Spark Streaming

1. 课程目标

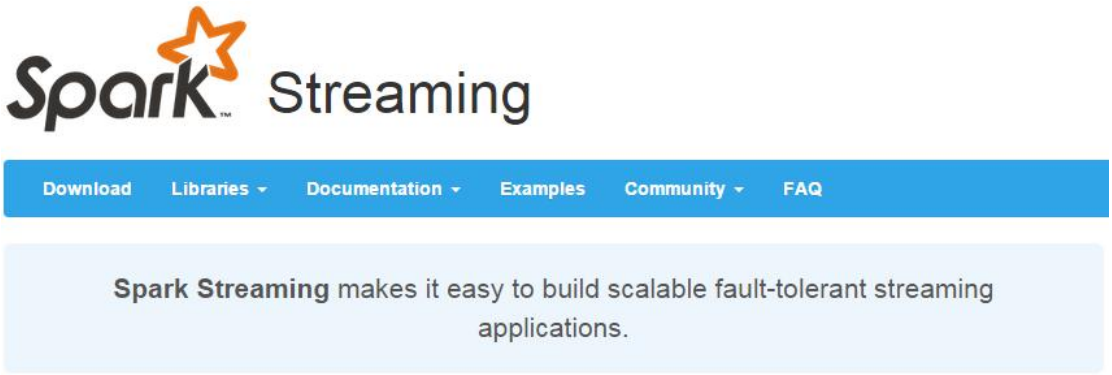
1.1. 掌握 Spark Streaming 的原理

1.2. 熟练使用 Spark Streaming 完成流式计算任务

2. Spark Streaming 介绍

2.1. Spark Streaming 概述

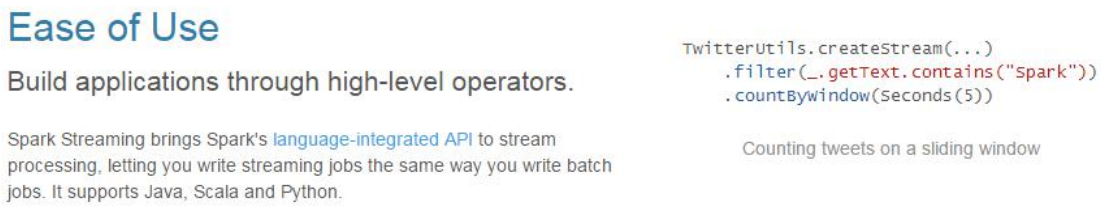
2.1.1. 什么是 Spark Streaming



Spark Streaming 类似于 Apache Storm，用于流式数据的处理。根据其官方文档介绍，Spark Streaming 有高吞吐量和容错能力强等特点。Spark Streaming 支持的数据输入源很多，例如：Kafka、Flume、Twitter、ZeroMQ 和简单的 TCP 套接字等等。数据输入后可以用 Spark 的高度抽象原语如：map、reduce、join、window 等进行运算。而结果也能保存在很多地方，如 HDFS，数据库等。另外 Spark Streaming 也能和 MLlib（机器学习）以及 Graphx 完美融合。

