Assessment 1 - PySpark Dataframe

```
"""
Dataset Description:
1. age  numeric
2. job  type of job (categorical: 'admin.','blue-collar','entrepreneur','housemaid','manag
3. marital status (categorical: 'divorced', 'married', 'single', 'unknown'; note: 'divorce
4. education    (categorical: 'basic.4y','basic.6y','basic.9y','high.school','illiterate',
5. default: has credit in default? (categorical: 'no', 'yes', 'unknown')
6. balance
7. housing: has housing loan? (categorical: 'no', 'yes', 'unknown')
8. loan has a personal loan? (categorical: 'no', 'yes', 'unknown')

# related to the last contact of the current campaign:
9. contact communication type (categorical: 'cellular', 'telephone')
10. month Month of last contact (categorical: 'jan', 'feb', 'mar', ..., 'nov', 'dec')
11. day_of_the_month last contact day of the week (integer)
12. duration last contact duration, in seconds (numeric).

#Important note: this attribute highly affects the output target (example, if duration=0 t
#Yet, the duration is not known before a call is performed. Also, after the end of the cal
#Thus, this input should only be included for benchmark purposes and should be discarded i

# other attributes:
13. campaign: number of times a customer was contacted during the campaign (numeric, inclu
14. pdays: number of days passed after the customer was last contacted from a previous cam
15. previous: number of times the customer was contacted prior to (or before) this campaig
16. poutcome: outcome of the previous marketing campaign (categorical: 'failure', 'nonexis
17. deposit: has the customer subscribed a term deposit? (binary: 'yes', 'no')

Analysis tasks that the marketing team has asked you to perform:
1.[ok]  Load data and create a Spark data frame
2.[ok]  Give marketing success rate (No. of people subscribed / total no. of entries)
3.[ok]  Give marketing failure rate
4.[ok]  Give the maximum, mean, and minimum age of the targeted customer
5.[ok]  Check the quality of customers by checking average balance, median balance of cust
6.[ok]  Check if age matters in marketing subscription for deposit
7.[ok]  Check if marital status mattered for a subscription to deposit
8.[ok]  Check if age and marital status together mattered for a subscription to deposit sc
9.[ok]  Do feature engineering for the bank and find the right age effect on the campaign

"""
```

Installing PySpark

```
pip install pyspark
```

```
    Requirement already satisfied: pyspark in /usr/local/lib/python3.7/dist-packages (3.2
    Requirement already satisfied: py4j==0.10.9.3 in /usr/local/lib/python3.7/dist-packag
```

Importing libraries

```
import pandas as pd
import numpy as np
import pyspark
import matplotlib.pyplot as plt
from pyspark.sql import SparkSession
from pyspark.sql.types import *
from pyspark.sql.functions import col,array_contains, count, isnan, when
from pyspark.mllib.feature import StandardScaler,PCA
from pyspark.mllib.stat import Statistics
from pyspark.ml.feature import VectorAssembler
```

Pandas Data Frame

```
data = pd.read_csv('Project 1_dataset.csv')
data.head()
```

	age	job	marital	education	default	balance	housing	loan	contact	day
0	95	retired	married	secondary	0	0	0	0	telephone	1
1	93	retired	married	unknown	0	775	0	0	cellular	4
2	93	retired	married	unknown	0	775	0	0	cellular	22
3	92	retired	married	unknown	0	775	0	0	cellular	22
4	92	retired	married	unknown	0	775	0	0	telephone	26

```
data.describe()
```

	age	default	balance	housing	loan	
count	45211.000000	45211.000000	45211.000000	45211.000000	45211.000000	45211.
mean	40.936210	0.018027	1362.272058	0.555838	0.160226	15.
std	10.618762	0.133049	3044.765829	0.496878	0.366820	8.
min	18.000000	0.000000	-8019.000000	0.000000	0.000000	1.
25%	33.000000	0.000000	72.000000	0.000000	0.000000	8.
50%	39.000000	0.000000	448.000000	1.000000	0.000000	16.
75%	48.000000	0.000000	1428.000000	1.000000	0.000000	21.
max	95.000000	1.000000	102127.000000	1.000000	1.000000	31.

