Project 7, Big Data Analysis

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Due: March 2, 2024

For project 7, Google Cloud was utilized to create a VM instance and run analyses. Project 7 conducted all analyses in this environment. I investigated data from E-Commerce - Product Inventory Management (www.kaggle.com) to gain insights into sales trends and reordering points. The e-commerce dataset has about 500,000 records with 8 column variables: Invoice Number as a numeric variable, Stock Code as a categorical variable, Description as a text character description, Quantity as a numeric variable (integer) for the number of items in the Description, Invoice Date as a character variable (date of transaction), Unit Price as a numeric variable representing the cost of the item in the Description, Customer ID as a numeric variable representing the customer's identifier and Country as a text variable representing the country selling the item in the Description.

Specific questions of interest included:

- What are the top 5 countries that have the highest prices?
- What are the top 5 countries that have the lowest prices?
- Who are the top 5 performing countries (sells the most quantities) in the world?
- Who are the lowest performing countries (sells the least quantities) in the world?
- Does pricing predict quantity?

To investigate these questions, this data was ingested in NiFi and analyzed using Spark, Pyspark. Initially, I did use scala to read the .json format to a dataframe and I describe challenges I encountered with this process below. I wanted to bring the data in using NiFi as I was interested to learn more about how NiFi might work to ingest larger amounts of data in what I thought might be a more common data flow. Though I did a smaller amount of analysis in scala – I ended up redoing all analysis in Pyspark. I picked Pyspark as it has many powerful components and is more intuitive from my perspective. As it is very widely used, I wanted to gain more experience with it.

To bring the data into NiFi, I copied the e-commerce dataset to our Google Cloud VM location using scp and copied the data to the appropriate folder location for NiFi. Then, I created a flow in NiFi to read the .csv into NiFi and create a .json file. Configuring the NiFi flow was challenging and after following a few different methods, I decided to use a tutorial and template as a guide (www.community.cloudera.com). Screenshot 1 shows the successful NiFi flow for this process and screenshot 2 shows the original file and the converted .json format of the file saved to the /dsc650-infra/bellevue-bigdata/hadoop-hive-spark-hbase/data location. Screenshots 3 and 4 show contents of each file in the original and json format.

Once the data was uploaded to the data folder, I read the file into a dataframe using Spark scala (Screenshot 5). I encountered many challenges doing this, and then learned that json can be 1.5 to 3 times bigger than .csv format (www.jsoneditoronline.org). A file of this size was very challenging to process on our VM instance (Screenshot 6) where our cluster does not have a lot of compute and because of this, I decided to move forward with analyzing the .csv file instead.

Because I moved forward with analyzing the .csv format, I decided to use Pyspark for data cleaning and analyses. After initially reading in the data, I looked at the highest or lowest values of frequency counts as well as the country list to determine if there were values that should be removed from analysis. Data cleaning steps included filtering the

Country variable to remove “Unspecified” as well as “European Community” and only keep those values of Unit Price that were greater than 0.10. Also, any missing values as well as any duplicates were removed from the data. Screenshot 7 shows reading in the data and creating a dataframe and changing numeric strings to numeric columns. Screenshot 8a shows frequencies of each column and displays the head or the tail to inspect each column for values that are not allowed for analysis (e.g., a negative value for Unit Price). Screenshot 8b shows the frequency of the column Country to clean this variable of entries that do not represent a single country. Screenshot 8c shows data cleaning steps of filtering and then removing duplicate rows as well as missing values. Screenshot 9 is the first 20 rows of the dataset used for analysis.

To investigate the highest and lowest performing countries in terms of item prices and quantities of items, a grouped frequency that sorted the data from highest to lowest was run, Screenshot 10 has the results for quantity and Screenshot 11 has the results for pricing.

Initially I was interested in running correlations or descriptive statistics on the dataframe and used the Summarizer package in Pyspark to investigate running these analyses. However, I was not able to run this error-free and need to further investigate what needs to be corrected with my code. Screenshot 12 shows the test data run I conducted in order to better understand the input format and vectors (www.spark.apache.org).

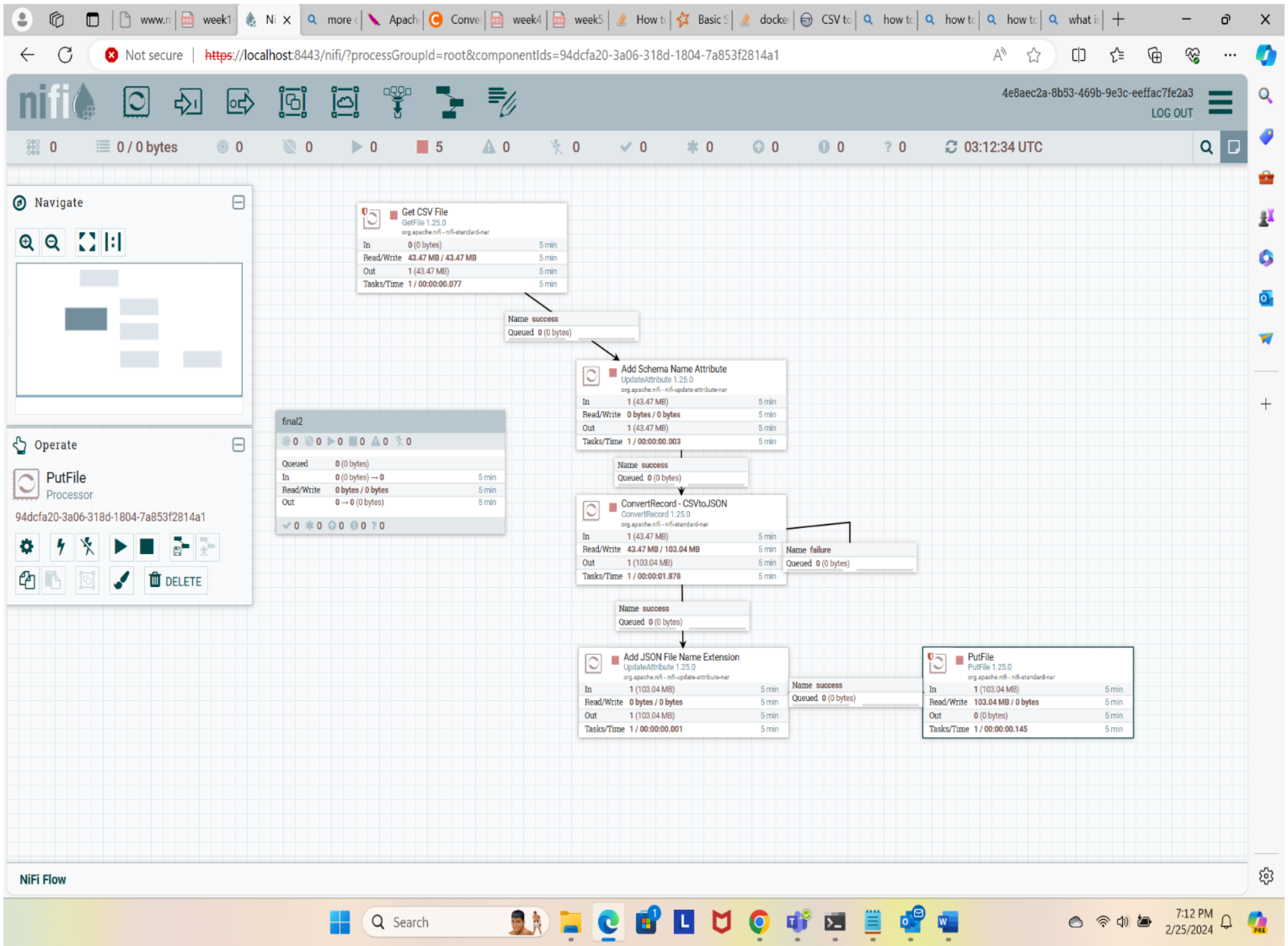
The final analysis that was run in Pyspark was a linear regression using Quantity as the dependent variable and Price as the independent variable, Screenshot 13. This simple regression model did not yield good results, Screenshot 14. I was very interested to get to this stage and explore how to run a model in Pyspark. There is a lot more to learn but it is interesting and motivating to scratch the surface of these analyses.

There were different issues that I ran into while completing this project, some I figured out and some are still being worked on. An issue that caused a lot of re-work was not knowing how to install packages of python that were missing (e.g., numpy) and though I figured this out (install on all nodes), it made me realize that it is quite complex to have a production environment even with installing a new package. Likewise, I spent a long time trying to install a plotting package until I read several articles on how plotting is often done outside of a big data architecture.

In closing, this project allowed me to explore a variety of tools and get a better understanding of how big data architecture works from data flow to analyses. There is a lot more to learn, however I enjoyed learning more about NiFi, scala and Pyspark as mentioned here.

Screenshots referenced in this document:

#1:



https://localhost:8443/nifi/?processGroupId=root&componentIds=94dcfa20-3a06-318d-1804-7a853f2814a1
Not secure
nifi
4e8aec2a-8b53-469b-9e3c-eeffac7fe2a3
LOG OUT
0 / 0 bytes
03:12:34 UTC
Navigate
Operate
PutFile
Processor
94dcfa20-3a06-318d-1804-7a853f2814a1
DELETE
final2
NiFi Flow
Search
7:12 PM
2/25/2024

Get CSV File — GetFile 1.25.0 — org.apache.nifi - nifi-standard-nar

In	0 (0 bytes)	5 min
Read/Write	43.47 MB / 43.47 MB	5 min
Out	1 (43.47 MB)	5 min
Tasks/Time	1 / 00:00:00.077	5 min

Name success
Queued 0 (0 bytes)

Add Schema Name Attribute — UpdateAttribute 1.25.0 — org.apache.nifi - nifi-update-attribute-nar

In	1 (43.47 MB)	5 min
Read/Write	0 bytes / 0 bytes	5 min
Out	1 (43.47 MB)	5 min
Tasks/Time	1 / 00:00:00.003	5 min

Name success
Queued 0 (0 bytes)

ConvertRecord - CSVtoJSON — ConvertRecord 1.25.0 — org.apache.nifi - nifi-standard-nar

In	1 (43.47 MB)	5 min
Read/Write	43.47 MB / 103.04 MB	5 min
Out	1 (103.04 MB)	5 min
Tasks/Time	1 / 00:00:01.878	5 min

Name failure
Queued 0 (0 bytes)

Name success
Queued 0 (0 bytes)

Add JSON File Name Extension — UpdateAttribute 1.25.0 — org.apache.nifi - nifi-update-attribute-nar

In	1 (103.04 MB)	5 min
Read/Write	0 bytes / 0 bytes	5 min
Out	1 (103.04 MB)	5 min
Tasks/Time	1 / 00:00:00.001	5 min

Name success
Queued 0 (0 bytes)

