

# STREAMER: Data Stream Framework

## Getting Started Guide



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Welcome to STREAMER! This guide will show you how to easily install and run your first use case with STREAMER. No worries, the process is straightforward. (For a detailed presentation of STREAMER read the “UserGuide.pdf”.)

Let’s start!

First of all, download STREAMER framework + environment setup from

<https://github.com/streamer-framework/streamer>

However, before we start the installation, you need to decide how you will use the framework. STREAMER is conceived to be used in two different ways (depending on your necessities):

1. **Development use:** (oriented to data scientists). You are interested on directly working on the code of the framework to add/develop several functionalities and test them.
2. **Product use:** (oriented to industrial use). You want to use the framework as a product (no need to get in contact with the code but execute STREAMER).  
In this case, you need to have in your computer the basic services STREAMER requires and STREAMER instance already packed.

## 1 Getting ready for Deployment use

- 1) In this case, you need to run the basic services that STREAMER requires. You can install them using the docker (recommended) following the steps of section 3.1, or install them yourself following section 4,
- 2) Install Eclipse (<https://www.eclipse.org/downloads/>) or the IDE you prefer.
- 3) Import the maven project: File->Import->Maven->Existing Maven Projects (and follow the steps to select the folder of **STREAMER** project).
- 4) Create your first use case in STREAMER by following the steps of section 6.
- 5) Run your application in STREAMER as section 5 shows.

## 2 Getting ready for Production use

Try our example use case in STREAMER by following the steps of Section 3.

## 3 Using Docker

We make simple and transparent the installation of STREAMER and its services by using Docker. We provide 2 docker files that serve to:

1. **Services environment** (section 3.1): it contains all the services used by the framework (*Kafka&Zookeeper, Redis, InfluxDB, Kibana&ElasticSearch*).
2. **Production environment** (section 3.2): it contains STREAMER for production purpose.

When downloading the zip file you will find:

```
streamer_environment (folder)
|   docker-compose.yml (file)
|   streamer_environment (sub-folder)
|       |   docker-compose.yml (file)
|       |   Dockerfile_producer (file)
|       |   Dockerfile_streamer (file)
|       |   Jar file (file)
|       |   requirements.txt (file)
|       |   data (sub-sub-folder)
```

### 3.1 Install & run all the services from Docker (recommended)

**[Warning]:** for Linux based systems, you may need to run all the commands in “sudo” mode as, for instance, “sudo docker-compose up --build -d”.

Follow the following steps to set all necessary services before running STREAMER:

1. Install docker on your machine. At the following link, you will find how to install the docker for all the different operating systems (Windows, Linux, Mac): <https://docs.docker.com/get-docker/>
2. [For Linux] also install docker-compose from <https://docs.docker.com/compose/install/>
3. Unzip the provided folder “streamer\_environment”.
4. Open a terminal and change directory to this “streamer\_environment” directory.
5. Run the following command to start the services:

```
docker-compose up --build -d
```

It should give an output similar to this:

```
Creating redis      ... done
Creating zookeeper ... done
Creating es01       ... done
Creating influxdb   ... done
Creating kibana     ... done
Creating kafka      ... done
```

In order to check if the services are running properly, check the following command:

```
docker ps
```

It should give an output similar to this:

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS
8650d6c48a3e	confluentinc/cp-kafka:6.0.0	"/etc/confluent/dock..."	3 minutes ago	Up 3 minutes	0.0.0.0:9092->9092/tcp, 0.0.0.0:9
101->9101/tcp,	0.0.0.0:29092->29092/tcp	kafka			
4d66bc73d65d	docker.elastic.co/kibana/kibana:7.5.2	"/usr/local/bin/dumb..."	3 minutes ago	Up 3 minutes	0.0.0.0:5601->5601/tcp
	kibana				
cedcb3893450	redis:2.8.23	"docker-entrypoint.s..."	3 minutes ago	Up 3 minutes	0.0.0.0:6379->6379/tcp
3b67eab3116e	influxdb:1.7.10	"/entrypoint.sh infl..."	3 minutes ago	Up 3 minutes	0.0.0.0:8086->8086/tcp
	influxdb				
367c7c06aac6	docker.elastic.co/elasticsearch/elasticsearch:7.5.2	"/usr/local/bin/dock..."	3 minutes ago	Up 3 minutes	0.0.0.0:9200->9200/tcp, 9300/tcp
	es01				
c891355a65a4	confluentinc/cp-zookeeper:6.0.0	"/etc/confluent/dock..."	3 minutes ago	Up 3 minutes	2888/tcp, 0.0.0.0:2181->2181/tcp,
3888/tcp	zookeeper				

