Project by Gero Krikawa 12/2023

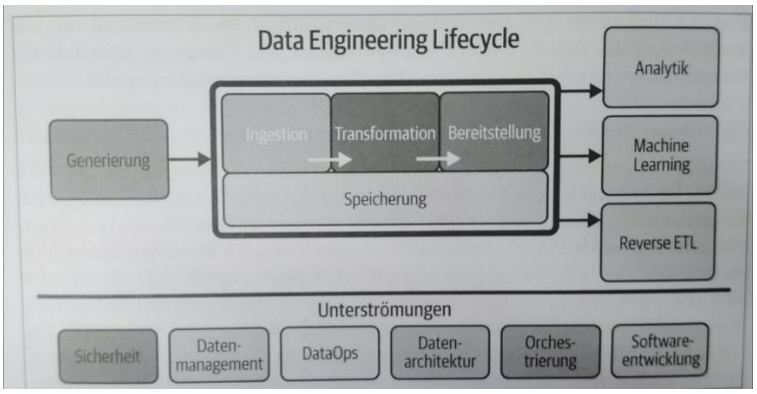
End to End Data Engineering Project in AWS using Spark (Pyspark)

Used Technologies:

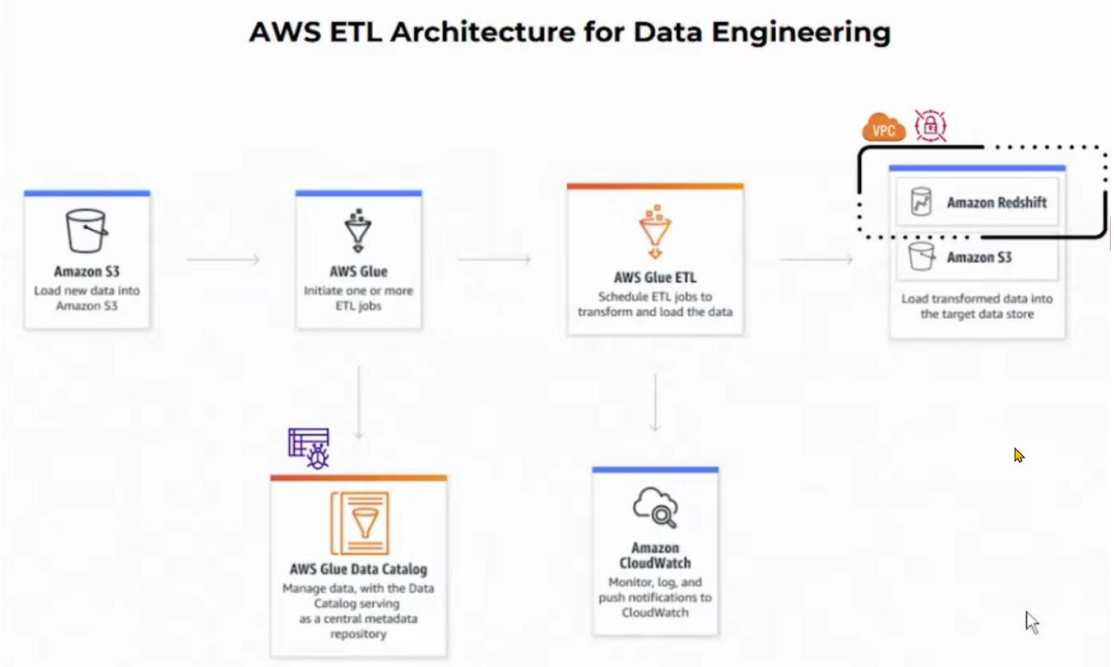
- AWS Cloud
- Infrastructure as a Code
- AWS Glue:
    - AWS Glue Data Catalog
    - AWS Glue ETL Datapipelines (CSV File → AWS Redshift,
        - Apache Spark
        - Jupyter Notebook, Pyspark (Data Cleaning, Transformation)
- AWS Redshift

1 Inhalt

2 Overview: Data Engineering Lifecycle



3 AWS ETL architecture for Data Engineering



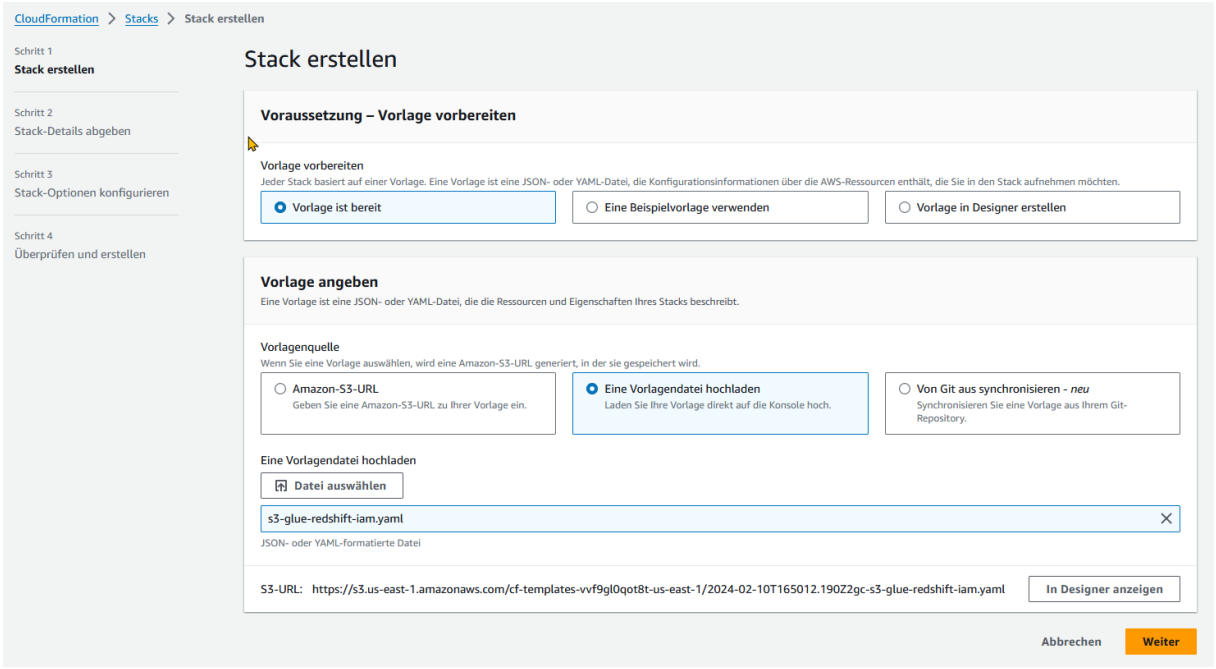
3.1 Project Workflow

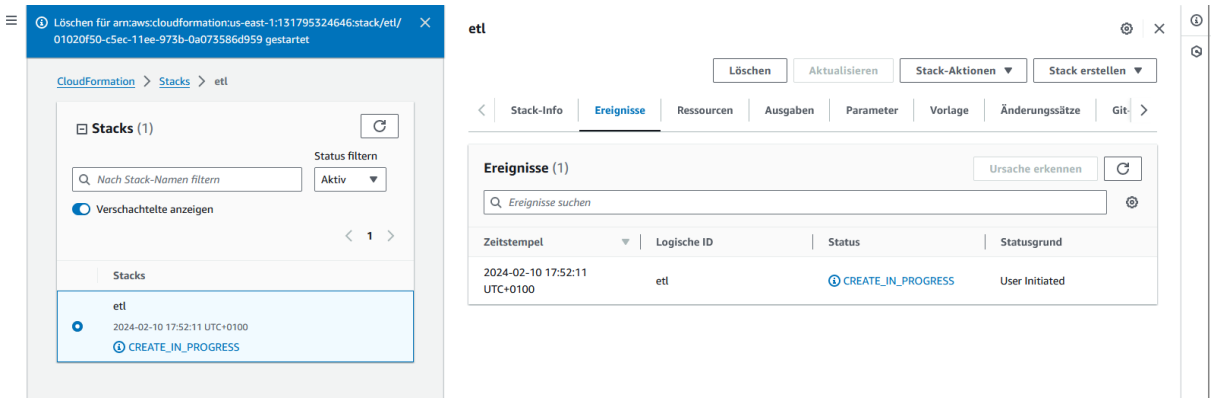
- Create Data Engineering System in AWS using „Infrastructure as Code“

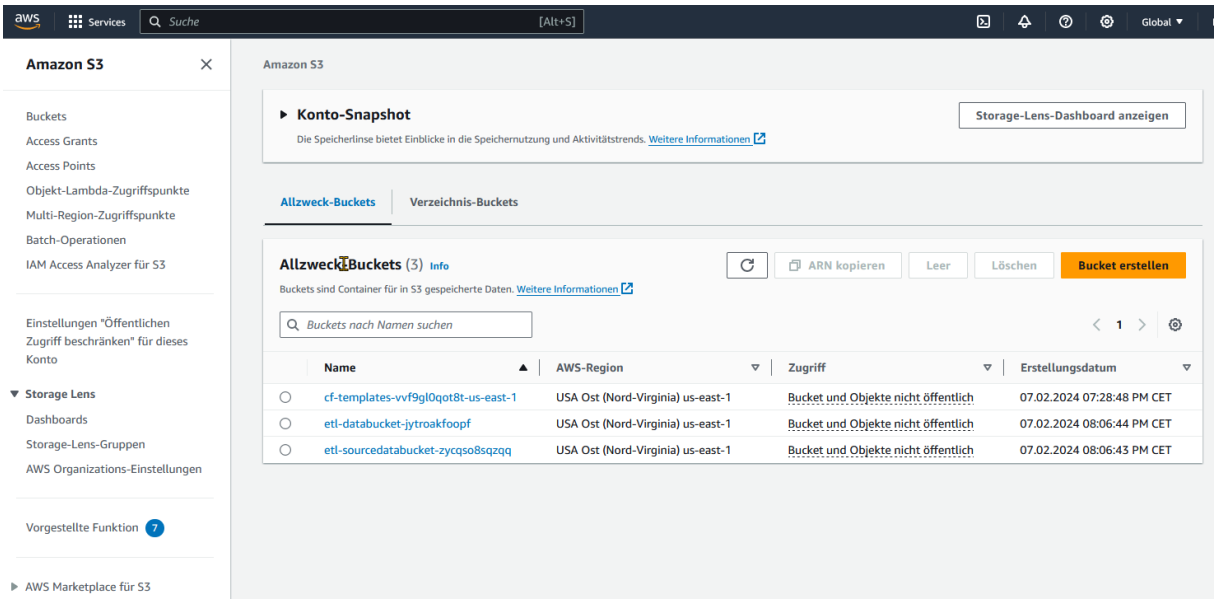
- End to End Data Pipeline
  - Data Source File: sales_records.csv
  - Destination: AWS Redshift
  - S3 Storage & Source of Data Pipeline
  - AWS Clue – using crawler to catalog data
  - Processing data using Pyspark within interactive Jupyter Notebook in Glue
    - Build Data Pipeline in Pyspark using Glue Jupyter interactive Notebook
    - Reading data from s3 storage, processing it in Spark and then loading it into Redshift (using dynamic frames and spark data frames

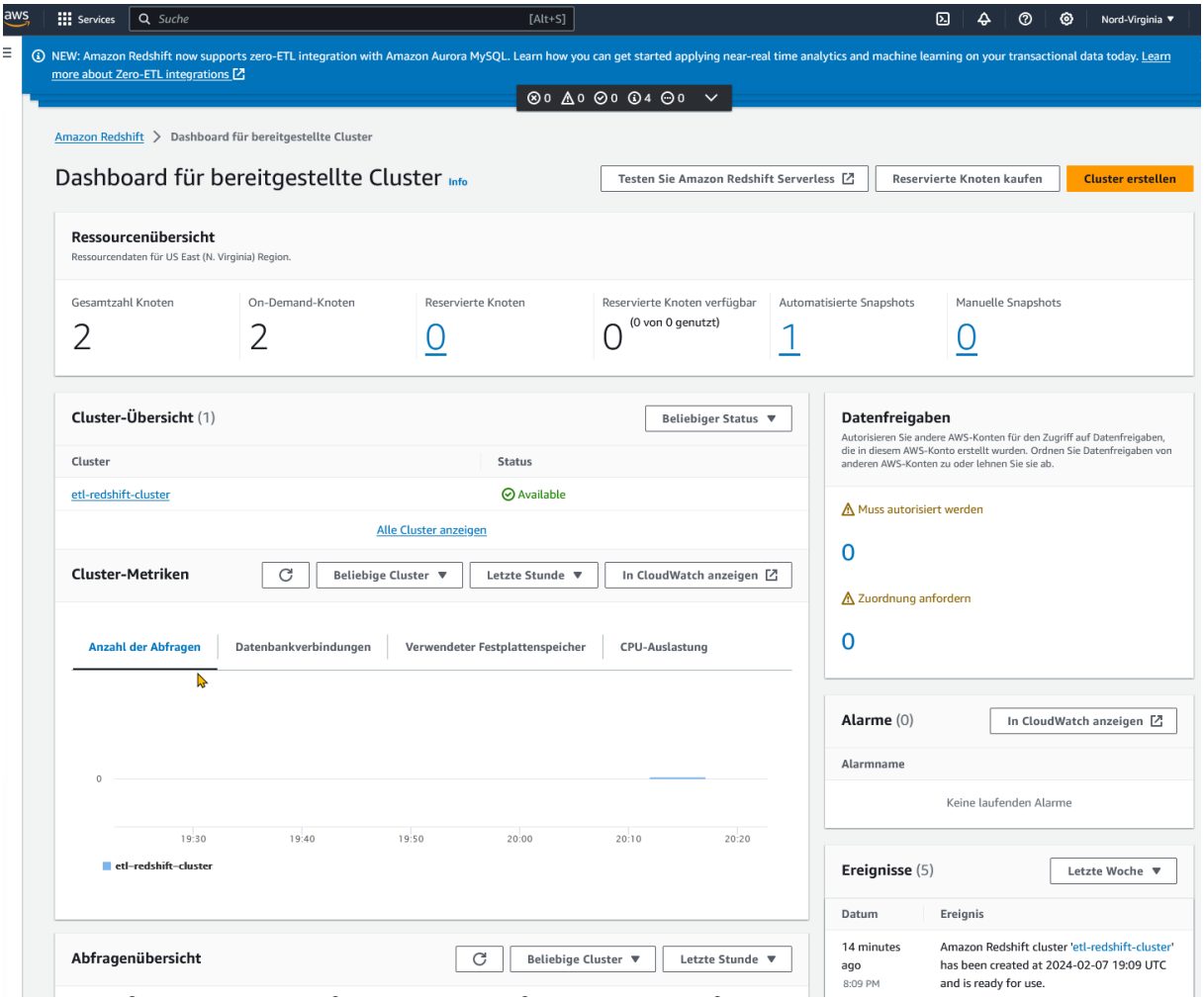
4 Screenshots and explanation during development