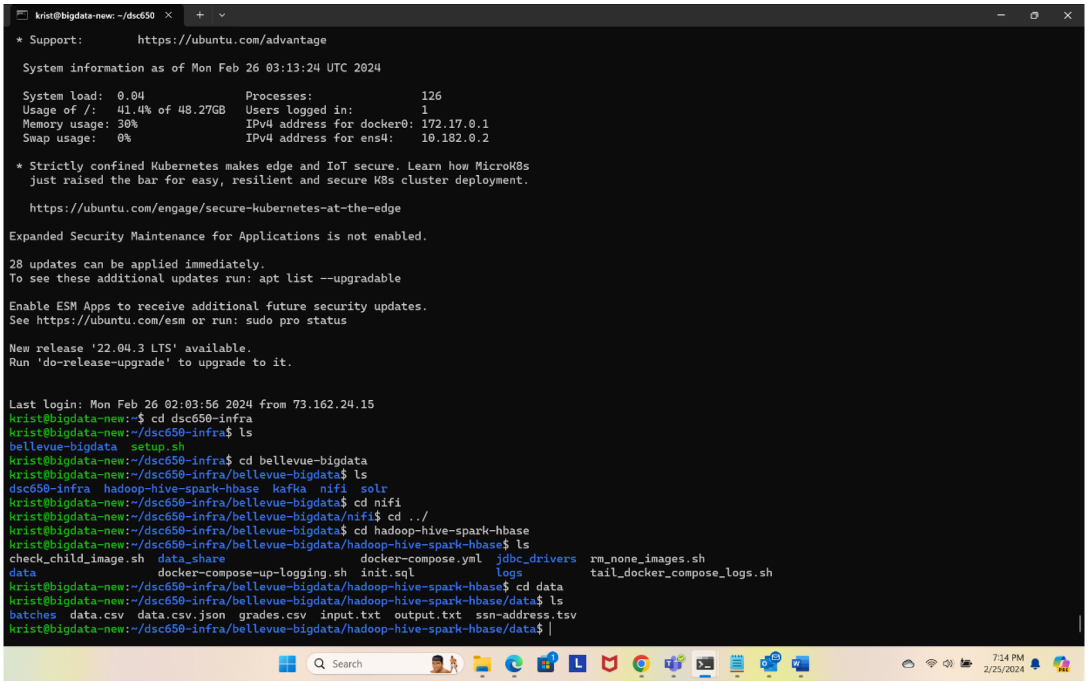
PutFile — PutFile 1.25.0 — org.apache.nifi - nifi-standard-nar

In	1 (103.04 MB)	5 min
Read/Write	103.04 MB / 0 bytes	5 min
Out	0 (0 bytes)	5 min
Tasks/Time	1 / 00:00:00.145	5 min

final2

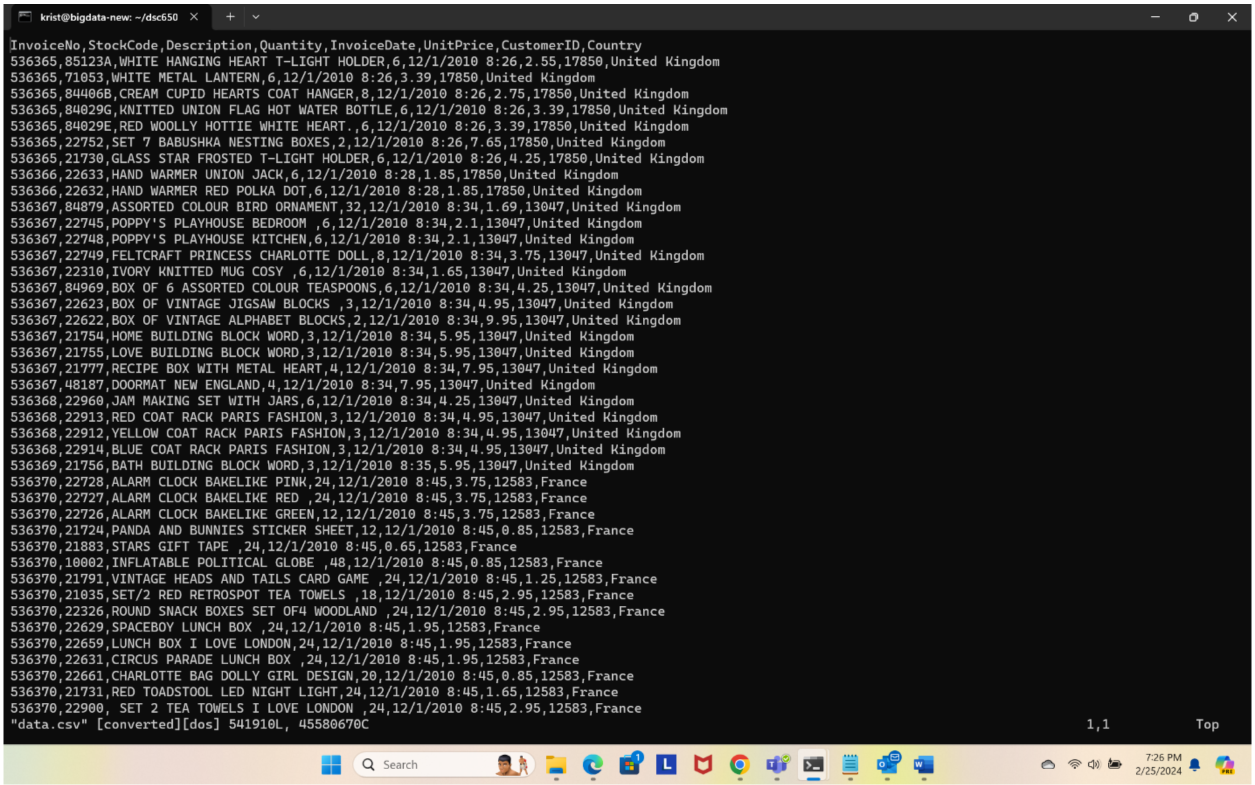
Queued	0 (0 bytes)	
In	0 (0 bytes) → 0	5 min
Read/Write	0 bytes / 0 bytes	5 min
Out	0 → 0 (0 bytes)	5 min

#2:



```
 * Support:        https://ubuntu.com/advantage

  System information as of Mon Feb 26 03:13:24 UTC 2024

  System load:  0.04               Processes:                126
  Usage of /:   41.4% of 48.27GB   Users logged in:          1
  Memory usage: 30%                IPv4 address for docker0: 172.17.0.1
  Swap usage:   0%                 IPv4 address for ens4:    10.182.0.2

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

   https://ubuntu.com/engage/secure-kubernetes-at-the-edge

Expanded Security Maintenance for Applications is not enabled.

28 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

New release '22.04.3 LTS' available.
Run 'do-release-upgrade' to upgrade to it.


Last login: Mon Feb 26 02:03:56 2024 from 73.162.24.15
krist@bigdata-new:~$ cd dsc650-infra
krist@bigdata-new:~/dsc650-infra$ ls
bellevue-bigdata  setup.sh
krist@bigdata-new:~/dsc650-infra$ cd bellevue-bigdata
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata$ ls
dsc650-infra  hadoop-hive-spark-hbase  kafka  nifi  solr
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata$ cd nifi
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata/nifi$ cd ../
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata$ cd hadoop-hive-spark-hbase
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata/hadoop-hive-spark-hbase$ ls
check_child_image.sh  data_share                   docker-compose.yml  jdbc_drivers  rm_none_images.sh
data                  docker-compose-up-logging.sh  init.sql            logs          tail_docker_compose_logs.sh
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata/hadoop-hive-spark-hbase$ cd data
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata/hadoop-hive-spark-hbase/data$ ls
batches  data.csv  data.csv.json  grades.csv  input.txt  output.txt  ssn-address.tsv
krist@bigdata-new:~/dsc650-infra/bellevue-bigdata/hadoop-hive-spark-hbase/data$ |
```

