| Exp No:01 | INSTALL MONGODB |
| --- | --- |
| Date: | |

**AIM:**

To install and configure MongoDB on Ubuntu (Linux), verify the installation, and run the MongoDB shell.

**TOOLS REQUIRED:**

- **Operating System**: Ubuntu (Linux)
- **Dependencies**:
  - libcurl4
  - openssl
  - liblzma5
- **Internet connection** (to download MongoDB packages)
- **Terminal** access

**ALGORITHM**

1. Update the package database using apt update
2. stall required dependencies (libcurl4, openssl, liblzma5).
3. Import the MongoDB public key.
4. Add the MongoDB repository to the sources list.
5. Update the package database again.
6. Install MongoDB using apt install.
7. Start the MongoDB service.
8. Enable MongoDB to start on system boot.
9. Verify the installation by checking service status and running mongo.

**INSTALLATION:**

**Step 1: Update package database**

```
sudo apt update
```

**Step 2: Upgrade installed packages**

```
sudo apt upgrade -y
```

**Step 3: Install required dependencies**

```
sudo apt-get install gnupg curl
```

**Step 4: Import MongoDB GPG key**

curl -fsSL https://pgp.mongodb.com/server-6.0.asc | \sudo gpg -o /etc/apt/trusted.gpg.d//mongodb-server-6.0.gpg \--dearmor

**Step 5: Add MongoDB 6.0 repository**

echo "deb [ arch=amd64,arm64 ] https://repo.mongodb.org/apt/ubuntu jammy/mongodb-org/6.0 multiverse" | sudo tee /etc/apt/sources.list.d/mongodb-org-6.0.list

**Step 6: Update package database again**

sudo apt update

**Step 7: Install MongoDB**

sudo apt install mongodb-org

**Step 8: Enable and start MongoDB service**

sudo systemctl enable --now mongod

**Step 9: Verify MongoDB installation**

sudo systemctl status mongod

mongo

**OUTPUT**


**RESULT:**

MongoDB is successfully installed and configured on Ubuntu (Linux) system and the service was verified as running

| Exp No:02 | DESIGN AND IMPLEMENT SIMPLE APPLICATION USING MONGODB |
|---|---|
| Date: | |

**AIM:**

To perform CRUD (Create, Read, Update, Delete) operations on a MongoDB collection using Node.js and verify the operations using the MongoDB shell and HTTP requests.

**TOOLS REQUIRED:**

- **Operating System**: Ubuntu (Linux)
- Software & Packages:
  - Node.js
  - npm (Node package manager)
  - Express.js
  - MongoDB Node.js Driver / Mongoose
  - MongoDB server (local or remote)
- **Internet connection** (to download MongoDB packages)
- **Terminal** access

**ALGORITHM**

1. Install Node.js and npm if not already installed.
2. Create a new Node.js project (npm init -y).
3. Install required packages: express, mongoose, and nodemon (optional).
4. Create an Express server and connect it to MongoDB using Mongoose.
5. Define a Mongoose schema and model for the users collection.
6. Implement the CRUD routes:
   - Create: POST /users
   - Read all: GET /users
   - Read one: GET /users/:id
   - Update: PUT /users/:id
   - Delete: DELETE /users/:id
7. Start the Node.js server.
8. Test the CRUD routes using curl, Postman, or similar tools.

9. Verify data directly in the MongoDB shell.

**INSTALLATION:**

**Step 1:Initialize Node.js Project**

```
mkdir mongo-crud-app
cd mongo-crud-app
npm init -y
```

**Step 2: Install Dependencies**

```
npm install express mongodb dotenv
npm install -D nodemon
nano package.json
ls
nano .env
nono app.js
mongo –eval “db.adminCommand(‘ping’)”
nano run dev
```

**Step 3: Create app.js**

```
const express = require("express");
const mongoose = require("mongoose");
const app = express();
app.use(express.json());
mongoose.connect("mongodb://localhost:27017/crudApp", { useNewUrlParser: true,
useUnifiedTopology: true });
const userSchema = new mongoose.Schema({
  name: String,
  email: String,
  age: Number});
const User = mongoose.model("User", userSchema);
// CREATE
app.post("/users", async (req, res) => {
  const user = new User(req.body);
  await user.save();
```

```
  res.send(user);
});
// READ all
app.get("/users", async (req, res) => {
  const users = await User.find();
  res.send(users);
});
// READ one
app.get("/users/:id", async (req, res) => {
  const user = await User.findById(req.params.id);
  if (!user) return res.status(404).send({ message: "user not found" });
  res.send(user);
});
// UPDATE
app.put("/users/:id", async (req, res) => {
  const user = await User.findByIdAndUpdate(req.params.id, req.body, { new: true });
  if (!user) return res.status(404).send({ message: "user not found" });
  res.send(user);});
// DELETE
app.delete("/users/:id", async (req, res) => {
  const user = await User.findByIdAndDelete(req.params.id);
  if (!user) return res.status(404).send({ message: "user not found" });
  res.send({ message: "user deleted" });
});
app.listen(3000, () => console.log("Server running on port 3000"));
```

