Kafka + Spark Streaming + PySpark on GCP Ubuntu

Step 1: Installing Spark

**Method 1: Using Instance VM

1) Download Spark Package and unpack it

```
cs570vmserver:~$ wget https://dlcdn.apache.org/spark/spark-3.3.1/spark-3.3.1-bin-hadoop3.tgz
2-12-06 06:10:07--  https://dlcdn.apache.org/spark/spark-3.3.1/spark-3.3.1-bin-hadoop3.tgz
ving dlcdn.apache.org (dlcdn.apache.org)... 151.101.2.132, 2a04:4e42::644
cting to dlcdn.apache.org (dlcdn.apache.org)|151.101.2.132|:443... connected.
request sent, awaiting response... 200 OK
h: 299350810 (285M) [application/x-gzip]
g to: 'spark-3.3.1-bin-hadoop3.tgz'

-3.3.1-bin-hadoop3.tgz 100%[===========================================>] 285.48M   137MB/s    in 2.1s

12-06 06:10:09 (137 MB/s) - 'spark-3.3.1-bin-hadoop3.tgz' saved [299350810/299350810]
```

```
@cs570vmserver:~$ tar -xvf spark-3.3.1-bin-hadoop3.tgz
k-3.3.1-bin-hadoop3/
k-3.3.1-bin-hadoop3/LICENSE
k-3.3.1-bin-hadoop3/NOTICE
k-3.3.1-bin-hadoop3/R/
k-3.3.1-bin-hadoop3/R/lib/
k-3.3.1-bin-hadoop3/R/lib/SparkR/
k-3.3.1-bin-hadoop3/R/lib/SparkR/DESCRIPTION
k-3.3.1-bin-hadoop3/R/lib/SparkR/INDEX
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/Rd.rds
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/features.rds
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/hsearch.rds
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/links.rds
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/nsInfo.rds
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/package.rds
k-3.3.1-bin-hadoop3/R/lib/SparkR/Meta/vignette.rds
k-3.3.1-bin-hadoop3/R/lib/SparkR/NAMESPACE
```

2) Add environment variable and path to ~/.bashrc

```
@cs570vmserver:~$ vi .bashrc
@cs570vmserver:~$ source ~/.bashrc
```

```
#set spark related environment varibales
export SPARK_HOME=/home/ycao/spark-3.3.1-bin-hadoop3
export PATH=$PATH:$SPARK_HOME/bin:$SPARK_HOME/sbin
```

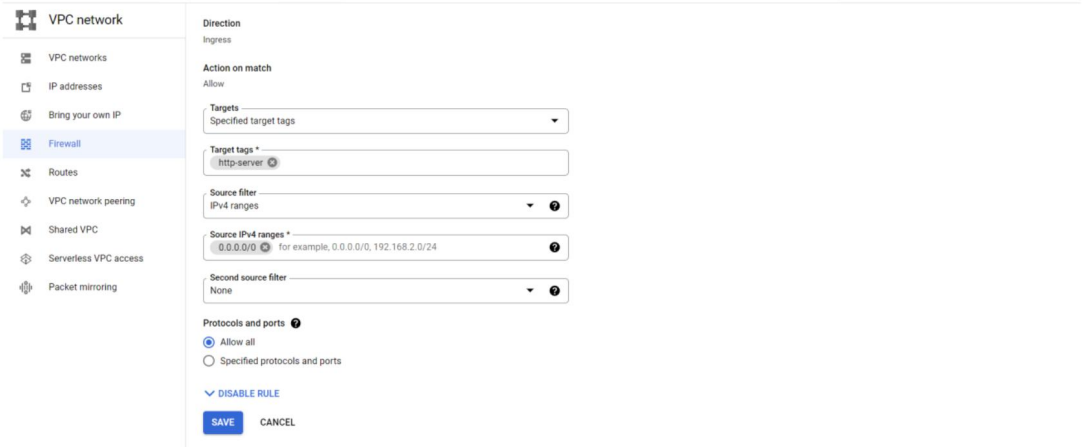
Note: Execute the file after changing the file ($ source ~/.bashrc)