To stop the services, use the following command:

```
docker-compose down
```

which should give an output similar to this:

```
Stopping kafka      ... done
Stopping kibana     ... done
Stopping redis      ... done
Stopping influxdb   ... done
Stopping es01       ... done
Stopping zookeeper  ... done
Removing kafka      ... done
Removing kibana     ... done
Removing redis      ... done
Removing influxdb   ... done
Removing es01       ... done
Removing zookeeper  ... done
Removing network streamer_environment_streamer_network
```



It should give an output similar to this:

CONTAINER ID	IMAGE	NAMES	COMMAND	CREATED	STATUS	PORTS
eed381ee08f9	streamer_environment_streamer-producer	streamer-producer	"/bin/sh -c 'java -c..."	45 seconds ago	Up 44 seconds	
ae5deec212dc	streamer_environment_streamer-producer_1	streamer-producer_1	"/bin/sh -c 'java -c..."	45 seconds ago	Up 44 seconds	
8650d6c48a3e	confluentinc/cp-kafka:6.0.0	streamer_environment_streamer_1	"/etc/confluent/dock..."	3 minutes ago	Up 3 minutes	0.0.0.0:9092->9092/tcp, 0.0.0.0:9181->9181/tcp
4d66bc73d65d	docker.elastic.co/kibana/kibana:7.5.2	kibana	"/usr/local/bin/dumb..."	3 minutes ago	Up 3 minutes	0.0.0.0:5601->5601/tcp
cedcb3893450	redis:2.8.23	redis	"docker-entrypoint.s..."	3 minutes ago	Up 3 minutes	0.0.0.0:6379->6379/tcp
3b67eab3116e	influxdb:1.7.10	influxdb	"/entrypoint.sh infl..."	3 minutes ago	Up 3 minutes	0.0.0.0:8086->8086/tcp
367c7c06aac6	docker.elastic.co/elasticsearch/elasticsearch:7.5.2	es01	"/usr/local/bin/dock..."	3 minutes ago	Up 3 minutes	0.0.0.0:9200->9200/tcp, 9300/tcp
c891355a65a4	confluentinc/cp-zookeeper:6.0.0	zookeeper	"/etc/confluent/dock..."	3 minutes ago	Up 3 minutes	2888/tcp, 0.0.0.0:2181->2181/tcp

To stop the services, use the following command:

If you started the framework without using (-d) property, first press (ctrl + c) and then the following (with (-d) or not):

```
docker-compose down
```

It should give an output similar to this:

```
Stopping streamer_environment_streamer-producer_1 ... done
Stopping streamer_environment_streamer_1 ... done
Removing streamer_environment_streamer-producer_1 ... done
Removing streamer_environment_streamer_1 ... done
Removing network streamer_environment_streamer_network
```

## 4 Installing STREAMER services yourself (from sources)

STREAMER use the following services that you can install yourself:

[Compulsory]:

- apache kafka / soft / Apache License 2.0 / kafka.version=2.12-2.3.0
- zookeeper / soft / Apache License 2.0 / zookeeper.version=3.4.14

<https://kafka.apache.org/quickstart>

- redis server / soft / BSD / Redis version=5.0.5 <https://redis.io/>

- influxdb / soft / MIT / version 1.7.7 <https://portal.influxdata.com/>

[Optional]

- elasticsearch / soft / Apache License 2.0 / version=7.5.2 <https://www.elastic.co/>
- kibana / soft / Elastic License/Apache License / version=7.5.2 <https://www.elastic.co/kibana>

A) For running from LOCALHOST

```
$ --zookeeper localhost:2181
```

```
$ --kafka localhost:9092
```

```
$ --broker-list localhost:9092
```

B) For running in CLUSTER

- \* zookeeper in port 2181 and with hadoop1-3

- \* Kafka and bootstrap-server in port 6667 and with hadoop1-9

```
$ --zookeeper hadoop1:2181
```

```
$ --kafka hadoop1:6667
```

```
$ --broker-list hadoop1:6667
```

Sections below provide some guidelines to help you install the services yourself.

