# Data Science in Spark with *sparklyr* : : CHEAT SHEET


## Connect

### DATABRICKS CONNECT (v2)

1. Open your .Renviron file: `usethis::edit_r_environ()`
2. In the .Renviron file add your Databricks Host Url and Token (PAT):
   - `DATABRICKS_HOST = [Your Host URL]`
   - `DATABRICKS_TOKEN = [Your PAT]`
3. Install extension: `install.packages("pysparklyr")`
4. Open connection:

```
sc <- spark_connect(
cluster_id = "[Your cluster's ID]",
method = "databricks_connect"
)
```

= Supported in Databricks Connect v2

### STANDALONE CLUSTER

1. Install RStudio Server on one of the existing nodes or a server in the same LAN
2. Open a connection

```
spark_connect(master="spark://host:port",
   version = "3.2",
   spark_home = [path to Spark])
```

### YARN CLIENT

1. Install RStudio Server on an edge node
2. Locate path to the cluster's Spark Home Directory, it normally is "/usr/lib/spark"
3. Basic configuration example

```
conf <- spark_config()
conf$spark.executor.memory <- "300M"
conf$spark.executor.cores <- 2
conf$spark.executor.instances <- 3
conf$spark.dynamicAllocation.enabled<-"false"
```

4. Open a connection

```
sc <- spark_connect(master = "yarn",
          spark_home = "/usr/lib/spark/",
          version = "2.1.0", config = conf)
```

### YARN CLUSTER

1. Make sure to have copies of the **yarn-site.xml** and **hive-site.xml** files in the RStudio Server
2. Point environment variables to the correct paths

```
Sys.setenv(JAVA_HOME="[Path]")
Sys.setenv(SPARK_HOME ="[Path]")
Sys.setenv(YARN_CONF_DIR ="[Path]")
```

3. Open a connection

```
sc <- spark_connect(master = "yarn-cluster")
```

### KUBERNETES

1. Use the following to obtain the Host and Port

```
system2("kubectl", "cluster-info")
```

2. Open a connection

```
sc <- spark_connect(config =
    spark_config_kubernetes(
     "k8s://https://[HOST]>:[PORT]",
     account = "default",
     image = "docker.io/owner/repo:version"
  ))
```

### LOCAL MODE

No cluster required. Use for learning purposes only

1. Install a local version of Spark: `spark_install()`
2. Open a connection

```
sc <- spark_connect(master="local")
```

### CLOUD

**Azure** - `spark_connect(method = "synapse")`

**Qubole**- `spark_connect(method = "qubole")`

## Import


Import data into Spark, not R

### READ A FILE INTO SPARK

**Arguments that apply to all functions:**
sc, name, path, options=list(), repartition=0, memory=TRUE, overwrite=TRUE

| | |
|---|---|
| **CSV** | **spark_read_csv(** header = TRUE, columns=NULL, infer_schema=TRUE, delimiter = ",", quote= "\"", escape = "\\", charset = "UTF-8", null_value = NULL**)** |
| **JSON** | **spark_read_json()** |
| **PARQUET** | **spark_read_parquet()** |
| **TEXT** | **spark_read_text()** |
| **DELTA** | **spark_read_delta()** |

### FROM A TABLE

dplyr::**tbl(**scr, …**)** - Creates a reference to the table without loading its data into memory

dbplyr::**in_catalog()** - Enables a three part table address

```
x <- tbl(sc,in_catalog("catalog", "schema", "table"))
```

**Import**
- From R (**copy_to()**)
- Read a file (**spark_read_**)
- Read Hive table (**tbl()**)

**Wrangle**
- **dplyr** verb
- **tidyr** commands
- Feature transformer (**ft_**)
- Direct Spark SQL (**DBI**)

**Visualize**
- Collect result, plot in R

**Model**
- Spark MLlib (**ml_**)
- H2O Extension

**Communicate**
Collect results into R share using **Quarto**

R for Data Science, Grolemund & Wickham

### R DATA FRAME INTO SPARK

dplyr::**copy_to(**dest, df, name**)**

Apache Arrow accelerates data transfer between R and Spark. To use, simply load the library

```
library(sparklyr)
library(arrow)
```