3) Test installation of pyspark

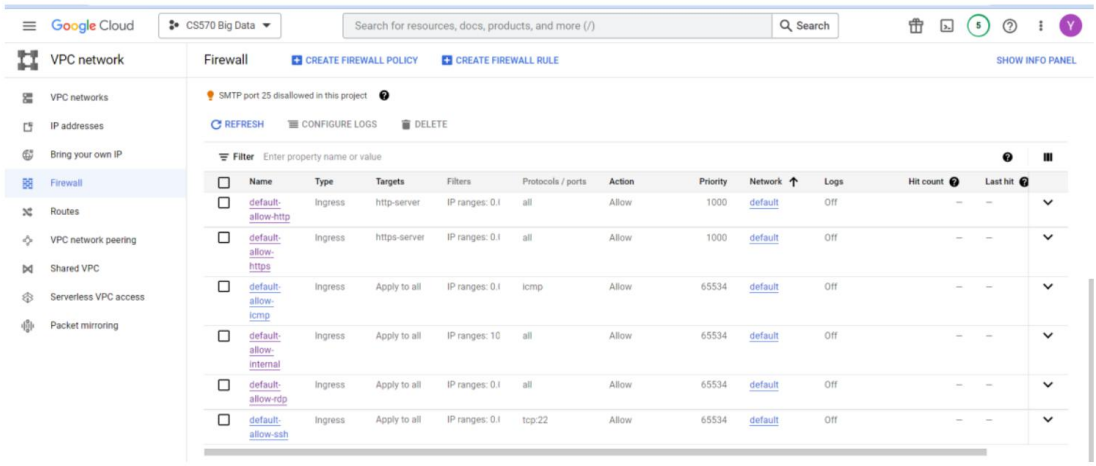
```
o@cs570vmserver:~$ pyspark
hon 3.8.10 (default, Jun 22 2022, 20:18:18)
C 9.4.0] on linux
e "help", "copyright", "credits" or "license" for more information.
ting default log level to "WARN".
adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
12/06 06:13:12 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builti
ava classes where applicable
come to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 3.3.1
      /_/

ng Python version 3.8.10 (default, Jun 22 2022 20:18:18)
rk context Web UI available at http://cs570vmserver.us-west2-a.c.cs570-big-data-363104.internal:4040
rk context available as 'sc' (master = local[*], app id = local-1670307194502).
rkSession available as 'spark'.
```

4) Change VM config on GCP ➔ VPC network



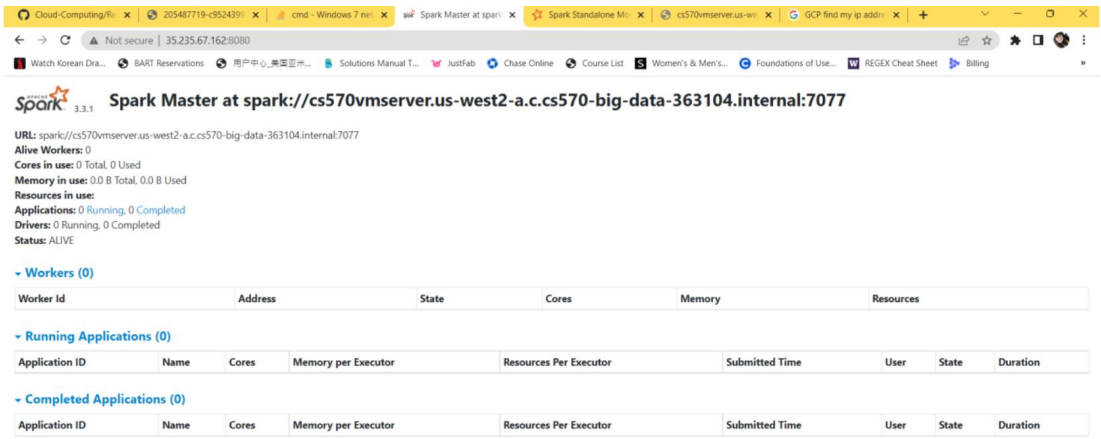
➔ Firewall



5) Start master

```
@cs570vmserver:~$ start-master.sh
ting org.apache.spark.deploy.master.Master, logging to /home/ycao/spark-3.3.1-bin-hadoop3/logs/spark-ycao-o
pache.spark.deploy.master.Master-1-cs570vmserver.out
@cs570vmserver:~$
```