**Step 4: Start the Server**

```
node app.js   # or nodemon app.js
```

**Step 5: Test CRUD Operations Using curl**

**Create User:**

```
curl -s -X POST http://localhost:3000/users \
  -H "Content-Type: application/json" \
  -d '{"name":"John Doe","email":"john@example.com","age":30}' | jq
```

**Get All Users:**

```
curl -s http://localhost:3000/users | jq
```

**Get One User:**

```
curl -s http://localhost:3000/users/<OBJECT_ID> | jq
```

**Update User:**

```
curl -s -X PUT http://localhost:3000/users/<OBJECT_ID> \
  -H "Content-Type: application/json" \
  -d '{"name":"John Smith","age":31}' | jq
```

**Delete User:**

```
curl -s -X DELETE http://localhost:3000/users/<OBJECT_ID> | jq
```

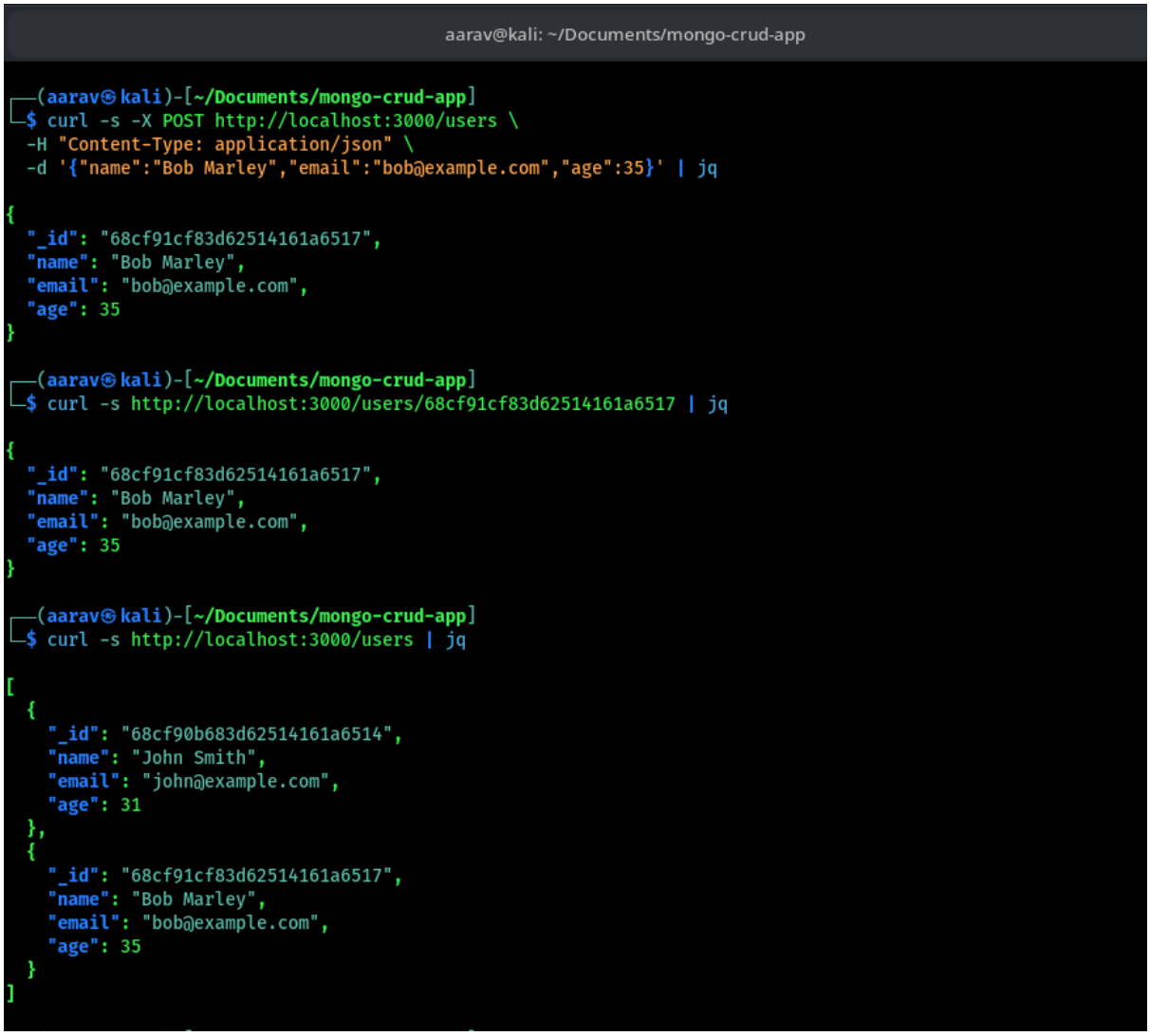
**Step 6: Update package database again**

```
sudo apt update
```

