Name: Harsh Chauhan
Username: hchauhan

BDA Mini Project

1. Introduction:

This comprehensive data analytics project focuses on processing Amazon's Digital Music review dataset(Amazon Reviews'23), which contains 130.4K reviews from 101K users across 70.5K items, totaling 11.4M review tokens. The pipeline implements a sophisticated architecture that combines AWS services with distributed computing frameworks: AWS S3 handles scalable storage, PySpark manages distributed data processing, AWS SageMaker powers machine learning capabilities, and QuickSight delivers data visualization. The dataset captures detailed customer interactions through a rich set of features including numerical ratings (1.0-5.0), timestamped reviews, purchase verification status, helpfulness votes, and review text. This structured approach enables efficient large-scale data processing while providing valuable insights into customer behavior and preferences in the digital music marketplace.

Example entry of Dataset: Digital_Music.jsonl


```
{"rating": 5.0, "title": "Nice", "text": "If i had a dollar for how many times I have played this cd and how many times I have asked Alexa to play it, I would be rich. Love this singer along with the Black Pumas. Finding a lot of new music that I like a lot on amazon. Try new things.", "images": [], "asin": "B004RQ2IRG", "parent_asin": "B004RQ2IRG", "user_id": "AFUOYIZBU3MTBOLYKOJE5Z35MBDA", "timestamp": 1618972613292, "helpful_vote": 0, "verified_purchase": true}
```


2. Environment Setup

1. AWS S3 for Data Storage:
    a. Step 1 : Create an S3 bucket to store data.

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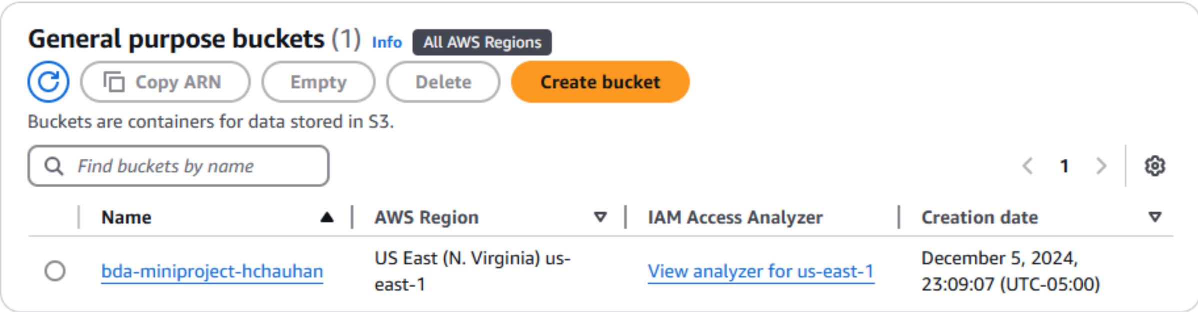
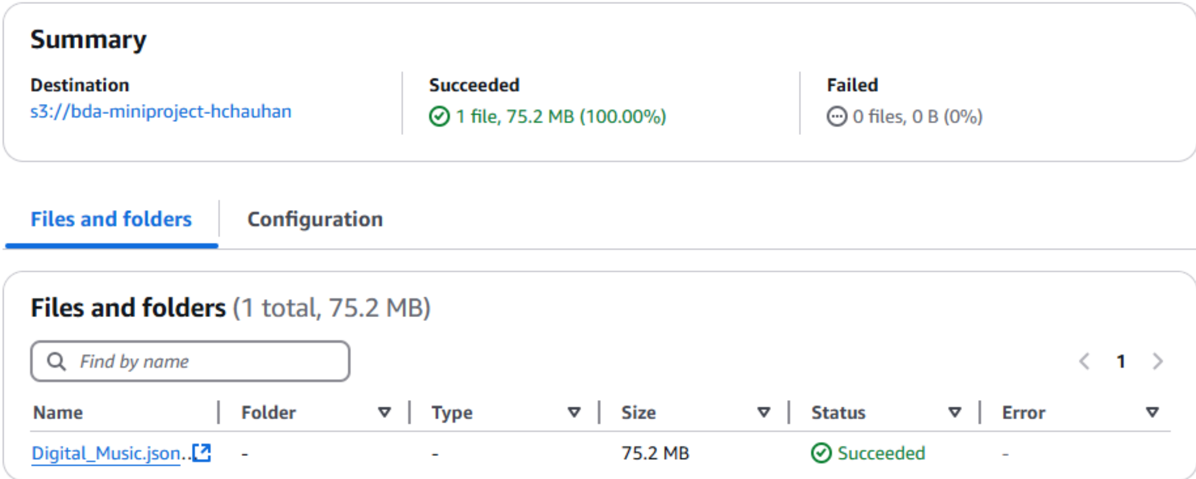


b. Step 2: Upload the raw dataset to the S3 bucket.

Uploaded Digital_music.jsonl to bda-miniproject-hchauhan S3 bucket



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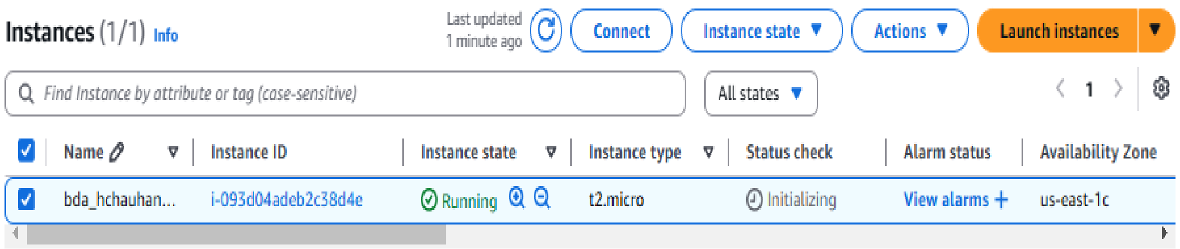
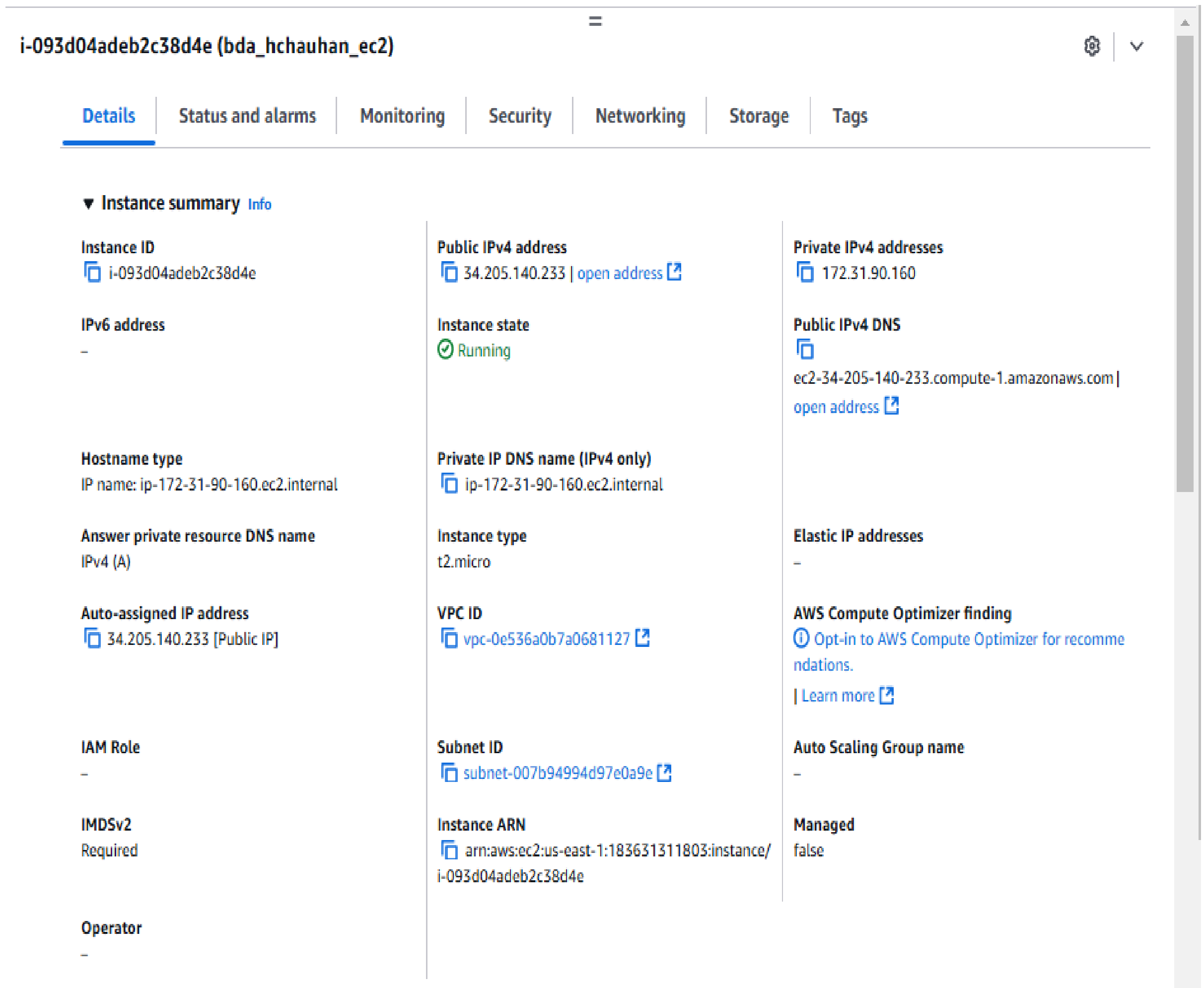
2. Linux Environment with PySpark

a. Step 1 : Setting up Ubuntu EC2 Instance.





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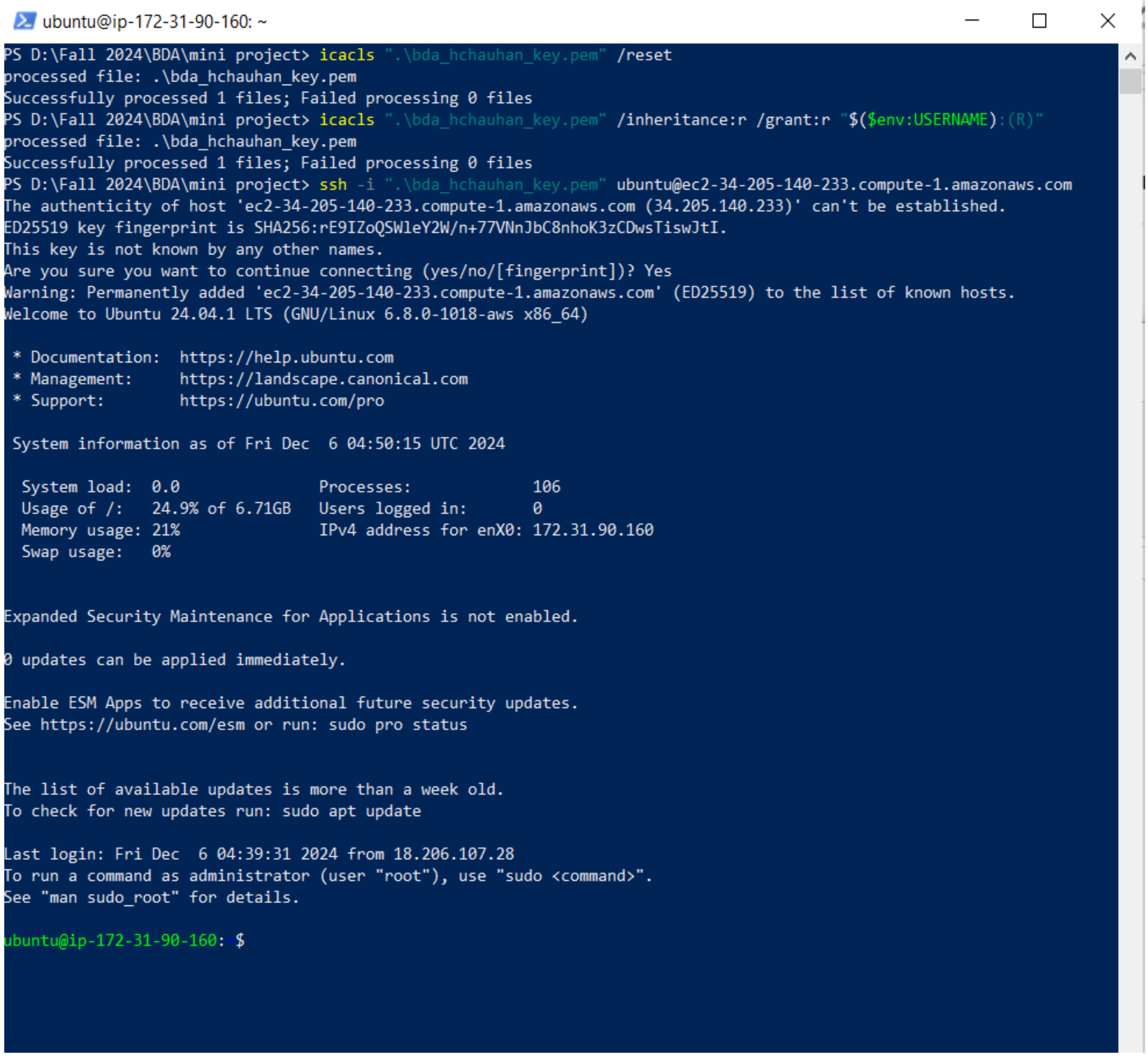
Established SSH connection:



```
ubuntu@ip-172-31-90-160: ~
PS D:\Fall 2024\BDA\mini project> icacls ".\bda_hchauhan_key.pem" /reset
processed file: .\bda_hchauhan_key.pem
Successfully processed 1 files; Failed processing 0 files
PS D:\Fall 2024\BDA\mini project> icacls ".\bda_hchauhan_key.pem" /inheritance:r /grant:r "$($env:USERNAME):(R)"
processed file: .\bda_hchauhan_key.pem
Successfully processed 1 files; Failed processing 0 files
PS D:\Fall 2024\BDA\mini project> ssh -i ".\bda_hchauhan_key.pem" ubuntu@ec2-34-205-140-233.compute-1.amazonaws.com
The authenticity of host 'ec2-34-205-140-233.compute-1.amazonaws.com (34.205.140.233)' can't be established.
ED25519 key fingerprint is SHA256:rE9IZoQSWleY2W/n+77VNnJbC8nhoK3zCDwsTiswJtI.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? Yes
Warning: Permanently added 'ec2-34-205-140-233.compute-1.amazonaws.com' (ED25519) to the list of known hosts.
Welcome to Ubuntu 24.04.1 LTS (GNU/Linux 6.8.0-1018-aws x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

 System information as of Fri Dec  6 04:50:15 UTC 2024

  System load:  0.0               Processes:             106
  Usage of /:   24.9% of 6.71GB   Users logged in:       0
  Memory usage: 21%               IPv4 address for enX0: 172.31.90.160
  Swap usage:   0%


Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

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


The list of available updates is more than a week old.
To check for new updates run: sudo apt update

Last login: Fri Dec  6 04:39:31 2024 from 18.206.107.28
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-90-160:~$
```

b. Step 2: Install PySpark for distributed data processing.

