission Deadline: 23rd December 2024**