#3:



```
InvoiceNo,StockCode,Description,Quantity,InvoiceDate,UnitPrice,CustomerID,Country
536365,85123A,WHITE HANGING HEART T-LIGHT HOLDER,6,12/1/2010 8:26,2.55,17850,United Kingdom
536365,71053,WHITE METAL LANTERN,6,12/1/2010 8:26,3.39,17850,United Kingdom
536365,84406B,CREAM CUPID HEARTS COAT HANGER,8,12/1/2010 8:26,2.75,17850,United Kingdom
536365,84029G,KNITTED UNION FLAG HOT WATER BOTTLE,6,12/1/2010 8:26,3.39,17850,United Kingdom
536365,84029E,RED WOOLLY HOTTIE WHITE HEART.,6,12/1/2010 8:26,3.39,17850,United Kingdom
536365,22752,SET 7 BABUSHKA NESTING BOXES,2,12/1/2010 8:26,7.65,17850,United Kingdom
536365,21730,GLASS STAR FROSTED T-LIGHT HOLDER,6,12/1/2010 8:26,4.25,17850,United Kingdom
536366,22633,HAND WARMER UNION JACK,6,12/1/2010 8:28,1.85,17850,United Kingdom
536366,22632,HAND WARMER RED POLKA DOT,6,12/1/2010 8:28,1.85,17850,United Kingdom
536367,84879,ASSORTED COLOUR BIRD ORNAMENT,32,12/1/2010 8:34,1.69,13047,United Kingdom
536367,22745,POPPY'S PLAYHOUSE BEDROOM ,6,12/1/2010 8:34,2.1,13047,United Kingdom
536367,22748,POPPY'S PLAYHOUSE KITCHEN,6,12/1/2010 8:34,2.1,13047,United Kingdom
536367,22749,FELTCRAFT PRINCESS CHARLOTTE DOLL,8,12/1/2010 8:34,3.75,13047,United Kingdom
536367,22310,IVORY KNITTED MUG COSY ,6,12/1/2010 8:34,1.65,13047,United Kingdom
536367,84969,BOX OF 6 ASSORTED COLOUR TEASPOONS,6,12/1/2010 8:34,4.25,13047,United Kingdom
536367,22623,BOX OF VINTAGE JIGSAW BLOCKS ,3,12/1/2010 8:34,4.95,13047,United Kingdom
536367,22622,BOX OF VINTAGE ALPHABET BLOCKS,2,12/1/2010 8:34,9.95,13047,United Kingdom
536367,21754,HOME BUILDING BLOCK WORD,3,12/1/2010 8:34,5.95,13047,United Kingdom
536367,21755,LOVE BUILDING BLOCK WORD,3,12/1/2010 8:34,5.95,13047,United Kingdom
536367,21777,RECIPE BOX WITH METAL HEART,4,12/1/2010 8:34,7.95,13047,United Kingdom
536367,48187,DOORMAT NEW ENGLAND,4,12/1/2010 8:34,7.95,13047,United Kingdom
536368,22960,JAM MAKING SET WITH JARS,6,12/1/2010 8:34,4.25,13047,United Kingdom
536368,22913,RED COAT RACK PARIS FASHION,3,12/1/2010 8:34,4.95,13047,United Kingdom
536368,22912,YELLOW COAT RACK PARIS FASHION,3,12/1/2010 8:34,4.95,13047,United Kingdom
536368,22914,BLUE COAT RACK PARIS FASHION,3,12/1/2010 8:34,4.95,13047,United Kingdom
536369,21756,BATH BUILDING BLOCK WORD,3,12/1/2010 8:35,5.95,13047,United Kingdom
536370,22728,ALARM CLOCK BAKELIKE PINK,24,12/1/2010 8:45,3.75,12583,France
536370,22727,ALARM CLOCK BAKELIKE RED ,24,12/1/2010 8:45,3.75,12583,France
536370,22726,ALARM CLOCK BAKELIKE GREEN,12,12/1/2010 8:45,3.75,12583,France
536370,21724,PANDA AND BUNNIES STICKER SHEET,12,12/1/2010 8:45,0.85,12583,France
536370,21883,STARS GIFT TAPE ,24,12/1/2010 8:45,0.65,12583,France
536370,10002,INFLATABLE POLITICAL GLOBE ,48,12/1/2010 8:45,0.85,12583,France
536370,21791,VINTAGE HEADS AND TAILS CARD GAME ,24,12/1/2010 8:45,1.25,12583,France
536370,21035,SET/2 RED RETROSPOT TEA TOWELS ,18,12/1/2010 8:45,2.95,12583,France
536370,22326,ROUND SNACK BOXES SET OF4 WOODLAND ,24,12/1/2010 8:45,2.95,12583,France
536370,22629,SPACEBOY LUNCH BOX ,24,12/1/2010 8:45,1.95,12583,France
536370,22659,LUNCH BOX I LOVE LONDON,24,12/1/2010 8:45,1.95,12583,France
536370,22631,CIRCUS PARADE LUNCH BOX ,24,12/1/2010 8:45,1.95,12583,France
536370,22661,CHARLOTTE BAG DOLLY GIRL DESIGN,20,12/1/2010 8:45,0.85,12583,France
536370,21731,RED TOADSTOOL LED NIGHT LIGHT,24,12/1/2010 8:45,1.65,12583,France
536370,22900, SET 2 TEA TOWELS I LOVE LONDON ,24,12/1/2010 8:45,2.95,12583,France
"data.csv" [converted][dos] 541910L, 45580670C                                             1,1           Top
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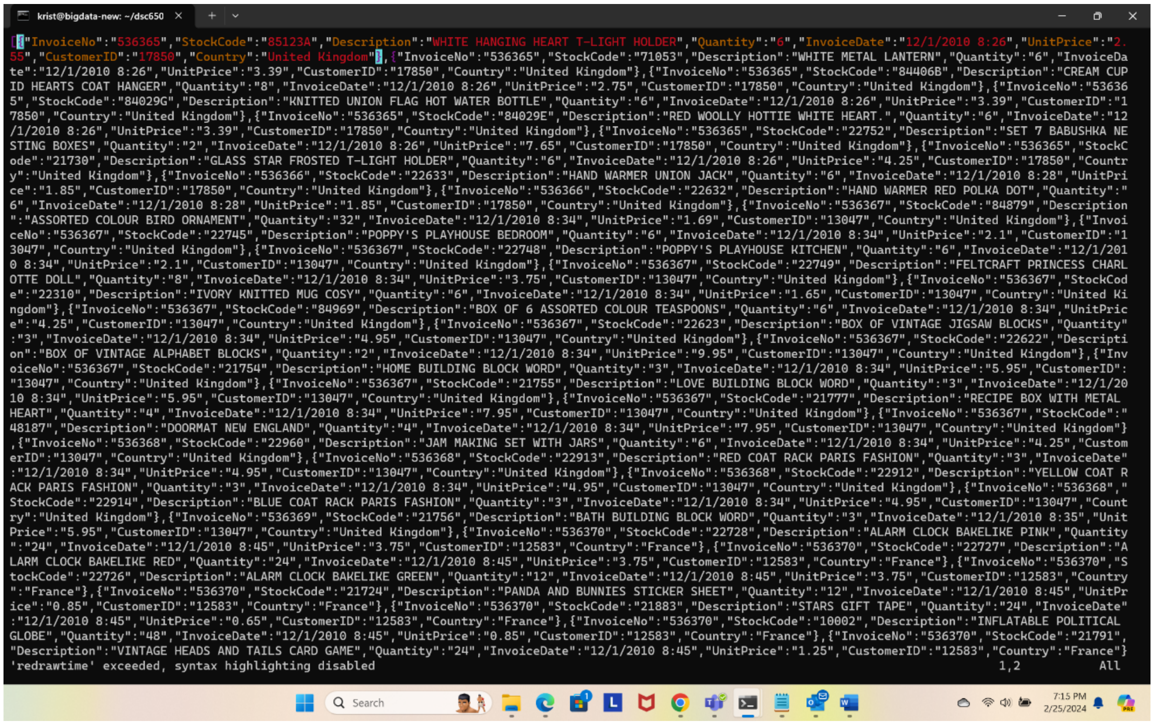
#4:



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GLOBE","Quantity":"48","InvoiceDate":"12/1/2010 8:45","UnitPrice":"0.85","CustomerID":"12583","Country":"France"},{"InvoiceNo":"536370","StockCode":"21791",
"Description":"VINTAGE HEADS AND TAILS CARD GAME","Quantity":"24","InvoiceDate":"12/1/2010 8:45","UnitPrice":"1.25","CustomerID":"12583","Country":"France"}
'redrawtime' exceeded, syntax highlighting disabled                                                                        1,2           All
```
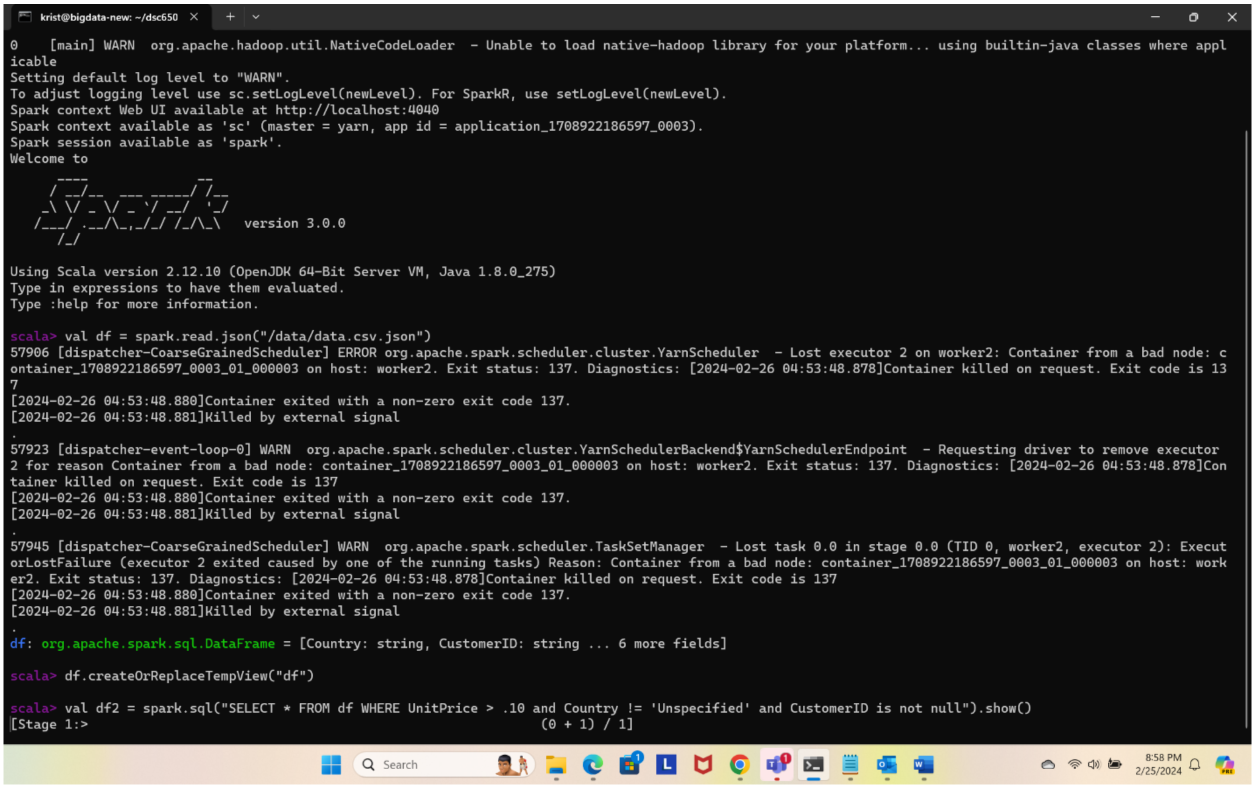
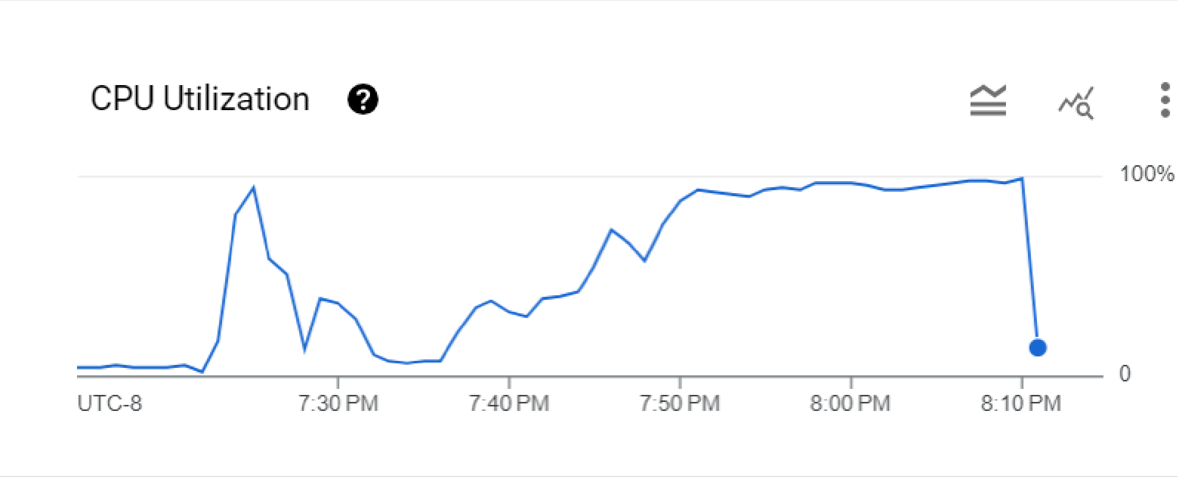

#5:

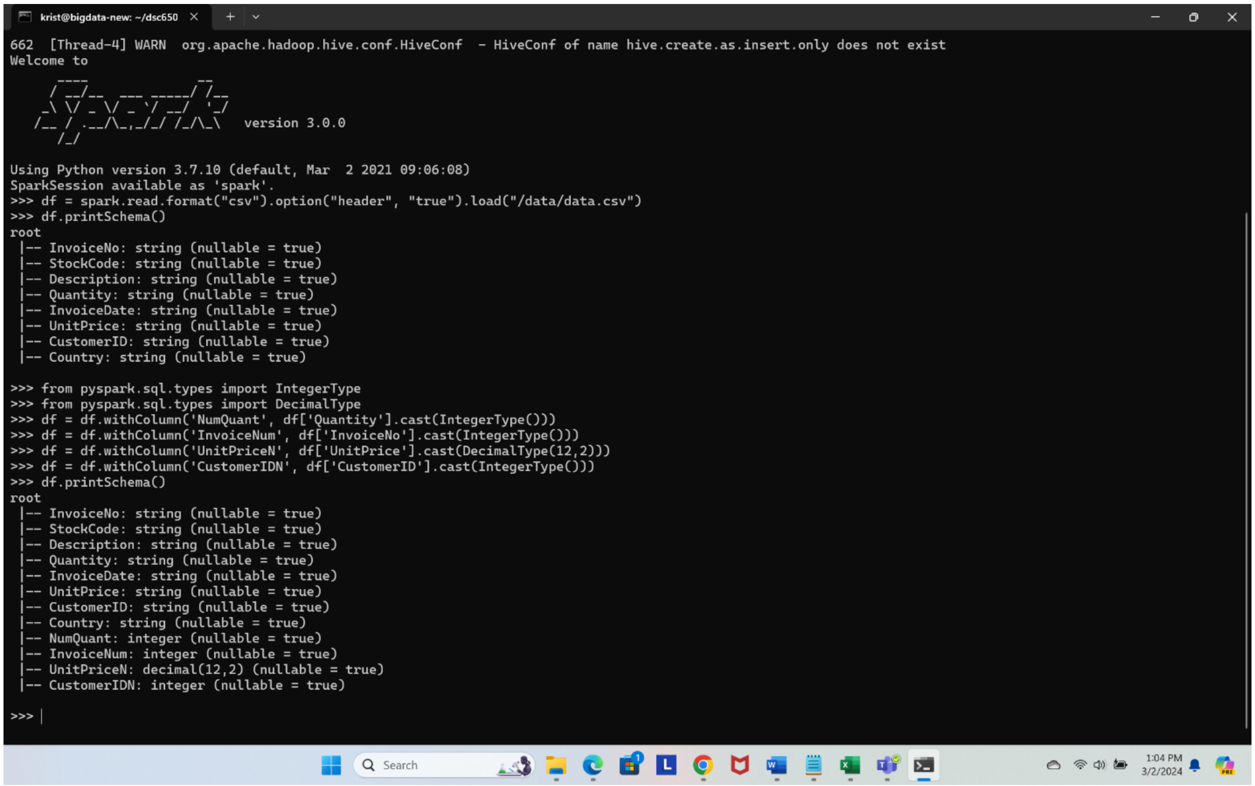


```
0    [main] WARN  org.apache.hadoop.util.NativeCodeLoader  - Unable to load native-hadoop library for your platform... using builtin-java classes where appl
icable
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
Spark context Web UI available at http://localhost:4040
Spark context available as 'sc' (master = yarn, app id = application_1708922186597_0003).
Spark session available as 'spark'.
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /___/ .__/\_,_/_/ /_/\_\   version 3.0.0
      /_/

Using Scala version 2.12.10 (OpenJDK 64-Bit Server VM, Java 1.8.0_275)
Type in expressions to have them evaluated.
Type :help for more information.

scala> val df = spark.read.json("/data/data.csv.json")
57906 [dispatcher-CoarseGrainedScheduler] ERROR org.apache.spark.scheduler.cluster.YarnScheduler  - Lost executor 2 on worker2: Container from a bad node: c
ontainer_1708922186597_0003_01_000003 on host: worker2. Exit status: 137. Diagnostics: [2024-02-26 04:53:48.878]Container killed on request. Exit code is 13
7
[2024-02-26 04:53:48.880]Container exited with a non-zero exit code 137.
[2024-02-26 04:53:48.881]Killed by external signal
.
57923 [dispatcher-event-loop-0] WARN  org.apache.spark.scheduler.cluster.YarnSchedulerBackend$YarnSchedulerEndpoint  - Requesting driver to remove executor
2 for reason Container from a bad node: container_1708922186597_0003_01_000003 on host: worker2. Exit status: 137. Diagnostics: [2024-02-26 04:53:48.878]Con
tainer killed on request. Exit code is 137
[2024-02-26 04:53:48.880]Container exited with a non-zero exit code 137.
[2024-02-26 04:53:48.881]Killed by external signal
.
57945 [dispatcher-CoarseGrainedScheduler] WARN  org.apache.spark.scheduler.TaskSetManager  - Lost task 0.0 in stage 0.0 (TID 0, worker2, executor 2): Execut
orLostFailure (executor 2 exited caused by one of the running tasks) Reason: Container from a bad node: container_1708922186597_0003_01_000003 on host: work
er2. Exit status: 137. Diagnostics: [2024-02-26 04:53:48.878]Container killed on request. Exit code is 137
[2024-02-26 04:53:48.880]Container exited with a non-zero exit code 137.
[2024-02-26 04:53:48.881]Killed by external signal
.
df: org.apache.spark.sql.DataFrame = [Country: string, CustomerID: string ... 6 more fields]

scala> df.createOrReplaceTempView("df")

scala> val df2 = spark.sql("SELECT * FROM df WHERE UnitPrice > .10 and Country != 'Unspecified' and CustomerID is not null").show()
[Stage 1:>                                                          (0 + 1) / 1]
```

#6:

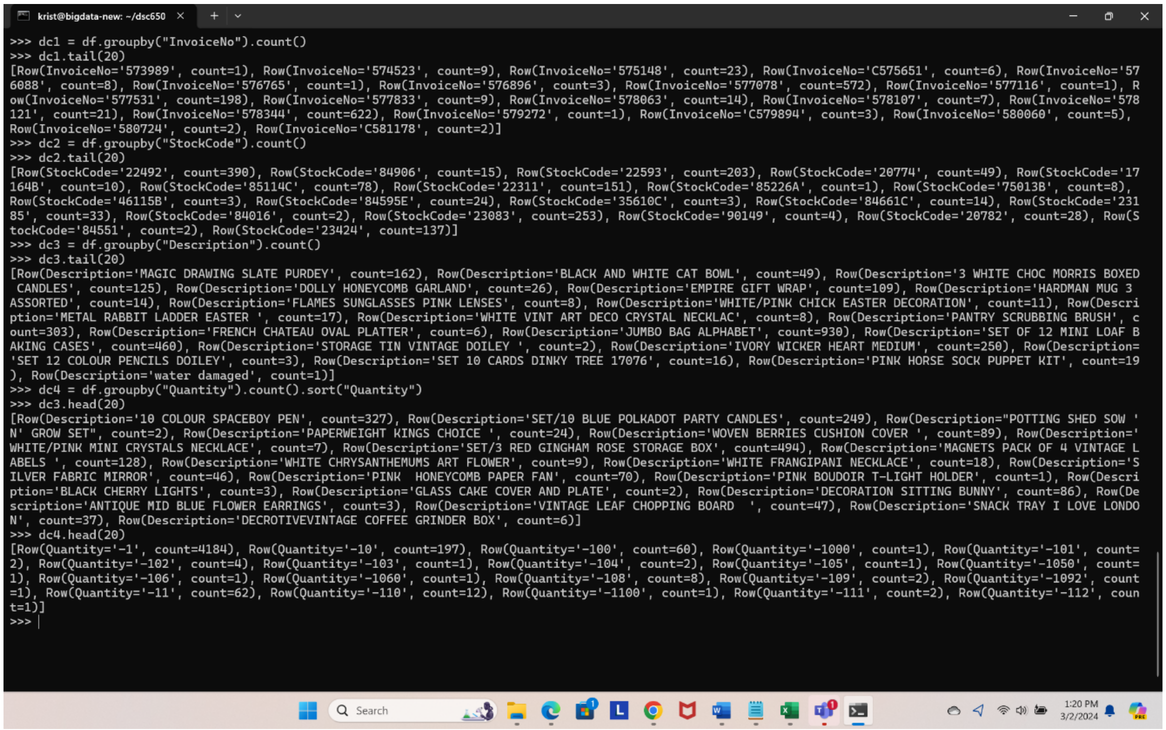


#7:



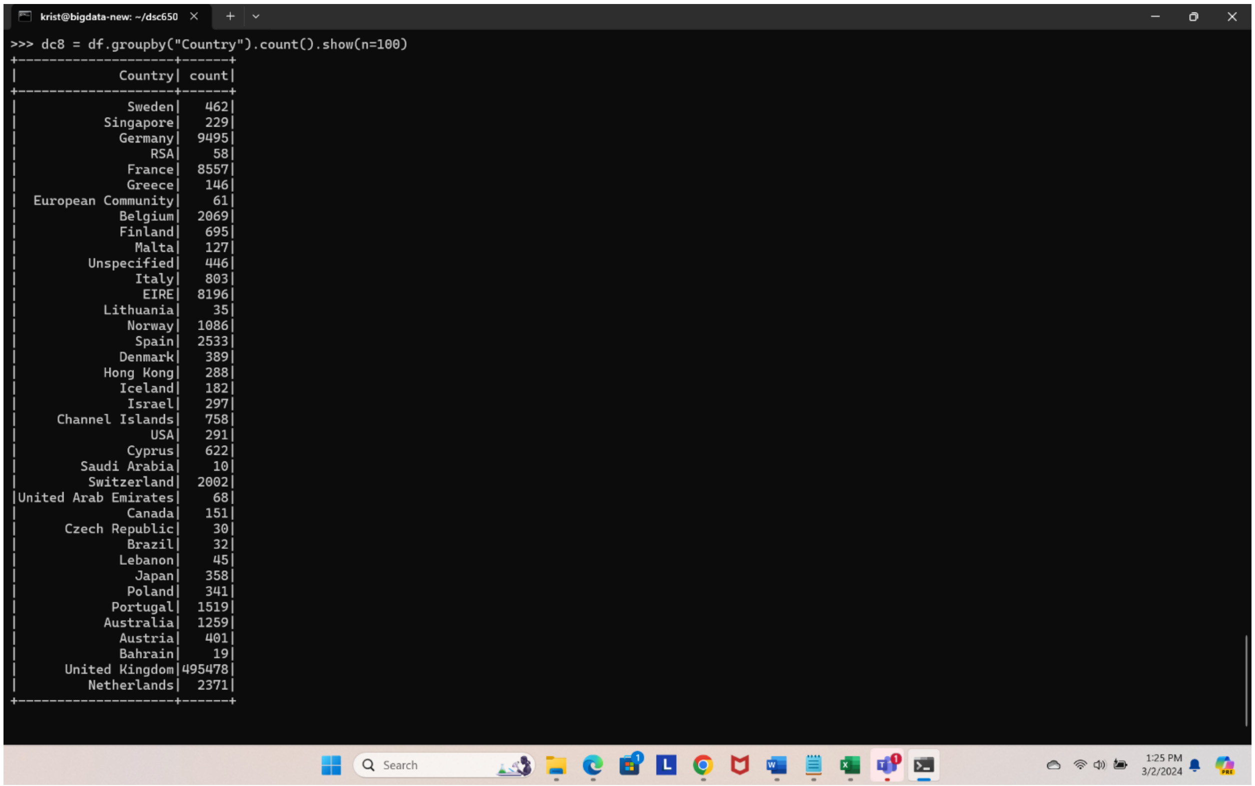
```
662  [Thread-4] WARN  org.apache.hadoop.hive.conf.HiveConf  - HiveConf of name hive.create.as.insert.only does not exist
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /__ / .__/\_,_/_/ /_/\_\   version 3.0.0
      /_/

Using Python version 3.7.10 (default, Mar  2 2021 09:06:08)
SparkSession available as 'spark'.
>>> df = spark.read.format("csv").option("header", "true").load("/data/data.csv")
>>> df.printSchema()
root
 |-- InvoiceNo: string (nullable = true)
 |-- StockCode: string (nullable = true)
 |-- Description: string (nullable = true)
 |-- Quantity: string (nullable = true)
 |-- InvoiceDate: string (nullable = true)
 |-- UnitPrice: string (nullable = true)
 |-- CustomerID: string (nullable = true)
 |-- Country: string (nullable = true)

>>> from pyspark.sql.types import IntegerType
>>> from pyspark.sql.types import DecimalType
>>> df = df.withColumn('NumQuant', df['Quantity'].cast(IntegerType()))
>>> df = df.withColumn('InvoiceNum', df['InvoiceNo'].cast(IntegerType()))
>>> df = df.withColumn('UnitPriceN', df['UnitPrice'].cast(DecimalType(12,2)))
>>> df = df.withColumn('CustomerIDN', df['CustomerID'].cast(IntegerType()))
>>> df.printSchema()
root
 |-- InvoiceNo: string (nullable = true)
 |-- StockCode: string (nullable = true)
 |-- Description: string (nullable = true)
 |-- Quantity: string (nullable = true)
 |-- InvoiceDate: string (nullable = true)
 |-- UnitPrice: string (nullable = true)
 |-- CustomerID: string (nullable = true)
 |-- Country: string (nullable = true)
 |-- NumQuant: integer (nullable = true)
 |-- InvoiceNum: integer (nullable = true)
 |-- UnitPriceN: decimal(12,2) (nullable = true)
 |-- CustomerIDN: integer (nullable = true)

>>> |
```

