dataArtisans

Apache Flink® Training

DataStream API Basic

August 26, 2015

DataStream API

- Stream Processing
- Java and Scala
- All examples here in Java
- Shares many concepts with DataSet API
- Documentation available at flink.apache.org

- Currently labeled as *beta* – some API changes are pending
  - Noted in the slides with a warning

DataStream API by Example

Window WordCount: main method

```
public static void main(String[] args) throws Exception {
    // set up the execution environment
    final StreamExecutionEnvironment env =
        StreamExecutionEnvironment.getExecutionEnvironment();

    DataSet<Tuple2<String, Integer>> counts = env
            // read stream of words from socket
            .socketTextStream("localhost", 9999)
            // split up the lines in tuples containing: (word,1)
            .flatMap(new Splitter())
            // group by the tuple field "0"
            .groupBy(0)
           // keep the last 5 minute of data
            .window(Time.of(5, TimeUnit.MINUTES))
            //sum up tuple field "1"
            .sum(1);

    // print result in command line
    counts.print();
    // execute program
    env.execute("Socket Incremental WordCount Example");
}
```

Stream Execution Environment

```
public static void main(String[] args) throws Exception {
    // set up the execution environment
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        StreamExecutionEnvironment.getExecutionEnvironment();

    DataSet<Tuple2<String, Integer>> counts = env
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Data Sources

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Data types

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

Transformations

```
public static void main(String[] args) throws Exception {
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    // print result in command line
    counts.print();
    // execute program
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}
```

User functions

```
public static void main(String[] args) throws Exception {
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        StreamExecutionEnvironment.getExecutionEnvironment();

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            .socketTextStream("localhost", 9999)
            // split up the lines in tuples containing: (word,1)
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    counts.print();
    // execute program
    env.execute("Socket Incremental WordCount Example");
}
```

DataSinks

```
public static void main(String[] args) throws Exception {
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            .sum(1);

    // print result in command line
    counts.print();
    // execute program
    env.execute("Socket Incremental WordCount Example");
}
```

Execute!

```
public static void main(String[] args) throws Exception {
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            .sum(1);

    // print result in command line
    counts.print();
    // execute program
    env.execute("Socket Incremental WordCount Example");
}
```

Window WordCount: FlatMap

```
public static class Splitter
  implements FlatMapFunction<String, Tuple2<String, Integer>> {

  @Override
  public void flatMap(String value,
                      Collector<Tuple2<String, Integer>> out)
    throws Exception {
        // normalize and split the line
        String[] tokens = value.toLowerCase().split("\\W+");

        // emit the pairs
        for (String token : tokens) {
            if (token.length() > 0) {
                out.collect(
                    new Tuple2<String, Integer>(token, 1));
            }
        }
    }
}
```

Note: Identical to DataSet API

WordCount: Map: Interface

```
public static class Splitter
  implements FlatMapFunction<String, Tuple2<String, Integer>> {

  @Override
  public void flatMap(String value,
                      Collector<Tuple2<String, Integer>> out)
    throws Exception {
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        for (String token : tokens) {
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            }
        }
    }
}
```

Note: Identical to DataSet API

WordCount: Map: Types

```
public static class Splitter
  implements FlatMapFunction<String, Tuple2<String, Integer>> {

  @Override
  public void flatMap(String value,
                      Collector<Tuple2<String, Integer>> out)
    throws Exception {
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                    new Tuple2<String, Integer>(token, 1));
            }
        }
    }
}
```

Note: Identical to DataSet API

WordCount: Map: Collector

```
public static class Splitter
  implements FlatMapFunction<String, Tuple2<String, Integer>> {

  @Override
  public void flatMap(String value,
                      Collector<Tuple2<String, Integer>> out)
    throws Exception {
        // normalize and split the line
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        // emit the pairs
        for (String token : tokens) {
            if (token.length() > 0) {
                out.collect(
                    new Tuple2<String, Integer>(token, 1));
            }
        }
    }
}
```

Note: Identical to DataSet API

DataStream API Concepts

(Selected) Data Types

- Basic Java Types
  - String, Long, Integer, Boolean,…
  - Arrays
- Composite Types
  - Tuples
  - Many more (covered in the advanced slides)

Note: Identical to DataSet API

Tuples

- The easiest and most lightweight way of encapsulating data in Flink
- Tuple1 up to Tuple25

```
Tuple2<String, String> person =
  new Tuple2<String, String>("Max", "Mustermann”);

Tuple3<String, String, Integer> person =
  new Tuple3<String, String, Integer>("Max", "Mustermann", 42);

Tuple4<String, String, Integer, Boolean> person =
  new Tuple4<String, String, Integer, Boolean>("Max", "Mustermann", 42, true);

// zero based index!
String firstName = person.f0;
String secondName = person.f1;
Integer age = person.f2;
Boolean fired = person.f3;
```

Note: Identical to DataSet API

Transformations: Map

```
DataStream<Integer> integers = env.fromElements(1, 2, 3, 4);

// Regular Map - Takes one element and produces one element
DataStream<Integer> doubleIntegers =
     integers.map(new MapFunction<Integer, Integer>() {
     @Override
          public Integer map(Integer value) {
            return value * 2;
          }
     });

doubleIntegers.print();
> 2, 4, 6, 8


// Flat Map - Takes one element and produces zero, one, or more elements.
DataStream<Integer> doubleIntegers2 =

     integers.flatMap(new FlatMapFunction<Integer, Integer>() {
          @Override
          public void flatMap(Integer value, Collector<Integer> out) {
               out.collect(value * 2);
          }
     });

doubleIntegers2.print();
> 2, 4, 6, 8
```

Note: Identical to DataSet API

Transformations: Filter