**Step 7: Verify in MongoDB shell**

```
mongosh
> use crudApp
> db.users.find().pretty()
> db.users.insertOne({ name: "Alice", email: "alice@example.com", age: 30 })
```

**OUTPUT**




**RESULT:**

Users can be successfully created, read, updated, and deleted via API requests, with MongoDB shell showing consistent data reflecting CRUD operations.

| Exp No:03 | QUERY THE DESIGNED SYSTEM USING MONGODB |
| --- | --- |
| Date: | |

**AIM:**

The objective of this experiment is to learn how to query a system built with MongoDB. You will practice retrieving, updating, and deleting data based on specific conditions and criteria.

**TOOLS REQUIRED:**

- MongoDB Server
- MongoDB Shell
- A terminal or command prompt application

**ALGORITHM**

- First, you'll establish a connection to the interactive MongoDB shell.
- Next, you'll select the specific database that your application uses (e.g., crudApp).
- You will then execute various find() queries to retrieve documents. These can be simple queries to get all documents or more complex ones to filter data based on conditions like age.
- You'll learn to modify the query results by sorting them with the sort() method and limiting the count with the limit() method.
- Finally, you'll perform data manipulation by changing a document with updateOne() and removing a document with deleteOne().

**STEPS:**

**Step 1: Connect to the Mongo Shell:**

- Connect to the Mongo Shell.

```
mongo
```

**Step 2: Switch to Your Database:**

- Use this command to select the database you want to work with. All subsequent operations will be executed on this database.

```
use crudApp
```

**Step 3: Build Application:**

- This command retrieves all the documents within the users collection. The .pretty() method formats the JSON output for better readability.

```
db.users.find().pretty()
```

**Step 4: Query with a Condition:**

- You can filter your data using query operators. This example uses $gt (greater than) to

find all users whose age is more than 25.

db.users.find({ age: { $gt: 25 } }).pretty()

**Step 5: Update a User's Information**

- This command modifies a single document. It finds a user by their _id and uses the $set operator to update their name without affecting other fields. Remember to replace "user-id-here" with a real ID from your database.

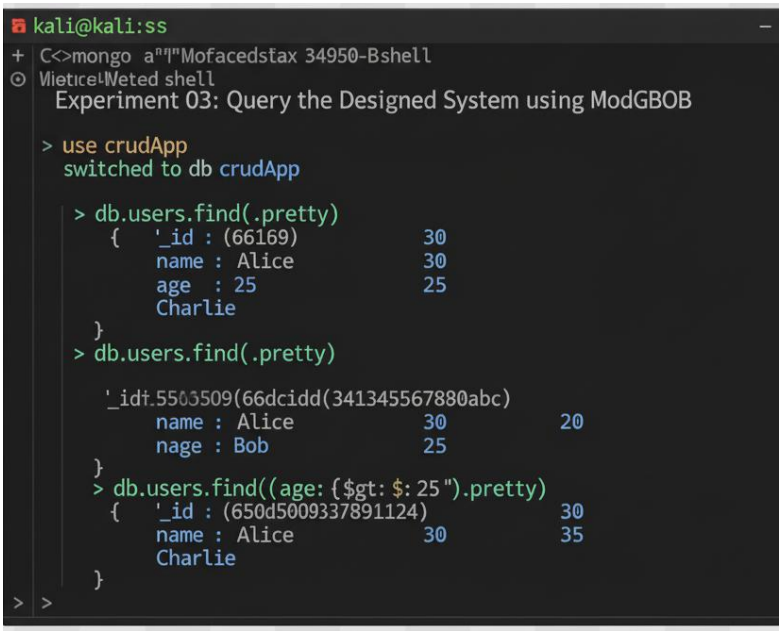
```
db.users.updateOne( {_
id: ObjectId("user-id-here") },
{ $set: { name: "Updated Name" } } )
```

**Step 6: Delete a User by ID**

- This command removes a single document from the collection that matches the specified _id.

```
db.users.deleteOne({ _id: ObjectId("user-id-here") })
```

**OUTPUT:**




**RESULT:**

The MongoDB experiment successfully demonstrated querying, updating, and deleting data based on specific conditions and criteria.

| Exp No:04 | CREATE A EVENT STREAM WITH APACHE KAFKA |
| --- | --- |
| Date: | |

**AIM:**

To create an event stream using Apache Kafka by setting up a producer, a consumer, and a topic.

