lab3

May 22, 2023

1 1 - Użycie PySpark w celu eksploracji Big Data

1.1 - Konfigurowanie środowiska w Anaconda lub Google Colab

Do wykonywania zadań został wybrany Google Colaboratory

[88]:
```
# Polecenie do zainstalowania pakietów pyspark i py4j:

! pip install pyspark==3.0.1 py4j==0.10.9
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-
wheels/public/simple/
Requirement already satisfied: pyspark==3.0.1 in /usr/local/lib/python3.10/dist-
packages (3.0.1)
Requirement already satisfied: py4j==0.10.9 in /usr/local/lib/python3.10/dist-
packages (0.10.9)
```

1.2 - Sesja Spark

1.3 - Tworzenie SparkSession

[89]:
```
from pyspark.sql import SparkSession
spark = SparkSession.builder\
.master("local[*]")\
.appName('PySpark_Tutorial')\
.getOrCreate()
```

1.4 - Czytanie danych

[90]:
```
csv_file = '/content/
  ↪IHME_GBD_2019_SMOKING_TOB_1990_2019_NUM_SMOKERS_Y2021M05D27.CSV'
df = spark.read.csv(csv_file)
```

1.5 - Pobieranie danych za pomocą URL

[91]:
```
from pyspark import SparkFiles

spark.sparkContext.addFile('https://storage.covid19datahub.io/level/1.csv')

df = spark.read.csv(SparkFiles.get("1.csv"), header=True)
```

2 2 - Strukturyzacja danych za pomocą schematu Spark

Kod do odczytu danych w formacie pliku CSV:

[92]:
```
data = spark.read.csv(
'/content/IHME_GBD_2019_SMOKING_TOB_1990_2019_NUM_SMOKERS_Y2021M05D27.CSV',
sep=',',
header=True,
)
data.printSchema()
```

```
root
 |-- measure_name: string (nullable = true)
 |-- location_id: string (nullable = true)
 |-- location_name: string (nullable = true)
 |-- sex_id: string (nullable = true)
 |-- sex_name: string (nullable = true)
 |-- age_group_id: string (nullable = true)
 |-- age_group_name: string (nullable = true)
 |-- year_id: string (nullable = true)
 |-- val: string (nullable = true)
 |-- upper: string (nullable = true)
 |-- lower: string (nullable = true)
```

Precyzowanie struktury danych

[93]:
```
from pyspark.sql.types import *
data_schema = [
                StructField('measure_name', StringType(), True),
                StructField('location_id', IntegerType(), True),
                StructField('location_name', StringType(), True),
                StructField('sex_id', IntegerType(), True),
                StructField('sex_name', StringType(), True),
                StructField('age_group_id', IntegerType(), True),
                StructField('age_group_name', StringType(), True),
                StructField('year_id', IntegerType(), True),
                StructField('val', DoubleType(), True),
                StructField('upper', DoubleType(), True),
                StructField('lower', DoubleType(), True),
                ]

final_struc = StructType(fields = data_schema)
data = spark.read.csv(
      '/content/IHME_GBD_2019_SMOKING_TOB_1990_2019_NUM_SMOKERS_Y2021M05D27.
 ↪CSV',
      sep=',',
      header=True,
```

```
      schema=final_struc
)
data.printSchema()
```

```
root
 |-- measure_name: string (nullable = true)
 |-- location_id: integer (nullable = true)
 |-- location_name: string (nullable = true)
 |-- sex_id: integer (nullable = true)
 |-- sex_name: string (nullable = true)
 |-- age_group_id: integer (nullable = true)
 |-- age_group_name: string (nullable = true)
 |-- year_id: integer (nullable = true)
 |-- val: double (nullable = true)
 |-- upper: double (nullable = true)
 |-- lower: double (nullable = true)
```

2.1 3 - Różne metody kontroli danych

schema(): Ta metoda zwraca schemat danych (ramka danych).