```
// The DataStream
DataStream<Integer> integers = env.fromElements(1, 2, 3, 4);

DataStream<Integer> filtered =

    integers.filter(new FilterFunction<Integer>() {
        @Override
        public boolean filter(Integer value) {
            return value != 3;
        }
    });

integers.print();
> 1, 2, 4
```

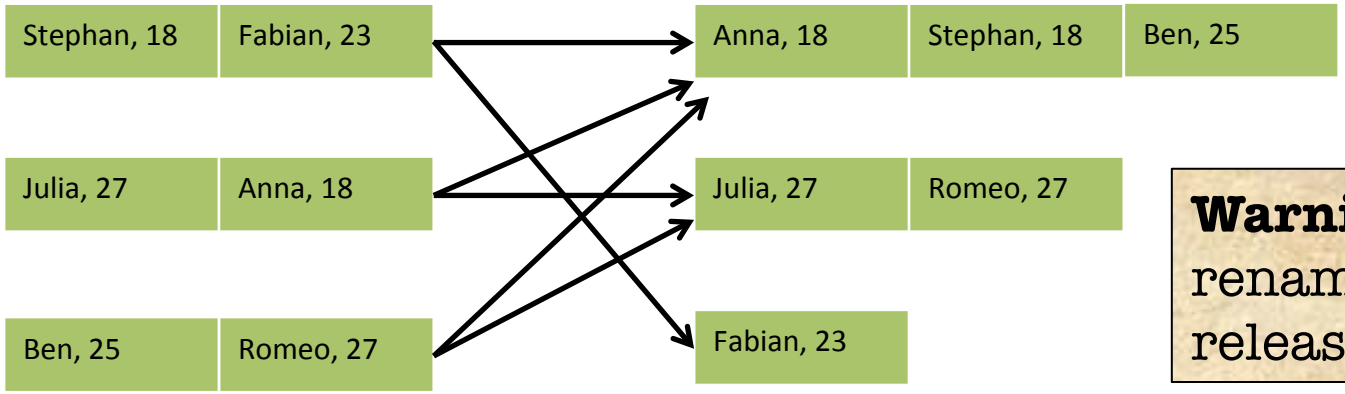
Note: Identical to DataSet API

Transformations: Partitioning

- DataStreams can be partitioned by a key

```
// (name, age) of employees
DataStream<Tuple2<String, Integer>> passengers = …

// group by second field (age)
DataStream<Integer, Integer> grouped = passengers.groupBy(1)
```



Warning: Possible renaming in next releases

Data shipping strategies

- Optionally, you can specify how data is shipped between two transformations
- Forward: `stream.forward()`
  - Only local communication
- Rebalance: `stream.rebalance()`
  - Round-robin partitioning
- Partition by hash: `stream.partitionByHash(...)`
- Custom partitioning: `stream.partitionCustom(...)`
- Broadcast: `stream.broadcast()`
  - Broadcast to all nodes

Data Sources

Collection

- `fromCollection(collection)`
- `fromElements(1,2,3,4,5)`

Note: Identical to DataSet API

Data Sources (2)

Text socket

- `socketTextStream("hostname",port)`

Text file

- `readFileStream(“/path/to/file”, 1000, WatchType.PROCESS_ONLY_APPENDED)`

Connectors

- E.g., Apache Kafka, RabbitMQ, …

Data Sources: Collections

```
StreamExecutionEnvironment env =
    StreamExecutionEnvironment.getExecutionEnvironment();

// read from elements
DataStream<String> names = env.fromElements("Some", "Example",
"Strings");

// read from Java collection
List<String> list = new ArrayList<String>();
list.add("Some");
list.add("Example");
list.add("Strings");

DataStream<String> names = env.fromCollection(list);
```

Data Sources: Files, sockets, connectors

```
StreamExecutionEnvironment env =
    StreamExecutionEnvironment.getExecutionEnvironment();


// read text socket from port
DataStream<String> socketLines = env
    .socketTextStream(”localhost", 9999);


// read a text file ingesting new elements every 100 milliseconds
DataStream<String> localLines = env
    .readFileStream(”/path/to/file", 1000,
     WatchType.PROCESS_ONLY_APPENDED);
```

Data Sinks

Text

- `writeAsText("/path/to/file")`

CSV

- `writeAsCsv("/path/to/file")`

Return data to the Client

- `print()`

Note: Identical to DataSet API

Data Sinks (2)

Socket

- `writeToSocket(hostname, port, SerializationSchema)`

Connectors

- E.g., Apache Kafka, Elasticsearch, Rolling HDFS Files

Data Sinks

- Lazily executed when `env.execute()` is called

```
DataStream<…> result;

// nothing happens
result.writeToSocket(...);

// nothing happens
result.writeAsText("/path/to/file", "\n", "|");

// Execution really starts here
env.execute();
```

Fault tolerance

Fault tolerance in Flink

- Flink provides recovery by taking a consistent checkpoint every *N* milliseconds and rolling back to the checkpointed state
  - https://ci.apache.org/projects/flink/flink-docs-master/internals/stream_checkpointing.html
- Exactly once (default)
  - ```
    // Take checkpoint every 5000 milliseconds
    env.enableCheckpointing (5000)
    ```
- At least once (for lower latency)
  - ```
    // Take checkpoint every 5000 milliseconds
    env.enableCheckpointing (5000, CheckpointingMode.AT_LEAST_ONCE)
    ```
- Setting the interval to few seconds should be good for most applications
- If checkpointing is not enabled, no recovery guarantees are provided

Best Practices

Some advice

- Use `env.fromElements(..)` or `env.fromCollection(..)` to quickly get a DataStream to experiment with

- Use `print()` to quickly print a DataStream