#8a:



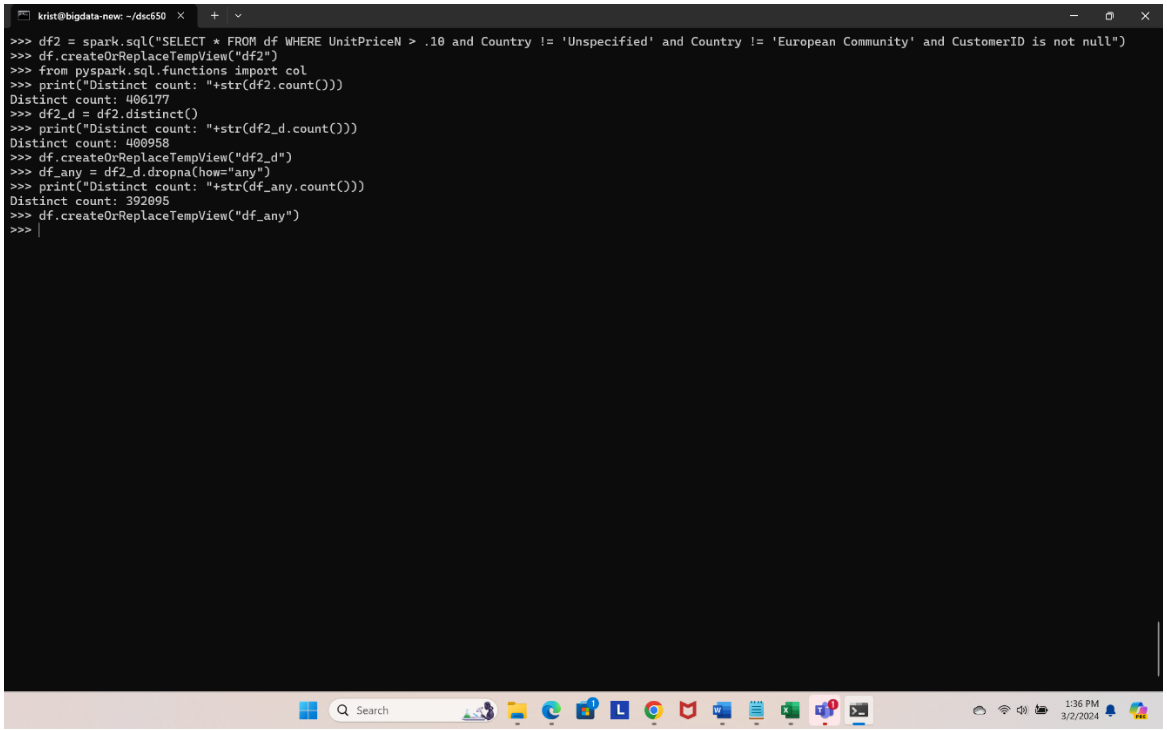
```
>>> dc1 = df.groupby("InvoiceNo").count()
>>> dc1.tail(20)
[Row(InvoiceNo='573989', count=1), Row(InvoiceNo='574523', count=9), Row(InvoiceNo='575148', count=23), Row(InvoiceNo='C575651', count=6), Row(InvoiceNo='57
6088', count=8), Row(InvoiceNo='576765', count=1), Row(InvoiceNo='576896', count=3), Row(InvoiceNo='577078', count=572), Row(InvoiceNo='577116', count=1), R
ow(InvoiceNo='577531', count=198), Row(InvoiceNo='577833', count=9), Row(InvoiceNo='578063', count=14), Row(InvoiceNo='578107', count=7), Row(InvoiceNo='578
121', count=21), Row(InvoiceNo='578344', count=622), Row(InvoiceNo='579272', count=1), Row(InvoiceNo='C579894', count=3), Row(InvoiceNo='580060', count=5),
Row(InvoiceNo='580724', count=2), Row(InvoiceNo='C581178', count=2)]
>>> dc2 = df.groupby("StockCode").count()
>>> dc2.tail(20)
[Row(StockCode='22492', count=390), Row(StockCode='84906', count=15), Row(StockCode='22593', count=203), Row(StockCode='20774', count=49), Row(StockCode='17
164B', count=10), Row(StockCode='85114C', count=78), Row(StockCode='22311', count=151), Row(StockCode='85226A', count=1), Row(StockCode='75013B', count=8),
Row(StockCode='46115B', count=3), Row(StockCode='84595E', count=24), Row(StockCode='35610C', count=3), Row(StockCode='84661C', count=14), Row(StockCode='231
85', count=33), Row(StockCode='84016', count=2), Row(StockCode='23083', count=253), Row(StockCode='90149', count=4), Row(StockCode='20782', count=28), Row(S
tockCode='84551', count=2), Row(StockCode='23424', count=137)]
>>> dc3 = df.groupby("Description").count()
>>> dc3.tail(20)
[Row(Description='MAGIC DRAWING SLATE PURDEY', count=162), Row(Description='BLACK AND WHITE CAT BOWL', count=49), Row(Description='3 WHITE CHOC MORRIS BOXED
 CANDLES', count=125), Row(Description='DOLLY HONEYCOMB GARLAND', count=26), Row(Description='EMPIRE GIFT WRAP', count=109), Row(Description='HARDMAN MUG 3
ASSORTED', count=14), Row(Description='FLAMES SUNGLASSES PINK LENSES', count=8), Row(Description='WHITE/PINK CHICK EASTER DECORATION', count=11), Row(Descri
ption='METAL RABBIT LADDER EASTER ', count=17), Row(Description='WHITE VINT ART DECO CRYSTAL NECKLAC', count=8), Row(Description='PANTRY SCRUBBING BRUSH', c
ount=303), Row(Description='FRENCH CHATEAU OVAL PLATTER', count=6), Row(Description='JUMBO BAG ALPHABET', count=930), Row(Description='SET OF 12 MINI LOAF B
AKING CASES', count=460), Row(Description='STORAGE TIN VINTAGE DOILEY ', count=2), Row(Description='IVORY WICKER HEART MEDIUM', count=250), Row(Description=
'SET 12 COLOUR PENCILS DOILEY', count=3), Row(Description='SET 10 CARDS DINKY TREE 17076', count=16), Row(Description='PINK HORSE SOCK PUPPET KIT', count=19
), Row(Description='water damaged', count=1)]
>>> dc4 = df.groupby("Quantity").count().sort("Quantity")
>>> dc3.head(20)
[Row(Description='10 COLOUR SPACEBOY PEN', count=327), Row(Description='SET/10 BLUE POLKADOT PARTY CANDLES', count=249), Row(Description="POTTING SHED SOW '
N' GROW SET", count=2), Row(Description='PAPERWEIGHT KINGS CHOICE ', count=24), Row(Description='WOVEN BERRIES CUSHION COVER ', count=89), Row(Description='
WHITE/PINK MINI CRYSTALS NECKLACE', count=7), Row(Description='SET/3 RED GINGHAM ROSE STORAGE BOX', count=494), Row(Description='MAGNETS PACK OF 4 VINTAGE L
ABELS ', count=128), Row(Description='WHITE CHRYSANTHEMUMS ART FLOWER', count=9), Row(Description='WHITE FRANGIPANI NECKLACE', count=18), Row(Description='S
ILVER FABRIC MIRROR', count=46), Row(Description='PINK  HONEYCOMB PAPER FAN', count=70), Row(Description='PINK BOUDOIR T-LIGHT HOLDER', count=1), Row(Descri
ption='BLACK CHERRY LIGHTS', count=3), Row(Description='GLASS CAKE COVER AND PLATE', count=2), Row(Description='DECORATION SITTING BUNNY', count=86), Row(De
scription='ANTIQUE MID BLUE FLOWER EARRINGS', count=3), Row(Description='VINTAGE LEAF CHOPPING BOARD  ', count=47), Row(Description='SNACK TRAY I LOVE LONDO
N', count=37), Row(Description='DECROTIVEVINTAGE COFFEE GRINDER BOX', count=6)]
>>> dc4.head(20)
[Row(Quantity='-1', count=4184), Row(Quantity='-10', count=197), Row(Quantity='-100', count=60), Row(Quantity='-1000', count=1), Row(Quantity='-101', count=
2), Row(Quantity='-102', count=4), Row(Quantity='-103', count=1), Row(Quantity='-104', count=2), Row(Quantity='-105', count=1), Row(Quantity='-1050', count=
1), Row(Quantity='-106', count=1), Row(Quantity='-1060', count=1), Row(Quantity='-108', count=8), Row(Quantity='-109', count=2), Row(Quantity='-1092', count
=1), Row(Quantity='-11', count=62), Row(Quantity='-110', count=12), Row(Quantity='-1100', count=1), Row(Quantity='-111', count=2), Row(Quantity='-112', coun
t=1)]
>>> 
```