[94]:
```
data.schema
```

[94]:
```
StructType(List(StructField(measure_name,StringType,true),StructField(location_i
d,IntegerType,true),StructField(location_name,StringType,true),StructField(sex_i
d,IntegerType,true),StructField(sex_name,StringType,true),StructField(age_group_
id,IntegerType,true),StructField(age_group_name,StringType,true),StructField(yea
r_id,IntegerType,true),StructField(val,DoubleType,true),StructField(upper,Double
Type,true),StructField(lower,DoubleType,true)))
```

dtypes zwraca listę krotek z nazwami kolumn i typami danych.

[95]:
```
data.dtypes
```

[95]:
```
[('measure_name', 'string'),
 ('location_id', 'int'),
 ('location_name', 'string'),
 ('sex_id', 'int'),
 ('sex_name', 'string'),
 ('age_group_id', 'int'),
 ('age_group_name', 'string'),
 ('year_id', 'int'),
 ('val', 'double'),
 ('upper', 'double'),
 ('lower', 'double')]
```

head(n) zwraca n wierszy jako listę.

[96]:
```
data.head(3)
```

[96]:
```
[Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=1, sex_name='Male', age_group_id=29, age_group_name='15+ years',
year_id=1990, val=803101467.1, upper=809622101.0, lower=795908635.8),
 Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=2, sex_name='Female', age_group_id=29, age_group_name='15+ years',
year_id=1990, val=189148834.0, upper=193092888.7, lower=185559469.9),
 Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=3, sex_name='Both', age_group_id=29, age_group_name='15+ years',
year_id=1990, val=992250301.2, upper=1000161258.0, lower=984788043.8)]
```

show() domyślnie wyświetla pierwsze 20 wierszy, a także przyjmuje liczbę jako parametr określający ich liczbę

[97]:
```
data.show()
```

```
+-----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+
|     measure_name|location_id|location_name|sex_id|sex_name|age_group_id|age_gr
oup_name|year_id|          val|        upper|        lower|
+-----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1990|8.031014671E8| 8.09622101E8|7.959086358E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1990| 1.89148834E8|1.930928887E8|1.855594699E8|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1990|9.922503012E8|1.000161258E9|9.847880438E8|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1991|8.138972164E8| 8.20033926E8|8.069514479E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1991|1.905375451E8|1.944249287E8|1.869744245E8|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1991|1.004434762E9|1.011924857E9|9.969810741E8|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1992|8.233148278E8|8.292228212E8|8.167263652E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1992|1.919026028E8|1.957108776E8|1.884066078E8|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1992|1.015217431E9| 1.02272003E9|1.007846871E9|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1993|8.313872544E8|8.372931128E8| 8.24949648E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1993|1.932817999E8|1.970625972E8|1.898391826E8|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1993|1.024669054E9|1.031964573E9|1.017550791E9|
|Number of Smokers|          1|       Global|     1|    Male|          29|
```

```
15+ years|   1994|8.378204498E8|8.437233083E8|8.316340039E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1994|1.947461502E8|1.985204504E8|1.913568137E8|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1994|  1.0325666E9|1.039842491E9|1.025630607E9|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1995|8.433043019E8|8.490080491E8|  8.3750097E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1995|1.963544335E8|2.002139588E8|1.930128599E8|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1995|1.039658735E9|1.047062623E9|1.032850499E9|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1996|8.478849471E8|8.536353541E8| 8.42071989E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1996|1.980633863E8|2.018466552E8|1.946320182E8|
+-----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+
only showing top 20 rows
```

first() zwraca pierwszy wiersz danych.

[98]:
```
data.first()
```

[98]:
```
Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=1, sex_name='Male', age_group_id=29, age_group_name='15+ years',
year_id=1990, val=803101467.1, upper=809622101.0, lower=795908635.8)
```