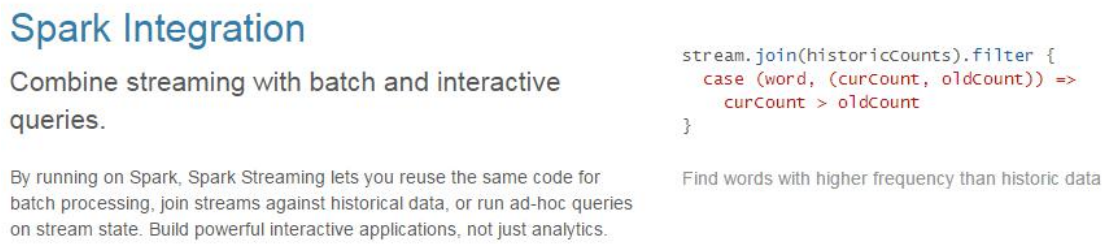
2.1.2. 为什么要学习 Spark Streaming

1.易用



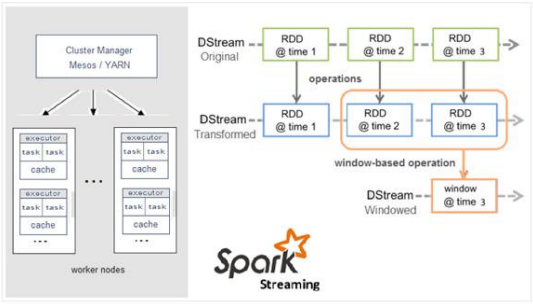
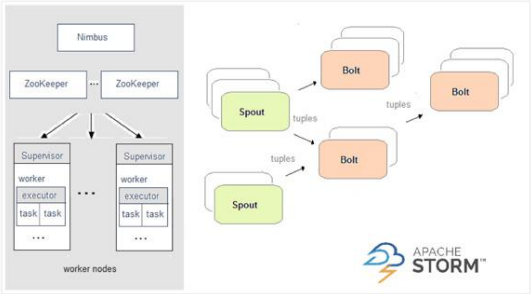
2.容错

3.易整合到 Spark 体系



2.1.3. Spark 与 Storm 的对比

Spark	Storm

<table>
<tr><td> 
</td><td> 
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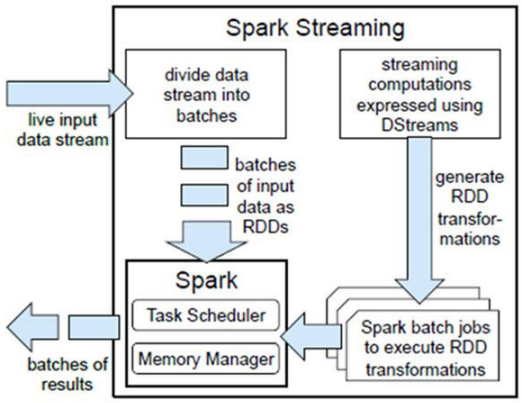
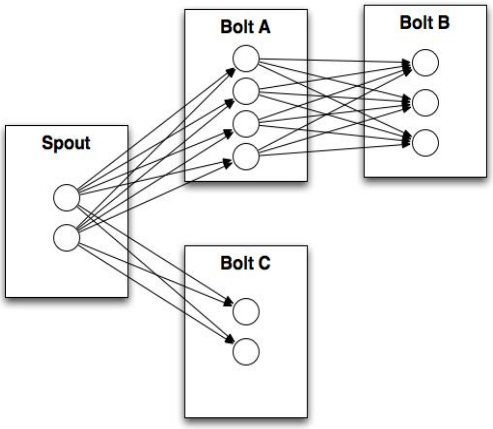
<tr><td>开发语言：Scala</td><td>开发语言：Clojure</td></tr>
<tr><td>编程模型：DStream</td><td>编程模型：Spout/Bolt</td></tr>
<tr><td> 
</td><td> 
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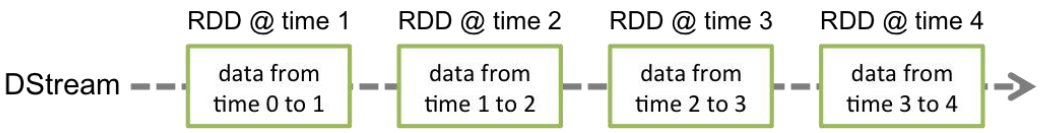
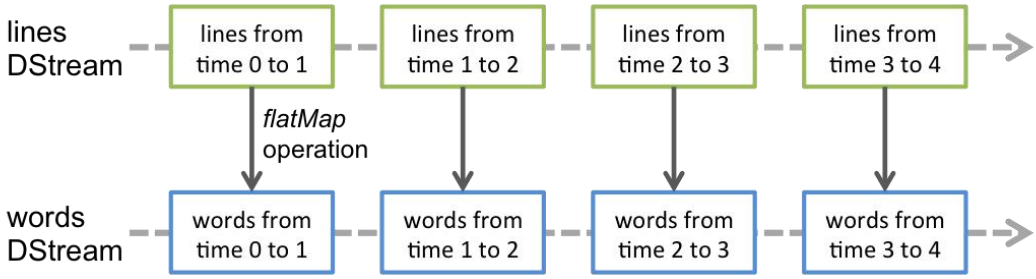
3. DStream

