Lambda Architecture for Twitter real-time image processing

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Outline

Introduction

- Big Data differs from traditional data processing through its use of parallelism, only by bringing multiple computing resources together we can process terabytes of data
- We need to find ways to analyze a large amount of data
- Lambda Architecture is a particular approach composed by:
  - *batch layer* : applies batch-oriented technologies (like MapReduce) on a master database. It is effective but it has a high latency
  - *serving layer* : specialized distributed database that supports batch updates and random reads
  - *speed layer* : only looks at recent data and uses low-latency techniques to update real-time views. It compensate for the high latency of the batch layer
- Image Processing applied to Big Data can produce some useful applications like to create clusters of a large amount of images and return the most representative ones.

Proposed approach

- The main goal was not a perfect image processing analysis but the implementation of the architecture
- Speed layer is started first with the keyword as arguments. It creates the speed layer tables at the start of the execution
- Only tweets that have images in their content and the hashtag formed by the keyword are selected

Image Processing with Lire

- Developed with *LIRE (Lucene Image Retrieval)* library
- We will use CEDD (Color and Edge Directivity Descriptor) to extract the 144-dimensional features vector from each image
- These vectors will be processed inside the K-Means algorithm implemented on MapReduce

Serving layer

Based on Apache HBase and composed by 4 tables:

- **tweet master database**: master database of the Lambda Architecture ($<$ *TweetID*, *Keyword*, *Path_img* $>$)
- **tweet real-time database**: stores the tweets on which the real-time view is based ($<$ *Keyword*, *Path_img*, *FeatureVector* $>$)
- **batch view**: result of the batch processing ($<$ *FeatureVector*, *NearestPath_img*, *numberOfPoints* $>$)
- **synchronization table**: contains the start and the end timestamps of the batch processing ($<$ *StartTimeStamp*, *EndTimeStamp* $>$)