take(n) zwraca pierwsze n wierszy

[99]:
```
data.take(5)
```

[99]:
```
[Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=1, sex_name='Male', age_group_id=29, age_group_name='15+ years',
year_id=1990, val=803101467.1, upper=809622101.0, lower=795908635.8),
 Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=2, sex_name='Female', age_group_id=29, age_group_name='15+ years',
year_id=1990, val=189148834.0, upper=193092888.7, lower=185559469.9),
 Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=3, sex_name='Both', age_group_id=29, age_group_name='15+ years',
year_id=1990, val=992250301.2, upper=1000161258.0, lower=984788043.8),
 Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=1, sex_name='Male', age_group_id=29, age_group_name='15+ years',
year_id=1991, val=813897216.4, upper=820033926.0, lower=806951447.9),
 Row(measure_name='Number of Smokers', location_id=1, location_name='Global',
sex_id=2, sex_name='Female', age_group_id=29, age_group_name='15+ years',
year_id=1991, val=190537545.1, upper=194424928.7, lower=186974424.5)]
```

describe() oblicza niektóre wartości statystyczne dla kolumn liczbowych.

[100]:
```
data.describe()
```

[100]:
```
DataFrame[summary: string, measure_name: string, location_id: string,
location_name: string, sex_id: string, sex_name: string, age_group_id: string,
age_group_name: string, year_id: string, val: string, upper: string, lower:
string]
```

columns zwraca listę zawierającą nazwy kolumn.

[101]:
```
data.columns
```

[101]:
```
['measure_name',
 'location_id',
 'location_name',
 'sex_id',
 'sex_name',
 'age_group_id',
 'age_group_name',
 'year_id',
 'val',
 'upper',
 'lower']
```

count() zwraca całkowitą liczbę wierszy w zestawie danych

[102]:
```
data.count()
```

[102]:
```
20970
```

differ() to liczba odmiennych wierszy w używanym zbiorze danych.

[103]:
```
data.differ()
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-103-2c299c4b5c86> in <cell line: 1>()
----> 1 data.differ()

/usr/local/lib/python3.10/dist-packages/pyspark/sql/dataframe.py in␣
 ↪__getattr__(self, name)
   1398         """
   1399         if name not in self.columns:
-> 1400             raise AttributeError(
   1401                 "'%s' object has no attribute '%s'" % (self.__class__.
 ↪__name__, name))
   1402         jc = self._jdf.apply(name)
```

```
AttributeError: 'DataFrame' object has no attribute 'differ'
```

printSchema() wyświetla schemat danych.

[104]:
```
data.printSchema()
```

```
root
 |-- measure_name: string (nullable = true)
 |-- location_id: integer (nullable = true)
 |-- location_name: string (nullable = true)
 |-- sex_id: integer (nullable = true)
 |-- sex_name: string (nullable = true)
 |-- age_group_id: integer (nullable = true)
 |-- age_group_name: string (nullable = true)
 |-- year_id: integer (nullable = true)
 |-- val: double (nullable = true)
 |-- upper: double (nullable = true)
 |-- lower: double (nullable = true)
```

3 4 - Manipulacja kolumnami

1 - Dodawanie kolumny:

[105]:
```
data = data.withColumn('location_name_copy', data.location_name)
data.show(5)
```

```
+----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+------------------+
|     measure_name|location_id|location_name|sex_id|sex_name|age_group_id|age_gr
oup_name|year_id|          val|        upper|        lower|location_name_copy|
+----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+------------------+
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1990|8.031014671E8| 8.09622101E8|7.959086358E8|            Global|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1990| 1.89148834E8|1.930928887E8|1.855594699E8|            Global|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1990|9.922503012E8|1.000161258E9|9.847880438E8|            Global|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1991|8.138972164E8| 8.20033926E8|8.069514479E8|            Global|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1991|1.905375451E8|1.944249287E8|1.869744245E8|            Global|
+----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+------------------+
only showing top 5 rows
```

2 - Aktualizacja kolumny:

[106]:
```
data = data.withColumnRenamed('location_name_copy', 'location_name_changed')
data.show(5)
```

```
+----------------+----------+------------+------+--------+-----------+------
--------+-------+------------+------------+------------+--------------------
+
|     measure_name|location_id|location_name|sex_id|sex_name|age_group_id|age_gr
oup_name|year_id|          val|        upper|
lower|location_name_changed|
+----------------+----------+------------+------+--------+-----------+------
--------+-------+------------+------------+------------+--------------------
+
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1990|8.031014671E8| 8.09622101E8|7.959086358E8|
Global|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1990| 1.89148834E8|1.930928887E8|1.855594699E8|
Global|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1990|9.922503012E8|1.000161258E9|9.847880438E8|
Global|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1991|8.138972164E8| 8.20033926E8|8.069514479E8|
Global|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1991|1.905375451E8|1.944249287E8|1.869744245E8|
Global|
+----------------+----------+------------+------+--------+-----------+------
--------+-------+------------+------------+------------+--------------------
+
only showing top 5 rows
```