## 4.1 Manually installation in Linux

### Zookeeper

1) Download and install Zookeeper. 2 options:

1.a) `$ sudo apt-get install zookeeper`

or

1.b) Download Zookeeper: <https://kafka.apache.org/quickstart>

2) From command line, go to zookeeper/bin folder and run:

```
$sudo zookeeper-server-start /etc/kafka/zookeeper.properties
```

(Zookeeper is now running on localhost:2181)

### Kafka

3) Download and install confluent:

<http://docs.confluent.io/current/installation.html#installation-apt>

4) Download Kafka and install it: <https://www.digitalocean.com/community/tutorials/how-to-install-apache-kafka-on-ubuntu-14-04>

5) From command line, go to kafka/bin folder and run:

```
$sudo kafka-server-start /etc/kafka/server.properties
```

### Redis

6) Download Redis : <https://redis.io/download> and install it

7) In Redis folder (where you installed it), go to folder "src" and run the command: `./redis-server`

## InfluxDB

8) Download InfluxDB and install it:

<https://docs.influxdata.com/influxdb/v0.9/introduction/installation/>

## NodeJS

9) In command line install: `$sudo apt-get install npm`

10) Download NodeJS for Linux and uncompress it: <https://nodejs.org/es/download/> and install it

11) Go to streamer\src\main\resources\graphics and run: `$ npm install`

12) That will install all the libraries needed

13) Run `$. /node ../../dsplatform/streamer/src/main/resources/graphics/app.js`

14) Open a web browser and type: localhost:8080

The interface will be displayed there.

## Kibana & ElasticSearch

15) Download Elasticsearch 7.5.2 and Kibana 7.5.2.

16) Go to the bin folders where you installed kibana and elastic search. Run in command line:

`$ elasticsearch-7.5.2/bin/elasticsearch`

`$ Kibana-7.5.2/bin/kibana`

## 4.2 Manually installation in Windows

### Zookeeper

1) Download Zookeeper : <http://www-eu.apache.org/dist/zookeeper/>

2) Extract Zookeeper and go to zookeeper/bin folder and run zkServer.cmd

Note : You may rename the zoo\_sample.cfg file (in .\conf) into zoo.cfg

Zookeeper is now running on localhost:2181

### Kafka

3) Download Kafka binary version: <http://kafka.apache.org/downloads.html>.

4) In command line go to kafka folder.

5) Extract Kafka and in .\config\server.properties replace log.dirs=c:/kafka/kafka-logs

6) Run this command to start Kafka : `.\bin\windows\kafka-server-start.bat`

`.\config\server.properties`

7) A Kafka broker is now running

### Redis

8) Download Redis : <https://github.com/rgl/redis/downloads> and install it

9) In Redis folder (where you installed it) run the command : `redis-server.exe`

## InfluxDB



- 10) Download InfluxDB: [https://dl.influxdata.com/influxdb/releases/influxdb-1.1.0\\_windows\\_amd64.zip](https://dl.influxdata.com/influxdb/releases/influxdb-1.1.0_windows_amd64.zip)
- 11) Unzip and in `\influxdb-1.1.0_windows_amd64\influxdb-1.1.0-1` run: `influxd.exe`

## NodeJS

- 12) Download NodeJS for Windows : <https://nodejs.org/en/> and install it
- 13) Now launch the Node.js command prompt and in the framework folder, go to `streamer\src\main\resources\graphics` and run : `npm install`  
That will install all the libraries needed

## Kibana & ElasticSearch

- 14) Download Elasticsearch 7.5.2 and Kibana 7.5.2.
- 15) Go to the bin folders where you installed kibana and elastic search. Run in command line:  
\$ `elasticsearch-7.5.2/bin/elasticsearch`  
\$ `Kibana-7.5.2/bin/kibana`

## 5 How to run a STREAMER use case

- 1) Set up all the properties in the files `.props` within `src/main/resources`.
- 2) For using the **data producer simulator** functionality, run `ProducerMain.java` (placed in folder `streamer/src/test/java/cea/streamer`):  
`ProducerMain.java [origin1 ... originN]`

A producer is now writing in Kafka topic(s).

`[origin1 ... originN]` Arguments are optional. Each of them runs a problem in a separate process; its name `originX` indicates the folder where the properties files are located for this specific execution. If no arguments indicated, the system considers the properties files directly placed in `src/main/resources/setup` folder.