## Wrangle

### DPLYR VERBS

Translates into Spark SQL statements

```
copy_to(sc, mtcars) %>%
  mutate(trm = ifelse(am == 0,
         "auto", "man")) %>%
group_by(trm) %>%
summarise_all(mean)
```

### TIDYR

**pivot_longer()** - Collapse several columns into two.

**pivot_wider()** - Expand two columns into several.

**nest() / unnest()** - Convert groups of cells into list-columns, and vice versa.

**unite() / separate()** - Split a single column into several columns, and vice versa.

**fill()** - Fill NA with the previous value

### FEATURE TRANSFORMERS

**ft_binarizer()** - Assigned values based on threshold

**ft_bucketizer()** - Numeric column to discretized column

**ft_count_vectorizer()** - Extracts a vocabulary from document

**ft_discrete_cosine_transform()** - 1D discrete cosine transform of a real vector

**ft_elementwise_product()** - Element- wise product between 2 cols

**ft_hashing_tf()** - Maps a sequence of terms to their term frequencies using the hashing trick.

**ft_idf()** - Compute the Inverse Document Frequency (IDF) given a collection of documents.

**ft_imputer()** - Imputation estimator for completing missing values, uses the mean or the median of the columns.

**ft_index_to_string()** - Index labels back to label as strings

**ft_interaction()** - Takes in Double and Vector columns and outputs a flattened vector of their feature interactions.

**ft_max_abs_scaler()** - Rescale each feature individually to range [-1, 1]

**ft_min_max_scaler()** - Rescale each feature to a common range [min, max] linearly

**ft_ngram()** - Converts the input array of strings into an array of n-grams

**ft_bucketed_random_projection_lsh()**
**ft_minhash_lsh()** - Locality Sensitive Hashing functions for Euclidean distance and Jaccard distance (MinHash)

# Data Science in Spark with *sparklyr* : : **CHEAT SHEET**


**ft_normalizer()** - Normalize a vector to have unit norm using the given p-norm

**ft_one_hot_encoder()**- Continuous to binary vectors

**ft_pca()** - Project vectors to a lower dimensional space of top k principal components.

**ft_quantile_discretizer()** - Continuous to binned categorical values.

**ft_regex_tokenizer()** - Extracts tokens either by using the provided regex pattern to split the text.

**ft_robust_scaler()** - Removes the median and scales according to standard scale.

**ft_standard_scaler()** - Removes the mean and scaling to unit variance using column summary statistics

**ft_stop_words_remover()** - Filters out stop words from input

**ft_string_indexer()** - Column of labels into a column of label indices.

**ft_tokenizer()** - Converts to lowercase and then splits it by white spaces

**ft_vector_assembler()** - Combine vectors into single row-vector

**ft_vector_indexer()** - Indexing categorical feature columns in a dataset of Vector

**ft_vector_slicer()** - Takes a feature vector and outputs a new feature vector with a subarray of the original features

**ft_word2vec()** - Word2Vec transforms a word into a code

## Visualize

### DPLYR + GGPLOT2

```
copy_to(sc, mtcars) %>%          Summarize in Spark
  group_by(cyl) %>%
  summarise(mpg_m = mean(mpg)) %>%
  collect() %>%
  ggplot() +                     Collect results in R
    geom_col(aes(cyl, mpg_m))    Create plot
```

## Modeling

### REGRESSION

**ml_linear_regression()** - Linear regression.

**ml_aft_survival_regression()** - Parametric survival regression model named accelerated failure time (AFT) model

**ml_generalized_linear_regression()** - GLM

**ml_isotonic_regression()** - Uses parallelized pool adjacent violators algorithm.

**ml_random_forest_regressor()** - Regression using random forests.

### CLASSIFICATION

**ml_linear_svc()** - Classification using linear support vector machines

**ml_logistic_regression()** - Logistic regression

**ml_multilayer_perceptron_classifier()** - Based on the Multilayer Perceptron.

**ml_naive_bayes()** - It supports Multinomial NB which can handle finitely supported discrete data

**ml_one_vs_rest()** - Reduction of Multiclass, performs reduction using one against all strategy.

### TREE

**ml_decision_tree_classifier()**|**ml_decision_tree()**|**ml_decision_tree_regressor()** - Classification and regression using decision trees