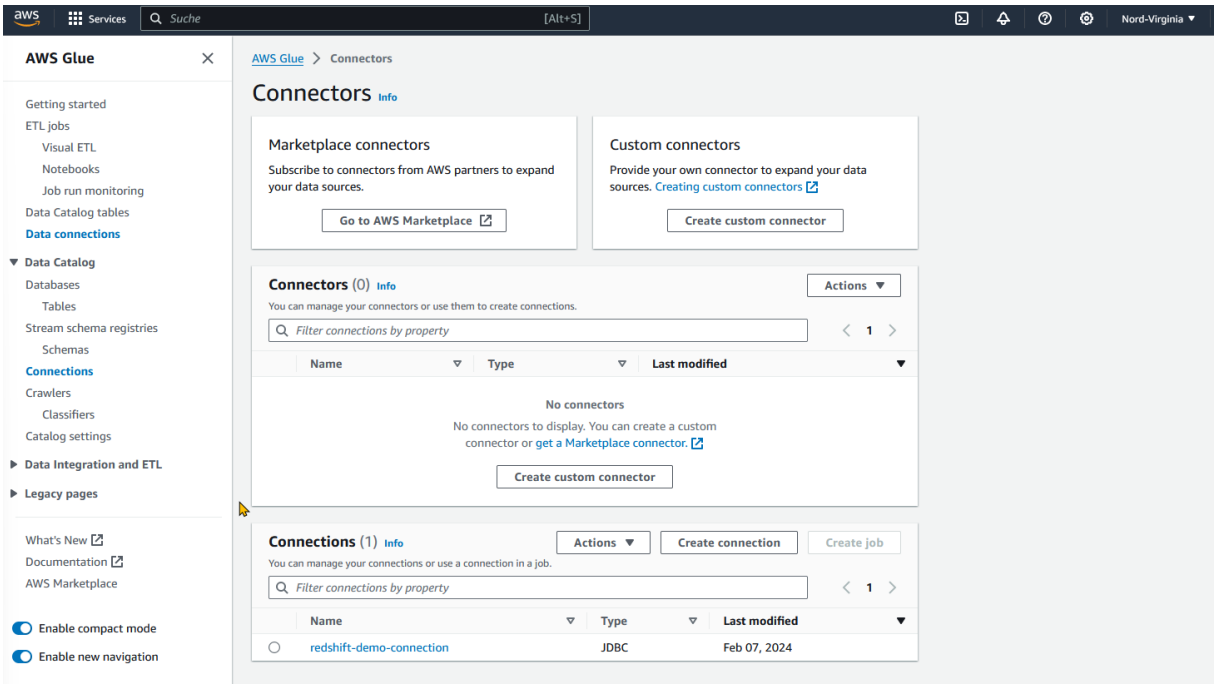
4.1 Create Data Engineering System in AWS using „Infrastructure as Code“



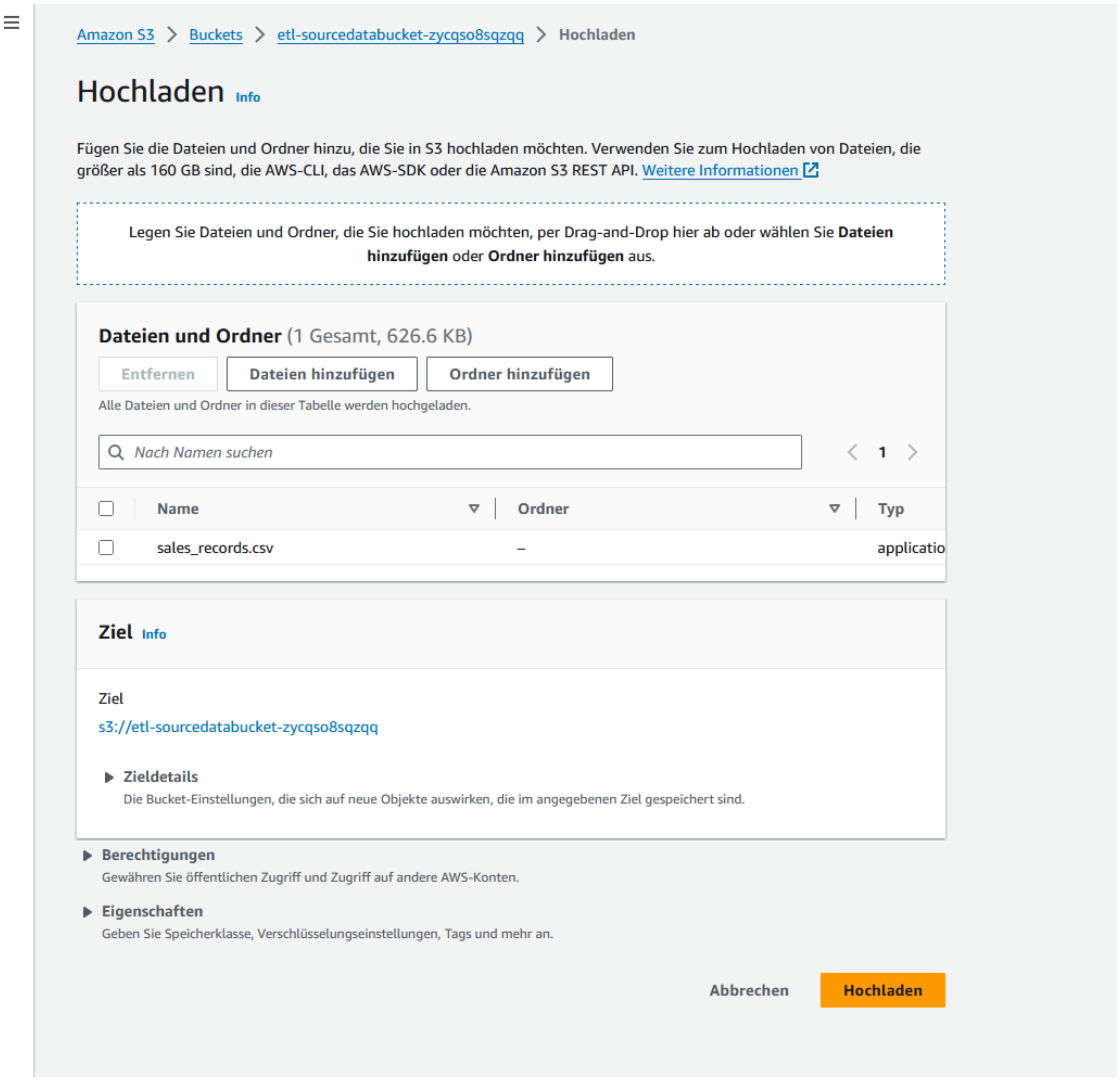


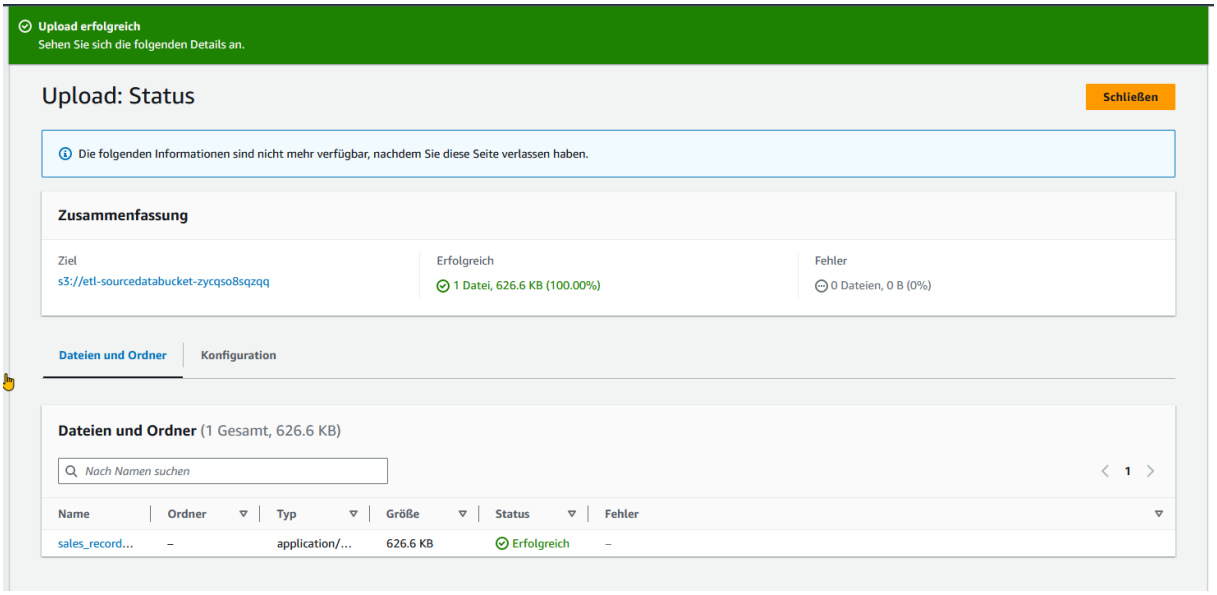

Services
Suche
[Alt+S]
Global
Amazon S3
Buckets
Access Grants
Access Points
Objekt-Lambda-Zugriffspunkte
Multi-Region-Zugriffspunkte
Batch-Operationen
IAM Access Analyzer für S3
Einstellungen "Öffentlichen Zugriff beschränken" für dieses Konto
Storage Lens
Dashboards
Storage-Lens-Gruppen
AWS Organizations-Einstellungen
Vorgestellte Funktion 7
AWS Marketplace für S3
Amazon S3
Konto-Snapshot
Die Speicherlinse bietet Einblicke in die Speichernutzung und Aktivitätstrends. Weitere Informationen
Storage-Lens-Dashboard anzeigen
Allzweck-Buckets
Verzeichnis-Buckets
Allzweck-Buckets (3) Info
Buckets sind Container für in S3 gespeicherte Daten. Weitere Informationen
ARN kopieren
Leer
Löschen
Bucket erstellen
Buckets nach Namen suchen
Name
AWS-Region
Zugriff
Erstellungsdatum
cf-templates-vvf9gl0qot8t-us-east-1
USA Ost (Nord-Virginia) us-east-1
Bucket und Objekte nicht öffentlich
07.02.2024 07:28:48 PM CET
etl-databucket-jytroakfoopf
USA Ost (Nord-Virginia) us-east-1
Bucket und Objekte nicht öffentlich
07.02.2024 08:06:44 PM CET
etl-sourcedatabucket-zycqso8sqzqq
USA Ost (Nord-Virginia) us-east-1
Bucket und Objekte nicht öffentlich
07.02.2024 08:06:43 PM CET


Services
Suche
[Alt+S]
Nord-Virginia
NEW: Amazon Redshift now supports zero-ETL integration with Amazon Aurora MySQL. Learn how you can get started applying near-real time analytics and machine learning on your transactional data today. Learn more about Zero-ETL integrations
Amazon Redshift
Dashboard für bereitgestellte Cluster
Dashboard für bereitgestellte Cluster Info
Testen Sie Amazon Redshift Serverless
Reservierte Knoten kaufen
Cluster erstellen
Ressourcenübersicht
Ressourcendaten für US East (N. Virginia) Region.
Gesamtzahl Knoten
2
On-Demand-Knoten
2
Reservierte Knoten
0
Reservierte Knoten verfügbar
0
(0 von 0 genutzt)
Automatisierte Snapshots
1
Manuelle Snapshots
0
Cluster-Übersicht (1)
Beliebiger Status
Cluster
Status
etl-redshift-cluster
Available
Alle Cluster anzeigen
Cluster-Metriken
Beliebige Cluster
Letzte Stunde
In CloudWatch anzeigen
Anzahl der Abfragen
Datenbankverbindungen
Verwendeter Festplattenspeicher
CPU-Auslastung
0
19:30
19:40
19:50
20:00
20:10
20:20
etl-redshift-cluster
Datenfreigaben
Autorisieren Sie andere AWS-Konten für den Zugriff auf Datenfreigaben, die in diesem AWS-Konto erstellt wurden. Ordnen Sie Datenfreigaben von anderen AWS-Konten zu oder lehnen Sie sie ab.
Muss autorisiert werden
0
Zuordnung anfordern
0
Alarme (0)
In CloudWatch anzeigen
Alarmname
Keine laufenden Alarme
Ereignisse (5)
Letzte Woche
Datum
Ereignis
14 minutes ago
8:09 PM
Amazon Redshift cluster 'etl-redshift-cluster' has been created at 2024-02-07 19:09 UTC and is ready for use.
Abfragenübersicht
Beliebige Cluster
Letzte Stunde

