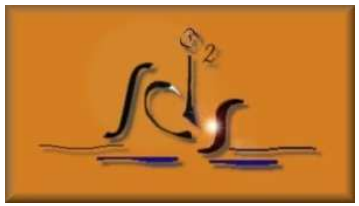
Ciencia de Datos: Un Enfoque Práctico en la Era del Big Data
Hadoop: Caso Práctico 2

Sara Del Río García

Departamento de Ciencias de la Computación e Inteligencia Artificial,
E.T.S. de Ingenierías Informática y de Telecomunicación,
srio@decsai.ugr.es

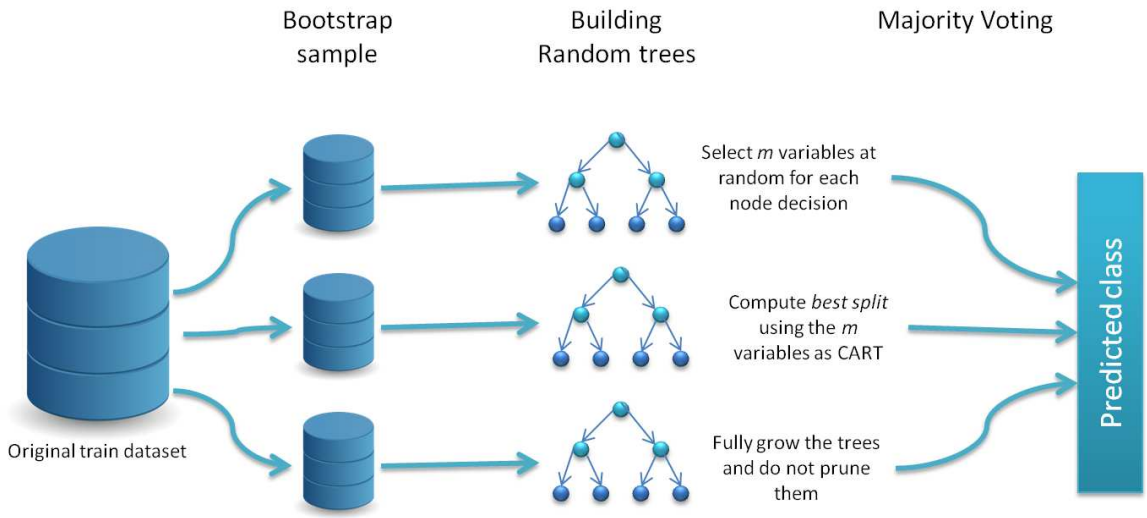


Contenido

Contenido

Ejemplo: Random Forest

- Random Forest (RF) es un ensemble de árboles de decisión.
- La clase predicha se calcula mediante la agregación de las predicciones del conjunto a través de la votación por mayoría



