

Digital Technologies Tech Talks

Apache Spark

An Introduction

April 13, 2022 - René Richard

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WRAP-UP



Source : <https://bit.ly/3i8C4sQ>

01 - INTRODUCTION

Is this for me?

- Some exposure to :
 - The command-line (on Unix-like OS)
 - Docker and docker-compose
 - **Python** or programming in general
 - Structure Query Language (SQL)
 - There will be a nod to Java and Scala jobs
 - **Interest** and/or **curiosity** (trumps all of the above)



Source : <https://bit.ly/3Jgo10c>

01 - INTRODUCTION

GitHub project link

- https://github.com/redsofa/dt_seminar_spark_intro
 - Includes :
 - Slides
 - Simulated cluster configurations
 - Source code
 - Data
 - Book



Source : <https://bit.ly/3q6VsdW>

01 - INTRODUCTION

About me

- Senior Programmer Analyst NRC, DT
- Member of the Scientific Data Mining group
- MScE (Geodesy and Geomatics Engineering) from UNB
- @NRC ~19 years
- Email : rene.richard@nrc.ca



02 - SPARK OVERVIEW

What is Apache Spark ?

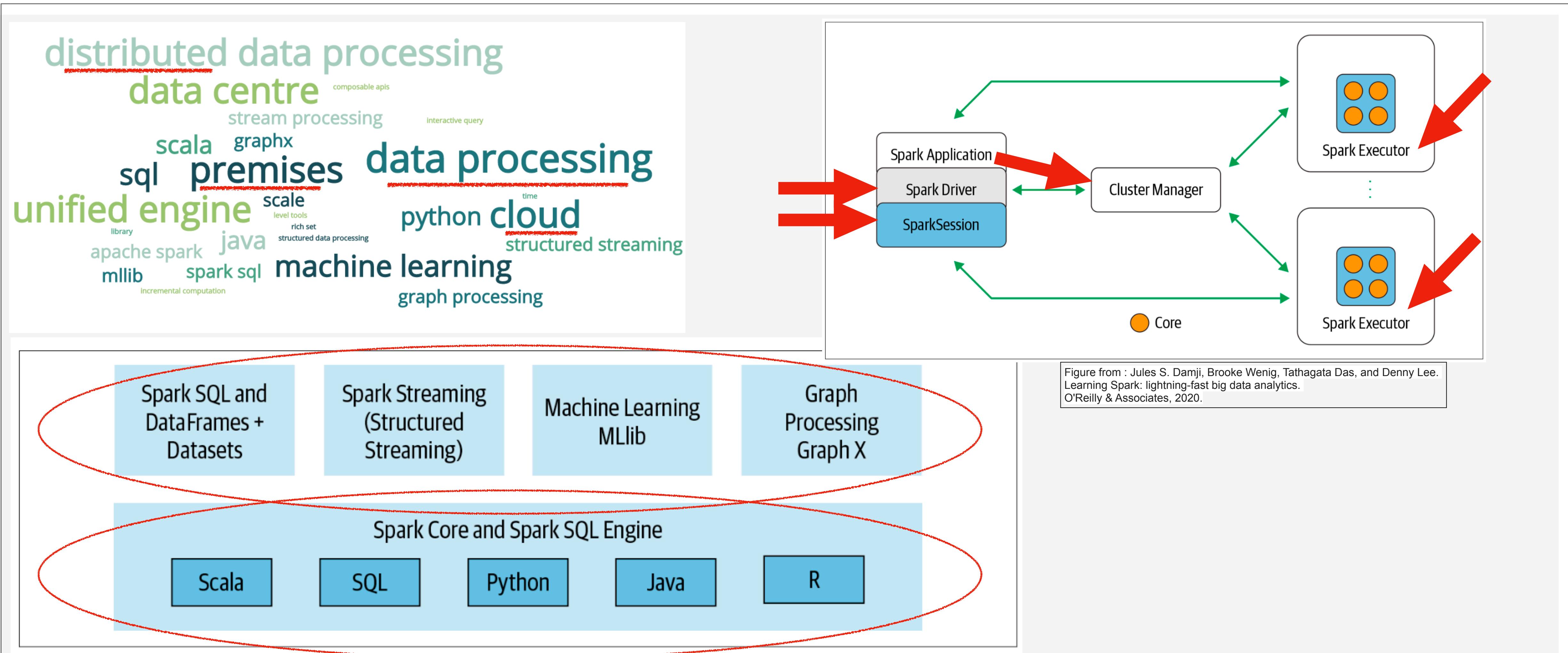


Figure from : Jules S. Damji, Brooke Wenig, Tathagata Das, and Denny Lee. Learning Spark: lightning-fast big data analytics. O'Reilly & Associates, 2020.