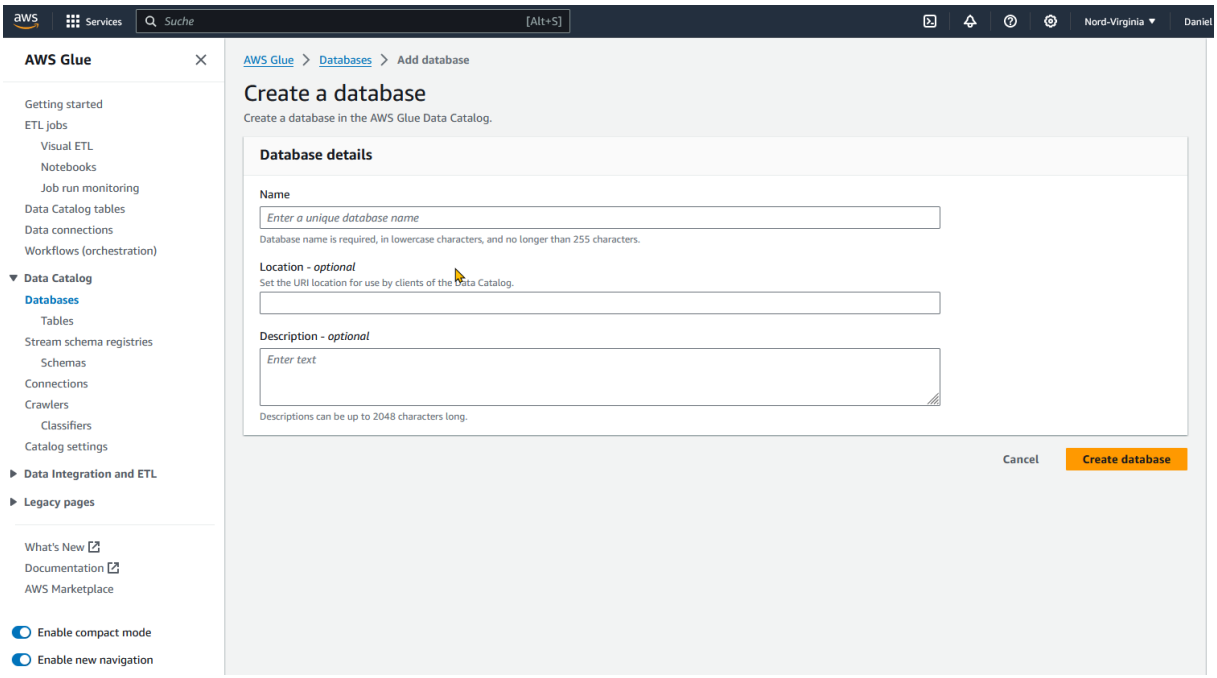

aws
Services
Suche
[Alt+S]
Nord-Virginia
AWS Glue
Getting started
ETL jobs
Visual ETL
Notebooks
Job run monitoring
Data Catalog tables
Data connections
Data Catalog
Databases
Tables
Stream schema registries
Schemas
Connections
Crawlers
Classifiers
Catalog settings
Data Integration and ETL
Legacy pages
What's New
Documentation
AWS Marketplace
Enable compact mode
Enable new navigation
AWS Glue > Connectors
Connectors Info
Marketplace connectors
Subscribe to connectors from AWS partners to expand your data sources.
Go to AWS Marketplace
Custom connectors
Provide your own connector to expand your data sources. Creating custom connectors
Create custom connector
Connectors (0) Info
Actions
You can manage your connectors or use them to create connections.
Filter connections by property
1
Name
Type
Last modified
No connectors
No connectors to display. You can create a custom connector or get a Marketplace connector.
Create custom connector
Connections (1) Info
Actions
Create connection
Create job
You can manage your connections or use a connection in a job.
Filter connections by property
1
Name
Type
Last modified
redshift-demo-connection
JDBC
Feb 07, 2024

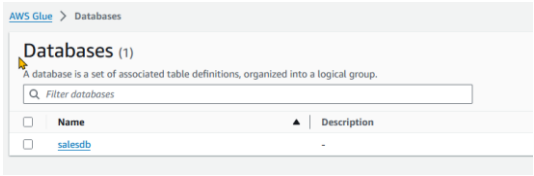
4.2 Upload csv in S3



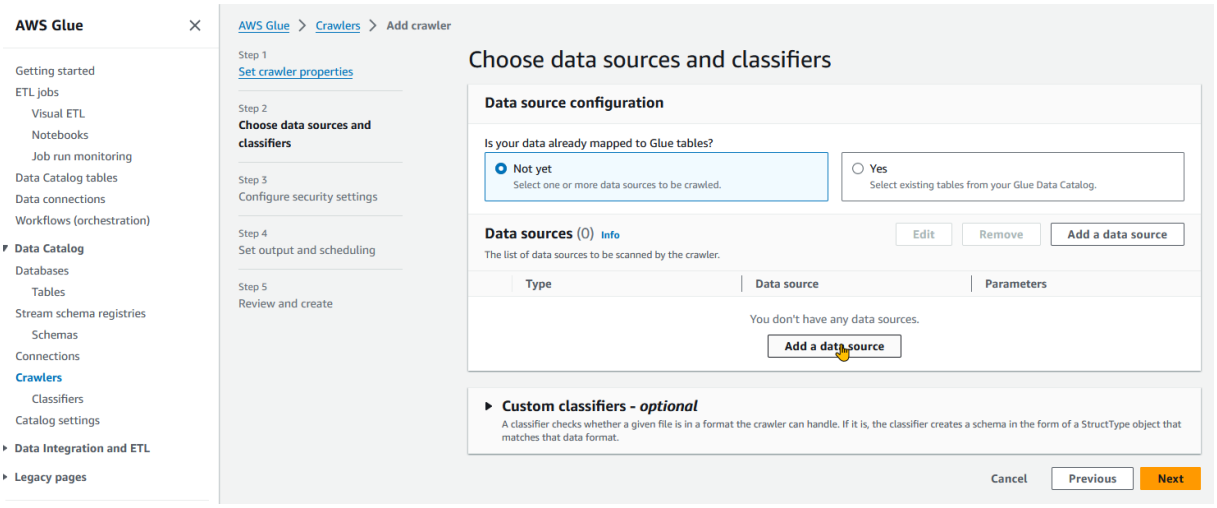


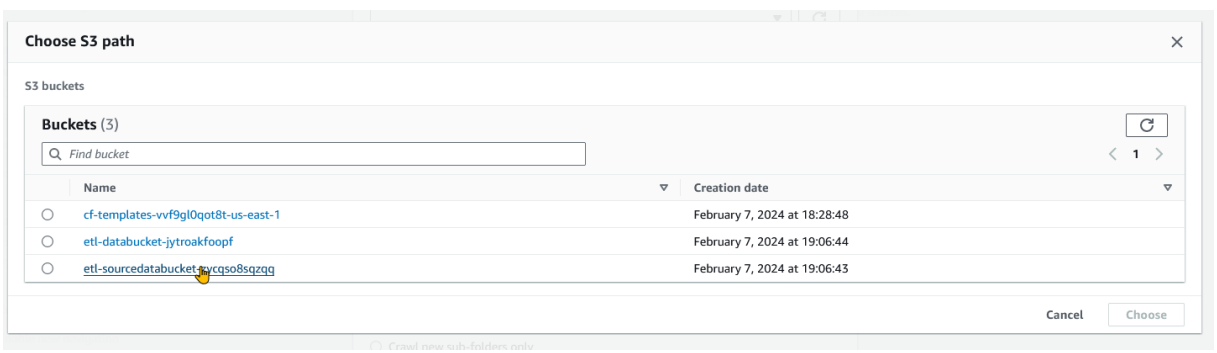
4.3 Create database

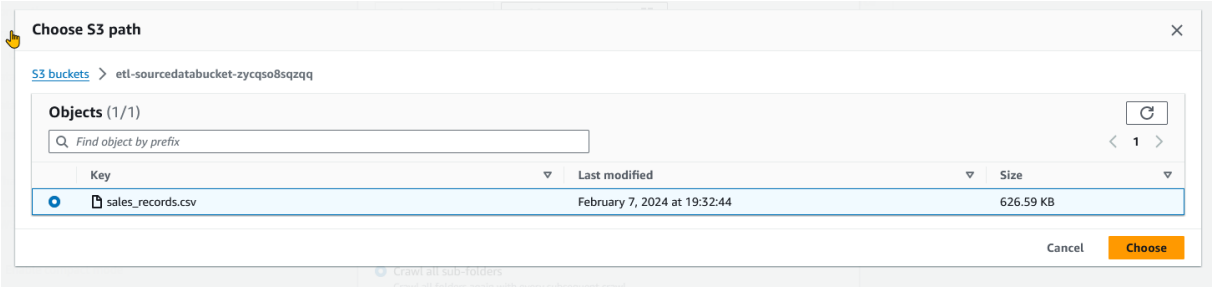


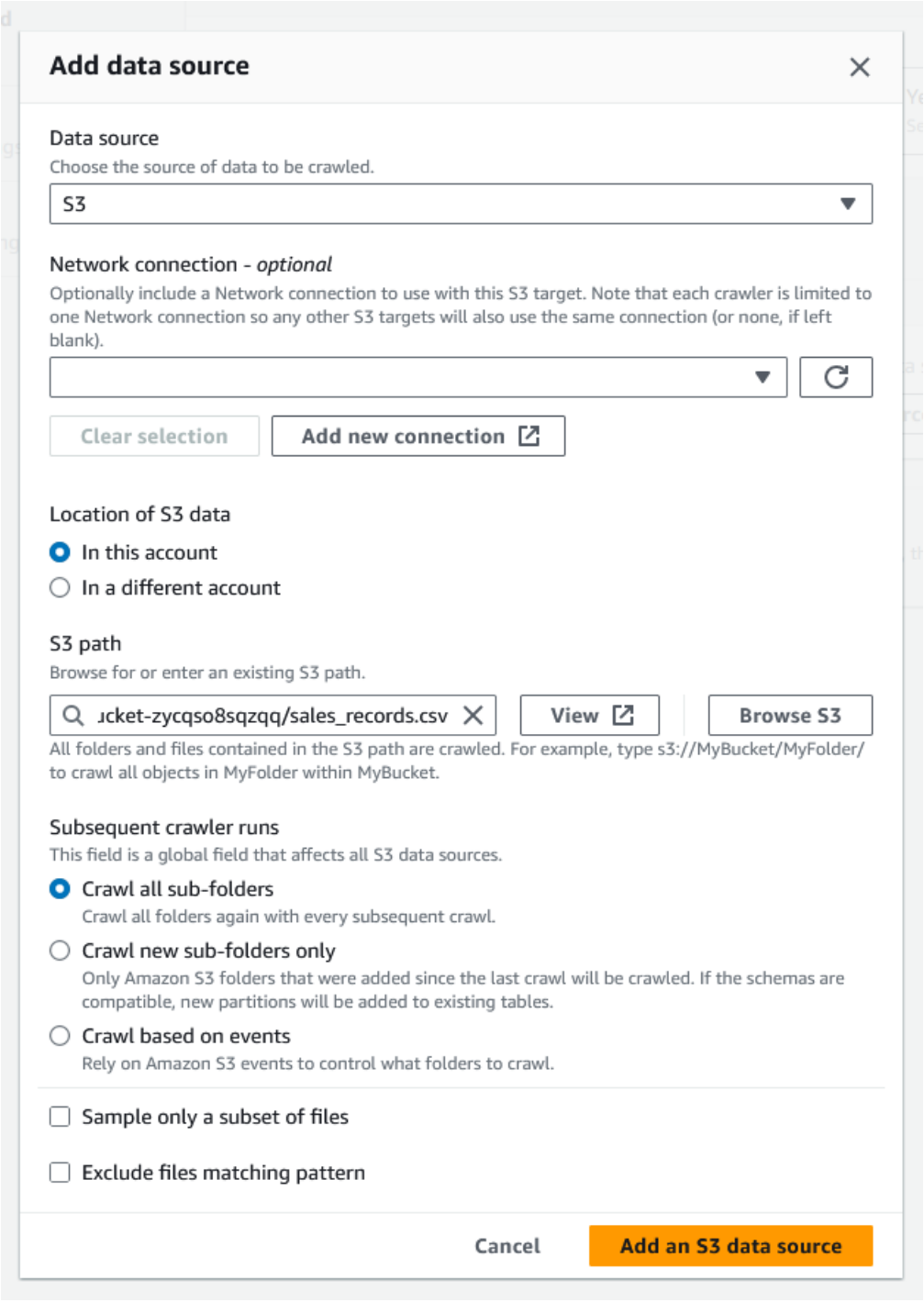


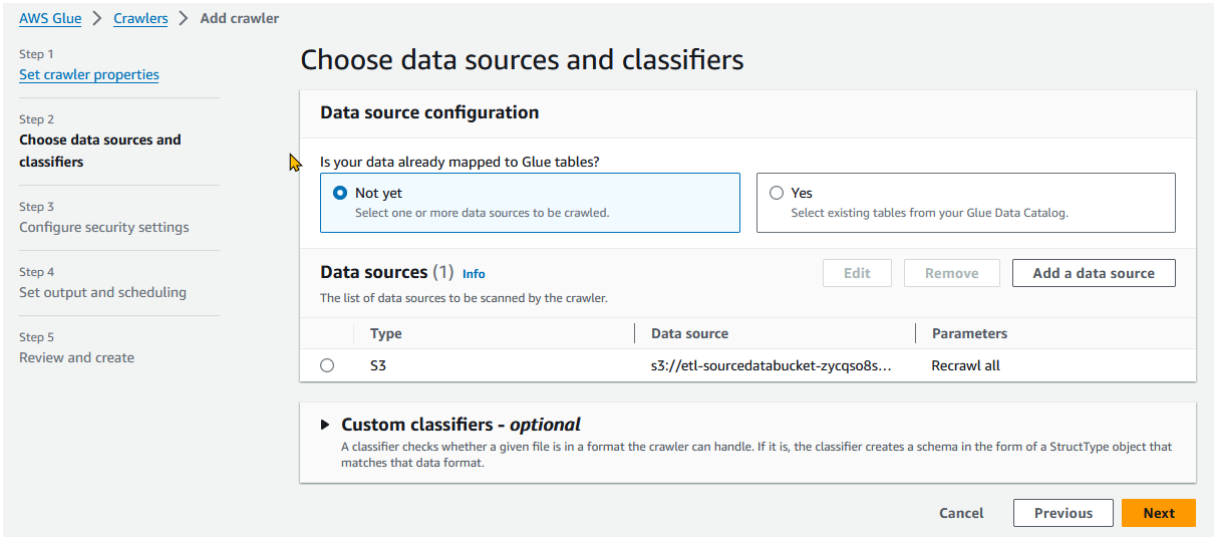
4.4 Create Crawler for tables with data souce sales_record.csv