#8b:



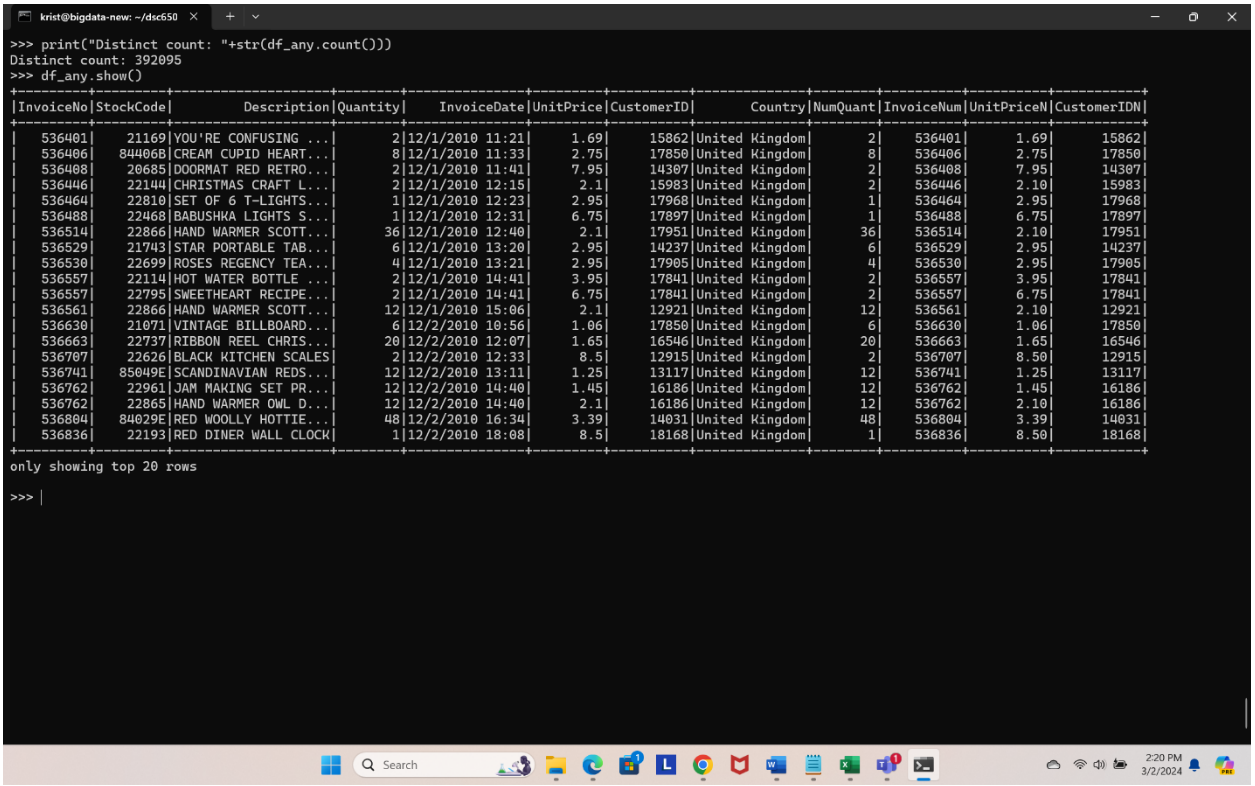
```
>>> dc8 = df.groupby("Country").count().show(n=100)
+--------------------+------+
|             Country| count|
+--------------------+------+
|              Sweden|   462|
|           Singapore|   229|
|             Germany|  9495|
|                 RSA|    58|
|              France|  8557|
|              Greece|   146|
|  European Community|    61|
|             Belgium|  2069|
|             Finland|   695|
|               Malta|   127|
|         Unspecified|   446|
|               Italy|   803|
|                EIRE|  8196|
|           Lithuania|    35|
|              Norway|  1086|
|               Spain|  2533|
|             Denmark|   389|
|           Hong Kong|   288|
|             Iceland|   182|
|              Israel|   297|
|     Channel Islands|   758|
|                 USA|   291|
|              Cyprus|   622|
|        Saudi Arabia|    10|
|         Switzerland|  2002|
|United Arab Emirates|    68|
|              Canada|   151|
|      Czech Republic|    30|
|              Brazil|    32|
|             Lebanon|    45|
|               Japan|   358|
|              Poland|   341|
|            Portugal|  1519|
|           Australia|  1259|
|             Austria|   401|
|             Bahrain|    19|
|      United Kingdom|495478|
|         Netherlands|  2371|
+--------------------+------+
```

#8c:



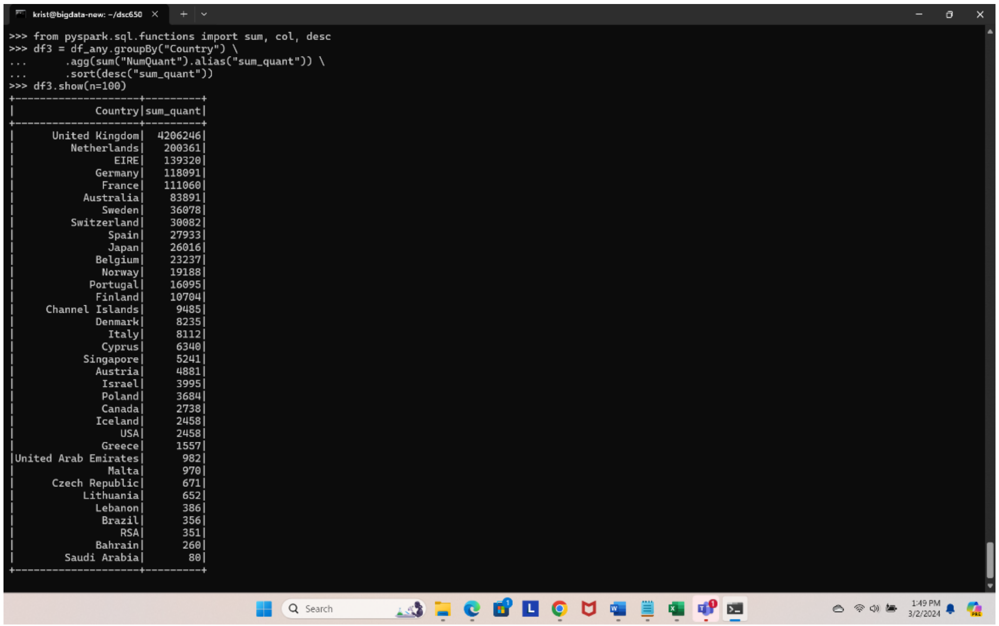
```
>>> df2 = spark.sql("SELECT * FROM df WHERE UnitPriceN > .10 and Country != 'Unspecified' and Country != 'European Community' and CustomerID is not null")
>>> df.createOrReplaceTempView("df2")
>>> from pyspark.sql.functions import col
>>> print("Distinct count: "+str(df2.count()))
Distinct count: 406177
>>> df2_d = df2.distinct()
>>> print("Distinct count: "+str(df2_d.count()))
Distinct count: 400958
>>> df.createOrReplaceTempView("df2_d")
>>> df_any = df2_d.dropna(how="any")
>>> print("Distinct count: "+str(df_any.count()))
Distinct count: 392095
>>> df.createOrReplaceTempView("df_any")
>>> |
```

#9:



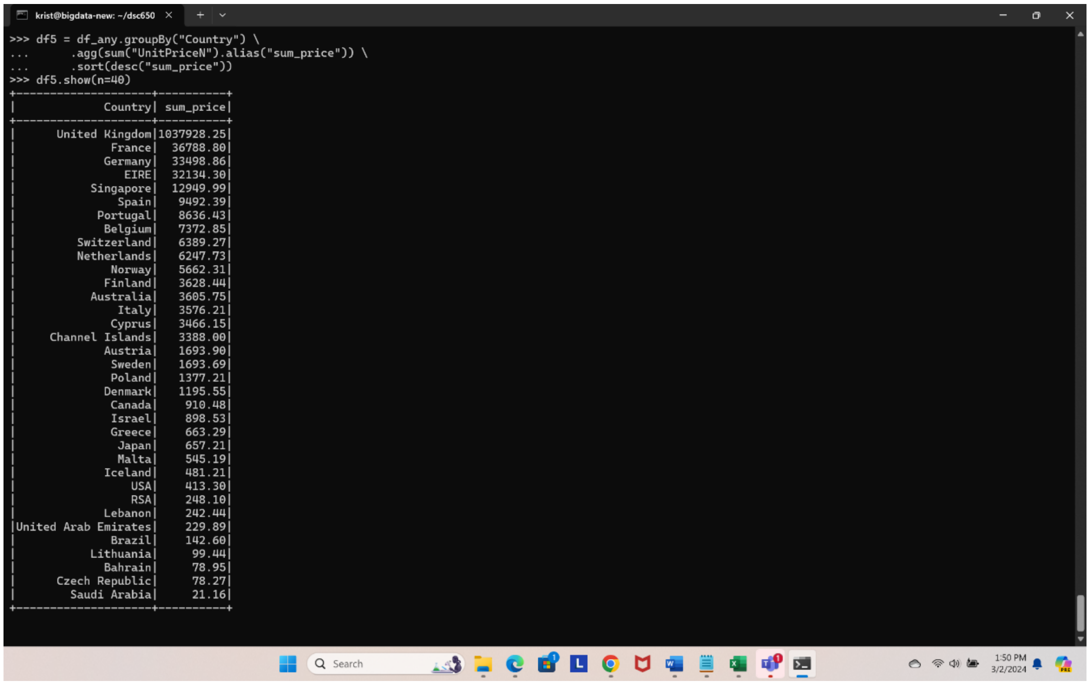
```
>>> print("Distinct count: "+str(df_any.count()))
Distinct count: 392095
>>> df_any.show()
+---------+---------+--------------------+--------+---------------+---------+----------+--------------+--------+----------+----------+-----------+
|InvoiceNo|StockCode|         Description|Quantity|    InvoiceDate|UnitPrice|CustomerID|       Country|NumQuant|InvoiceNum|UnitPriceN|CustomerIDN|
+---------+---------+--------------------+--------+---------------+---------+----------+--------------+--------+----------+----------+-----------+
|   536401|    21169|YOU'RE CONFUSING ...|       2|12/1/2010 11:21|     1.69|     15862|United Kingdom|       2|    536401|      1.69|      15862|
|   536406|   84406B|CREAM CUPID HEART...|       8|12/1/2010 11:33|     2.75|     17850|United Kingdom|       8|    536406|      2.75|      17850|
|   536408|    20685|DOORMAT RED RETRO...|       2|12/1/2010 11:41|     7.95|     14307|United Kingdom|       2|    536408|      7.95|      14307|
|   536446|    22144|CHRISTMAS CRAFT L...|       2|12/1/2010 12:15|      2.1|     15983|United Kingdom|       2|    536446|      2.10|      15983|
|   536464|    22810|SET OF 6 T-LIGHTS...|       1|12/1/2010 12:23|     2.95|     17968|United Kingdom|       1|    536464|      2.95|      17968|
|   536488|    22468|BABUSHKA LIGHTS S...|       1|12/1/2010 12:31|     6.75|     17897|United Kingdom|       1|    536488|      6.75|      17897|
|   536514|    22866|HAND WARMER SCOTT...|      36|12/1/2010 12:40|      2.1|     17951|United Kingdom|      36|    536514|      2.10|      17951|
|   536529|    21743|STAR PORTABLE TAB...|       6|12/1/2010 13:20|     2.95|     14237|United Kingdom|       6|    536529|      2.95|      14237|
|   536530|    22699|ROSES REGENCY TEA...|       4|12/1/2010 13:21|     2.95|     17905|United Kingdom|       4|    536530|      2.95|      17905|
|   536557|    22114|HOT WATER BOTTLE ...|       2|12/1/2010 14:41|     3.95|     17841|United Kingdom|       2|    536557|      3.95|      17841|
|   536557|    22795|SWEETHEART RECIPE...|       2|12/1/2010 14:41|     6.75|     17841|United Kingdom|       2|    536557|      6.75|      17841|
|   536561|    22866|HAND WARMER SCOTT...|      12|12/1/2010 15:06|      2.1|     12921|United Kingdom|      12|    536561|      2.10|      12921|
|   536630|    21071|VINTAGE BILLBOARD...|       6|12/2/2010 10:56|     1.06|     17850|United Kingdom|       6|    536630|      1.06|      17850|
|   536663|    22737|RIBBON REEL CHRIS...|      20|12/2/2010 12:07|     1.65|     16546|United Kingdom|      20|    536663|      1.65|      16546|
|   536707|    22626|BLACK KITCHEN SCALES|       2|12/2/2010 12:33|      8.5|     12915|United Kingdom|       2|    536707|      8.50|      12915|
|   536741|   85049E|SCANDINAVIAN REDS...|      12|12/2/2010 13:11|     1.25|     13117|United Kingdom|      12|    536741|      1.25|      13117|
|   536762|    22961|JAM MAKING SET PR...|      12|12/2/2010 14:40|     1.45|     16186|United Kingdom|      12|    536762|      1.45|      16186|
|   536762|    22865|HAND WARMER OWL D...|      12|12/2/2010 14:40|      2.1|     16186|United Kingdom|      12|    536762|      2.10|      16186|
|   536804|   84029E|RED WOOLLY HOTTIE...|      48|12/2/2010 16:34|     3.39|     14031|United Kingdom|      48|    536804|      3.39|      14031|
|   536836|    22193|RED DINER WALL CLOCK|       1|12/2/2010 18:08|      8.5|     18168|United Kingdom|       1|    536836|      8.50|      18168|
+---------+---------+--------------------+--------+---------------+---------+----------+--------------+--------+----------+----------+-----------+
only showing top 20 rows

>>> |
```