02 - SPARK OVERVIEW

Deployment Modes

Mode	Spark driver	Spark executor	Cluster manager
★ Local	Runs on a single JVM, like a laptop or single node	Runs on the same JVM as the driver	Runs on the same host
★ Standalone	Can run on any node in the cluster	Each node in the cluster will launch its own executor JVM	Can be allocated arbitrarily to any host in the cluster
YARN (client)	Runs on a client, not part of the cluster	YARN's NodeManager's container	YARN's Resource Manager works with YARN's Application Master to allocate the containers on NodeManagers for executors
YARN (cluster)	Runs with the YARN Application Master	Same as YARN client mode	Same as YARN client mode
Kubernetes	Runs in a Kubernetes pod	Each worker runs within its own pod	Kubernetes Master

Figure from : Jules S. Damji, Brooke Wenig, Tathagata Das, and Denny Lee. Learning Spark: lightning-fast big data analytics. O'Reilly & Associates, 2020.

02 - SPARK OVERVIEW

Local Deployment Mode

- Easiest way to try out Apache Spark (pip or conda install and go)
- All processing is done on single machine
- Still benefit from parallelized processing across all the cores on single machine, but not across several servers

```
from pyspark.sql import SparkSession  
  
spark = SparkSession\  
    .builder\  
    .master("local[20]")\  
    .appName("pyspark_local")\  
    .getOrCreate()
```

Local Spark thread-based cluster using 20 cores

02 - SPARK OVERVIEW

Popular Spark use cases

- Parallelize computations, hide complexity, enjoy distribution and fault tolerance
- Perform **ad-hoc queries** to explore and visualize data sets
- Combine data from multiple sources
- Prepare data for downstream **ML modelling**
- Training and evaluating ML models (MLlib)
- End-to-end pipelines from **streaming** data (Structured Streaming)

02 - SPARK OVERVIEW

Spark SQL

- DataFrame and dataset abstractions
- Data read/write (JSON, CSV, Avro, Parquet, ORC, etc.)
- Bridge to standard tools via JDBC/ODBC connectors
- Generates optimized query plans for final execution
- Support for ANSI SQL:2003-compliant commands

Transformations	Actions
orderBy()	show()
groupBy()	take()
filter()	count()
select()	collect()
join()	save()

02 - SPARK OVERVIEW

GPU-Accelerated ETL - (new in Spark 3.x)