3.1. 什么是 DStream

Discretized Stream 是 Spark Streaming 的基础抽象，代表持续性的数据流和经过各种 Spark 原语操作后的结果数据流。在内部实现上，DStream 是一系列连续的 RDD 来表示。每个 RDD 含有一段时间间隔内的数据，如下图：



对数据的操作也是按照 RDD 为单位来进行的



计算过程由 Spark engine 来完成

3.2. DStream 相关操作

DStream 上的原语与 RDD 的类似，分为 Transformations（转换）和 Output Operations（输出）两种，此外转换操作中还有一些比较特殊的原语，如：updateStateByKey()、transform()以及各种 Window 相关的原语。

3.2.1. Transformations on DStreams

Transformation	Meaning
map(func)	Return a new DStream by passing each element of the source DStream through a function func.
flatMap(func)	Similar to map, but each input item can be mapped to 0 or more output items.
filter(func)	Return a new DStream by selecting only the records of the source DStream on which func returns true.
repartition(numPartitions)	Changes the level of parallelism in this DStream by creating more or fewer partitions.
union(otherStream)	Return a new DStream that contains the union of the elements in the source DStream and otherDStream.
count()	Return a new DStream of single-element RDDs by counting the number of elements in each RDD of the source DStream.
reduce(func)	Return a new DStream of single-element RDDs by aggregating the elements in each RDD of the source

	DStream using a function func (which takes two arguments and returns one). The function should be associative so that it can be computed in parallel.
countByValue()	When called on a DStream of elements of type K, return a new DStream of (K, Long) pairs where the value of each key is its frequency in each RDD of the source DStream.
reduceByKey(func, [numTasks])	When called on a DStream of (K, V) pairs, return a new DStream of (K, V) pairs where the values for each key are aggregated using the given reduce function. Note: By default, this uses Spark's default number of parallel tasks (2 for local mode, and in cluster mode the number is determined by the config property spark.default.parallelism) to do the grouping. You can pass an optional numTasks argument to set a different number of tasks.
join(otherStream, [numTasks])	When called on two DStreams of (K, V) and (K, W) pairs, return a new DStream of (K, (V, W)) pairs with all pairs of elements for each key.
cogroup(otherStream, [numTasks])	When called on a DStream of (K, V) and (K, W) pairs, return a new DStream of (K, Seq[V], Seq[W]) tuples.
transform(func)	Return a new DStream by applying a RDD-to-RDD function to every RDD of the source DStream. This can be used to do arbitrary RDD operations on the DStream.
updateStateByKey(func)	Return a new "state" DStream where the state for each key is updated by applying the given function on the previous state of the key and the new values for the key. This can be used to maintain arbitrary state data for each key.

特殊的 Transformations

1.UpdateStateByKey Operation

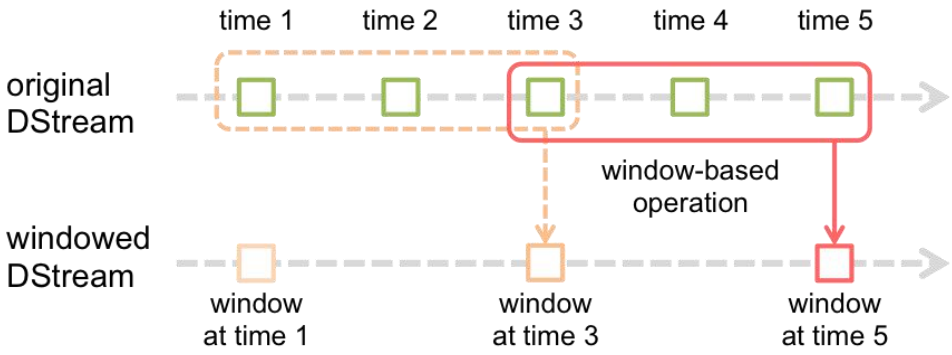
UpdateStateByKey 原语用于记录历史记录，上文中 Word Count 示例中就用到了该特性。若不用 UpdateStateByKey 来更新状态，那么每次数据进来后分析完成后，结果输出后将不在保存

2.Transform Operation

Transform 原语允许 DStream 上执行任意的 RDD-to-RDD 函数。通过该函数可以方便的扩展 Spark API。此外，MLlib（机器学习）以及 Graphx 也是通过本函数来进行结合的。

3.Window Operations

Window Operations 有点类似于 Storm 中的 State，可以设置窗口的大小和滑动窗口的间隔来动态的获取当前 Steaming 的允许状态



3.2.2. Output Operations on DStreams

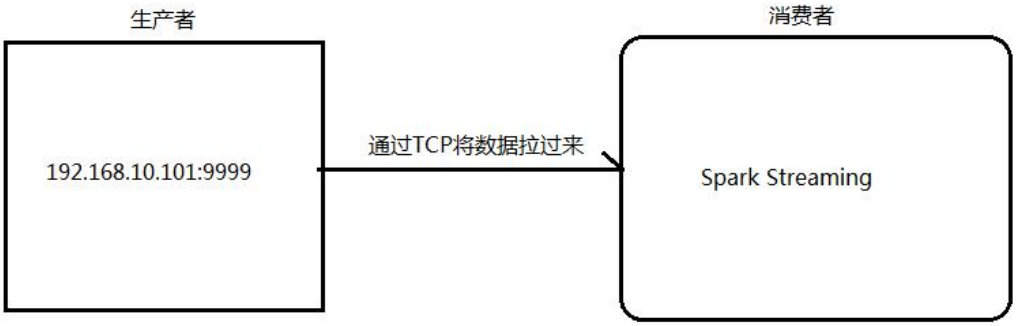
Output Operations 可以将 DStream 的数据输出到外部的数据库或文件系统，当某个 Output Operations 原语被调用时（与 RDD 的 Action 相同），streaming 程序才会开始真正的计算过程。

Output Operation	Meaning
print()	Prints the first ten elements of every batch of data in a DStream on the driver node running the streaming application. This is useful for development and debugging.
saveAsTextFiles(prefix, [suffix])	Save this DStream's contents as text files. The file name at each batch interval is generated based on prefix and suffix: "prefix-TIME_IN_MS[.suffix]".
saveAsObjectFiles(prefix, [suffix])	Save this DStream's contents as SequenceFiles of serialized Java objects. The file name at each batch interval is generated based on prefix and suffix: "prefix-TIME_IN_MS[.suffix]".
saveAsHadoopFiles(prefix, [suffix])	Save this DStream's contents as Hadoop files. The file name at each batch interval is generated based on prefix and suffix: "prefix-TIME_IN_MS[.suffix]".
foreachRDD(func)	The most generic output operator that applies a function, func, to each RDD generated from the stream. This function should push the data in each RDD to an external system, such as saving the RDD to files, or writing it over the network to a database. Note that the function func is executed in the driver process running the streaming application, and will usually have RDD actions in it that will force the computation of the streaming RDDs.

4. 实战

4.1. 用 Spark Streaming 实现实时 WordCount

架构图：



1.安装并启动生成者

首先在一台 Linux（ip：192.168.10.101）上用 YUM 安装 nc 工具

```
yum install -y nc
```

启动一个服务端并监听 9999 端口

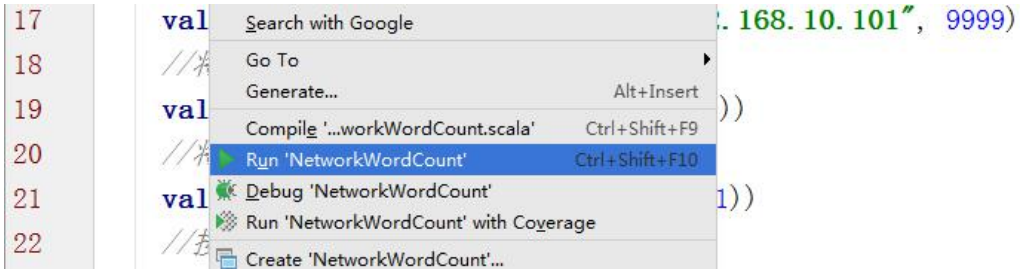
```
nc -lk 9999
```

2.编写 Spark Streaming 程序

```
package cn.itcast.spark.streaming

import cn.itcast.spark.util.LoggerLevel
import org.apache.spark.SparkConf
import org.apache.spark.streaming.{Seconds, StreamingContext}

object NetworkWordCount {
  def main(args: Array[String]) {
    //设置日志级别
    LoggerLevel.setStreamingLogLevels()
    //创建 SparkConf 并设置为本地模式运行
    //注意 local[2]代表开两个线程
    val conf = new SparkConf().setMaster("local[2]").setAppName("NetworkWordCount")
    //设置 DStream 批次时间间隔为 2 秒
    val ssc = new StreamingContext(conf, Seconds(2))
    //通过网络读取数据
    val lines = ssc.socketTextStream("192.168.10.101", 9999)
    //将读到的数据用空格切成单词
```

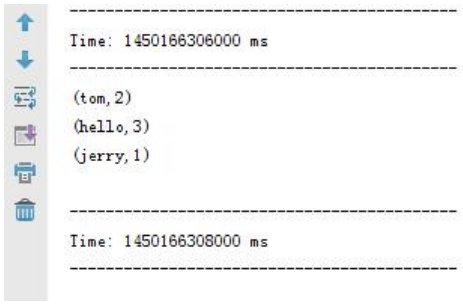
```
    val words = lines.flatMap(_.split(" "))
    //将单词和 1 组成一个 pair
    val pairs = words.map(word => (word, 1))
    //按单词进行分组求相同单词出现的次数
    val wordCounts = pairs.reduceByKey(_ + _)
    //打印结果到控制台
    wordCounts.print()
    //开始计算
    ssc.start()
    //等待停止
    ssc.awaitTermination()
  }
}
```

3.启动 Spark Streaming 程序：由于使用的是本地模式"local[2]"所以可以直接在本地运行该程序
注意：要指定并行度，如在本地运行设置 setMaster("local[2]")，相当于启动两个线程，一个给 receiver，一个给 computer。如果是在集群中运行，必须要求集群中可用 core 数大于 1