Initializing SparkSession

```
spark = SparkSession.builder.getOrCreate()
sc = spark.sparkContext
```

Reading CSV file and formating spark schema

```
#df = spark.read.csv('Project 1_dataset.csv')
```

```
rdd_dataset = spark.read.csv("Project 1_dataset.csv").rdd
```

```
schema = StructType() \
      .add("age",IntegerType(),True) \
      .add("job",StringType(),True) \
      .add("marital",StringType(),True) \
      .add("education",StringType(),True) \
      .add("default",IntegerType(),True) \
      .add("balance",IntegerType(),True) \
      .add("housing",IntegerType(),True) \
      .add("loan",IntegerType(),True) \
      .add("contact",StringType(),True) \
      .add("day",IntegerType(),True) \
      .add("month",StringType(),True) \
      .add("duration",IntegerType(),True) \
      .add("campaign",IntegerType(),True) \
      .add("pdays",IntegerType(),True) \
      .add("previous",IntegerType(),True) \
      .add("poutcome",StringType(),True) \
      .add("deposit",IntegerType(),True,)

spark_df = spark.read.format("csv") \
      .option("header", True) \
      .schema(schema) \
      .load("Project 1_dataset.csv")
spark_df.printSchema()
spark_df.show(10)
```

```
root
 |-- age: integer (nullable = true)
 |-- job: string (nullable = true)
 |-- marital: string (nullable = true)
 |-- education: string (nullable = true)
 |-- default: integer (nullable = true)
 |-- balance: integer (nullable = true)
 |-- housing: integer (nullable = true)
 |-- loan: integer (nullable = true)
 |-- contact: string (nullable = true)
 |-- day: integer (nullable = true)
 |-- month: string (nullable = true)
 |-- duration: integer (nullable = true)
 |-- campaign: integer (nullable = true)
 |-- pdays: integer (nullable = true)
 |-- previous: integer (nullable = true)
 |-- poutcome: string (nullable = true)
 |-- deposit: integer (nullable = true)

+---+-------+--------+---------+-------+-------+-------+----+---------+---+-----+---
|age|    job| marital|education|default|balance|housing|loan|  contact|day|month|dura
+---+-------+--------+---------+-------+-------+-------+----+---------+---+-----+---
| 95|retired| married|secondary|      0|      0|      0|   0|telephone|  1|  oct|
| 93|retired| married|  unknown|      0|    775|      0|   0| cellular|  4|  aug|
| 93|retired| married|  unknown|      0|    775|      0|   0| cellular| 22|  jul|
| 92|retired| married|  unknown|      0|    775|      0|   0| cellular| 22|  oct|
| 92|retired| married|  unknown|      0|    775|      0|   0|telephone| 26|  jan|
| 89|retired| married| tertiary|      0|    553|      0|   0| cellular| 19|  aug|
| 95|retired|divorced|  primary|      0|   2282|      0|   0|telephone| 21|  apr|
| 94|retired|divorced|secondary|      0|   1234|      0|   0|telephone|  3|  mar|
| 89|retired| married|  primary|      0|      0|      0|   0| cellular| 27|  sep|
| 90|retired|divorced|secondary|      0|      1|      0|   0|telephone| 13|  feb|
+---+-------+--------+---------+-------+-------+-------+----+---------+---+-----+---
only showing top 10 rows
```

```
schema = StructType() \
      .add("deposit",IntegerType(),True,)\
      .add("age",IntegerType(),True) \
      .add("marital",IntegerType(),True)


spark_df2 = spark.read.format("csv") \
      .option("header", True) \
      .schema(schema) \
      .load("Project 1_dataset2.csv")
spark_df2.printSchema()
spark_df2.show(10)
```

```
root
 |-- deposit: integer (nullable = true)
 |-- age: integer (nullable = true)
 |-- marital: integer (nullable = true)

+-------+---+-------+
|deposit|age|marital|
+-------+---+-------+
|      1| 95|      1|
|      1| 93|      1|
|      0| 93|      1|
|      0| 92|      1|
|      0| 92|      1|
|      1| 89|      1|
|      0| 95|      0|
|      0| 94|      0|
|      0| 89|      1|
|      0| 90|      0|
+-------+---+-------+
only showing top 10 rows
```

Statistics

1. Success Rate
2. Failure Rate
3. Max, Min and Avg Age of Targeted Customer
4. Average and Median Balance of Customers
5. Correlation between Age and Deposits
6. Correlation between Marital Status and Deposits
7. Marital Status and Age together mattered for Deposits
8. Right Age Effect for the Campaign