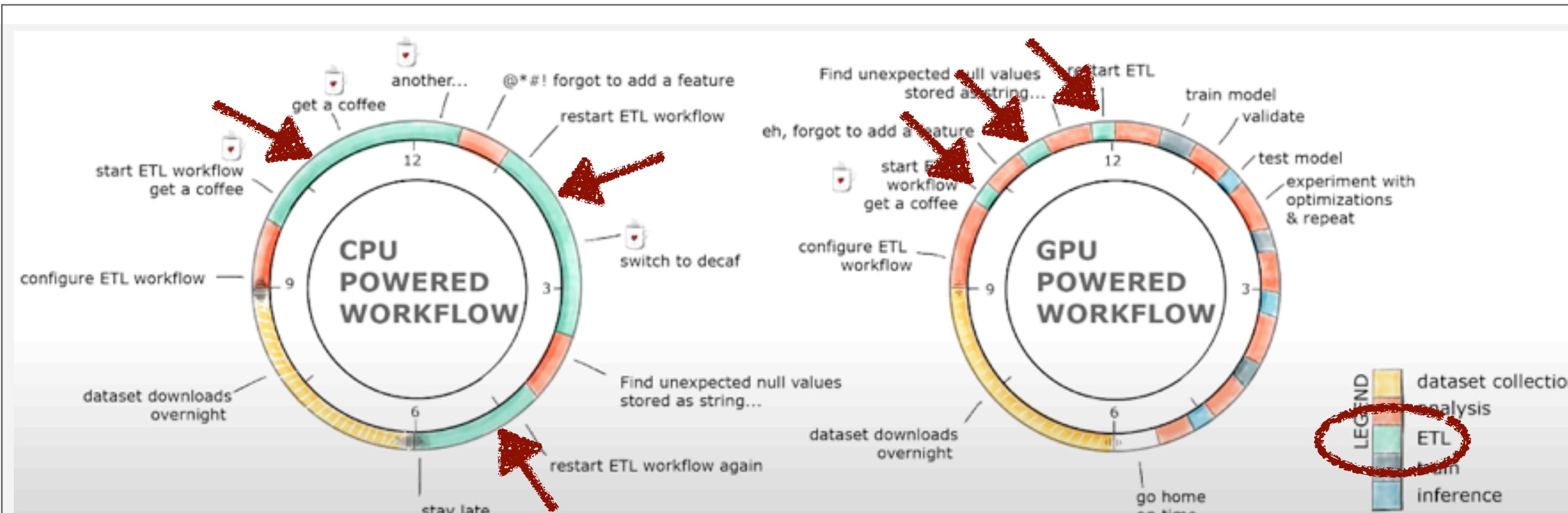


Figure from : <https://bit.ly/3wmUTkv>

Dask cuDF
cuDF, Pandas