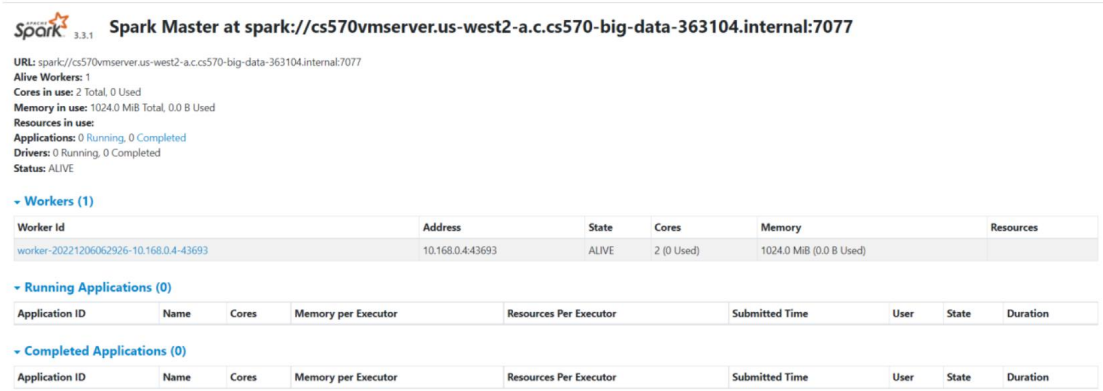
➔ Spark UI



6) Start slave

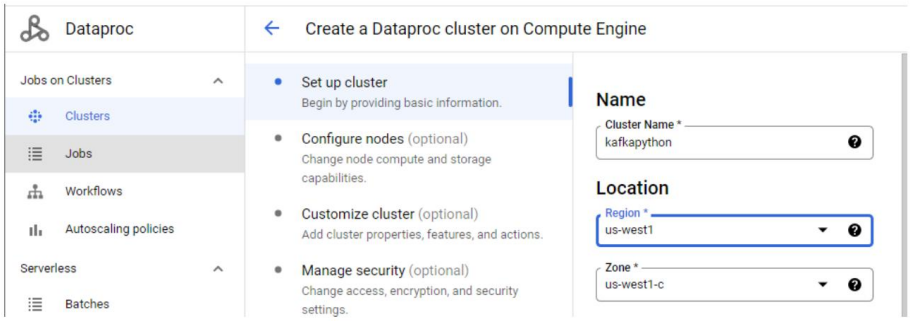
```
@cs570vmserver:~$ start-slave.sh spark://35.235.67.162:7077
 script is deprecated, use start-worker.sh
ting org.apache.spark.deploy.worker.Worker, logging to /home/ycao/spark-3.3.1-bin-hadoop3/logs/spark-ycao-o
pache.spark.deploy.worker.Worker-1-cs570vmserver.out
@cs570vmserver:~$
```