- 3) For using the **streaming pipeline** functionality, run `LauncherMain.java` (placed in folder `streamer\src\test\java\cea\streamer`) as:  
`LauncheMain.java [origin1 ... originN]`

`[origin1 ... originN]` Arguments are optional. Each of them runs a problem in a separate process; its name `originX` indicates the folder where the properties files are located for this specific execution. If no arguments indicated, the system considers the properties files directly placed in `src/main/resources/setup` folder.

- 4) For using the **learning API** in **offline** mode (algorithms test and/or train) run *AlgInvokerMain\_offline.java* (placed in folder *streamer\src\test\java\cea\streamer*) as *AlgInvoker\_Main.java arg1 arg2 arg3 arg4 [arg5]*

Arguments are:

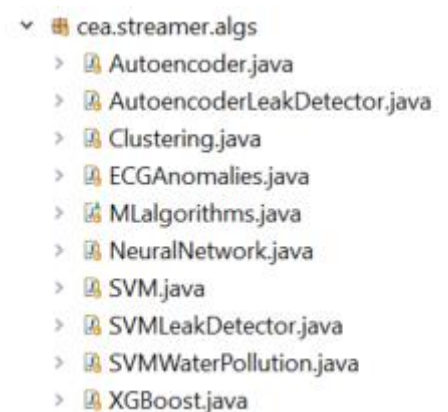
- a) *arg1*. Data source type: From where data must be retrieved. Option: [*influx* or *file*]. It could be either “influx” to build the model using the data stored in InfluxDB or “file” to directly use the data from the file specify in *algs.properties* (*data.training*).
  - b) *arg2*. Origin: [*influx-data-base-name* or *origin*]. *origin* indicates the folder where the properties files are located for this specific execution. If no arguments indicated, the system considers the properties files directly placed in *src/main/resources/setup* folder.
  - c) *arg3*. Perform training [*true* or *false*] (train).
  - d) *arg4*. Perform model running [*true* or *false*] (test).
  - e) [*arg5*]. [Optional] Path from where to store/retrieve the trained model.
- 5) For using **kibana graphical interface** (only available for *ECG anomaly detection problem*) open a web browser and type <http://localhost:5601>. The dashboard will appear.

## 6 How to Integrate your Algorithm in STREAMER

In order to create your running application in STREAMER, two main phases are required:

### 6.1 PHASE 1: INTEGRATE OR CREATE YOUR ALGORITHM

- 1) We add the main algorithm class to the *cea.streamer.algs* package :
  - a. Implement both methods *learn* and *run* for training and testing phases (if necessary).
  - b. If your model is not coded in Java, you will have to use Redis as an intermediary data storage to save the arriving records to be accessible from the algorithm (in the example below, the algorithm is coded in Python).



```

package cea.streamer.algs;

import java.util.Vector;

public class HoeffdingTreeClassifier extends MLalgorithms {

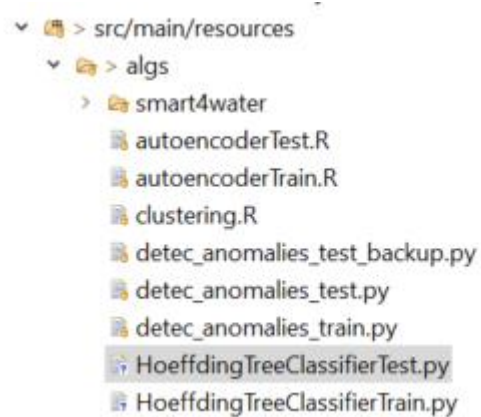
    @Override
    public void learn(Vector<TimeRecord> data, String id) {
        //this method represent the training/learning phase

        // the path of the training file to perform the training from python
        String learningFile = new GlobalUtils().getAbsolutePathProjectPath()
        // push the data to Redis to be available for the python training f
        RedisConnector.dataToRedis(data, "datatrain"+id);
        // execute the training phase
        CodeConnectors.execPyFile(learningFile, id);
    }

    public void run(Vector<TimeRecord> data, String id) {
        //this method represent the testing/prediction phase

        // the path of the testing file to perform the prediction from python
        String testingFile = new GlobalUtils().getAbsolutePathProjectPath()
        // push the data to Redis to be available for the python testing file
        RedisConnector.dataToRedis(data, "datatest"+id);
        // execute the testing phase
        String result = CodeConnectors.execPyFile(testingFile, id);
    }
}

```



- 2) Add the training and testing python files to the path src/main/resources/algs
  - a. While coding the algorithms in Python, pay attention for the training file to read the data from Redis, and write the model in Redis.
  - b. Likewise, for the testing file, pay attention to read the data and the model from Redis, and write the predictions as one line String in Redis and precise the separator used between the predictions' values in another redis key. These predictions are read by the framework in order to do the realtime evaluation of the model's performance.