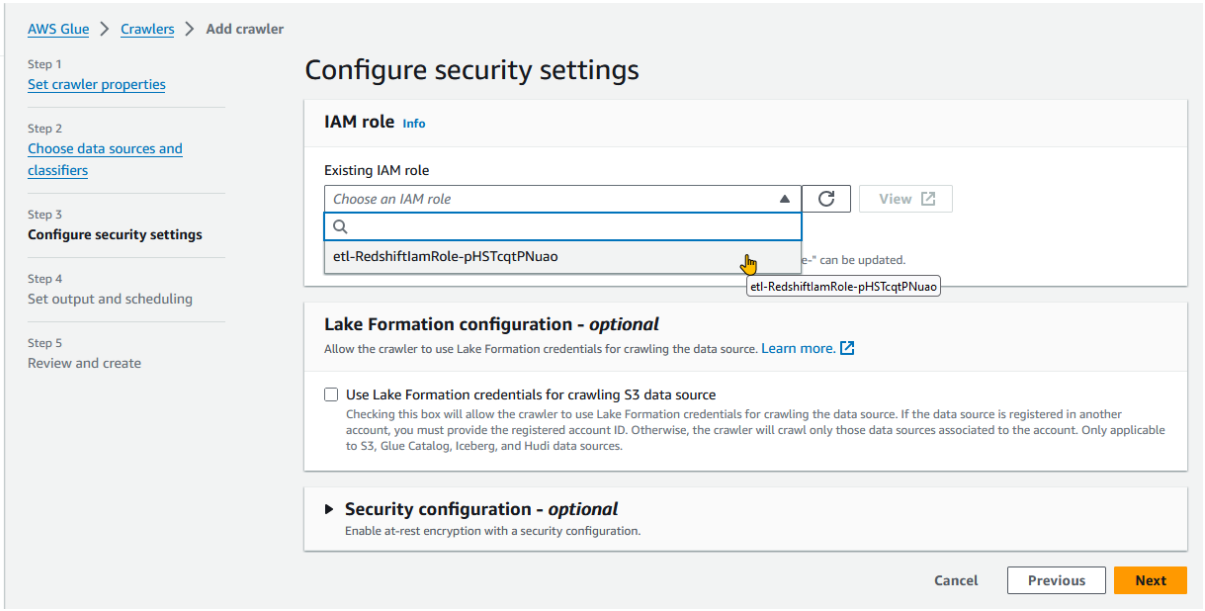


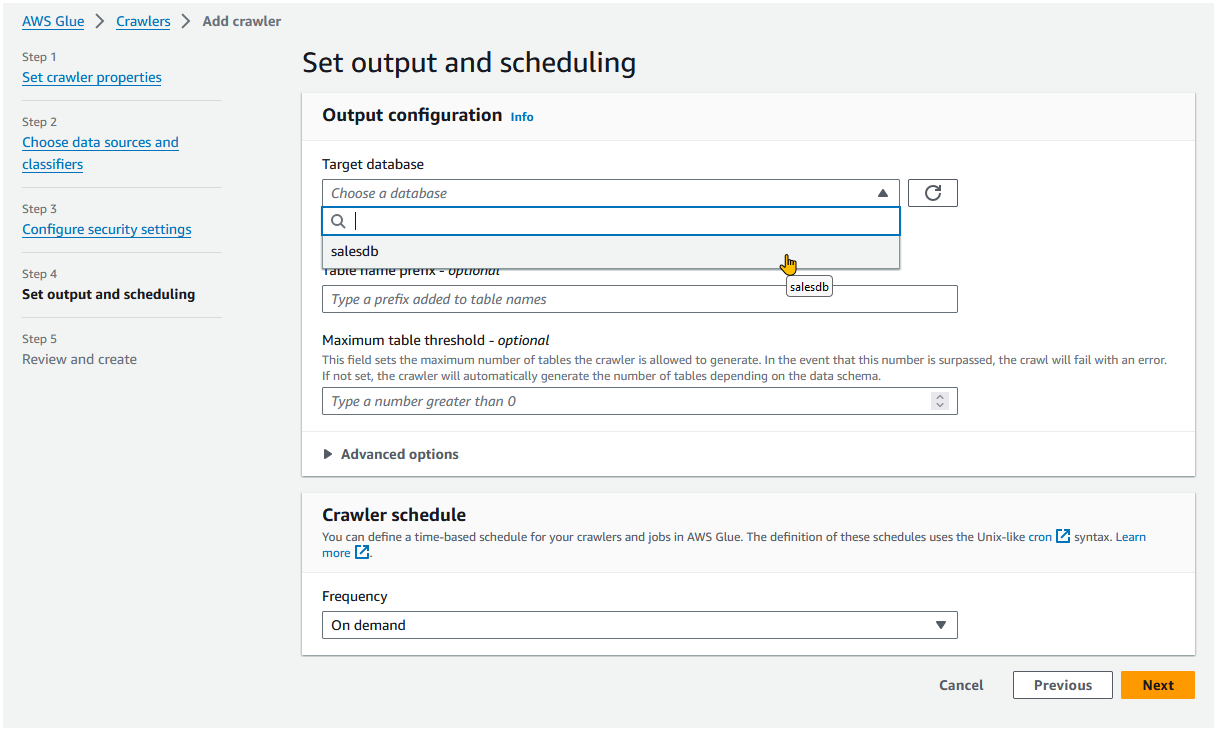


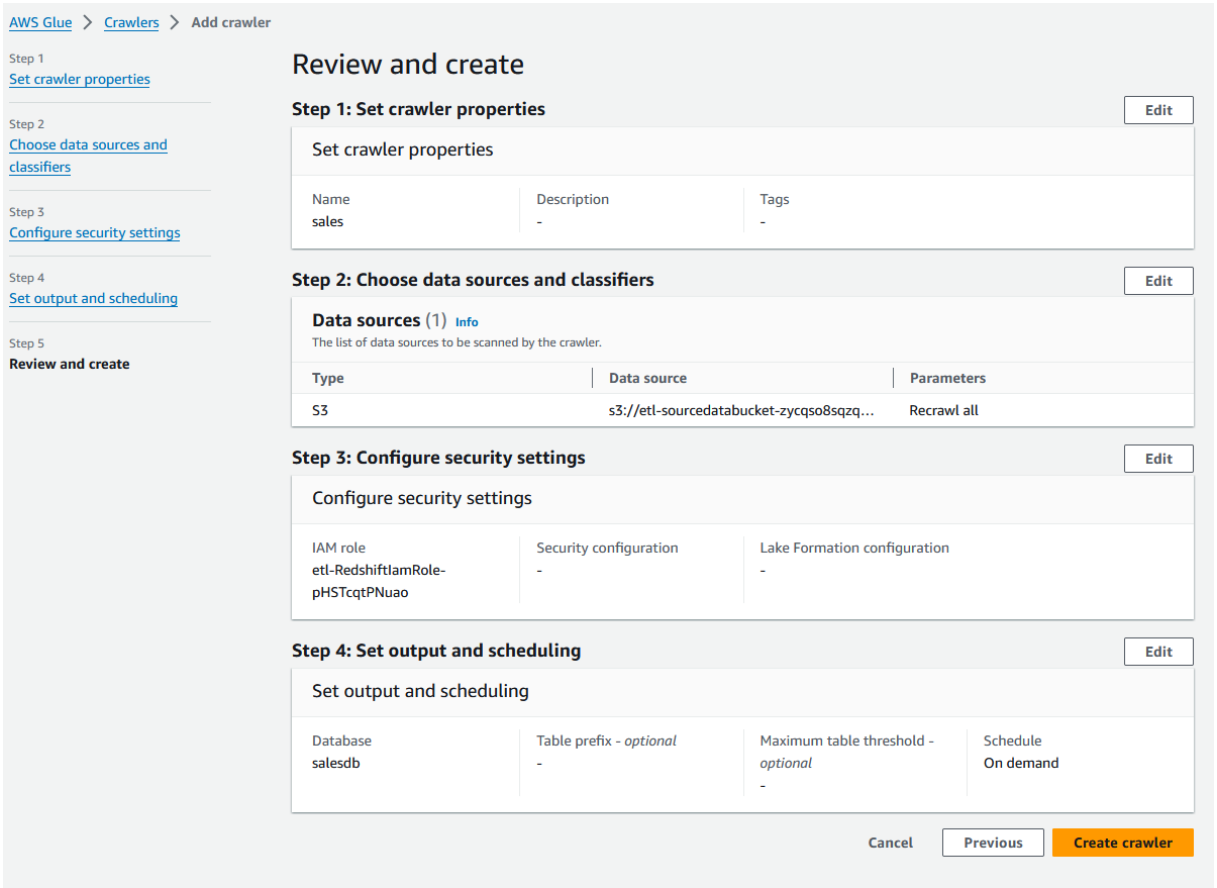

Choose S3 path
S3 buckets
etl-sourcedatabucket-zycqso8sqzqq
Objects (1/1)
Find object by prefix
1
Key
Last modified
Size
sales_records.csv
February 7, 2024 at 19:32:44
626.59 KB
Cancel
Choose

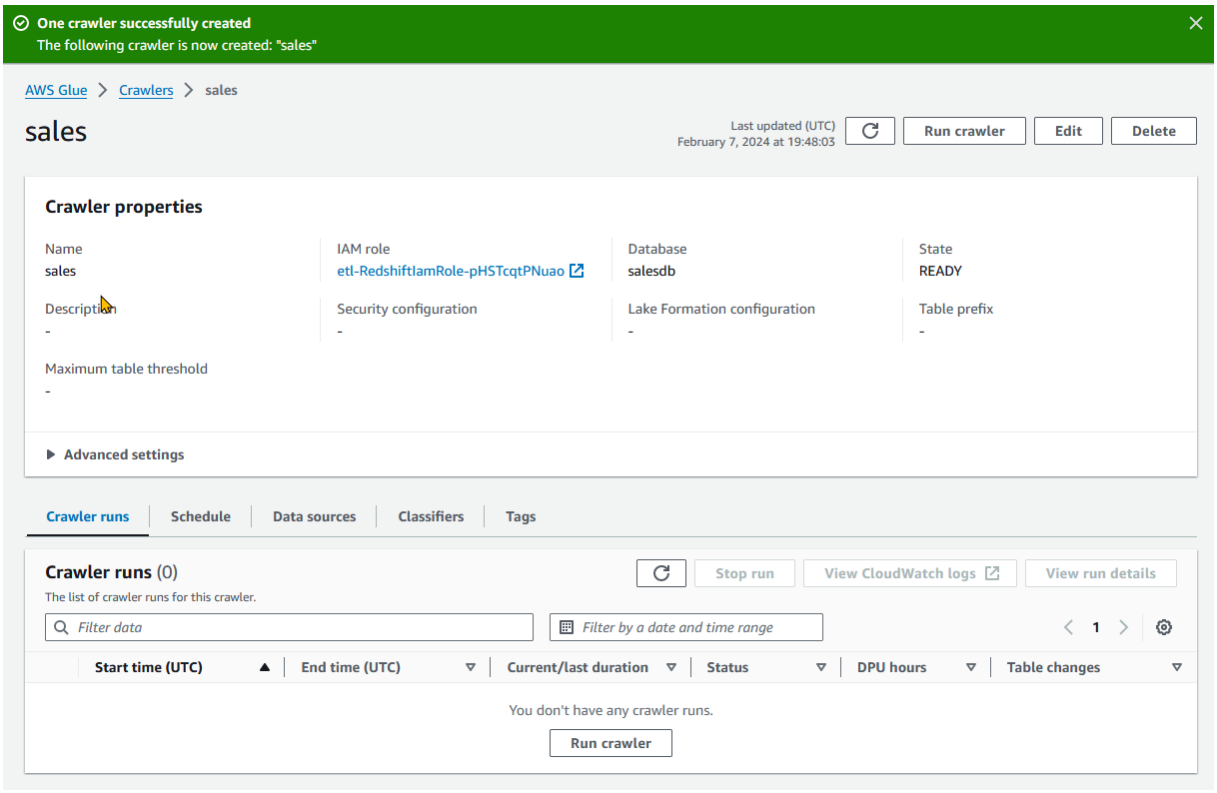

Add data source
Data source
Choose the source of data to be crawled.
S3
Network connection - optional
Optionally include a Network connection to use with this S3 target. Note that each crawler is limited to one Network connection so any other S3 targets will also use the same connection (or none, if left blank).
Clear selection
Add new connection
Location of S3 data
In this account
In a different account
S3 path
Browse for or enter an existing S3 path.
ucket-zycqso8sqzqq/sales_records.csv
View
Browse S3
All folders and files contained in the S3 path are crawled. For example, type s3://MyBucket/MyFolder/ to crawl all objects in MyFolder within MyBucket.
Subsequent crawler runs
This field is a global field that affects all S3 data sources.
Crawl all sub-folders
Crawl all folders again with every subsequent crawl.
Crawl new sub-folders only
Only Amazon S3 folders that were added since the last crawl will be crawled. If the schemas are compatible, new partitions will be added to existing tables.
Crawl based on events
Rely on Amazon S3 events to control what folders to crawl.
Sample only a subset of files
Exclude files matching pattern
Cancel
Add an S3 data source

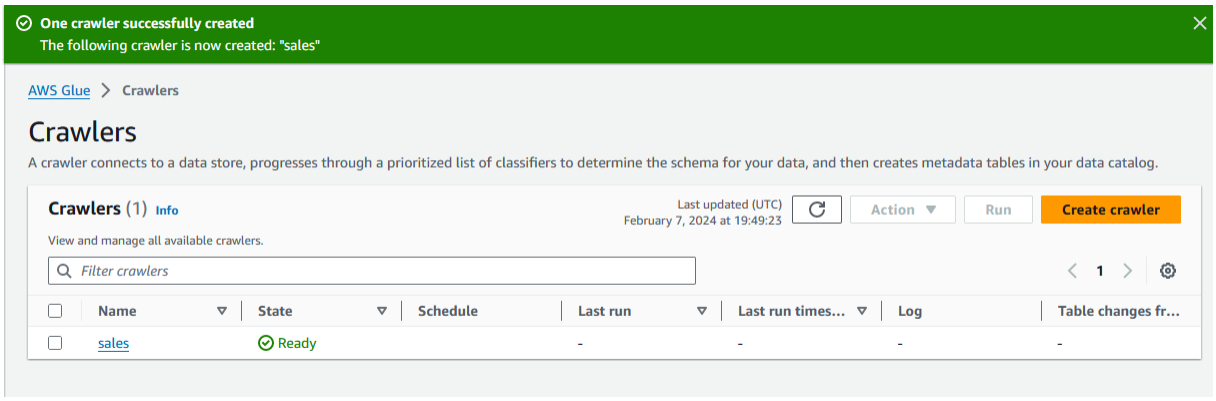

AWS Glue > Crawlers > Add crawler
Step 1
Set crawler properties
Step 2
Choose data sources and classifiers
Step 3
Configure security settings
Step 4
Set output and scheduling
Step 5
Review and create
Choose data sources and classifiers
Data source configuration
Is your data already mapped to Glue tables?
Not yet
Select one or more data sources to be crawled.
Yes
Select existing tables from your Glue Data Catalog.
Data sources (1) Info
Edit
Remove
Add a data source
The list of data sources to be scanned by the crawler.
Type
Data source
Parameters
S3
s3://etl-sourcedatabucket-zycqso8s...
Recrawl all
Custom classifiers - optional
A classifier checks whether a given file is in a format the crawler can handle. If it is, the classifier creates a schema in the form of a StructType object that matches that data format.
Cancel
Previous
Next