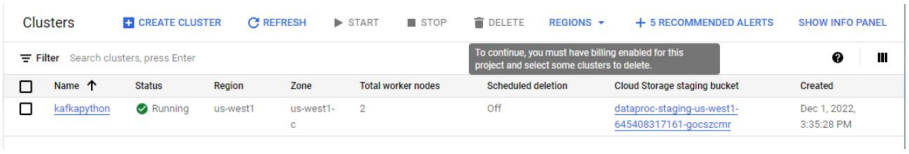
➜ Spark UI



**Method 2: Using Cluster

1) Create cluster





➜ Test pyspark

```
@kafkapython-m:~$ pyspark
on 3.8.13 | packaged by conda-forge | (default, Mar 25 2022, 06:04:10)
 10.3.0] on linux
 "help", "copyright", "credits" or "license" for more information.
ing default log level to "WARN".
djust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
2/02 00:14:46 INFO org.apache.spark.SparkEnv: Registering MapOutputTracker
2/02 00:14:46 INFO org.apache.spark.SparkEnv: Registering BlockManagerMaster
2/02 00:14:47 INFO org.apache.spark.SparkEnv: Registering BlockManagerMasterHeartbeat
2/02 00:14:47 INFO org.apache.spark.SparkEnv: Registering OutputCommitCoordinator
ome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   __ / .__/\_,_/_/ /_/\_\   version 3.1.3
      /_/

g Python version 3.8.13 (default, Mar 25 2022 06:04:10)
k context Web UI available at http://kafkapython-m.us-west1-c.c.cs570-big-data-363104.internal:44009
k context available as 'sc' (master = yarn, app id = application_1669937816581_0002).
kSession available as 'spark'.
```

Step 2: Install Kafka (Same with both methods)

1) Download and Unpack Kafka

```
@kafkapython-m:~$ wget https://dlcdn.apache.org/kafka/3.3.1/kafka_2.13-3.3.1.tgz
22-12-01 23:45:04--  https://dlcdn.apache.org/kafka/3.3.1/kafka_2.13-3.3.1.tgz
lving dlcdn.apache.org (dlcdn.apache.org)... 151.101.2.132, 2a04:4e42::644
ecting to dlcdn.apache.org (dlcdn.apache.org)|151.101.2.132|:443... connected.
 request sent, awaiting response... 200 OK
th: 105053134 (100M) [application/x-gzip]
ng to: 'kafka_2.13-3.3.1.tgz'

a_2.13-3.3.1.tgz          100%[===================================================>] 100.19M   226MB/s    in 0.4s

-12-01 23:45:05 (226 MB/s) - 'kafka_2.13-3.3.1.tgz' saved [105053134/105053134]

@kafkapython-m:~$
```

Step 3: Starting Kafka and Test with Example

1) Pre-requisites test

NOTE: Your local environment must have Java 8+ installed.

2) Start zookeeper (Terminal 1)

```
$ bin/zookeeper-server-start.sh config/zookeeper.properties
```

```
:.ZKDatabase)
-01 23:47:51,404] INFO Snapshotting: 0x0 to /tmp/zookeeper/version-2/snapshot.0 (org.apache.zookeeper.server.pe
e.FileTxnSnapLog)
-01 23:47:51,404] INFO Snapshot taken in 1 ms (org.apache.zookeeper.server.ZooKeeperServer)
-01 23:47:51,435] INFO zookeeper.request_throttler.shutdownTimeout = 10000 (org.apache.zookeeper.server.Request
r)
-01 23:47:51,436] INFO PrepRequestProcessor (sid:0) started, reconfigEnabled=false (org.apache.zookeeper.server
uestProcessor)
-01 23:47:51,479] INFO Using checkIntervalMs=60000 maxPerMinute=10000 maxNeverUsedIntervalMs=0 (org.apache.zook
rver.ContainerManager)
-01 23:47:51,480] INFO ZooKeeper audit is disabled. (org.apache.zookeeper.audit.ZKAuditProvider)
-01 23:48:48,397] INFO Creating new log file: log.1 (org.apache.zookeeper.server.persistence.FileTxnLog)
```