An example of coding in python for the training file:

```

redis_key = 'kdd-cup-99'
if(len(sys.argv)>1):
    redis_key = sys.argv[1]

redis_key_data = 'datatrain' + redis_key
redis_key_target = 'datatrain' + redis_key + 'target'
redis_key_model = redis_key + 'model'

# Redis connection to connect the python program to Redis
redisConn = configuringRedis()
if(len(sys.argv)>3):
    redisConn = configuringRedis(host=sys.argv[2], port=int(sys.argv[3]))

#read the training data from redis
list_data = redisConn.lrange(redis_key_data, 0, -1)
if not list_data:
    print("Please check if the training data is stored properly in Redis!")
    return

# read the labels from redis for the training data
list_output = redisConn.lrange(redis_key_target, 0, -1)
if not list_data:
    print("Please check if the labels of the training data are stored properly in Redis!")
    return
.

```

```

.
.
.
.
#print("The model's training phase is done!")

# saving the model in redis
pickled_model = pickle.dumps(model)
redisConn.set(redis_key_model, pickled_model)

```

An example of coding in python for the testing file:

```

redis_key = 'kdd-cup-99'
if(len(sys.argv)>1):
    redis_key = sys.argv[1]

redis_key_data = 'datatest' + redis_key
redis_key_target = 'datatest' + redis_key + 'target'
redis_key_model = redis_key + 'model'
redis_key_output = 'classifResults' + redis_key
redis_key_output_sep = 'separation' + redis_key

# Redis connection to connect the python program to Redis
redisConn = configuringRedis()
if(len(sys.argv)>3):
    redisConn = configuringRedis(host=sys.argv[2], port=int(sys.argv[3]))

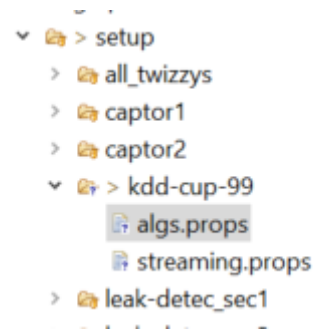
#read the testing data from redis
list_data = redisConn.lrange(redis_key_data, 0, -1)
if not list_data:
    print("Please check if the testing data is stored properly in Redis!")
    return

# read the labels from redis for the testing data
list_output = redisConn.lrange(redis_key_target, 0, -1)
if not list_data:
    print("Please check if the labels of the testing data are stored properly in Redis!")
    return
.
.
.
# loading the existing model from redis
model = None
try:
    model = pickle.loads(redisConn.get(redis_key_model))
except Exception as ex:
    pass
# if model doesn't exist then exit (model is not ready yet or something wrong in training phase
if not model:
    return
.
.
.
# transform the list to a string separated by comma
sep = ','
preds = sep.join(str(v) for v in list_pred)
# save them in redis
redisConn.set(redis_key_output, preds)
redisConn.set(redis_key_output_sep, sep)

```

## 6.2 PHASE 2: INTEGRATE OR CREATE YOUR USE CASE APPLICATION

- 1) Add a folder with the project name
- 2) Add two configuration files to this folder:
  - a. Algs.props
  - b. Streaming.props



### Algs.props:

```
# The algorithm used for this application is the KDD CUP 99 Cybersecurity dataset
algorithm = HoeffdingTreeClassifier
# Online training will be performed every 20 seconds
training.interval = 20000
# The maximum allowed data for training
training.maxdata = 5000
#10000000
# This source is used for Offline training
#training.source = ../data/data_kdd-cup-99/binary_classification_kdd_cup_99.csv
evaluation.metrics =
AccuracyBinaryClassificationMetric,SensitivityBinaryClassificationMetric,PrecisionBinaryClassificationM
etric,F1scoreBinaryClassificationMetric
```

Note: The user can choose metrics for evaluating the model by simply adding the name of the metric class. It is also possible for the user to extend the existing metrics with new ones.