Installing Python on EC2 instance:

Name: Harsh Chauhan
Username: hchauhan

```
ubuntu@ip-172-31-90-160: ~
ubuntu@ip-172-31-90-160:~$ sudo apt install python3-venv python3-full
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  2to3 blt fontconfig-config fonts-dejavu-core fonts-dejavu-mono fonts-mathjax idle idle-python3.12 javascript-common
  libfontconfig1 libjs-jquery libjs-mathjax libjs-underscore libpython3.12-minimal libpython3.12-stdlib
  libpython3.12-testsuite libpython3.12t64 libtk8.6 libxft2 libxrender1 libxss1 net-tools python3-doc python3-examples
  python3-lib2to3 python3-pip-whl python3-setuptools-whl python3-tk python3.12 python3.12-doc python3.12-examples
  python3.12-full python3.12-minimal python3.12-venv tk8.6-blt2.5 x11-common
Suggested packages:
  blt-demo apache2 | lighttpd | httpd fonts-mathjax-extras fonts-stix libjs-mathjax-doc tk8.6 python3-dev tix
  python3-tk-dbg binutils python3.12-dev binfmt-support
The following NEW packages will be installed:
  2to3 blt fontconfig-config fonts-dejavu-core fonts-dejavu-mono fonts-mathjax idle idle-python3.12 javascript-common
  libfontconfig1 libjs-jquery libjs-mathjax libjs-underscore libpython3.12-testsuite libtk8.6 libxft2 libxrender1
  libxss1 net-tools python3-doc python3-examples python3-full python3-lib2to3 python3-pip-whl python3-setuptools-whl
  python3-tk python3-venv python3.12-doc python3.12-examples python3.12-full python3.12-venv tk8.6-blt2.5 x11-common
The following packages will be upgraded:
  libpython3.12-minimal libpython3.12-stdlib libpython3.12t64 python3.12 python3.12-minimal
5 upgraded, 33 newly installed, 0 to remove and 35 not upgraded.
Need to get 40.3 MB of archives.
After this operation, 163 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 libpython3.12t64 amd64 3.12.3-1ubuntu0.3 [
2333 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 python3.12 amd64 3.12.3-1ubuntu0.3 [651 kB
]
Get:3 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 libpython3.12-stdlib amd64 3.12.3-1ubuntu0
.3 [2068 kB]
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 python3.12-minimal amd64 3.12.3-1ubuntu0.3
 [2333 kB]
Get:5 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/main amd64 libpython3.12-minimal amd64 3.12.3-1ubuntu
0.3 [834 kB]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/universe amd64 python3-lib2to3 all 3.12.3-0ubuntu1 [78.0 kB]
Get:7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble-updates/universe amd64 2to3 all 3.12.3-0ubuntu2 [11.0 kB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 fonts-dejavu-mono all 2.37-8 [502 kB]
Get:9 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 fonts-dejavu-core all 2.37-8 [835 kB]
Get:10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 fontconfig-config amd64 2.15.0-1.1ubuntu2 [37.3 k
B]
Get:11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 libfontconfig1 amd64 2.15.0-1.1ubuntu2 [139 kB]
Get:12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 libxrender1 amd64 1:0.9.10-1.1build1 [19.0 kB]
Get:13 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 libxft2 amd64 2.3.6-1build1 [45.3 kB]
Get:14 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 x11-common all 1:7.7+23ubuntu3 [21.7 kB]
Get:15 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 libxss1 amd64 1:1.2.3-1build3 [7204 B]
Get:16 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 libtk8.6 amd64 8.6.14-1build1 [779 kB]
Get:17 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 tk8.6-blt2.5 amd64 2.5.3+dfsg-7build1 [630 kB]
Get:18 http://us-east-1.ec2.archive.ubuntu.com/ubuntu noble/main amd64 blt amd64 2.5.3+dfsg-7build1 [4840 B]
```

Installing PySpark on EC2 instance:

Name: Harsh Chauhan
Username: hchauhan

```
ubuntu@ip-172-31-90-160:~$ python3 -m venv ~/pyspark_env
ubuntu@ip-172-31-90-160:~$ source ~/pyspark_env/bin/activate
(pyspark_env) ubuntu@ip-172-31-90-160:~$ pip3 install pyspark
Collecting pyspark
  Downloading pyspark-3.5.3.tar.gz (317.3 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 317.3/317.3 MB 2.0 MB/s eta 0:00:00
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Preparing metadata (pyproject.toml) ... done
Collecting py4j==0.10.9.7 (from pyspark)
  Downloading py4j-0.10.9.7-py2.py3-none-any.whl.metadata (1.5 kB)
Downloading py4j-0.10.9.7-py2.py3-none-any.whl (200 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 200.5/200.5 kB 19.0 MB/s eta 0:00:00
Building wheels for collected packages: pyspark
  Building wheel for pyspark (pyproject.toml) ... done
  Created wheel for pyspark: filename=pyspark-3.5.3-py2.py3-none-any.whl size=317840629 sha256=545a7981a8c9ae25c9a952879385edb9dde5ed36d38c880017cb8d63f822e6e8
  Stored in directory: /home/ubuntu/.cache/pip/wheels/07/a0/a3/d24c94bf043ab5c7e38c30491199a2a11fef8d2584e6df7fb7
Successfully built pyspark
Installing collected packages: py4j, pyspark
Successfully installed py4j-0.10.9.7 pyspark-3.5.3
(pyspark_env) ubuntu@ip-172-31-90-160:~$
```

c. Step 3: Configure AWS CLI to interact with S3 buckets.

Installation of AWS CLI:

```
Windows PowerShell
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\USER> aws --version
aws-cli/2.22.12 Python/3.12.6 Windows/10 exe/AMD64
PS C:\Users\USER>
```

Name: Harsh Chauhan
Username: hchauhan

3. Data Pipeline Implementation:

Task 1: Data Ingestion From S3:
data-ingestion.py

Code:

ubuntu@ip-172-31-90-160: ~

```
  GNU nano 7.2                                                                    data-ingestion.py
from pyspark.sql import SparkSession

# Initialize Spark Session with S3 configurations
spark = SparkSession.builder \
    .appName("BDA_MiniProject") \
    .config("spark.jars.packages", "org.apache.hadoop:hadoop-aws:3.3.4") \
    .config("spark.hadoop.fs.s3a.access.key", "AKIASVQKHOO5U2ILKIAE") \
    .config("spark.hadoop.fs.s3a.secret.key", "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") \
    .config("spark.hadoop.fs.s3a.impl", "org.apache.hadoop.fs.s3a.S3AFileSystem") \
    .config("spark.hadoop.fs.s3a.aws.credentials.provider", "org.apache.hadoop.fs.s3a.SimpleAWSCredentialsProvider") \
    .getOrCreate()

# Read data from S3
s3_path = "s3a://bda-miniproject-hchauhan/Digital_Music.jsonl"
df = spark.read.json(s3_path)

# Basic Dataset Information
print("Dataset Overview:")
print(f"Number of rows: {df.count()}")
print(f"Number of columns: {len(df.columns)}")

# Display schema
print("\nDataset Schema:")
df.printSchema()

# Show sample data
print("\nSample Data:")
df.show(5)
```

Output:

ubuntu@ip-172-31-90-160: ~

```
(pyspark_env) ubuntu@ip-172-31-90-160:~$ python3 data-ingestion.py
:: loading settings :: url = jar:file:/home/ubuntu/pyspark_env/lib/python3.12/site-packages/pyspark/jars/ivy-2.5.1.jar!/org/apache/ivy/core/settings/ivysettings.xml
Ivy Default Cache set to: /home/ubuntu/.ivy2/cache
The jars for the packages stored in: /home/ubuntu/.ivy2/jars
org.apache.hadoop#hadoop-aws added as a dependency
:: resolving dependencies :: org.apache.spark#spark-submit-parent-47582e15-e102-445c-bdb5-939231e122e5;1.0
        confs: [default]
        found org.apache.hadoop#hadoop-aws;3.3.4 in central
        found com.amazonaws#aws-java-sdk-bundle;1.12.262 in central
        found org.wildfly.openssl#wildfly-openssl;1.0.7.Final in central
:: resolution report :: resolve 548ms :: artifacts dl 20ms
        :: modules in use:
        com.amazonaws#aws-java-sdk-bundle;1.12.262 from central in [default]
        org.apache.hadoop#hadoop-aws;3.3.4 from central in [default]
        org.wildfly.openssl#wildfly-openssl;1.0.7.Final from central in [default]
        ---------------------------------------------------------------------
        |                  |            modules            ||   artifacts   |
        |       conf       | number| search|dwnlded|evicted|| number|dwnlded|
        ---------------------------------------------------------------------
        |      default     |   3   |   0   |   0   |   0   ||   3   |   0   |
        ---------------------------------------------------------------------
:: retrieving :: org.apache.spark#spark-submit-parent-47582e15-e102-445c-bdb5-939231e122e5
        confs: [default]
        0 artifacts copied, 3 already retrieved (0kB/14ms)
24/12/06 23:03:47 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
24/12/06 23:04:05 ERROR Inbox: Ignoring error
org.apache.spark.SparkException: Exception thrown in awaitResult:
        at org.apache.spark.util.SparkThreadUtils$.awaitResult(SparkThreadUtils.scala:56)
        at org.apache.spark.util.ThreadUtils$.awaitResult(ThreadUtils.scala:310)
```

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Username: hchauhan

```
24/12/06 23:04:08 WARN MetricsConfig: Cannot locate configuration: tried hadoop-metrics2-s3a-file-system.properties,hadoop-metrics2.properties
Dataset Overview:
Number of rows: 130434
Number of columns: 10

Dataset Schema:
root
 |-- asin: string (nullable = true)
 |-- helpful_vote: long (nullable = true)
 |-- images: array (nullable = true)
 |    |-- element: struct (containsNull = true)
 |    |    |-- attachment_type: string (nullable = true)
 |    |    |-- large_image_url: string (nullable = true)
 |    |    |-- medium_image_url: string (nullable = true)
 |    |    |-- small_image_url: string (nullable = true)
 |-- parent_asin: string (nullable = true)
 |-- rating: double (nullable = true)
 |-- text: string (nullable = true)
 |-- timestamp: long (nullable = true)
 |-- title: string (nullable = true)
 |-- user_id: string (nullable = true)
 |-- verified_purchase: boolean (nullable = true)


Sample Data:
+----------+------------+------+-----------+------+--------------------+-------------+--------------------+--------------------+-----------------+
|      asin|helpful_vote|images|parent_asin|rating|                text|    timestamp|               title|             user_id|verified_purchase|
+----------+------------+------+-----------+------+--------------------+-------------+--------------------+--------------------+-----------------+
|B004RQ2IRG|           0|    []| B004RQ2IRG|   5.0|If i had a dollar...|1618972613292|                Nice|AFUOYIZBU3MTBOLYK...|             true|
|B0026UZEI0|           0|    []| B0026UZEI0|   5.0|awesome sound - c...|1308167525000|           Excellent|AHGAOIZVODNHYMNCB...|             true|
|B0055JSYHC|           0|    []| B0055JSYHC|   5.0|This is a great c...|1615838793006|       Great service|AFGEM6BXCYHUILEOA...|             true|
|B000F9SMUQ|           0|    []| B000F9SMUQ|   1.0|These are not rea...|1405219741000|             No good|AH3OG6QD6EDJGZRVC...|             true|
|B0049D1WVK|           0|    []| B0049D1WVK|   3.0|I first heard thi...|1309029595000|Cool concept, so-...|AFW2PDT3AMT4X3PYQ...|            false|
+----------+------------+------+-----------+------+--------------------+-------------+--------------------+--------------------+-----------------+
only showing top 5 rows

(pyspark_env) ubuntu@ip-172-31-90-160:~$ 
```

Task 2: Data Processing With PySpark.

1) Data Transformation: Year , Month Transformation

year_month_transformation.py

Code:

```
ubuntu@ip-172-31-90-160: ~
  GNU nano 7.2                                                          year_month_transformation.py
from pyspark.sql import SparkSession
from pyspark.sql.functions import from_unixtime, year, month

# Initialize Spark Session with S3 configurations
spark = SparkSession.builder \
    .appName("BDA_MiniProject") \
    .config("spark.jars.packages", "org.apache.hadoop:hadoop-aws:3.3.4") \
    .config("spark.hadoop.fs.s3a.access.key", "AKIASVQKHOO5U2ILKIAE") \
    .config("spark.hadoop.fs.s3a.secret.key", "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") \
    .config("spark.hadoop.fs.s3a.impl", "org.apache.hadoop.fs.s3a.S3AFileSystem") \
    .config("spark.hadoop.fs.s3a.aws.credentials.provider", "org.apache.hadoop.fs.s3a.SimpleAWSCredentialsProvider") \
    .getOrCreate()

# Read data from S3
s3_path = "s3a://bda-miniproject-hchauhan/Digital_Music.jsonl"
df = spark.read.json(s3_path)

# Transform timestamp to year and month
df_transformed = df \
    .withColumn("review_date", from_unixtime(df.timestamp/1000)) \
    .withColumn("year", year("review_date")) \
    .withColumn("month", month("review_date"))

# Select columns excluding 'images'
df_transformed_simple = df_transformed.select(
    'asin', 'helpful_vote', 'parent_asin', 'rating', 'text',
    'timestamp', 'title', 'user_id', 'verified_purchase',
    'review_date', 'year', 'month'
)

# Show transformed data
print("Transformed Data Sample:")
df_transformed_simple.show(5)

# Write to CSV
df_transformed_simple.write.option("header", "true").csv("transformed_data", mode="overwrite")
```

Name: Harsh Chauhan
Username: hchauhan

Output:

```
(pyspark_env) ubuntu@ip-172-31-90-160:~$ (pyspark_env) ubuntu@ip-172-31-90-160:~$ python3 year_month_transformation.py
:: loading settings :: url = jar:file:/home/ubuntu/pyspark_env/lib/python3.12/site-packages/pyspark/jars/ivy-2.5.1.jar!/org/apache/ivy/core/settings/ivysettings.xml
Ivy Default Cache set to: /home/ubuntu/.ivy2/cache
The jars for the packages stored in: /home/ubuntu/.ivy2/jars
org.apache.hadoop#hadoop-aws added as a dependency
:: resolving dependencies :: org.apache.spark#spark-submit-parent-d5fa02bf-d638-481d-92da-b3ed6b6ec70d;1.0
        confs: [default]
        found org.apache.hadoop#hadoop-aws;3.3.4 in central
        found com.amazonaws#aws-java-sdk-bundle;1.12.262 in central
        found org.wildfly.openssl#wildfly-openssl;1.0.7.Final in central
:: resolution report :: resolve 571ms :: artifacts dl 25ms
        :: modules in use:
        com.amazonaws#aws-java-sdk-bundle;1.12.262 from central in [default]
        org.apache.hadoop#hadoop-aws;3.3.4 from central in [default]
        org.wildfly.openssl#wildfly-openssl;1.0.7.Final from central in [default]
        ---------------------------------------------------------------------
        |                  |            modules            ||   artifacts   |
        |       conf       | number| search|dwnlded|evicted|| number|dwnlded|
        ---------------------------------------------------------------------
        |      default     |   3   |   0   |   0   |   0   ||   3   |   0   |
        ---------------------------------------------------------------------
:: retrieving :: org.apache.spark#spark-submit-parent-d5fa02bf-d638-481d-92da-b3ed6b6ec70d
        confs: [default]
        0 artifacts copied, 3 already retrieved (0kB/13ms)
24/12/06 23:24:59 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
24/12/06 23:25:19 WARN MetricsConfig: Cannot locate configuration: tried hadoop-metrics2-s3a-file-system.properties,hadoop-metrics2.properties
Transformed Data Sample:
+----------+------------+-----------+------+--------------------+-------------+--------------------+--------------------+-----------------+-------------------+----+-----+
|      asin|helpful_vote|parent_asin|rating|                text|    timestamp|               title|             user_id|verified_purchase|        review_date|year|month|
+----------+------------+-----------+------+--------------------+-------------+--------------------+--------------------+-----------------+-------------------+----+-----+
|B004RQ2IRG|           0| B004RQ2IRG|   5.0|If i had a dollar...|1618972613292|                Nice|AFUOYIZBU3MTBOLYK...|             true|2021-04-21 02:36:53|2021|    4|
|B0026UZEI0|           0| B0026UZEI0|   5.0|awesome sound - c...|1308167525000|           Excellent|AHGAOIZVODNHYMNCB...|             true|2011-06-15 19:52:05|2011|    6|
|B0055JSYHC|           0| B0055JSYHC|   5.0|This is a great c...|1615838793006|       Great service|AFGEM6BXCYHUILEOA...|             true|2021-03-15 20:06:33|2021|    3|
|B000F9SMUQ|           0| B000F9SMUQ|   1.0|These are not rea...|1405219741000|             No good|AH3OG6QD6EDJGZRVC...|             true|2014-07-13 02:49:01|2014|    7|
|B0049D1WVK|           0| B0049D1WVK|   3.0|I first heard thi...|1309029595000|Cool concept, so-...|AFW2PDT3AMT4X3PYQ...|            false|2011-06-25 19:19:55|2011|    6|
+----------+------------+-----------+------+--------------------+-------------+--------------------+--------------------+-----------------+-------------------+----+-----+
only showing top 5 rows
```

2) Data Aggregration:

The 5 key Metric performed are as follows:

- Rating Distribution by Year
  Shows the average ratings and total review count for each year, helping track how product satisfaction has evolved over time. This metric reveals long-term trends in customer satisfaction.