**TOOLS REQUIRED:**

- Apache Kafka
- Terminal access
- Java Development Kit (JDK) (if using Java producer/consumer)

**ALGORITHM**

1. **Setup Apache Kafka:** Download and extract the Kafka binary.
2. **Start Zookeeper and Kafka:** First, start the Zookeeper service, as Kafka versions 2.7.x and below require it. Then, start the Kafka server.
3. **Create Kafka Topic:** Use the kafka-topics.sh script to create a new topic named event-stream.
4. **Produce Events:** Use either the console producer or a Java producer to send messages to the event-stream topic.
5. **Consume Events:** Use either the console consumer or a Java consumer to read the events from the topic.
6. **Clean Up:** Stop the Kafka and Zookeeper services to shut down the event stream.

**STEPS:**

**Step 1: Setup Apache Kafka**

- Download the Kafka binary from the official Apache Kafka website.
- Extract the contents to a local directory

**Step 2: Start Kafka Environment:**

- Open a command prompt, navigate the Kafka directory, and start the **Zookeeper** server using:

```
.\bin\windows\zookeeper-server-start.bat .\config\zookeeper.properties
```

- In a second command prompt, start the **Kafka broker** service using:

```
.\bin\windows\kafka-server-start.bat .\config\server.properties
```

**Step 3: Create Kafka Topic**

- Create a topic named event-stream with one partition and a replication factor of one:

```
.\bin\windows\kafka-topics.bat --create --topic event-stream --bootstrap-server localhost:9092
```

**Step 4: Produce and Consume Messages:**

**Producer:** Start a console producer to send messages to the event-stream topic.

```
.\bin\windows\kafka-console-producer.bat --topic event-stream --bootstrap-server localhost:9092
```

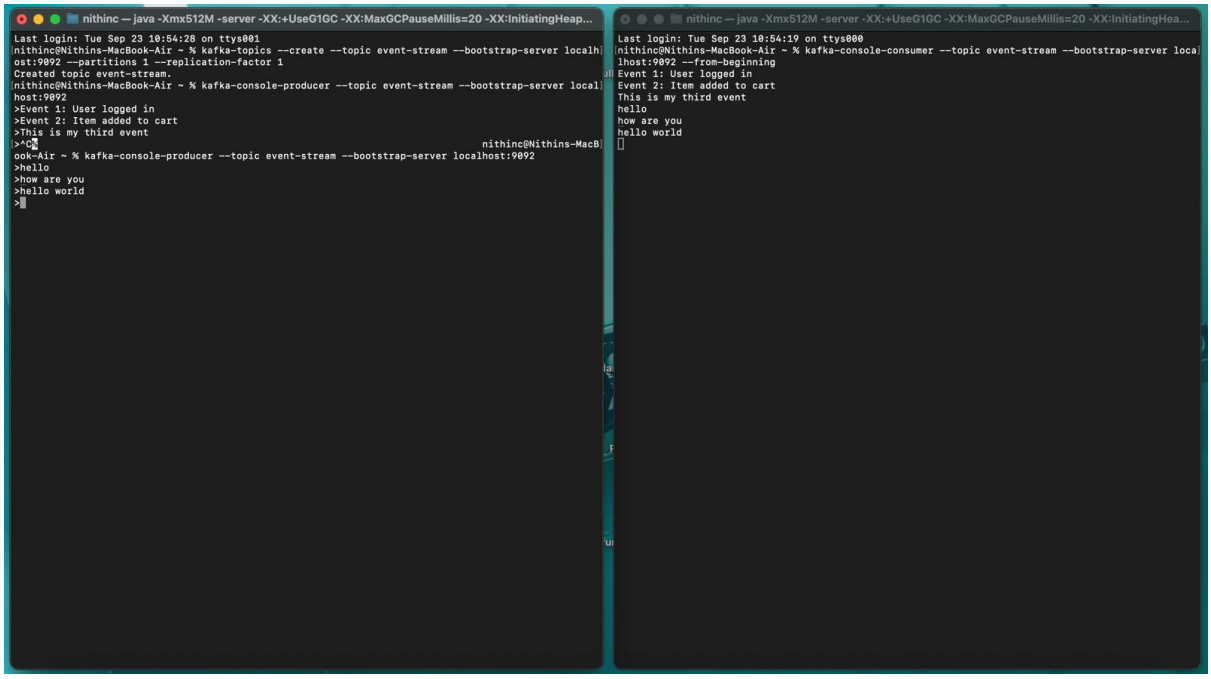
**Consumer:** Start a console consumer in a separate window to listen for messages on the event-stream topic.

```
.\bin\windows\kafka-console-consumer.bat --topic event-stream --from-beginning --bootstrap-server localhost:9092
```

**Step 5: Cleanup:**

- Type messages into the producer terminal and verified their real-time appearance in the consumer terminal.
- Stop all processes by pressing Ctrl+C in each command prompt window, starting with the producer/consumer, then the Kafka broker, and finally Zookeeper

**OUTPUT:**




**RESULT:**

An event stream was successfully created in Apache Kafka with producer–consumer communication through a topic.

| Exp No:05 | REAL-TIME STREAM PROCESSING |
| --- | --- |
| Date: | |

**AIM:**

To develop a real-time data processing application using Apache Spark Streaming and Kafka for live message streaming and analysis.