1. Success Rate

```
spark_df.createOrReplaceTempView("dataset")
```

```
spark.sql("SELECT poutcome,COUNT(poutcome) as Total FROM dataset\
GROUP BY poutcome ORDER BY Total DESC").show()
```

```
+-----------+-----+
|   poutcome|Total|
+-----------+-----+
|    success|15221|
|    failure|15021|
|nonexistent|14969|
+-----------+-----+
```

```
success_rate = 15221/(15021+14969+15221)*100
print(success_rate,'%')
```

```
33.666585565459734 %
```

2. Failure Rate

```
spark_df.groupby('poutcome').count().show()
```

```
+-----------+-----+
|   poutcome|count|
+-----------+-----+
|    success|15221|
|    failure|15021|
|nonexistent|14969|
+-----------+-----+
```

```
failure_rate = 15021/(15021+14969+15221)*100
print(failure_rate,'%')
```

```
33.22421534582292 %
```

Average By Month

```
spark_df.groupby('month').mean().show()
```

```
+-----+------------------+--------------------+------------------+-------------------
|month|          avg(age)|        avg(default)|      avg(balance)|       avg(housing)
+-----+------------------+--------------------+------------------+-------------------
|  jun|42.438120202209326|0.020782624976596144|1608.2222430256506|0.4169631155214379
|  aug| 42.89450936449496|0.015527453177525212|1427.7017768528895|0.1765647510805186
|  may| 38.89110852825803|0.017434258317594074| 1034.992590440215| 0.877233764346941
|  feb| 40.88523971309928| 0.01321253303133258| 1319.098905247263| 0.427331068327670
|  sep| 43.95854922279793|0.001727115716753...|1948.2918825561312|0.2227979274611398
|  mar|42.941299790356396|                 0.0|2046.2285115303982|0.2368972746331236
|  oct| 45.89159891598916|                 0.0| 2312.371273712737|0.2262872628726287
|  jul| 41.00884699057288| 0.03190717911530094| 900.0255257432923|0.4841189267585206
|  nov| 42.05793450881612| 0.02065491183879093|2512.9329974811085| 0.557682619647355
|  apr| 39.77080491132333|0.003751705320600273|1542.5511596180081| 0.705661664392905
|  dec| 44.45794392523364|                 0.0|2315.6728971962616|0.1915887850467289
|  jan| 40.49322879543835|0.012829650748396294|  946.783321454027| 0.371347113328581
+-----+------------------+--------------------+------------------+-------------------
```

3. MAX, MIN and AVG Ages

```
spark.sql("SELECT MAX(age) FROM dataset").show()
```

```
+--------+
|max(age)|
+--------+
|      95|
+--------+
```

```
spark.sql("SELECT MIN(age) FROM dataset").show()
```

```
+--------+
|min(age)|
+--------+
|      18|
+--------+
```

```
spark.sql("SELECT AVG(age) FROM dataset").show()
```

```
+-----------------+
|         avg(age)|
+-----------------+
|40.93621021432837|
+-----------------+
```

4. AVG and Median Balances

```
spark.sql("SELECT AVG(balance) FROM dataset").show()
```

```
+-----------------+
|     avg(balance)|
+-----------------+
|1362.2720576850766|
+-----------------+
```

```
spark_df.approxQuantile("balance", [0.5], 0)
```

```
[448.0]
```

5. Correlation between Balance and Deposits

```
spark_df.corr('balance','deposit')
```

```
-0.001253202290976878
```

6. Correlation between Marital Status and Deposits

```
spark.sql("SELECT marital, COUNT(deposit) as Total_of_deposits FROM dataset\
WHERE deposit=1 GROUP BY marital ORDER BY Total_of_deposits DESC").show()
```

```
+--------+-----------------+
| marital|Total_of_deposits|
+--------+-----------------+
| married|             9149|
|  single|             4318|
|divorced|             1754|
+--------+-----------------+
```