- Helpful Vote Analysis by Rating
  Analyzes the relationship between rating scores (1-5) and helpful votes, showing which ratings tend to be considered most helpful by other users. This helps understand community engagement with different types of reviews.

- Verified Purchase Impact
  Compares ratings between verified and non-verified purchases across years, helping assess the credibility and potential bias in reviews. The sample shows both true/false verification status.

- Monthly Review Volume

Name: Harsh Chauhan
Username: hchauhan

Tracks the number of reviews submitted each month across different years, revealing seasonal patterns and overall review activity trends.

- Top Reviewers Analysis
  Identifies the most active reviewers based on review count, average rating, and helpful votes, helping understand user engagement patterns.

Code:

```
ubuntu@ip-172-31-90-160: ~
  GNU nano 7.2                                                                    data_aggregration.py
from pyspark.sql import SparkSession
from pyspark.sql.functions import from_unixtime, year, month, avg, count, desc

spark = SparkSession.builder \
    .appName("BDA_MiniProject") \
    .config("spark.jars.packages", "org.apache.hadoop:hadoop-aws:3.3.4") \
    .config("spark.hadoop.fs.s3a.access.key", "AKIASVQKHOO5U2ILKIAE") \
    .config("spark.hadoop.fs.s3a.secret.key", "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") \
    .config("spark.hadoop.fs.s3a.impl", "org.apache.hadoop.fs.s3a.S3AFileSystem") \
    .config("spark.hadoop.fs.s3a.aws.credentials.provider", "org.apache.hadoop.fs.s3a.SimpleAWSCredentialsProvider") \
    .getOrCreate()

# Read data from S3
df = spark.read.json("s3a://bda-miniproject-hchauhan/Digital_Music.jsonl")
df_transformed_simple = spark.read.csv("transformed_data", header=True)

# 1. Rating Distribution by Year
yearly_ratings = df_transformed_simple.groupBy("year") \
    .agg(avg("rating").alias("avg_rating"), count("*").alias("review_count")) \
    .orderBy("year")
print("\n1. Rating Distribution by Year:")
yearly_ratings.show()

# 2. Helpful Vote Analysis by Rating
helpful_votes_analysis = df_transformed_simple.groupBy("rating") \
    .agg(avg("helpful_vote").alias("avg_helpful_votes"), count("*").alias("total_reviews")) \
    .orderBy("rating")
print("\n2. Helpful Vote Analysis by Rating:")
helpful_votes_analysis.show()

# 3. Verified Purchase Impact
verified_impact = df_transformed_simple.groupBy("verified_purchase", "year") \
    .agg(avg("rating").alias("avg_rating"), count("*").alias("review_count")) \
    .orderBy("year", "verified_purchase")
print("\n3. Verified Purchase Impact by Year:")
verified_impact.show()

# 4. Monthly Review Volume
monthly_volume = df_transformed_simple.groupBy("year", "month") \
    .agg(count("*").alias("review_count")) \
    .orderBy("year", "month")
print("\n4. Monthly Review Volume:")
monthly_volume.show()

# 5. Top Reviewers Analysis
top_reviewers = df_transformed_simple.groupBy("user_id") \
    .agg(count("*").alias("review_count"),
         avg("rating").alias("avg_rating"),
         avg("helpful_vote").alias("avg_helpful_votes")) \
    .orderBy(desc("review_count")) \
    .limit(10)
```


```
# 5. Top Reviewers Analysis
top_reviewers = df_transformed_simple.groupBy("user_id") \
    .agg(count("*").alias("review_count"),
         avg("rating").alias("avg_rating"),
         avg("helpful_vote").alias("avg_helpful_votes")) \
    .orderBy(desc("review_count")) \
    .limit(10)
```


```
print("\n5. Top Reviewers Analysis:")
top_reviewers.show()
```

Name: Harsh Chauhan
Username: hchauhan

Output:

1) Rating Distribution By Year:

1. Rating Distribution by Year:

year	avg_rating	review_count
1997	5.0	2
1998	4.666666666666667	21
1999	4.5256410256410255	78
2000	4.346153846153846	416
2001	4.275773195876289	388
2002	3.9575757575757575	660
2003	4.368852459016393	244
2004	4.4534005037783375	397
2005	4.404150197628459	1012
2006	4.477292965271594	1123
2007	4.454377311960543	1622
2008	4.434092112228693	1889
2009	4.4973776223776225	2288
2010	4.508384146341464	2624
2011	4.412309530923215	3347
2012	4.518949771689497	4380
2013	4.526229315808004	8521
2014	4.526788741946422	11796
2015	4.614016736401673	14340
2016	4.578699840703937	13183

only showing top 20 rows

2) Helpful Vote Analysis by Rating:

2. Helpful Vote Analysis by Rating:

rating	avg_helpful_votes	total_reviews
1.0	1.6851368970013039	6136
2.0	1.4713516935739157	3159
3.0	1.1760012515644556	6392
4.0	1.3267039422464435	14129
5.0	0.9447613747043273	100618

3) Verified Purchase Impact by Year:

Name: Harsh Chauhan
Username: hchauhan

3. Verified Purchase Impact by Year:

verified_purchase	year	avg_rating	review_count
false	1997	5.0	2
false	1998	4.65	20
true	1998	5.0	1
false	1999	4.51948051948052	77
true	1999	5.0	1
false	2000	4.338383838383838	396
true	2000	4.5	20
false	2001	4.254794520547946	365
true	2001	4.608695652173913	23
false	2002	3.949675324675325	616
true	2002	4.068181818181818	44
false	2003	4.358078602620087	229
true	2003	4.533333333333333	15
false	2004	4.510695187165775	374
true	2004	3.5217391304347827	23
false	2005	4.41044776119403	938
true	2005	4.324324324324325	74
false	2006	4.503913894324853	1022
true	2006	4.207920792079208	101
false	2007	4.495633187772926	1374

only showing top 20 rows

4) Monthly Review Volume:

4. Monthly Review Volume:

year	month	review_count
1997	12	1
1997	9	1
1998	10	2
1998	11	2
1998	12	5
1998	4	1
1998	6	2
1998	7	2
1998	8	3
1998	9	4
1999	1	1
1999	10	11
1999	11	13
1999	12	14
1999	2	3
1999	3	4
1999	4	4
1999	5	6
1999	6	4
1999	7	3

only showing top 20 rows

Name: Harsh Chauhan
Username: hchauhan

5) Top Review Analysis:

```
5. Top Reviewers Analysis:
+--------------------+------------+------------------+-------------------+
|             user_id|review_count|        avg_rating|  avg_helpful_votes|
+--------------------+------------+------------------+-------------------+
|AGAFM74L2RIJ5O36N...|         341| 3.865102639296188| 1.6070381231671553|
|AEDFM4VDH2MKYVBKG...|         182| 1.043956043956044| 1.4725274725274726|
|AH3FC6V3IUJIN2Y7B...|         175|4.9314285714285715|                1.4|
|AEFLICXXHRBMNT4HA...|         136|3.8676470588235294| 0.8235294117647058|
|AFMUUMXTKB6C52CCE...|         130| 4.553846153846154|0.36153846153846153|
|AEIOEJHOTKH6PKPVP...|         126| 4.325396825396825| 0.5476190476190477|
|AEBMZ7Q2F2EHZ4CTO...|         113| 4.584070796460177| 0.4336283185840708|
|AGS3YH5GKIZCIPYFF...|         111|               5.0| 2.9279279279279278|
|AEKGXJDXUVQKHP55J...|          95|4.4526315789473685|0.30526315789473685|
|AE6CHAOE2U5GBCM34...|          83| 4.506024096385542| 1.1325301204819278|
+--------------------+------------+------------------+-------------------+
```

Task 3: Store Processed Data back to S3:

Step 1: Saving metrics to csv
file_to_csv.py

Code:

Name: Harsh Chauhan
Username: hchauhan

```
ubuntu@ip-172-31-90-160: ~
 GNU nano 7.2                                   file_to_csv.py
from pyspark.sql import SparkSession
from pyspark.sql.functions import avg, count, desc

# Initialize Spark session
spark = SparkSession.builder \
    .appName("BDA_MiniProject") \
    .config("spark.jars.packages", "org.apache.hadoop:hadoop-aws:3.3.4") \
    .config("spark.hadoop.fs.s3a.access.key", "AKIASVQKHOO5U2ILKIAE") \
    .config("spark.hadoop.fs.s3a.secret.key", "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") \
    .config("spark.hadoop.fs.s3a.impl", "org.apache.hadoop.fs.s3a.S3AFileSystem") \
    .config("spark.hadoop.fs.s3a.aws.credentials.provider", "org.apache.hadoop.fs.s3a.SimpleAWSCredentialsProvider")>
    .getOrCreate()

# Read data from S3
df = spark.read.json("s3a://bda-miniproject-hchauhan/Digital_Music.jsonl")
df_transformed_simple = spark.read.csv("transformed_data", header=True)

# 1. Rating Distribution by Year
yearly_ratings = df_transformed_simple.groupBy("year") \
    .agg(avg("rating").alias("avg_rating"), count("*").alias("review_count")) \
    .orderBy("year")
yearly_ratings.write.csv('yearly_ratings', header=True, mode='overwrite')
print("Successfully saved yearly_ratings.csv")

# 2. Helpful Vote Analysis by Rating
helpful_votes_analysis = df_transformed_simple.groupBy("rating") \
    .agg(avg("helpful_vote").alias("avg_helpful_votes"), count("*").alias("total_reviews")) \
    .orderBy("rating")
helpful_votes_analysis.write.csv('helpful_votes_analysis', header=True, mode='overwrite')
print("Successfully saved helpful_votes_analysis.csv")

# 3. Verified Purchase Impact by Year
verified_impact = df_transformed_simple.groupBy("verified_purchase", "year") \
    .agg(avg("rating").alias("avg_rating"), count("*").alias("review_count")) \
    .orderBy("year", "verified_purchase")
verified_impact.write.csv('verified_impact', header=True, mode='overwrite')
print("Successfully saved verified_impact.csv")

# 4. Monthly Review Volume
monthly_volume = df_transformed_simple.groupBy("year", "month") \
    .agg(count("*").alias("review_count")) \
    .orderBy("year", "month")
monthly_volume.write.csv('monthly_volume', header=True, mode='overwrite')
print("Successfully saved monthly_volume.csv")

# 5. Top Reviewers Analysis
top_reviewers = df_transformed_simple.groupBy("user_id") \
    .agg(count("*").alias("review_count"),
         avg("rating").alias("avg_rating"),
         avg("helpful_vote").alias("avg_helpful_votes")) \
    .orderBy(desc("review_count")) \
```

```
# 5. Top Reviewers Analysis
top_reviewers = df_transformed_simple.groupBy("user_id") \
    .agg(count("*").alias("review_count"),
         avg("rating").alias("avg_rating"),
         avg("helpful_vote").alias("avg_helpful_votes")) \
    .orderBy(desc("review_count")) \
    .limit(10)
top_reviewers.write.csv('top_reviewers', header=True, mode='overwrite')
print("Successfully saved top_reviewers.csv")
```

Output:

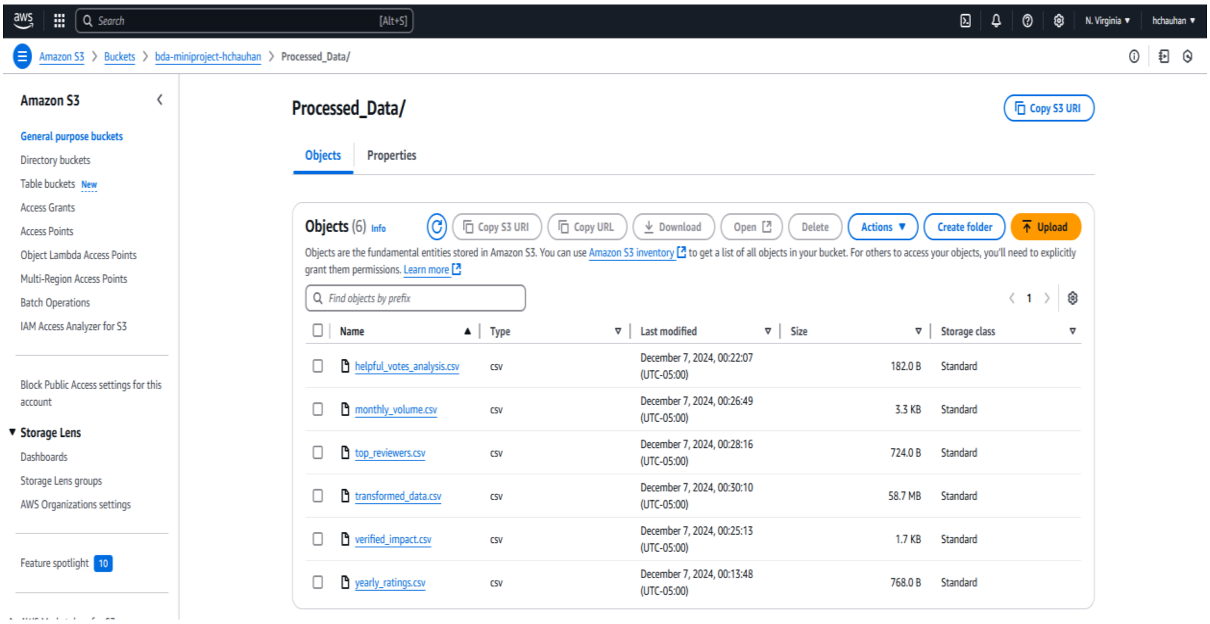
Name: Harsh Chauhan
Username: hchauhan

```
(pyspark_env) ubuntu@ip-172-31-90-160:~$ (pyspark_env) ubuntu@ip-172-31-90-160:~$ python3 file_to_csv.py
:: loading settings :: url = jar:file:/home/ubuntu/pyspark_env/lib/python3.12/site-packages/pyspark/jars/ivy-2.5.1.ja
r!/org/apache/ivy/core/settings/ivysettings.xml
Ivy Default Cache set to: /home/ubuntu/.ivy2/cache
The jars for the packages stored in: /home/ubuntu/.ivy2/jars
org.apache.hadoop#hadoop-aws added as a dependency
:: resolving dependencies :: org.apache.spark#spark-submit-parent-90048e76-6770-4403-9270-187b9b6f65f9;1.0
        confs: [default]
        found org.apache.hadoop#hadoop-aws;3.3.4 in central
        found com.amazonaws#aws-java-sdk-bundle;1.12.262 in central
        found org.wildfly.openssl#wildfly-openssl;1.0.7.Final in central
:: resolution report :: resolve 609ms :: artifacts dl 23ms
        :: modules in use:
        com.amazonaws#aws-java-sdk-bundle;1.12.262 from central in [default]
        org.apache.hadoop#hadoop-aws;3.3.4 from central in [default]
        org.wildfly.openssl#wildfly-openssl;1.0.7.Final from central in [default]
        ---------------------------------------------------------------------
        |                  |            modules            ||   artifacts   |
        |       conf       | number| search|dwnlded|evicted|| number|dwnlded|
        ---------------------------------------------------------------------
        |      default     |   3   |   0   |   0   |   0   ||   3   |   0   |
        ---------------------------------------------------------------------
:: retrieving :: org.apache.spark#spark-submit-parent-90048e76-6770-4403-9270-187b9b6f65f9
        confs: [default]
        0 artifacts copied, 3 already retrieved (0kB/12ms)
24/12/07 05:10:35 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java
 classes where applicable
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
24/12/07 05:10:57 WARN MetricsConfig: Cannot locate configuration: tried hadoop-metrics2-s3a-file-system.properties,h
adoop-metrics2.properties
Successfully saved yearly_ratings.csv
Successfully saved helpful_votes_analysis.csv
Successfully saved verified_impact.csv
Successfully saved monthly_volume.csv
Successfully saved top_reviewers.csv
```