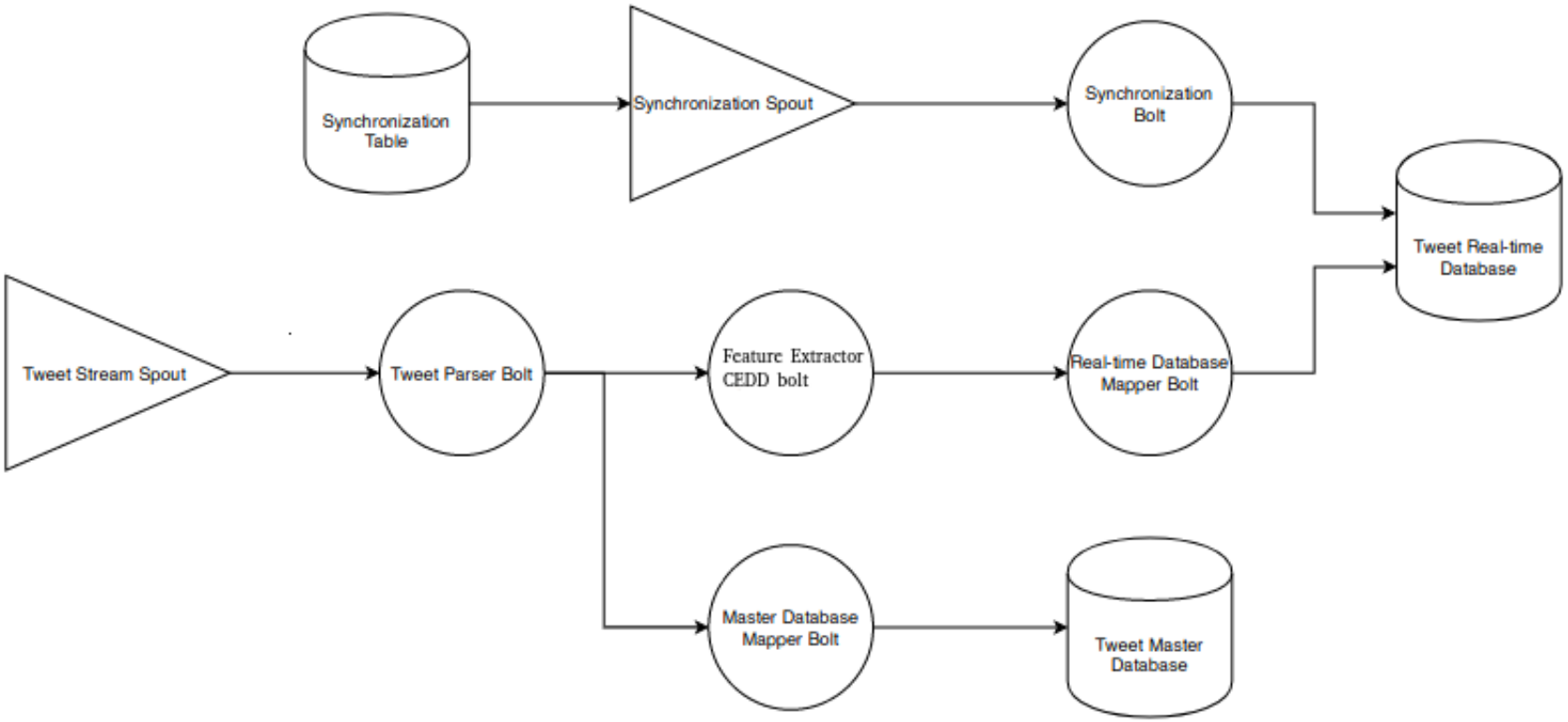
Batch layer

- Represented by Apache Hadoop
- Implements the K-Means algorithm inside MapReduce job on *tweet master database*
- Writes its results from scratch in *batch view*
- Writes the start and the end timestamps of the computation in *synchronization table*
- Two classes are created to simplify the K-Means algorithm.
  - Point : each tweet will be a Point (indexC, path_img, listOfFeatures)
  - Center (extends Point) : it has an index and the numberOfPoint associated with it.

Batch layer

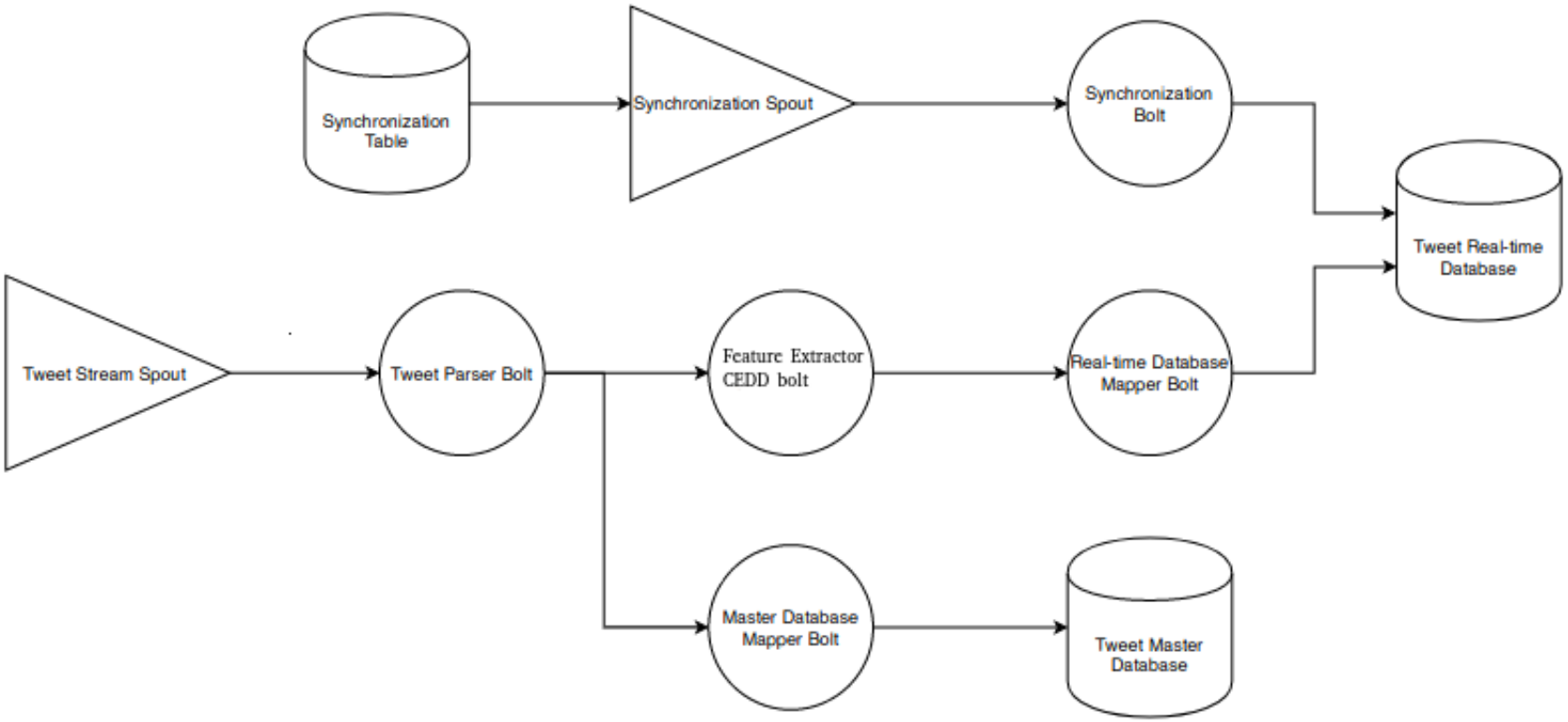
- Driver coordinate the job, set the configuration, create the initial center, start the K-Means loop in MapReduce and update the *batch view*
- Mapper takes a tweet in input and outputs a $< Center, Point >$ tuple
- Combiner takes a $< Center, Point >$ tuple as input and adds up all the vector features of the points associated with a center and returns a $< Center, Point >$ tuple
- Reducer takes a tuple in input, do the average dividing the sum (computed in combiner phase) with the number of points associated with the center. The output will be a $< IntWritable, Center >$ tuple for each center required
- An HTML page will show the results obtained at the end of the KMeans algorithm.