Spark DataFrame,
Scala, PySpark

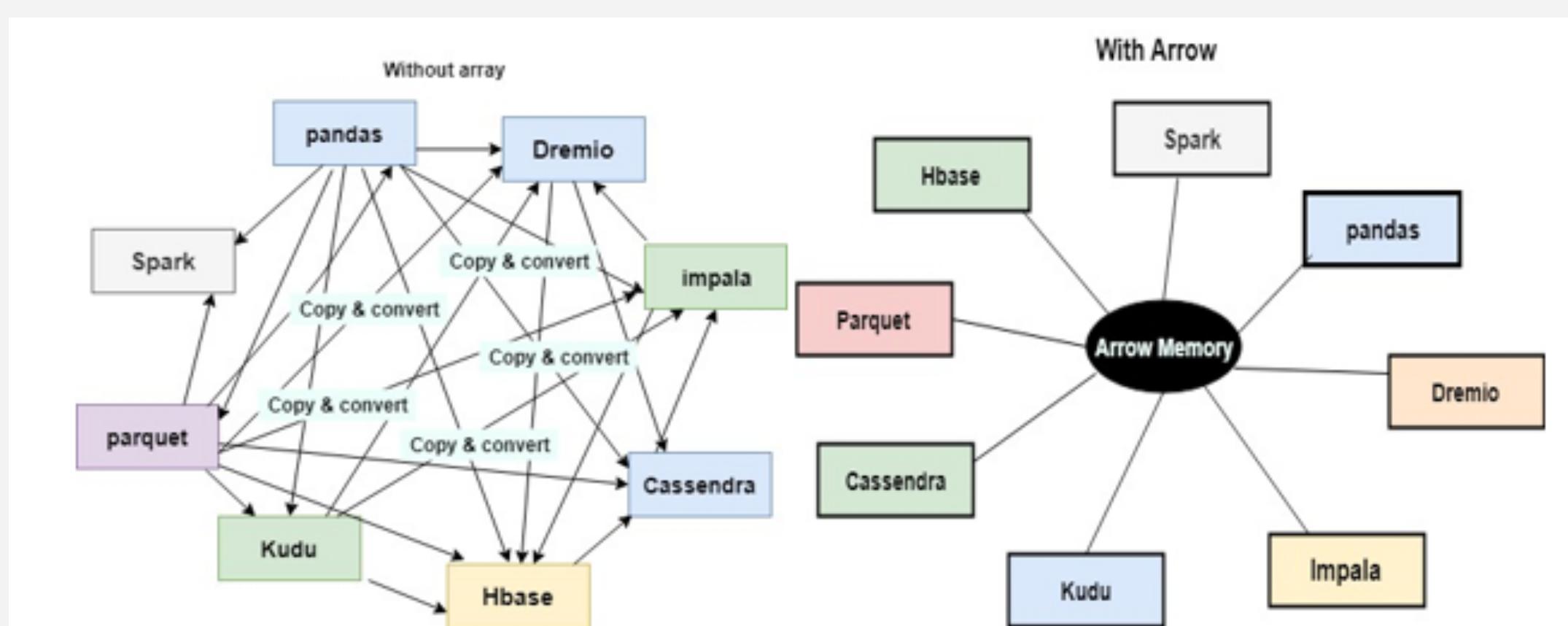


Figure from : <https://www.tutorialandexample