### Streaming.props:

```
#bootstrap.servers=10.0.238.12:9092
bootstrap.servers=localhost:9092

####Producer:
acks=all
retries=0
batch.size=16384
auto.commit.interval.ms=1000
linger.ms=0
key.serializer=org.apache.kafka.common.serialization.StringSerializer
value.serializer=org.apache.kafka.common.serialization.StringSerializer
block.on.buffer.full=true

maxBlocks = 1000
recordsPerBlock = 1000
producerTimeInterval = 10000
#recordsPerBlock = 50
#producerTimeInterval = 14000

# The path of the data used in the kdd cup 99 cybersecurity project (online classification algorithm)
#datafile = ../data/data_kdd-cup-99/multiclass_classification_kdd_cup_99.csv
datafile = ../data/data_kdd-cup-99/binary_classification_kdd_cup_99.csv
### Production Type (ONLINE /OFFLINE)
producerType = OFFLINE
epsilon = -3000
scale = 1800

####Launcher:
group.id=test
application.id=test
#enable.auto.commit=true
key.deserializer=org.apache.kafka.common.serialization.StringDeserializer
```

```

value.deserializer=org.apache.kafka.common.serialization.StringDeserializer
# fast session timeout makes it more fun to play with failover
session.timeout.ms=10000
# These buffer sizes seem to be needed to avoid consumer switching to
# a mode where it processes one bufferful every 5 seconds with multiple
# timeouts along the way. No idea why this happens.
fetch.min.bytes=50000
receive.buffer.bytes=262144
max.partition.fetch.bytes=2097152

readingTimeInterval = 100
problem.type = KDDClassification
#consumer.prepostprocessor = PrePostProcessorKDDClassification (to be added if needed)
outputTopic = OutputPlatformKDDB

#### Common Params
#mainTopic = topic_kddbclassMM
mainTopic = topic_kddbclassMMM

```

The attribute `problem.type = KDDClassification` means that we should create a class named `KDDClassificationRecord` that extends the main `TimeRecord` class.

### 3) Create the record class:

- a. It is essential to name the record class in this exact way:

`problem.type + "Record" + ".java"`

- b. You can precise the headers of the dataset
- c. Implement the `fill` method to indicate how the records should be filled with the correct values.
- d. In case the dataset does not contain timestamp, use `sleep` and generate a new timestamp.

```

package cea.streamer.core;

public class KDDClassificationRecord extends TimeRecord {

    private static String[] headers = {"duration",
                                        "src_bytes",
                                        "dst_bytes",
                                        "land",
                                        "wrong_fragment",
                                        "urgent", ...
                                        "flag_SH",
                                        "label"};

    public KDDClassificationRecord() {
        super();
    }

    @Override
    public void fill(String data) {

```

```

        if(data.trim() != "") {
            String[] fields = data.trim().toLowerCase().split(";");
            if(fields.length > 1) {
                try {
                    //This sleep is added for the reason that I am assigning the
timestamps to the used dataset and thus we should have a little gap in time to obtain different
microseconds

                    TimeUnit.MICROSECONDS.sleep(10);
                } catch (InterruptedException e) {
                    e.printStackTrace();
                }
                source = fields[0];
                timestamp = new SimpleDateFormat("dd-MMM-yy HH:mm:ss.SSS",
Locale.ENGLISH).format(new Date());
                // skip if this record contains the header of the csv file.
                if(fields[1].contains("duration")) {
                    System.out.println(fields[1]);
                    return;
                }
                String[] features = fields[1].split(",");
                for(int i=0;i<features.length - 1;i++) {
                    values.put(headers[i], features[i]);
                    extractors.put(headers[i], new NumericalExtractor());
                }
                String label = fields[1].substring(fields[1].lastIndexOf(",")+1);
                target = label;
                extractors.put("classification", new NumericalExtractor());
            }
        }
    }
}

```

As you arrived this far, it is time to run the application:

```

cmd1> java -cp dsplatform-1.0.0-test-jar-with-dependencies.jar cea.streamer.LauncherMain kdd-cup-99
cmd2> java -cp dsplatform-1.0.0-test-jar-with-dependencies.jar cea.streamer.ProducerMain kdd-cup-99

```