Moving these csv files to new S3 folder along with transformed_data:

```
(pyspark_env) ubuntu@ip-172-31-90-160:~$ ls yearly_ratings
_SUCCESS  part-00000-dd51cbe0-dc1e-4016-a29d-15d202c350e5-c000.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ mv yearly_ratings/part-00000-*.csv yearly_ratings.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ aws s3 cp yearly_ratings.csv s3://bda-miniproject-hchauhan/Processed_Data/
upload: ./yearly_ratings.csv to s3://bda-miniproject-hchauhan/Processed_Data/yearly_ratings.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ mv helpful_votes_analysis/part-00000-*.csv helpful_votes_analysis.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ aws s3 cp helpful_votes_analysis.csv s3://bda-miniproject-hchauhan/Processed
_Data/
upload: ./helpful_votes_analysis.csv to s3://bda-miniproject-hchauhan/Processed_Data/helpful_votes_analysis.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ mv verified_impact/part-00000-*.csv verified_impact.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ aws s3 cp verified_impact.csv s3://bda-miniproject-hchauhan/Processed_Data/
upload: ./verified_impact.csv to s3://bda-miniproject-hchauhan/Processed_Data/verified_impact.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ mv monthly_volume/part-00000-*.csv monthly_volume.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ aws s3 cp monthly_volume.csv s3://bda-miniproject-hchauhan/Processed_Data/
upload: ./monthly_volume.csv to s3://bda-miniproject-hchauhan/Processed_Data/monthly_volume.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ mv top_reviewers/part-00000-*.csv top_reviewers.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ aws s3 cp top_reviewers.csv s3://bda-miniproject-hchauhan/Processed_Data/
upload: ./top_reviewers.csv to s3://bda-miniproject-hchauhan/Processed_Data/top_reviewers.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ mv transformed_data/part-00000-*.csv transformed_data.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$ aws s3 cp transformed_data.csv s3://bda-miniproject-hchauhan/Processed_Data/
upload: ./transformed_data.csv to s3://bda-miniproject-hchauhan/Processed_Data/transformed_data.csv
(pyspark_env) ubuntu@ip-172-31-90-160:~$
```

Name: Harsh Chauhan
Username: hchauhan



Task 4 : Data Analysis With Spark SQL:

Code:

```
ubuntu@ip-172-31-90-160: ~
  GNU nano 7.2                                          sql_analysis.py
from pyspark.sql import SparkSession
from pyspark.sql.functions import from_unixtime, year, month

# Initialize Spark Session
spark = SparkSession.builder \
    .appName("BDA_MiniProject") \
    .config("spark.jars.packages", "org.apache.hadoop:hadoop-aws:3.3.4") \
    .config("spark.hadoop.fs.s3a.access.key", "AKIASVQKHOO5U2ILKIAE") \
    .config("spark.hadoop.fs.s3a.secret.key", "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") \
    .config("spark.hadoop.fs.s3a.impl", "org.apache.hadoop.fs.s3a.S3AFileSystem") \
    .config("spark.hadoop.fs.s3a.aws.credentials.provider", "org.apache.hadoop.fs.s3a.SimpleAWSCredentialsProvider") \
    .getOrCreate()

# Load the transformed data
df = spark.read.csv("s3a://bda-miniproject-hchauhan/Processed_Data/transformed_data.csv", header=True)

# Create temporary view for SQL queries
df.createOrReplaceTempView("digital_music")

# 1. Top-Rated Products Analysis
query1 = """
SELECT asin, title,
       AVG(CAST(rating AS DOUBLE)) as avg_rating,
       COUNT(*) as review_count
FROM digital_music
GROUP BY asin, title
HAVING COUNT(*) > 10
ORDER BY avg_rating DESC
LIMIT 5
"""

# 2. Monthly Review Growth Analysis
query2 = """
SELECT year, month,
       COUNT(*) as review_count,
       LAG(COUNT(*)) OVER (PARTITION BY year ORDER BY month) as prev_month_count
FROM digital_music
GROUP BY year, month
ORDER BY year, month
"""
```

Name: Harsh Chauhan
Username: hchauhan

ubuntu@ip-172-31-90-160: ~

GNU nano 7.2 sql_analysis.py

```
# 3. Verified vs Non-Verified Purchase Impact
query3 = """
SELECT verified_purchase,
       AVG(CAST(rating AS DOUBLE)) as avg_rating,
       COUNT(*) as total_reviews,
       AVG(CAST(helpful_vote AS DOUBLE)) as avg_helpful_votes
FROM digital_music
GROUP BY verified_purchase
"""

# 4. Most Helpful Reviews Analysis
query4 = """
SELECT user_id, rating, title, helpful_vote
FROM digital_music
WHERE CAST(helpful_vote AS INT) > 0
ORDER BY CAST(helpful_vote AS INT) DESC
LIMIT 10
"""

# 5. Yearly Rating Distribution
query5 = """
SELECT year,
       COUNT(*) as total_reviews,
       AVG(CAST(rating AS DOUBLE)) as avg_rating,
       COUNT(CASE WHEN CAST(rating AS DOUBLE) >= 4 THEN 1 END) as positive_reviews
FROM digital_music
GROUP BY year
ORDER BY year
"""

# Execute and display results
print("\nExecuting SQL Queries for Digital Music Analysis:")

queries = [query1, query2, query3, query4, query5]
titles = [
    "Top-Rated Products Analysis",
    "Monthly Review Growth Analysis",
    "Verified vs Non-Verified Purchase Impact",
    "Most Helpful Reviews Analysis",
    "Yearly Rating Distribution"
]

for i, (query, title) in enumerate(zip(queries, titles), 1):
    print(f"\n{i}. {title}:")
    spark.sql(query).show(truncate=False)
```

Name: Harsh Chauhan
Username: hchauhan

Output:

```
(pyspark_env) ubuntu@ip-172-31-90-160:~$ (pyspark_env) ubuntu@ip-172-31-90-160:~$ python3 sql_analysis.py
:: loading settings :: url = jar:file:/home/ubuntu/pyspark_env/lib/python3.12/site-packages/pyspark/jars/ivy-2.5.1.jar!/
org/apache/ivy/core/settings/ivysettings.xml
Ivy Default Cache set to: /home/ubuntu/.ivy2/cache
The jars for the packages stored in: /home/ubuntu/.ivy2/jars
org.apache.hadoop#hadoop-aws added as a dependency
:: resolving dependencies :: org.apache.spark#spark-submit-parent-ac91b3e4-309f-4293-b835-0ff69073592f;1.0
        confs: [default]
        found org.apache.hadoop#hadoop-aws;3.3.4 in central
        found com.amazonaws#aws-java-sdk-bundle;1.12.262 in central
        found org.wildfly.openssl#wildfly-openssl;1.0.7.Final in central
:: resolution report :: resolve 550ms :: artifacts dl 14ms
        :: modules in use:
        com.amazonaws#aws-java-sdk-bundle;1.12.262 from central in [default]
        org.apache.hadoop#hadoop-aws;3.3.4 from central in [default]
        org.wildfly.openssl#wildfly-openssl;1.0.7.Final from central in [default]
        ---------------------------------------------------------------------
        |                  |            modules            ||   artifacts   |
        |       conf       | number| search|dwnlded|evicted|| number|dwnlded|
        ---------------------------------------------------------------------
        |      default     |   3   |   0   |   0   |   0   ||   3   |   0   |
        ---------------------------------------------------------------------
:: retrieving :: org.apache.spark#spark-submit-parent-ac91b3e4-309f-4293-b835-0ff69073592f
        confs: [default]
        0 artifacts copied, 3 already retrieved (0kB/14ms)
24/12/07 06:54:04 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java cl
asses where applicable
Setting default log level to "WARN".
To adjust logging level use sc.setLogLevel(newLevel). For SparkR, use setLogLevel(newLevel).
24/12/07 06:54:26 WARN MetricsConfig: Cannot locate configuration: tried hadoop-metrics2-s3a-file-system.properties,hado
op-metrics2.properties

Executing SQL Queries for Digital Music Analysis:

1. Top-Rated Products Analysis:
+----------+----------+----------+------------+
|asin      |title     |avg_rating|review_count|
+----------+----------+----------+------------+
|B001EJH4SW|Five Stars|5.0       |30          |
|B0009PUCUE|Five Stars|5.0       |34          |
|B00ZUPPH5S|Five Stars|5.0       |17          |
|B00PG5G5QC|Five Stars|5.0       |15          |
|B00IKM5NZC|Five Stars|5.0       |15          |
+----------+----------+----------+------------+
```

Name: Harsh Chauhan
Username: hchauhan

2. Monthly Review Growth Analysis:

year	month	review_count	prev_month_count
1997	12	1	NULL
1997	9	1	1
1998	10	2	NULL
1998	11	2	2
1998	12	5	2
1998	4	1	5
1998	6	2	1
1998	7	2	2
1998	8	3	2
1998	9	4	3
1999	1	1	NULL
1999	10	11	1
1999	11	13	11
1999	12	14	13
1999	2	3	14
1999	3	4	3
1999	4	4	4
1999	5	6	4
1999	6	4	6
1999	7	3	4

only showing top 20 rows

3. Verified vs Non-Verified Purchase Impact:

verified_purchase	avg_rating	total_reviews	avg_helpful_votes
false	4.411412458940147	34401	1.904072556030348
true	4.576333135484677	96033	0.7373298761883935

4. Most Helpful Reviews Analysis:

user_id	rating	title	helpful_vote
AFCRT2KE2N5P4VSA7MY74SGRV6AA	2.0	Overpriced for what you get.	259
AGAWJK3Z57FRGCVR5TNWIQIDQ2SA	5.0	Let's set the record straight...	213
AHVIMKECEZDXXK5QIGX7KWJPN6DQ	4.0	A Grimm, Grimm tale	191
AGK5K3EAMWHSIPWG2VXJP7W32M7Q	4.0	1991 Gramophone Award Winner	162
AGY3BQJXYGHK7OVCFHCEXBCIWPNA	5.0	ANTHOLOGY 1 - MAINLY FOR BEATLES FANS AND COLLECTORS ONLY	160
AFPRDHJPDFDTVOSZKAE5F2U56LBQ	5.0	The Clash of Titans	157
AH64C6DXEZN3IMX4W2SDHXKJP5GA	1.0	Where are the "Unleashing" techniques?	148
AH2NK6SZGQXS6NSD4VVP2OU4HTWA	5.0	Beyond Awesome!	141
AHSF3JIVAMNDRI7PLZ7373VXISHA	5.0	The Two Origins	140
AFIV4IC7VU6FRI364KGJKBPXXJFA	4.0	Bodes well for Clooney's future behind the camera!	130

5. Yearly Rating Distribution:

year	total_reviews	avg_rating	positive_reviews
1997	2	5.0	2
1998	21	4.666666666666667	20
1999	78	4.5256410256410255	70
2000	416	4.346153846153846	349
2001	388	4.275773195876289	317
2002	660	3.9575757575757575	473
2003	244	4.368852459016393	206
2004	397	4.4534005037783375	345
2005	1012	4.404150197628459	861
2006	1123	4.477292965271594	979
2007	1622	4.454377311960543	1422
2008	1889	4.434092112228693	1641
2009	2288	4.4973776223776225	2013
2010	2624	4.508384146341464	2331
2011	3347	4.412309530923215	2867
2012	4380	4.518949771689497	3868
2013	8521	4.526229315808004	7483
2014	11796	4.526788741946422	10369
2015	14340	4.614016736401673	12915
2016	13183	4.578699840703937	11781

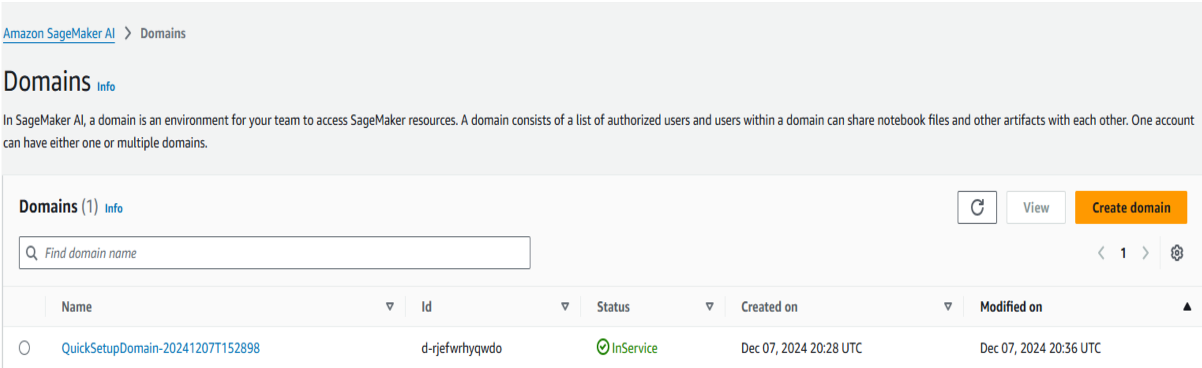
only showing top 20 rows

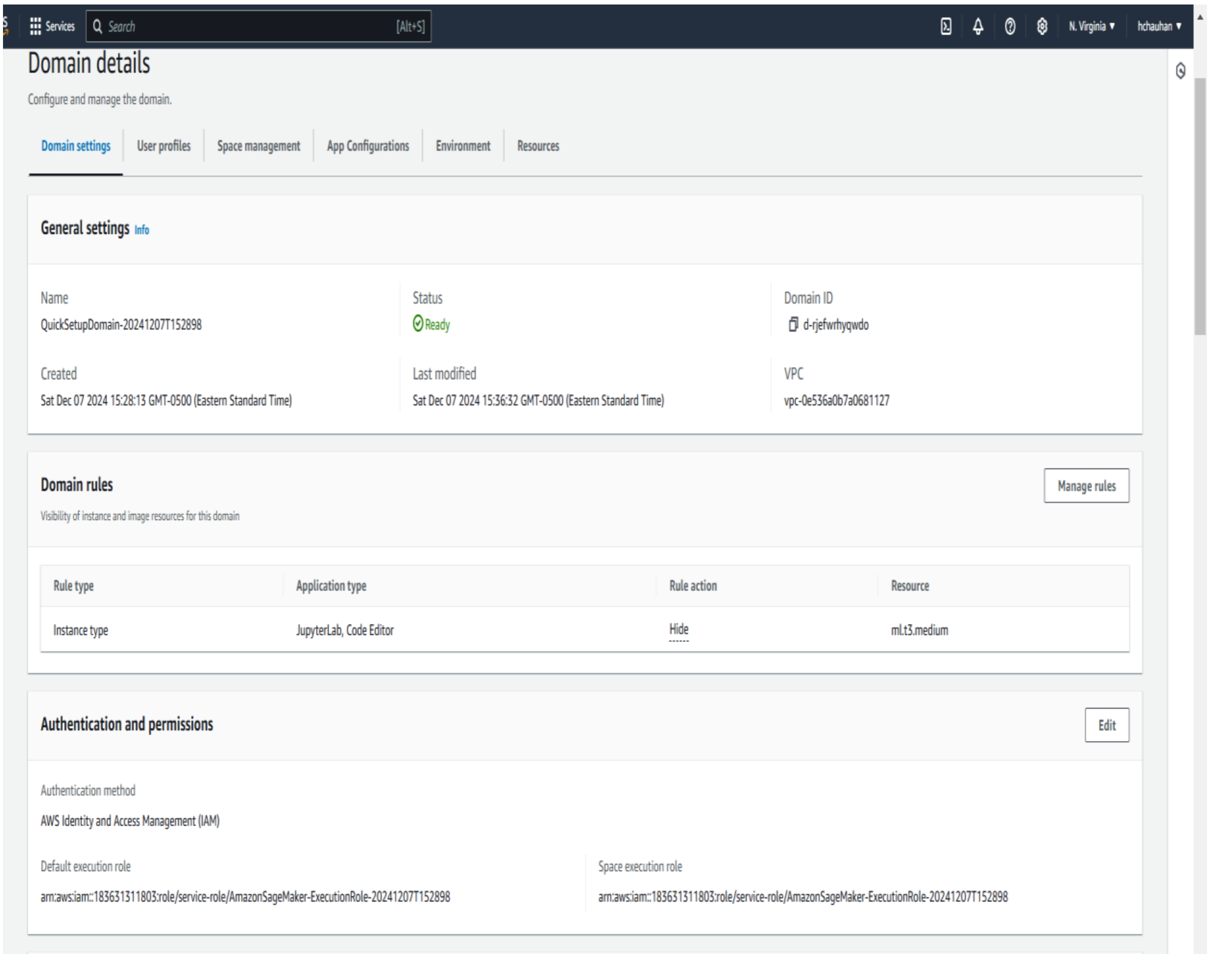
```
(pyspark_env) ubuntu@ip-172-31-90-160: $
```