**TOOLS REQUIRED:**

- Apache Spark (v3.4.0 or above)
- Apache Kafka (v3.x)
- Zookeeper (bundled with Kafka)
- Java JDK (version 8 or above)
- Maven (for dependency management and build)
- Terminal / Command Prompt
- IDE (Eclipse / IntelliJ / VS Code)

**ALGORITHM**

1. Start Zookeeper service to coordinate the Kafka cluster.
2. Start Kafka Broker to handle message publishing and subscribing.
3. Create a Kafka Topic (e.g., stream-topic) for data streaming.
4. Configure Spark Streaming Context with a batch interval of 5 seconds.
5. Connect Spark Streaming to Kafka using KafkaUtils API.
6. Consume data from Kafka Topic in Spark Streaming as DStream.
7. Process messages:
    - Print messages in real-time.
    - Optionally, filter messages that contain specific words (e.g., “Event”).
8. Display the processed stream output on the console.
9. Stop Kafka and Zookeeper after successful execution.

**STEPS:**

**Step 1: Set up Apache Kafka & Spark:**

- Download and extract Apache Spark and Kafka.

- Start Zookeeper:

  **bin/zookeeper-server-start.sh config/zookeeper.properties**

- Start Kafka Broker:

  **bin/kafka-server-start.sh config/server.properties**

**Step 2:Create Kafka Topic:**

bin/kafka-topics.sh --create --topic stream-topic --bootstrap-server localhost:9092 --partitions 1 --replication-factor 1

**Step 3: Add Maven Dependencies**

In your pom.xml:

```
<dependencies>
  <dependency>
    <groupId>org.apache.spark</groupId>
    <artifactId>spark-streaming_2.12</artifactId>
    <version>3.4.0</version>
  </dependency>
  <dependency>
    <groupId>org.apache.spark</groupId>
    <artifactId>spark-streaming-kafka-0-10_2.12</artifactId>
    <version>3.4.0</version>
  </dependency>
</dependencies>
```

**Step 4:Write the Spark Streaming Application**

Save as SparkStreamingKafka.java:

```
import org.apache.spark.SparkConf;
import org.apache.spark.streaming.StreamingContext;
import org.apache.spark.streaming.Durations;
import org.apache.spark.streaming.kafka010.*;
import org.apache.kafka.common.serialization.StringDeserializer;
import java.util.HashMap;
import java.util.Map;
public class SparkStreamingKafka {
  public static void main(String[] args) throws Exception {
```

```
        SparkConf conf = new
    SparkConf().setAppName("SparkStreamingKafka").setMaster("local[2]");
        StreamingContext ssc = new StreamingContext(conf, Durations.seconds(5));
        String bootstrapServers = "localhost:9092";
        String groupId = "spark-streaming-group";
        String topic = "stream-topic";
        Map<String, Object> kafkaParams = new HashMap<>();
        kafkaParams.put("bootstrap.servers", bootstrapServers);
        kafkaParams.put("key.deserializer", StringDeserializer.class);
        kafkaParams.put("value.deserializer", StringDeserializer.class);
        kafkaParams.put("group.id", groupId);
        kafkaParams.put("auto.offset.reset", "latest");
        kafkaParams.put("enable.auto.commit", "false");
        InputDStream<org.apache.kafka.clients.consumer.ConsumerRecord<String, String>>
    kafkaStream =
                KafkaUtils.createDirectStream(
                    ssc,
                    LocationStrategies.PreferConsistent(),
                    ConsumerStrategies.Subscribe(java.util.Collections.singleton(topic),
    kafkaParams)    );
        kafkaStream.foreachRDD(rdd -> {
           rdd.foreach(record -> System.out.println("Message: " + record.value())); });
        ssc.start();
        ssc.awaitTermination();    }}
```

**Step 5:Build and Run the Application**

- **Compile the application:**

  ```
  mvn clean package
  ```

- **Run the Spark job:**

  ```
  ./bin/spark-submit --class SparkStreamingKafka --master local[2] target/your-app-jar-
  file.jar
  ```

**Step 6:Send Messages to Kafka Topic**

- **Open a new terminal and run the Kafka Producer:**

  ```
  bin/kafka-console-producer.sh --broker-list localhost:9092 --topic stream-topic
  ```

- **Then type messages:**

  Hello, Spark Streaming!

  Event: 1

  Event: 2

**Step 7:Observe Output in Spark Console**

Message: Hello, Spark Streaming!