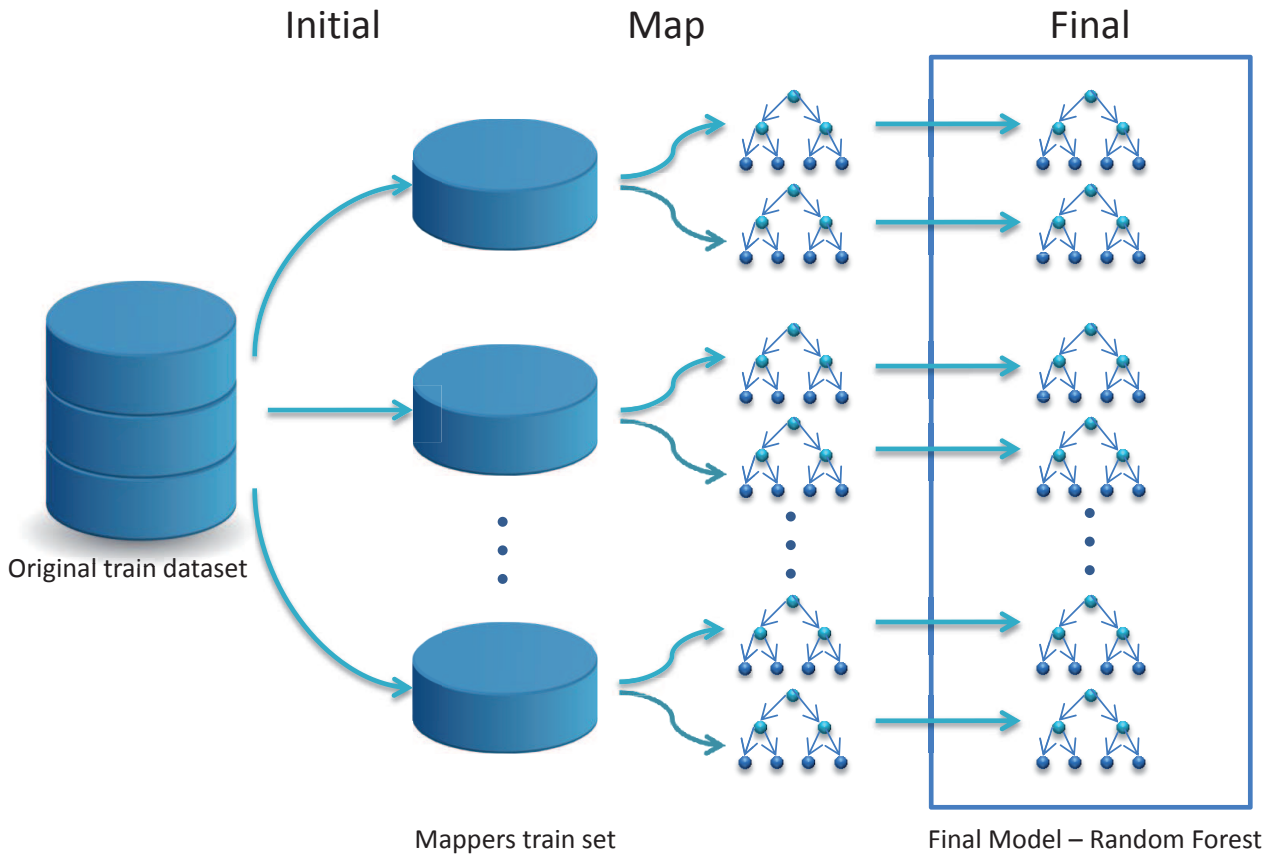
Contenido

Random Forest usando MapReduce

- La implementación Partial de la biblioteca Mahout (RF-BigData) es un algoritmo que construye múltiples árboles para diferentes porciones de los datos
- Este algoritmo consta de dos fases diferentes:
  1. Fase de Construcción del Modelo
  2. Fase de Clasificación
- De forma adicional, cada una de las fases constan de tres etapas:
  1. Inicial
  2. Map
  3. Final