Name: Harsh Chauhan
Username: hchauhan

Task 5 : Machine Learning with AWS Sagemaker Autopilot

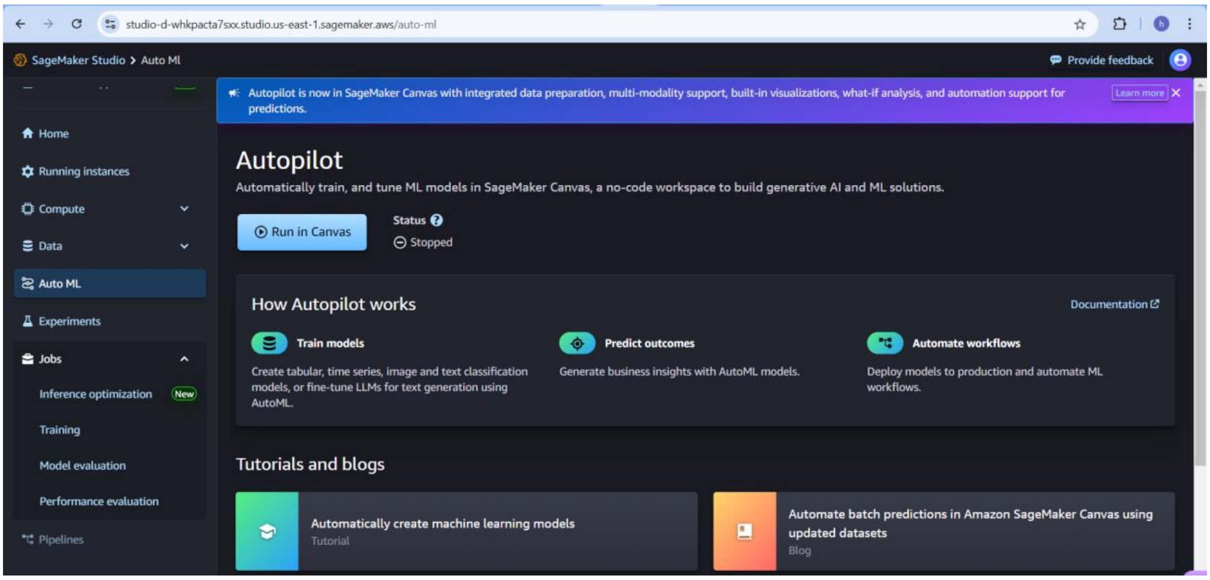
Created Domain on SageMaker





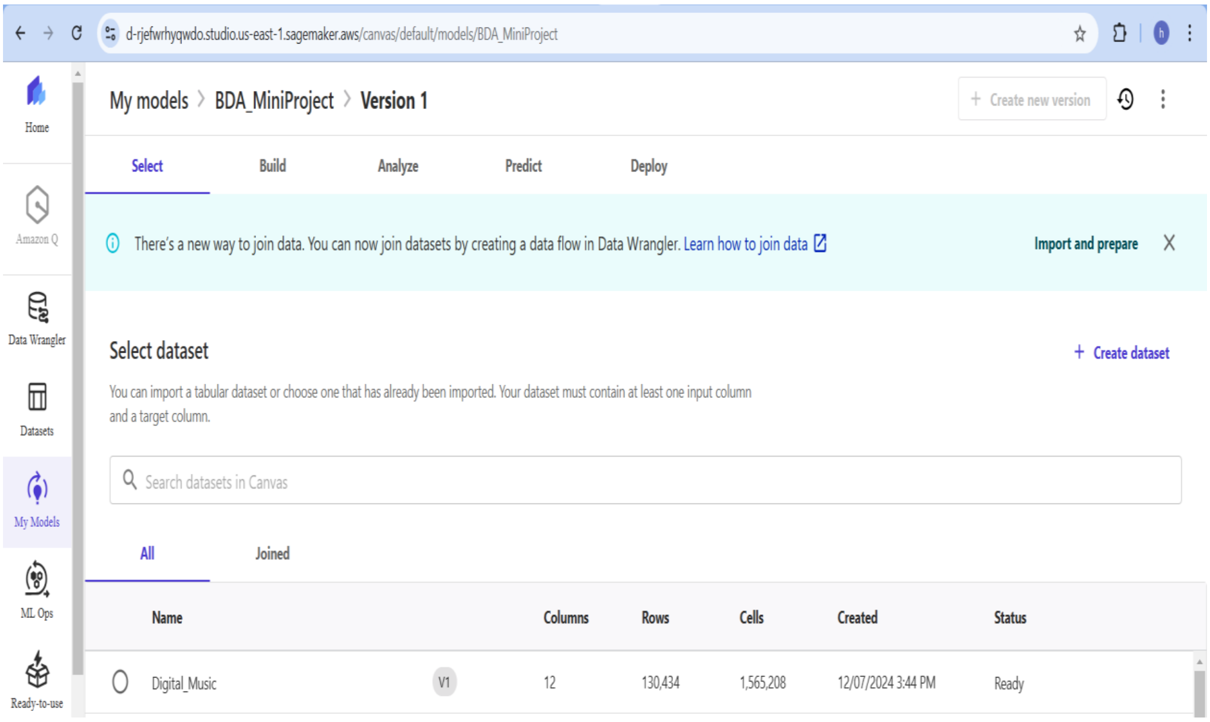
Name: Harsh Chauhan
Username: hchauhan

Connected to AWS Studio:



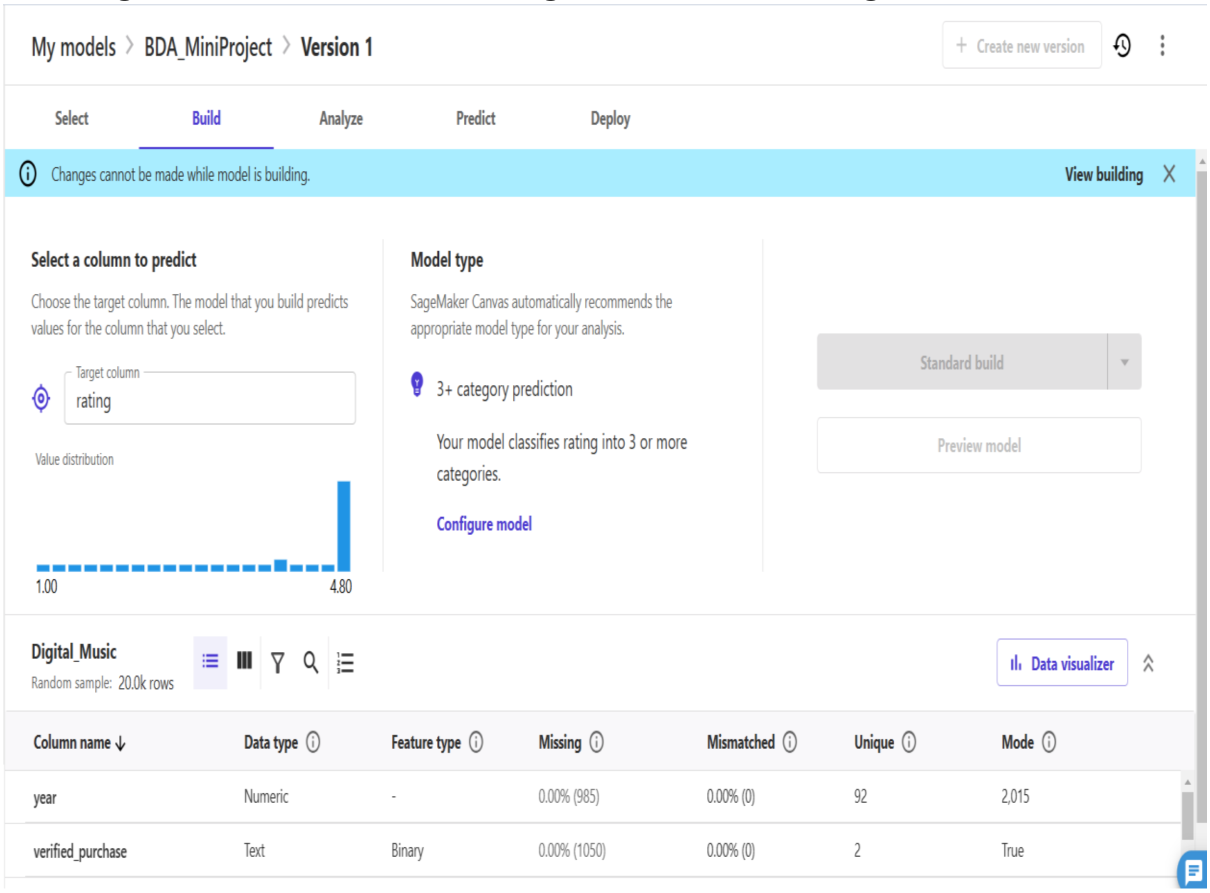
Connected to Canvas for AutoML:

Imported Dataset to Canvas

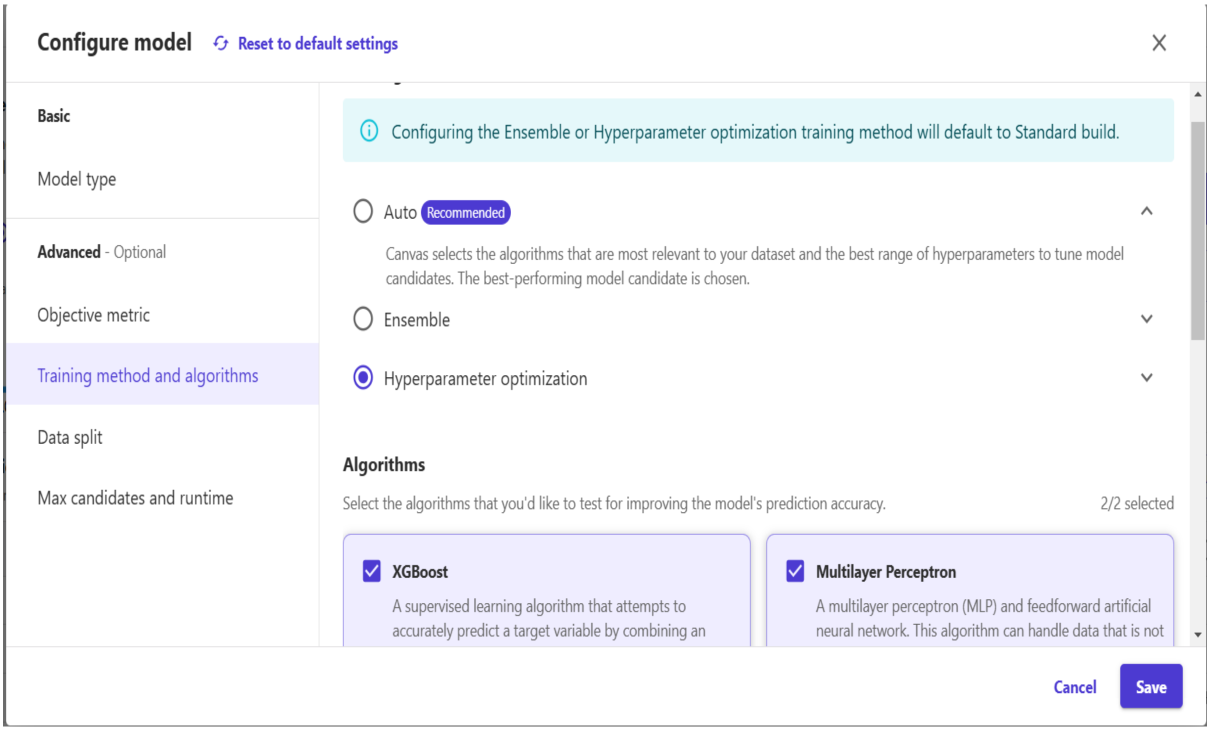


Name: Harsh Chauhan
Username: hchauhan

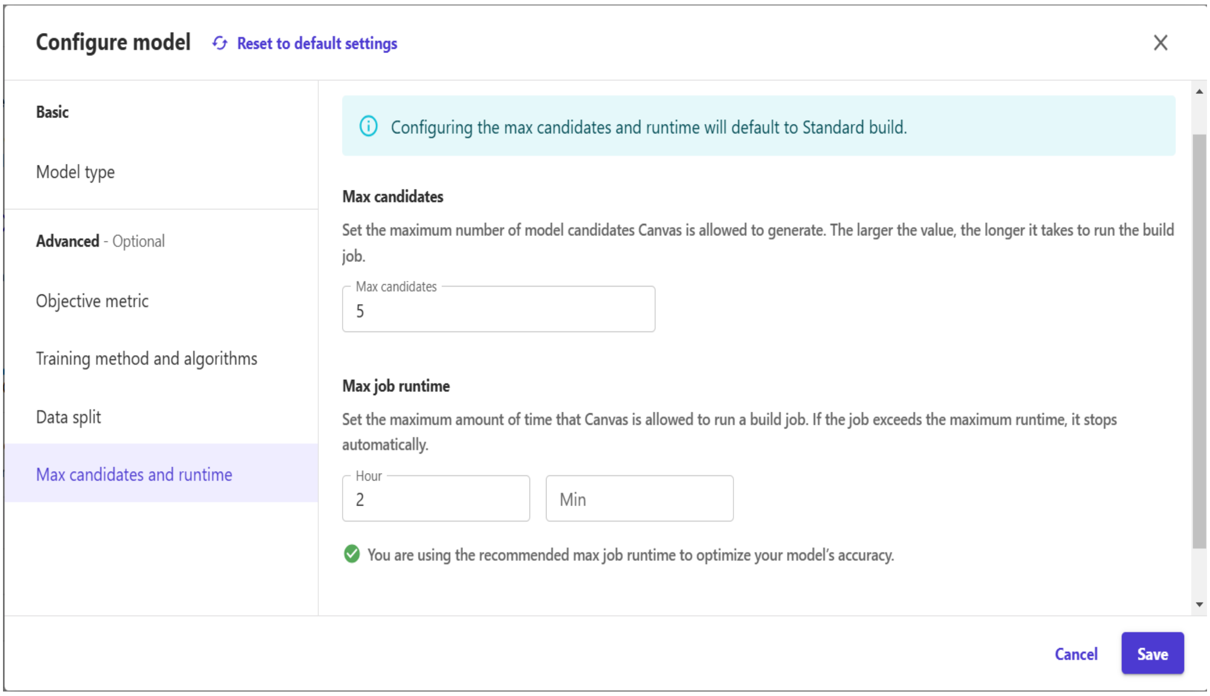
Building Standard Model with target column as Rating



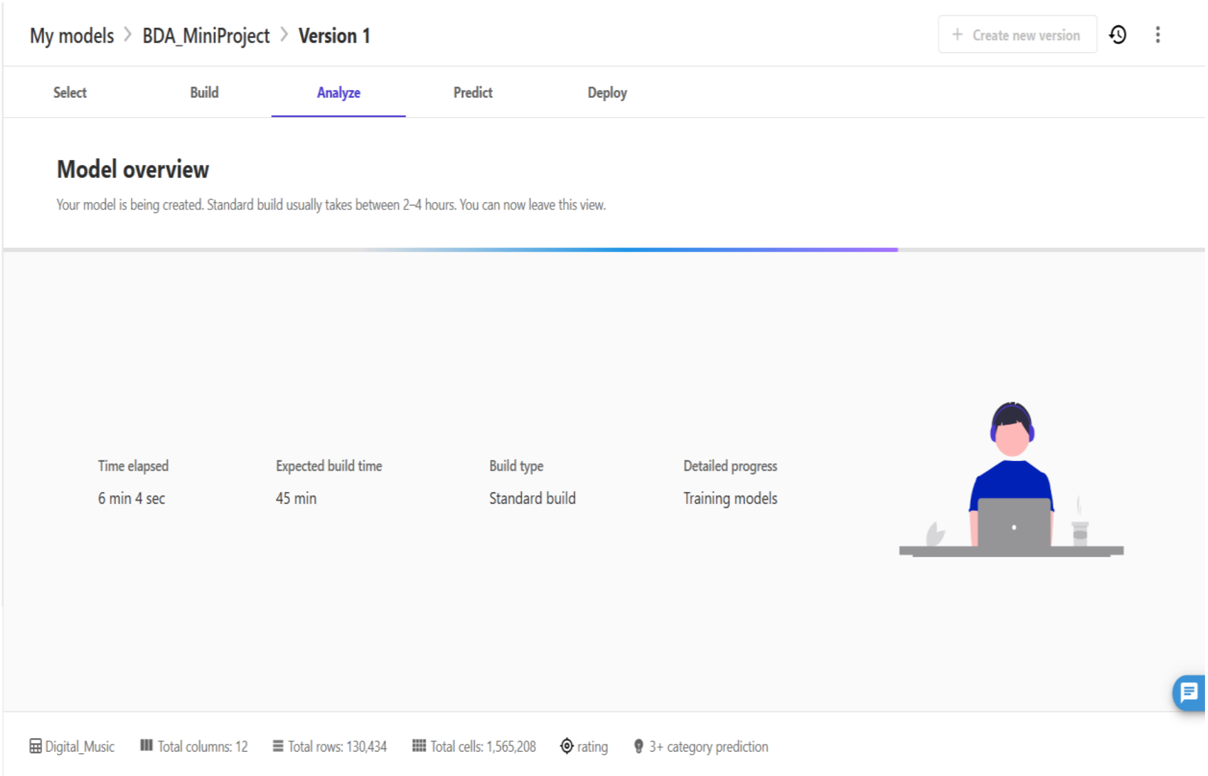
Configuring Model Setting:



Name: Harsh Chauhan
Username: hchauhan

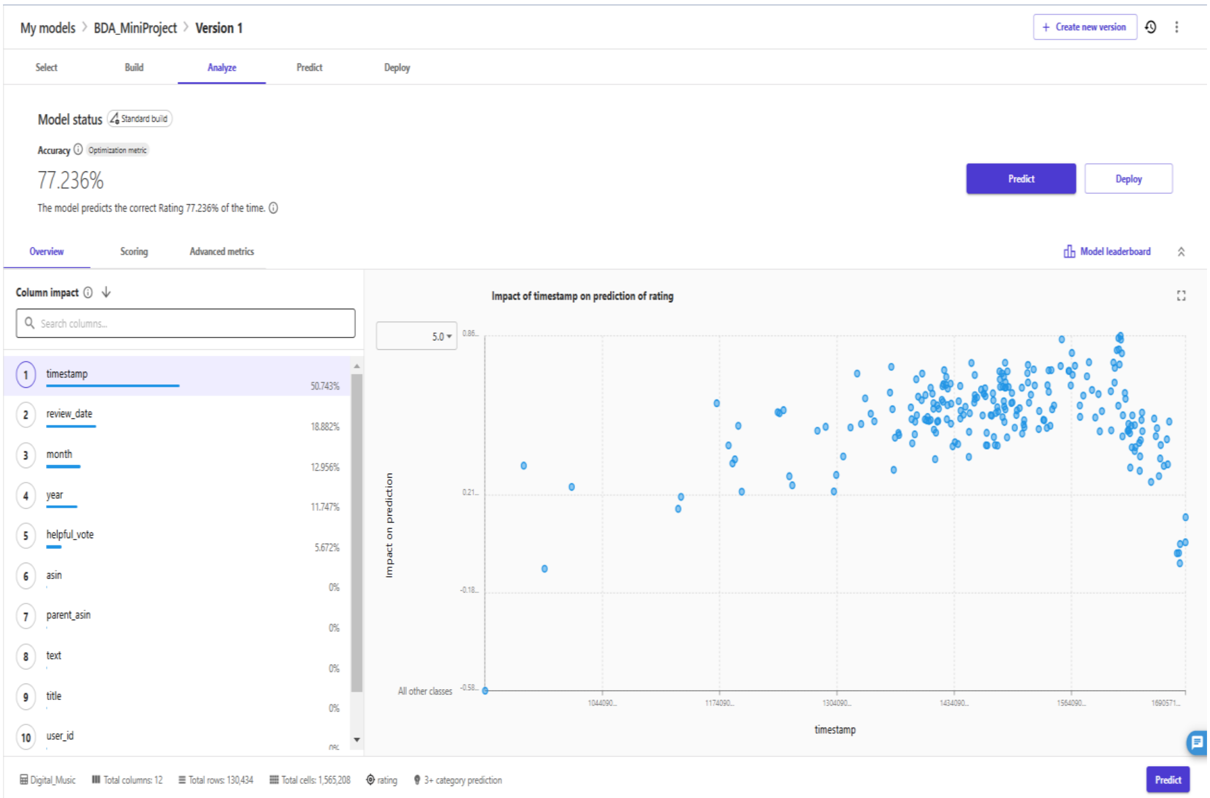


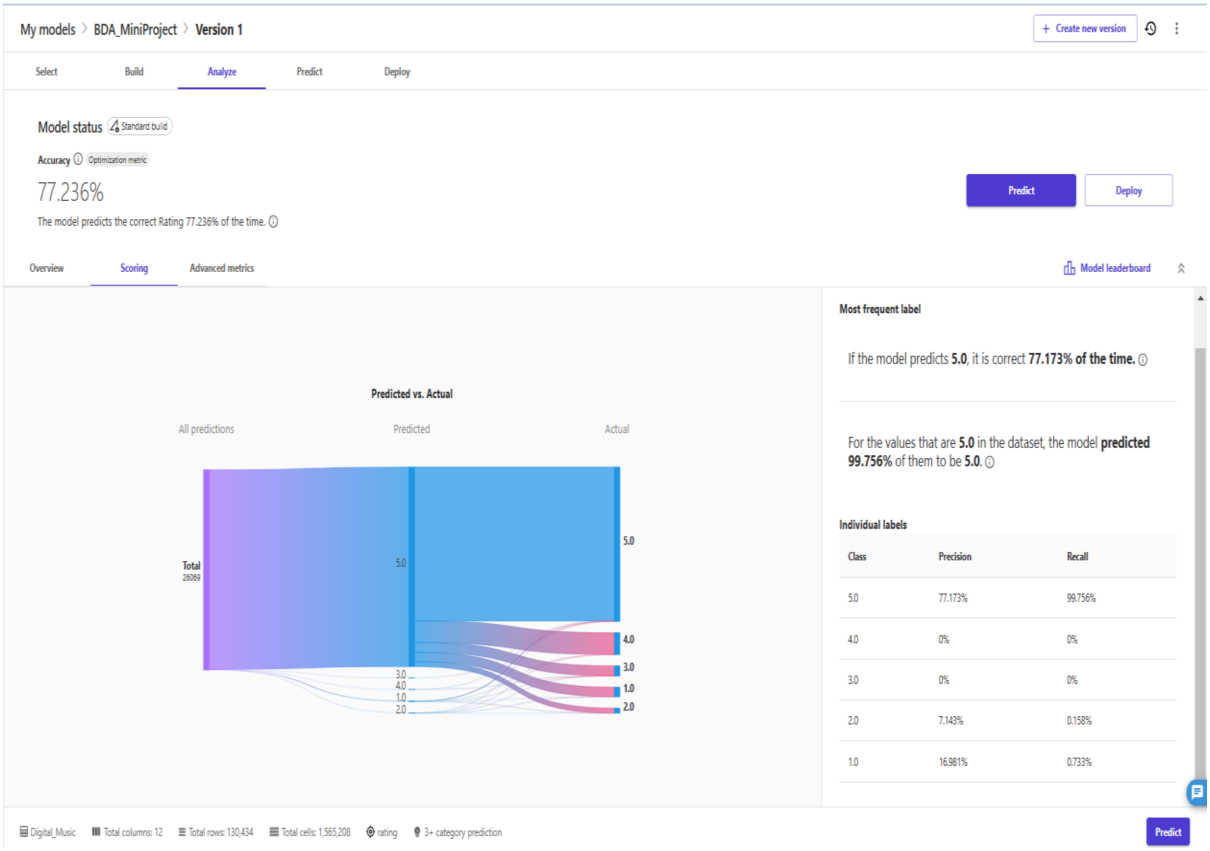
Model Training:



Name: Harsh Chauhan
Username: hchauhan

Model Results:





Name: Harsh Chauhan
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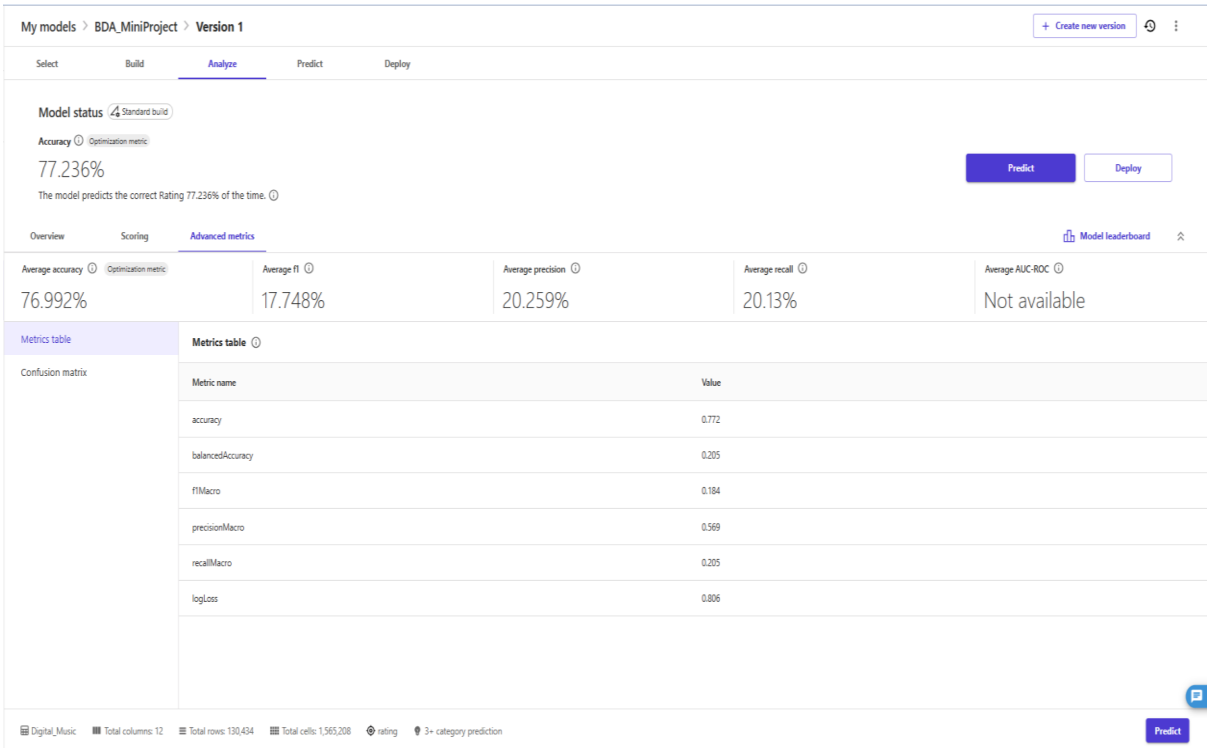
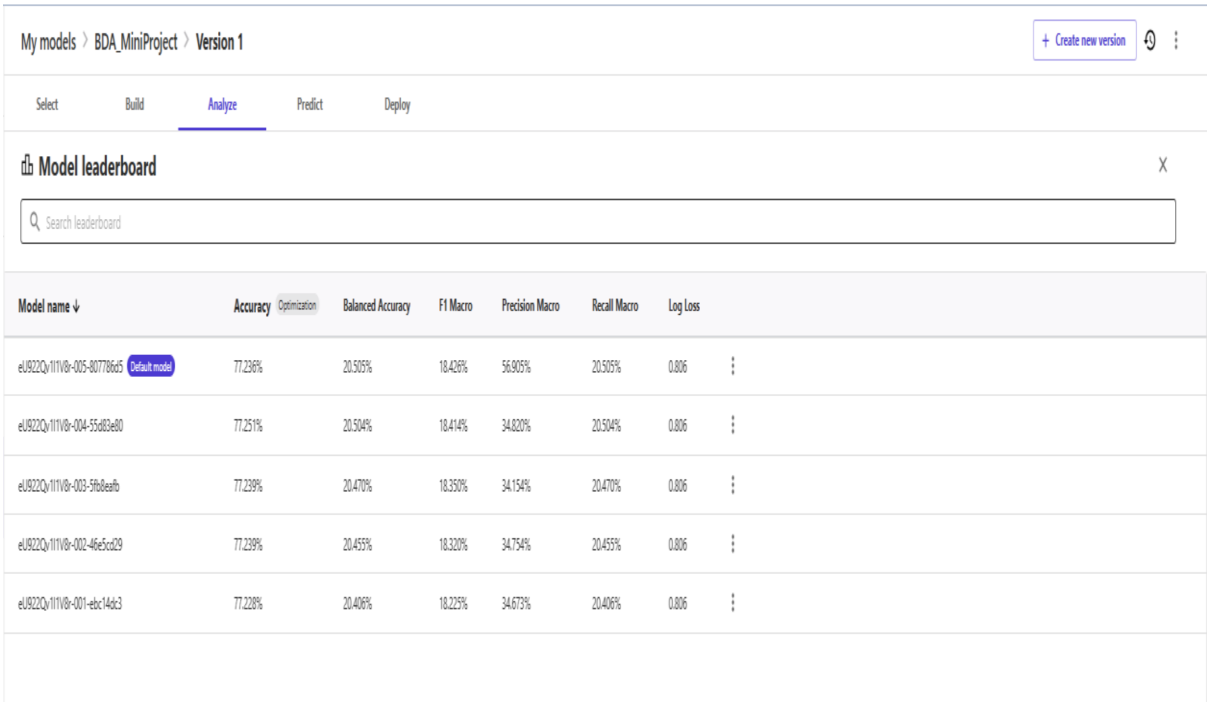


Metrics table

Metric name	Value
accuracy	0.772
balancedAccuracy	0.205
f1Macro	0.184
precisionMacro	0.569
recallMacro	0.205
logLoss	0.806



Model name ↓	Accuracy Optimization	Balanced Accuracy	F1 Macro	Precision Macro	Recall Macro	Log Loss
eU922Qv1I1V8r-005-807786d5 Default model	77.236%	20.505%	18.426%	56.905%	20.505%	0.806
eU922Qv1I1V8r-004-55d83e80	77.251%	20.504%	18.414%	34.820%	20.504%	0.806
eU922Qv1I1V8r-003-5fb8eafb	77.239%	20.470%	18.350%	34.154%	20.470%	0.806
eU922Qv1I1V8r-002-46e5cd29	77.239%	20.455%	18.320%	34.754%	20.455%	0.806
eU922Qv1I1V8r-001-ebc14dc3	77.228%	20.406%	18.225%	34.673%	20.406%	0.806

The results show a strong bias towards predicting class 5.0, with 77.173% precision and 99.756% recall for this class. This indicates that the dataset likely has a significant imbalance, with class 5.0 being the dominant category.The model shows very poor performance on other classes (4.0, 3.0, 2.0, 1.0), with 0% precision and recall for most of

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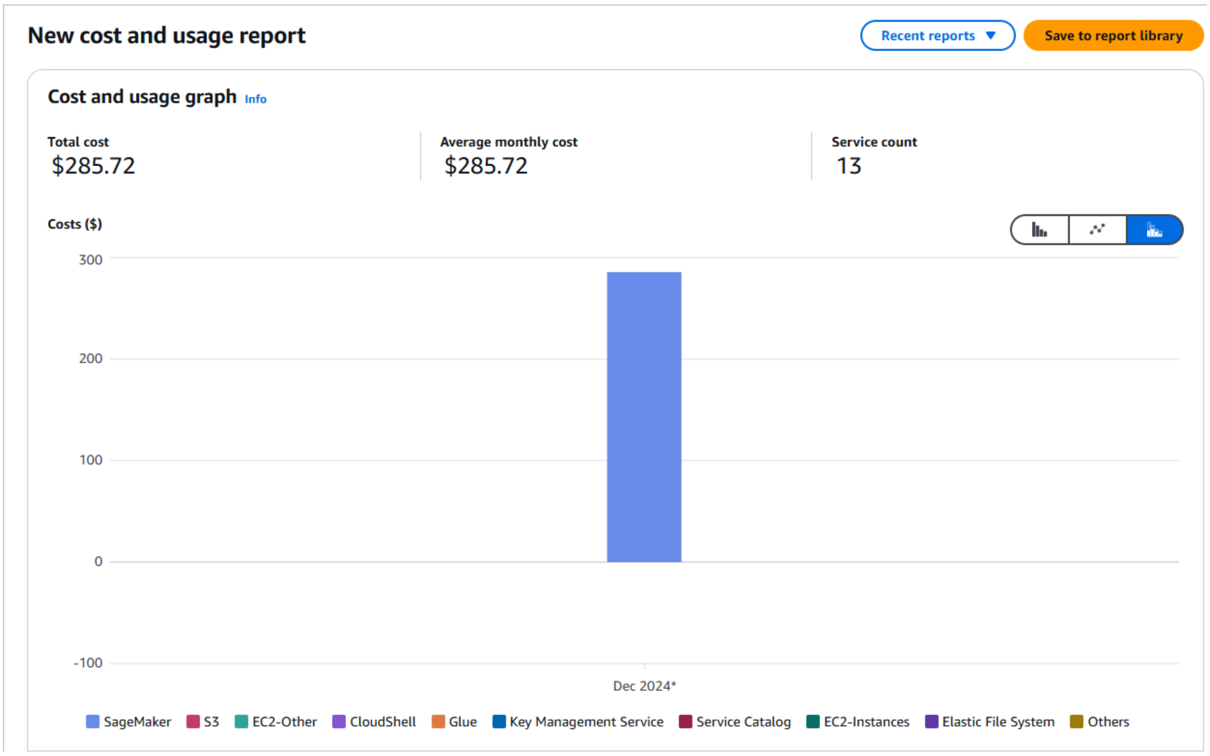
them. This further confirms the class imbalance issue and suggests the model struggles to identify less common categories. The advanced metrics show average accuracy (76.992%), F1 score (17.748%), precision (20.259%), and recall (20.13%), which are relatively low, indicating that while the model performs well on the dominant class, it struggles with overall balanced performance across all classes.These results suggest that the dataset has a significant class imbalance issue, and the model has overfit to the majority class (5.0). To improve results, we may need to address the class imbalance, possibly through resampling techniques, class weighting, or collecting more data for underrepresented classes.