.com/apache-arrow-tutorial>

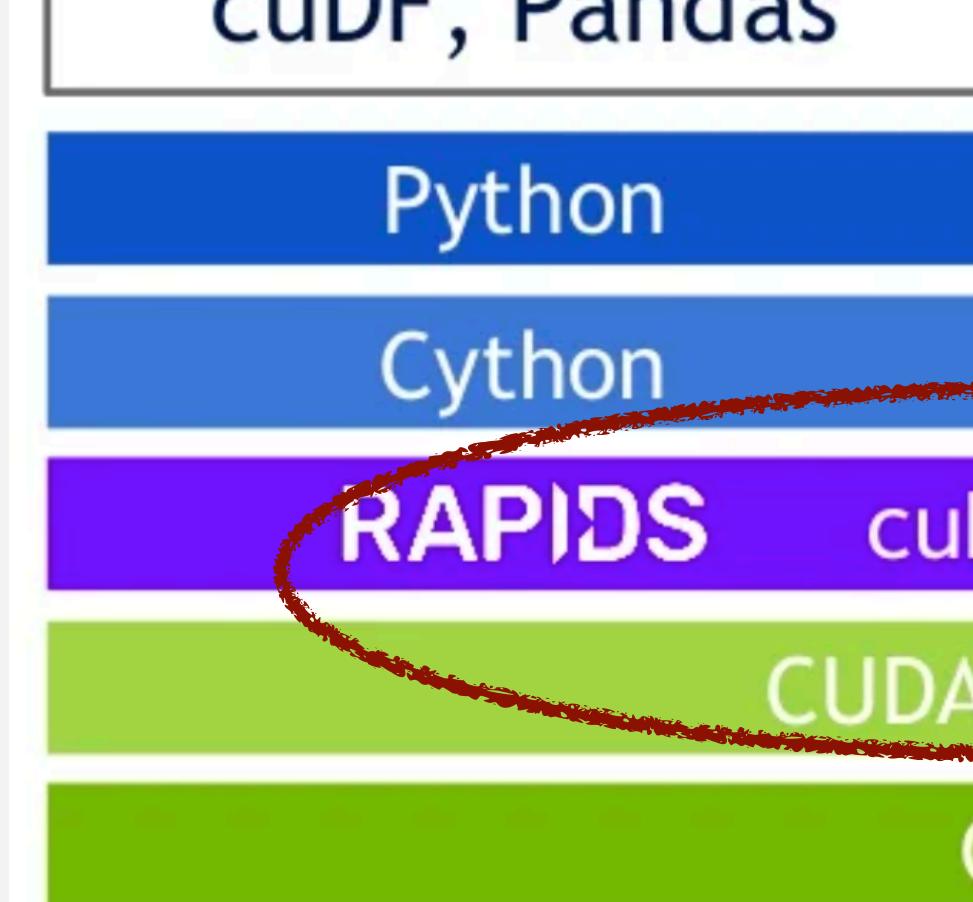
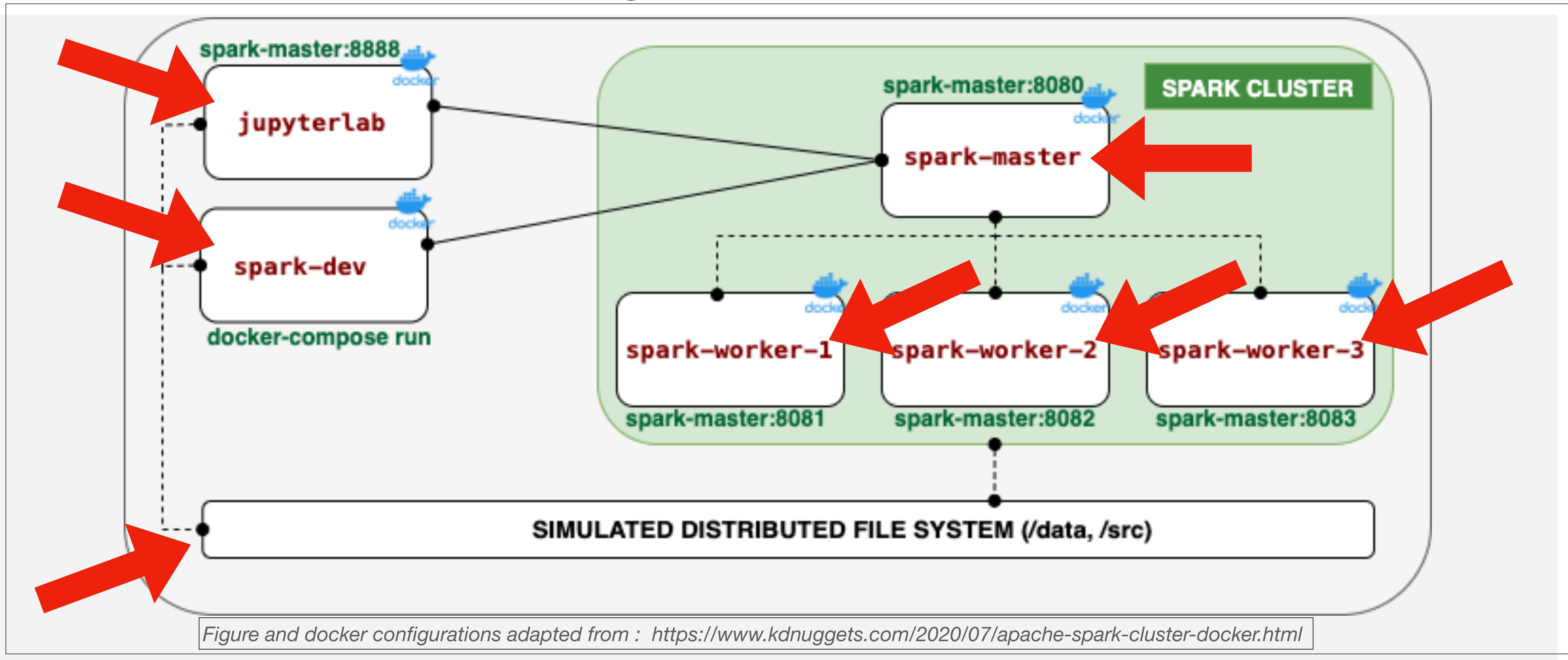