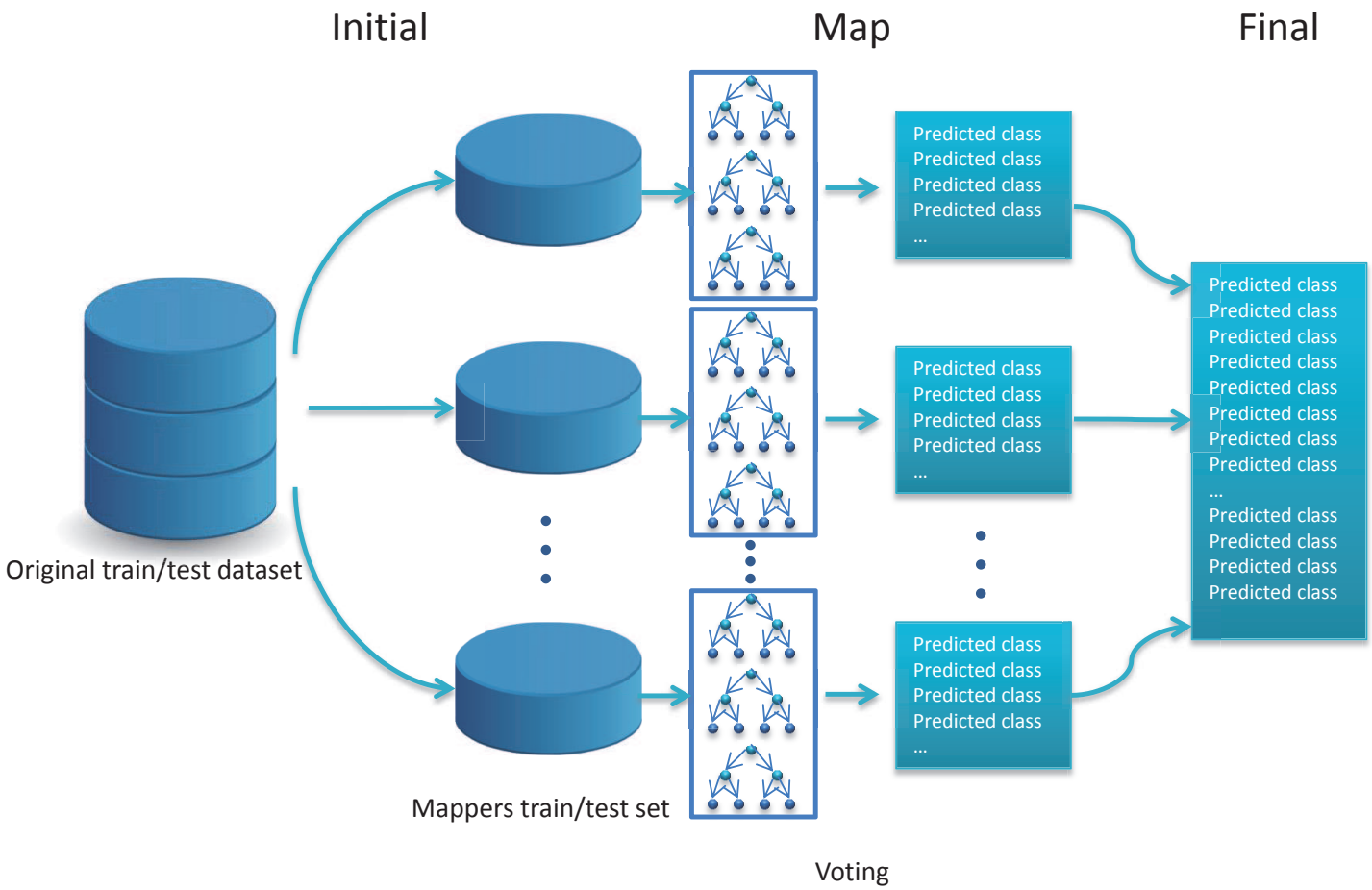
Random Forest usando MapReduce

- Fase de Construcción del Modelo



Random Forest usando MapReduce

- Fase de Clasificación



Random Forest usando MapReduce

Fase de Construcción del Modelo - Mapper Class

```
public class Step1Mapper extends MapredMapper<
    LongWritable,Text,TreeID,MapredOutput> {

/** number of trees to be built by this mapper */
private int nbTrees;

/** will contain all instances if this mapper's split */
private final List<Instance> instances = Lists.newArrayList();

    ...

    protected void setup(Context context) throws IOException
        , InterruptedException {
  super.setup(context);
  Configuration conf = context.getConfiguration();

  configure(Builder.getRandomSeed(conf), conf.getInt("mapred.
      task.partition", -1),
    Builder.getNumMaps(conf), Builder.getNbTrees(conf));
}
```