Incurred charges for AWS Sagemaker:



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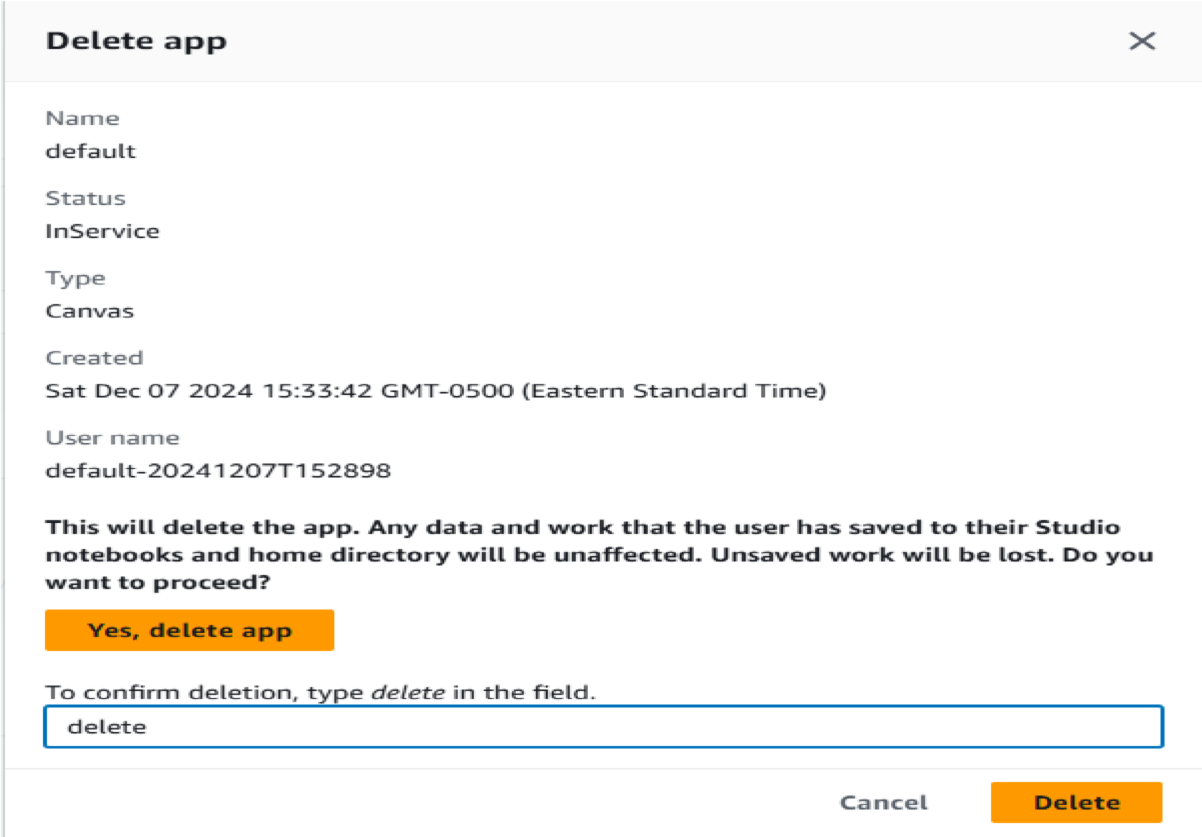
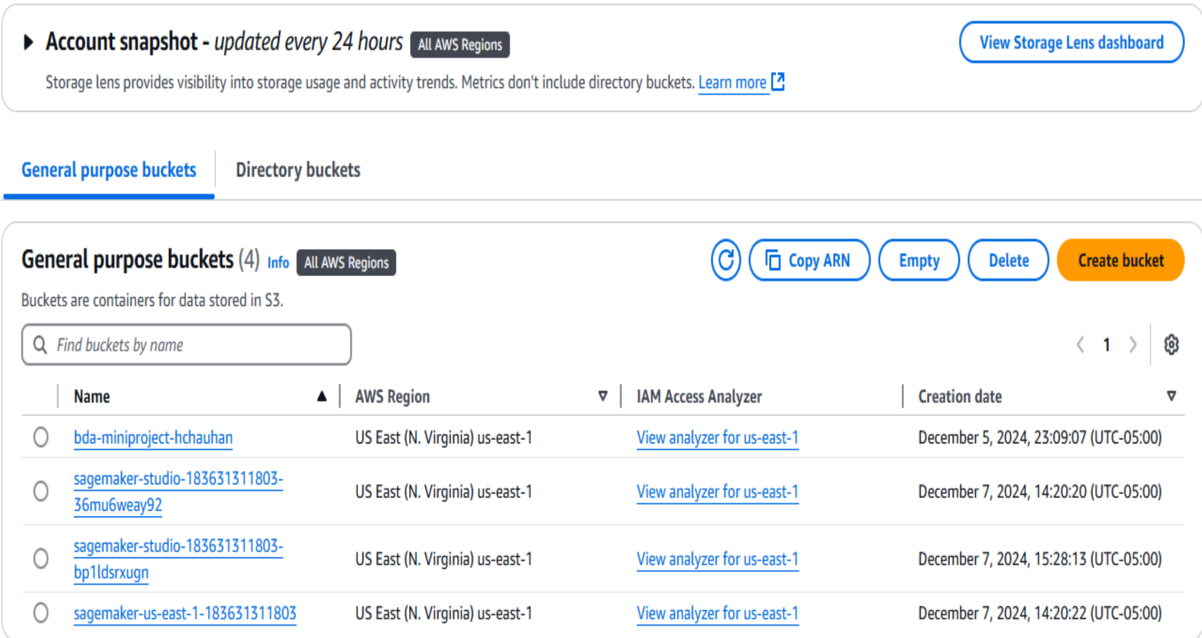
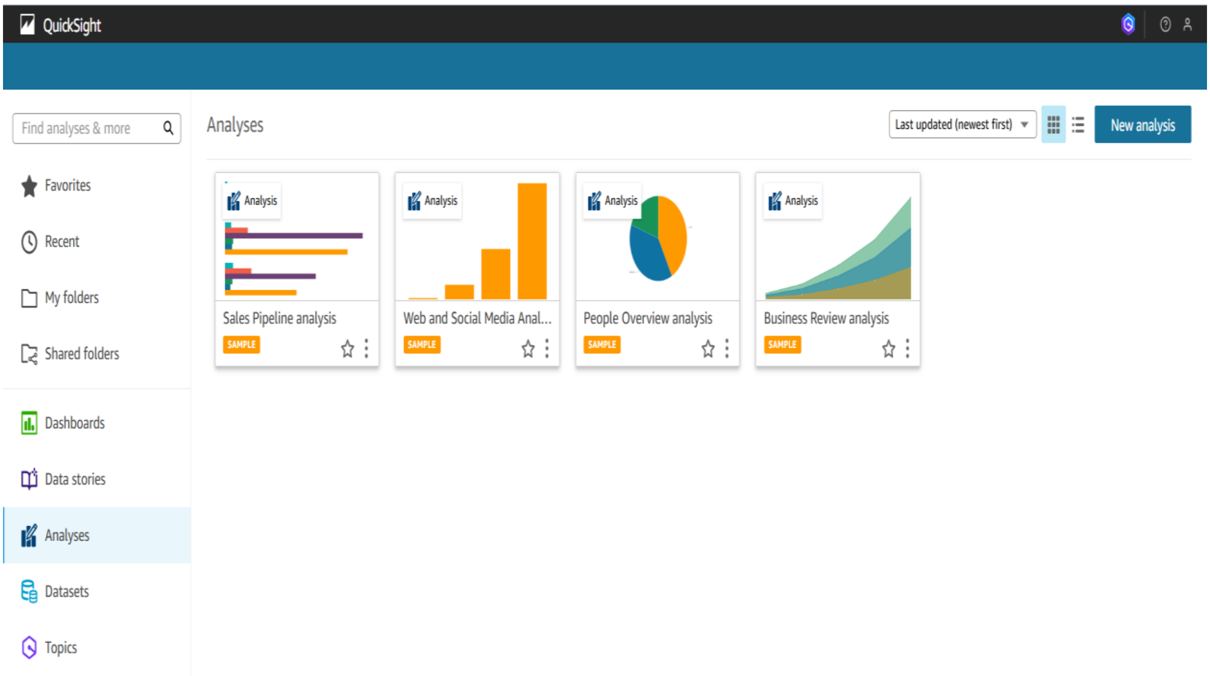




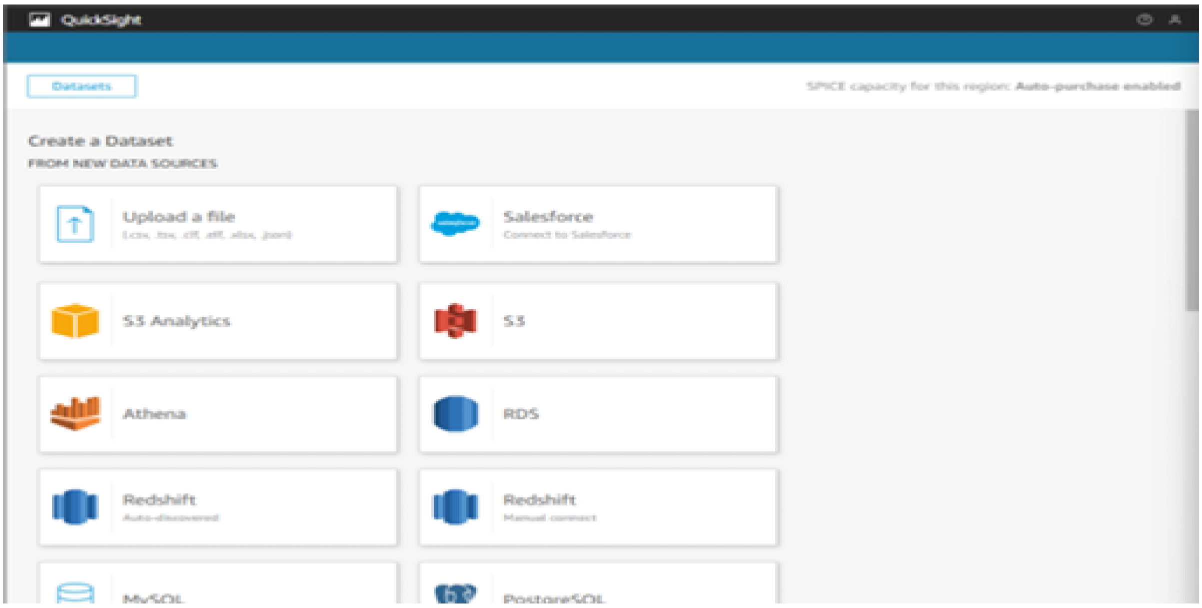
Even though I have set domain rule to ml.t3.medium and modified the model to only use hyperparameter optimization algorithm , setting the number of candidates to 5 and maximum run job time to 2 hours , using memory only till 5gb from 100 gb and still I incurred charges from AWS Sagemaker so I have deleted the Model, Domain, all the S3 buckets along with EC2 instances.

4. Visualizations:

Created Quicksight Account:



Importing Dataset From S3:



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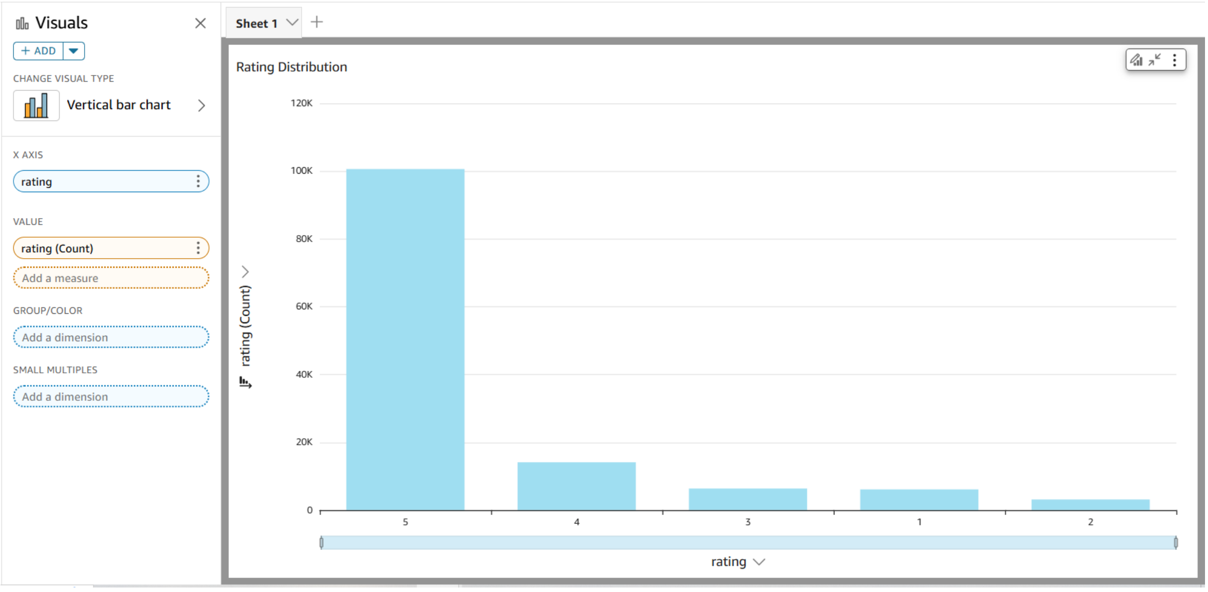
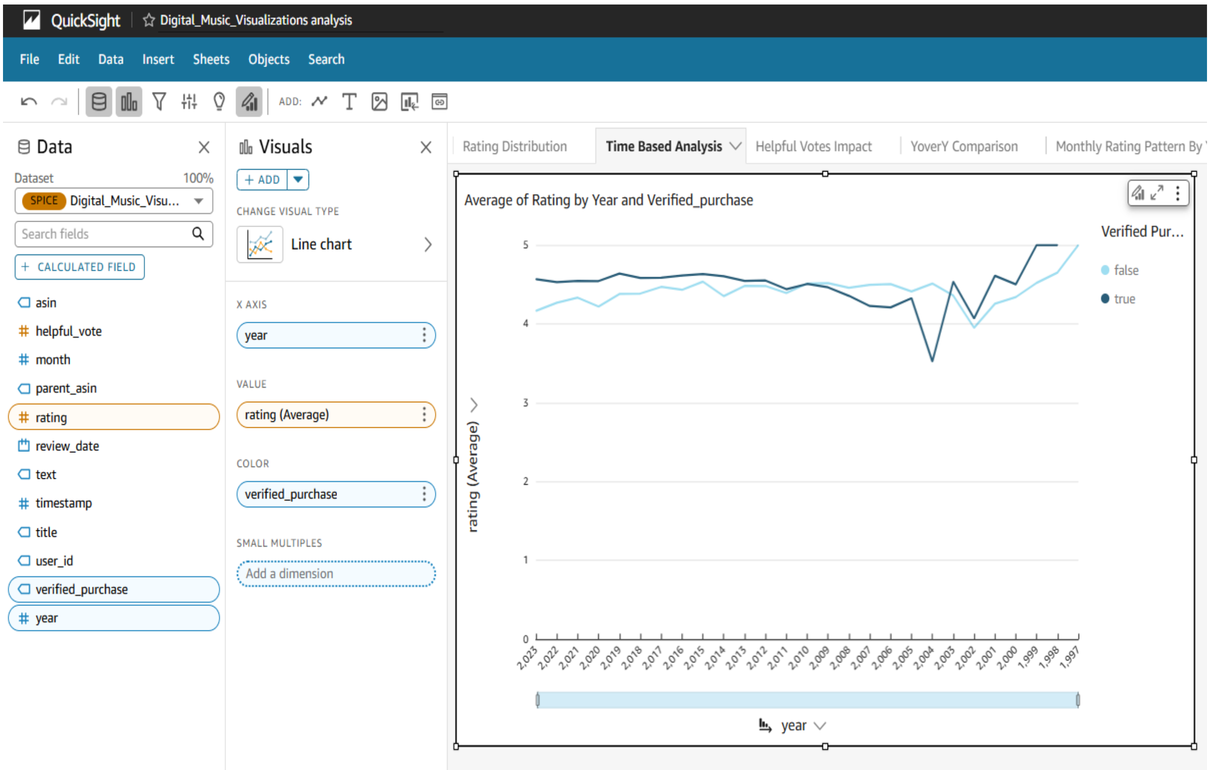
Visualizations:

1)Rating Distribution:



2) Time Based Analysis



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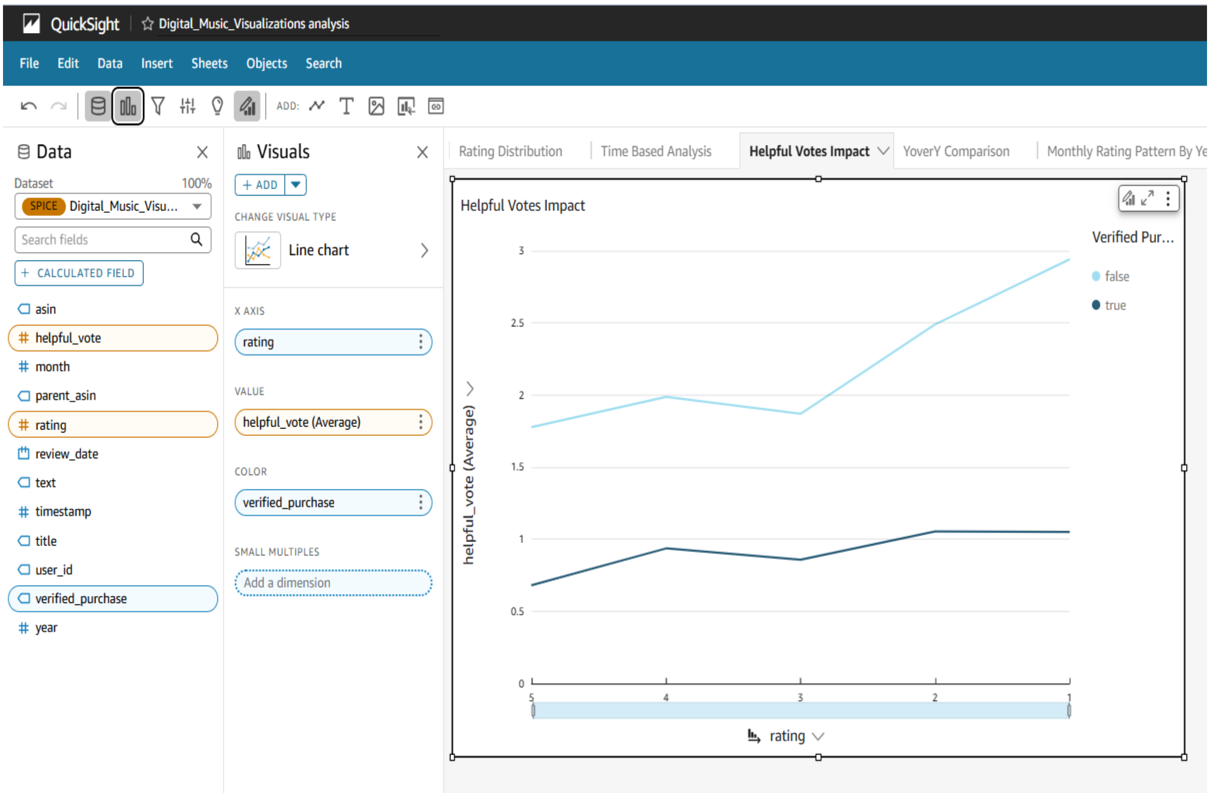
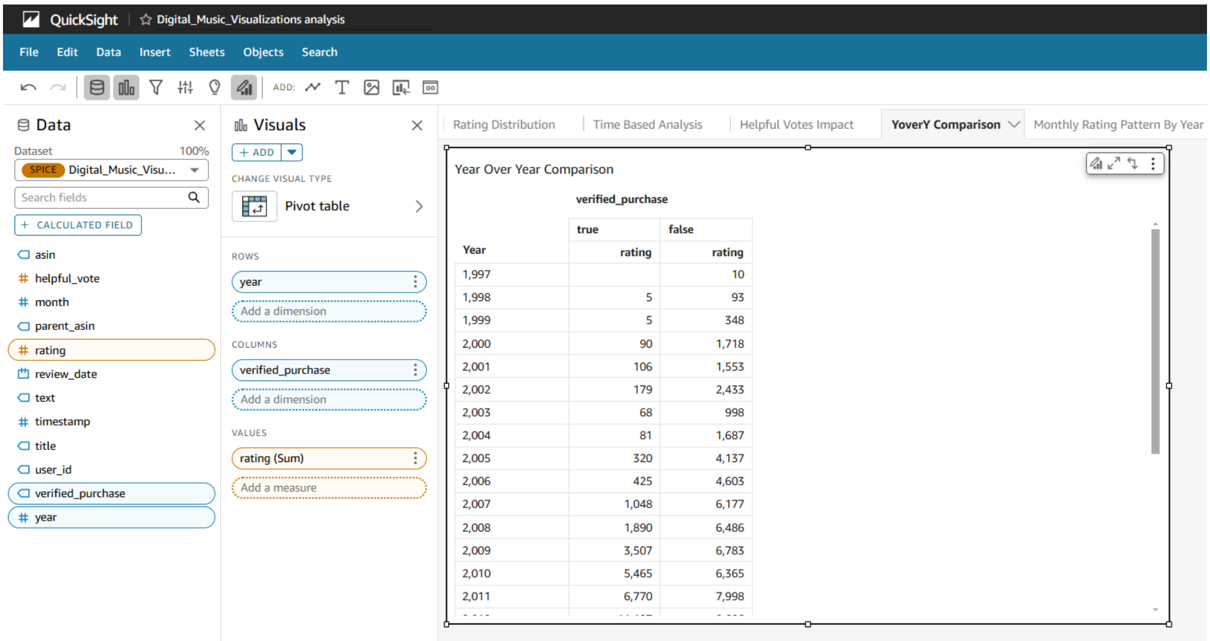
3) Helpful Votes Impact

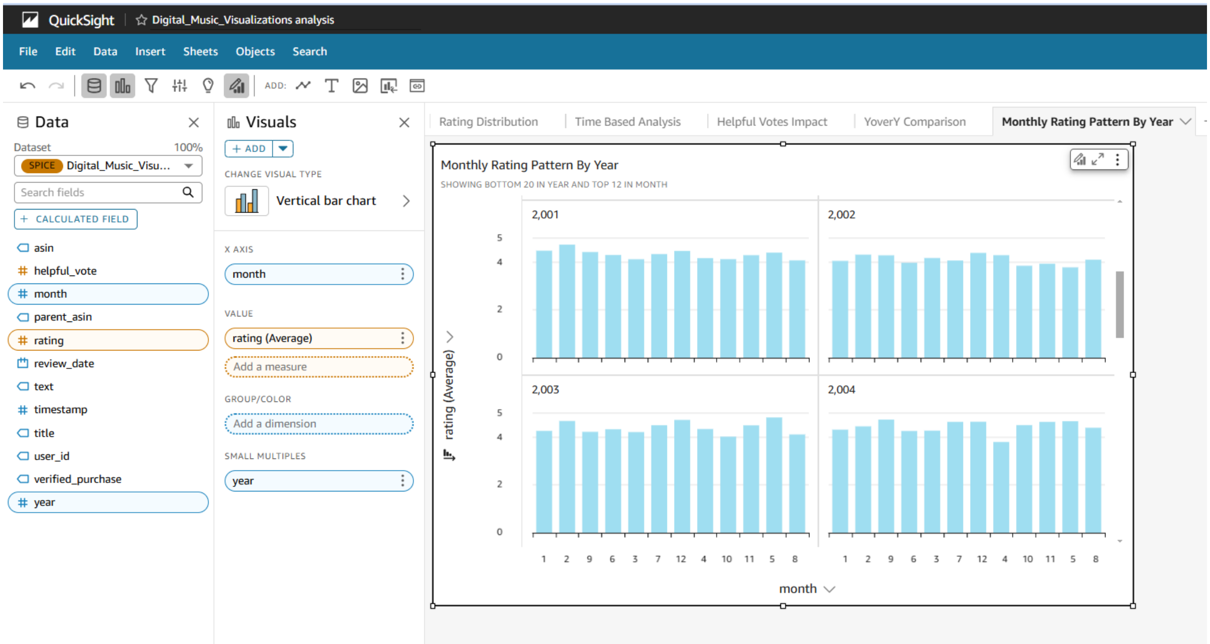


4) Year Over Year Comparison

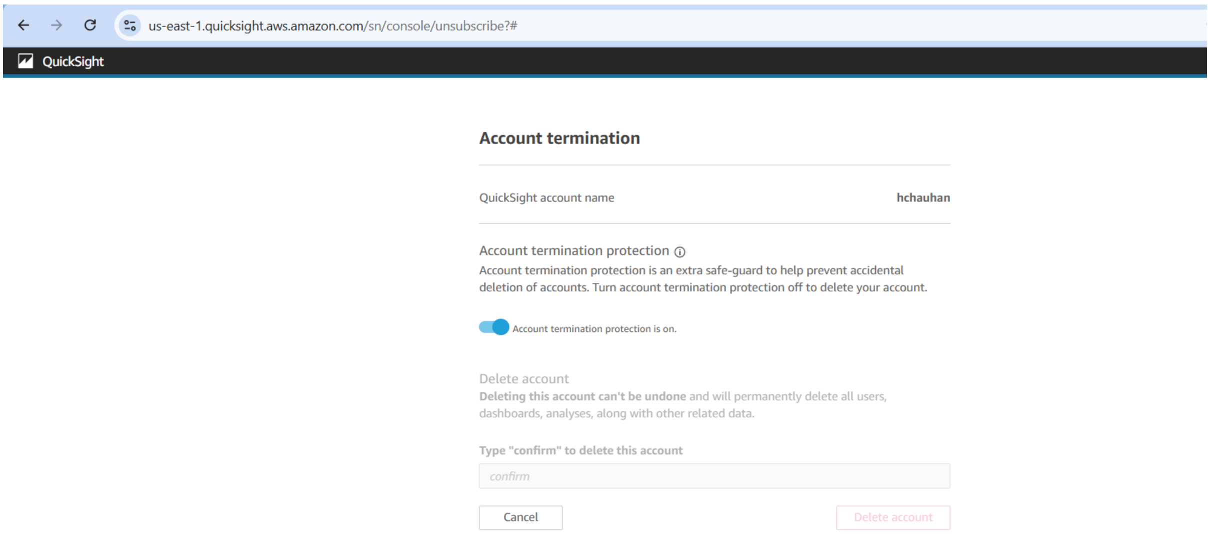


Name: Harsh Chauhan
Username: hchauhan

5) Monthly Rating Pattern by Year



Deleting the Quicksight account : In order to not incur any further charges , I have deleted the account.



5. Results and Analysis:

1) Machine Learning Results:
Sagemaker Model Analysis:

Name: Harsh Chauhan
Username: hchauhan

Model achieved 77.236% accuracy.

Performance metrics:
1) F1 Macro: 17.748%
2) Precision: 20.259%
3) Recall: 20.13%

The results show a strong bias towards predicting class 5.0, with 77.173% precision and 99.756% recall for this class. This indicates that the dataset likely has a significant imbalance, with class 5.0 being the dominant category. The model shows very poor performance on other classes (4.0, 3.0, 2.0, 1.0), with 0% precision and recall for most of them. This further confirms the class imbalance issue and suggests the model struggles to identify less common categories. The advanced metrics show average accuracy (76.992%), F1 score (17.748%), precision (20.259%), and recall (20.13%), which are relatively low, indicating that while the model performs well on the dominant class, it struggles with overall balanced performance across all classes. These results suggest that the dataset has a significant class imbalance issue, and the model has overfit to the majority class (5.0). To improve results, we may need to address the class imbalance, possibly through resampling techniques, class weighting, or collecting more data for underrepresented classes.

2) Visualization Analysis:

1) Rating Distribution

The rating distribution shows a strong positive skew with 5-star ratings dominating at approximately 100,000 counts, while ratings 4 through 1 have significantly lower frequencies around 10,000-20,000 counts each.

2) Time Based Analysis:

The graph shows average ratings over time (1997-2023) with verified purchases consistently rating slightly higher than non-verified ones, both generally maintaining ratings between 4.0-4.5 stars.

3)Helpful Votes Impact
The graph shows that helpful votes increase as the rating increases, with verified purchases having a higher impact on helpfulness across all ratings.

4)Year over Year Comparison
The data shows a consistent year-over-year increase in both verified and non-verified purchase ratings from 1997 to 2011, with non-verified purchases maintaining higher volumes throughout the period.

5)Monthly rating pattern by Year
The monthly rating patterns across 1997-2023 show consistent average ratings between 4-5 stars with slight seasonal fluctuations but overall stable performance throughout each year.

6. Challenges:

1) Challenges faced with the AWS Sagemaker model configuration.
2) Incurred unexpected AWS charges ($285.72) primarily from using Sagemaker.

7. Conclusion:

This project highlights the power of combining distributed computing frameworks and cloud-based tools to process and analyze large-scale datasets. By leveraging AWS S3, PySpark, AWS SageMaker, and QuickSight, the study successfully processed Amazon's Digital Music review dataset, providing valuable insights into customer behavior, preferences, and review patterns. Key findings include the dominance of 5-star ratings, seasonal trends in review activity, and the impact of verified purchases on helpfulness and satisfaction scores.

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Username: hchauhan

The machine learning model developed using SageMaker achieved a 77.236% accuracy but revealed significant challenges related to class imbalance, overfitting, and limited generalization across all rating categories. This underlines the need for future improvements, such as balancing datasets through resampling or class weighting, to enhance model performance.

While the project faced challenges, including unexpected AWS charges and configuration issues with SageMaker, these experiences offered practical insights into the complexities of cloud-based analytics workflows. The visualizations created through QuickSight provided intuitive representations of trends and patterns, aiding in comprehending the dataset's dynamics.

This project underscores the importance of careful resource management and configuration in cloud services and demonstrates the potential of data analytics to derive actionable insights in the digital music domain. Future efforts could expand on this foundation by addressing identified limitations and exploring other feature sets within the dataset.

8. References:

a) AWS Documentation.
b) Sagemaker Documention.
c) PySpark Documentation.
d) Amazon Review Dataset: Amazon Reviews'23
e) Quicksight Documentation
f) Reffered Perplexity.ai for setup error and configuration doubts.