4.在 Linux 端命令行中输入单词

5.在 IDEA 控制台中查看结果

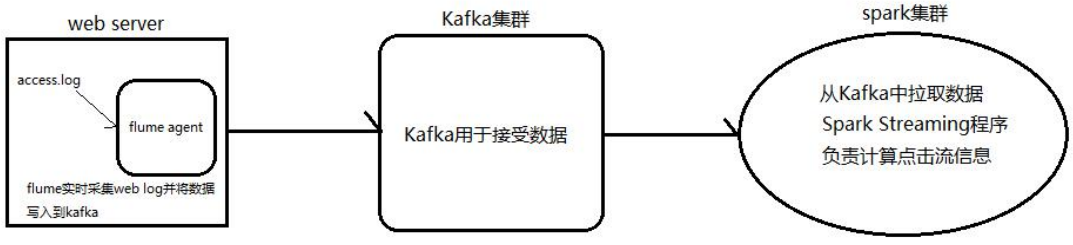


问题：结果每次在 Linux 段输入的单词次数都被正确的统计出来，但是结果不能累加！如果需要累加需要使用 updateStateByKey(func)来更新状态，下面给出一个例子：

```
package cn.itcast.spark.streaming


import cn.itcast.spark.util.LoggerLevel

import org.apache.spark.{HashPartitioner, SparkConf}
```

```scala
import org.apache.spark.streaming.{StreamingContext, Seconds}


object NetworkUpdateStateWordCount {
  /**
    * String : 单词 hello
    * Seq[Int] ：单词在当前批次出现的次数
    * Option[Int] ： 历史结果
    */
  val updateFunc = (iter: Iterator[(String, Seq[Int], Option[Int])]) => {
    //iter.flatMap(it=>Some(it._2.sum + it._3.getOrElse(0)).map(x=>(it._1,x)))
    iter.flatMap{case(x,y,z)=>Some(y.sum + z.getOrElse(0)).map(m=>(x, m))}
  }


  def main(args: Array[String]) {
    LoggerLevel.setStreamingLogLevels()
    val conf = new SparkConf().setMaster("local[2]").setAppName("NetworkUpdateStateWordCount")
    val ssc = new StreamingContext(conf, Seconds(5))
    //做 checkpoint 写入共享存储中
    ssc.checkpoint("c://aaa")
    val lines = ssc.socketTextStream("192.168.10.100", 9999)
    //reduceByKey 结果不累加
    //val result = lines.flatMap(_.split(" ")).map((_, 1)).reduceByKey(_+_)
    //updateStateByKey 结果可以累加但是需要传入一个自定义的累加函数：updateFunc
    val results = lines.flatMap(_.split(" ")).map((_,1)).updateStateByKey(updateFunc, new
HashPartitioner(ssc.sparkContext.defaultParallelism), true)
    results.print()
    ssc.start()
    ssc.awaitTermination()
  }
}
```

4.2. Spark Streaming 整合 Kafka 完成网站点击流实时统计



1.安装并配置 zk

2.安装并配置 Kafka

3.启动 zk

4.启动 Kafka

5.创建 topic

```
bin/kafka-topics.sh --create --zookeeper node1.itcast.cn:2181,node2.itcast.cn:2181 \
--replication-factor 3 --partitions 3 --topic urlcount
```

6.编写 Spark Streaming 应用程序

```
package cn.itcast.spark.streaming


package cn.itcast.spark

import org.apache.spark.{HashPartitioner, SparkConf}
import org.apache.spark.storage.StorageLevel
import org.apache.spark.streaming.kafka.KafkaUtils
import org.apache.spark.streaming.{Seconds, StreamingContext}

object UrlCount {
  val updateFunc = (iterator: Iterator[(String, Seq[Int], Option[Int])]) => {
    iterator.flatMap{case(x,y,z)=> Some(y.sum + z.getOrElse(0)).map(n=>(x, n))}
  }

  def main(args: Array[String]) {
    //接收命令行中的参数
    val Array(zkQuorum, groupId, topics, numThreads, hdfs) = args
    //创建 SparkConf 并设置 AppName
    val conf = new SparkConf().setAppName("UrlCount")
    //创建 StreamingContext
    val ssc = new StreamingContext(conf, Seconds(2))
    //设置检查点
    ssc.checkpoint(hdfs)
    //设置 topic 信息
    val topicMap = topics.split(",").map((_, numThreads.toInt)).toMap
    //重 Kafka 中拉取数据创建 DStream
    val lines = KafkaUtils.createStream(ssc, zkQuorum ,groupId, topicMap, StorageLevel.MEMORY_AND_DISK).map(_._2)
    //切分数据，截取用户点击的 url
    val urls = lines.map(x=>(x.split(" ")(6), 1))
    //统计 URL 点击量
    val result = urls.updateStateByKey(updateFunc, new HashPartitioner(ssc.sparkContext.defaultParallelism),
true)
    //将结果打印到控制台
    result.print()
    ssc.start()
    ssc.awaitTermination()
  }
}
```