尚硅谷大数据技术之 Flink-CDC

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版本：V 2.0

第 1 章 CDC 简介

1.1 什么是 CDC

CDC 是 Change Data Capture(变更数据获取)的简称。核心思想是，监测并捕获数据库的变动（包括数据或数据表的插入、更新以及删除等），将这些变更按发生的顺序完整记录下来，写入到消息中间件中以供其他服务进行订阅及消费。

1.2 CDC 的种类

CDC 主要分为基于查询和基于 Binlog 两种方式，我们主要了解一下这两种之间的区别：

	基于查询的 CDC	基于 Binlog 的 CDC
开源产品	Sqoop、Kafka JDBC Source	Canal、Maxwell、Debezium
执行模式	Batch	Streaming
是否可以捕获所有数据变化	否	是
延迟性	高延迟	低延迟
是否增加数据库压力	是	否

1.3 Flink-CDC

Flink 社区开发了 flink-cdc-connectors 组件，这是一个可以直接从 MySQL、PostgreSQL 等数据库直接读取全量数据和增量变更数据的 source 组件。目前也已开源，开源地址：https://github.com/ververica/flink-cdc-connectors

Connector	Database	Database Version	Flink Version
MySQL CDC	MySQL	Database: 5.7, 8.0.x JDBC Driver: 8.0.16	1.11+
Postgres CDC	PostgreSQL	Database: 9.6, 10, 11, 12 JDBC Driver: 42.2.12	1.11+

第 2 章 FlinkCDC 案例实操

2.1 DataStream 方式的应用

2.1.1 导入依赖

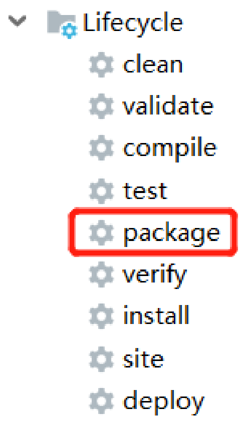
```
<dependencies>
        <dependency>
                <groupId>org.apache.flink</groupId>
                <artifactId>flink-java</artifactId>
                <version>1.12.0</version>
        </dependency>

        <dependency>
                <groupId>org.apache.flink</groupId>
                <artifactId>flink-streaming-java_2.12</artifactId>
                <version>1.12.0</version>
        </dependency>

        <dependency>
                <groupId>org.apache.flink</groupId>
                <artifactId>flink-clients_2.12</artifactId>
                <version>1.12.0</version>
        </dependency>

        <dependency>
                <groupId>org.apache.hadoop</groupId>
                <artifactId>hadoop-client</artifactId>
                <version>3.1.3</version>
        </dependency>

        <dependency>
                <groupId>mysql</groupId>
                <artifactId>mysql-connector-java</artifactId>
                <version>5.1.49</version>
        </dependency>
        <dependency>
            <groupId>com.alibaba.ververica</groupId>
            <artifactId>flink-connector-mysql-cdc</artifactId>
            <version>1.2.0</version>
        </dependency>

        <dependency>
            <groupId>com.alibaba</groupId>
            <artifactId>fastjson</artifactId>
            <version>1.2.75</version>
        </dependency>
</dependencies>

<build>
        <plugins>
            <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-assembly-plugin</artifactId>
                <version>3.0.0</version>
                <configuration>
                    <descriptorRefs>
                        <descriptorRef>jar-with-dependencies</descriptorRef>
                    </descriptorRefs>
                </configuration>
                <executions>
                    <execution>
                        <id>make-assembly</id>
                        <phase>package</phase>
                        <goals>
                            <goal>single</goal>
                        </goals>
                    </execution>
                </executions>
            </plugin>
        </plugins>
</build>
```

