

# **Big data: architectures and data analytics**

# **Itemset and Association rule mining**

## Itemset and Association rule mining

- Spark MLlib provides
  - An itemset mining algorithm based on the FP-growth algorithm
    - That extracts all the sets of items (of any length) with a minimum frequency
  - A rule mining algorithm
    - That extracts the association rules with a minimum frequency and a minimum confidence
    - Only the rules with one single item in the consequent of the rules are extracted

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## Itemset and Association rule mining

- The input dataset in this case is a set of transactions
- Each transaction is defined as a set of items
- Transactional dataset: example
  - A B C D
  - A B
  - B C
  - A D E
- The example dataset contains 4 transactions

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# The FP-Growth algorithm and Association rule mining

## The FP-Growth algorithm

- FP-growth is one of the most popular and efficient itemset mining algorithms
- It is characterized by one single parameter
  - The minimum support threshold (**minsup**)
    - i.e., the minimum frequency of the itemset in the input transactional dataset
    - It is a real value in the range (0-1]
  - The minsup threshold is used to limit the number of mined itemsets
- The input dataset is a transactional dataset

## Association Rule Mining

- Given a set of frequent itemsets, the frequent association rules can be mined
- An association rule is mined if
  - Its frequency is greater than the minimum support threshold (**minsup**)
    - i.e., a minimum frequency
    - The minsup value is specified during the itemset mining step and not during the association rule mining step
  - Its confidence is greater than the minimum confidence threshold (**minconf**)
    - i.e., a minimum "correlation"
    - It is a real value in the range (0-1]

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## Itemset and Association Rule Mining: example

- The following slides show how to
  - Extract the set of frequent itemsets from a transactional dataset
  - Extract the association rules from the frequent itemsets
- The input dataset is a transactional dataset

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## Itemset and Association Rule Mining: example

- Example of input file

A B C D

A B

B C

A D E

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## Itemset and Association Rule Mining: example

```
package it.polito.bigdata.spark.sparkmllib;

import java.util.ArrayList;

import org.apache.spark.SparkConf;
import org.apache.spark.api.java.JavaRDD;
import org.apache.spark.api.java.JavaSparkContext;
import org.apache.spark.mllib.fpm.AssociationRules;
import org.apache.spark.mllib.fpm.FPGrowth;
import org.apache.spark.mllib.fpm.FPGrowth.FreqItemset;
import org.apache.spark.mllib.fpm.FPGrowthModel;
```

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## Itemset and Association Rule Mining: example

```
public class SparkDriver {

    public static void main(String[] args) {
        String inputFile;
        String outputFolderItemsets;
        String outputFolderRules;
        double minSupport;
        double minConfidence;

        inputFile = args[0];
        outputFolderItemsets = args[1];
        outputFolderRules = args[2];
        minSupport = Double.parseDouble(args[3]);
        minConfidence = Double.parseDouble(args[4]);
    }
}
```

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## Itemset and Association Rule Mining: example

```
// Create a configuration object and set the name of the application
SparkConf conf=new SparkConf().setAppName("Itemset and Association rule
mining");

// Create a Spark Context object
JavaSparkContext sc = new JavaSparkContext(conf);

JavaRDD<String> inputRDD = sc.textFile(inputFile);

// Read the input data
// Each line of the input file contains one transaction,
// i.e., a list of items
// Each element of the JavaRDD represents one transaction = a list of strings
JavaRDD<ArrayList<String>>transactions =inputRDD.map(new InputRecord());
```

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## Itemset and Association Rule Mining: example

```
// Create an FPGrowth object
FPGrowth fp=new FPGrowth();

// Set the minimum support (frequency threshold)
fp.setMinSupport(minSupport);

// Run the algorithm
FPGrowthModel<String> model = fp.run(transactions);

// Retrieve the extracted itemsets
JavaRDD<FreqItemset<String>> freqItemsets=model.freqItemsets().toJavaRDD();
```

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## Itemset and Association Rule Mining: example

```
// FreqItemset<String> is a complex data type. It contains a list of items
// and the frequency of that set
// The following map is used to map each FreqItemset object to a String
// containing the set of items and the support using the format
// [list of items], frequency=frequency
JavaRDD<String> freqItemsetsString=freqItemsets.map(
    new ItemsetAsSingleString());

freqItemsetsString.saveAsTextFile(outputFolderItemsets);
```

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## Itemset and Association Rule Mining: example

```
// Association rule mining from the set of frequent itemsets mined
// by using FPGrowth
// Instance an AssociationRules object
AssociationRules arules = new AssociationRules();

// Set the minimum confidence threshold
arules.setMinConfidence(minConfidence);

// Extract the rules
JavaRDD<AssociationRules.Rule<String>> assRules = arules.run(freqItemsets);
```

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## Itemset and Association Rule Mining: example

```
package it.polito.bigdata.spark.sparkmllib;
import java.util.ArrayList;
import org.apache.spark.api.java.function.Function;

@SuppressWarnings("serial")
public class InputRecord implements Function<String, ArrayList<String>> {

    public ArrayList<String> call(String line) {
        ArrayList<String> itemsList=new ArrayList<String>();
        String[] items = line.split("");

        for (String item: items) {
            itemsList.add(item);
        }
        return itemsList;
    }
}
```

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## Itemset and Association Rule Mining: example

```

package it.polito.bigdata.spark.sparkmllib;

import org.apache.spark.api.java.function.Function;
import org.apache.spark.mllib.fpm.FPGrowth.FreqItemset;

@SuppressWarnings("serial")
public class ItemsetAsSingleString implements Function<FreqItemset<String>,
    String> {

    @Override
    public String call(FreqItemset<String> itemset) {
        return new String "[" + itemset.javaItems() + "], frequency=" + itemset.freq();
    }
}

```

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## Itemset and Association Rule Mining: example

```

package it.polito.bigdata.spark.sparkmllib;

import org.apache.spark.api.java.function.Function;
import org.apache.spark.mllib.fpm.AssociationRules.Rule;

@SuppressWarnings("serial")
public class AssRuleToString implements Function<Rule<String>, String> {

    public String call(Rule<String> rule) throws Exception {

        return new String "{" + rule.javaAntecedent() + "}" -> {" +
            rule.javaConsequent() + "}" +
            "confidence=" + rule.confidence();
    }
}

```

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