Project by Gero Krikawa 09/2023

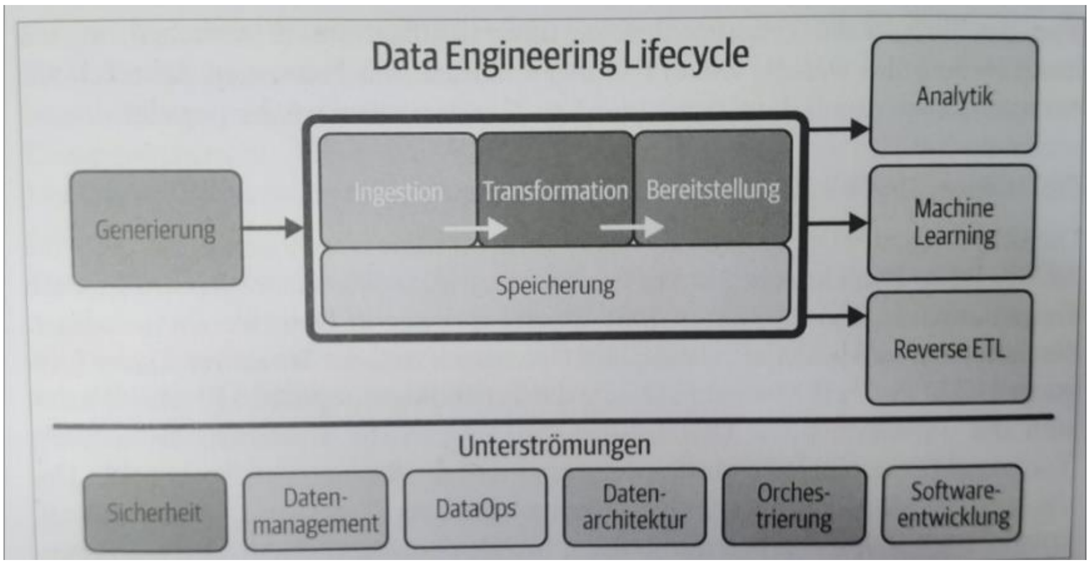
End to End Data Engineering Project in AWS using Spark (Pyspark)

Used Technologies:

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

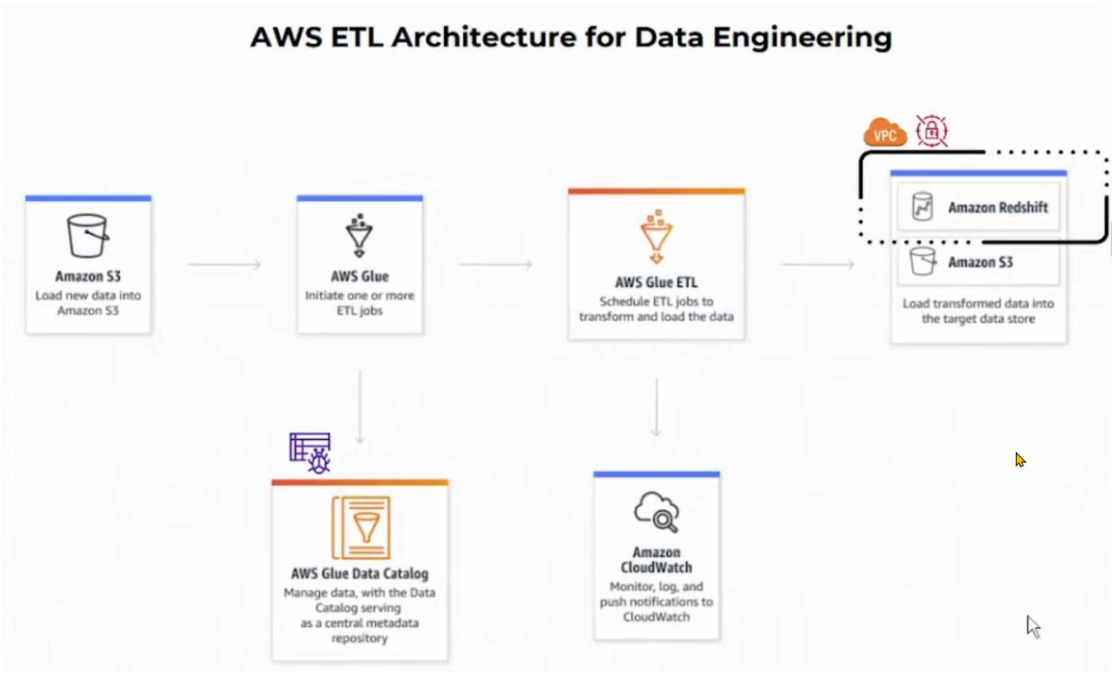
1 Inhalt

2 Overview: Data Engineering Lifecycle



Overview of the general Data Engineering Livecycle. Data Pipeline from Source on the left to the destination on the right

3 AWS ETL architecture for Data Engineering


AWS ETL Architecture for Data Engineering
Amazon S3
Load new data into Amazon S3
AWS Glue
Initiate one or more ETL jobs
AWS Glue ETL
Schedule ETL jobs to transform and load the data
VPC
Amazon Redshift
Amazon S3
Load transformed data into the target data store
AWS Glue Data Catalog
Manage data, with the Data Catalog serving as a central metadata repository
Amazon CloudWatch
Monitor, log, and push notifications to CloudWatch

Overview oft he AWS architecture for Data Engineering. Explanation see below Chapters.

3.1 Project description

Data-Engineer end to end project using AWS Cloud.
Using of infrastructure as a Code for creation of necessary AWS infrastructure.
Building an end to end Data Pipeline using Pyspark for loading Data from S3 Source, Transformation, Aggregation, Data Quality, writing in AWS Redshift.

3.2 Project Workflow

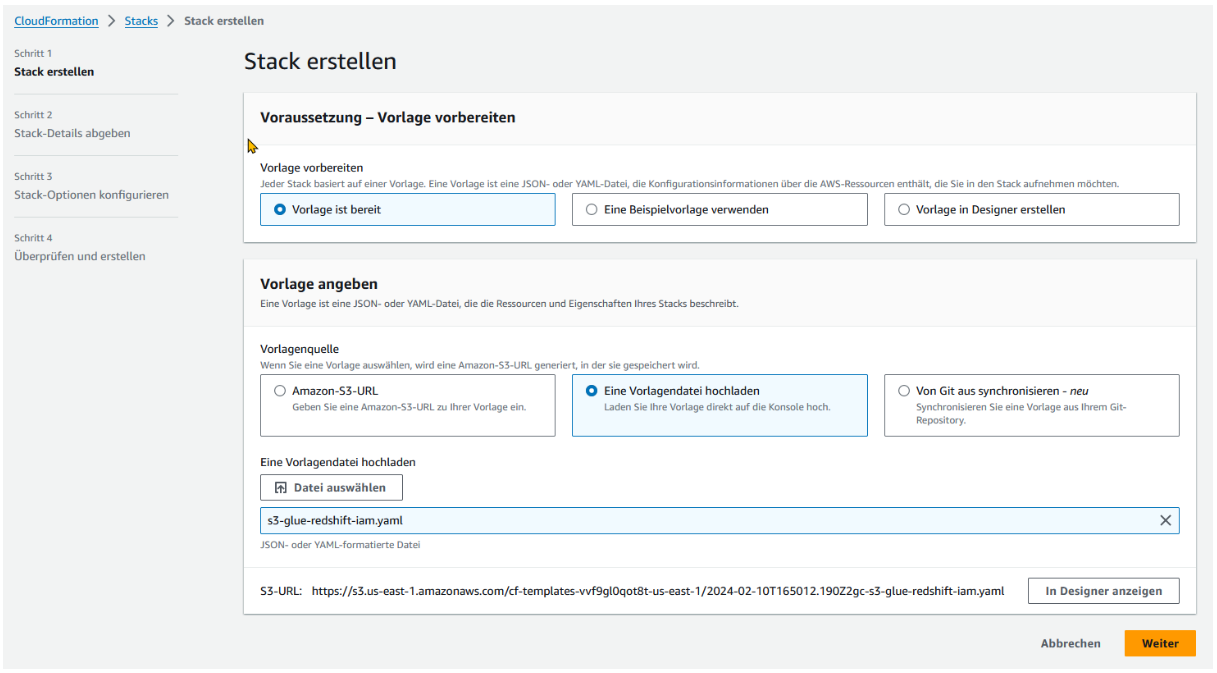
- Create Data Engineering System in AWS using „Infrastructure as Code“
- Test the created infrastructure
- Develop the necessary components (crawler, database..)

- Create an End to End Data Pipeline
  - Source File: sales_records.csv
  - Destination: AWS Redshift database
  - 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 (Data Quality, Transformation, Aggregation…)
    - Reading data from s3 storage, processing it via Data Pipeline 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“

This Chaper shows screenshots of the above explained development workflow in AWS.



CloudFormation > Stacks > Stack erstellen

Schritt 1
Stack erstellen

Schritt 2
Stack-Details abgeben

Schritt 3
Stack-Optionen konfigurieren

Schritt 4
Überprüfen und erstellen

Stack erstellen

Voraussetzung – Vorlage vorbereiten

Vorlage vorbereiten
Jeder Stack basiert auf einer Vorlage. Eine Vorlage ist eine JSON- oder YAML-Datei, die Konfigurationsinformationen über die AWS-Ressourcen enthält, die Sie in den Stack aufnehmen möchten.

[✓ Vorlage ist bereit] Eine Beispielvorlage verwenden Vorlage in Designer erstellen

Vorlage angeben
Eine Vorlage ist eine JSON- oder YAML-Datei, die die Ressourcen und Eigenschaften Ihres Stacks beschreibt.

Vorlagenquelle
Wenn Sie eine Vorlage auswählen, wird eine Amazon-S3-URL generiert, in der sie gespeichert wird.

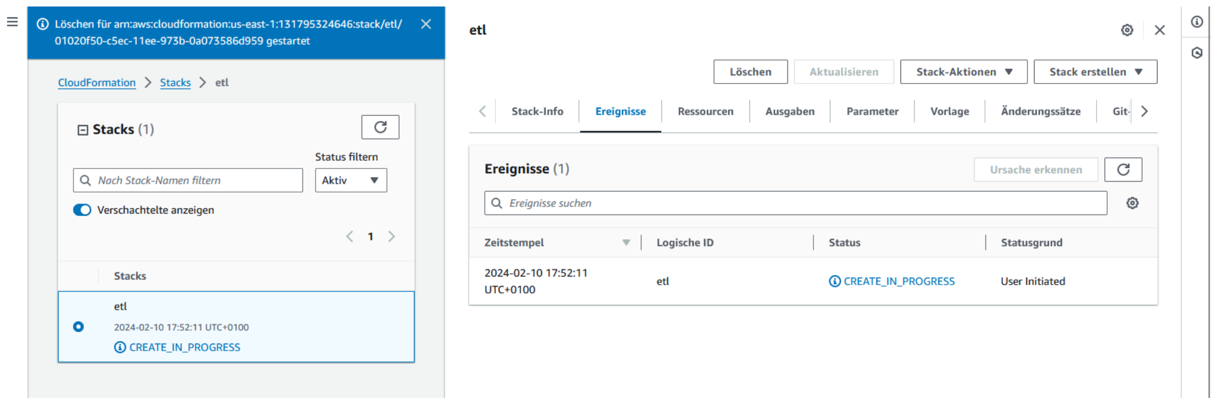
Amazon-S3-URL — Geben Sie eine Amazon-S3-URL zu Ihrer Vorlage ein.
[✓ Eine Vorlagendatei hochladen — Laden Sie Ihre Vorlage direkt auf die Konsole hoch.]
Von Git aus synchronisieren - *neu* — Synchronisieren Sie eine Vorlage aus Ihrem Git-Repository.

Eine Vorlagendatei hochladen
Datei auswählen
s3-glue-redshift-iam.yaml
JSON- oder YAML-formatierte Datei

S3-URL: https://s3.us-east-1.amazonaws.com/cf-templates-vvf9gl0qot8t-us-east-1/2024-02-10T165012.190Z2gc-s3-glue-redshift-iam.yaml

In Designer anzeigen

Abbrechen Weiter



Löschen für arn:aws:cloudformation:us-east-1:131795324646:stack/etl/01020f50-c5ec-11ee-973b-0a073586d959 gestartet

CloudFormation > Stacks > etl

Stacks (1)

Nach Stack-Namen filtern
Status filtern: Aktiv
Verschachtelte anzeigen

Stacks
etl 2024-02-10 17:52:11 UTC+0100 CREATE_IN_PROGRESS

etl

Löschen Aktualisieren Stack-Aktionen Stack erstellen

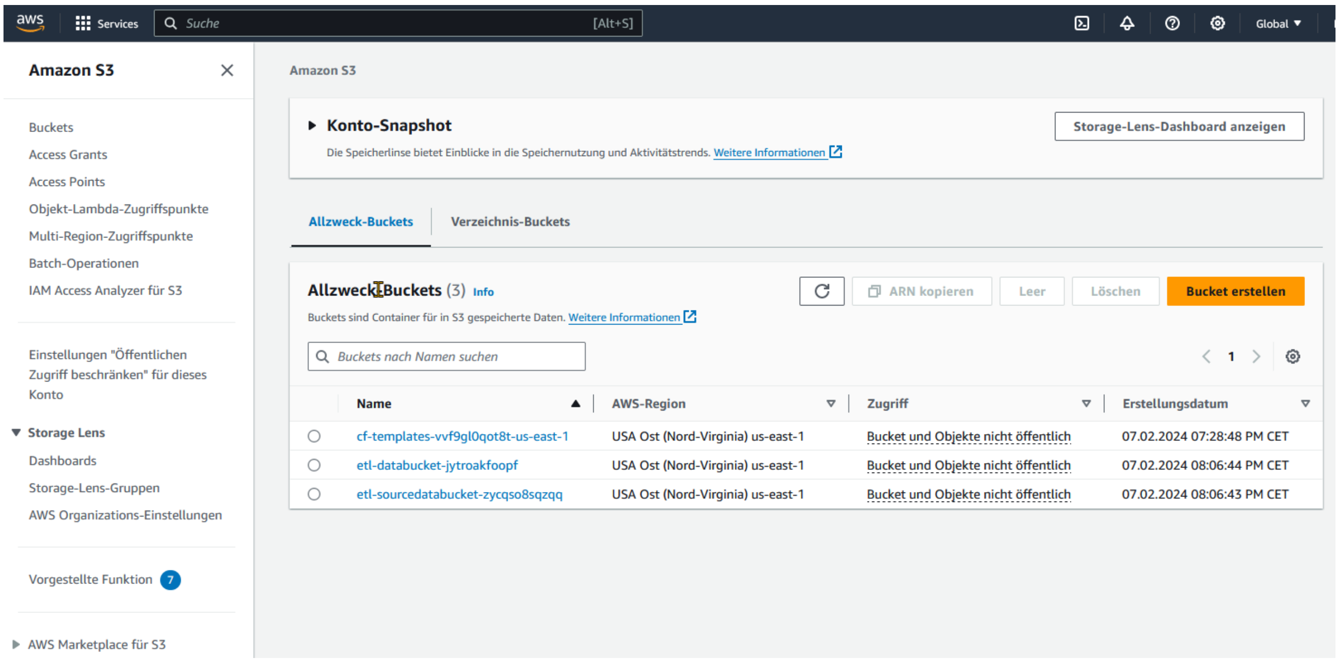
Stack-Info **Ereignisse** Ressourcen Ausgaben Parameter Vorlage Änderungssätze Git-

Ereignisse (1)

Ursache erkennen

Ereignisse suchen

Zeitstempel	Logische ID	Status	Statusgrund
2024-02-10 17:52:11 UTC+0100	etl	CREATE_IN_PROGRESS	User Initiated



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

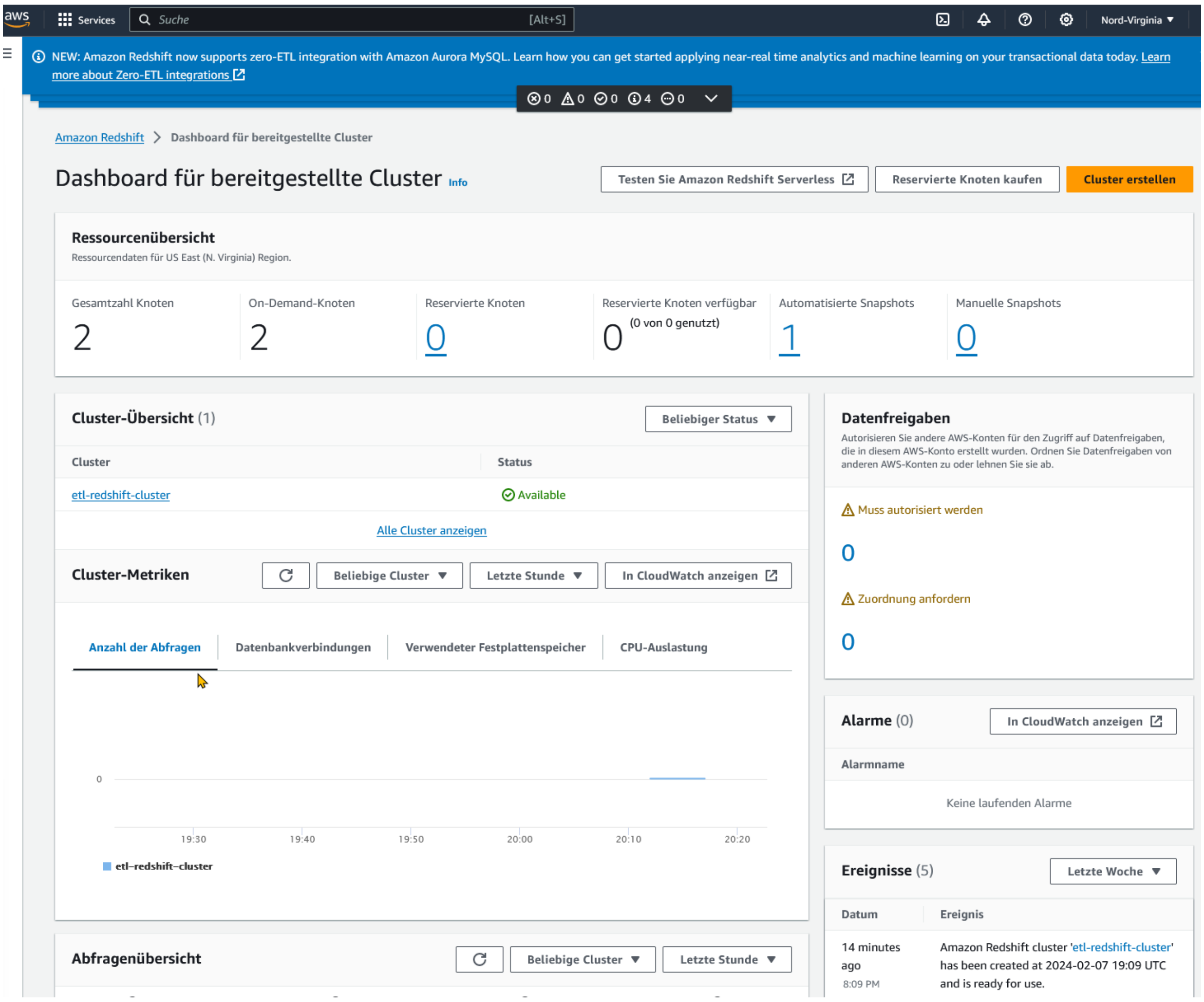
Allzweck-Buckets (3) Info

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



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	On-Demand-Knoten	Reservierte Knoten	Reservierte Knoten verfügbar	Automatisierte Snapshots	Manuelle Snapshots
2	2	0	0 (0 von 0 genutzt)	1	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

Abfragenübersicht — Beliebige Cluster | Letzte Stunde

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

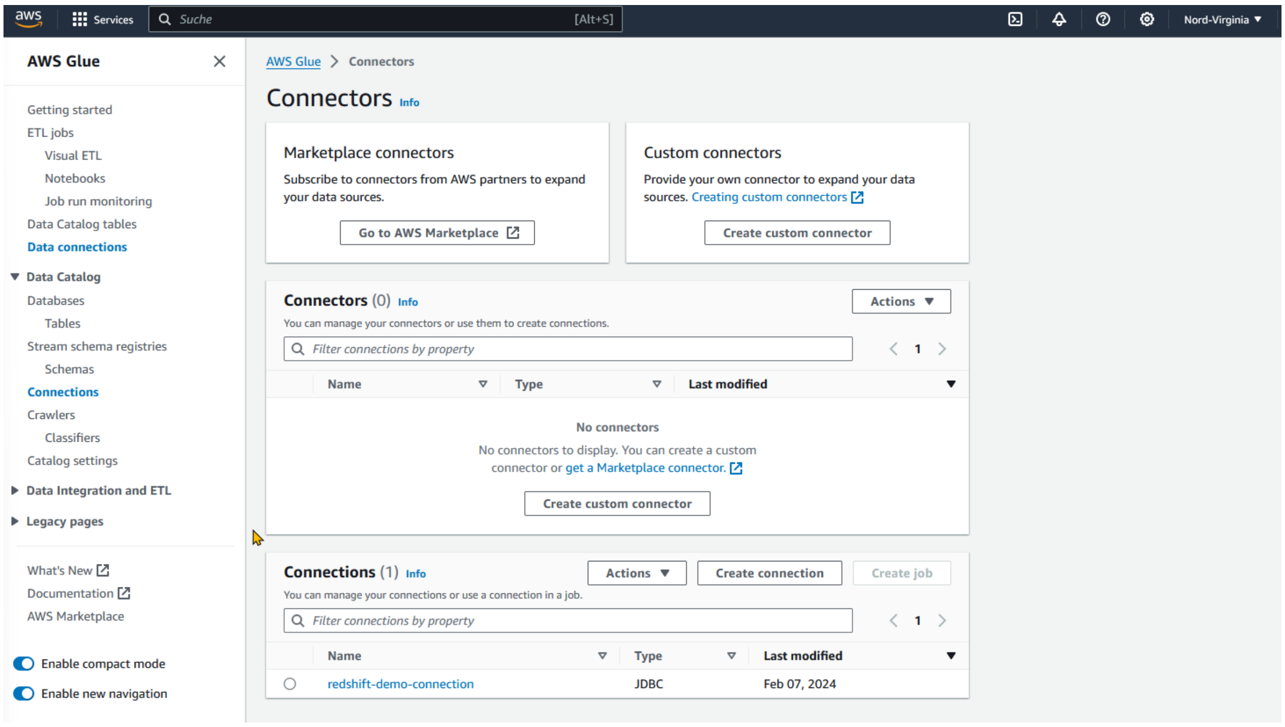
0

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.



Connectors Info

Marketplace connectors

Subscribe to connectors from AWS partners to expand your data sources.

Custom connectors

Provide your own connector to expand your data sources. Creating custom connectors

Connectors (0) Info

You can manage your connectors or use them to create connections.

Name	Type	Last modified

No connectors

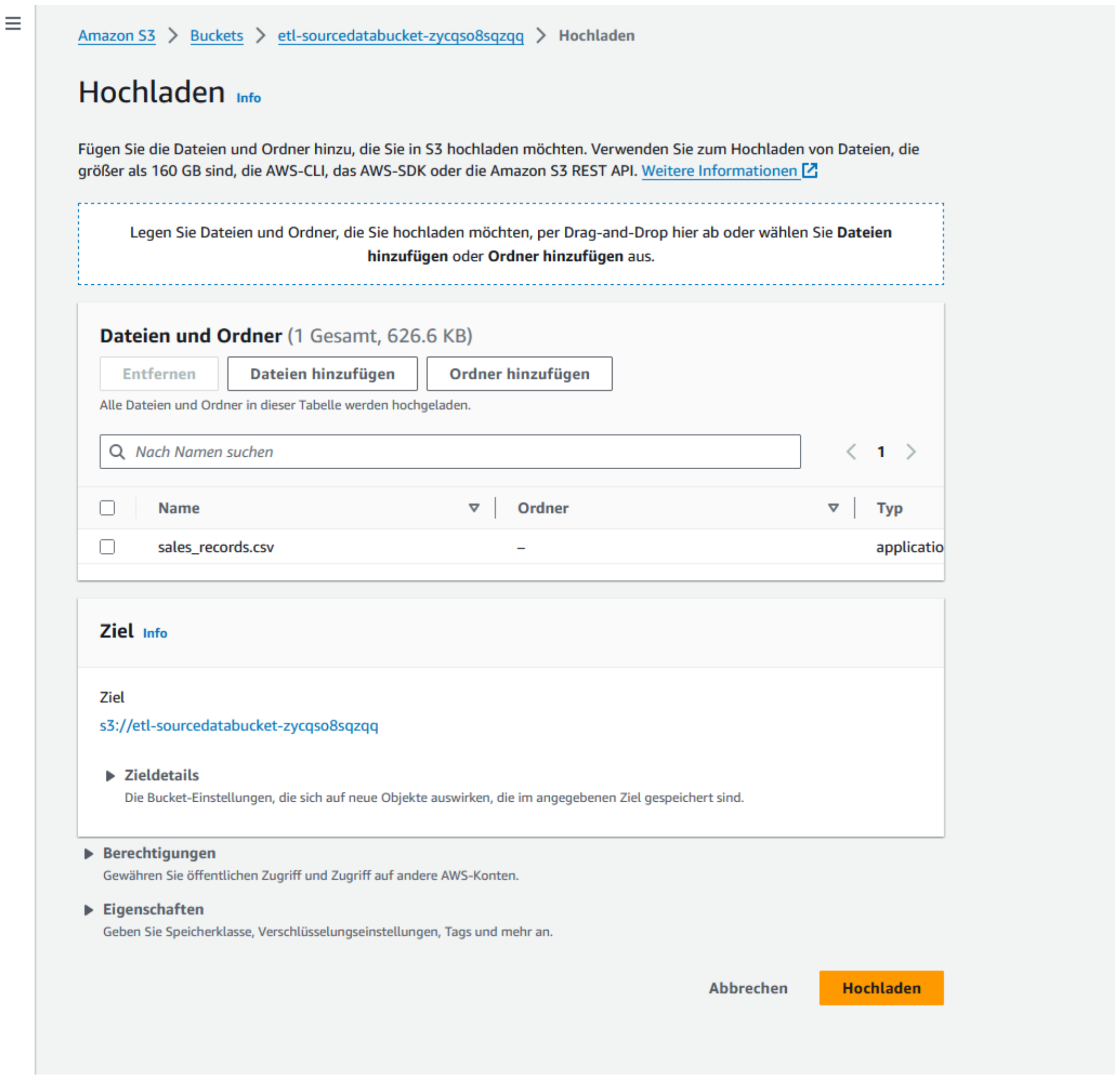
No connectors to display. You can create a custom connector or get a Marketplace connector.

Connections (1) Info

You can manage your connections or use a connection in a job.

	Name	Type	Last modified
○	redshift-demo-connection	JDBC	Feb 07, 2024

4.2 Upload csv in S3



Amazon S3 > Buckets > etl-sourcedatabucket-zycqso8sqzqq > Hochladen

Hochladen Info

Fügen Sie die Dateien und Ordner hinzu, die Sie in S3 hochladen möchten. Verwenden Sie zum Hochladen von Dateien, die größer als 160 GB sind, die AWS-CLI, das AWS-SDK oder die Amazon S3 REST API. Weitere Informationen

Legen Sie Dateien und Ordner, die Sie hochladen möchten, per Drag-and-Drop hier ab oder wählen Sie **Dateien hinzufügen** oder **Ordner hinzufügen** aus.

Dateien und Ordner (1 Gesamt, 626.6 KB)

Entfernen | Dateien hinzufügen | Ordner hinzufügen

Alle Dateien und Ordner in dieser Tabelle werden hochgeladen.

Nach Namen suchen

Name	Ordner	Typ
sales_records.csv	–	applicatio

Ziel Info

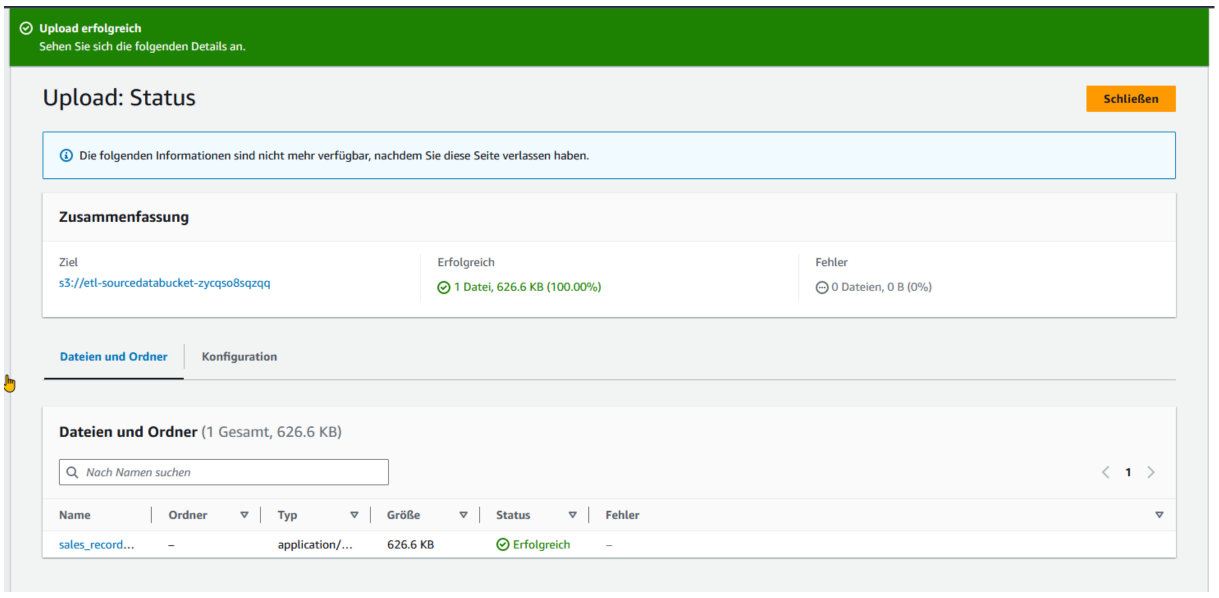
Ziel
s3://etl-sourcedatabucket-zycqso8sqzqq

▶ Zieldetails
Die Bucket-Einstellungen, die sich auf neue Objekte auswirken, die im angegebenen Ziel gespeichert sind.

▶ Berechtigungen
Gewähren Sie öffentlichen Zugriff und Zugriff auf andere AWS-Konten.

▶ Eigenschaften
Geben Sie Speicherklasse, Verschlüsselungseinstellungen, Tags und mehr an.

Abbrechen | Hochladen



Upload erfolgreich
Sehen Sie sich die folgenden Details an.

Upload: Status

Schließen

Die folgenden Informationen sind nicht mehr verfügbar, nachdem Sie diese Seite verlassen haben.

Zusammenfassung

Ziel	Erfolgreich	Fehler
s3://etl-sourcedatabucket-zycqso8sqzqq	1 Datei, 626.6 KB (100.00%)	0 Dateien, 0 B (0%)

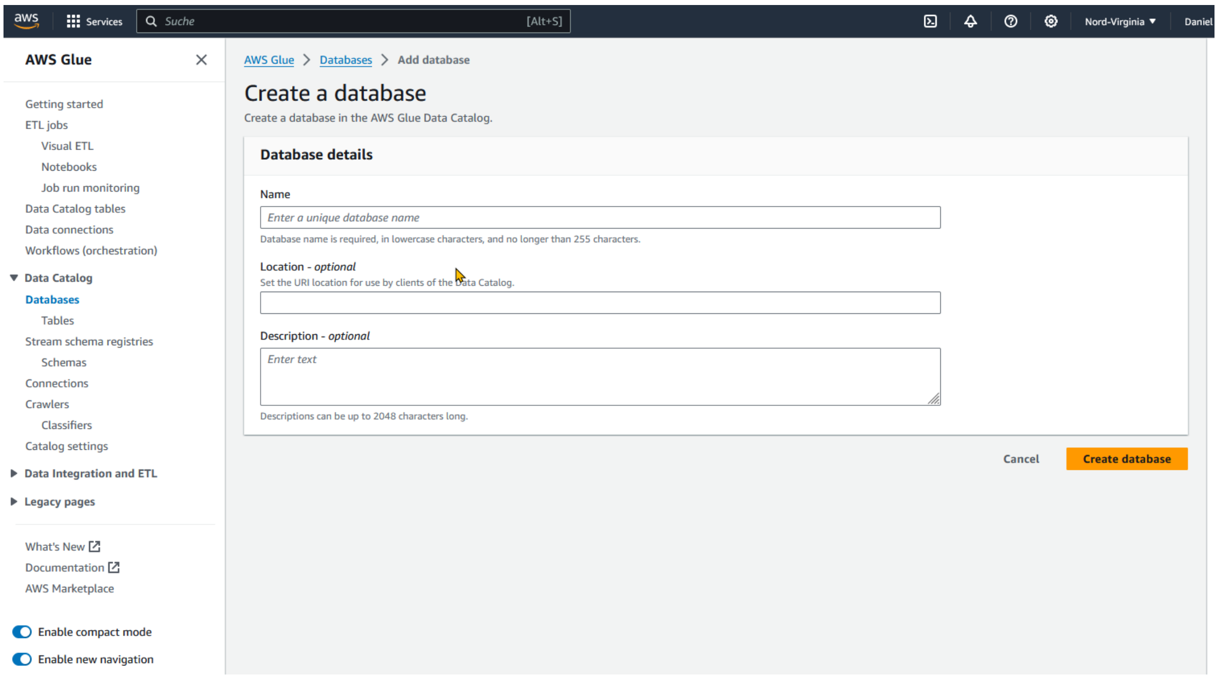
Dateien und Ordner | Konfiguration

Dateien und Ordner (1 Gesamt, 626.6 KB)

Nach Namen suchen

Name	Ordner	Typ	Größe	Status	Fehler
sales_record...	–	application/...	626.6 KB	Erfolgreich	–

4.3 Create database



AWS Glue

- Getting started
- ETL jobs
  - Visual ETL
  - Notebooks
  - Job run monitoring
- Data Catalog tables
- Data connections
- Workflows (orchestration)
- ▼ 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 > Databases > Add database

Create a database

Create a database in the AWS Glue Data Catalog.

Database details

Name

Enter a unique database name

Database name is required, in lowercase characters, and no longer than 255 characters.

Location - *optional*

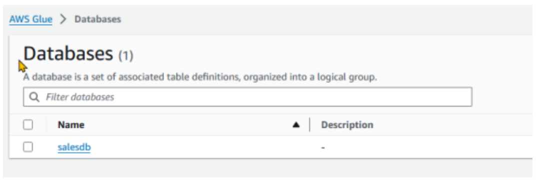
Set the URI location for use by clients of the Data Catalog.

Description - *optional*

Enter text

Descriptions can be up to 2048 characters long.

Cancel | **Create database**



AWS Glue > Databases

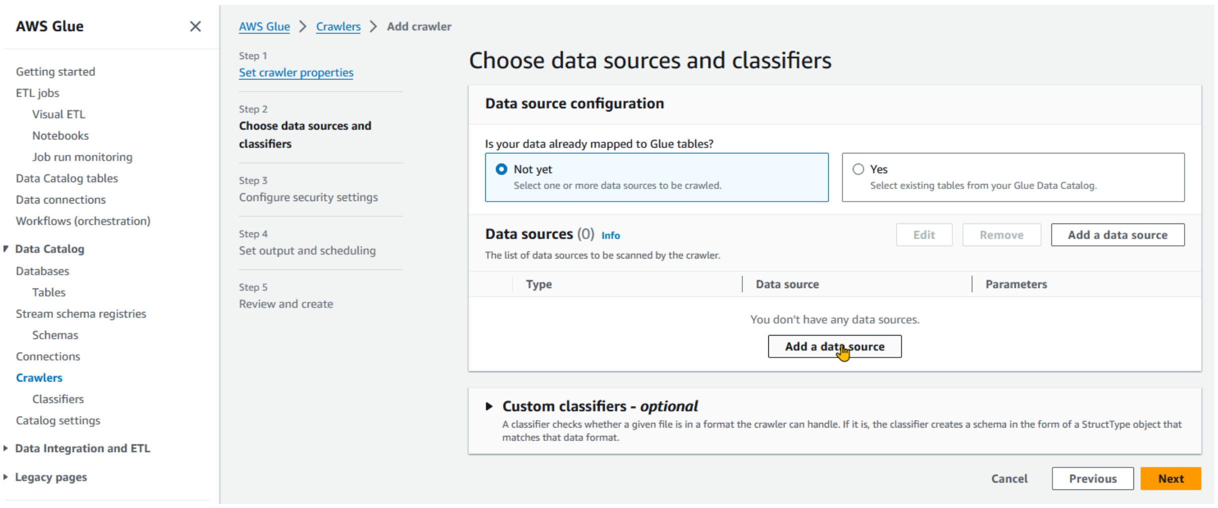
Databases (1)

A database is a set of associated table definitions, organized into a logical group.

Filter databases

Name	Description
salesdb	-

4.4 Create Crawler for tables with data souce sales_record.csv



AWS Glue

- Getting started
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- ▼ Data Catalog
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    - Tables
  - Stream schema registries
    - Schemas
  - Connections
  - Crawlers
    - Classifiers
  - Catalog settings
- ▶ Data Integration and ETL
- ▶ Legacy pages

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 (0) Info

The list of data sources to be scanned by the crawler.

Edit | Remove | Add a data source

Type	Data source	Parameters

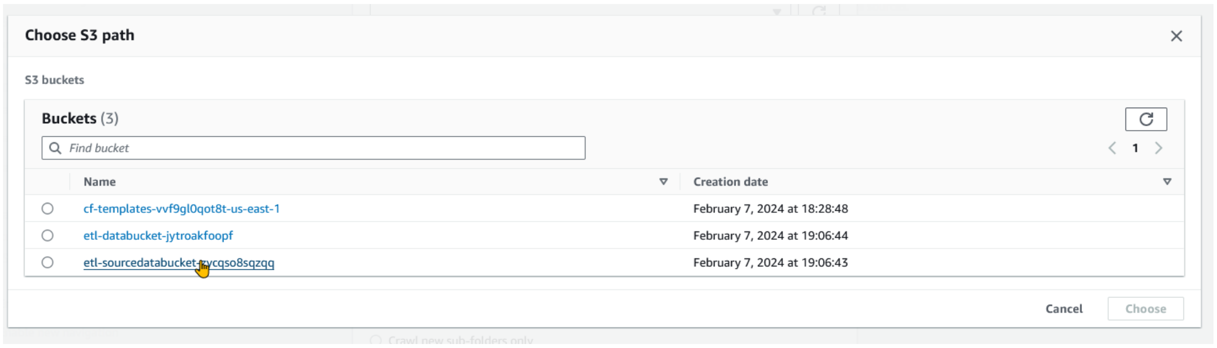
You don't have any data sources.

Add a data source

▶ **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**



Choose S3 path

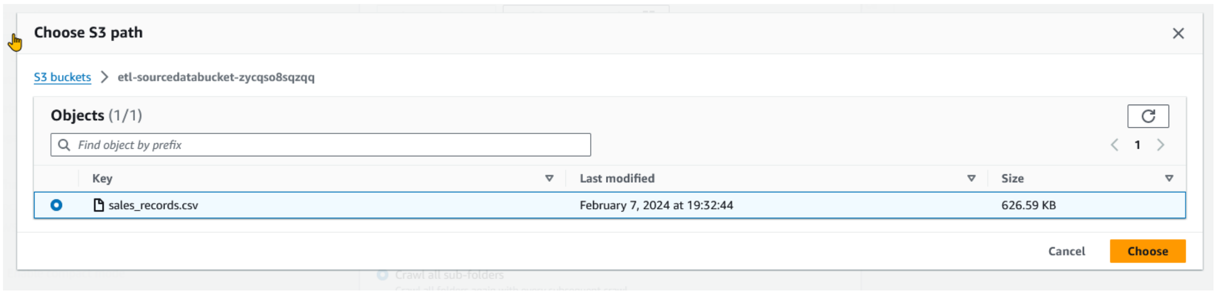
S3 buckets

Buckets (3)

Find bucket

	Name	Creation date
○	cf-templates-vvf9gl0qot8t-us-east-1	February 7, 2024 at 18:28:48
○	etl-databucket-jytroakfoopf	February 7, 2024 at 19:06:44
○	etl-sourcedatabucket-rycqso8sqzqq	February 7, 2024 at 19:06:43

Cancel | Choose



Choose S3 path

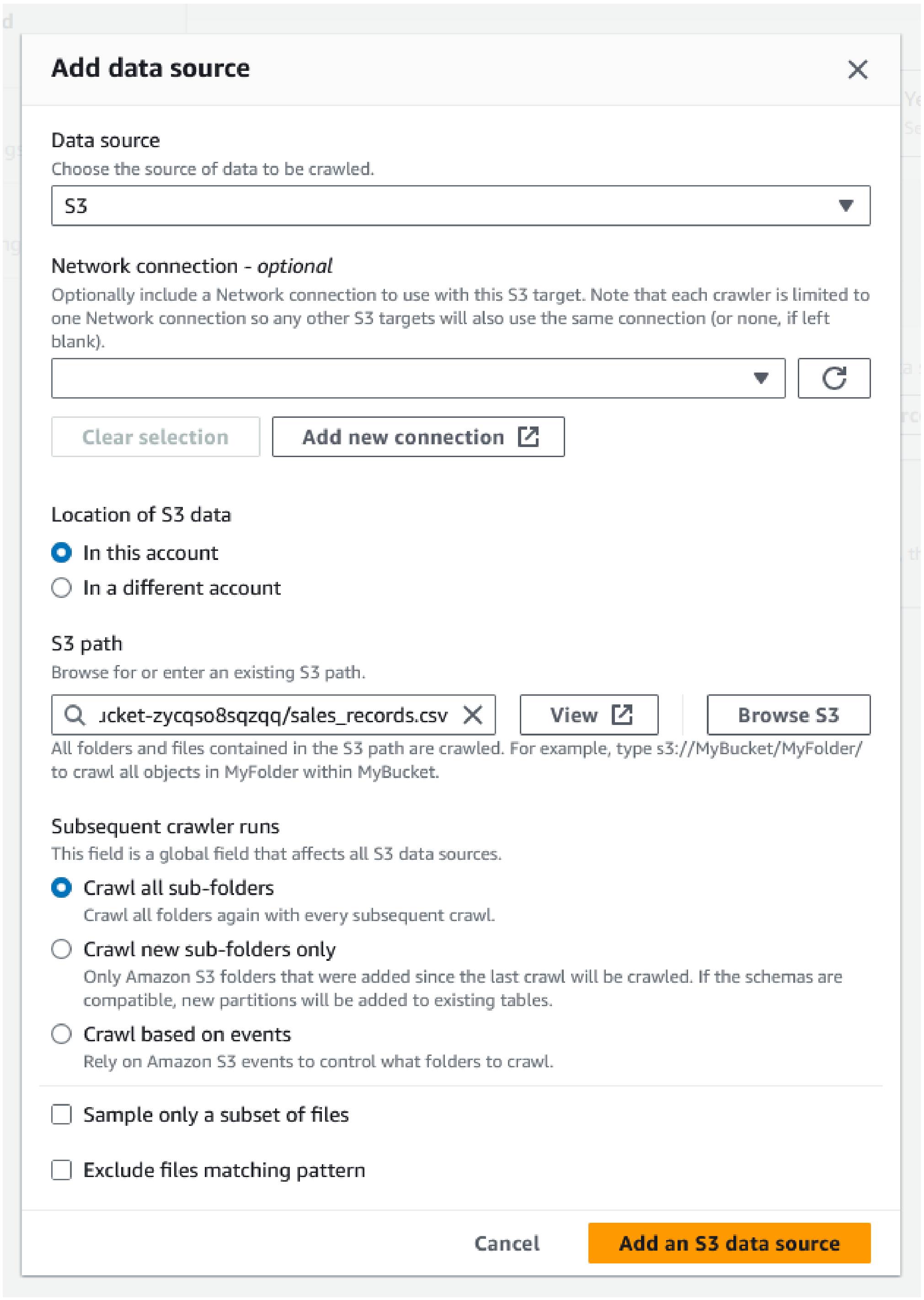
S3 buckets > etl-sourcedatabucket-zycqso8sqzqq

Objects (1/1)

Find object by prefix

	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.

ıcket-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.

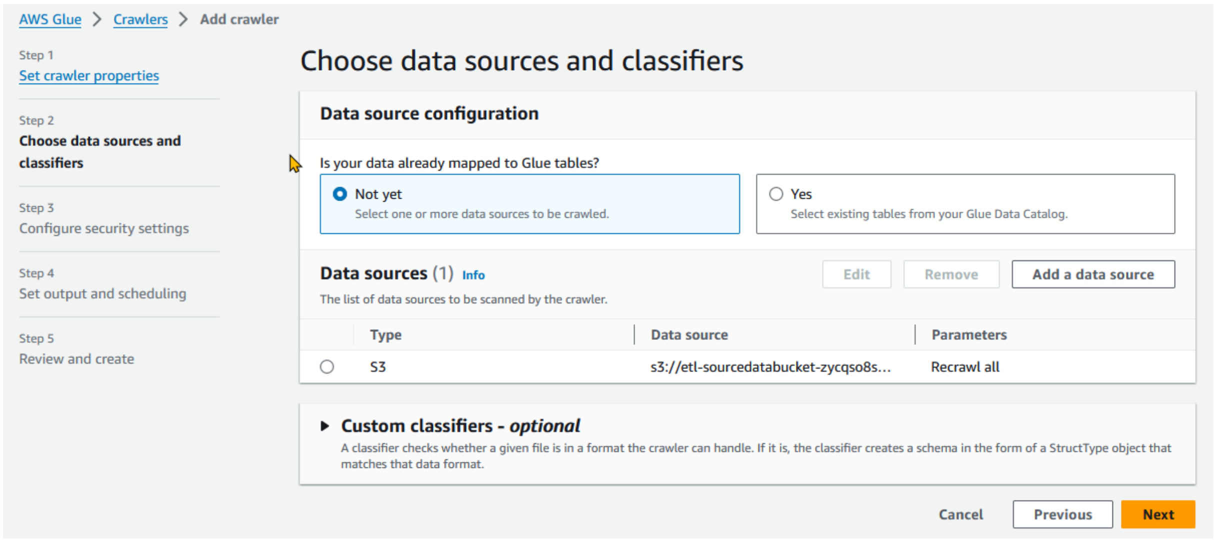
Crawl new sub-folders only
Only Amazon S3 folders that were added since the last crawl will be crawled. If the schemas are compatible, new partitions will be added to existing tables.

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.

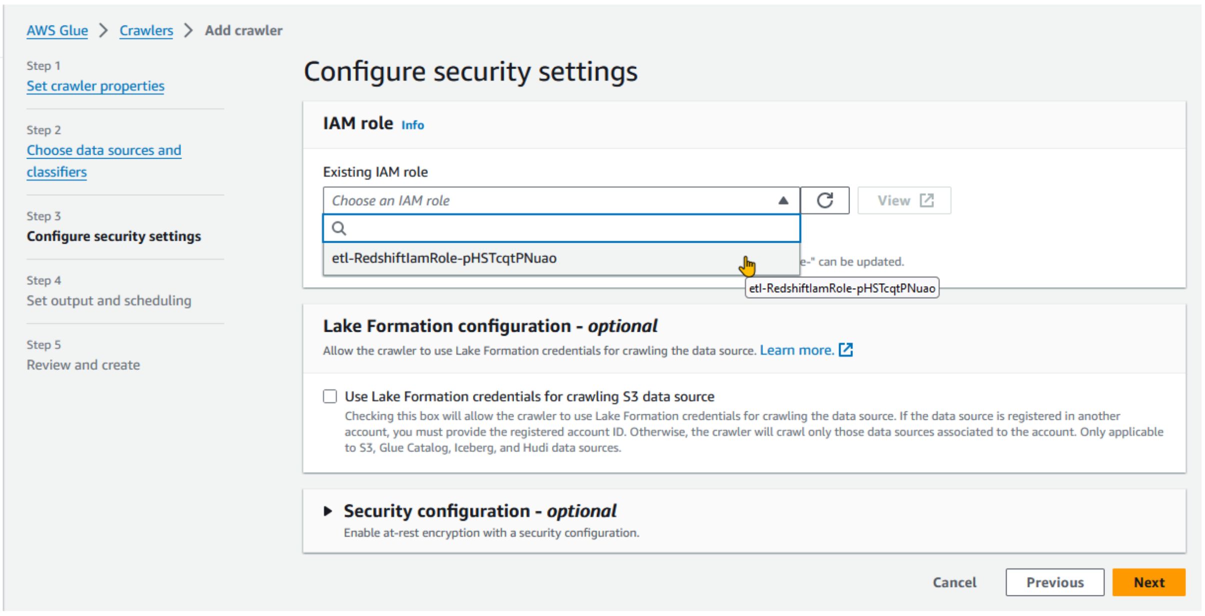
Data sources (1) Info

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.


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

etl-RedshiftIamRole-pHSTcqtPNuao

e-" can be updated.

etl-RedshiftIamRole-pHSTcqtPNuao

Lake Formation configuration - *optional*

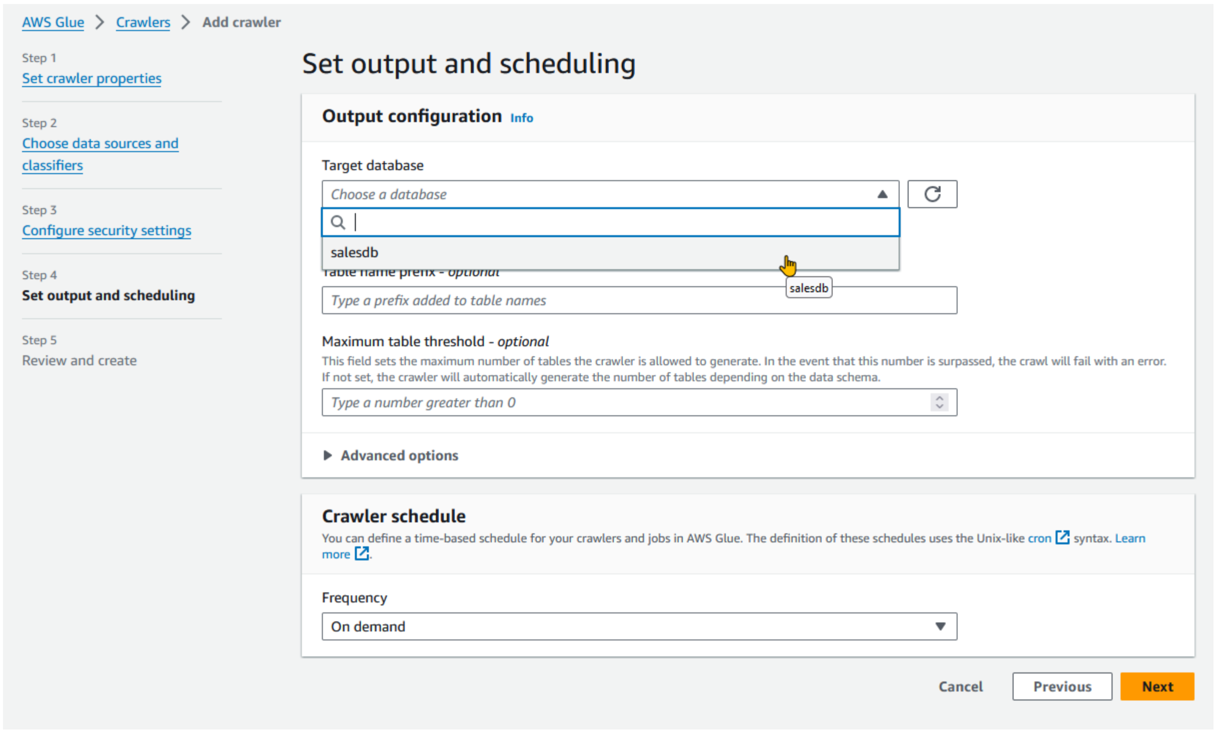
Allow the crawler to use Lake Formation credentials for crawling the data source. Learn more.

☐ 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.


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

Table name prefix - *optional*: 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.

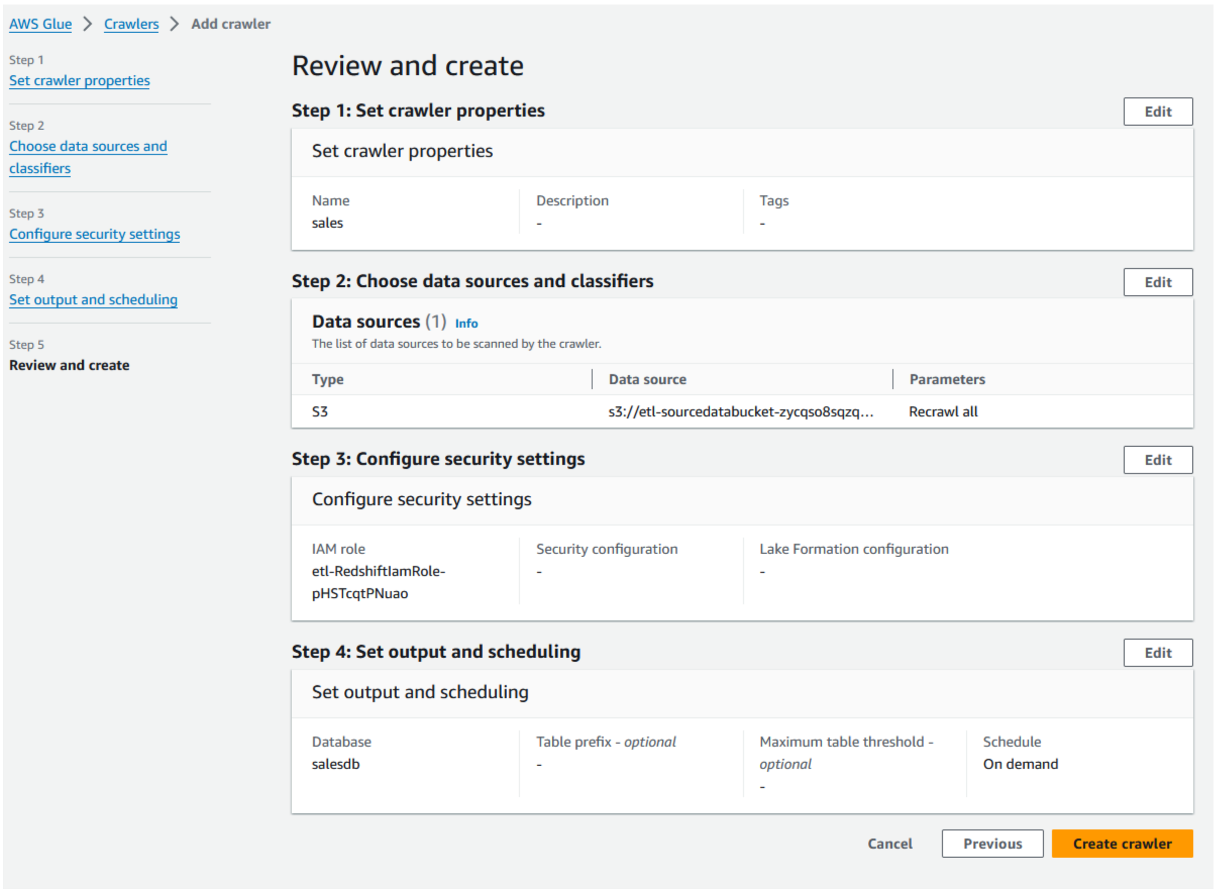
Type a number greater than 0

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


AWS Glue > Crawlers > Add crawler
Step 1
Set crawler properties
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Step 4
Set output and scheduling
Step 5
Review and create

Review and create

Step 1: Set crawler properties

Set crawler properties

Name	Description	Tags
sales	-	-

Step 2: Choose data sources and classifiers

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

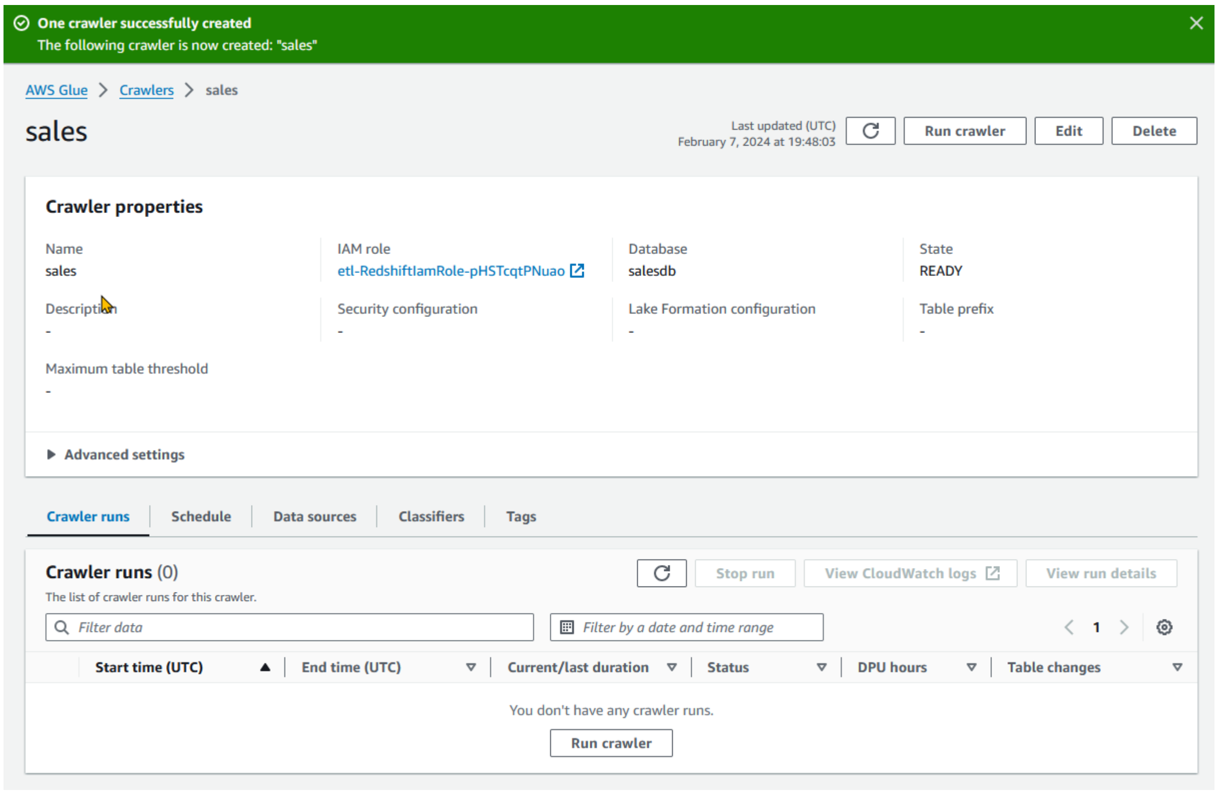
Configure security settings

IAM role	Security configuration	Lake Formation configuration
etl-RedshiftIamRole-pHSTcqtPNuao	-	-

Step 4: Set output and scheduling

Set output and scheduling

Database	Table prefix - *optional*	Maximum table threshold - *optional*	Schedule
salesdb	-	-	On demand


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.

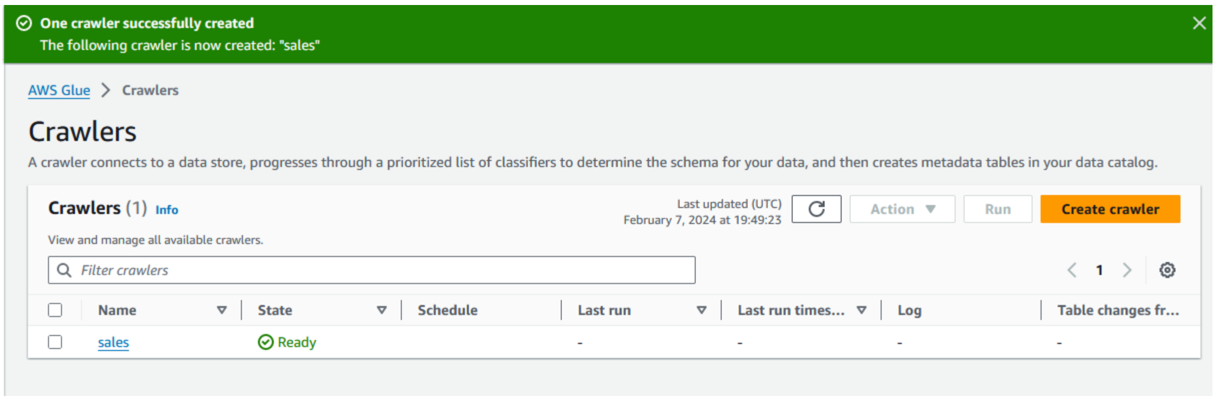
Stop run | View CloudWatch logs | View run details

Filter data | Filter by a date and time range

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

View and manage all available crawlers.

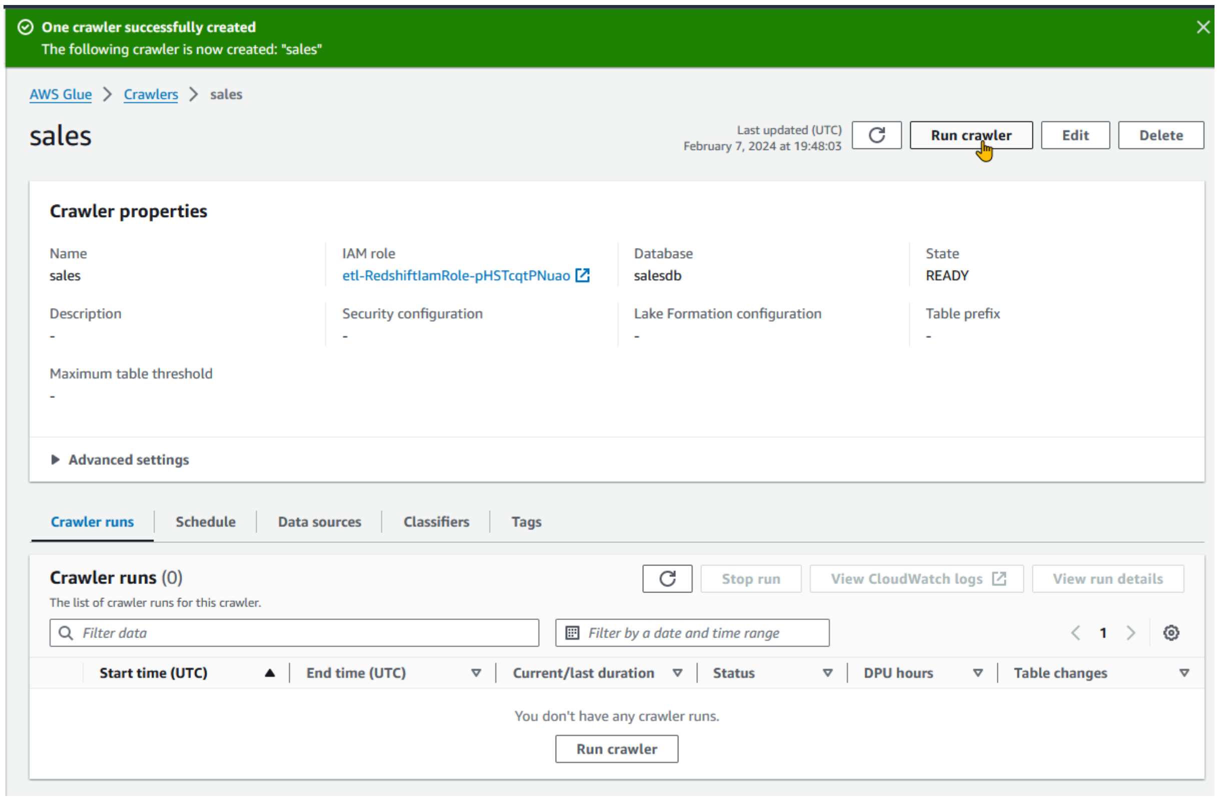
Last updated (UTC)
February 7, 2024 at 19:49:23

Action | Run | Create crawler

Filter crawlers

Name	State	Schedule	Last run	Last run times...	Log	Table changes fr...
sales	✓ Ready		-	-	-	-

4.5 Run the 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

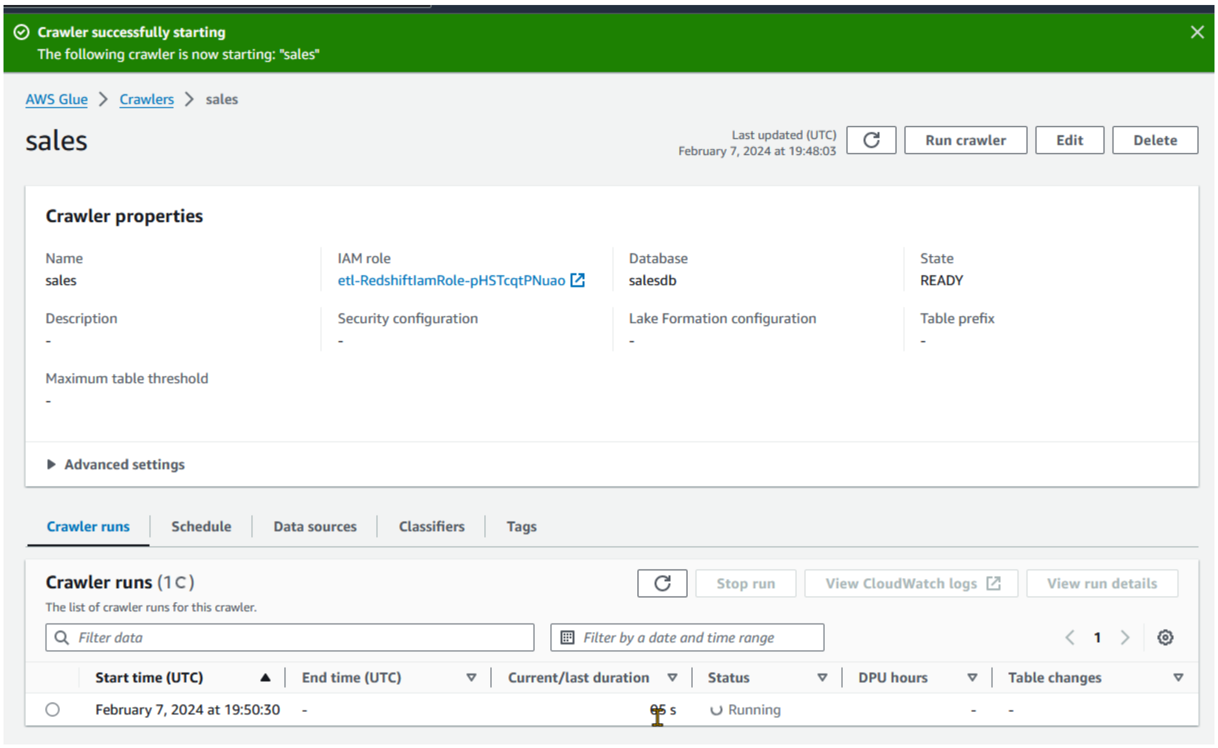
Crawler properties

Name sales	IAM role etl-RedshiftIamRole-pHSTcqtPNuao	Database salesdb	State READY
Description -	Security configuration -	Lake Formation configuration -	Table prefix -
Maximum table threshold -			

Crawler runs (0)
The list of crawler runs for this crawler.

Start time (UTC)	End time (UTC)	Current/last duration	Status	DPU hours	Table changes

You don't have any crawler runs.



Crawler successfully starting
The following crawler is now starting: "sales"

AWS Glue > Crawlers > sales

sales

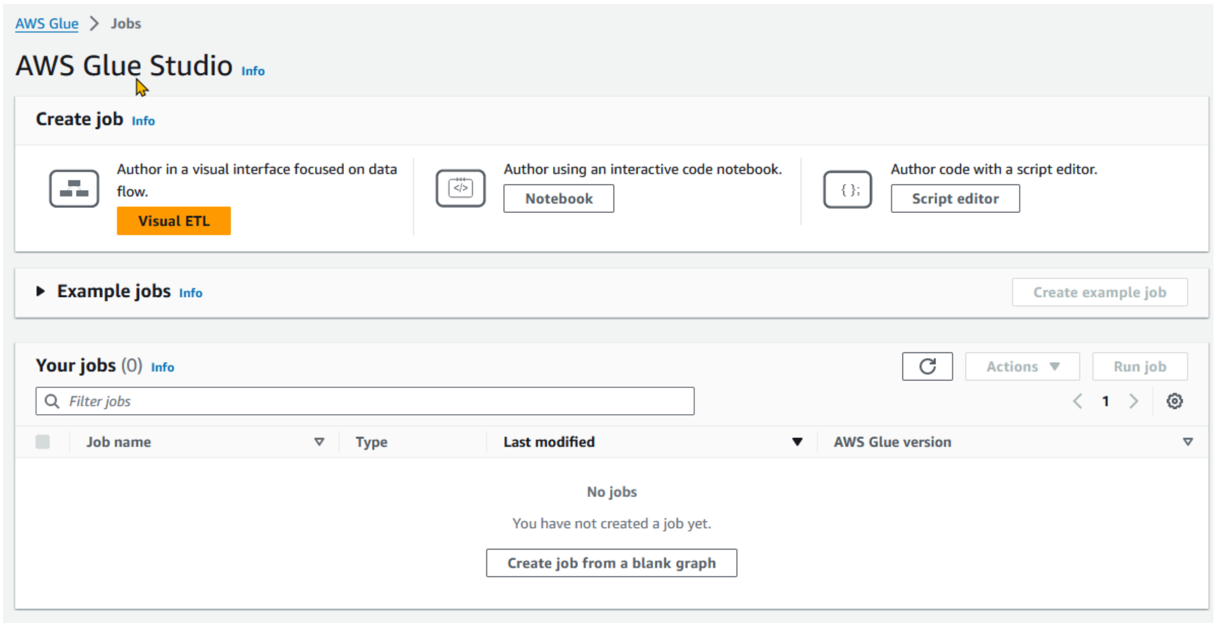
Last updated (UTC)
February 7, 2024 at 19:48:03

Crawler properties

Name sales	IAM role etl-RedshiftIamRole-pHSTcqtPNuao	Database salesdb	State READY
Description -	Security configuration -	Lake Formation configuration -	Table prefix -
Maximum table threshold -			

Crawler runs (1)
The list of crawler runs for this crawler.

Start time (UTC)	End time (UTC)	Current/last duration	Status	DPU hours	Table changes
February 7, 2024 at 19:50:30	-	65 s	Running	-	-


AWS Glue > Jobs

AWS Glue Studio Info

Create job Info

Author in a visual interface focused on data flow.

Author using an interactive code notebook.

Author code with a script editor.

Example jobs Info

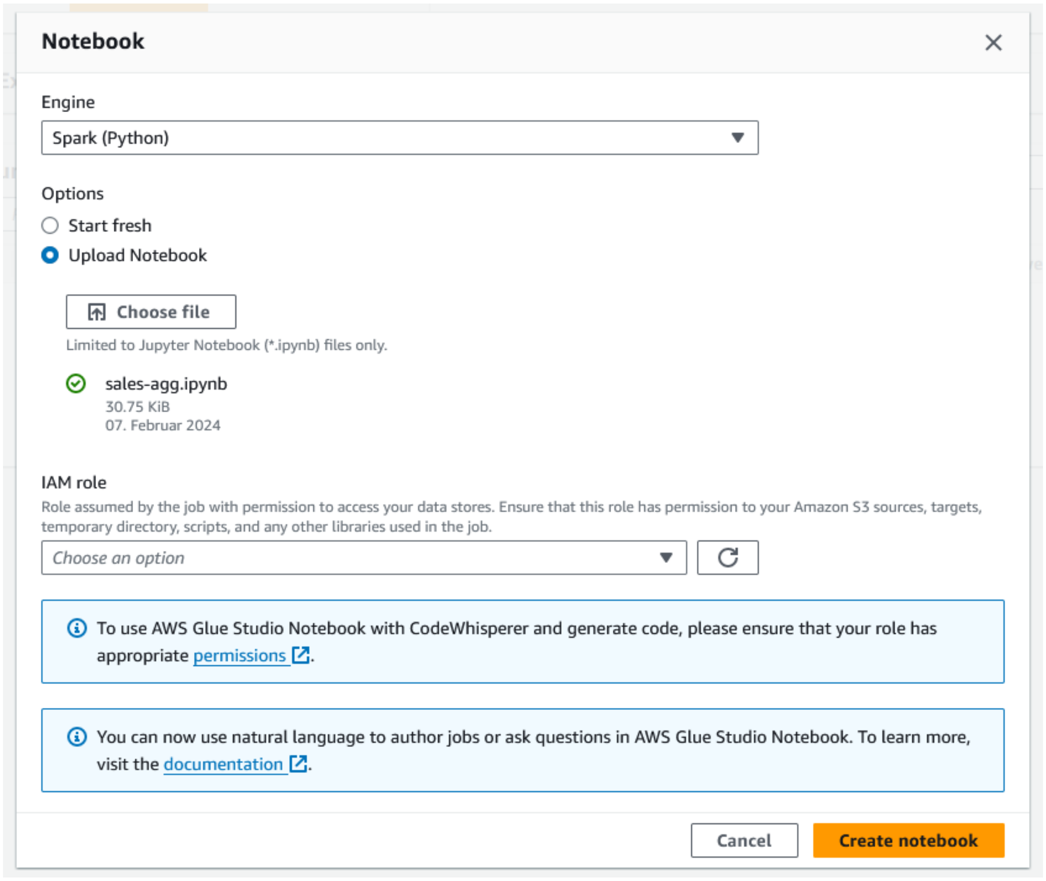
Your jobs (0) Info

Job name	Type	Last modified	AWS Glue version

No jobs

You have not created a job yet.

4.6 ETL Job as interactive jupyter Notebook using pyspark


Notebook

Engine

Spark (Python)

Options

Start fresh

[✓ Upload Notebook]

Limited to Jupyter Notebook (*.ipynb) files only.

sales-agg.ipynb
30.75 KiB
07. Februar 2024

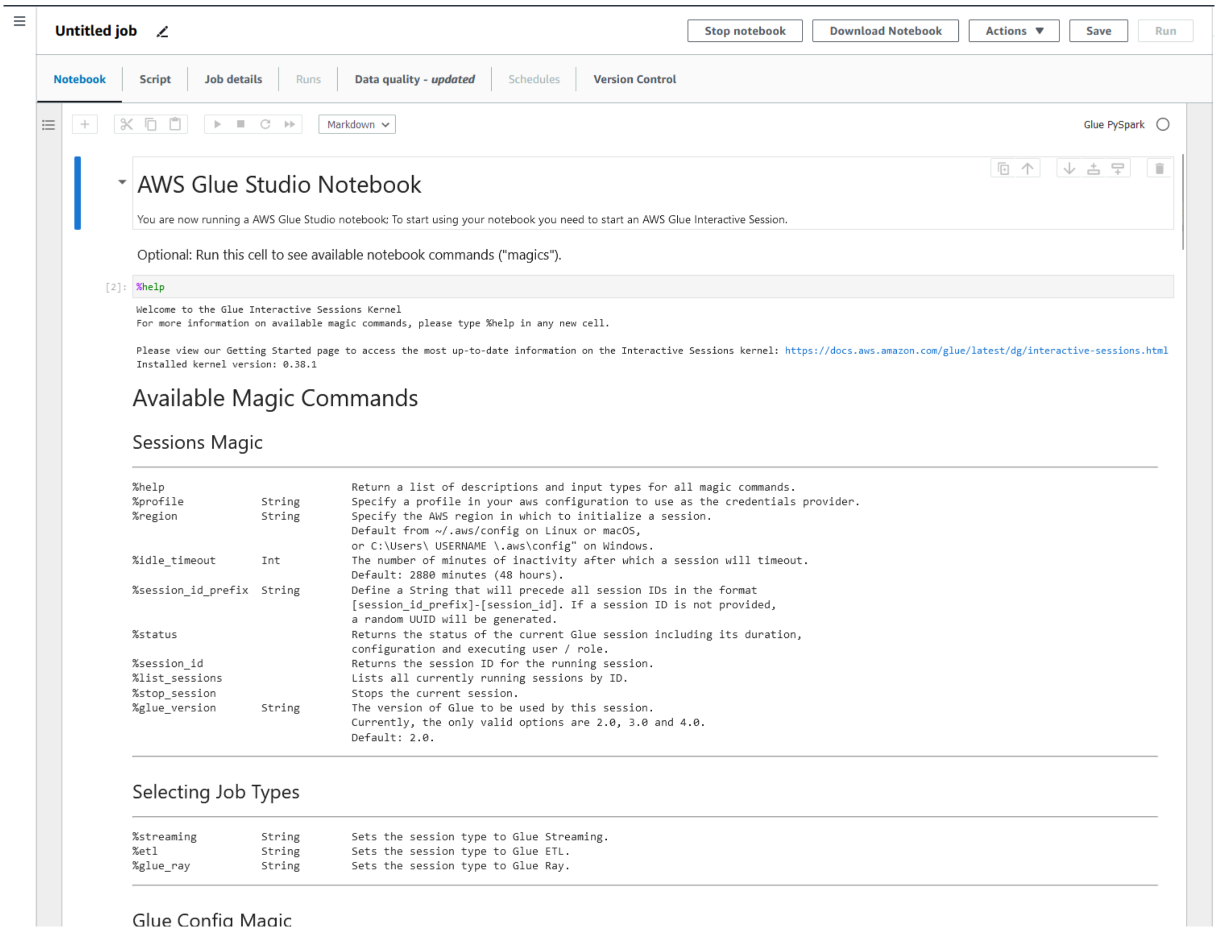
IAM role

Role assumed by the job with permission to access your data stores. Ensure that this role has permission to your Amazon S3 sources, targets, temporary directory, scripts, and any other libraries used in the job.

Choose an option

To use AWS Glue Studio Notebook with CodeWhisperer and generate code, please ensure that your role has appropriate permissions.

You can now use natural language to author jobs or ask questions in AWS Glue Studio Notebook. To learn more, visit the documentation.



AWS Glue Studio Notebook

You are now running a AWS Glue Studio notebook; To start using your notebook you need to start an AWS Glue Interactive Session.

Optional: Run this cell to see available notebook commands ("magics").

```
[2]: %help
```

```
Welcome to the Glue Interactive Sessions Kernel
For more information on available magic commands, please type %help in any new cell.

Please view our Getting Started page to access the most up-to-date information on the Interactive Sessions kernel: https://docs.aws.amazon.com/glue/latest/dg/interactive-sessions.html
Installed kernel version: 0.38.1
```

Available Magic Commands

Sessions Magic

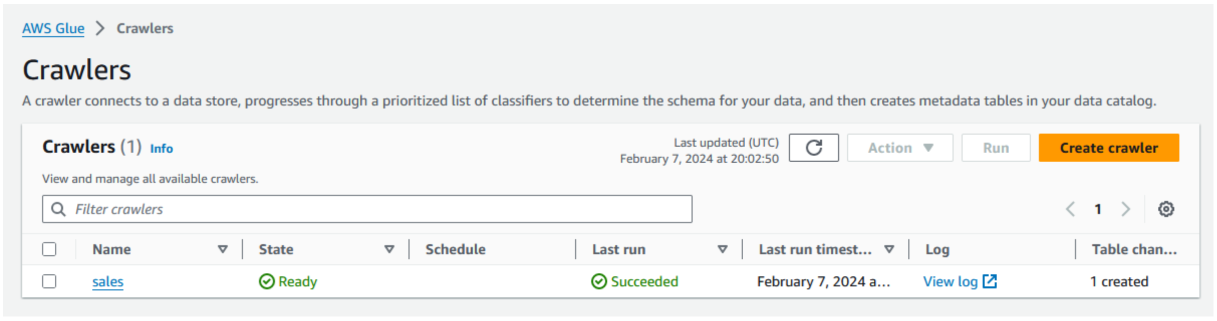
```
%help                                Return a list of descriptions and input types for all magic commands.
%profile             String          Specify a profile in your aws configuration to use as the credentials provider.
%region              String          Specify the AWS region in which to initialize a session.
                                     Default from ~/.aws/config on Linux or macOS,
                                     or C:\Users\ USERNAME \.aws\config" on Windows.
%idle_timeout        Int             The number of minutes of inactivity after which a session will timeout.
                                     Default: 2880 minutes (48 hours).
%session_id_prefix   String          Define a String that will precede all session IDs in the format
                                     [session_id_prefix]-[session_id]. If a session ID is not provided,
                                     a random UUID will be generated.
%status                              Returns the status of the current Glue session including its duration,
                                     configuration and executing user / role.
%session_id                          Returns the session ID for the running session.
%list_sessions                       Lists all currently running sessions by ID.
%stop_session                        Stops the current session.
%glue_version        String          The version of Glue to be used by this session.
                                     Currently, the only valid options are 2.0, 3.0 and 4.0.
                                     Default: 2.0.
```

Selecting Job Types

```
%streaming           String          Sets the session type to Glue Streaming.
%etl                 String          Sets the session type to Glue ETL.
%glue_ray            String          Sets the session type to Glue Ray.
```

Glue Config Magic

Crawler run succeeded



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)

Last updated (UTC) February 7, 2024 at 20:02:50

View and manage all available crawlers.

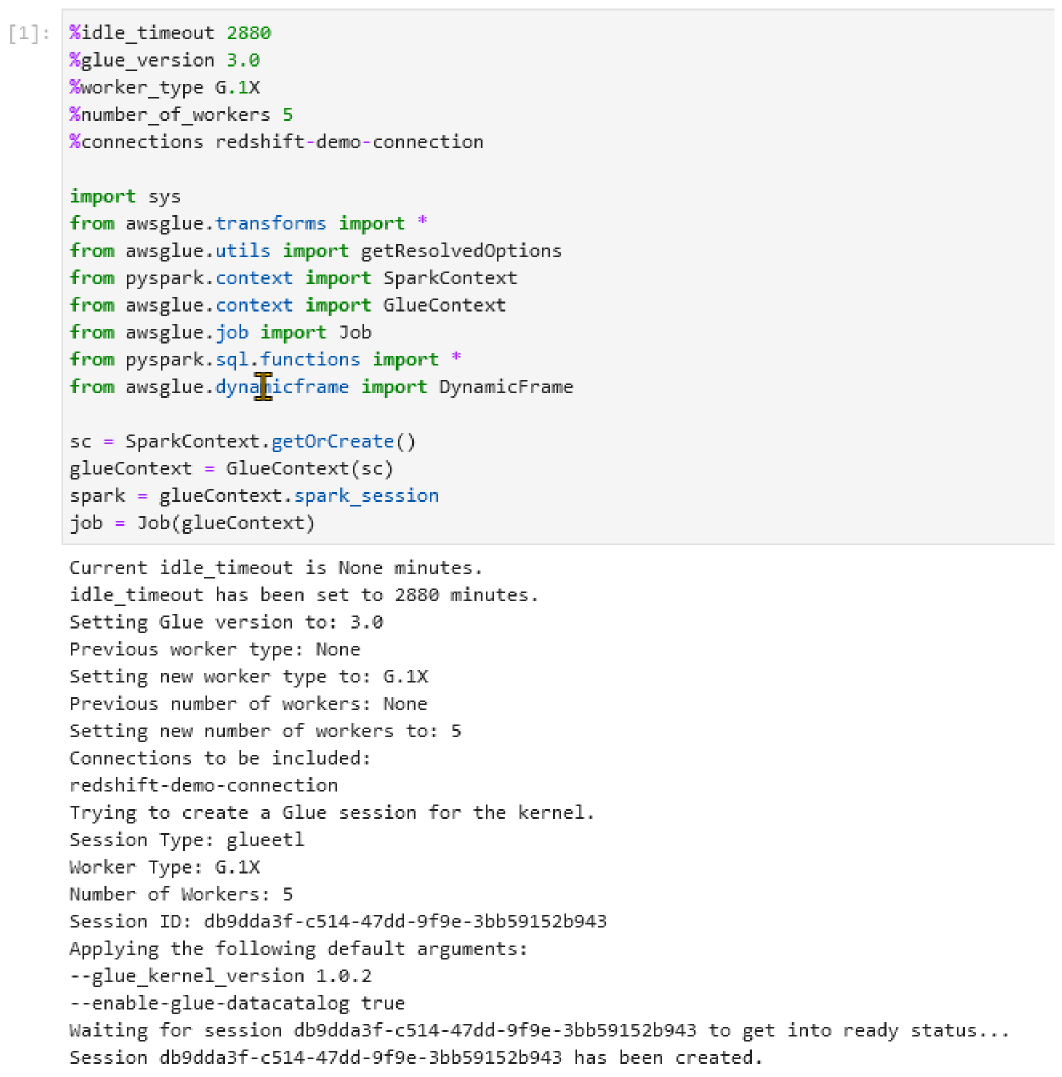
Name	State	Schedule	Last run	Last run timest...	Log	Table chan...
sales	Ready		Succeeded	February 7, 2024 a...	View log	1 created

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

Workflow steps:

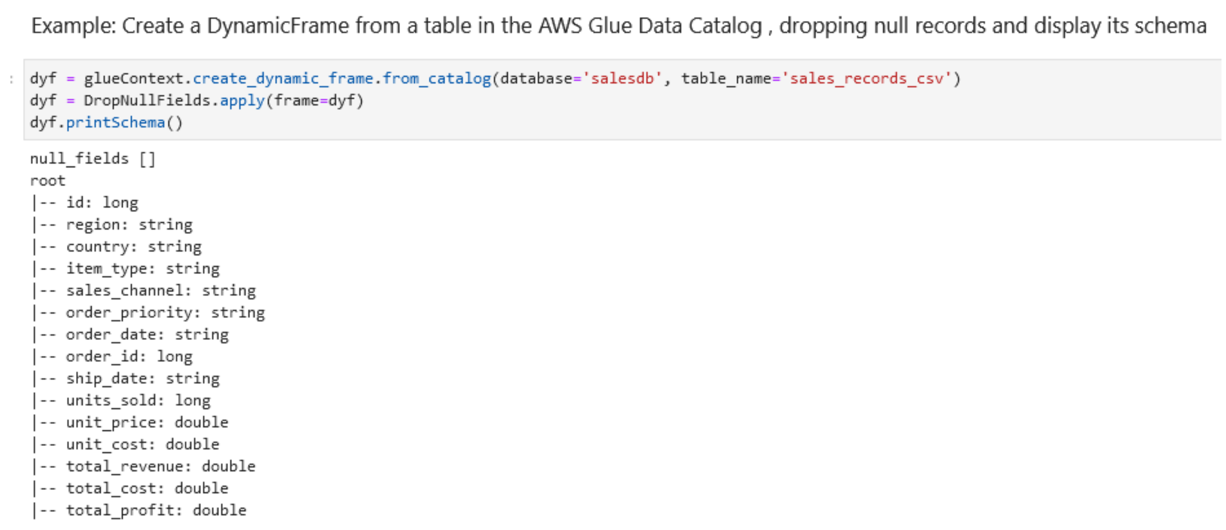
- fetch data from S3 in csv format,
- catalog data,
- clean (dropping null values)
- transform (date)
- perform some aggregation
- write data to redshift db

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

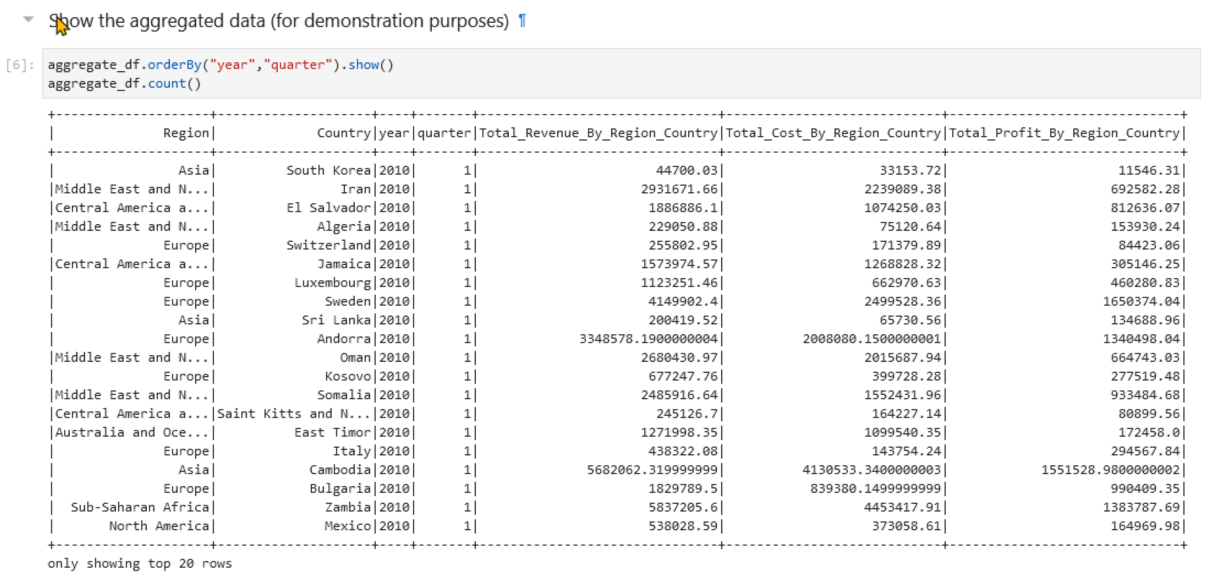
Example: Perform data transformations

```
[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

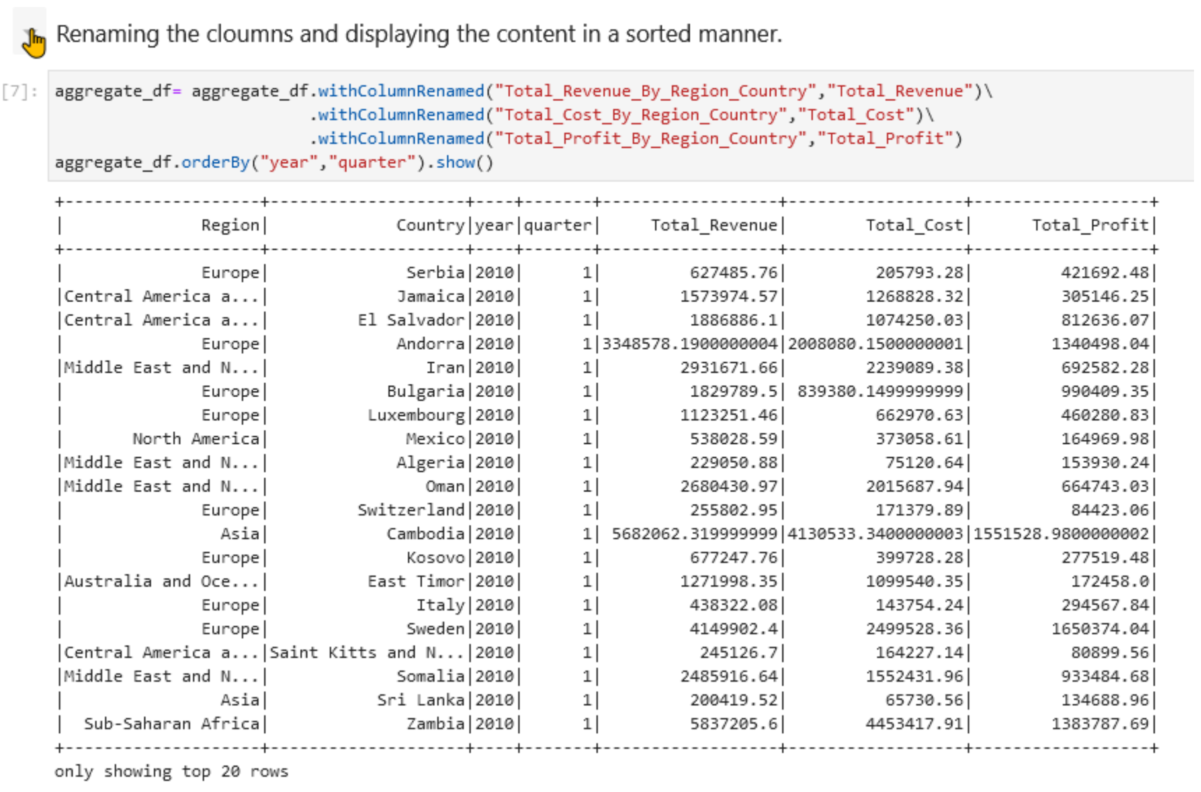
```
[5]: aggregate_df = sales_df.groupBy("Region", "Country", year("order_date").alias('year'), quarter("order_date").alias('quarter')).agg(
         sum("Total_Revenue").alias("Total_Revenue_By_Region_Country"),
         sum("Total_Cost").alias("Total_Cost_By_Region_Country"),
         sum("Total_Profit").alias("Total_Profit_By_Region_Country")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