#10:



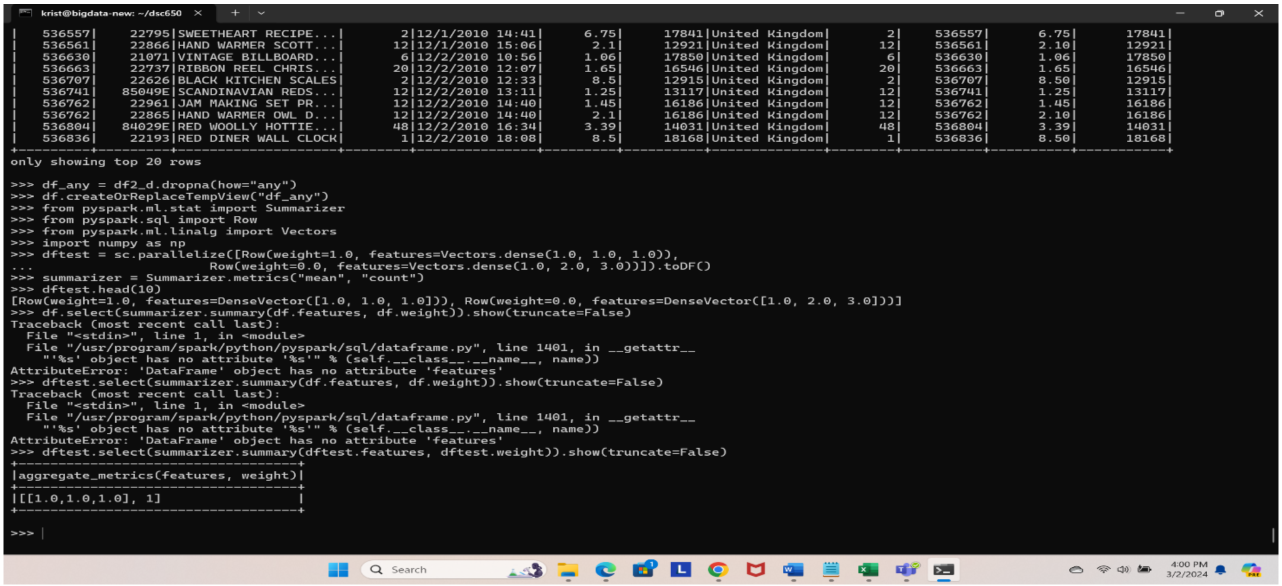
```
>>> from pyspark.sql.functions import sum, col, desc
>>> df3 = df_any.groupBy("Country") \
...       .agg(sum("NumQuant").alias("sum_quant")) \
...       .sort(desc("sum_quant"))
>>> df3.show(n=100)
+--------------------+---------+
|             Country|sum_quant|
+--------------------+---------+
|      United Kingdom|  4206246|
|         Netherlands|   200361|
|                EIRE|   139320|
|             Germany|   118091|
|              France|   111060|
|           Australia|    83891|
|              Sweden|    36078|
|         Switzerland|    30082|
|               Spain|    27933|
|               Japan|    26016|
|             Belgium|    23237|
|              Norway|    19188|
|            Portugal|    16095|
|             Finland|    10704|
|     Channel Islands|     9485|
|             Denmark|     8235|
|               Italy|     8112|
|              Cyprus|     6340|
|           Singapore|     5241|
|             Austria|     4881|
|              Israel|     3995|
|              Poland|     3684|
|              Canada|     2738|
|             Iceland|     2458|
|                 USA|     2458|
|              Greece|     1557|
|United Arab Emirates|      982|
|               Malta|      970|
|      Czech Republic|      671|
|           Lithuania|      652|
|             Lebanon|      386|
|              Brazil|      356|
|                 RSA|      351|
|             Bahrain|      260|
|        Saudi Arabia|       80|
+--------------------+---------+
```

#11:



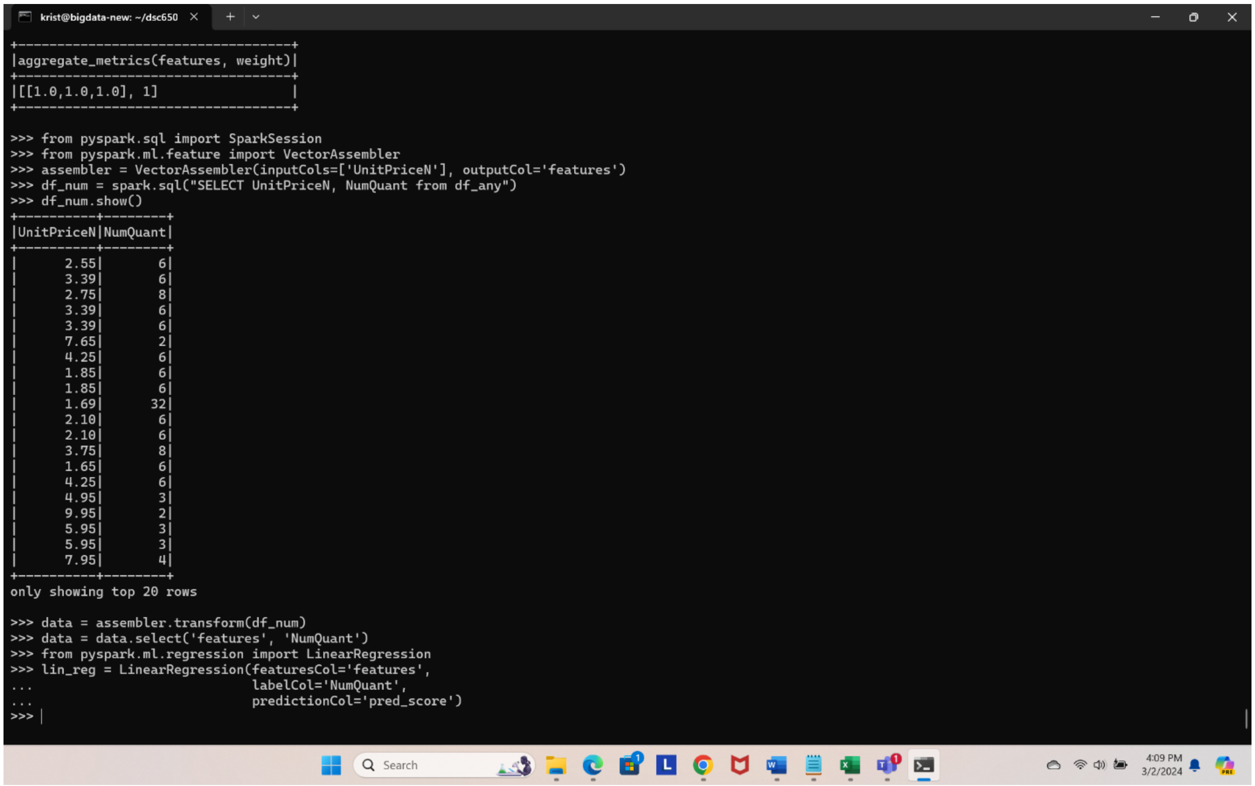
```
>>> df5 = df_any.groupBy("Country") \
...       .agg(sum("UnitPriceN").alias("sum_price")) \
...       .sort(desc("sum_price"))
>>> df5.show(n=40)
+--------------------+----------+
|             Country| sum_price|
+--------------------+----------+
|      United Kingdom|1037928.25|
|              France|  36788.80|
|             Germany|  33498.86|
|                EIRE|  32134.30|
|           Singapore|  12949.99|
|               Spain|   9492.39|
|            Portugal|   8636.43|
|             Belgium|   7372.85|
|         Switzerland|   6389.27|
|         Netherlands|   6247.73|
|              Norway|   5662.31|
|             Finland|   3628.44|
|           Australia|   3605.75|
|               Italy|   3576.21|
|              Cyprus|   3466.15|
|     Channel Islands|   3388.00|
|             Austria|   1693.90|
|              Sweden|   1693.69|
|              Poland|   1377.21|
|             Denmark|   1195.55|
|              Canada|    910.48|
|              Israel|    898.53|
|              Greece|    663.29|
|               Japan|    657.21|
|               Malta|    545.19|
|             Iceland|    481.21|
|                 USA|    413.30|
|                 RSA|    248.10|
|             Lebanon|    242.44|
|United Arab Emirates|    229.89|
|              Brazil|    142.60|
|           Lithuania|     99.44|
|             Bahrain|     78.95|
|      Czech Republic|     78.27|
|        Saudi Arabia|     21.16|
+--------------------+----------+
```