**ml_gbt_classifier()**|**ml_gradient_boosted_trees()** | **ml_gbt_regressor()** - Binary classification and regression using gradient boosted trees

**ml_random_forest_classifier()** - Classification and regression using random forests.

**ml_feature_importances()** | **ml_tree_feature_importance()** - Feature Importance for Tree Models

### CLUSTERING

**ml_bisecting_kmeans()** - A bisecting k-means algorithm based on the paper

**ml_lda()** | **ml_describe_topics()** | **ml_log_likelihood()** | **ml_log_perplexity()** | **ml_topics_matrix()** - LDA topic model designed for text documents.

**ml_gaussian_mixture()** - Expectation maximization for multivariate Gaussian Mixture Models (GMMs)

**ml_kmeans()** | **ml_compute_cost()** |**ml_compute_silhouette_measure()** - Clustering with support for k-means

**ml_power_iteration()** - For clustering vertices of a graph given pairwise similarities as edge properties.

### RECOMMENDATION

**ml_als()** | **ml_recommend()** - Recommendation using Alternating Least Squares matrix factorization

### EVALUATION

**ml_clustering_evaluator()** - Evaluator for clustering

**ml_evaluate()** - Compute performance metrics

**ml_binary_classification_evaluator()** | **ml_binary_classification_eval()** | **ml_classification_eval()** - A set of functions to calculate performance metrics for prediction models.

### FREQUENT PATTERN

**ml_fpgrowth()** | **ml_association_rules()** | **ml_freq_itemsets()** - A parallel FP-growth algorithm to mine frequent itemsets.

**ml_freq_seq_patterns()** | **ml_prefixspan()** - PrefixSpan algorithm for mining frequent itemsets.

### STATS

**ml_summary()** - Extracts a metric from the summary object of a Spark ML model

**ml_corr()** - Compute correlation matrix

### RECOMMENDATION

**ml_als()** | **ml_recommend()** - Recommendation using Alternating Least Squares matrix factorization

### FEATURE

**ml_chisquare_test(x,features,label)** - Pearson's independence test for every feature against the label

**ml_default_stop_words()** - Loads the default stop words for the given language

### UTILITIES

**ml_call_constructor()** - Identifies the associated sparklyr ML constructor for the JVM

**ml_model_data()** - Extracts data associated with a Spark ML model

**ml_standardize_formula()** - Generates a formula string from user inputs

**ml_uid()** - Extracts the UID of an ML object.

## ML Pipelines

*Easily create a formal Spark Pipeline models using R. Save the Pipeline in native Sacala. It will have **no dependencies** on R.*

### INITIALIZE AND TRAIN

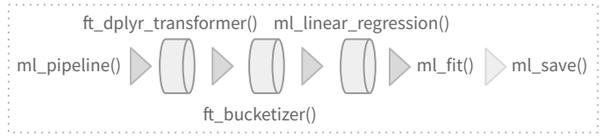
**ml_pipeline()** - Initializes a new Spark Pipeline

**ml_fit()** - Trains the model, outputs a Spark Pipeline Model.

### SAVE AND RETRIEVE

**ml_save()** - Saves into a format that can be read by Scala and PySpark .

**ml_read()** - Reads Spark object into sparklyr.




*spark.posit.co/guides/pipelines*

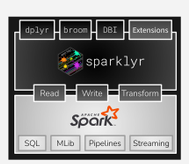
## Distributed R

Run arbitrary R code at scale inside your cluster with **spark_apply()**. Useful when there you need functionality only available in R, and to solve 'embarrassingly parallel problems'

**spark_apply(**x, f, columns = NULL, memory = TRUE, group_by = NULL, name = NULL, barrier = NULL, fetch_result_as_sdf = TRUE**)**

```
copy_to(sc, mtcars) %>%
  spark_apply(
    nrow, # R only function
    group_by = "am",
    columns = "am double, x long"
    )
```

### More Info

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