3 - Upuszczanie kolumny:

[107]:
```
data = data.drop('location_name_changed')
data.show(5)
```

```
+----------------+----------+------------+------+--------+-----------+------
--------+-------+------------+------------+------------+
|     measure_name|location_id|location_name|sex_id|sex_name|age_group_id|age_gr
oup_name|year_id|          val|        upper|        lower|
+----------------+----------+------------+------+--------+-----------+------
--------+-------+------------+------------+------------+
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1990|8.031014671E8| 8.09622101E8|7.959086358E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
```

```
15+ years|   1990| 1.89148834E8|1.930928887E8|1.855594699E8|
|Number of Smokers|          1|       Global|     3|    Both|          29|
15+ years|   1990|9.922503012E8|1.000161258E9|9.847880438E8|
|Number of Smokers|          1|       Global|     1|    Male|          29|
15+ years|   1991|8.138972164E8| 8.20033926E8|8.069514479E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   1991|1.905375451E8|1.944249287E8|1.869744245E8|
+-----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+
only showing top 5 rows
```

4 5 - Radzenie sobie z brakującymi wartościami

[108]:
```
from pyspark.sql import functions as f
# Usuń wiersze z brakującymi wartościami w dowolnej z kolumn
data.na.drop()
# Zastąp brakujące wartości za pomocą średniej
data.na.fill(data.select(f.mean(data['age_group_id'])).collect()[0][0])
# Zastąp brakujące wartości nowymi
# data.na.replace(old_value, new_vallue)
```

[108]:
```
DataFrame[measure_name: string, location_id: int, location_name: string, sex_id:
int, sex_name: string, age_group_id: int, age_group_name: string, year_id: int,
val: double, upper: double, lower: double]
```

5 6 - Pobieranie danych

1 - Select

[109]:
```
# wybór jednej kolumny
data.select('year_id').show(5)
```

```
+-------+
|year_id|
+-------+
|   1990|
|   1990|
|   1990|
|   1991|
|   1991|
+-------+
only showing top 5 rows
```

[110]:
```
# wybór kilku kolumn
data.select(['location_name', 'sex_name', 'year_id']).show(5)
```

```
+-------------+--------+-------+
|location_name|sex_name|year_id|
+-------------+--------+-------+
|       Global|    Male|   1990|
|       Global|  Female|   1990|
|       Global|    Both|   1990|
|       Global|    Male|   1991|
|       Global|  Female|   1991|
+-------------+--------+-------+
only showing top 5 rows
```

2 - Filter

[111]:
```
from pyspark.sql.functions import col
data.filter( (col('year_id') >= 2000) & (col('sex_name') == 'Female') ).show(5)
```

```
+-----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+
|     measure_name|location_id|location_name|sex_id|sex_name|age_group_id|age_gr
oup_name|year_id|          val|        upper|        lower|
+-----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   2000| 2.03389244E8|2.070119921E8|2.000443639E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   2001|2.043228487E8|2.078410984E8|2.011225869E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   2002|2.051251323E8|2.086136115E8|2.019432714E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   2003| 2.05852521E8|2.094216076E8|2.026372326E8|
|Number of Smokers|          1|       Global|     2|  Female|          29|
15+ years|   2004|2.064882331E8|2.099930308E8|2.031999303E8|
+-----------------+-----------+-------------+------+--------+------------+------
--------+-------+-------------+-------------+-------------+
only showing top 5 rows
```