3) Open another terminal session and start Kafka server(Terminal 2)

```
$ bin/kafka-server-start.sh config/server.properties
```

```
rk.SocketServer)
-02 06:14:44,364] INFO Kafka version: 3.3.1 (org.apache.kafka.common.utils.AppInfoParser)
-02 06:14:44,364] INFO Kafka commitId: e23c59d00e687ff5 (org.apache.kafka.common.utils.AppInfoParser)
-02 06:14:44,365] INFO Kafka startTimeMs: 1669961684362 (org.apache.kafka.common.utils.AppInfoParser)
-02 06:14:44,369] INFO [KafkaServer id=0] started (kafka.server.KafkaServer)
-02 06:14:44,428] INFO [BrokerToControllerChannelManager broker=0 name=forwarding]: Recorded new control
m now on will use broker kafkapython-m.us-west1-c.c.cs570-big-data-363104.internal:9092 (id: 0 rack: nul
a.server.BrokerToControllerRequestThread)
-02 06:14:44,500] INFO [BrokerToControllerChannelManager broker=0 name=alterPartition]: Recorded new con
 from now on will use broker kafkapython-m.us-west1-c.c.cs570-big-data-363104.internal:9092 (id: 0 rack:
kafka.server.BrokerToControllerRequestThread)
```

Once all services have successfully launched, you will have a basic Kafka environment running and ready to use.

4) Topics (Open another terminal: Terminal 3) ➔ Create topics

$ bin/kafka-topics.sh --create --topic input_recommend_product --bootstrap-server localhost:9092 —partition 3 —replication-factor 1

```
WARNING: Due to limitations in metric names, topics with a period ('.') or underscore ('_') could collide. To avoid is
sues it is best to use either, but not both.
Created topic input_recommend_product.
```

➔ To check details of topic

```
@kafkapython-m:~/kafka_2.13-3.3.1$ bin/kafka-topics.sh --describe --topic quickstart-events --bootstrap-server loca
t:9092
c: quickstart-events        TopicId: iGzxKEnpTZ-ds3g5r-xUGQ PartitionCount: 1       ReplicationFactor: 1    Configs

    Topic: quickstart-events        Partition: 0    Leader: 0       Replicas: 0     Isr: 0
@kafkapython-m:~/kafka_2.13-3.3.1$
```

➔ To check list of topic

```
$ bin/kafka-topics.sh --list --bootstrap-server localhost:9092
```

5) Example Demo

Example 1: quickstart-evernts

➔ Write event

```
$ bin/kafka-console-producer.sh --topic quickstart-events --bootstrap-server localhost:9092
```

This is my first event

This is my second event

```
>This is my first line item
>This is the second
>
```

➔ Read event (Open another terminal: Terminal 4)

```
$ bin/kafka-console-consumer.sh --topic quickstart-events --from-beginning
```

```
--bootstrap-server localhost:9092
```

This is my first event

This is my second event

```
This is my first line item
This is the second
```

Example 2: input_recomment_product(Kafka-Python)

➜ With zookeeper and kafka terminal opened

➜ Check Ptyhon3 is installed

$ pip install kafka-python

```
@kafkapython-m:~/kafka_2.13-3.3.1$ pip install kafka-python
ulting to user installation because normal site-packages is not writeable
ecting kafka-python
wnloading kafka_python-2.0.2-py2.py3-none-any.whl (246 kB)
 ---------------------------------------- 246.5/246.5 kB 10.4 MB/s eta 0:00:00
alling collected packages: kafka-python
essfully installed kafka-python-2.0.2
@kafkapython-m:~/kafka_2.13-3.3.1$
```

➜ Open python3 shell and start to type consumer.py

```
SSH-in-browser                                   UPLOAD FILE   DOWNLOAD FILE
from kafka import KafkaConsumer

consumer = KafkaConsumer('input_recommend_product', bootstrap_servers=['localhost:9092'])
for msg in consumer:
    print(msg.value)
~
~
~
~
~
```

```
ao@cs570vmserver:~$ python3
thon 3.8.10 (default, Jun 22 2022, 20:18:18)
CC 9.4.0] on linux
pe "help", "copyright", "credits" or "license" for more information.
> from kafka import KafkaConsumer
>
> consumer = KafkaConsumer('input_recommend_product', bootstrap_servers=['localhost:9092'])
> for msg in consumer:
.     print(msg.value)
.
(1, Main Menu), (2, Phone) , (3, Smart Phone), (4, iPhone)'
This is the end of testing for input_recommend_product topic.'
```