#12:



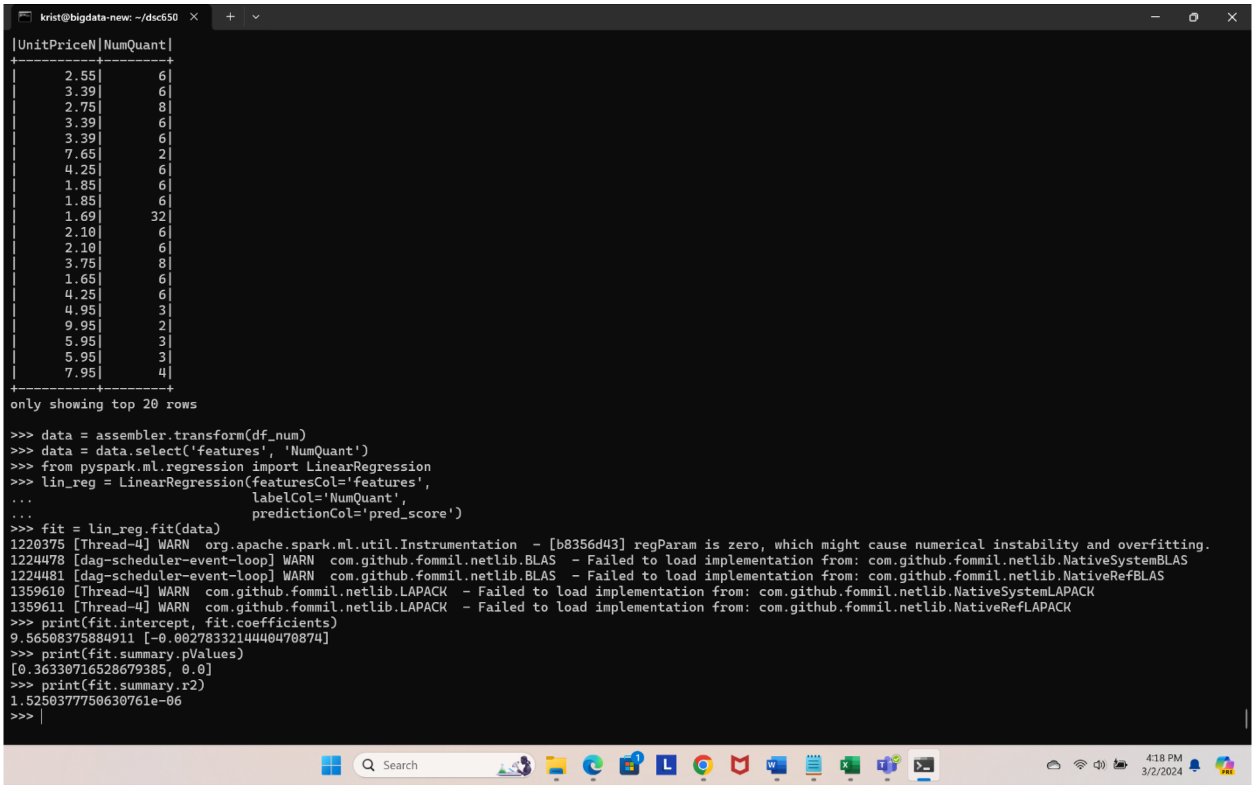
```
|    536557|     22795|SWEETHEART RECIPE...|         2|12/1/2010 14:41|      6.75|     17841|United Kingdom|         2|    536557|      6.75|     17841|
|    536561|     22866|HAND WARMER SCOTT...|        12|12/1/2010 15:06|       2.1|     12921|United Kingdom|        12|    536561|      2.10|     12921|
|    536630|     21071|VINTAGE BILLBOARD...|         6|12/2/2010 10:56|      1.06|     17850|United Kingdom|         6|    536630|      1.06|     17850|
|    536663|     22737|RIBBON REEL CHRIS...|        20|12/2/2010 12:07|      1.65|     16546|United Kingdom|        20|    536663|      1.65|     16546|
|    536707|     22626|BLACK KITCHEN SCALES|         2|12/2/2010 12:33|       8.5|     12915|United Kingdom|         2|    536707|      8.50|     12915|
|    536741|    85049E|SCANDINAVIAN REDS...|        12|12/2/2010 13:11|      1.25|     13117|United Kingdom|        12|    536741|      1.25|     13117|
|    536762|     22961|JAM MAKING SET PR...|        12|12/2/2010 14:40|      1.45|     16186|United Kingdom|        12|    536762|      1.45|     16186|
|    536762|     22865|HAND WARMER OWL D...|        12|12/2/2010 14:40|       2.1|     16186|United Kingdom|        12|    536762|      2.10|     16186|
|    536804|    84029E|RED WOOLLY HOTTIE...|        48|12/2/2010 16:34|      3.39|     14031|United Kingdom|        48|    536804|      3.39|     14031|
|    536836|     22193|RED DINER WALL CLOCK|         1|12/2/2010 18:08|       8.5|     18168|United Kingdom|         1|    536836|      8.50|     18168|
+----------+----------+--------------------+----------+---------------+----------+----------+--------------+----------+----------+----------+----------+
only showing top 20 rows

>>> df_any = df2_d.dropna(how="any")
>>> df.createOrReplaceTempView("df_any")
>>> from pyspark.ml.stat import Summarizer
>>> from pyspark.sql import Row
>>> from pyspark.ml.linalg import Vectors
>>> import numpy as np
>>> dftest = sc.parallelize([Row(weight=1.0, features=Vectors.dense(1.0, 1.0, 1.0)),
...                          Row(weight=0.0, features=Vectors.dense(1.0, 2.0, 3.0))]).toDF()
>>> summarizer = Summarizer.metrics("mean", "count")
>>> dftest.head(10)
[Row(weight=1.0, features=DenseVector([1.0, 1.0, 1.0])), Row(weight=0.0, features=DenseVector([1.0, 2.0, 3.0]))]
>>> df.select(summarizer.summary(df.features, df.weight)).show(truncate=False)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "/usr/program/spark/python/pyspark/sql/dataframe.py", line 1401, in __getattr__
    "'%s' object has no attribute '%s'" % (self.__class__.__name__, name))
AttributeError: 'DataFrame' object has no attribute 'features'
>>> dftest.select(summarizer.summary(df.features, df.weight)).show(truncate=False)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "/usr/program/spark/python/pyspark/sql/dataframe.py", line 1401, in __getattr__
    "'%s' object has no attribute '%s'" % (self.__class__.__name__, name))
AttributeError: 'DataFrame' object has no attribute 'features'
>>> dftest.select(summarizer.summary(dftest.features, dftest.weight)).show(truncate=False)
+-----------------------------------+
|aggregate_metrics(features, weight)|
+-----------------------------------+
|[[1.0,1.0,1.0], 1]                 |
+-----------------------------------+

>>> |
```

#13:



```
+-----------------------------------+
|aggregate_metrics(features, weight)|
+-----------------------------------+
|[[1.0,1.0,1.0], 1]                 |
+-----------------------------------+

>>> from pyspark.sql import SparkSession
>>> from pyspark.ml.feature import VectorAssembler
>>> assembler = VectorAssembler(inputCols=['UnitPriceN'], outputCol='features')
>>> df_num = spark.sql("SELECT UnitPriceN, NumQuant from df_any")
>>> df_num.show()
+----------+--------+
|UnitPriceN|NumQuant|
+----------+--------+
|      2.55|       6|
|      3.39|       6|
|      2.75|       8|
|      3.39|       6|
|      3.39|       6|
|      7.65|       2|
|      4.25|       6|
|      1.85|       6|
|      1.85|       6|
|      1.69|      32|
|      2.10|       6|
|      2.10|       6|
|      3.75|       8|
|      1.65|       6|
|      4.25|       6|
|      4.95|       3|
|      9.95|       2|
|      5.95|       3|
|      5.95|       3|
|      7.95|       4|
+----------+--------+
only showing top 20 rows

>>> data = assembler.transform(df_num)
>>> data = data.select('features', 'NumQuant')
>>> from pyspark.ml.regression import LinearRegression
>>> lin_reg = LinearRegression(featuresCol='features',
...                               labelCol='NumQuant',
...                               predictionCol='pred_score')
>>> |
```

#14:



```
|UnitPriceN|NumQuant|
+----------+--------+
|      2.55|       6|
|      3.39|       6|
|      2.75|       8|
|      3.39|       6|
|      3.39|       6|
|      7.65|       2|
|      4.25|       6|
|      1.85|       6|
|      1.85|       6|
|      1.69|      32|
|      2.10|       6|
|      2.10|       6|
|      3.75|       8|
|      1.65|       6|
|      4.25|       6|
|      4.95|       3|
|      9.95|       2|
|      5.95|       3|
|      5.95|       3|
|      7.95|       4|
+----------+--------+
only showing top 20 rows

>>> data = assembler.transform(df_num)
>>> data = data.select('features', 'NumQuant')
>>> from pyspark.ml.regression import LinearRegression
>>> lin_reg = LinearRegression(featuresCol='features',
...                            labelCol='NumQuant',
...                            predictionCol='pred_score')
>>> fit = lin_reg.fit(data)
1220375 [Thread-4] WARN  org.apache.spark.ml.util.Instrumentation  - [b8356d43] regParam is zero, which might cause numerical instability and overfitting.
1224478 [dag-scheduler-event-loop] WARN  com.github.fommil.netlib.BLAS  - Failed to load implementation from: com.github.fommil.netlib.NativeSystemBLAS
1224481 [dag-scheduler-event-loop] WARN  com.github.fommil.netlib.BLAS  - Failed to load implementation from: com.github.fommil.netlib.NativeRefBLAS
1359610 [Thread-4] WARN  com.github.fommil.netlib.LAPACK  - Failed to load implementation from: com.github.fommil.netlib.NativeSystemLAPACK
1359611 [Thread-4] WARN  com.github.fommil.netlib.LAPACK  - Failed to load implementation from: com.github.fommil.netlib.NativeRefLAPACK
>>> print(fit.intercept, fit.coefficients)
9.56508375884911 [-0.0027833214440470874]
>>> print(fit.summary.pValues)
[0.36330716528679385, 0.0]
>>> print(fit.summary.r2)
1.5250377750630761e-06
>>> |
```

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