3 - Between

[112]:
```
data.filter(data.year_id.between(1995, 2000)).show()
```

```
+-----------------+-----------+--------------------+------+--------+------------
+-------------+-------+-------------+-------------+-------------+
|     measure_name|location_id|
location_name|sex_id|sex_name|age_group_id|age_group_name|year_id|          val|
```

```
upper|        lower|
+-----------------+-----------+--------------------+------+--------+------------
+-------------+-------+------------+------------+-------------+
|Number of Smokers|          1|              Global|     1|    Male|
29|     15+ years|   1995|8.433043019E8|8.490080491E8|  8.3750097E8|
|Number of Smokers|          1|              Global|     2|  Female|
29|     15+ years|   1995|1.963544335E8|2.002139588E8|1.930128599E8|
|Number of Smokers|          1|              Global|     3|    Both|
29|     15+ years|   1995|1.039658735E9|1.047062623E9|1.032850499E9|
|Number of Smokers|          1|              Global|     1|    Male|
29|     15+ years|   1996|8.478849471E8|8.536353541E8| 8.42071989E8|
|Number of Smokers|          1|              Global|     2|  Female|
29|     15+ years|   1996|1.980633863E8|2.018466552E8|1.946320182E8|
|Number of Smokers|          1|              Global|     3|    Both|
29|     15+ years|   1996|1.045948333E9|1.053276972E9|1.039024799E9|
|Number of Smokers|          1|              Global|     1|    Male|
29|     15+ years|   1997|8.516471918E8|8.573761175E8|8.457102366E8|
|Number of Smokers|          1|              Global|     2|  Female|
29|     15+ years|   1997|1.996329437E8|2.032874241E8|1.962767139E8|
|Number of Smokers|          1|              Global|     3|    Both|
29|     15+ years|   1997|1.051280135E9| 1.05835932E9|1.044430801E9|
|Number of Smokers|          1|              Global|     1|    Male|
29|     15+ years|   1998|8.550585577E8|8.608097687E8|8.491967263E8|
|Number of Smokers|          1|              Global|     2|  Female|
29|     15+ years|   1998|2.010668729E8|2.048237827E8|1.978497379E8|
|Number of Smokers|          1|              Global|     3|    Both|
29|     15+ years|   1998|1.056125431E9|1.062905206E9|1.049476558E9|
|Number of Smokers|          1|              Global|     1|    Male|
29|     15+ years|   1999|8.582672178E8|8.639698017E8|8.525235784E8|
|Number of Smokers|          1|              Global|     2|  Female|
29|     15+ years|   1999|2.023213713E8|2.059460479E8|1.989813106E8|
|Number of Smokers|          1|              Global|     3|    Both|
29|     15+ years|   1999|1.060588589E9|1.067665003E9|1.053944039E9|
|Number of Smokers|          1|              Global|     1|    Male|
29|     15+ years|   2000|  8.6154577E8| 8.67412168E8|8.560329846E8|
|Number of Smokers|          1|              Global|     2|  Female|
29|     15+ years|   2000| 2.03389244E8|2.070119921E8|2.000443639E8|
|Number of Smokers|          1|              Global|     3|    Both|
29|     15+ years|   2000|1.064935014E9|1.071795767E9|1.058216329E9|
|Number of Smokers|          4|Southeast Asia, E…|     1|    Male|
29|     15+ years|   1995|3.779077105E8| 3.82356775E8|3.731279345E8|
|Number of Smokers|          4|Southeast Asia, E…|     2|  Female|
29|     15+ years|   1995|2.964856863E7|3.221889337E7|2.751987308E7|
+-----------------+-----------+--------------------+------+--------+------------
+-------------+-------+------------+------------+-------------+
only showing top 20 rows
```

4 - When

[113]:
```
data.select('location_name', 'sex_name',
f.when(data.year_id == '2000', 1).otherwise(0)
).show(5)
```

```
+-------------+--------+-----------------------------------------+
|location_name|sex_name|CASE WHEN (year_id = 2000) THEN 1 ELSE 0 END|
+-------------+--------+-----------------------------------------+
|       Global|    Male|                                        0|
|       Global|  Female|                                        0|
|       Global|    Both|                                        0|
|       Global|    Male|                                        0|
|       Global|  Female|                                        0|
+-------------+--------+-----------------------------------------+
only showing top 5 rows
```