AWS Glue > Crawlers > Add crawler
Step 1
Set crawler properties
Step 2
Choose data sources and classifiers
Step 3
Configure security settings
Step 4
Set output and scheduling
Step 5
Review and create
Configure security settings
IAM role Info
Existing IAM role
Choose an IAM role
View
etl-RedshiftIamRole-pHSTcqtPNuao
e-* can be updated.
etl-RedshiftIamRole-pHSTcqtPNuao
Lake Formation configuration - optional
Allow the crawler to use Lake Formation credentials for crawling the data source. Learn more.
Use Lake Formation credentials for crawling S3 data source
Checking this box will allow the crawler to use Lake Formation credentials for crawling the data source. If the data source is registered in another account, you must provide the registered account ID. Otherwise, the crawler will crawl only those data sources associated to the account. Only applicable to S3, Glue Catalog, Iceberg, and Hudi data sources.
Security configuration - optional
Enable at-rest encryption with a security configuration.
Cancel
Previous
Next

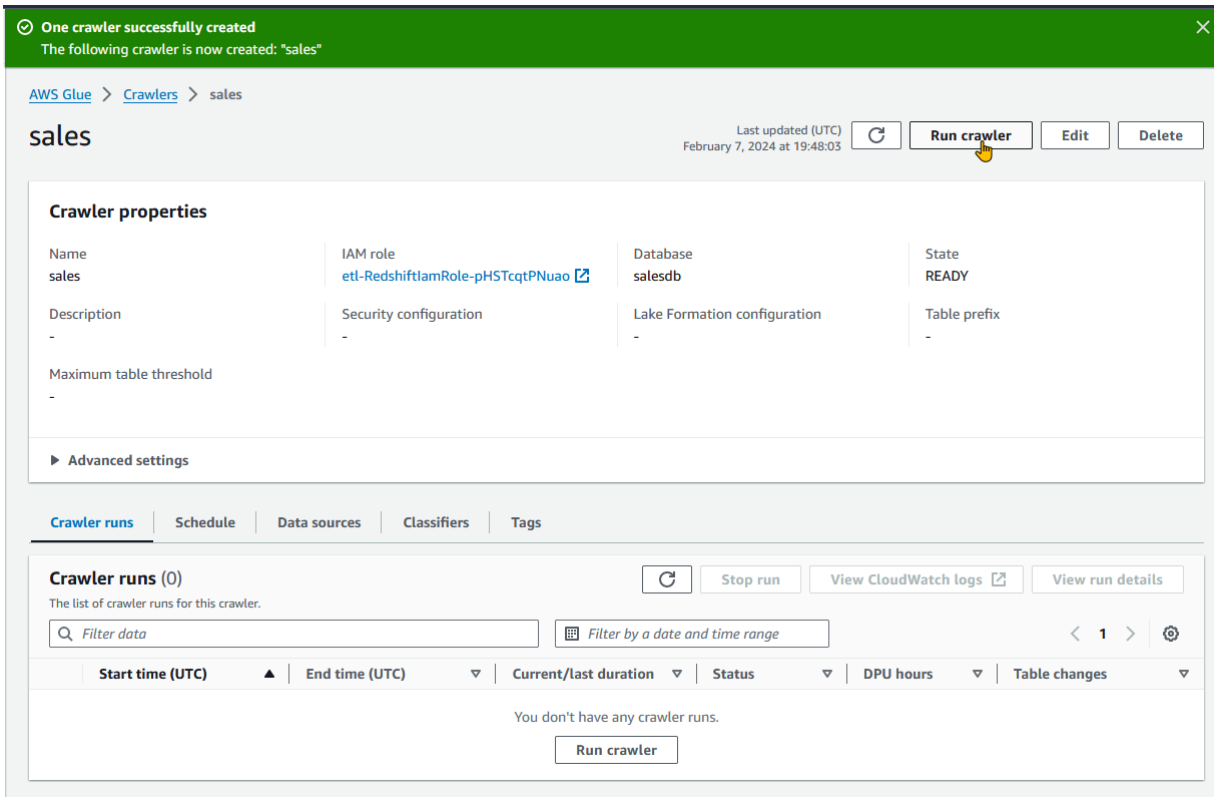

AWS Glue > Crawlers > Add crawler
Step 1
Set crawler properties
Step 2
Choose data sources and classifiers
Step 3
Configure security settings
Step 4
Set output and scheduling
Step 5
Review and create
Set output and scheduling
Output configuration Info
Target database
Choose a database
salesdb
salesdb
Type a prefix added to table names
Maximum table threshold - optional
This field sets the maximum number of tables the crawler is allowed to generate. In the event that this number is surpassed, the crawl will fail with an error. If not set, the crawler will automatically generate the number of tables depending on the data schema.
Type a number greater than 0
Advanced options
Crawler schedule
You can define a time-based schedule for your crawlers and jobs in AWS Glue. The definition of these schedules uses the Unix-like cron syntax. Learn more.
Frequency
On demand
Cancel
Previous
Next

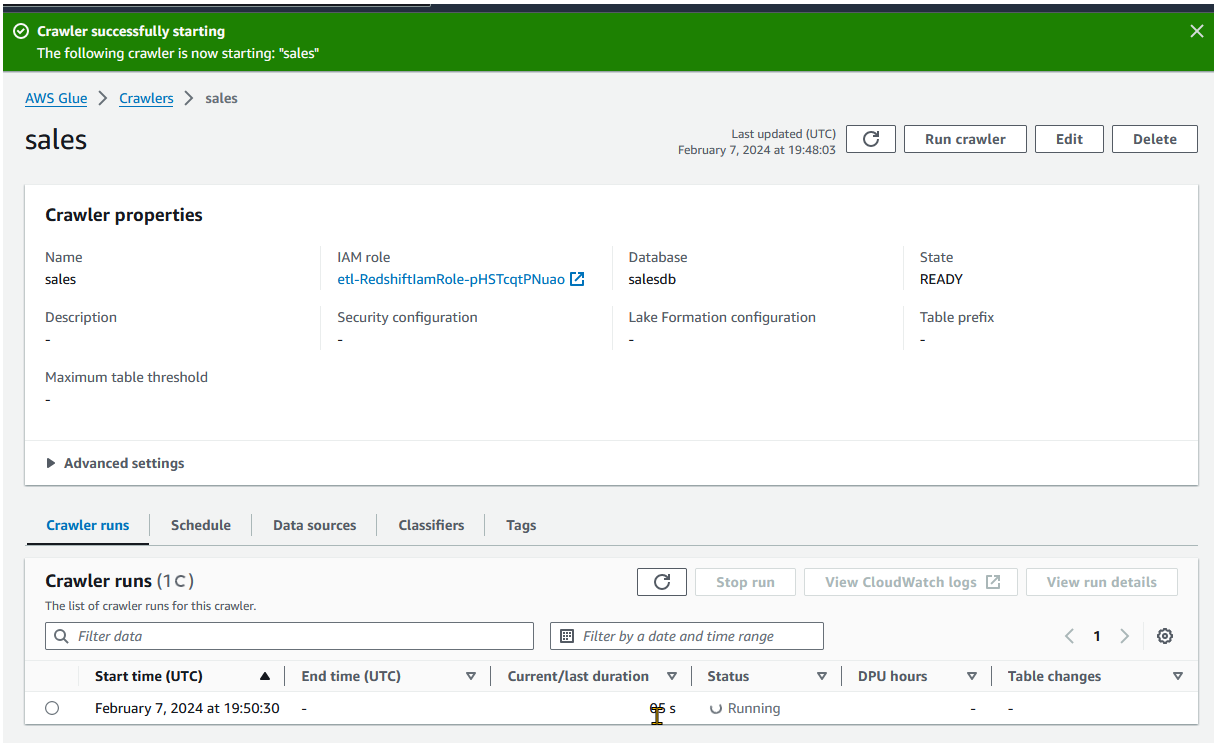

AWS Glue > Crawlers > Add crawler
Step 1
Set crawler properties
Step 2
Choose data sources and classifiers
Step 3
Configure security settings
Step 4
Set output and scheduling
Step 5
Review and create
Review and create
Step 1: Set crawler properties
Edit
Set crawler properties
Name
sales
Description
-
Tags
-
Step 2: Choose data sources and classifiers
Edit
Data sources (1) Info
The list of data sources to be scanned by the crawler.
Type
Data source
Parameters
S3
s3://etl-sourcedatabucket-zycqso8sqzq...
Recrawl all
Step 3: Configure security settings
Edit
Configure security settings
IAM role
etl-RedshiftIamRole-pHSTcqtPNuao
Security configuration
-
Lake Formation configuration
-
Step 4: Set output and scheduling
Edit
Set output and scheduling
Database
salesdb
Table prefix - optional
-
Maximum table threshold - optional
-
Schedule
On demand
Cancel
Previous
Create crawler

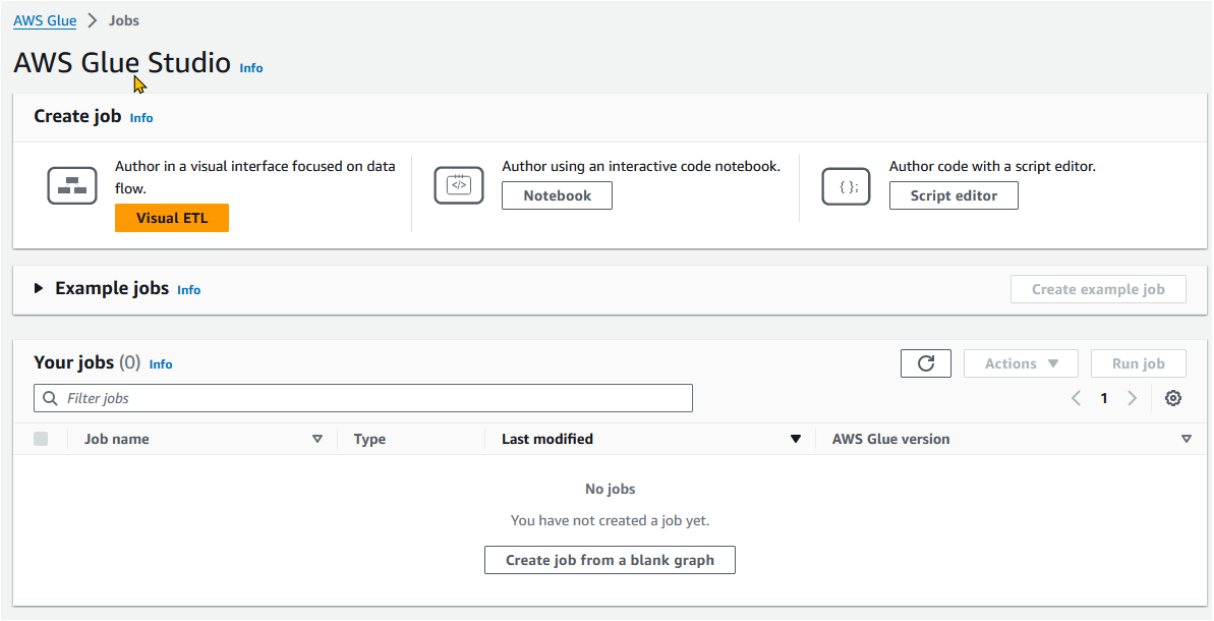

One crawler successfully created
The following crawler is now created: "sales"
AWS Glue > Crawlers > sales
sales
Last updated (UTC)
February 7, 2024 at 19:48:03
Run crawler
Edit
Delete
Crawler properties
Name
sales
IAM role
etl-RedshiftIamRole-pHSTcqtPNuao
Database
salesdb
State
READY
Description
-
Security configuration
-
Lake Formation configuration
-
Table prefix
-
Maximum table threshold
-
Advanced settings
Crawler runs
Schedule
Data sources
Classifiers
Tags
Crawler runs (0)
The list of crawler runs for this crawler.
Stop run
View CloudWatch logs
View run details
Filter data
Filter by a date and time range
1
Start time (UTC)
End time (UTC)
Current/last duration
Status
DPU hours
Table changes
You don't have any crawler runs.
Run crawler


One crawler successfully created
The following crawler is now created: "sales"
AWS Glue > Crawlers
Crawlers
A crawler connects to a data store, progresses through a prioritized list of classifiers to determine the schema for your data, and then creates metadata tables in your data catalog.
Crawlers (1) Info
Last updated (UTC)
February 7, 2024 at 19:49:23
Action
Run
Create crawler
View and manage all available crawlers.
Filter crawlers
1
Name
State
Schedule
Last run
Last run times...
Log
Table changes fr...
sales
Ready
-
-
-
-

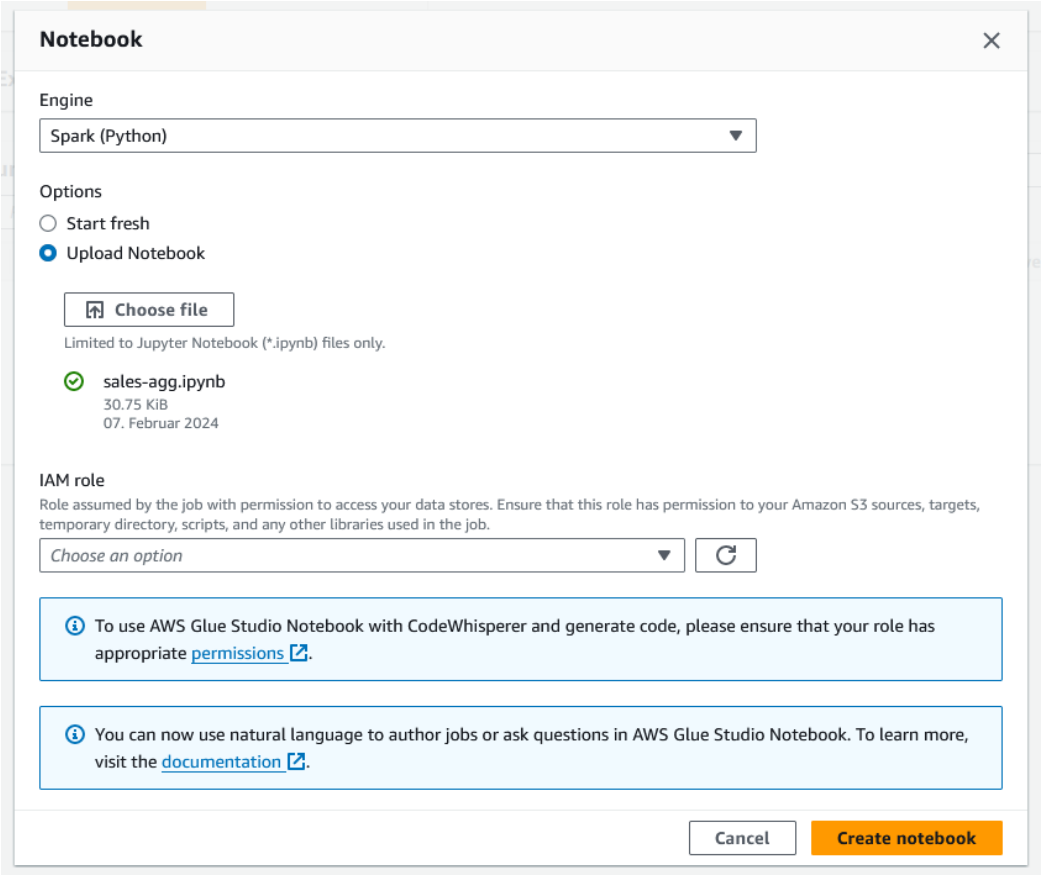
4.5 Run the crawler

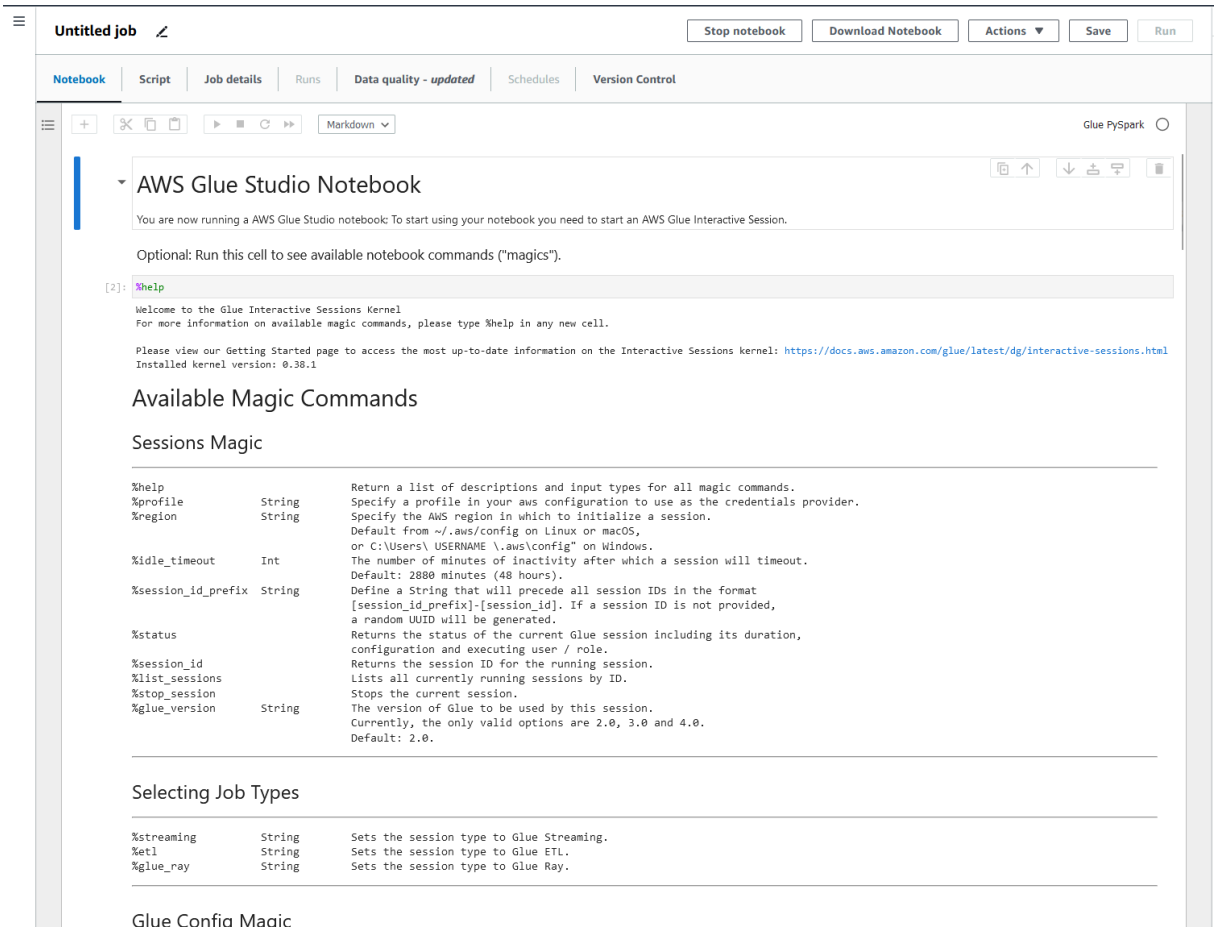




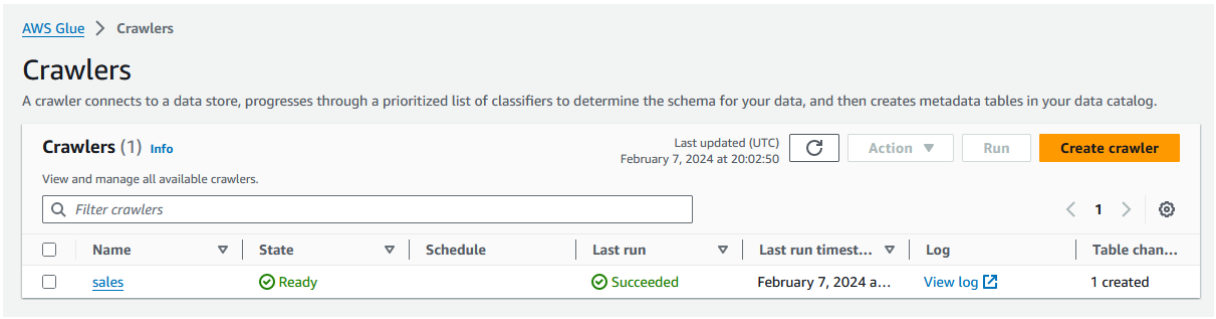


4.6 ETL Job as interactive jupyter Notebook using pyspark





Crawler run succeeded



4.6.1 Jupyter Notebook for ETL Process using Spark / Pyspark – Step by Step as interactive Notebook

Workflow steps:

- fetch data from S3 in csv format,
- catalog data,
- clean (dropping null values)
- transform (date)
- perform some aggregation
- write data to redshift db

Import Libaries & initializing Spark and glue context (main entry point for AWS glue ETL)

[1]:
```
%idle_timeout 2880
%glue_version 3.0
%worker_type G.1X
%number_of_workers 5
%connections redshift-demo-connection

import sys
from awsglue.transforms import *
from awsglue.utils import getResolvedOptions
from pyspark.context import SparkContext
from awsglue.context import GlueContext
from awsglue.job import Job
from pyspark.sql.functions import *
from awsglue.dynamicframe import DynamicFrame

sc = SparkContext.getOrCreate()
glueContext = GlueContext(sc)
spark = glueContext.spark_session
job = Job(glueContext)
```

```
Current idle_timeout is None minutes.
idle_timeout has been set to 2880 minutes.
Setting Glue version to: 3.0
Previous worker type: None
Setting new worker type to: G.1X
Previous number of workers: None
Setting new number of workers to: 5
Connections to be included:
redshift-demo-connection
Trying to create a Glue session for the kernel.
Session Type: glueetl
Worker Type: G.1X
Number of Workers: 5
Session ID: db9dda3f-c514-47dd-9f9e-3bb59152b943
Applying the following default arguments:
--glue_kernel_version 1.0.2
--enable-glue-datacatalog true
Waiting for session db9dda3f-c514-47dd-9f9e-3bb59152b943 to get into ready status...
Session db9dda3f-c514-47dd-9f9e-3bb59152b943 has been created.
```

Example: Create a DynamicFrame from a table in the AWS Glue Data Catalog , dropping null records and display its schema

```
dyf = glueContext.create_dynamic_frame.from_catalog(database='salesdb', table_name='sales_records_csv')
dyf = DropNullFields.apply(frame=dyf)
dyf.printSchema()
```

```
null_fields []
root
|-- id: long
|-- region: string
|-- country: string
|-- item_type: string
|-- sales_channel: string
|-- order_priority: string
|-- order_date: string
|-- order_id: long
|-- ship_date: string
|-- units_sold: long
|-- unit_price: double
|-- unit_cost: double
|-- total_revenue: double
|-- total_cost: double
|-- total_profit: double
```

Dynamic DataFrame similar to spark dataframe but different syntax to perfom action

Example: Convert the DynamicFrame to a Spark DataFrame and display a sample of the data

[3]:
```
df = dyf.toDF()
df.show()
```

```
+---+--------------------+--------------------+--------------+-------------+--------------+----------+---------+----------+----------+----------+
---------+-------------+----------+------------+
| id|              region|             country|     item_type|sales_channel|order_priority|order_date| order_id| ship_date|units_sold|unit_price|uni
t_cost|total_revenue|total_cost|total_profit|
+---+--------------------+--------------------+--------------+-------------+--------------+----------+---------+----------+----------+----------+
---------+-------------+----------+------------+
|  1|Central America a...|Antigua and Barbuda |     Baby Food|       Online|             M|12/20/2013|957081544| 1/11/2014|       552|    255.28|
159.42|    140914.56|  87999.84|    52914.72|
|  2|Central America a...|              Panama|        Snacks|      Offline|             C|  7/5/2010|301644504| 7/26/2010|      2167|    152.58|
97.44|    330640.86| 211152.48|   119488.38|
|  3|              Europe|      Czech Republic|     Beverages|      Offline|             C| 9/12/2011|478051030| 9/29/2011|      4778|     47.45|
31.79|     226716.1| 151892.62|    74823.48|
|  4|                Asia|         North Korea|        Cereal|      Offline|             L| 5/13/2010|892599952| 6/15/2010|      9016|     205.7|
117.11|    1854591.2|1055863.76|   798727.44|
|  5|                Asia|           Sri Lanka|        Snacks|      Offline|             C| 7/20/2015|571902596| 7/27/2015|      7542|    152.58|
97.44|   1150758.36| 734892.48|   415865.88|
|  6|Middle East and N...|             Morocco|  Personal Care|      Offline|             L| 11/8/2010|412882792|11/22/2010|        48|     81.73|
56.67|      3923.04|   2720.16|     1202.88|
|  7|Australia and Oce...|Federated States ...|       Clothes|      Offline|             H| 3/28/2011|932776868| 5/10/2011|      8258|    109.28|
35.84|    902434.24| 295966.72|   606467.52|
|  8|              Europe|Bosnia and Herzeg...|       Clothes|       Online|             M|10/14/2013|919133651| 11/4/2013|       927|    109.28|
35.84|    101302.56|  33223.68|    68078.88|
|  9|Middle East and N...|         Afghanistan|       Clothes|      Offline|             M| 8/27/2016|579814469| 10/5/2016|      8841|    109.28|
35.84|    966144.48| 316861.44|   649283.04|
| 10|  Sub-Saharan Africa|            Ethiopia|     Baby Food|       Online|             M| 4/13/2015|192993152|  5/7/2015|      9817|    255.28|
159.42|   2506083.76|1565026.14|   941057.62|
| 11|Middle East and N...|              Turkey|Office Supplies|      Offline|             C| 9/25/2013|557156026|10/15/2013|      3704|    651.21|
```

Date Transformation

Example: Perform data transformations

[4]:
```
spark.sql("set spark.sql.legacy.timeParserPolicy=LEGACY")
sales_df = df.withColumn("Order_Date", to_date(unix_timestamp(col('order_date'), 'MM/dd/yyyy').cast('timestamp'))) \
             .withColumn("Ship_Date", to_date(unix_timestamp(col('ship_date'), 'MM/dd/yyyy').cast('timestamp')))

sales_df.show(10, True)
```

```
+---+--------------------+--------------------+--------------+-------------+--------------+----------+---------+----------+----------+----------+
---------+-------------+----------+------------+
| id|              region|             country|     item_type|sales_channel|order_priority|Order_Date| order_id| Ship_Date|units_sold|unit_price|unit_
cost|total_revenue|total_cost|total_profit|
+---+--------------------+--------------------+--------------+-------------+--------------+----------+---------+----------+----------+----------+
---------+-------------+----------+------------+
|  1|Central America a...|Antigua and Barbuda |     Baby Food|       Online|             M|2013-12-20|957081544|2014-01-11|       552|    255.28|   15
9.42|    140914.56|  87999.84|    52914.72|
|  2|Central America a...|              Panama|        Snacks|      Offline|             C|2010-07-05|301644504|2010-07-26|      2167|    152.58|    9
7.44|    330640.86| 211152.48|   119488.38|
|  3|              Europe|      Czech Republic|     Beverages|      Offline|             C|2011-09-12|478051030|2011-09-29|      4778|     47.45|    3
1.79|     226716.1| 151892.62|    74823.48|
|  4|                Asia|         North Korea|        Cereal|      Offline|             L|2010-05-13|892599952|2010-06-15|      9016|     205.7|   11
7.11|    1854591.2|1055863.76|   798727.44|
|  5|                Asia|           Sri Lanka|        Snacks|      Offline|             C|2015-07-20|571902596|2015-07-27|      7542|    152.58|    9
7.44|   1150758.36| 734892.48|   415865.88|
|  6|Middle East and N...|             Morocco|  Personal Care|      Offline|             L|2010-11-08|412882792|2010-11-22|        48|     81.73|    5
6.67|      3923.04|   2720.16|     1202.88|
|  7|Australia and Oce...|Federated States ...|       Clothes|      Offline|             H|2011-03-28|932776868|2011-05-10|      8258|    109.28|    3
```

Group by Region and Country and calculate aggregate metrics

[5]:
```
aggregate_df = sales_df.groupBy("Region", "Country", year("order_date").alias('year'), quarter("order_date").alias('quarter')).agg(
    sum("Total_Revenue").alias("Total_Revenue_By_Region_Country"),
    sum("Total_Cost").alias("Total_Cost_By_Region_Country"),
    sum("Total_Profit").alias("Total_Profit_By_Region_Country")
)
```

Show the aggregated data (for demonstration purposes) ¶

[6]:
```
aggregate_df.orderBy("year","quarter").show()
aggregate_df.count()
```

```
+--------------------+--------------------+----+-------+-----------------------------+---------------------------+-----------------------------+
|              Region|             Country|year|quarter|Total_Revenue_By_Region_Country|Total_Cost_By_Region_Country|Total_Profit_By_Region_Country|
+--------------------+--------------------+----+-------+-----------------------------+---------------------------+-----------------------------+
|                Asia|         South Korea|2010|      1|                     44700.03|                   33153.72|                     11546.31|
|Middle East and N...|                Iran|2010|      1|                   2931671.66|                 2239089.38|                    692582.28|
|Central America a...|         El Salvador|2010|      1|                    1886886.1|                 1074250.03|                    812636.07|
|Middle East and N...|             Algeria|2010|      1|                    229050.88|                   75120.64|                    153930.24|
|              Europe|         Switzerland|2010|      1|                    255802.95|                  171379.89|                     84423.06|
|Central America a...|             Jamaica|2010|      1|                   1573974.57|                 1268828.32|                    305146.25|
|              Europe|          Luxembourg|2010|      1|                   1123251.46|                  662970.63|                    460280.83|
|              Europe|              Sweden|2010|      1|                    4149902.4|                 2499528.36|                   1650374.04|
|                Asia|           Sri Lanka|2010|      1|                    200419.52|                   65730.56|                    134688.96|
|              Europe|             Andorra|2010|      1|           3348578.1900000004|         2008080.1500000001|                   1340498.04|
|Middle East and N...|                Oman|2010|      1|                   2680430.97|                 2015687.94|                    664743.03|
|              Europe|              Kosovo|2010|      1|                    677247.76|                  399728.28|                    277519.48|
|Middle East and N...|             Somalia|2010|      1|                   2485916.64|                 1552431.96|                    933484.68|
|Central America a...|Saint Kitts and N...|2010|      1|                    245126.7|                  164227.14|                     80899.56|
|Australia and Oce...|          East Timor|2010|      1|                   1271998.35|                 1099540.35|                    172458.0|
|              Europe|               Italy|2010|      1|                    438322.08|                  143754.24|                    294567.84|
|                Asia|            Cambodia|2010|      1|           5682062.319999999|         4130533.3400000003|          1551528.9800000002|
|              Europe|            Bulgaria|2010|      1|                    1829789.5|                  839380.1499999999|                    990409.35|
|  Sub-Saharan Africa|              Zambia|2010|      1|                    5837205.6|                  4453417.91|                   1383787.69|
|       North America|              Mexico|2010|      1|                    538028.59|                  373058.61|                    164969.98|
+--------------------+--------------------+----+-------+-----------------------------+---------------------------+-----------------------------+
only showing top 20 rows
```

Renaming the cloumns and displaying the content in a sorted manner.

[7]:
```
aggregate_df= aggregate_df.withColumnRenamed("Total_Revenue_By_Region_Country","Total_Revenue")\
                          .withColumnRenamed("Total_Cost_By_Region_Country","Total_Cost")\
                          .withColumnRenamed("Total_Profit_By_Region_Country","Total_Profit")
aggregate_df.orderBy("year","quarter").show()
```

```
+--------------------+--------------------+----+-------+-----------------+-----------------+-----------------+
|              Region|             Country|year|quarter|    Total_Revenue|       Total_Cost|     Total_Profit|
+--------------------+--------------------+----+-------+-----------------+-----------------+-----------------+
|              Europe|              Serbia|2010|      1|        627485.76|        205793.28|        421692.48|
|Central America a...|             Jamaica|2010|      1|       1573974.57|       1268828.32|        305146.25|
|Central America a...|         El Salvador|2010|      1|        1886886.1|       1074250.03|        812636.07|
|              Europe|             Andorra|2010|      1|3348578.1900000004|2008080.1500000001|       1340498.04|
|Middle East and N...|                Iran|2010|      1|       2931671.66|       2239089.38|        692582.28|
|              Europe|            Bulgaria|2010|      1|        1829789.5| 839380.1499999999|        990409.35|
|              Europe|          Luxembourg|2010|      1|       1123251.46|        662970.63|        460280.83|
|       North America|              Mexico|2010|      1|        538028.59|        373058.61|        164969.98|
|Middle East and N...|             Algeria|2010|      1|        229050.88|         75120.64|        153930.24|
|Middle East and N...|                Oman|2010|      1|       2680430.97|       2015687.94|        664743.03|
|              Europe|         Switzerland|2010|      1|        255802.95|        171379.89|         84423.06|
|                Asia|            Cambodia|2010|      1| 5682062.319999999|4130533.3400000003|1551528.9800000002|
|              Europe|              Kosovo|2010|      1|        677247.76|        399728.28|        277519.48|
|Australia and Oce...|          East Timor|2010|      1|       1271998.35|       1099540.35|         172458.0|
|              Europe|               Italy|2010|      1|        438322.08|        143754.24|        294567.84|
|              Europe|              Sweden|2010|      1|        4149902.4|       2499528.36|       1650374.04|
|Central America a...|Saint Kitts and N...|2010|      1|         245126.7|        164227.14|         80899.56|
|Middle East and N...|             Somalia|2010|      1|       2485916.64|       1552431.96|        933484.68|
|                Asia|           Sri Lanka|2010|      1|        200419.52|         65730.56|        134688.96|
|  Sub-Saharan Africa|              Zambia|2010|      1|        5837205.6|       4453417.91|       1383787.69|
+--------------------+--------------------+----+-------+-----------------+-----------------+-----------------+
only showing top 20 rows
```

Example: Convert the Spark DataFrame to a DynamicFrame and display a sample of the data

[8]:
```
dyf = DynamicFrame.fromDF(aggregate_df, glueContext, "dynamic_frame")
```

Example: load the dynamic frame into our Amazon Redshift cluster

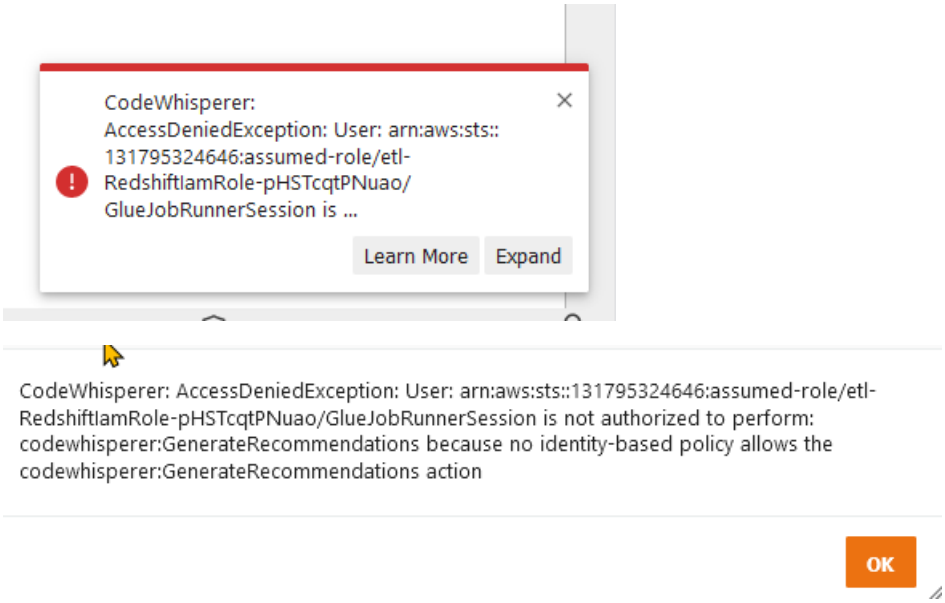
[9]:
```
dyf.show()
```


```
{"Region": "Europe", "Country": "Luxembourg", "year": 2010, "quarter": 1, "Total_Revenue": 1123251.46, "Total_Cost": 662970.63, "Total_Profit": 460280.83}
{"Region": "Europe", "Country": "Switzerland", "year": 2014, "quarter": 1, "Total_Revenue": 4429651.8, "Total_Cost": 2873705.61, "Total_Profit": 1555946.19}
{"Region": "Central America and the Caribbean", "Country": "Dominica", "year": 2010, "quarter": 2, "Total_Revenue": 1255966.53, "Total_Cost": 1085682.13, "Total_Profit": 170284.4}
{"Region": "Australia and Oceania", "Country": "Federated States of Micronesia", "year": 2012, "quarter": 2, "Total_Revenue": 5588354.33, "Total_Cost": 4029198.36, "Total_Profit": 1559155.97}
{"Region": "Europe", "Country": "Poland", "year": 2015, "quarter": 4, "Total_Revenue": 5740416.15, "Total_Cost": 4627522.4, "Total_Profit": 1112893.75}
{"Region": "Sub-Saharan Africa", "Country": "Namibia", "year": 2016, "quarter": 1, "Total_Revenue": 1861809.39, "Total_Cost": 1500860.64, "Total_Profit": 360948.75}
{"Region": "Europe", "Country": "Estonia", "year": 2011, "quarter": 2, "Total_Revenue": 657986.0, "Total_Cost": 396311.65, "Total_Profit": 261674.35}
{"Region": "Europe", "Country": "Armenia", "year": 2011, "quarter": 1, "Total_Revenue": 1000641.06, "Total_Cost": 647551.76, "Total_Profit": 353089.3}
{"Region": "Europe", "Country": "Denmark", "year": 2016, "quarter": 2, "Total_Revenue": 27948.05, "Total_Cost": 18724.31, "Total_Profit": 9223.74}
{"Region": "Middle East and North Africa", "Country": "Lebanon", "year": 2011, "quarter": 2, "Total_Revenue": 3937826.65, "Total_Cost": 2884792.9, "Total_Profit": 1053033.75}
{"Region": "Central America and the Caribbean", "Country": "Jamaica", "year": 2013, "quarter": 3, "Total_Revenue": 792397.3799999999, "Total_Cost": 629472.22, "Total_Profit": 162925.16}
{"Region": "Middle East and North Africa", "Country": "Afghanistan", "year": 2013, "quarter": 2, "Total_Revenue": 278255.2, "Total_Cost": 173767.8, "Total_Profit": 104487.4}
{"Region": "Europe", "Country": "Spain", "year": 2011, "quarter": 4, "Total_Revenue": 4544537.69, "Total_Cost": 3633328.41, "Total_Profit": 911209.28}
{"Region": "Asia", "Country": "Taiwan", "year": 2014, "quarter": 4, "Total_Revenue": 3204577.16, "Total_Cost": 1694851.36, "Total_Profit": 1509725.7999999998}
{"Region": "Europe", "Country": "Macedonia", "year": 2014, "quarter": 3, "Total_Revenue": 4672951.7, "Total_Cost": 3482977.09, "Total_Profit": 1189974.61}
{"Region": "Sub-Saharan Africa", "Country": "Liberia", "year": 2015, "quarter": 4, "Total_Revenue": 871139.5, "Total_Cost": 495960.85, "Total_Profit": 375178.65}
{"Region": "Central America and the Caribbean", "Country": "Jamaica", "year": 2017, "quarter": 2, "Total_Revenue": 6577657.34, "Total_Cost": 4587400.02, "Total_Profit": 1990257.3199999998}
{"Region": "Sub-Saharan Africa", "Country": "Senegal", "year": 2011, "quarter": 3, "Total_Revenue": 80527.23, "Total_Cost": 59726.52, "Total_Profit": 20800.71}
{"Region": "Asia", "Country": "Turkmenistan", "year": 2010, "quarter": 4, "Total_Revenue": 3508859.13, "Total_Cost": 3033126.73, "Total_Profit": 475732.4}
{"Region": "Middle East and North Africa", "Country": "Saudi Arabia", "year": 2013, "quarter": 4, "Total_Revenue": 9850970.7, "Total_Cost": 7127364.779999999, "Total Profit": 2723605.92}
```


Writing dynamicFrame to Redshift
Authorization access problem

[10]:
```
redshift_output = glueContext.write_dynamic_frame.from_jdbc_conf(
    frame=dyf,
    catalog_connection="redshift-demo-connection",
    connection_options={"dbtable": "public.Regionalsales","database":"dev"},
    redshift_tmp_dir = "s3://aws-glue-assets-262136919150-us-east-1/temporary/",
    transformation_ctx = "redshift_output"
)
```

```
Py4JJavaError: An error occurred while calling o140.pyWriteDynamicFrame.
: java.io.IOException: com.amazon.ws.emr.hadoop.fs.shaded.com.amazonaws.services.s3.model.AmazonS3Exception: Access Denied (Service: Amazon S3; Status Code: 403; Error Code: AccessDenied; Request ID: A6MX3A6X22NX7BK4; S3 Extended Request ID: NDKfHBBP8vpeTqgOqn0AIT8WLWESsLUrDt9MgNfYZ/VPtWFBkx9bVDat0sQzXpjoGazn2T1Dcus=; Proxy: null), S3 Extended Request ID: NDKfHBBP8vpeTqgOqn0AIT8WLWESsLUrDt9MgNfYZ/VPtWFBkx9bVDat0sQzXpjoGazn2T1Dcus=
        at com.amazon.ws.emr.hadoop.fs.s3n.Jets3tNativeFileSystemStore.list(Jets3tNativeFileSystemStore.java:303)
        at com.amazon.ws.emr.hadoop.fs.s3n.S3NativeFileSystem.getFileStatus(S3NativeFileSystem.java:510)
        at org.apache.hadoop.fs.FileSystem.exists(FileSystem.java:1690)
        at com.amazon.ws.emr.hadoop.fs.EmrFileSystem.exists(EmrFileSystem.java:436)
        at org.apache.spark.sql.execution.datasources.InsertIntoHadoopFsRelationCommand.run(InsertIntoHadoopFsRelationCommand.scala:124)
        at org.apache.spark.sql.execution.command.DataWritingCommandExec.sideEffectResult$lzycompute(commands.scala:108)
        at org.apache.spark.sql.execution.command.DataWritingCommandExec.sideEffectResult(commands.scala:106)
        at org.apache.spark.sql.execution.command.DataWritingCommandExec.doExecute(commands.scala:131)
        at org.apache.spark.sql.execution.SparkPlan.$anonfun$execute$1(SparkPlan.scala:185)
        at org.apache.spark.sql.execution.SparkPlan.$anonfun$executeQuery$1(SparkPlan.scala:223)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:151)
        at org.apache.spark.sql.execution.SparkPlan.executeQuery(SparkPlan.scala:220)
        at org.apache.spark.sql.execution.SparkPlan.execute(SparkPlan.scala:181)
        at org.apache.spark.sql.execution.QueryExecution.toRdd$lzycompute(QueryExecution.scala:134)
        at org.apache.spark.sql.execution.QueryExecution.toRdd(QueryExecution.scala:133)
        at org.apache.spark.sql.DataFrameWriter.$anonfun$runCommand$1(DataFrameWriter.scala:989)
        at org.apache.spark.sql.catalyst.QueryPlanningTracker$.withTracker(QueryPlanningTracker.scala:107)
        at org.apache.spark.sql.execution.SQLExecution$.withTracker(SQLExecution.scala:232)
```