Random Forest usando MapReduce

Fase de Construcción del Modelo - Mapper Class

```
protected void map(LongWritable key, Text value, Context
    context) throws IOException, InterruptedException {
  instances.add(converter.convert(value.toString()));
}

protected void cleanup(Context context) throws IOException,
    InterruptedException {
  Data data = new Data(getDataset(), instances);
  Bagging bagging = new Bagging(getTreeBuilder(), data);
  TreeID key = new TreeID();

  for (int treeId = 0; treeId < nbTrees; treeId++) {
    Node tree = bagging.build(rng);
    key.set(partition, firstTreeId + treeId);
    if (isOutput()) {
      MapredOutput emOut = new MapredOutput(tree);
      context.write(key, emOut);
    }
  }
}
```

Random Forest usando MapReduce

Fase de Clasificación - Mapper Class

```
public static class CMapper extends Mapper<LongWritable, Text,
    DoubleWritable, Text> {
    private DataConverter converter;
    private DecisionForest forest;
    private final Text lvalue = new Text();
    private Dataset dataset;
    private final DoubleWritable lkey = new DoubleWritable();

                ...

    protected void setup(Context context) throws IOException,
        InterruptedException {
      super.setup(context);
      Configuration conf = context.getConfiguration();
      Path[] files = HadoopUtil.getCachedFiles(conf);
      dataset = Dataset.load(conf, files[0]);
      converter = new DataConverter(dataset);
      forest = DecisionForest.load(conf, files[1]);

                        ...
}
```

Random Forest usando MapReduce

Fase de Clasificación - Mapper Class

```
protected void map(LongWritable key, Text value, Context
    context) throws IOException, InterruptedException {
                    ...

  String line = value.toString();
  if (!line.isEmpty()) {
    Instance instance = converter.convert(line);
    double prediction = forest.classify(dataset, rng,
        instance);
    lkey.set(dataset.getLabel(instance));
    lvalue.set(Double.toString(prediction));
    context.write(lkey, lvalue);
  }
 }
}
```

Random Forest usando MapReduce

- Marco Experimental:
  - Conjunto de datos **Iris**
    - # Características: 4
    - # Instancias: 150
    - # Clases: 3 {Iris-setosa, Iris-versicolor, Iris-virginica}
  - Disponible en *UCI Machine Learning Repository*
  - Esquema de validación cruzada en 5 particiones (usaremos la primera partición)

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  1. Crear el directorio de entrada "/user/hadoop/datasets/iris" en HDFS:

     hadoop fs -mkdir /user/hadoop/datasets
     /user/hadoop/datasets/iris

  2. Mover los conjuntos de datos al directorio creado previamente en HDFS:

     hadoop fs -put *.arff datasets/iris

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  3. Generar el fichero que describe al conjunto de datos:

```
hadoop jar /home/hadoop/mahout-distribution-0.9.jar
org.apache.mahout.classifier.df.tools.Describe
-p datasets/iris/iris-5-1tra.arff
-f datasets/iris/iris-5-1tra.info
-d 4 N L
```

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  3. Generar el fichero que describe al conjunto de datos:

```
[srio@hadoop-master ~]$ hadoop jar /home/srio/mahout-distribution-0.9.jar
p/kddcup_10_normal_versus_DOS-5-1tra.info -d N 3 C 37 N L
15/04/01 13:06:22 INFO tools.Describe: Generating the descriptor...
15/04/01 13:06:23 INFO tools.Describe: generating the dataset...
15/04/01 13:06:26 INFO tools.Describe: storing the dataset description
[srio@hadoop-master ~]$
```

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  4. Ejecutar la aplicación:

```
hadoop jar /home/hadoop/mahout-distribution-0.9.jar
org.apache.mahout.classifier.df.mapreduce.BuildForest
-Dmapreduce.input.fileinputformat.split.minsize=728
-Dmapreduce.input.fileinputformat.split.maxsize=728
-o output_iris_5maps
-d datasets/iris/iris-5-1tra.arff
-ds datasets/iris/iris-5-1tra.info
-sl 3 -p -t 10
```