5 - Like

[114]:
```
data.select('location_name', data.location_name.rlike('^[G,P]').
 ↪alias('location_name zaczyba sie na litere G lub P')).distinct().show()
```

```
+--------------------+----------------------------------------+
|       location_name|location_name zaczyba sie na litere G lub P|
+--------------------+----------------------------------------+
|                Cuba|                                   false|
|          Mauritania|                                   false|
|            Djibouti|                                   false|
|            Slovenia|                                   false|
|  Sub-Saharan Africa|                                   false|
|              Malawi|                                   false|
|      United Kingdom|                                   false|
|            Pakistan|                                    true|
|            Botswana|                                   false|
|          Madagascar|                                   false|
|           Australia|                                   false|
|United States of …|                                  false|
|               Ghana|                                    true|
|             Tokelau|                                   false|
|             Belarus|                                   false|
|Bolivia (Plurinat…|                                  false|
|  Dominican Republic|                                   false|
|            Paraguay|                                    true|
|             Croatia|                                   false|
|             Ukraine|                                   false|
+--------------------+----------------------------------------+
only showing top 20 rows
```

6 - GroupBy

[115]:
```
data.select(['val', 'upper', 'lower']).groupBy('val').mean().show()
```

```
+-------------+-------------+-------------+------------+
|          val|     avg(val)|   avg(upper)|  avg(lower)|
+-------------+-------------+-------------+------------+
|  134007.9694|  134007.9694|   139677.191| 128260.0995|
|  8270.464532|  8270.464532|  9504.142112| 7096.286328|
|  11829.30213|  11829.30213|  13621.19377| 10115.58969|
|  35698.65734|  35698.65734|   37600.2659| 33870.85627|
|  46355.98657|  46355.98657|   49432.5945| 43154.77478|
|  13869.07463|  13869.07463|  15706.97617| 12179.06027|
|  20742.10263|  20742.10263|  22062.18255| 19357.08588|
|  7423.071697|  7423.071697|  8228.304212|  6694.14611|
|  7448.841156|  7448.841156|  8213.962619| 6706.265256|
|  9104.794872|  9104.794872|  10096.50032| 8162.279112|
|  2887.470373|  2887.470373|  3818.180825| 2189.147345|
|  4744.936929|  4744.936929|   5932.17345| 3729.904017|
|  458.0840221|  458.0840221|  606.3972438| 344.4231654|
|  3185.522508|  3185.522508|  3507.963054|  2861.54479|
|  3986.842432|  3986.842432|  4810.125966| 3191.818067|
|  7677.332734|  7677.332734|  8179.958609| 7109.126253|
|  12568.07874|  12568.07874|  13358.02037| 11766.13512|
|  4478.782127|  4478.782127|   4815.00638| 4148.004533|
|  441.7884447|  441.7884447|  565.9563718|  331.323542|
|8.313872544E8|8.313872544E8|8.372931128E8|8.24949648E8|
+-------------+-------------+-------------+------------+
only showing top 20 rows
```

7 - Agregacja

[116]:
```
from pyspark.sql import functions as f

data.filter((col('val') >= 1000000) & (col('val') <= 5000000))\
.groupBy("location_name") \
.agg(f.min("val").alias("from"),
f.max("val").alias("to"),
f.min("val").alias("minimum vaccinated"),
f.max("val").alias("maximum vaccinated"),
f.avg("val").alias("average vaccinated"),
f.min("val").alias("minimum␣economic_support_index"),
f.max("val").alias("maximum␣_economic_support_index"),
f.avg("val").alias("average␣_economic_support_index"),
).show(truncate=False)
```

```
+----------------+----------+----------+-----------------+-----------------
+-----------------+-----------------------------+---------------------------
```