SSH-in-browser UPLOAD FILE DOWNLOAD FILE

```
from kafka import KafkaProducer

producer = KafkaProducer(bootstrap_servers='localhost:9092')

producer.send('input_recommend_product', b'(1, Main Menu), (2, Phone) , (3, Smart Phone), (4, iPhone)')

~
~
~
```

```
ao@cs570vmserver:~$ python3
thon 3.8.10 (default, Jun 22 2022, 20:18:18)
CC 9.4.0] on linux
pe "help", "copyright", "credits" or "license" for more information.
> from kafka import KafkaProducer
> producer = KafkaProducer(bootstrap_servers='localhost:9092')
> producer.send('input_recommend_product', b'(1, Main Menu), (2, Phone) , (3, Smart Phone), (4, iPhone)')
afka.producer.future.FutureRecordMetadata object at 0x7ff028cb3c70>
> producer.send('input_recommend_product', b'This is the end of testing for input_recommend_product topic.')
afka.producer.future.FutureRecordMetadata object at 0x7ff028ccd2e0>
>
```

Step 4: Spark Streaming

➔ Start NetCat $nc -lk 9999

```
Hello world
What are you doing
Are you doing homework
Almost finish your homework
^Z
[1]+  Stopped                 nc -lk 9999
```

➔ Open another terminal, start streaming in spark folder

$ ./bin/spark-submit examples/src/main/python/streaming/network_wordcount.py localhost 9999

```
2/09 03:21:54 INFO SparkContext: Running Spark version 3.3.1
2/09 03:21:54 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin
a classes where applicable
2/09 03:21:54 INFO ResourceUtils: ==============================================================
2/09 03:21:54 INFO ResourceUtils: No custom resources configured for spark.driver.
2/09 03:21:54 INFO ResourceUtils: ==============================================================
2/09 03:21:54 INFO SparkContext: Submitted application: PythonStreamingNetworkWordCount
2/09 03:21:54 INFO ResourceProfile: Default ResourceProfile created, executor resources: Map(cores -> name:
s, amount: 1, script: , vendor: , memory -> name: memory, amount: 1024, script: , vendor: , offHeap -> name:
Heap, amount: 0, script: , vendor: ), task resources: Map(cpus -> name: cpus, amount: 1.0)
2/09 03:21:54 INFO ResourceProfile: Limiting resource is cpu
2/09 03:21:54 INFO ResourceProfileManager: Added ResourceProfile id: 0
2/09 03:21:54 INFO SecurityManager: Changing view acls to: ycao
2/09 03:21:54 INFO SecurityManager: Changing modify acls to: ycao
2/09 03:21:54 INFO SecurityManager: Changing view acls groups to:
2/09 03:21:54 INFO SecurityManager: Changing modify acls groups to:
2/09 03:21:54 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users  with
 permissions: Set(ycao); groups with view permissions: Set(); users  with modify permissions: Set(ycao); gro
with modify permissions: Set()
```

Step 5: Try Kafka-python streaming

1) Create the topics needed

```
ycao@kafkapython-m:~/kafka_2.13-3.3.1$ bin/kafka-topics.sh --create --topic input_event --bootstrap-server local
host:9092
WARNING: Due to limitations in metric names, topics with a period ('.') or underscore ('_') could collide. To av
oid issues it is best to use either, but not both.
Created topic input_event.
ycao@kafkapython-m:~/kafka_2.13-3.3.1$ bin/kafka-topics.sh --create --topic output_event --bootstrap-server loca
lhost:9092
WARNING: Due to limitations in metric names, topics with a period ('.') or underscore ('_') could collide. To av
oid issues it is best to use either, but not both.
Created topic output_event.
ycao@kafkapython-m:~/kafka_2.13-3.3.1$
```

```
ycao@kafkapython-m:~/kafka_2.13-3.3.1$ bin/kafka-topics.sh --list --bootstrap-server localhost:9092
input_event
output_event
ycao@kafkapython-m:~/kafka_2.13-3.3.1$
```