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  4. Ejecutar la aplicación:

```
15/04/01 13:15:32 INFO mapreduce.Job: Counters: 30
        File System Counters
                FILE: Number of bytes read=13415
                FILE: Number of bytes written=535495
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=59448653
                HDFS: Number of bytes written=262746
                HDFS: Number of read operations=25
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=10
        Job Counters
                Launched map tasks=5
                Rack-local map tasks=5
                Total time spent by all maps in occupied slots (ms)=394639
                Total time spent by all reduces in occupied slots (ms)=0
                Total time spent by all map tasks (ms)=56377
                Total vcore-seconds taken by all map tasks=56377
                Total megabyte-seconds taken by all map tasks=394639000
        Map-Reduce Framework
                Map input records=388495
                Map output records=100
                Input split bytes=755
                Spilled Records=0
                Failed Shuffles=0
                Merged Map outputs=0
                GC time elapsed (ms)=386
                CPU time spent (ms)=50090
                Physical memory (bytes) snapshot=3682967552
                Virtual memory (bytes) snapshot=35931688960
                Total committed heap usage (bytes)=6913261568
        File Input Format Counters
                Bytes Read=59447898
        File Output Format Counters
                Bytes Written=262746
15/04/01 13:15:32 INFO common.HadoopUtil: Deleting hdfs://hadoop-master/user/srio/output
15/04/01 13:15:32 INFO mapreduce.BuildForest: Build Time: 0h 0m 23s 868
15/04/01 13:15:32 INFO mapreduce.BuildForest: Forest num Nodes: 14141
15/04/01 13:15:32 INFO mapreduce.BuildForest: Forest mean num Nodes: 141
15/04/01 13:15:32 INFO mapreduce.BuildForest: Forest mean max Depth: 8
15/04/01 13:15:32 INFO mapreduce.BuildForest: Storing the forest in: output/forest.seq
```

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  5. Usar el modelo generado en el paso anterior para clasificar nuevos datos:

```
hadoop jar /home/hadoop/mahout-distribution-0.9.jar
org.apache.mahout.classifier.df.mapreduce.TestForest
-i datasets/iris/iris-5-1tst.arff
-ds datasets/iris/iris-5-1tra.info
-m output_iris_5maps
-a -mr
-o predictions_iris_5maps
```

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  5. Usar el modelo generado en el paso anterior para clasificar nuevos datos:

```
15/04/01 13:21:17 INFO common.HadoopUtil: Deleting predictions/mappers
15/04/01 13:21:17 INFO mapreduce.TestForest:
=======================================================
Summary
-------------------------------------------------------
Correctly Classified Instances          :      97117       99.9969%
Incorrectly Classified Instances        :          3        0.0031%
Total Classified Instances              :      97120

=======================================================
Confusion Matrix
-------------------------------------------------------
a       b       <--Classified as
77732   1        |  77733       a     = negative
2       19385    |  19387       b     = positive

=======================================================
Statistics
-------------------------------------------------------
Kappa                                       -0.5406
Accuracy                                    99.9969%
Reliability                                 66.6628%
Reliability (standard deviation)             0.5773
```

Random Forest usando MapReduce

- Caso de estudio: 5 maps - 10 árboles
- Uso:
  6. Comprobar la salida:

     hadoop fs -cat predictions_iris_5maps/iris-5-1tst.arff.out | head

Comprobar el estado de las ejecuciones a través de la siguiente consola web:

http://localhost:8088/cluster

Repetir los pasos 4 - 6 con los dos últimos casos de estudio

Contenido

Referencias

- Apache Mahout:

  http://mahout.apache.org/

- Random Forest MapReduce implementation in Mahout:

  http://mahout.apache.org/users/classification/partial-implementation.html

- UCI Machine Learning Repository - Iris dataset:

  https://archive.ics.uci.edu/ml/datasets/Iris

Happy Hadooping!

Ciencia de Datos: Un Enfoque Práctico en la Era del Big Data
Hadoop: Caso Práctico 2

Sara Del Río García

Departamento de Ciencias de la Computación e Inteligencia Artificial,
E.T.S. de Ingenierías Informática y de Telecomunicación,
srio@decsai.ugr.es