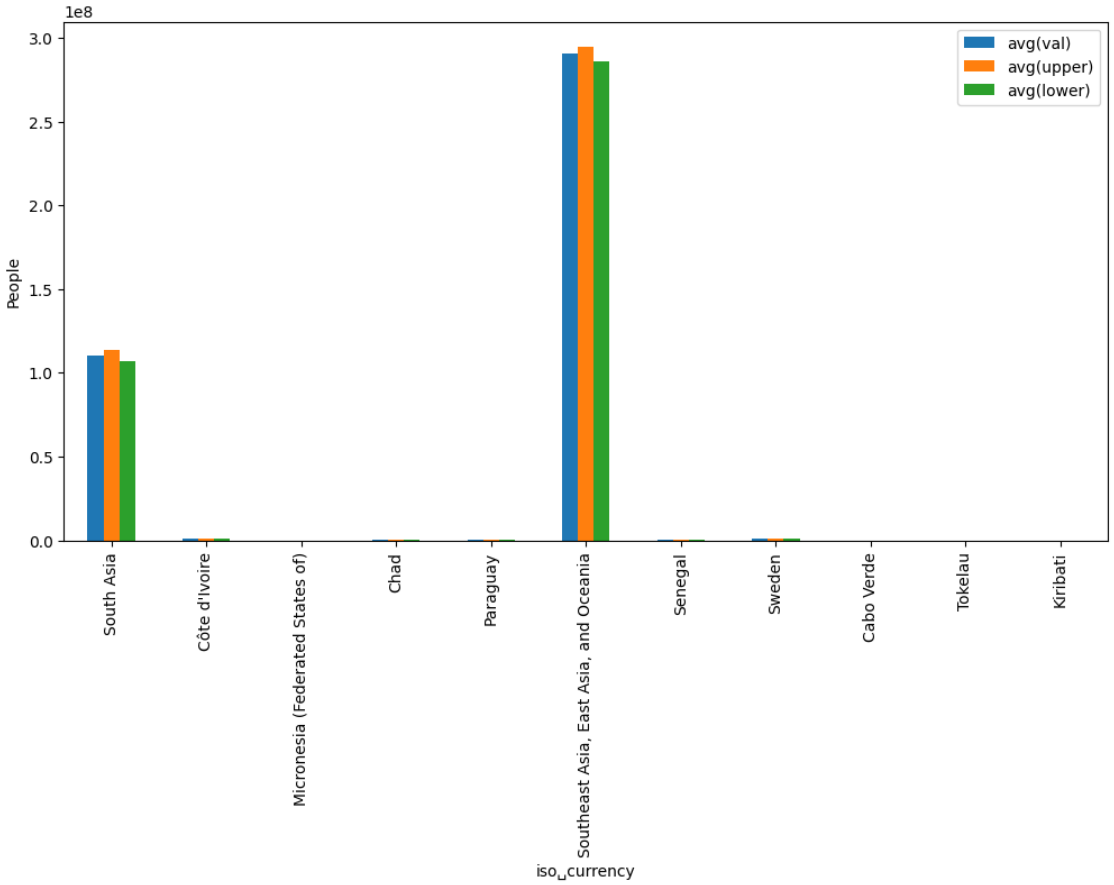
```
--+-------------------------------+
|location_name    |from       |to         |minimum vaccinated|maximum
vaccinated|average vaccinated|minimum␣economic_support_index|maximum␣_economic_s
upport_index|average␣_economic_support_index|
+----------------+-----------+-----------+------------------+-----------------
+------------------+-----------------------------+--------------------------
--+-------------------------------+
|Côte d'Ivoire    |1023886.493|2165483.532|1023886.493       |2165483.532
|1601788.6232857148|1023886.493                  |2165483.532
|1601788.6232857148             |
|Yemen            |1030535.291|3657898.202|1030535.291       |3657898.202
|1993066.6792333333|1030535.291                  |3657898.202
|1993066.6792333333             |
|Sweden           |1067123.166|1644302.372|1067123.166       |1644302.372
|1308458.0137666664|1067123.166                  |1644302.372
|1308458.0137666664             |
|Republic of Korea|1063356.593|1179678.716|1063356.593       |1179678.716
|1147212.8582666668|1063356.593                  |1179678.716
|1147212.8582666668             |
|Philippines      |2214973.74 |3144082.409|2214973.74        |3144082.409
|2863151.9060000004|2214973.74                   |3144082.409
|2863151.9060000004             |
|Malaysia         |2942804.951|4978849.254|2942804.951       |4978849.254
|4206188.935574467 |2942804.951                  |4978849.254
|4206188.935574467              |
|Turkey           |3198400.064|4940216.419|3198400.064       |4940216.419
|4282831.987909092 |3198400.064                  |4940216.419
|4282831.987909092              |
|Malawi           |1019364.093|1164664.74 |1019364.093       |1164664.74
|1083080.244666667 |1019364.093                  |1164664.74
|1083080.244666667              |
|Iraq             |2135606.051|4941969.609|2135606.051       |4941969.609
|3431766.7088846145|2135606.051                  |4941969.609
|3431766.7088846145             |
|Cambodia         |1089526.703|2373559.505|1089526.703       |2373559.505
|1725967.798783333 |1089526.703                  |2373559.505
|1725967.798783333              |
|Afghanistan      |1013802.294|2257180.971|1013802.294       |2257180.971
|1605877.0142962963|1013802.294                  |2257180.971
|1605877.0142962963             |
|Jordan           |1015421.261|2817093.164|1015421.261       |2817093.164
|1765783.7067692312|1015421.261                  |2817093.164
|1765783.7067692312             |
|Sudan            |1210513.281|2689229.553|1210513.281       |2689229.553