2.1.2 编写代码

```
import com.alibaba.ververica.cdc.connectors.mysql.MySQLSource;
import com.alibaba.ververica.cdc.debezium.DebeziumSourceFunction;
import com.alibaba.ververica.cdc.debezium.StringDebeziumDeserializationSchema;
import org.apache.flink.api.common.restartstrategy.RestartStrategies;
import org.apache.flink.runtime.state.filesystem.FsStateBackend;
import org.apache.flink.streaming.api.CheckpointingMode;
import org.apache.flink.streaming.api.datastream.DataStreamSource;
import org.apache.flink.streaming.api.environment.CheckpointConfig;
import org.apache.flink.streaming.api.environment.StreamExecutionEnvironment;

import java.util.Properties;

public class FlinkCDC {

    public static void main(String[] args) throws Exception {

        //1.创建执行环境
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        env.setParallelism(1);

        //2.Flink-CDC 将读取 binlog 的位置信息以状态的方式保存在 CK,如果想要做到断点
续传,需要从 Checkpoint 或者 Savepoint 启动程序
        //2.1 开启 Checkpoint,每隔 5 秒钟做一次 CK
        env.enableCheckpointing(5000L);
        //2.2 指定 CK 的一致性语义
env.getCheckpointConfig().setCheckpointingMode(CheckpointingMode.EXACTLY_ONCE);
        //2.3 设置任务关闭的时候保留最后一次 CK 数据
env.getCheckpointConfig().enableExternalizedCheckpoints(CheckpointConfig.ExternalizedCheckp
ointCleanup.RETAIN_ON_CANCELLATION);
        //2.4 指定从 CK 自动重启策略
        env.setRestartStrategy(RestartStrategies.fixedDelayRestart(3, 2000L));
        //2.5 设置状态后端
        env.setStateBackend(new FsStateBackend("hdfs://hadoop102:8020/flinkCDC"));
        //2.6 设置访问 HDFS 的用户名
        System.setProperty("HADOOP_USER_NAME", "atguigu");

        //3.创建 Flink-MySQL-CDC 的 Source
        //initial (default): Performs an initial snapshot on the monitored database tables upon
first startup, and continue to read the latest binlog.
        //latest-offset: Never to perform snapshot on the monitored database tables upon first
startup, just read from the end of the binlog which means only have the changes since the
connector was started.
        //timestamp: Never to perform snapshot on the monitored database tables upon first
startup, and directly read binlog from the specified timestamp. The consumer will traverse the
binlog from the beginning and ignore change events whose timestamp is smaller than the
specified timestamp.
        //specific-offset: Never to perform snapshot on the monitored database tables upon
first startup, and directly read binlog from the specified offset.
        DebeziumSourceFunction<String> mysqlSource = MySQLSource.<String>builder()
                .hostname("hadoop102")
                .port(3306)
                .username("root")
                .password("000000")
                .databaseList("gmall-flink")
                .tableList("gmall-flink.z_user_info") //可选配置项,如果不指定该参数,则会
读取上一个配置下的所有表的数据，注意：指定的时候需要使用"db.table"的方式
                        .startupOptions(StartupOptions.initial())
                        .deserializer(new StringDebeziumDeserializationSchema())
                        .build();

            //4.使用 CDC Source 从 MySQL 读取数据
            DataStreamSource<String> mysqlDS = env.addSource(mysqlSource);

            //5.打印数据
            mysqlDS.print();

            //6.执行任务
            env.execute();

      }
}
```

2.1.3 案例测试

1）打包并上传至 Linux



2）开启 MySQL Binlog 并重启 MySQL

3）启动 Flink 集群

```
[atguigu@hadoop102 flink-standalone]$ bin/start-cluster.sh
```

4）启动 HDFS 集群

```
[atguigu@hadoop102 flink-standalone]$ start-dfs.sh
```

5）启动程序

```
[atguigu@hadoop102 flink-standalone]$ bin/flink run -c com.atguigu.FlinkCDC flink-1.0-SNAPSHOT-jar-with-dependencies.jar
```

6）在 MySQL 的 gmall-flink.z_user_info 表中添加、修改或者删除数据

7）给当前的 Flink 程序创建 Savepoint

```
[atguigu@hadoop102 flink-standalone]$ bin/flink savepoint JobId
hdfs://hadoop102:8020/flink/save
```

8）关闭程序以后从 Savepoint 重启程序

```
[atguigu@hadoop102 flink-standalone]$ bin/flink run -s hdfs://hadoop102:8020/flink/save/... -c
com.atguigu.FlinkCDC flink-1.0-SNAPSHOT-jar-with-dependencies.jar
```

2.2 FlinkSQL 方式的应用

2.2.1 添加依赖

```
<dependency>
    <groupId>org.apache.flink</groupId>
    <artifactId>flink-table-planner-blink_2.12</artifactId>
    <version>1.12.0</version>
</dependency>
```

2.2.2 代码实现

```
import org.apache.flink.api.common.restartstrategy.RestartStrategies;
import org.apache.flink.runtime.state.filesystem.FsStateBackend;
import org.apache.flink.streaming.api.CheckpointingMode;
import org.apache.flink.streaming.api.environment.CheckpointConfig;
import org.apache.flink.streaming.api.environment.StreamExecutionEnvironment;
import org.apache.flink.table.api.bridge.java.StreamTableEnvironment;

public class FlinkSQL_CDC {

    public static void main(String[] args) throws Exception {

        //1.创建执行环境
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        env.setParallelism(1);
        StreamTableEnvironment tableEnv = StreamTableEnvironment.create(env);

        //2.创建 Flink-MySQL-CDC 的 Source
        tableEnv.executeSql("CREATE TABLE user_info (" +
                        "    id INT," +
                        "    name STRING," +
                        "    phone_num STRING" +
                        ") WITH (" +
                        "    'connector' = 'mysql-cdc'," +
                        "    'hostname' = 'hadoop102'," +
                        "    'port' = '3306'," +
                        "    'username' = 'root'," +
                        "    'password' = '000000'," +
                        "    'database-name' = 'gmall-flink'," +
                        "    'table-name' = 'z_user_info'" +
                        ")");

            tableEnv.executeSql("select * from user_info").print();

            env.execute();

    }

}
```