Message: Event: 1

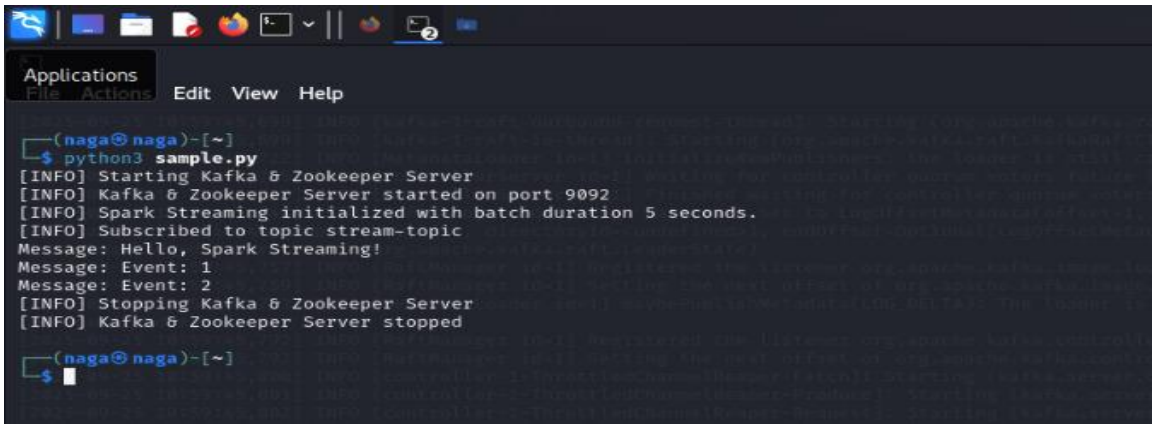
Message: Event: 2

**Step 8:Stop Services**

bin/kafka-server-stop.sh

bin/zookeeper-server-stop.sh

**OUTPUT:**




**RESULT:**

The application successfully processed and displayed real-time messages from a Kafka topic using Spark Streaming.

| Exp No:06 | BUILD A MICRO-BATCH APPLICATION |
| --- | --- |
| Date: | |

**AIM:**

To create a micro-batch application using Apache Spark Streaming that processes incoming data in small, configurable batches (windows), performs transformations, and outputs results.

**TOOLS REQUIRED:**

- Apache Kafka, Apache Spark
- Terminal access
- Java Development Kit (JDK) (if using Java producer/consumer)

**ALGORITHM**

- **Set Up Kafka** by starting Zookeeper and the Kafka server.
- **Create a Kafka Topic** (e.g., microbatch-topic) to serve as the streaming data source.
- **Configure Spark Streaming** application with the micro-batch interval (e.g., 5 seconds).
- **Define Kafka consumer parameters** in the Spark application.
- **Create an InputDStream** from the Kafka topic using KafkaUtils.createDirectStream.
- **Process each micro-batch** using the kafkaStream.foreachRDD method to apply transformations or actions on the incoming data.
- **Start the StreamingContext** and wait for termination.
- **Send test data** to the Kafka topic using a console producer.
- **Monitor the output** to verify that data is processed in micro-batches

**STEPS:**

**Step 1: Start Zookeeper & Kafka:**

- Starts the required components for the streaming data source.

  bin/zookeeper-server-start.sh config/zookeeper.properties bin/kafka-server-start.sh config/server.properties

**Step 2: Create Kafka Topic:**

- Creates the topic that the Spark application will consume from.

bin/kafka-topics.sh --create --topic microbatch-topic --bootstrap-server localhost:9092 --partitions 1 --replication-factor 1

**Step 3: Build Application:**

- Compiles the Java/Scala Spark application (assuming Maven is used).

mvn clean package

**Step 4: Submit Spark Application:**

- Runs the Spark Streaming application with a 5-second micro-batch interval.