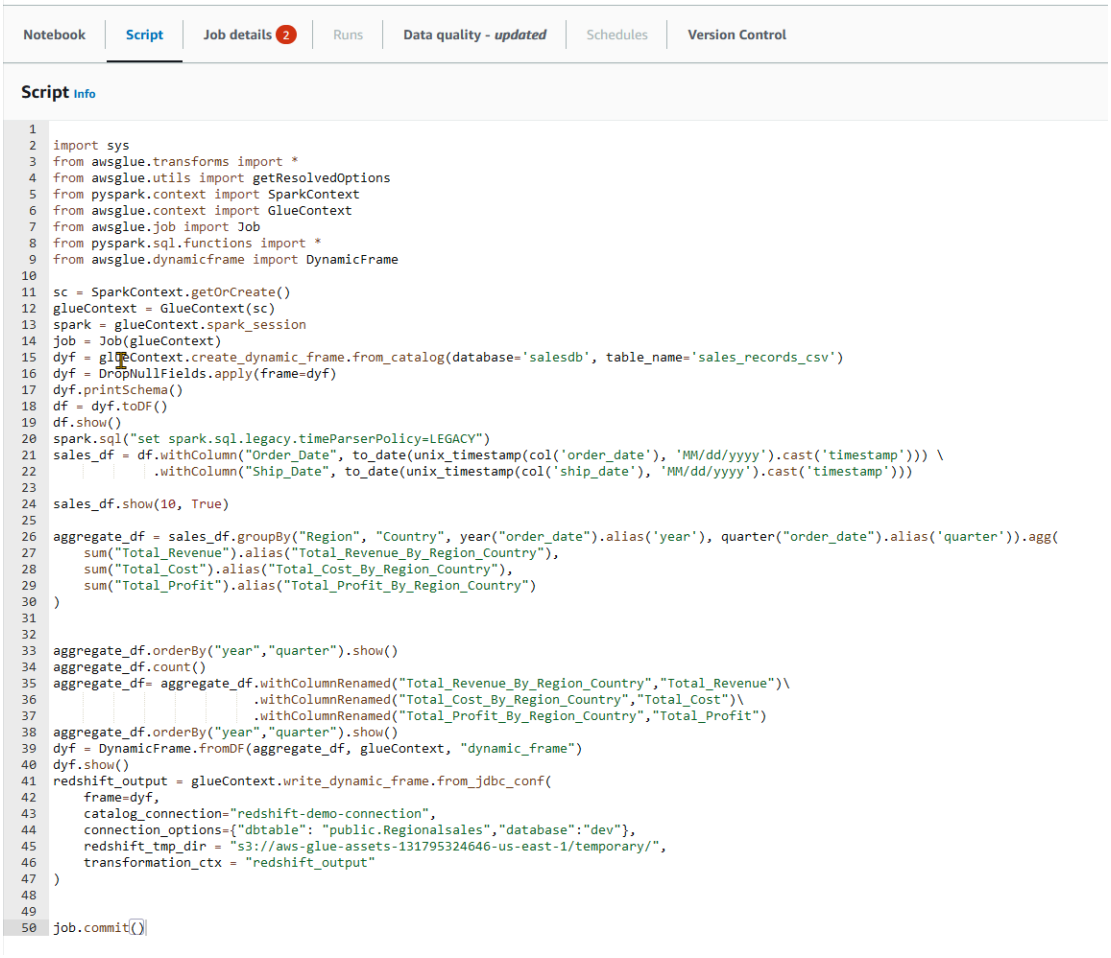


Solution:
First a lot of trial & error concerning role authorizations…but the solution was much simpler…
The adress for the redshift temp directory was wrong that caused the autohrization problem.

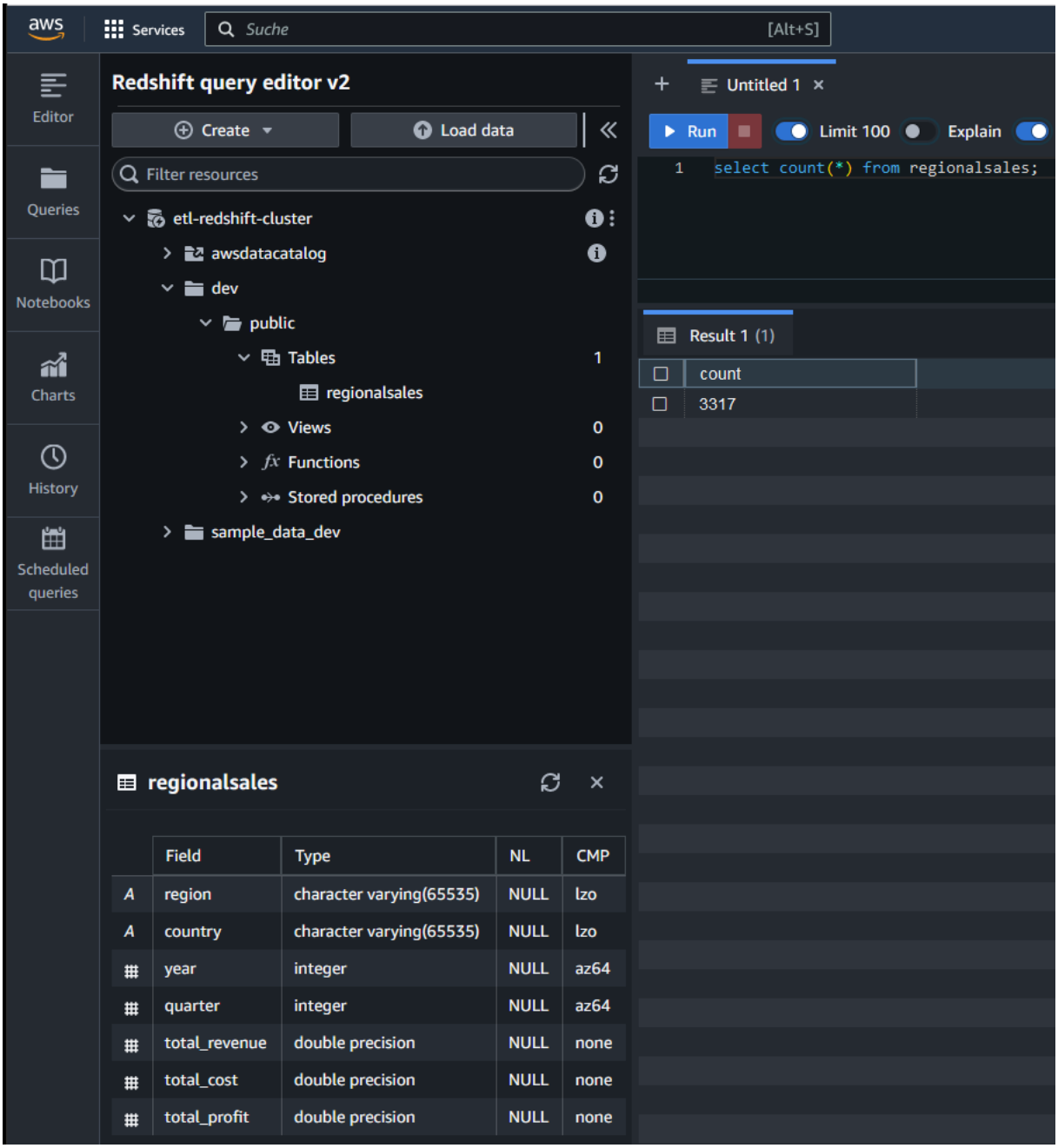
[10]:
```
redshift_output = glueContext.write_dynamic_frame.from_jdbc_conf(
    frame=dyf,
    catalog_connection="redshift-demo-connection",
    connection_options={"dbtable": "public.Regionalsales","database":"dev"},
    redshift_tmp_dir = "s3://aws-glue-assets-131795324646-us-east-1/temporary/",
    transformation_ctx = "redshift_output"
)
```

[ ]:
```
```

4.6.2 Jupyter Notebook as Pyspark Script that could be sheduled

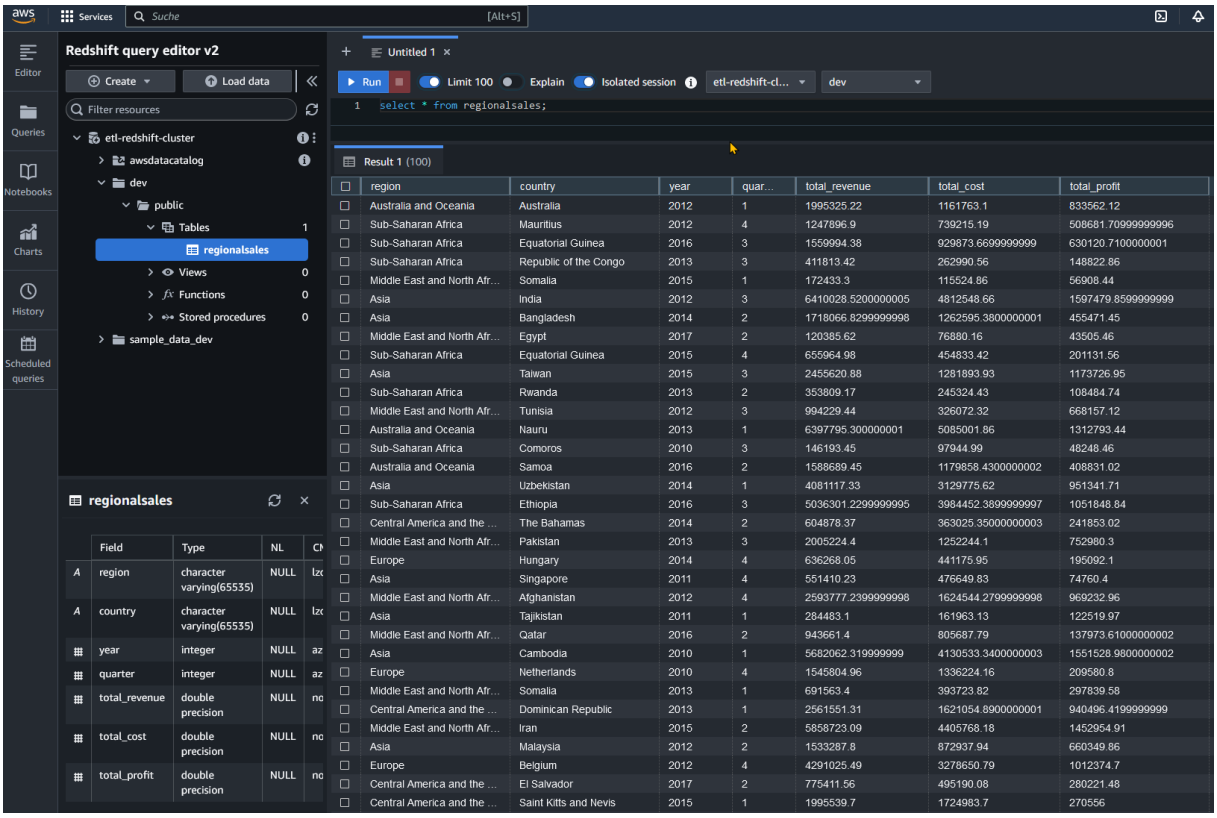


5 AWS Redshift




```
only showing top 20 rows

3317
```


aws
Services
Suche
[Alt+S]
Redshift query editor v2
Editor
Queries
Notebooks
Charts
History
Scheduled queries
Create
Load data
Filter resources
etl-redshift-cluster
awsdatacatalog
dev
public
Tables 1
regionalsales
Views 0
Functions 0
Stored procedures 0
sample_data_dev
Untitled 1
Run
Limit 100
Explain
Isolated session
etl-redshift-cl...
dev
1 select * from regionalsales;
Result 1 (100)
region country year quar... total_revenue total_cost total_profit
Australia and Oceania Australia 2012 1 1995325.22 1161763.1 833562.12
Sub-Saharan Africa Mauritius 2012 4 1247896.9 739215.19 508681.70999999996
Sub-Saharan Africa Equatorial Guinea 2016 3 1559994.38 929873.6699999999 630120.7100000001
Sub-Saharan Africa Republic of the Congo 2013 3 411813.42 262990.56 148822.86
Middle East and North Afr... Somalia 2015 1 172433.3 115524.86 56908.44
Asia India 2012 3 6410028.5200000005 4812548.66 1597479.8599999999
Asia Bangladesh 2014 2 1718066.8299999998 1262595.3800000001 455471.45
Middle East and North Afr... Egypt 2017 2 120385.62 76880.16 43505.46
Sub-Saharan Africa Equatorial Guinea 2015 4 655964.98 454833.42 201131.56
Asia Taiwan 2015 3 2455620.88 1281893.93 1173726.95
Sub-Saharan Africa Rwanda 2013 2 353809.17 245324.43 108484.74
Middle East and North Afr... Tunisia 2012 3 994229.44 326072.32 668157.12
Australia and Oceania Nauru 2013 1 6397795.300000001 5085001.86 1312793.44
Sub-Saharan Africa Comoros 2010 3 146193.45 97944.99 48248.46
Australia and Oceania Samoa 2016 2 1588689.45 1179858.4300000002 408831.02
Asia Uzbekistan 2014 1 4081117.33 3129775.62 951341.71
Sub-Saharan Africa Ethiopia 2016 3 5036301.2299999995 3984452.3899999997 1051848.84
Central America and the ... The Bahamas 2014 2 604878.37 363025.35000000003 241853.02
Middle East and North Afr... Pakistan 2013 3 2005224.4 1252244.1 752980.3
Europe Hungary 2014 4 636268.05 441175.95 195092.1
Asia Singapore 2011 4 551410.23 476649.83 74760.4
Middle East and North Afr... Afghanistan 2012 4 2593777.2399999998 1624544.2799999998 969232.96
Asia Tajikistan 2011 1 284483.1 161963.13 122519.97
Middle East and North Afr... Qatar 2016 2 943661.4 805687.79 137973.61000000002
Asia Cambodia 2010 1 5682062.319999999 4130533.3400000003 1551528.9800000002
Europe Netherlands 2010 4 1545804.96 1336224.16 209580.8
Middle East and North Afr... Somalia 2013 1 691563.4 393723.82 297839.58
Central America and the ... Dominican Republic 2013 1 2561551.31 1621054.8900000001 940496.4199999999
Middle East and North Afr... Iran 2015 2 5858723.09 4405768.18 1452954.91
Asia Malaysia 2012 2 1533287.8 872937.94 660349.86
Europe Belgium 2012 4 4291025.49 3278650.79 1012374.7
Central America and the ... El Salvador 2017 2 775411.56 495190.08 280221.48
Central America and the ... Saint Kitts and Nevis 2015 1 1995539.7 1724983.7 270556
regionalsales
Field Type NL
region character varying(65535) NULL
country character varying(65535) NULL
year integer NULL
quarter integer NULL
total_revenue double precision NULL
total_cost double precision NULL
total_profit double precision NULL