2) Create spark_script folder and download spark_streaming_kafka jar file

```
ao@kafkapython-m:~$ cd spark_script
ao@kafkapython-m:~/spark_script$ wget https://repo1.maven.org/maven2/org/apache/spark/spark-streaming-kafka-0-
2.11/2.4.3/spark-streaming-kafka-0-8_2.11-2.4.3.jar
-2022-12-04 04:34:19--  https://repo1.maven.org/maven2/org/apache/spark/spark-streaming-kafka-0-8_2.11/2.4.3/sp
k-streaming-kafka-0-8_2.11-2.4.3.jar
solving repo1.maven.org (repo1.maven.org)... 199.232.192.209, 199.232.196.209
nnecting to repo1.maven.org (repo1.maven.org)|199.232.192.209|:443... connected.
TP request sent, awaiting response... 200 OK
ngth: 302964 (296K) [application/java-archive]
aving to: 'spark-streaming-kafka-0-8_2.11-2.4.3.jar'

ark-streaming-kafka-0-8_2 100%[===========================================>] 295.86K  --.-KB/s    in 0.02s

022-12-04 04:34:19 (14.1 MB/s) - 'spark-streaming-kafka-0-8_2.11-2.4.3.jar' saved [302964/302964]
```

3) Create spark_processor.py file

```python
#create SC with the specified configuration
def spark_context_creator():
    conf = SparkConf()
    #set name for our app
    conf.setAppName("ConnectingDotsSparkKafkaStreaming")
    #The master URL to connect
    conf.setMaster('spark://abc.def.ghi.jkl:7077')
    sc = None
    try:
        sc.stop()
        sc = SparkContext(conf=conf)
    except:
        sc = SparkContext(conf=conf)
    return sc

sc = spark_context_creator()
#To avoid unncessary logs
sc.setLogLevel("WARN")

#batch duration, here i process for each second
ssc = StreamingContext(sc,1)

kafkaStream = KafkaUtils.createStream(ssc, 'abc.def.ghi.jkl:2181', 'test-consumer-group', {'input_event':1})

#processing each micro batch
def process_events(event):
    return (event[0], Counter(event[1].split(" ")).most_common(3))

lines = kafkaStream.map(lambda x : process_events(x))

producer = KafkaProducer(bootstrap_servers='abc.def.com:9092', value_serializer=str.encode, key_serializer=str.encode)

#push the processed event to Kafka
def push_back_to_kafka(processed_events):
    list_of_processed_events = processed_events.collect()
    producer.send('output_event', value = str(list_of_processed_events))

lines.foreachRDD(push_back_to_kafka)
~
```

4) Run spark_processor.py file

*Added some package to solve errors but still not able to fixed all

$ spark-submit --jars /spark_script/spark-streaming-kafka-0-8-assembly_2.11-2.4.8.jar --packages

org.apache.spark:spark-streaming-kafka-0-8_2.11:2.1.2 org.apache.spark:spark-sql-kafka-0-