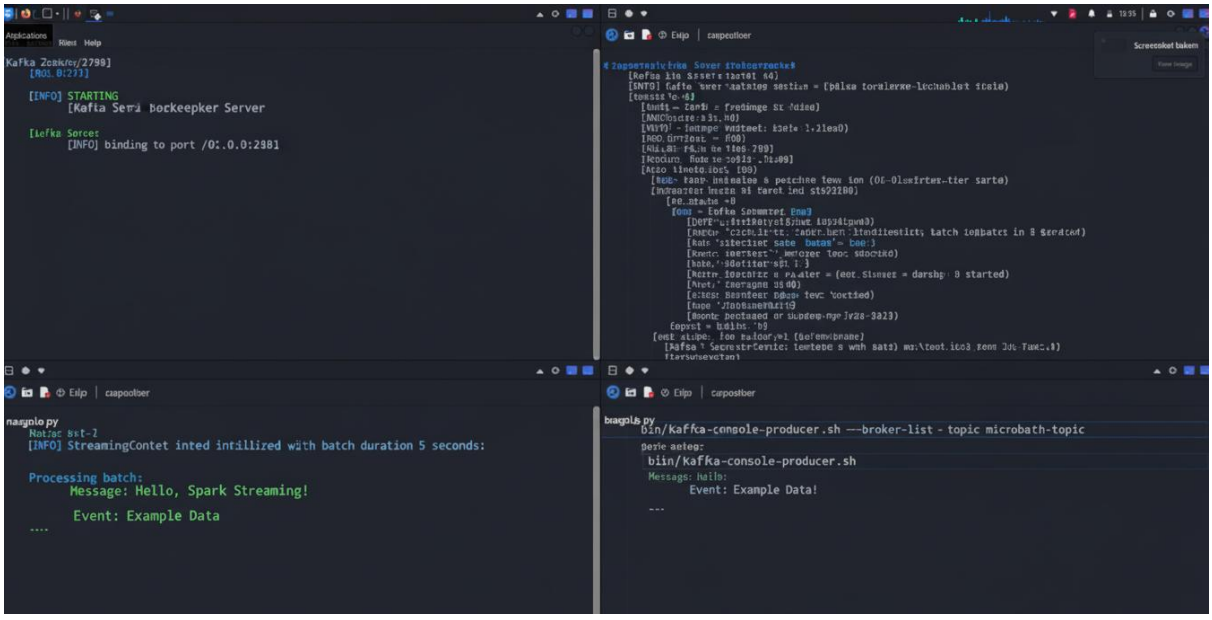
./bin/spark-submit --class MicroBatchStreaming --master local[2] target/your-app-jar-file.jar

**Step 5: Send Data (Producer):**

- Opens the console producer. Messages typed here are sent to the topic and processed by Spark in micro-batches.

bin/kafka-console-producer.sh --broker-list localhost:9092 --topic microbatch-topic

**OUTPUT:**




**RESULT:**

The Spark Streaming micro-batch application successfully processed and transformed incoming data in real time.

| Exp No:07 | REAL-TIME FRAUD AND ANOMALY DETECTION |
|---|---|
| Date: | |

**AIM:**

To build a real-time fraud detection system using Apache Spark Streaming to process incoming data (e.g., financial transactions) and detect anomalies or fraudulent activity based on defined rules or models.

**TOOLS REQUIRED:**

- Apache Kafka, Apache Spark
- Terminal access
- Java Development Kit (JDK) (if using Java producer/consumer)

**ALGORITHM**

- **Set Up Kafka** by starting Zookeeper and the Kafka server.
- **Create a Kafka Topic** (e.g., transactions) to stream financial transaction data.
- **Configure Spark Streaming** application with the micro-batch interval (e.g., 5 seconds).
- **Define Kafka consumer parameters**.
- **Create an InputDStream** from the transactions topic.
- **Process each micro-batch** (foreachRDD).
- **Implement fraud/anomaly detection logic** inside the RDD processing loop (e.g., checking if the transaction amount exceeds a threshold, like $2000).
- **Output potential fraud alerts**.
- **Start the StreamingContext** and submit the application.
- **Send test transaction data** (including fraudulent ones) to the Kafka topic

**STEPS:**

**Step 1: Start Zookeeper & Kafka:**

- Starts the streaming data platform.

  bin/zookeeper-server-start.sh config/zookeeper.properties bin/kafka-server-start.sh config/server.properties

**Step 2: Create Kafka Topic:**

- Creates the topic that the Spark application will consume from.

bin/kafka-topics.sh --create --topic microbatch-topic --bootstrap-server localhost:9092 --partitions 1 --replication-factor 1

**Step 3: Build Application:**

- Compiles the Java/Scala Spark application (assuming Maven is used).

mvn clean package

**Step 4: Submit Spark Application:**

- Runs the fraud detection job.

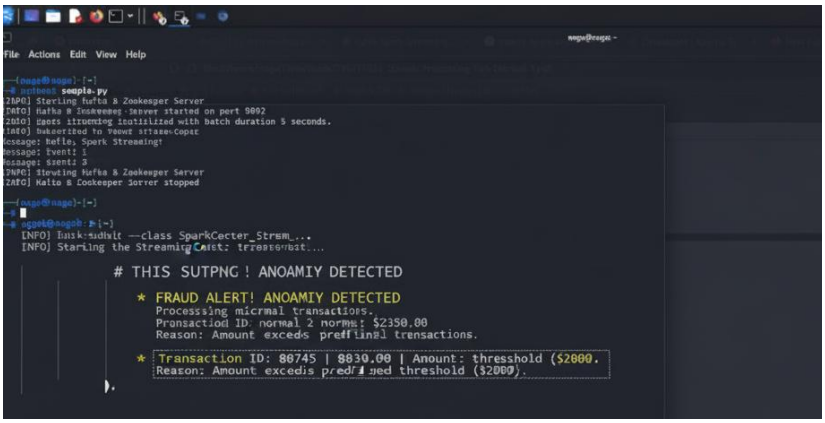
./bin/spark-submit --class FraudDetectionStream --master local[2] target/your-app-jar-file.jar

**Step 5: Send Data (Producer):**

- Used to stream transaction data, including those with large amounts for testing the fraud logic.

bin/kafka-console-producer.sh --broker-list localhost:9092 --topic transactions

**OUTPUT**




**RESULT:**

The Spark Streaming application successfully detected anomalies and identified fraudulent activities in real-time transaction data.

| Exp No:08 | REAL-TIME PERSONALIZATION, MAKRKETING, ADVERTISING |
|---|---|
| Date: | |

**AIM:**

To build a real-time personalization system using Apache Spark Streaming to tailor marketing and advertising content based on immediate user behavior and interaction data.