2.3 自定义反序列化器

2.3.1 代码实现

```
import com.alibaba.fastjson.JSONObject;
import com.alibaba.ververica.cdc.connectors.mysql.MySQLSource;
import com.alibaba.ververica.cdc.debezium.DebeziumDeserializationSchema;
import com.alibaba.ververica.cdc.debezium.DebeziumSourceFunction;
import io.debezium.data.Envelope;
import org.apache.flink.api.common.restartstrategy.RestartStrategies;
import org.apache.flink.api.common.typeinfo.TypeInformation;
import org.apache.flink.runtime.state.filesystem.FsStateBackend;
import org.apache.flink.streaming.api.CheckpointingMode;
import org.apache.flink.streaming.api.datastream.DataStreamSource;
import org.apache.flink.streaming.api.environment.CheckpointConfig;
import org.apache.flink.streaming.api.environment.StreamExecutionEnvironment;
import org.apache.flink.util.Collector;
import org.apache.kafka.connect.data.Field;
import org.apache.kafka.connect.data.Struct;
import org.apache.kafka.connect.source.SourceRecord;

import java.util.Properties;

public class Flink_CDCWithCustomerSchema {

    public static void main(String[] args) throws Exception {
        //1.创建执行环境
        StreamExecutionEnvironment env = 
StreamExecutionEnvironment.getExecutionEnvironment();
        env.setParallelism(1);

        //2.创建 Flink-MySQL-CDC 的 Source
        Properties properties = new Properties();

        //initial (default): Performs an initial snapshot on the monitored database tables upon 
first startup, and continue to read the latest binlog.
        //latest-offset: Never to perform snapshot on the monitored database tables upon first 
startup, just read from the end of the binlog which means only have the changes since the 
connector was started.
        //timestamp: Never to perform snapshot on the monitored database tables upon first 
startup, and directly read binlog from the specified timestamp. The consumer will traverse the 
binlog from the beginning and ignore change events whose timestamp is smaller than the 
specified timestamp.
        //specific-offset: Never to perform snapshot on the monitored database tables upon 
first startup, and directly read binlog from the specified offset.
        DebeziumSourceFunction<String> mysqlSource = MySQLSource.<String>builder()
                .hostname("hadoop102")
                .port(3306)
                .username("root")
                .password("000000")
                .databaseList("gmall-flink")
                .tableList("gmall-flink.z_user_info")           //可选配置项,如果不指定该
参数,则会读取上一个配置下的所有表的数据,注意：指定的时候需要使用"db.table"的方式
.startupOptions(StartupOptions.initial())
                .deserializer(new DebeziumDeserializationSchema<String>() {  //自定义数
据解析器
                    @Override
                    public void deserialize(SourceRecord sourceRecord, Collector<String> 
collector) throws Exception {

                        //获取主题信息,包含着数据库和表名
mysql_binlog_source.gmall-flink.z_user_info
                        String topic = sourceRecord.topic();
                        String[] arr = topic.split("\\.");
                        String db = arr[1];
                        String tableName = arr[2];

                        //获取操作类型  READ DELETE UPDATE CREATE
                        Envelope.Operation operation = 
Envelope.operationFor(sourceRecord);

                        //获取值信息并转换为 Struct 类型
                        Struct value = (Struct) sourceRecord.value();
                        //获取变化后的数据
                        Struct after = value.getStruct("after");

                        //创建 JSON 对象用于存储数据信息
                        JSONObject data = new JSONObject();
                        for (Field field : after.schema().fields()) {
                            Object o = after.get(field);
                            data.put(field.name(), o);
                        }

                        //创建 JSON 对象用于封装最终返回值数据信息
                        JSONObject result = new JSONObject();
                        result.put("operation", operation.toString().toLowerCase());
                        result.put("data", data);
                        result.put("database", db);
                        result.put("table", tableName);

                        //发送数据至下游
                        collector.collect(result.toJSONString());
                    }

                    @Override
                    public TypeInformation<String> getProducedType() {
                        return TypeInformation.of(String.class);
                    }
                })
                .build();

        //3.使用 CDC Source 从 MySQL 读取数据
        DataStreamSource<String> mysqlDS = env.addSource(mysqlSource);

        //4.打印数据
        mysqlDS.print();

        //5.执行任务
        env.execute();
    }
}
```