10_2.12:3.3.1 --deploy-mode client spark_script/spark_processor.py

```
:: loading settings :: url = jar:file:/usr/lib/spark/jars/ivy-2.4.0.jar!/org/apache/ivy/core/settings/ivysettings.xml
Ivy Default Cache set to: /home/ycao/.ivy2/cache
The jars for the packages stored in: /home/ycao/.ivy2/jars
org.apache.spark#spark-streaming-kafka-0-8_2.11 added as a dependency
:: resolving dependencies :: org.apache.spark#spark-submit-parent-a504dec0-10db-4767-8823-b329576d3974;1.0
	confs: [default]
	found org.apache.spark#spark-streaming-kafka-0-8_2.11;2.1.2 in central
	found org.apache.kafka#kafka_2.11;0.8.2.1 in central
	found org.scala-lang.modules#scala-xml_2.11;1.0.2 in central
	found com.yammer.metrics#metrics-core;2.2.0 in central
	found org.slf4j#slf4j-api;1.7.16 in central
	found org.scala-lang.modules#scala-parser-combinators_2.11;1.0.2 in central
	found com.101tec#zkclient;0.3 in central
	found log4j#log4j;1.2.17 in central
	found org.apache.kafka#kafka-clients;0.8.2.1 in central
	found net.jpountz.lz4#lz4;1.3.0 in central
	found org.xerial.snappy#snappy-java;1.1.2.6 in central
	found org.spark-project.spark#unused;1.0.0 in central
:: resolution report :: resolve 1999ms :: artifacts dl 26ms
	:: modules in use:
	com.101tec#zkclient;0.3 from central in [default]
	com.yammer.metrics#metrics-core;2.2.0 from central in [default]
	log4j#log4j;1.2.17 from central in [default]
	net.jpountz.lz4#lz4;1.3.0 from central in [default]
	org.apache.kafka#kafka-clients;0.8.2.1 from central in [default]
	org.apache.kafka#kafka_2.11;0.8.2.1 from central in [default]
	org.apache.spark#spark-streaming-kafka-0-8_2.11;2.1.2 from central in [default]
	org.scala-lang.modules#scala-parser-combinators_2.11;1.0.2 from central in [default]
	org.scala-lang.modules#scala-xml_2.11;1.0.2 from central in [default]
	org.slf4j#slf4j-api;1.7.16 from central in [default]
	org.spark-project.spark#unused;1.0.0 from central in [default]
	org.xerial.snappy#snappy-java;1.1.2.6 from central in [default]
	---------------------------------------------------------------------
	|                  |            modules            ||   artifacts   |
	|       conf       | number| search|dwnlded|evicted|| number|dwnlded|
	---------------------------------------------------------------------
	|      default     |   12  |   1   |   1   |   0   ||   12  |   0   |
	---------------------------------------------------------------------
:: retrieving :: org.apache.spark#spark-submit-parent-a504dec0-10db-4767-8823-b329576d3974
	confs: [default]
	0 artifacts copied, 12 already retrieved (0kB/25ms)
Exception in thread "main" java.lang.NullPointerException
	at org.apache.hadoop.fs.Path.getName(Path.java:418)
	at org.apache.spark.deploy.DependencyUtils$.downloadFile(DependencyUtils.scala:136)
	at org.apache.spark.deploy.SparkSubmit.$anonfun$prepareSubmitEnvironment$8(SparkSubmit.scala:376)
	at scala.Option.map(Option.scala:230)
	at org.apache.spark.deploy.SparkSubmit.prepareSubmitEnvironment(SparkSubmit.scala:376)
	at org.apache.spark.deploy.SparkSubmit.org$apache$spark$deploy$SparkSubmit$$runMain(SparkSubmit.scala:894)
	at org.apache.spark.deploy.SparkSubmit.doRunMain$1(SparkSubmit.scala:180)
	at org.apache.spark.deploy.SparkSubmit.submit(SparkSubmit.scala:203)
	at org.apache.spark.deploy.SparkSubmit.doSubmit(SparkSubmit.scala:90)
	at org.apache.spark.deploy.SparkSubmit$$anon$2.doSubmit(SparkSubmit.scala:1039)
	at org.apache.spark.deploy.SparkSubmit$.main(SparkSubmit.scala:1048)
	at org.apache.spark.deploy.SparkSubmit.main(SparkSubmit.scala)
```

➜ Producer.py

```
from kafka import KafkaProducer

producer = KafkaProducer(bootstrap_servers='abc.def.com:9092', value_serializer=str.encode, key_serializer=str.encode)
event_stream_key = 'product_list'
event_stream_value = 'product1 product2 product3 product1'
producer.send('input_event', key = event_stream_key, value = event_stream_value)
~
~
~
~
~
```

➜ Consumer.py

SSH-in-browser UPLOAD FILE

```
from kafka import KafkaConsumer

consumer = KafkaConsumer('output_event', bootstrap_servers=['abc.def.com:9092'])
for msg in consumer:
    print(msg.value)
~
~
~
```