7. Marital Status and Age together mattered for Deposits

```
spark_df2.corr('age','deposit')
```

```
-0.0011683102615502072
```

```
from pyspark.sql.functions import col
new_data = spark_df2.select(*(col(c).cast("float") for c in spark_df2.columns))
new_data.show(10)
```

```
+-------+----+-------+
|deposit| age|marital|
+-------+----+-------+
|    1.0|95.0|    1.0|
|    1.0|93.0|    1.0|
|    0.0|93.0|    1.0|
|    0.0|92.0|    1.0|
|    0.0|92.0|    1.0|
|    1.0|89.0|    1.0|
|    0.0|95.0|    0.0|
|    0.0|94.0|    0.0|
|    0.0|89.0|    1.0|
|    0.0|90.0|    0.0|
+-------+----+-------+
only showing top 10 rows
```

```
col_names = new_data.columns
```

```
new_data_rdd = new_data.rdd.map(lambda row: row[0:])
```

```
corr_mat=Statistics.corr(new_data_rdd, method="pearson")
corr_df = pd.DataFrame(corr_mat)
corr_df.index, corr_df.columns = col_names, col_names
corr_df
```

	deposit	age	marital
deposit	1.000000	-0.001168	-0.001245
age	-0.001168	1.000000	0.286257
marital	-0.001245	0.286257	1.000000

```
spark.sql("SELECT age, COUNT(deposit) as Total_of_deposits FROM dataset\
WHERE deposit=1 GROUP BY age ORDER BY Total_of_deposits DESC").show(10)
spark.sql("SELECT marital, COUNT(deposit) as Total_of_deposits FROM dataset\
WHERE deposit=1 GROUP BY marital ORDER BY Total_of_deposits DESC").show(10)
```

```
+---+-----------------+
|age|Total_of_deposits|
+---+-----------------+
| 32|              702|
| 34|              670|
| 31|              657|
| 33|              645|
| 35|              643|
| 36|              627|
| 37|              568|
| 30|              560|
| 39|              503|
| 38|              460|
+---+-----------------+
only showing top 10 rows

+--------+-----------------+
| marital|Total_of_deposits|
+--------+-----------------+
| married|             9149|
|  single|             4318|
|divorced|             1754|
+--------+-----------------+
```

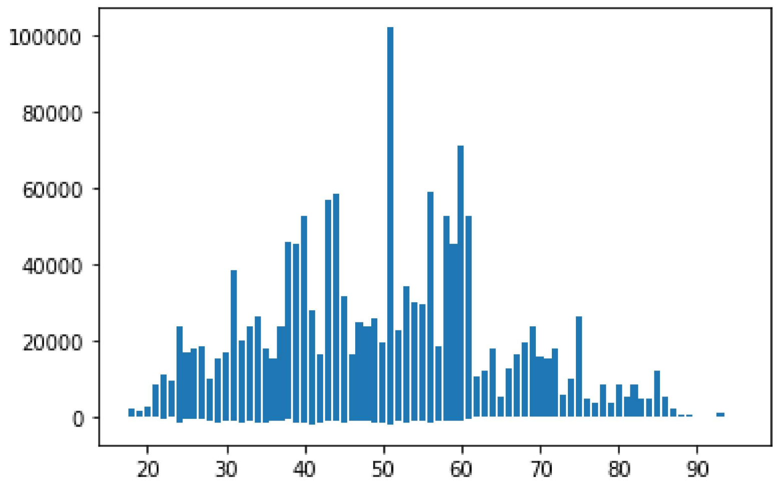
8. Right Age Effect for the Campaign

```
spark.sql("SELECT age,AVG(balance),COUNT(deposit) as Total_of_deposits,\
AVG(balance)*COUNT(deposit) as TOTAL FROM dataset WHERE deposit=1 GROUP BY age ORDER BY ag
```

```
+---+------------------+-----------------+--------+
|age|      avg(balance)|Total_of_deposits|   TOTAL|
+---+------------------+-----------------+--------+
| 18| 415.1666666666667|                6|  2491.0|
| 19|             707.0|                9|  6363.0|
| 20| 369.7391304347826|               23|  8504.0|
| 21|1133.9166666666667|               24| 27214.0|
| 22| 867.9591836734694|               49| 42530.0|
| 23|1307.6716417910447|               67| 87614.0|
| 24|1107.2522522522522|              111|122905.0|
| 25| 914.2272727272727|              198|181017.0|
| 26|1024.0212765957447|              282|288774.0|
| 27| 1185.715210355987|              309|366386.0|
+---+------------------+-----------------+--------+
only showing top 10 rows
```

```
data['Total_deposits']=data['balance']*data['deposit']

plt.bar(data['age'],data['Total_deposits'])
plt.show()
```


100000
80000
60000
40000
20000
0
20
30
40
50
60
70
80
90