|1917168.4488166673|1210513.281                  |2689229.553
|1917168.4488166673             |
|Greece           |1269978.149|3921930.694|1269978.149       |3921930.694
|2422811.3991111116|1269978.149                  |3921930.694
```

```
|2422811.3991111116             |
|Sri Lanka         |2073078.052|2606806.575|2073078.052       |2606806.575
|2329932.261716666 |2073078.052                   |2606806.575
|2329932.261716666              |
|Algeria           |2473253.484|4979791.166|2473253.484       |4979791.166
|3636862.253909091 |2473253.484                   |4979791.166
|3636862.253909091              |
|Slovakia          |1156863.894|1331143.078|1156863.894       |1331143.078
|1260198.3315666674|1156863.894                   |1331143.078
|1260198.3315666674             |
|Argentina         |2982430.438|4846195.904|2982430.438       |4846195.904
|3803538.7871000012|2982430.438                   |4846195.904
|3803538.7871000012             |
|Belgium           |1007284.838|2783487.184|1007284.838       |2783487.184
|1656247.782831326 |1007284.838                   |2783487.184
|1656247.782831326              |
|Angola            |1002162.849|1519341.656|1002162.849       |1519341.656
|1212375.1044736842|1002162.849                   |1519341.656
|1212375.1044736842             |
+------------------+-----------+-----------+------------------+------------------
+------------------+------------------------------+------------------------------
--+------------------------------+
only showing top 20 rows
```

6 7 - wizualizacja danych

[117]:
```
from matplotlib import pyplot as plt

currency_df = data.select(['location_name',
'val',
'upper',
'lower']
)\
.groupBy('location_name')\
.mean()\
.toPandas()
ind = list(range(12))
ind.pop(6)
currency_df.iloc[ind ,:].plot(kind='bar', x='location_name', y=currency_df.
 ↪columns.tolist()[1:],
figsize=(12, 6), ylabel='People', xlabel='iso currency')
plt.show()
```



7 8 - Zapisywanie/zapisywanie danych do pliku

[ ]:
```
# CSV
data.write.csv('dataset.csv')
# JSON
data.write.save('dataset.json', format='json')
# Parquet
data.write.save('dataset.parquet', format='parquet')
```

[ ]:
```
# Zapisywanie wybranych kolumn
# CSV
data.select(['location_name','sex_name','year_id','val'])\
.write.csv('dataset_columns.csv')
# JSON
data.select(['location_name','sex_name','year_id','val'])\
.write.save('dataset_columns.json', format='json')
# Parquet
data.select(['location_name','sex_name','year_id','val'])\
```

```
.write.save('dataset_columns.parquet', format='parquet')
```

[ ]: