Panduan Praktik Proyek Sederhana MongoDB dengan Mongo Express

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Daftar Isi

Pendahuluan

MongoDB adalah database NoSQL yang populer dan banyak digunakan dalam industri modern. Dokumen ini akan memandu mahasiswa langkah demi langkah dalam membuat proyek sederhana menggunakan MongoDB dengan antarmuka grafis Mongo Express yang berjalan di dalam container Docker.

Tujuan Pembelajaran

Setelah menyelesaikan praktik ini, mahasiswa diharapkan dapat:

- Memahami konsep dasar database NoSQL dan MongoDB
- Menginstal dan mengonfigurasi MongoDB dengan Docker
- Menggunakan Mongo Express untuk manajemen database
- Membuat aplikasi sederhana dengan operasi CRUD
- Melakukan query dan indexing dasar
- Memahami best practices dalam pengembangan aplikasi dengan MongoDB

Mengapa Docker?

Docker menyederhanakan proses instalasi dan pengelolaan lingkungan pengembangan. Dengan Docker, kita tidak perlu menginstal MongoDB secara langsung di sistem operasi,

sehingga menghindari konflik dengan software lain dan memudahkan reproduksi lingkungan yang sama di berbagai mesin.

Prasyarat

Sebelum memulai praktik ini, pastikan Anda telah memenuhi persyaratan berikut:

Sistem Operasi yang Didukung

- **Windows 10/11** (dengan WSL2 enabled)
- **macOS** (versi 10.14 atau lebih baru)
- **Linux** (Ubuntu 18.04+, CentOS 7+, atau distribusi lainnya)

Spesifikasi Minimum Sistem

Komponen	Minimum	Rekomendasi
RAM	4 GB	8 GB atau lebih
Ruang Disk	10 GB	20 GB atau lebih
Processor	2 core	4 core atau lebih

Software yang Diperlukan

1. **Docker Desktop** (versi 20.10 atau lebih baru)
2. **Docker Compose** (biasanya sudah terinstal dengan Docker Desktop)
3. **Text Editor** (VS Code, Sublime Text, atau Atom)
4. **Terminal/Command Prompt**
5. **Web Browser** (Chrome, Firefox, atau Edge)

Verifikasi Instalasi Docker

Buka terminal dan jalankan perintah berikut untuk memverifikasi instalasi Docker:

```
# Cek versi Docker
docker --version

# Cek versi Docker Compose
docker-compose --version

# Test Docker dengan menjalankan container hello-world
docker run hello-world
```

Jika semua perintah berjalan dengan baik, sistem Anda siap untuk praktik ini.

Konsep Dasar MongoDB

Sebelum memulai praktik, penting untuk memahami konsep fundamental MongoDB yang membedakannya dari database relasional tradisional (PRAKTIKUM 10 DATABASE NOSQL, n.d.).

Arsitektur MongoDB

MongoDB menggunakan arsitektur yang berbeda dengan database SQL. Berikut adalah perbandingannya:

```
graph TD
    A[Database SQL] --> B[Tables]
    A --> C[Rows]
    A --> D[Columns]

    E[Database MongoDB] --> F[Collections]
    E --> G[Documents]
    E --> H[Fields]

    style A fill:#ffcccc
    style E fill:#ccffcc
```

Terminologi MongoDB

Terminologi SQL	Terminologi MongoDB	Deskripsi
Database	Database	Kontainer untuk collections
Table	Collection	Grup dokumen MongoDB
Row	Document	Struktur data tunggal dalam BSON
Column	Field	Pasangan key-value dalam dokumen
Primary Key	_id	Unique identifier otomatis

Struktur Data MongoDB

MongoDB menyimpan data dalam format BSON (Binary JSON). Contoh struktur dokumen:

```
{
  "_id": ObjectId("635a1b2c3d4e5f6789abc123"),
  "nama": "John Doe",
  "email": "john@example.com",
  "umur": 25,
  "alamat": {
    "jalan": "Jl. Sudirman No. 123",
    "kota": "Jakarta",
    "kode_pos": "12345"
  },
  "hobi": ["membaca", "berenang", "coding"],
  "tanggal_registrasi": ISODate("2023-10-30T10:00:00Z")
}
```

Keuntungan MongoDB

1. **Schema Flexibility**: Struktur dokumen dapat bervariasi dalam satu collection
2. **Scalability**: Mudah untuk scaling horizontal
3. **Performance**: Optimized untuk read operations
4. **Rich Queries**: Mendukung query yang kompleks dan aggregation
5. **Document-oriented**: Cocok untuk aplikasi modern dengan data kompleks

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Instalasi Docker

Proses instalasi Docker berbeda untuk setiap sistem operasi. Ikuti panduan berikut sesuai dengan sistem yang Anda gunakan.

Instalasi di Windows

1. **Download Docker Desktop**
   - Kunjungi docker.com/products/docker-desktop
   - Download installer untuk Windows
   - Pastikan sistem Anda menggunakan Windows 10/11 dengan fitur WSL2
2. **Enable WSL2**

```
# Buka PowerShell sebagai Administrator
dism.exe /online /enable-feature /featurename:Microsoft-Windows-Subsystem-
Linux /all /norestart
dism.exe /online /enable-feature /featurename:VirtualMachinePlatform /all
/norestart
```

1. **Install Docker Desktop**
   - Jalankan installer yang telah diunduh
   - Restart komputer setelah instalasi
   - Launch Docker Desktop dari Start Menu

Instalasi di macOS

1. **Download Docker Desktop**
   - Kunjungi docker.com/products/docker-desktop
   - Pilih versi untuk Mac dengan chip Intel atau Apple Silicon
2. **Install Docker Desktop**
   - Buka file .dmg yang telah diunduh
   - Drag Docker.app ke folder Applications
   - Launch Docker dari Launchpad
3. **Konfigurasi**
   - Ikuti wizard setup awal
   - Berikan password sistem saat diminta

- Tunggu hingga Docker selesai menginisialisasi

Instalasi di Linux (Ubuntu)

1. **Update System Packages**

```
sudo apt-get update
sudo apt-get install ca-certificates curl gnupg
```

1. **Add Docker's GPG Key**

```
sudo install -m 0755 -d /etc/apt/keyrings
curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo gpg --dearmor
-o /etc/apt/keyrings/docker.gpg
sudo chmod a+r /etc/apt/keyrings/docker.gpg
```

1. **Add Docker Repository**

```
echo \
  "deb [arch=$(dpkg --print-architecture) signed-
by=/etc/apt/keyrings/docker.gpg] https://download.docker.com/linux/ubuntu \
  $(. /etc/os-release && echo "$VERSION_CODENAME") stable" | \
  sudo tee /etc/apt/sources.list.d/docker.list > /dev/null
```

1. **Install Docker**

```
sudo apt-get update
sudo apt-get install docker-ce docker-ce-cli containerd.io docker-buildx-
plugin docker-compose-plugin
```

1. **Configure Docker to Run Without sudo**

```
sudo groupadd docker
sudo usermod -aG docker $USER
newgrp docker
```

Verifikasi Instalasi

Setelah instalasi selesai, verifikasi dengan perintah berikut:

```
# Test instalasi Docker
docker run hello-world

# Check Docker info
docker info

# List running containers
docker ps
```

Setup MongoDB dengan Docker

Setelah Docker terinstal, langkah selanjutnya adalah mengatur lingkungan MongoDB menggunakan container Docker.

Metode 1: Menggunakan Docker Run

Cara tercepat untuk menjalankan MongoDB adalah dengan perintah `docker run`:

```
# Pull image MongoDB
docker pull mongo:latest

# Jalankan container MongoDB
docker run --name mongodb-container \
  -p 27017:27017 \
  -d mongo:latest

# Verifikasi container berjalan
docker ps
```

Metode 2: Menggunakan Docker Compose (Rekomendasi)

Docker Compose memungkinkan kita mendefinisikan layanan dalam file YAML. Buat file `docker-compose.yml`:

```
version: '3.8'

services:
  mongodb:
    image: mongo:latest
    container_name: mongodb-server
    restart: always
    ports:
      - "27017:27017"
    environment:
      MONGO_INITDB_ROOT_USERNAME: admin
      MONGO_INITDB_ROOT_PASSWORD: password123
    volumes:
      - mongodb_data:/data/db
      - ./init-mongo.js:/docker-entrypoint-initdb.d/init-mongo.js:ro

volumes:
  mongodb_data:
```

Konfigurasi Lanjutan

Untuk penggunaan produksi, tambahkan konfigurasi berikut:

```
version: '3.8'

services:
  mongodb:
    image: mongo:6.0
    container_name: mongodb-server
    restart: always
    ports:
```

```
      - "27017:27017"
    environment:
      MONGO_INITDB_ROOT_USERNAME: admin
      MONGO_INITDB_ROOT_PASSWORD: password123
      MONGO_INITDB_DATABASE: aplikasi_db
    volumes:
      - mongodb_data:/data/db
      - ./mongo-config:/etc/mongo
      - ./init-scripts:/docker-entrypoint-initdb.d
    command: mongod --auth

  mongo-express:
    image: mongo-express:latest
    container_name: mongo-express-ui
    restart: always
    ports:
      - "8081:8081"
    environment:
      ME_CONFIG_MONGODB_ADMINUSERNAME: admin
      ME_CONFIG_MONGODB_ADMINPASSWORD: password123
      ME_CONFIG_MONGODB_URL: mongodb://admin:password123@mongodb:27017/
    depends_on:
      - mongodb

volumes:
  mongodb_data:
```

Inisialisasi Database

Buat file `init-mongo.js` untuk inisialisasi awal database:

```
// init-mongo.js
db = db.getSiblingDB('aplikasi_db');

// Buat user aplikasi
db.createUser({
  user: 'app_user',
  pwd: 'app_password',
  roles: [
    {
      role: 'readWrite',
      db: 'aplikasi_db'
    }
  ]
});

// Buat collection awal
db.createCollection('users');
db.createCollection('produk');
db.createCollection('transaksi');
```

```
// Insert data awal
db.users.insertOne({
  nama: "Admin User",
  email: "admin@example.com",
  role: "admin",
  created_at: new Date()
});
```

Menjalankan Container

```
# Jalankan semua services
docker-compose up -d

# Cek logs
docker-compose logs -f mongodb

# Cek status container
docker-compose ps
```

Koneksi ke MongoDB

Anda dapat terhubung ke MongoDB menggunakan beberapa metode:

1. **Mongo Shell**

```
# Connect ke container
docker exec -it mongodb-server mongosh

# Connect dengan authentication
docker exec -it mongodb-server mongosh -u admin -p password123 --
authenticationDatabase admin
```

1. **MongoDB Compass** (GUI Desktop)
   - Connection string: `mongodb://admin:password123@localhost:27017/`
2. **Dari Aplikasi**

```
// Node.js example
const { MongoClient } = require('mongodb');
const uri = "mongodb://admin:password123@localhost:27017/?authSource=admin";
```

Instalasi Mongo Express

Mongo Express adalah antarmuka web berbasis Node.js untuk administrasi MongoDB. Ini menyediakan GUI yang user-friendly untuk mengelola database MongoDB.

Cara Instalasi Mongo Express

Metode 1: Standalone

```
# Pull image Mongo Express
docker pull mongo-express:latest

# Jalankan Mongo Express
docker run --name mongo-express \
  --link mongodb-server:mongo \
  -p 8081:8081 \
  -e ME_CONFIG_MONGODB_ADMINUSERNAME=admin \
  -e ME_CONFIG_MONGODB_ADMINPASSWORD=password123 \
  -e ME_CONFIG_MONGODB_URL=mongodb://admin:password123@mongodb:27017/ \
  -d mongo-express
```

Metode 2: Dengan Docker Compose (Sudah termasuk di file sebelumnya)

Jika Anda menggunakan file `docker-compose.yml` dari bagian sebelumnya, Mongo Express sudah terkonfigurasi dan akan otomatis terinstall saat menjalankan `docker-compose up`.

Konfigurasi Mongo Express

Environment Variables

Variable	Deskripsi	Default
`ME_CONFIG_MONGODB_SERVER`	MongoDB server hostname	localhost
`ME_CONFIG_MONGODB_PORT`	MongoDB port	27017
`ME_CONFIG_MONGODB_ADMINUSERNAME`	Admin username	-
`ME_CONFIG_MONGODB_ADMINPASSWORD`	Admin password	-
`ME_CONFIG_MONGODB_URL`	Connection string	-
`ME_CONFIG_BASICAUTH_USERNAME`	Basic auth username	-
`ME_CONFIG_BASICAUTH_PASSWORD`	Basic auth password	-

Konfigurasi Advanced

Buat file `config.default.js` untuk konfigurasi lanjutan:

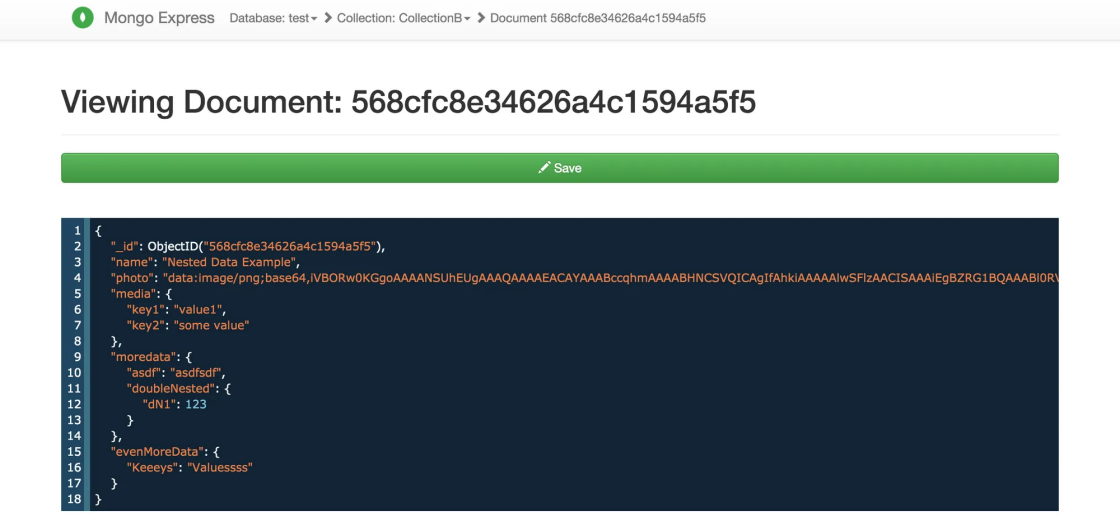
```
module.exports = {
  mongodb: {
    server: 'mongodb',
    port: 27017,
    // SSL options
    ssl: false,
    sslValidate: false,
    sslCA: null,
    authentication: {
      authSource: 'admin'
    }
  },
```

```
  site: {
    baseUrl: '/',
    cookieKeyName: 'mongo-express',
    sessionSecret: process.env.ME_CONFIG_SITE_SESSION_SECRET ||
'sessionscret',
    cookieSecret: process.env.ME_CONFIG_SITE_COOKIE_SECRET || 'cookiesecret'
  },
  setBasicAuth: {
    username: process.env.ME_CONFIG_BASICAUTH_USERNAME,
    password: process.env.ME_CONFIG_BASICAUTH_PASSWORD
  }
};
```

Mengakses Mongo Express

1. **Buka Browser**
   - Navigate ke `http://localhost:8081`
   - Login dengan credentials yang telah diset
2. **Interface Overview**
   - **Database List**: Daftar semua database
   - **Collection View**: Tampilan dokumen dalam collection
   - **Query Builder**: Interface untuk membuat query
   - **Index Manager**: Manajemen index
   - **User Management**: Manajemen user database

Fitur-Fitur Utama Mongo Express



Mongo Express Interface

1. Database Management

- View semua database yang tersedia
- Create new database
- Drop database
- View database statistics

2. Collection Operations

- Create new collection
- Insert documents
- View documents dengan pagination
- Edit documents
- Delete documents
- Import/Export documents

3. Query Builder

Interface visual untuk membuat query MongoDB:

```
// Example query di Mongo Express
{
  "nama": "John Doe",
  "umur": { "$gt": 18 }
}
```

4. Index Management

- Create indexes
- View existing indexes
- Drop indexes
- Compound indexes

Security Best Practices

1. **Jangan expose ke public internet tanpa authentication**
2. **Gunakan HTTPS di production**
3. **Batasi akses dengan firewall**
4. **Gunakan environment variables untuk sensitive data**
5. **Regular backup database**

Tips Penggunaan Mongo Express

- **Use the Query Builder untuk query kompleks**
- **Export data sebagai JSON atau CSV**
- **Use aggregation pipeline untuk analisis data**
- **Monitor performance dengan explain()**
- **Backup regular melalui interface**

Membuat Proyek Sederhana: Sistem Manajemen Kontak

Sekarang kita akan membuat proyek sederhana berupa Sistem Manajemen Kontak menggunakan MongoDB dan Mongo Express. Proyek ini akan mendemonstrasikan konsep dasar database NoSQL dalam aplikasi nyata.

Spesifikasi Proyek

Sistem Manajemen Kontak akan memiliki fitur:

1. **Manajemen Kontak** - Tambah, edit, hapus kontak
2. **Kategorisasi** - Grup kontak (keluarga, teman, kerja)
3. **Pencarian** - Cari kontak berdasarkan nama atau email
4. **Export Data** - Export kontak ke format CSV/JSON
5. **Import Batch** - Import kontak dari file

Desain Database

Collection: kontak

```
{
  "_id": ObjectId("635a1b2c3d4e5f6789abc123"),
  "nama_depan": "John",
  "nama_belakang": "Doe",
  "email": "john.doe@example.com",
  "telepon": [
    {
      "tipe": "mobile",
      "nomor": "+628123456789",
      "utama": true
    },
    {
      "tipe": "office",
      "nomor": "+622212345678",
      "utama": false
    }
  ],
  "alamat": {
    "jalan": "Jl. Sudirman No. 123",
    "kota": "Jakarta",
    "provinsi": "DKI Jakarta",
    "kode_pos": "12345",
    "negara": "Indonesia"
  },
  "tanggal_lahir": ISODate("1990-01-15T00:00:00Z"),
  "grup": "teman",
  "foto": "https://example.com/foto/johndoe.jpg",
  "catatan": "Kolega dari kantor lama",
  "tags": ["programming", "javascript", "nodejs"],
  "dibuat_pada": ISODate("2023-10-30T10:00:00Z"),
```

```
  "diperbarui_pada": ISODate("2023-10-30T10:00:00Z"),
  "status": "aktif"
}
```

Collection: grup

```
{
  "_id": ObjectId("635a1b2c3d4e5f6789abc124"),
  "nama": "keluarga",
  "deskripsi": "Anggota keluarga dekat",
  "warna": "#FF5733",
  "dibuat_pada": ISODate("2023-10-30T10:00:00Z"),
  "status": "aktif"
}
```

Langkah 1: Membuka Mongo Express

1. Buka browser
2. Navigate ke `http://localhost:8081`
3. Login dengan credentials yang telah diset

Langkah 2: Membuat Database

1. Klik **Create Database**
2. Masukkan nama database: `kontak_manager`
3. Klik **Create**

Langkah 3: Membuat Collections

Buat Collection grup

1. Pilih database `kontak_manager`
2. Klik **New Collection**
3. Masukkan nama collection: `grup`
4. Klik **Create**

Buat Collection kontak

1. Klik **New Collection**
2. Masukkan nama collection: `kontak`
3. Klik **Create**

Langkah 4: Insert Data Awal

Insert Data Grup

Klik collection `grup` → **Insert Document**:

```
{
  "nama": "keluarga",
  "deskripsi": "Anggota keluarga dekat",
  "warna": "#FF5733",
  "dibuat_pada": {
```

```
    "$date": "2023-10-30T10:00:00.000Z"
  },
  "status": "aktif"
}

{
  "nama": "teman",
  "deskripsi": "Teman-teman dekat",
  "warna": "#33FF57",
  "dibuat_pada": {
    "$date": "2023-10-30T10:00:00.000Z"
  },
  "status": "aktif"
}

{
  "nama": "kerja",
  "deskripsi": "Rekan kerja",
  "warna": "#3357FF",
  "dibuat_pada": {
    "$date": "2023-10-30T10:00:00.000Z"
  },
  "status": "aktif"
}
```

Insert Data Kontak

Klik collection kontak → **Insert Document**:

```
{
  "nama_depan": "Ahmad",
  "nama_belakang": "Pratama",
  "email": "ahmad.pratama@example.com",
  "telepon": [
    {
      "tipe": "mobile",
      "nomor": "+6281234567890",
      "utama": true
    }
  ],
  "alamat": {
    "jalan": "Jl. Thamrin No. 45",
    "kota": "Jakarta Pusat",
    "provinsi": "DKI Jakarta",
    "kode_pos": "10230",
    "negara": "Indonesia"
  },
  "tanggal_lahir": {
    "$date": "1992-05-15T00:00:00.000Z"
  },
  "grup": "teman",
```

```
  "tags": ["developer", "javascript"],
  "dibuat_pada": {
    "$date": "2023-10-30T10:00:00.000Z"
  },
  "diperbarui_pada": {
    "$date": "2023-10-30T10:00:00.000Z"
  },
  "status": "aktif"
}

{
  "nama_depan": "Siti",
  "nama_belakang": "Nurhaliza",
  "email": "siti.nurhaliza@example.com",
  "telepon": [
    {
      "tipe": "mobile",
      "nomor": "+6282345678901",
      "utama": true
    },
    {
      "tipe": "home",
      "nomor": "+622134567890",
      "utama": false
    }
  ],
  "alamat": {
    "jalan": "Jl. Gatot Subroto No. 78",
    "kota": "Bandung",
    "provinsi": "Jawa Barat",
    "kode_pos": "40111",
    "negara": "Indonesia"
  },
  "tanggal_lahir": {
    "$date": "1990-12-20T00:00:00.000Z"
  },
  "grup": "keluarga",
  "tags": ["designer", "ui/ux"],
  "dibuat_pada": {
    "$date": "2023-10-30T10:00:00.000Z"
  },
  "diperbarui_pada": {
    "$date": "2023-10-30T10:00:00.000Z"
  },
  "status": "aktif"
}
```

Langkah 5: Membuat Index

Index penting untuk optimasi query performance:

```
// Index untuk pencarian nama
db.kontak.createIndex({ "nama_depan": 1, "nama_belakang": 1 });

// Index untuk email (unique)
db.kontak.createIndex({ "email": 1 }, { unique: true });

// Index untuk grup
db.kontak.createIndex({ "grup": 1 });

// Index untuk tags
db.kontak.createIndex({ "tags": 1 });

// Index compound untuk pencarian lanjutan
db.kontak.createIndex({
  "grup": 1,
  "status": 1,
  "dibuat_pada": -1
});
```

Langkah 6: Validasi Schema

MongoDB mendukung schema validation untuk menjaga konsistensi data:

```
db.runCommand({
  collMod: "kontak",
  validator: {
    $jsonSchema: {
      bsonType: "object",
      required: ["nama_depan", "email", "telepon", "grup"],
      properties: {
        nama_depan: {
          bsonType: "string",
          minLength: 2,
          maxLength: 50
        },
        email: {
          bsonType: "string",
          pattern: "^[a-zA-Z0-9._%+-]+@[a-zA-Z0-9.-]+\\.[a-zA-Z]{2,}$"
        },
        telepon: {
          bsonType: "array",
          minItems: 1,
          items: {
            bsonType: "object",
            required: ["tipe", "nomor"],
            properties: {
              tipe: {
                enum: ["mobile", "home", "office", "other"]
              },
              nomor: {
```

```
                bsonType: "string",
                pattern: "^\\+?[0-9]{10,15}$"
              }
            }
          }
        }
      }
    }
  },
  validationLevel: "moderate",
  validationAction: "error"
});
```

Langkah 7: Aggregation Pipeline

Contoh aggregation untuk analisis data:

```
// Hitung jumlah kontak per grup
db.kontak.aggregate([
  {
    $match: { status: "aktif" }
  },
  {
    $group: {
      _id: "$grup",
      jumlah: { $sum: 1 },
      email_list: { $push: "$email" }
    }
  },
  {
    $sort: { jumlah: -1 }
  }
]);

// Cari kontak dengan umur tertentu
db.kontak.aggregate([
  {
    $addFields: {
      umur: {
        $dateDiff: {
          startDate: "$tanggal_lahir",
          endDate: "$$NOW",
          unit: "year"
        }
      }
    }
  },
  {
    $match: { umur: { $gte: 25 } }
  },
```

```
  {
    $project: {
      nama: { $concat: ["$nama_depan", " ", "$nama_belakang"] },
      email: 1,
      umur: 1,
      grup: 1
    }
  }
]);
```

Langkah 8: Testing Query

Test berbagai query untuk memastikan sistem berfungsi:

```
// Cari kontak berdasarkan nama
db.kontak.find({
  $or: [
    { nama_depan: /Ahmad/i },
    { nama_belakang: /Ahmad/i }
  ]
});

// Cari berdasarkan grup
db.kontak.find({ grup: "teman" });

// Cari dengan multiple tags
db.kontak.find({
  tags: { $all: ["developer", "javascript"] }
});

// Update kontak
db.kontak.updateOne(
  { _id: ObjectId("635a1b2c3d4e5f6789abc123") },
  {
    $set: { diperbarui_pada: new Date() },
    $push: { tags: "updated" }
  }
);
```

Operasi CRUD Dasar

CRUD (Create, Read, Update, Delete) adalah operasi fundamental dalam database management. MongoDB menyediakan metode yang intuitif untuk melakukan operasi ini (Tugas Praktikum Mongodb, n.d.).

Create Operations

Single Document Insert

```
// Method 1: insertOne()
db.kontak.insertOne({
  "nama_depan": "Budi",
  "nama_belakang": "Santoso",
  "email": "budi.santoso@example.com",
  "telepon": [
    {
      "tipe": "mobile",
      "nomor": "+6283456789012",
      "utama": true
    }
  ],
  "grup": "kerja",
  "dibuat_pada": new Date(),
  "status": "aktif"
});

// Method 2: insert() (deprecated)
db.kontak.insert({
  "nama_depan": "Dewi",
  "nama_belakang": "Lestari",
  "email": "dewi.lestari@example.com",
  "grup": "teman"
});
```

Multiple Document Insert

```
// Insert multiple documents
db.kontak.insertMany([
  {
    "nama_depan": "Rizki",
    "nama_belakang": "Putra",
    "email": "rizki.putra@example.com",
    "grup": "teman",
    "tags": ["gamer", "streamer"]
  },
  {
    "nama_depan": "Maya",
    "nama_belakang": "Sari",
    "email": "maya.sari@example.com",
    "grup": "kerja",
    "tags": ["marketing", "sales"]
  },
  {
    "nama_depan": "Fajar",
    "nama_belakang": "Hidayat",
    "email": "fajar.hidayat@example.com",
    "grup": "keluarga",
```

```
    "tags": ["student", "programming"]
  }
]);

// Insert dengan ordered flag
db.kontak.insertMany(
  [
    { "nama_depan": "User1", "email": "user1@example.com" },
    { "nama_depan": "User2", "email": "user2@example.com" },
    { "nama_depan": "User3", "email": "user1@example.com" } // Duplicate
email
  ],
  { ordered: false } // Continue on error
);
```

Best Practices untuk Create Operations

1. **Gunakan insertOne() untuk single document**
2. **Gunakan insertMany() untuk batch insert**
3. **Validasi data sebelum insert**
4. **Gunakan transactions untuk multiple collection operations**
5. **Handle duplicate key errors**

Read Operations

Basic Find

```
// Find all documents
db.kontak.find();

// Find with criteria
db.kontak.find({ grup: "teman" });

// Find with projection
db.kontak.find(
  { grup: "teman" },
  { nama_depan: 1, email: 1, _id: 0 }
);

// Find with pretty print
db.kontak.find().pretty();
```

Query Operators

```
// Comparison operators
db.kontak.find({ umur: { $gt: 25 } });        // Greater than
db.kontak.find({ umur: { $gte: 25 } });       // Greater than or equal
db.kontak.find({ umur: { $lt: 30 } });        // Less than
db.kontak.find({ umur: { $lte: 30 } });       // Less than or equal
db.kontak.find({ umur: { $ne: null } });      // Not equal
db.kontak.find({ umur: { $in: [25, 30, 35] } }); // In array
db.kontak.find({ umur: { $nin: [20, 21] } }); // Not in array
```

```
// Logical operators
db.kontak.find({ $and: [{ grup: "teman" }, { status: "aktif" }] });
db.kontak.find({ $or: [{ grup: "teman" }, { grup: "kerja" }] });
db.kontak.find({ $nor: [{ grup: "teman" }, { status: "nonaktif" }] });

// Element operators
db.kontak.find({ email: { $exists: true } });
db.kontak.find({ tags: { $type: "array" } });
```

Array Operations

```
// Find documents with specific array value
db.kontak.find({ tags: "programming" });

// Find documents with multiple array values
db.kontak.find({ tags: { $all: ["programming", "javascript"] } });

// Find by array size
db.kontak.find({ telepon: { $size: 2 } });

// Array element matching
db.kontak.find({ "telepon.tipe": "mobile" });

// Nested array query
db.kontak.find({
  telepon: {
    $elemMatch: {
      tipe: "mobile",
      utama: true
    }
  }
});
```

Regular Expressions

```
// Case insensitive search
db.kontak.find({ nama_depan: /ahmad/i });

// Starts with
db.kontak.find({ email: /^ahmad/ });

// Ends with
db.kontak.find({ email: /example\.com$/ });

// Contains
db.kontak.find({ nama_depan: /a/ });
```

Update Operations

Update Single Document

```
// updateOne - modifies first matching document
db.kontak.updateOne(
  { email: "ahmad.pratama@example.com" },
  { $set: { status: "updated" } }
);

// Add field to document
db.kontak.updateOne(
  { _id: ObjectId("635a1b2c3d4e5f6789abc123") },
  {
    $set: { "alamat.negara": "Indonesia" },
    $push: { tags: "verified" },
    $inc: { login_count: 1 }
  }
);
```

Update Multiple Documents

```
// updateMany - modifies all matching documents
db.kontak.updateMany(
  { grup: "teman" },
  { $set: { kategori_prioritas: "medium" } }
);

// Update with conditions
db.kontak.updateMany(
  {
    grup: "kerja",
    "telepon.tipe": "mobile"
  },
  { $set: { "telepon.$[].verified": true } }
);
```

Update Operators

```
// $set - Set or update field value
db.kontak.updateOne(
  { _id: ObjectId("...") },
  { $set: { last_login: new Date() } }
);

// $unset - Remove field
db.kontak.updateOne(
  { _id: ObjectId("...") },
  { $unset: { temporary_field: "" } }
);

// $inc - Increment number
db.kontak.updateOne(
```

```
  { _id: ObjectId("...") },
  { $inc: { login_count: 1 } }
);

// $push - Add element to array
db.kontak.updateOne(
  { _id: ObjectId("...") },
  { $push: { tags: "new_tag" } }
);

// $pull - Remove element from array
db.kontak.updateOne(
  { _id: ObjectId("...") },
  { $pull: { tags: "old_tag" } }
);

// $addToSet - Add unique element to array
db.kontak.updateOne(
  { _id: ObjectId("...") },
  { $addToSet: { tags: "unique_tag" } }
);
```

Replace Document

```
// replaceOne - replaces entire document
db.kontak.replaceOne(
  { _id: ObjectId("635a1b2c3d4e5f6789abc123") },
  {
    "nama_depan": "Ahmad",
    "nama_belakang": "Pratama",
    "email": "ahmad.new@example.com",
    "grup": "updated",
    "version": 2
  }
);
```

Delete Operations

Delete Single Document

```
// deleteOne - deletes first matching document
db.kontak.deleteOne({ email: "old.email@example.com" });

// Delete by _id
db.kontak.deleteOne({ _id: ObjectId("635a1b2c3d4e5f6789abc123") });
```

Delete Multiple Documents

```
// deleteMany - deletes all matching documents
db.kontak.deleteMany({ status: "inactive" });

// Delete all documents (use with caution!)
db.kontak.deleteMany({});
```

Safe Delete Pattern

```
// First check what will be deleted
db.kontak.find({ status: "inactive" });

// Confirm deletion
var result = db.kontak.deleteMany({ status: "inactive" });
print("Deleted " + result.deletedCount + " documents");
```

Bulk Operations

```
// Initialize bulk operations
var bulk = db.kontak.initializeUnorderedBulkOp();

// Add operations
bulk.insert({ nama_depan: "Bulk1", email: "bulk1@example.com" });
bulk.find({ email: "old@example.com" }).updateOne({ $set: { status: "updated"
} });
bulk.find({ status: "temp" }).deleteOne();

// Execute bulk operations
var result = bulk.execute();
print("Inserted: " + result.nInserted);
print("Updated: " + result.nUpserted);
print("Deleted: " + result.nRemoved);
```

Query Lanjutan

Setelah memahami operasi CRUD dasar, kita akan mendalami query yang lebih kompleks untuk mengekstrak insight dari data MongoDB.

Aggregation Framework

Aggregation framework adalah fitur powerful MongoDB untuk processing dan analisis data.

Pipeline Stages

```
graph LR
    A[Input Documents] --> B[$match]
    B --> C[$group]
    C --> D[$sort]
    D --> E[$limit]
    E --> F[$project]
    F --> G[Output Documents]
```

Basic Aggregation Example

```
// Contoh: Hitung jumlah kontak per grup
db.kontak.aggregate([
  // Stage 1: Filter hanya kontak aktif
  {
```

```
    $match: {
      status: "aktif"
    }
  },
  // Stage 2: Group by grup
  {
    $group: {
      _id: "$grup",
      total_kontak: { $sum: 1 },
      nama_kontak: { $push: { $concat: ["$nama_depan", " ", "$nama_belakang"]
} }
    }
  },
  // Stage 3: Sort descending
  {
    $sort: {
      total_kontak: -1
    }
  },
  // Stage 4: Rename fields
  {
    $project: {
      grup: "$_id",
      jumlah: "$total_kontak",
      daftar_nama: "$nama_kontak",
      _id: 0
    }
  }
]);
```

Advanced Aggregation Operations

```
// Multi-stage aggregation dengan computed fields
db.kontak.aggregate([
  // Add computed fields
  {
    $addFields: {
      nama_lengkap: { $concat: ["$nama_depan", " ", "$nama_belakang"] },
      jumlah_telepon: { $size: "$telepon" },
      usia: {
        $dateDiff: {
          startDate: "$tanggal_lahir",
          endDate: "$$NOW",
          unit: "year"
        }
      },
      kategori_usia: {
        $switch: {
          branches: [
            { case: { $lt: ["$usia", 18] }, then: "remaja" },
            { case: { $lt: ["$usia", 35] }, then: "dewasa" },
```

```
            { case: { $lt: ["$usia", 60] }, then: "paruh baya" }
          ],
          default: "lansia"
        }
      }
    }
  },
  // Filter berdasarkan kategori
  {
    $match: {
      kategori_usia: { $in: ["dewasa", "paruh baya"] }
    }
  },
  // Group dengan multiple aggregations
  {
    $group: {
      _id: {
        grup: "$grup",
        kategori_usia: "$kategori_usia"
      },
      rata_rata_usia: { $avg: "$usia" },
      total_kontak: { $sum: 1 },
      kontak_tertua: {
        $max: "$nama_lengkap"
      },
      email_list: { $push: "$email" }
    }
  },
  // Sort hasil
  {
    $sort: {
      "_id.grup": 1,
      rata_rata_usia: -1
    }
  }
]);
```

Lookup (Join Operations)

MongoDB mendukung operasi join antar collections dengan `$lookup`.

```
// Join kontak dengan grup
db.kontak.aggregate([
  {
    $lookup: {
      from: "grup",
      localField: "grup",
      foreignField: "nama",
      as: "info_grup"
    }
```

```
  },
  {
    $unwind: "$info_grup" // Flatten array result
  },
  {
    $project: {
      nama_lengkap: { $concat: ["$nama_depan", " ", "$nama_belakang"] },
      email: 1,
      grup_warna: "$info_grup.warna",
      grup_deskripsi: "$info_grup.deskripsi"
    }
  }
]);

// Multiple lookup
db.kontak.aggregate([
  {
    $lookup: {
      from: "grup",
      localField: "grup",
      foreignField: "nama",
      as: "grup_info"
    }
  },
  {
    $lookup: {
      from: "transaksi",
      localField: "_id",
      foreignField: "kontak_id",
      as: "transaksi_history"
    }
  },
  {
    $project: {
      nama: { $concat: ["$nama_depan", " ", "$nama_belakang"] },
      email: 1,
      grup_nama: { $arrayElemAt: ["$grup_info.nama", 0] },
      total_transaksi: { $size: "$transaksi_history" }
    }
  }
]);
```

Text Search

MongoDB memiliki built-in full-text search capability.

```
// Create text index
db.kontak.createIndex({
  nama_depan: "text",
  nama_belakang: "text",
```

```
  catatan: "text"
});

// Text search
db.kontak.find({
  $text: { $search: "ahmad developer" }
});

// Text search dengan score
db.kontak.find(
  { $text: { $search: "developer programming" } },
  { score: { $meta: "textScore" } }
).sort({ score: { $meta: "textScore" } });

// Advanced text search
db.kontak.find({
  $text: {
    $search: "developer -designer", // Exclude designer
    $caseSensitive: false,
    $diacriticSensitive: false
  }
});
```

Geospatial Queries

Untuk aplikasi yang membutuhkan lokasi geografis:

```
// Create 2dsphere index
db.kontak.createIndex({
  "alamat.location": "2dsphere"
});

// Insert dengan GeoJSON
db.kontak.insertOne({
  nama: "Jakarta Office",
  "alamat": {
    location: {
      type: "Point",
      coordinates: [106.8196, -6.2088] // [longitude, latitude]
    }
  }
});

// Find nearby locations
db.kontak.find({
  "alamat.location": {
    $near: {
      $geometry: {
        type: "Point",
        coordinates: [106.8227, -6.1751] // Jakarta coordinates
```

```
      },
      $maxDistance: 5000 // 5km radius
    }
  }
});

// GeoWithin for area search
db.kontak.find({
  "alamat.location": {
    $geoWithin: {
      $geometry: {
        type: "Polygon",
        coordinates: [[
          [106.8, -6.2],
          [106.9, -6.2],
          [106.9, -6.1],
          [106.8, -6.1],
          [106.8, -6.2]
        ]]
      }
    }
  }
});
```

Performance Optimization

```
// Explain query performance
db.kontak.find({ grup: "teman" }).explain("executionStats");

// Use covered queries
db.kontak.createIndex({ grup: 1, email: 1 });
db.kontak.find(
  { grup: "teman" },
  { email: 1, _id: 0 } // Only indexed fields
);

// Use hint for index selection
db.kontak.find({ grup: "teman" }).hint({ grup: 1 });

// Limit and skip for pagination
var page = 1;
var pageSize = 10;
db.kontak.find()
  .sort({ dibuat_pada: -1 })
  .skip((page - 1) * pageSize)
  .limit(pageSize);
```

Complex Query Patterns

```
// Find duplicates
db.kontak.aggregate([
  {
```

```
    $group: {
      _id: "$email",
      count: { $sum: 1 },
      docs: { $push: "$_id" }
    }
  },
  {
    $match: { count: { $gt: 1 } }
  }
]);

// Conditional aggregation
db.kontak.aggregate([
  {
    $group: {
      _id: "$grup",
      kontak_dengan_foto: {
        $sum: {
          $cond: [
            { $ifNull: ["$foto", false] },
            1,
            0
          ]
        }
      },
      total_kontak: { $sum: 1 }
    }
  },
  {
    $addFields: {
      persentase_berfoto: {
        $multiply: [
          100,
          { $divide: ["$kontak_dengan_foto", "$total_kontak"] }
        ]
      }
    }
  }
]);

// Time-based analysis
db.kontak.aggregate([
  {
    $group: {
      _id: {
        year: { $year: "$dibuat_pada" },
        month: { $month: "$dibuat_pada" }
      },
      total_registrasi: { $sum: 1 },
      grup_populer: {
```

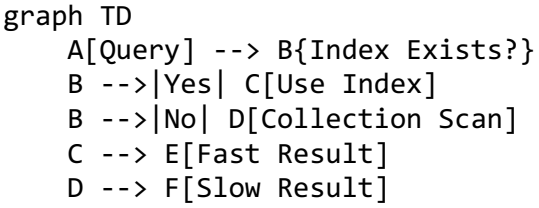
```
        $push: { $arrayElemAt: ["$grup", 0] }
      }
    }
  },
  {
    $sort: { "_id.year": -1, "_id.month": -1 }
  }
]);
```

Indexing dan Optimasi

Indexing adalah salah satu fitur paling penting untuk optimasi performa query MongoDB. Index memungkinkan database untuk menemukan dokumen dengan cepat tanpa melakukan scan seluruh collection.

Konsep Dasar Indexing

Bagaimana Index Bekerja



Jenis-Jenis Index

```
// 1. Single Field Index
db.kontak.createIndex({ email: 1 });

// 2. Compound Index
db.kontak.createIndex({ grup: 1, nama_depan: 1 });

// 3. Multikey Index (for arrays)
db.kontak.createIndex({ tags: 1 });

// 4. Text Index
db.kontak.createIndex({
  nama_depan: "text",
  nama_belakang: "text"
});

// 5. Hashed Index
db.kontak.createIndex({ email: "hashed" });

// 6. Geospatial Index
db.kontak.createIndex({ "alamat.location": "2dsphere" });
```

```
// 7. TTL Index (Time-To-Live)
db.sessions.createIndex({ created_at: 1 }, { expireAfterSeconds: 3600 });
```

Index Strategy

Menentukan Field untuk Di-index

Candidate fields untuk indexing:

1. **Fields yang sering di-query**
2. **Fields untuk sorting**
3. **Fields untuk range queries**
4. **Fields yang unik (untuk unique index)**
5. **Array fields untuk array queries**

Compound Index Best Practices

```
// Rule of thumb: ESR (Equality, Sort, Range)
db.kontak.createIndex({
  status: 1,        // Equality field
  grup: 1,          // Another equality
  dibuat_pada: -1   // Range field (sorting)
});

// Query yang optimal untuk index di atas:
db.kontak.find({
  status: "aktif",
  grup: "teman"
}).sort({ dibuat_pada: -1 });

// Index prefix rules:
// Index: { a: 1, b: 1, c: 1 }
// Queries yang bisa menggunakan index:
// { a: value }
// { a: value, b: value }
// { a: value, b: value, c: value }
// Query yang TIDAK bisa menggunakan index:
// { b: value }
// { b: value, c: value }
```

Index Management

View Existing Indexes

```
// List all indexes on collection
db.kontak.getIndexes();

// Get index stats
db.kontak.getIndexStats();

// Detailed index information
```

```
db.kontak.getIndexes().forEach(function(index) {
  print("Index: " + JSON.stringify(index.key));
  print("Size: " + index.size);
  print("Usage: " + index.accesses.ops);
});
```

Drop Indexes

```
// Drop specific index
db.kontak.dropIndex({ email: 1 });

// Drop index by name
db.kontak.dropIndex("email_1");

// Drop all indexes except _id
db.kontak.dropIndexes();
```

Special Index Types

Unique Index

```
// Unique index untuk mencegah duplikasi
db.kontak.createIndex({ email: 1 }, { unique: true });

// Compound unique index
db.kontak.createIndex({
  nama_depan: 1,
  nama_belakang: 1
}, { unique: true });

// Partial unique index
db.kontak.createIndex(
  { email: 1 },
  {
    unique: true,
    partialFilterExpression: { status: "aktif" }
  }
);
```

Sparse Index

```
// Index hanya untuk dokumen yang memiliki field tersebut
db.kontak.createIndex({ fax: 1 }, { sparse: true });

// Sparse vs Regular Index:
// Regular: null untuk missing values
// Sparse: tidak index dokumen tanpa field
```

TTL Index

```
// Auto-expire documents after certain time
db.sessions.createIndex(
  { created_at: 1 },
  { expireAfterSeconds: 3600 } // 1 hour
```

```
);

// Capped collection dengan TTL
db.logs.createIndex(
  { timestamp: 1 },
  { expireAfterSeconds: 86400 } // 24 hours
);
```

Query Optimization

Explain Plan

```
// Basic explain
db.kontak.find({ email: "test@example.com" }).explain();

// Detailed execution stats
db.kontak.find({ grup: "teman" }).explain("executionStats");

// All execution plans
db.kontak.find({ tags: "javascript" }).explain("allPlansExecution");
```

Reading Explain Output

```
// Check if index is used
var explain = db.kontak.find({ grup: "teman" }).explain("executionStats");
print("Total docs examined: " + explain.executionStats.totalDocsExamined);
print("Total docs returned: " + explain.executionStats.totalDocsReturned);
print("Execution time (ms): " + explain.executionStats.executionTimeMillis);

// Index usage ratio
var ratio = explain.executionStats.totalDocsReturned /
            explain.executionStats.totalDocsExamined;
print("Efficiency ratio: " + ratio);
// Ratio close to 1 = efficient query
```

Covered Queries

```
// Create covering index
db.kontak.createIndex({
  grup: 1,
  email: 1,
  nama_depan: 1
});

// Query that uses covered index
db.kontak.find(
  { grup: "teman" },
  { email: 1, nama_depan: 1, _id: 0 } // Only indexed fields
);

// Verify covered query
db.kontak.find(
  { grup: "teman" },
```

```
  { email: 1, nama_depan: 1, _id: 0 }
).explain("executionStats").executionStats.totalDocsExamined ===
db.kontak.find(
  { grup: "teman" },
  { email: 1, nama_depan: 1, _id: 0 }
).explain("executionStats").executionStats.totalDocsReturned;
```

Performance Monitoring

Index Usage Statistics

```
// Monitor index usage over time
db.runCommand({
  collStats: "kontak",
  indexDetails: true
});

// Check unused indexes
db.kontak.aggregate([
  { $indexStats: {} },
  {
    $project: {
      name: "$name",
      usage: "$accesses.ops",
      lastUsed: "$accesses.since"
    }
  },
  { $sort: { usage: -1 } }
]);
```

Slow Query Analysis

```
// Enable profiler (use with caution in production)
db.setProfilingLevel(2); // Log all operations
db.setProfilingLevel(1, { slowms: 100 }); // Log operations > 100ms

// View slow queries
db.system.profile.find().sort({ ts: -1 }).limit(5);

// Get profiler status
db.getProfilingStatus();
```

Index Maintenance

Rebuild Indexes

```
// Rebuild all indexes
db.kontak.reIndex();

// Check index fragmentation
db.kontak.aggregate([ { $indexStats: {} } ]);
```

```
// Compact collection (requires exclusive lock)
db.runCommand({ compact: "kontak" });
```

Index Size Management

```
// Check index size
db.kontak.totalIndexSize();

// Detailed size info
db.kontak.stats().indexSizes;

// Reduce index size with selective indexing
db.kontak.createIndex(
  { tags: 1 },
  {
    sparse: true,
    partialFilterExpression: {
      tags: { $exists: true, $ne: [] }
    }
  }
);
```

Backup dan Restore

Backup dan restore adalah operasi krusial dalam manajemen database untuk melindungi data dari kehilangan dan corruption.

Backup Methods

1. Mongodump

Mongodump adalah tool untuk membuat backup binary dari MongoDB database.

```
# Backup single database
mongodump --host localhost:27017 --db kontak_manager

# Backup dengan authentication
mongodump --host localhost:27017 \
  --username admin \
  --password password123 \
  --authenticationDatabase admin \
  --db kontak_manager

# Backup specific collections
mongodump --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --collection grup
```

```
# Backup dengan compression
mongodump --host localhost:27017 \
  --db kontak_manager \
  --gzip \
  --out /backup/$(date +%Y%m%d)

# Backup dengan query filter
mongodump --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --query '{"status": "aktif"}'
```

2. Mongoexport

Mongoexport untuk export data dalam format JSON, CSV, atau TSV.

```
# Export collection ke JSON
mongoexport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --out kontak.json

# Export ke CSV
mongoexport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --type=csv \
  --fields=nama_depan,nama_belakang,email,grup,status \
  --out kontak.csv

# Export dengan query
mongoexport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --query '{"grup": "teman"}' \
  --out kontak_teman.json

# Export array ke CSV
mongoexport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --type=csv \
  --fields=nama_depan,email,grup \
  --out kontak.csv
```

Automated Backup Scripts

Bash Script untuk Daily Backup

```
#!/bin/bash
# backup_mongodb.sh
```

```
BACKUP_DIR="/backup/mongodb"
DATE=$(date +%Y%m%d_%H%M%S)
DB_NAME="kontak_manager"
RETENTION_DAYS=7

# Create backup directory
mkdir -p $BACKUP_DIR

# Backup dengan mongodump
mongodump \
  --host localhost:27017 \
  --username admin \
  --password password123 \
  --authenticationDatabase admin \
  --db $DB_NAME \
  --gzip \
  --out $BACKUP_DIR/backup_$DATE

# Compress backup folder
tar -czf $BACKUP_DIR/backup_$DATE.tar.gz -C $BACKUP_DIR backup_$DATE
rm -rf $BACKUP_DIR/backup_$DATE

# Delete old backups
find $BACKUP_DIR -name "backup_*.tar.gz" -mtime +$RETENTION_DAYS -delete

echo "Backup completed: backup_$DATE.tar.gz"
```

Docker Backup Script

```
#!/bin/bash
# mongodb_docker_backup.sh

CONTAINER_NAME="mongodb-server"
BACKUP_DIR="/backup/mongodb"
DATE=$(date +%Y%m%d_%H%M%S)

# Create backup directory
mkdir -p $BACKUP_DIR

# Backup from Docker container
docker exec $CONTAINER_NAME mongodump \
  --db kontak_manager \
  --gzip \
  --out /backup/backup_$DATE

# Copy backup from container
docker cp $CONTAINER_NAME:/backup/backup_$DATE $BACKUP_DIR/

# Compress
```

```
tar -czf $BACKUP_DIR/backup_$DATE.tar.gz -C $BACKUP_DIR backup_$DATE
rm -rf $BACKUP_DIR/backup_$DATE

echo "Docker backup completed: backup_$DATE.tar.gz"
```

Restore Operations

1. Mongorestore

```
# Restore entire database
mongorestore --host localhost:27017 \
  --db kontak_manager \
  /backup/20231030/backup_20231030/kontak_manager

# Restore dengan overwrite
mongorestore --host localhost:27017 \
  --db kontak_manager \
  --drop \
  /backup/20231030/backup_20231030/kontak_manager

# Restore specific collection
mongorestore --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  /backup/20231030/backup_20231030/kontak_manager/kontak.bson

# Restore dari compressed backup
mongorestore --host localhost:27017 \
  --db kontak_manager \
  --gzip \
  /backup/20231030/backup_20231030.tar.gz

# Restore dengan authentication
mongorestore --host localhost:27017 \
  --username admin \
  --password password123 \
  --authenticationDatabase admin \
  --db kontak_manager \
  /backup/20231030/backup_20231030/kontak_manager
```

2. Mongoimport

```
# Import dari JSON
mongoimport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --file kontak.json

# Import dari CSV
mongoimport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
```

```
  --type=csv \
  --headerline \
  --file kontak.csv

# Import dengan mode upsert
mongoimport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak \
  --file kontak.json \
  --mode=upsert \
  --upsertFields=email

# Import ke collection baru
mongoimport --host localhost:27017 \
  --db kontak_manager \
  --collection kontak_backup \
  --file kontak.json
```

Point-in-Time Recovery

Oplog untuk Point-in-Time Recovery

```
// Enable oplog (replica set required)
// Check oplog size
db.getReplicationInfo();
db.printReplicationInfo();

// Query oplog
use local;
db.oplog.rs.find().sort({ ts: -1 }).limit(5);

// Restore to specific timestamp
mongorestore --host localhost:27017 \
  --db kontak_manager \
  --oplogReplay \
  --oplogLimit 1672444800:1 \
  /backup/base_backup/
```

Backup Strategies

1. Full Backup Strategy

```
# Weekly full backup
#!/bin/bash
# weekly_full_backup.sh

BACKUP_DIR="/backup/mongodb/full"
DATE=$(date +%Y%m%d)

mongodump --host localhost:27017 \
  --db kontak_manager \
  --gzip \
```

```
  --out $BACKUP_DIR/full_$DATE

# Keep 4 weeks of full backups
find $BACKUP_DIR -name "full_*" -mtime +28 -delete
```

2. Incremental Backup Strategy

```
# Daily incremental backup menggunakan oplog
#!/bin/bash
# incremental_backup.sh

BACKUP_DIR="/backup/mongodb/incremental"
DATE=$(date +%Y%m%d)
LAST_BACKUP=$(cat $BACKUP_DIR/last_backup.txt)

# Extract oplog since last backup
mongodump --host localhost:27017 \
  --db local \
  --collection oplog.rs \
  --query '{"ts":{"$gt":{"$timestamp":{"t":'$LAST_BACKUP',"i":1}}}}' \
  --out $BACKUP_DIR/inc_$DATE

# Update last backup timestamp
date +%s > $BACKUP_DIR/last_backup.txt
```

3. Cloud Backup Strategy

```
# Backup ke AWS S3
#!/bin/bash
# s3_backup.sh

S3_BUCKET="mongodb-backups-bucket"
LOCAL_BACKUP="/backup/mongodb"
DATE=$(date +%Y%m%d)

# Create backup
mongodump --host localhost:27017 \
  --db kontak_manager \
  --gzip \
  --out $LOCAL_BACKUP/backup_$DATE

# Upload to S3
aws s3 cp $LOCAL_BACKUP/backup_$DATE.tar.gz \
  s3://$S3_BUCKET/mongodb/backup_$DATE.tar.gz

# Clean local backup
rm -rf $LOCAL_BACKUP/backup_$DATE*
```

Verification and Testing

Backup Verification

```
#!/bin/bash
# verify_backup.sh

BACKUP_FILE=$1
TEST_DB="kontak_manager_test"

# Create test database
mongorestore --host localhost:27017 \
  --db $TEST_DB \
  --drop \
  $BACKUP_FILE

# Verify data integrity
mongo --host localhost:27017 --eval "
db = db.getSiblingDB('$TEST_DB');
var originalCount = db.getSiblingDB('kontak_manager').kontak.count();
var restoredCount = db.kontak.count();
print('Original count: ' + originalCount);
print('Restored count: ' + restoredCount);
print('Verification: ' + (originalCount === restoredCount ? 'PASSED' :
'FAILED'));
db.dropDatabase();
"
```

Disaster Recovery Testing

```
#!/bin/bash
# disaster_recovery_test.sh

# 1. Simulate data corruption
mongo kontak_manager --eval "
db.kontak.updateMany({}, {\$set: {corrupted: true}});
"

# 2. Restore from latest backup
LATEST_BACKUP=$(ls -t /backup/mongodb/backup_*.tar.gz | head -1)
tar -xzf $LATEST_BACKUP
mongorestore --host localhost:27017 \
  --db kontak_manager \
  --drop \
  backup_*/kontak_manager

# 3. Verify recovery
mongo kontak_manager --eval "
var count = db.kontak.count({corrupted: {\$exists: false}});
print('Recovered documents: ' + count);
"
```

Monitoring Backup Health

Backup Health Check Script

```
#!/bin/bash
# backup_health_check.sh

BACKUP_DIR="/backup/mongodb"
ALERT_EMAIL="admin@example.com"
MAX_AGE_HOURS=24

# Check latest backup
LATEST_BACKUP=$(ls -t $BACKUP_DIR/backup_*.tar.gz | head -1)
BACKUP_AGE=$(($(date +%s) - $(stat -c %Y $LATEST_BACKUP)))
BACKUP_AGE_HOURS=$((BACKUP_AGE / 3600))

if [ $BACKUP_AGE_HOURS -gt $MAX_AGE_HOURS ]; then
  echo "ALERT: Latest backup is $BACKUP_AGE_HOURS hours old!" | \
    mail -s "MongoDB Backup Alert" $ALERT_EMAIL
fi

# Check backup file integrity
if ! tar -tzf $LATEST_BACKUP > /dev/null; then
  echo "ALERT: Backup file is corrupted!" | \
    mail -s "MongoDB Backup Alert" $ALERT_EMAIL
fi

echo "Backup health check completed"
```

Troubleshooting

Dalam praktik pengembangan dengan MongoDB, berbagai masalah dapat terjadi. Bagian ini membahas troubleshooting umum dan solusinya.

Connection Issues

Problem: Cannot Connect to MongoDB

Symptoms:

- Connection timeout error
- "Cannot connect to MongoDB" message
- Docker container not accessible

Solutions:

```
# 1. Check if MongoDB container is running
docker ps | grep mongo
```

```
# 2. Check container logs
docker logs mongodb-container

# 3. Restart MongoDB container
docker restart mongodb-container

# 4. Check port availability
netstat -tlnp | grep 27017

# 5. Test connection with telnet
telnet localhost 27017

# 6. Check Docker network
docker network ls
docker network inspect bridge
```

Problem: Authentication Failed

Symptoms:

- "Authentication failed" error
- Cannot login with credentials

Solutions:

```
// 1. Check if users exist
use admin
db.getUsers();

// 2. Create admin user if not exists
use admin
db.createUser({
  user: "admin",
  pwd: "password123",
  roles: ["userAdminAnyDatabase", "dbAdminAnyDatabase"]
});

// 3. Check authentication database
mongo mongodb://admin:password123@localhost:27017/?authSource=admin
```

Performance Issues

Problem: Slow Queries

Diagnosis:

```
// 1. Enable profiler
db.setProfilingLevel(2);

// 2. Check slow queries
db.system.profile.find().sort({millis: -1}).limit(5);
```

```
// 3. Explain slow query
db.kontak.find({grup: "teman"}).explain("executionStats");

// 4. Check index usage
db.kontak.getIndexes();
db.kontak.getIndexStats();
```

Solutions:

```
// 1. Create appropriate indexes
db.kontak.createIndex({grup: 1, status: 1});

// 2. Use covered queries
db.kontak.find({grup: "teman"}, {email: 1, _id: 0});

// 3. Optimize aggregation pipeline
db.kontak.aggregate([
  {$match: {status: "aktif"}}, // Early filtering
  {$group: {_id: "$grup", count: {$sum: 1}}},
  {$sort: {count: -1}}
]);
```

Problem: High Memory Usage

Diagnosis:

```
// Check memory usage
db.serverStatus().mem;

// Check working set
db.serverStatus().wiredTiger.cache;

// Check connection stats
db.serverStatus().connections;
```

Solutions:

```
# 1. Limit connections in docker-compose.yml
environment:
  - MONGO_INITDB_ROOT_USERNAME=admin
  - MONGO_INITDB_ROOT_PASSWORD=password123
  - WIRED_TIGER_CACHE_SIZE_GB=1

# 2. Monitor with docker stats
docker stats mongodb-container

# 3. Configure max connections
command: mongod --maxConns 1000
```

Data Issues

Problem: Duplicate Documents

Detection:

```
// Find duplicate emails
db.kontak.aggregate([
  {$group: {_id: "$email", count: {$sum: 1}, docs: {$push: "$_id"}}},
  {$match: {count: {$gt: 1}}}
]);
```

Solution:

```
// Remove duplicates keeping latest
db.kontak.aggregate([
  {$sort: {dibuat_pada: -1}},
  {$group: {
    _id: "$email",
    latest: {$first: "$$ROOT"},
    dups: {$push: "$$ROOT"}
  }},
  {$match: {"dups.1": {$exists: true}}},
  {$replaceRoot: {newRoot: "$latest"}}
]).forEach(function(doc) {
  db.kontak.deleteMany({_id: {$ne: doc._id}, email: doc.email});
});
```

Problem: Schema Inconsistency

Detection:

```
// Find documents missing required fields
db.kontak.find({email: {$exists: false}});

// Find documents with wrong field types
db.kontak.find({umur: {$not: {$type: "number"}}});
```

Solution:

```
// Add missing fields with default values
db.kontak.updateMany(
  {status: {$exists: false}},
  {$set: {status: "aktif"}}
);

// Fix type issues
db.kontak.find({umur: {$type: "string"}}).forEach(function(doc) {
  db.kontak.updateOne(
    {_id: doc._id},
    {$set: {umur: parseInt(doc.umur)}}
```

```
  );
});
```

Docker Issues

Problem: Container Keeps Restarting

Diagnosis:

```
# Check container status
docker ps -a | grep mongo

# Check logs for errors
docker logs mongodb-container

# Inspect container
docker inspect mongodb-container
```

Common Solutions:

```
# 1. Fix volume permissions in docker-compose.yml
volumes:
  - mongodb_data:/data/db
  - ./init-scripts:/docker-entrypoint-initdb.d:ro

# 2. Add health check
healthcheck:
  test: ["CMD", "mongosh", "--eval", "db.adminCommand('ping')"]
  interval: 30s
  timeout: 10s
  retries: 3
```

Problem: Data Persistence Issues

Diagnosis:

```
# Check volume mounts
docker volume ls
docker volume inspect mongodb_mongodb_data

# Check data directory
docker exec mongodb-container ls -la /data/db
```

Solution:

```
# Ensure proper volume configuration
volumes:
  mongodb_data:
    driver: local

services:
```

```
  mongodb:
    volumes:
      - mongodb_data:/data/db
      - ./backup:/backup
```

Mongo Express Issues

Problem: Cannot Access Mongo Express

Solutions:

```
# 1. Check if container is running
docker ps | grep mongo-express

# 2. Check port conflict
netstat -tlnp | grep 8081

# 3. Verify network connection
docker network ls
docker network connect mongodb_default mongo-express-container

# 4. Check environment variables
docker logs mongo-express-ui
```

Problem: Mongo Express Shows "Cannot GET /"

Solution:

```
# Fix ME_CONFIG_MONGODB_URL format
environment:
  ME_CONFIG_MONGODB_URL: "mongodb://admin:password123@mongodb:27017/"
  ME_CONFIG_MONGODB_ENABLE_ADMIN: "true"
```

Common Error Messages

"Operation time out"

```
// Solution: Increase timeout or optimize query
db.adminCommand({
  setParameter: 1,
  internalQueryExecMaxBlockingSortBytes: 104857600
});
```

"Document not found"

```
// Check if document exists before update
var doc = db.kontak.findOne({_id: ObjectId("...")});
if (doc) {
  db.kontak.updateOne({_id: doc._id}, {$set: {field: "value"}});
}
```

"Write conflict"

```
// Use retry logic
var attempts = 0;
var maxAttempts = 3;

while (attempts < maxAttempts) {
  try {
    db.kontak.updateOne({_id: id}, {$set: {field: value}});
    break;
  } catch (e) {
    attempts++;
    sleep(100); // Wait 100ms
  }
}
```

Monitoring and Diagnostics

Health Check Script

```
#!/bin/bash
# mongodb_health_check.sh

CONTAINER="mongodb-server"
PORT=27017

# Check container status
if ! docker ps | grep -q $CONTAINER; then
  echo "ERROR: MongoDB container is not running"
  exit 1
fi

# Check port connectivity
if ! nc -z localhost $PORT; then
  echo "ERROR: Cannot connect to MongoDB port $PORT"
  exit 1
fi

# Check database connectivity
if ! docker exec $CONTAINER mongosh --eval "db.adminCommand('ping')" >
/dev/null; then
  echo "ERROR: MongoDB not responding to ping"
  exit 1
fi

# Check disk space
DISK_USAGE=$(docker exec $CONTAINER df /data/db | tail -1 | awk '{print $5}'
| sed 's/%//')
if [ $DISK_USAGE -gt 80 ]; then
  echo "WARNING: Disk usage is ${DISK_USAGE}%"
fi
```

```
echo "MongoDB health check passed"
```

Performance Monitoring

```
// Create monitoring script in MongoDB
var monitoring = {
  checkConnections: function() {
    var stats = db.serverStatus().connections;
    print("Current connections: " + stats.current);
    print("Available connections: " + stats.available);
    if (stats.current / stats.available > 0.8) {
      print("WARNING: High connection usage");
    }
  },

  checkOperations: function() {
    var stats = db.serverStatus().opcounters;
    print("Operations since start:");
    print("  Insert: " + stats.insert);
    print("  Query: " + stats.query);
    print("  Update: " + stats.update);
    print("  Delete: " + stats.delete);
  },

  checkMemory: function() {
    var mem = db.serverStatus().mem;
    print("Memory usage:");
    print("  Resident: " + (mem.resident / 1024) + " MB");
    print("  Virtual: " + (mem.virtual / 1024) + " MB");
    print("  Mapped: " + (mem.mapped / 1024) + " MB");
  }
};

// Run monitoring
monitoring.checkConnections();
monitoring.checkOperations();
monitoring.checkMemory();
```

Latihan Tambahan

Setelah menyelesaikan praktik dasar, lanjutkan dengan latihan berikut untuk memperdalam pemahaman MongoDB.

Latihan 1: Advanced Schema Design

Tujuan: Mendesain schema yang optimal untuk kasus kompleks

Scenario: Buat sistem e-commerce sederhana dengan collections:

1. **products** - Produk dengan variasi dan review
2. **orders** - Order dengan multiple items
3. **users** - User dengan shopping cart dan wishlist

Task:

```
// 1. Buat collection products dengan embedded reviews
db.products.insertOne({
  name: "Laptop XYZ",
  category: "electronics",
  price: 15000000,
  specifications: {
    brand: "XYZ Corp",
    cpu: "Intel i7",
    ram: "16GB",
    storage: "512GB SSD"
  },
  variations: [
    {
      color: "black",
      stock: 10,
      sku: "XYZ-LAP-BLK"
    },
    {
      color: "silver",
      stock: 5,
      sku: "XYZ-LAP-SLV"
    }
  ],
  reviews: [
    {
      user_id: ObjectId("..."),
      rating: 5,
      comment: "Excellent laptop!",
      date: new Date("2023-10-01")
    }
  ],
  tags: ["laptop", "gaming", "professional"],
  created_at: new Date()
});

// 2. Buat aggregation untuk hitung rata-rata rating per produk
db.products.aggregate([
  {
    $addFields: {
      avg_rating: { $avg: "$reviews.rating" },
      total_reviews: { $size: "$reviews" }
    }
  },
  {
```

```
    $project: {
      name: 1,
      price: 1,
      avg_rating: 1,
      total_reviews: 1
    }
  }
]);

// 3. Query produk dengan variasi tertentu
db.products.find({
  "variations.color": "black",
  "variations.stock": { $gt: 0 }
});
```

Latihan 2: Performance Optimization

Tujuan: Mengoptimasi performa query dengan indexing

Task:

```
// 1. Identifikasi slow queries
db.products.find({
  category: "electronics",
  "specifications.brand": "XYZ Corp"
}).explain("executionStats");

// 2. Buat compound index yang optimal
db.products.createIndex({
  category: 1,
  "specifications.brand": 1,
  price: -1
});

// 3. Test performa dengan explain
db.products.find({
  category: "electronics",
  "specifications.brand": "XYZ Corp"
}).sort({ price: -1 }).explain("executionStats");

// 4. Implementasi pagination yang efisien
function getProductsPage(pageNumber, pageSize) {
  var skip = (pageNumber - 1) * pageSize;
  return db.products.find()
    .sort({ created_at: -1 })
    .skip(skip)
    .limit(pageSize)
    .toArray();
}
```

```
// 5. Implementasi search dengan text index
db.products.createIndex({
  name: "text",
  "specifications.cpu": "text",
  tags: "text"
});

db.products.find({
  $text: { $search: "laptop gaming" }
}, { score: { $meta: "textScore" } })
.sort({ score: { $meta: "textScore" } });
```

Latihan 3: Data Validation and Security

Tujuan: Implementasi schema validation dan security best practices

Task:

```
// 1. Buat schema validation untuk products
db.runCommand({
  collMod: "products",
  validator: {
    $jsonSchema: {
      bsonType: "object",
      required: ["name", "category", "price"],
      properties: {
        name: {
          bsonType: "string",
          minLength: 3,
          maxLength: 100
        },
        price: {
          bsonType: "number",
          minimum: 0
        },
        category: {
          enum: ["electronics", "clothing", "books", "home"]
        }
      }
    }
  }
});

// 2. Test validation
try {
  db.products.insertOne({
    name: "Invalid Product",
    category: "invalid_category",
    price: -100
  });
```

```
} catch (e) {
  print("Validation error: " + e.message);
}

// 3. Buat role-based access control
use admin
db.createRole({
  role: "productManager",
  privileges: [
    {
      resource: { db: "ecommerce", collection: "products" },
      actions: ["find", "insert", "update"]
    }
  ],
  roles: []
});

// 4. Create user dengan role tertentu
db.createUser({
  user: "product_manager",
  pwd: "secure_password",
  roles: [
    { role: "productManager", db: "ecommerce" }
  ]
});
```

Latihan 4: Advanced Aggregation

Tujuan: Master aggregation pipeline untuk analisis data kompleks

Task:

```
// 1. Sales analytics dashboard
db.orders.aggregate([
  // Stage 1: Filter date range
  {
    $match: {
      order_date: {
        $gte: new Date("2023-01-01"),
        $lte: new Date("2023-12-31")
      },
      status: "completed"
    }
  },
  // Stage 2: Unwind items
  { $unwind: "$items" },
  // Stage 3: Lookup product details
  {
    $lookup: {
      from: "products",
```

```
      localField: "items.product_id",
      foreignField: "_id",
      as: "product"
    }
  },
  // Stage 4: Calculate metrics
  {
    $group: {
      _id: {
        month: { $month: "$order_date" },
        product_category: { $arrayElemAt: ["$product.category", 0] }
      },
      total_revenue: {
        $sum: {
          $multiply: ["$items.quantity", "$items.price"]
        }
      },
      total_items_sold: { $sum: "$items.quantity" },
      unique_orders: { $addToSet: "$_id" }
    }
  },
  // Stage 5: Final calculations
  {
    $project: {
      month: "$_id.month",
      category: "$_id.product_category",
      revenue: "$total_revenue",
      items_sold: "$total_items_sold",
      order_count: { $size: "$unique_orders" },
      avg_order_value: {
        $divide: ["$total_revenue", { $size: "$unique_orders" }]
      }
    }
  },
  // Stage 6: Sort results
  { $sort: { month: 1, revenue: -1 } }
]);
```

Latihan 5: Replication and High Availability

Tujuan: Memahami konsep replica set untuk high availability

Task:

```
# 1. Setup replica set dengan Docker Compose
# docker-compose.replica.yml
version: '3.8'
services:
  mongo-primary:
    image: mongo:6.0
    container_name: mongo-primary
```

```
    command: mongod --replSet rs0 --bind_ip_all
    ports:
      - "27017:27017"

  mongo-secondary1:
    image: mongo:6.0
    container_name: mongo-secondary1
    command: mongod --replSet rs0 --bind_ip_all
    ports:
      - "27018:27017"

  mongo-secondary2:
    image: mongo:6.0
    container_name: mongo-secondary2
    command: mongod --replSet rs0 --bind_ip_all
    ports:
      - "27019:27017"
```

```
// 2. Initialize replica set
rs.initiate({
  _id: "rs0",
  members: [
    { _id: 0, host: "mongo-primary:27017", priority: 2 },
    { _id: 1, host: "mongo-secondary1:27017", priority: 1 },
    { _id: 2, host: "mongo-secondary2:27017", priority: 1 }
  ]
});

// 3. Check replica set status
rs.status();
rs.conf();

// 4. Test failover
// Step down primary
rs.stepDown();

// 5. Configure read preferences
db.collection.find().readPref("secondaryPreferred");
```

Latihan 6: Sharding for Scalability

Tujuan: Memahami horizontal scaling dengan sharding

Task:

```
// 1. Enable sharding for database
sh.enableSharding("ecommerce");

// 2. Shard collection based on user_id
sh.shardCollection("ecommerce.orders", { user_id: 1 });
```

```
// 3. Check sharding status
sh.status();

// 4. Monitor shard distribution
db.runCommand({ listCollections: 1 });
db.runCommand({ shardConnPoolStats: 1 });
```

Latihan 7: Change Streams

Tujuan: Implementasi real-time data change notifications

Task:

```
// 1. Open change stream on collection
var changeStream = db.products.watch();

// 2. Listen for changes
changeStream.on('change', function(change) {
  print("Change detected:");
  print(JSON.stringify(change, null, 2));

  // Process different operation types
  if (change.operationType === 'insert') {
    print("New product added: " + change.fullDocument.name);
  } else if (change.operationType === 'update') {
    print("Product updated: " + change.documentKey._id);
  }
});

// 3. Filter change stream
var filteredStream = db.products.watch([
  { $match: { operationType: 'insert' } }
]);

// 4. Change stream with full document
var fullDocStream = db.products.watch(
  [], // Pipeline
  { fullDocument: 'updateLookup' }
);
```

Latihan 8: Transactions

Tujuan: Implementasi multi-document ACID transactions

Task:

```
// 1. Start transaction
session = db.getMongo().startSession();
session.startTransaction();
```

```
try {
  // 2. Update inventory
  session.getDatabase("ecommerce").products.updateOne(
    { _id: ObjectId("..."), "variations.stock": { $gt: 0 } },
    { $inc: { "variations.$.stock": -1 } }
  );

  // 3. Create order
  session.getDatabase("ecommerce").orders.insertOne({
    user_id: ObjectId("..."),
    items: [{
      product_id: ObjectId("..."),
      quantity: 1,
      price: 15000000
    }],
    total: 15000000,
    status: "pending",
    created_at: new Date()
  });

  // 4. Commit transaction
  session.commitTransaction();
  print("Transaction committed successfully");

} catch (error) {
  // 5. Rollback on error
  session.abortTransaction();
  print("Transaction rolled back: " + error);

} finally {
  session.endSession();
}

// 6. Retry transaction on write conflict
function executeTransactionWithRetry(retryCount) {
  var session = db.getMongo().startSession();

  for (var i = 0; i < retryCount; i++) {
    try {
      session.startTransaction();

      // Transaction operations here
      session.getDatabase("ecommerce").products.updateOne(
        { _id: productId },
        { $inc: { stock: -quantity } }
      );

      session.commitTransaction();
      return true;
```

```
    } catch (error) {
      session.abortTransaction();
      if (i === retryCount - 1) throw error;
      sleep(100 * (i + 1)); // Exponential backoff
    }
  }

  session.endSession();
}
```

Referensi

Berikut adalah referensi yang digunakan dalam penyusunan dokumen ini:

1. Mari Belajar MongoDB - Product Engineering. (2023, February). Diambil dari https://waresix.engineering/mongodb-9674028e545d
2. PRAKTIKUM 10 DATABASE NOSQL. (n.d.). Diambil dari https://yunia.lecturer.pens.ac.id/Praktikum%20Basis%20Data%20Lanjut/10%20Praktikum%20Database%20NoSQL.pdf
3. Tugas Praktikum Mongodb | PDF. (n.d.). Diambil dari https://id.scribd.com/document/730001683/TUGAS-PRAKTIKUM-MONGODB-4

Lampiran

A. Cheatsheet Perintah MongoDB

Basic Operations

```
// Insert
db.collection.insertOne({field: "value"});
db.collection.insertMany([{field: "value1"}, {field: "value2"}]);

// Find
db.collection.find();
db.collection.findOne({field: "value"});
db.collection.find({field: {$gt: 10}});

// Update
db.collection.updateOne({field: "value"}, {$set: {newField: "newValue"}});
db.collection.updateMany({field: "value"}, {$set: {newField: "newValue"}});

// Delete
db.collection.deleteOne({field: "value"});
db.collection.deleteMany({field: "value"});
```

Index Operations

```
// Create indexes
db.collection.createIndex({field: 1});
db.collection.createIndex({field1: 1, field2: -1});
db.collection.createIndex({field: "text"});

// View indexes
db.collection.getIndexes();
db.collection.getIndexStats();

// Drop indexes
db.collection.dropIndex({field: 1});
db.collection.dropIndexes();
```

Aggregation

```
// Basic aggregation
db.collection.aggregate([
  {$match: {field: "value"}},
  {$group: {_id: "$groupField", count: {$sum: 1}}},
  {$sort: {count: -1}}
]);

// Lookup (join)
db.collection.aggregate([
  {$lookup: {
    from: "otherCollection",
    localField: "field",
    foreignField: "field",
    as: "joinedData"
  }}
]);
```

B. Docker Commands Reference

Container Management

```
# Run container
docker run -d --name container-name image

# Stop container
docker stop container-name

# Start container
docker start container-name

# Remove container
docker rm container-name

# View logs
docker logs container-name
```

Docker Compose

```
# Start services
docker-compose up -d

# Stop services
docker-compose down

# View logs
docker-compose logs -f

# Rebuild services
docker-compose up --build

# Execute command in container
docker-compose exec service-name command
```

C. Configuration File Templates

MongoDB Configuration

```
# docker-compose.yml
version: '3.8'
services:
  mongodb:
    image: mongo:6.0
    container_name: mongodb
    restart: always
    ports:
      - "27017:27017"
    environment:
      MONGO_INITDB_ROOT_USERNAME: admin
      MONGO_INITDB_ROOT_PASSWORD: password
    volumes:
      - mongodb_data:/data/db

volumes:
  mongodb_data:
```

Mongo Express Configuration

```
# docker-compose.yml (extended)
version: '3.8'
services:
  mongodb:
    image: mongo:6.0
    container_name: mongodb
    restart: always
    environment:
      MONGO_INITDB_ROOT_USERNAME: admin
      MONGO_INITDB_ROOT_PASSWORD: password
    volumes:
```

```
      - mongodb_data:/data/db

  mongo-express:
    image: mongo-express
    container_name: mongo-express
    restart: always
    ports:
      - "8081:8081"
    environment:
      ME_CONFIG_MONGODB_ADMINUSERNAME: admin
      ME_CONFIG_MONGODB_ADMINPASSWORD: password
      ME_CONFIG_MONGODB_URL: mongodb://admin:password@mongodb:27017/
    depends_on:
      - mongodb

volumes:
  mongodb_data:
```