Speed layer



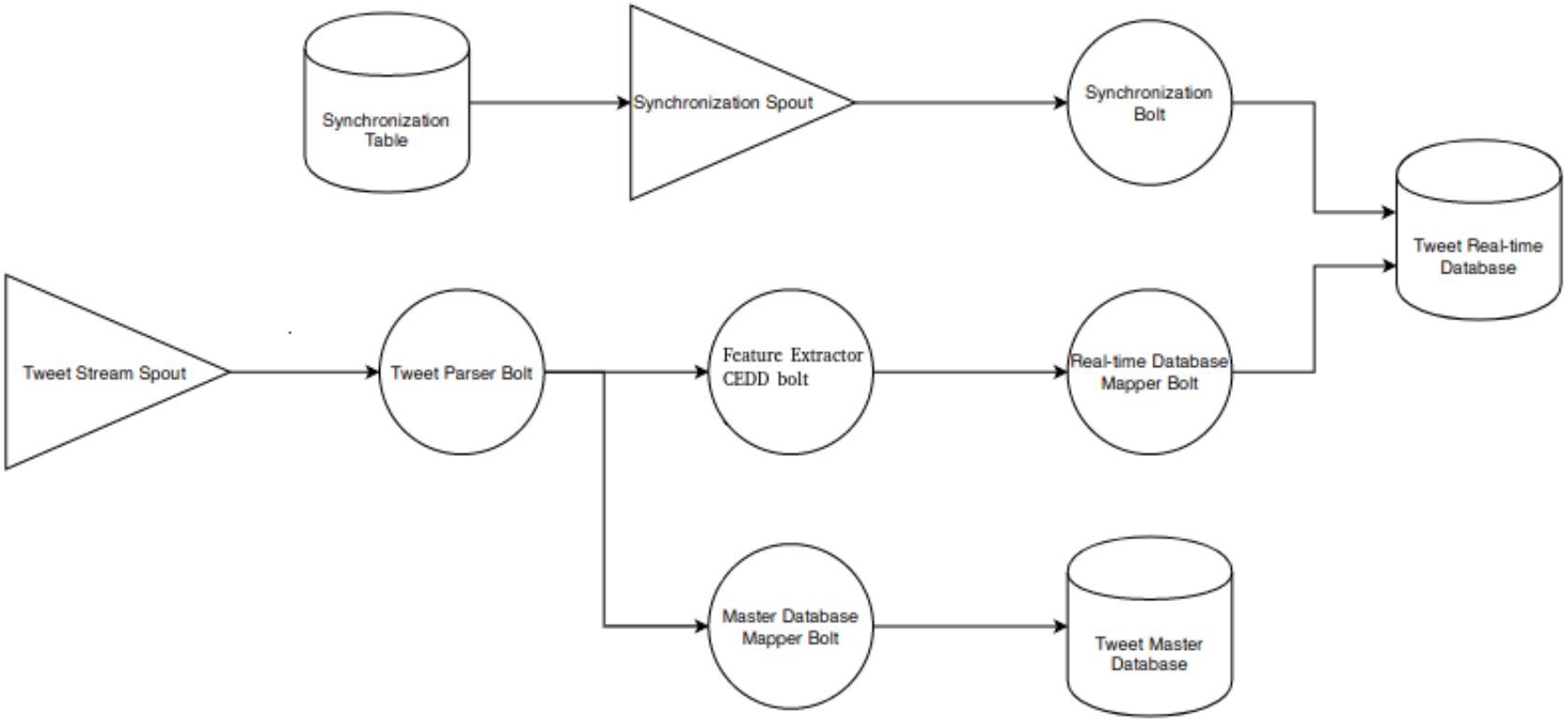
- **tweet stream spout**: gets a real-time stream of tweets with *Twitter4j* library and filters them
- **tweet parser bolt**: parse a tweet object to a tuple