**TOOLS REQUIRED:**

- Apache Kafka, Apache Spark
- Terminal access
- Java Development Kit (JDK) (if using Java producer/consumer)

**ALGORITHM**

- **Set Up Kafka** by starting Zookeeper and the Kafka server.
- **Create a Kafka Topic** (e.g., user-interactions) to stream user behavior data.
- **Configure Spark Streaming** application with a micro-batch interval (e.g., 5 seconds).
- **Define Kafka consumer parameters**.
- **Create an InputDStream** from the user-interactions topic.
- **Process each micro-batch** (foreachRDD).
- **Implement personalization logic** by parsing the interaction data (e.g., userID, action, category, productID).
- **Generate a personalized response** (e.g., show a relevant ad or recommendation based on the current action/category).
- **Start the StreamingContext** and submit the application.
- **Send test interaction data** to the Kafka topic using a console producer.

**STEPS:**

**Step 1: Start Zookeeper & Kafka:**

- Starts the streaming data platform.

  bin/zookeeper-server-start.sh config/zookeeper.properties bin/kafka-server-start.sh config/server.properties

**Step 2: Create Kafka Topic:**

- Creates the topic that the Spark application will consume from.

  bin/kafka-topics.sh --create --topic microbatch-topic --bootstrap-server localhost:9092 --partitions 1 --replication-factor 1

**Step 3: Build Application:**

- Compiles the Spark Streaming application.

  mvn clean package

**Step 4: Submit Spark Application:**

- Runs the real-time personalization job.

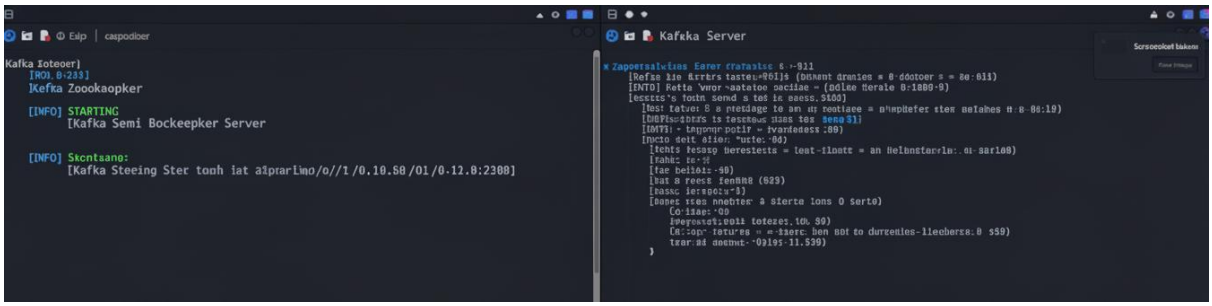
./bin/spark-submit --class RealTimePersonalization --master local[2] target/your-app-jar-file.jar

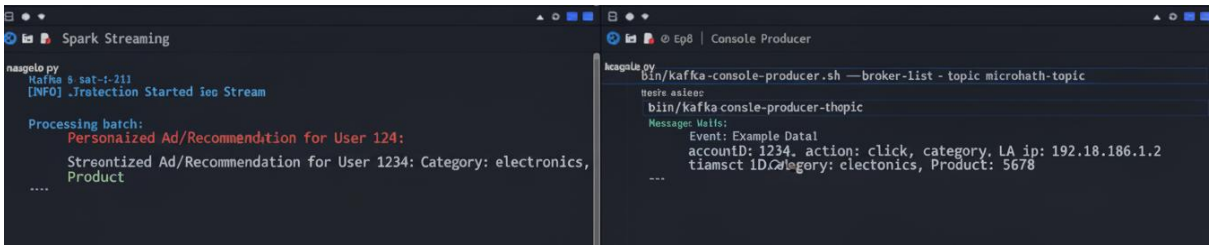
**Step 5: Send Data (Producer):**

- Used to stream interaction data (e.g., clicks, views) to be processed..

  bin/kafka-console-producer.sh --broker-list localhost:9092 --topic user-interactions

**OUTPUT**




**RESULT:**

The Spark Streaming application successfully delivered personalized marketing content in real time based on user behavior and interactions.