Figure from : <https://bit.ly/3lfIXmx>

03 - SIMULATED CLUSTER

Standalone cluster configuration



Start simulated cluster



Hands-on content

Explore simulated cluster



Hands-on content

04 - SPARK-SUBMIT

HelloWorld examples

- Spark-submit utility
 - Client and cluster deploy-modes
 - Resource requests
- Code API similarity across languages

Submit HelloWorld.scala



Hands-on content

Submit HelloWorld.java



Hands-on content

05 - DATA TRANSFORMATIONS

Data contextualization

- TODO ... Why do we do this? Why is it easy with Spark?
- Exploratory analytics on structured data can :
 - Inform the feature extraction approach
 - Influence the design of models
 - Lead to valuable insights even before we train a model
- Identifying ways to transform data where structure is preserved
- Where ML models make predictions while reducing computation costs
- TODO...Noise reduction ...

05 - DATA TRANSFORMATIONS

Common operations

- Dataframes
- Spark SQL
- UDFs
- Broadcast
- Accumulator
- Etc..

The ETL notebook



06 - SPARK MLLIB

Main machine learning techniques

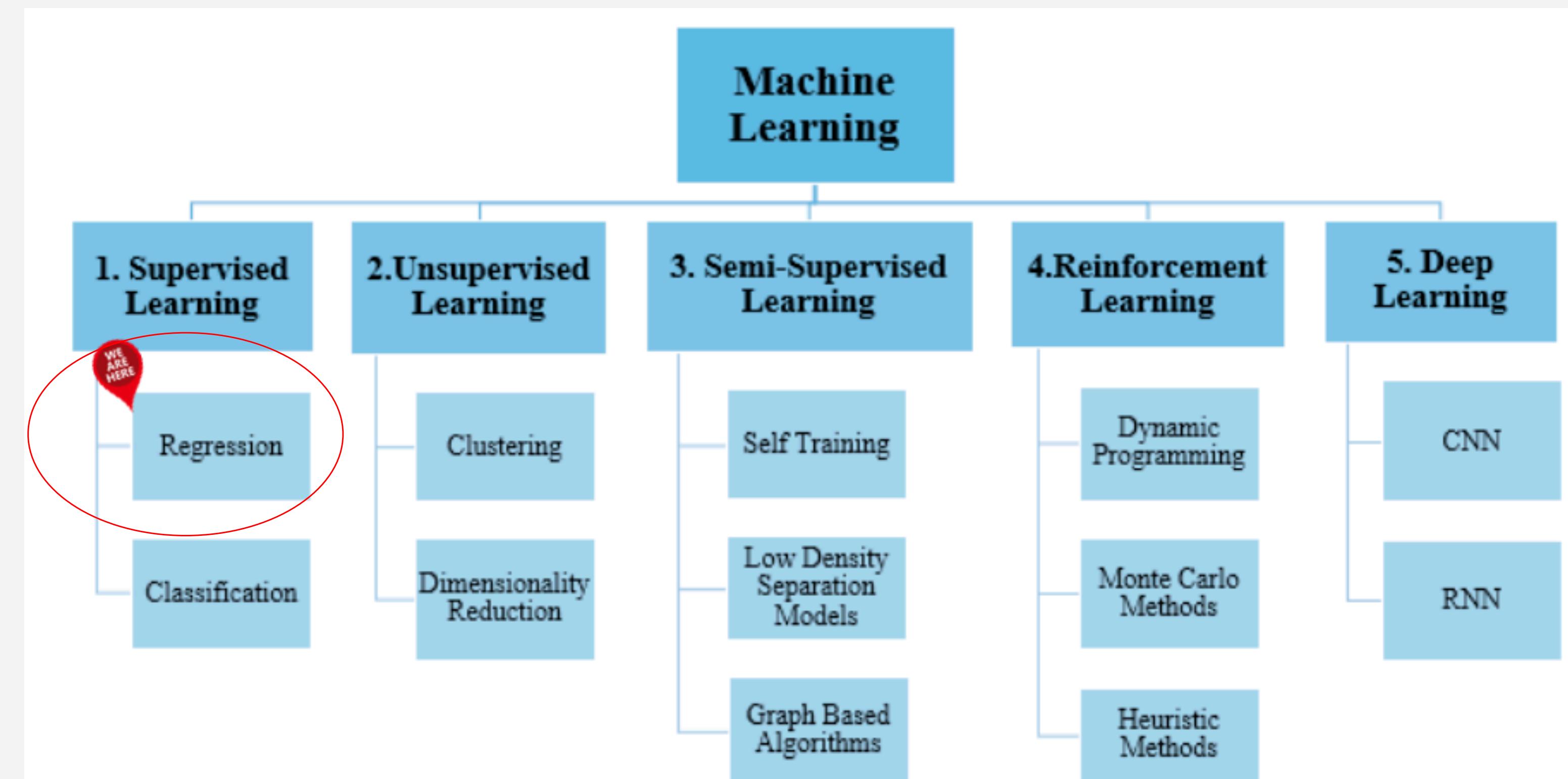


Figure from : Nassif, A. B., Shahin, I., Attili, I., Azzeh, M., & Shaalan, K. (2019). Speech recognition using deep neural networks: A systematic review. *IEEE access*, 7, 19143-19165.

06 - SPARK MLLIB

Vehicle price prediction

- Can I predict the price of the car I want to buy?
- Using random forest regression
- Kaggle car_data.csv data set
-



Source : <https://bit.ly/3I9OIIP>

06 - SPARK MLLIB

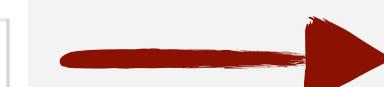
Random forest I/O columns

Input Columns

Param name	Type(s)	Default	Description
labelCol	Double	"label"	Label to predict
featuresCol	Vector	"features"	Feature vector

Output Columns (Predictions)

Param name	Type(s)	Default	Description	Notes
predictionCol	Double	"prediction"	Predicted label	
rawPredictionCol	Vector	"rawPrediction"	Vector of length # classes, with the counts of training instance labels at the tree node which makes the prediction	Classification only
probabilityCol	Vector	"probability"	Vector of length # classes equal to rawPrediction normalized to a multinomial distribution	Classification only



featuresCol	predictionCol	labelCol
algorithmic_input	prediction	Selling_Price
[1.6,1200.0,0.0,5.0,1.0,0.0,0.0,1.0]	1.5092715887040848 1.45	
[0.75,26000.0,1.0,14.0,1.0,0.0,0.0,1.0]	0.2966107827960572 0.25	
[0.99,14500.0,0.0,10.0,1.0,0.0,0.0,1.0]	0.5599952838539594 0.45	
[3.46,45280.0,0.0,8.0,1.0,0.0,1.0,1.0]	2.712267776467363 2.5	
[3.95,25000.0,0.0,6.0,1.0,0.0,1.0,1.0]	3.3483788668185857 2.85	

Source : <https://spark.apache.org/docs/latest/ml-classification-regression.html#random-forests>

Modeling notebook



Hands-on content

07 - WRAP UP

Thank you and some resources

- Spark on HPC infrastructure:
 - <https://bit.ly/3Ng9LXB>
- Databricks free trial:
 - <https://bit.ly/3qsDenn>
- Pandas API on Spark :
 - <https://bit.ly/3tFACox>