Speed layer



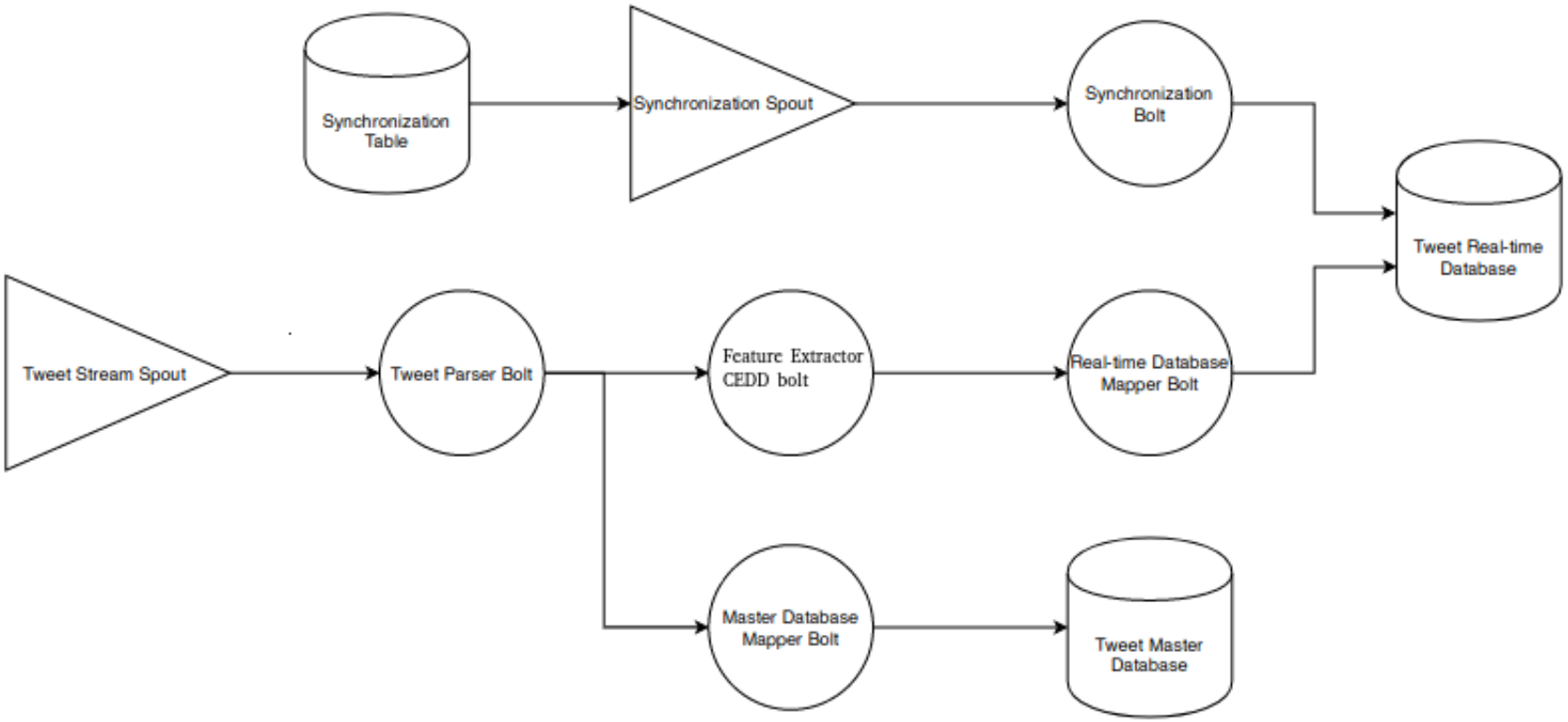
- **master database mapper bolt**: inserts tweets in *tweet master database*

Speed layer



- **feature extractor CEDD bolt**: extract a 144-dimensional vector from each image in input
- **real-time database mapper bolt**: inserts tuples in *tweet real-time database*

Speed layer



- **synchronization spout**: checks when batch processing ends
- **synchronization bolt**: deletes already processed tweets from *tweet real-time database*

Conclusion

Center #1

Nearest Image path : /home/alessio/Desktop/output/Tue-18-34-@gigiqns.jpg
Number of Points : 54

Center #2

Nearest Image path : /home/alessio/Desktop/output/Tue-18-34-@KITTYBAYOUTSFAN.jpg
Number of Points : 8

Center #3

Nearest Image path : /home/alessio/Desktop/output/Tue-18-34-@DouglasDowellJD.jpg

Conclusions

- It has been shown an implementation of a Lambda Architecture capable of getting the most representative images of real-time tweets using several techniques together.
- The final result of K-Means can be seen in the "Hbase Shell" by looking the "tweet_batch_view" table or in the HTML page made at the end of the KMeans algorithm as in figure above.
- As a future development could be added :
  - A GUI to visualize easily the result
  - A filter to select only the images that truly reflect the keyword
  - A different approach of K-Means