Show the aggregated data (for demonstration purposes) ¶

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

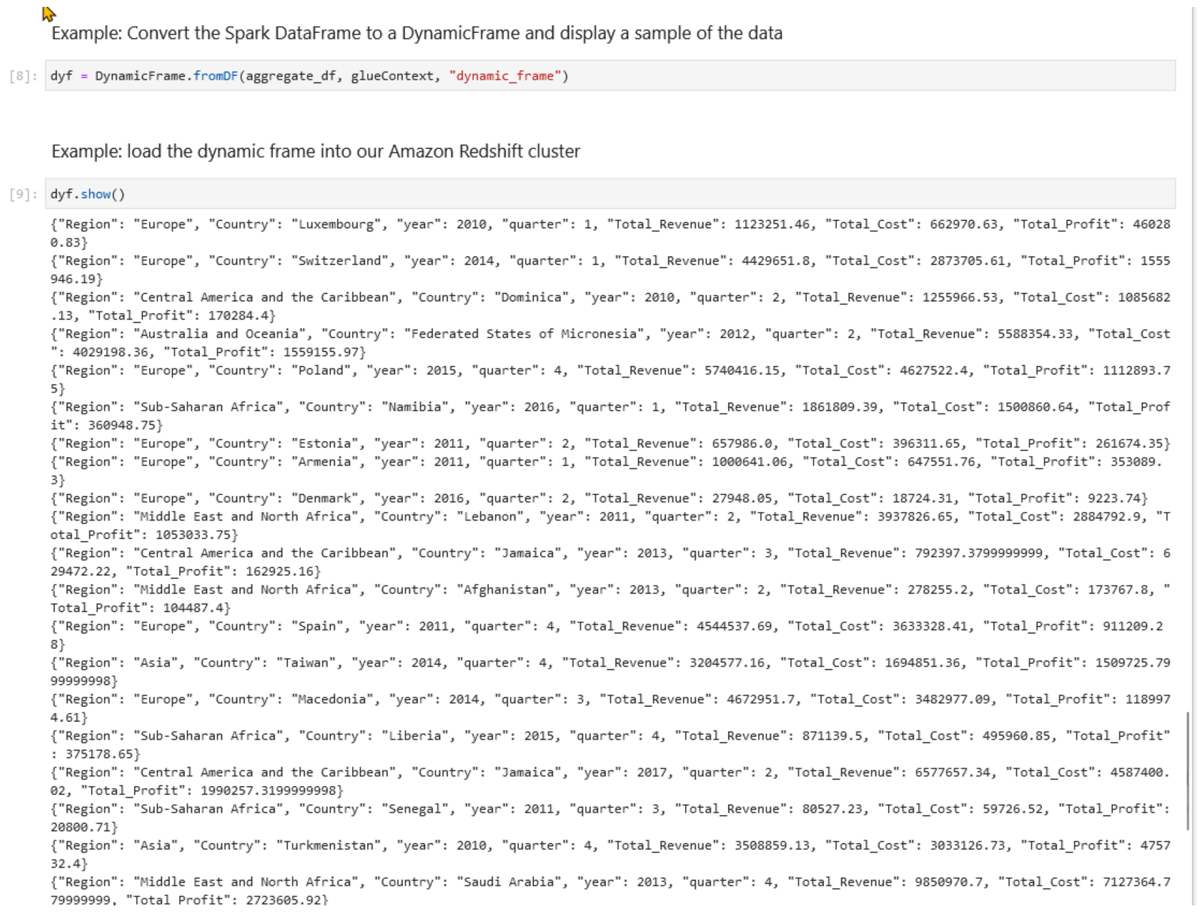
```
+--------------------+--------------------+----+-------+-------------------------------+----------------------------+------------------------------+
|              Region|             Country|year|quarter|Total_Revenue_By_Region_Country|Total_Cost_By_Region_Country|Total_Profit_By_Region_Country|
+--------------------+--------------------+----+-------+-------------------------------+----------------------------+------------------------------+
|                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

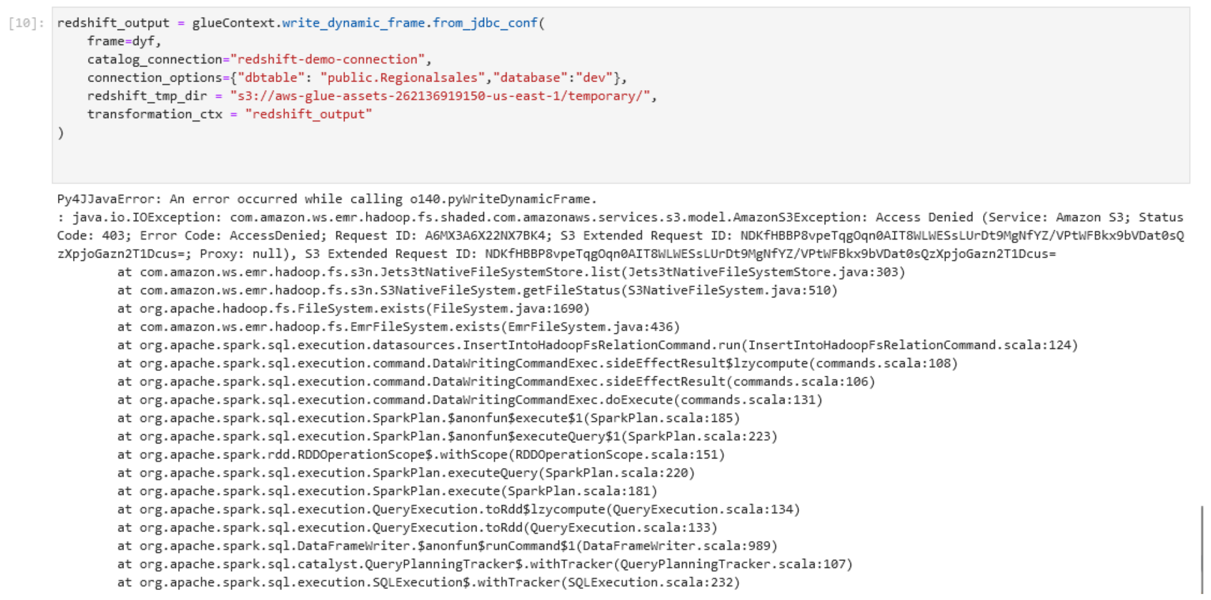
```
[8]: dyf = DynamicFrame.fromDF(aggregate_df, glueContext, "dynamic_frame")
```

Example: load the dynamic frame into our Amazon Redshift cluster

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

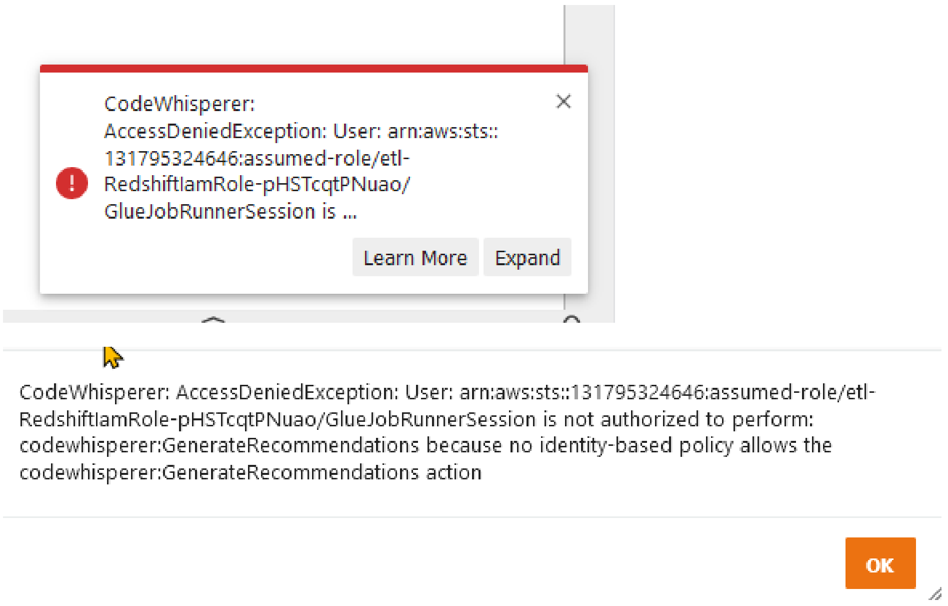
```
{"Region": "Europe", "Country": "Luxembourg", "year": 2010, "quarter": 1, "Total_Revenue": 1123251.46, "Total_Cost": 662970.63, "Total_Profit": 46028
0.83}
{"Region": "Europe", "Country": "Switzerland", "year": 2014, "quarter": 1, "Total_Revenue": 4429651.8, "Total_Cost": 2873705.61, "Total_Profit": 1555
946.19}
{"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": 1112893.7
5}
{"Region": "Sub-Saharan Africa", "Country": "Namibia", "year": 2016, "quarter": 1, "Total_Revenue": 1861809.39, "Total_Cost": 1500860.64, "Total_Prof
it": 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, "T
otal_Profit": 1053033.75}
{"Region": "Central America and the Caribbean", "Country": "Jamaica", "year": 2013, "quarter": 3, "Total_Revenue": 792397.3799999999, "Total_Cost": 6
29472.22, "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": 911209.2
8}
{"Region": "Asia", "Country": "Taiwan", "year": 2014, "quarter": 4, "Total_Revenue": 3204577.16, "Total_Cost": 1694851.36, "Total_Profit": 1509725.79
99999998}
{"Region": "Europe", "Country": "Macedonia", "year": 2014, "quarter": 3, "Total_Revenue": 4672951.7, "Total_Cost": 3482977.09, "Total_Profit": 118997
4.61}
{"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": 4757
32.4}
{"Region": "Middle East and North Africa", "Country": "Saudi Arabia", "year": 2013, "quarter": 4, "Total_Revenue": 9850970.7, "Total_Cost": 7127364.7
79999999, "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"
      )
```

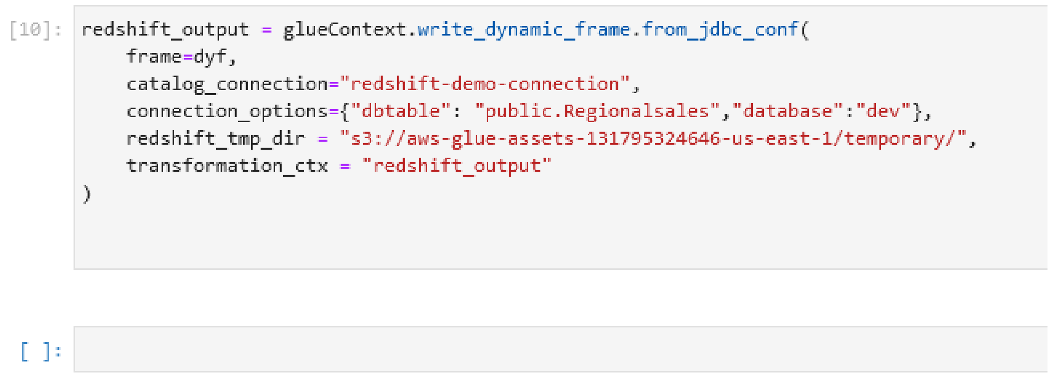
```
Py4JJavaError: An error occurred while calling o140.pyWriteDynamicFrame.
: java.io.IOException: com.amazon.ws.emr.hadoop.fs.shaded.com.amazonaws.services.s3.model.AmazonS3Exception: Access Denied (Service: Amazon S3; Status
Code: 403; Error Code: AccessDenied; Request ID: A6MX3A6X22NX7BK4; S3 Extended Request ID: NDKfHBBP8vpeTqgOqn0AIT8WLWESsLUrDt9MgNfYZ/VPtWFBkx9bVDat0sQ
zXpjoGazn2T1Dcus=; 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)
```



CodeWhisperer:
AccessDeniedException: User: arn:aws:sts::
131795324646:assumed-role/etl-
RedshiftIamRole-pHSTcqtPNuao/
GlueJobRunnerSession is ...

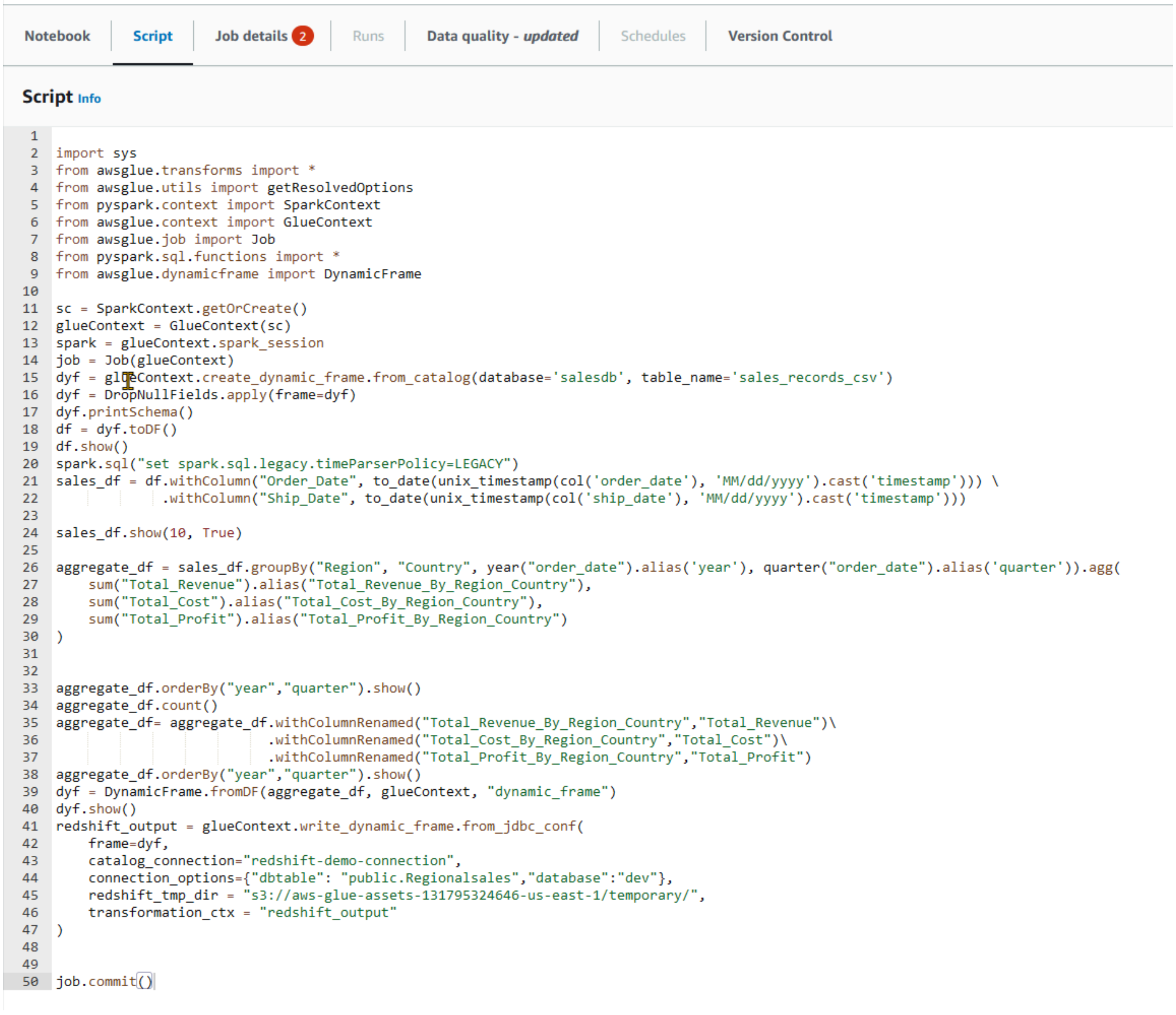
```
CodeWhisperer: AccessDeniedException: User: arn:aws:sts::131795324646:assumed-role/etl-
RedshiftIamRole-pHSTcqtPNuao/GlueJobRunnerSession is not authorized to perform:
codewhisperer:GenerateRecommendations because no identity-based policy allows the
codewhisperer:GenerateRecommendations action
```

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"
      )

[ ]:
```

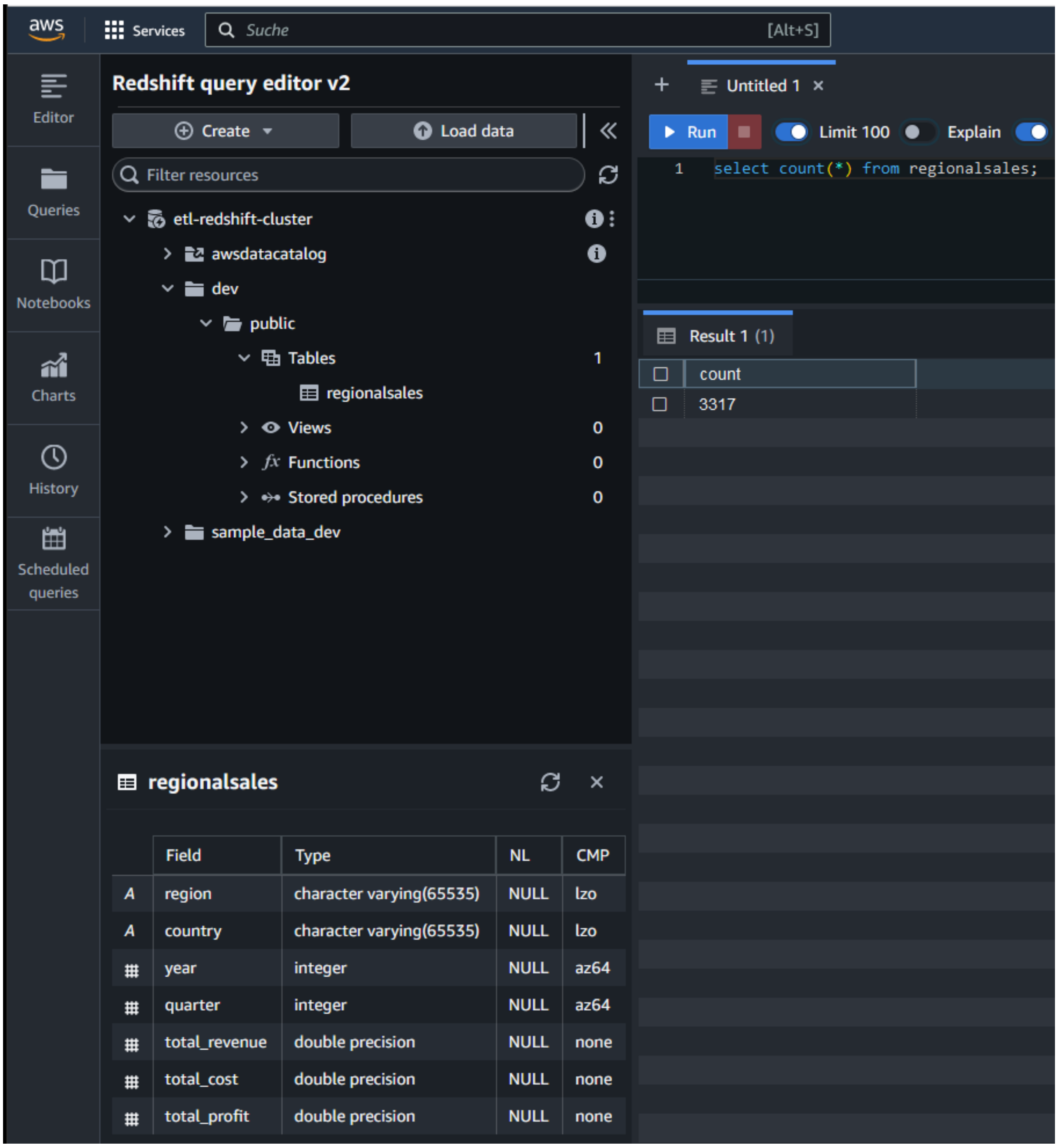
4.6.2 Jupyter Notebook as Pyspark Script that could be sheduled



```python

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

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")
)


aggregate_df.orderBy("year","quarter").show()
aggregate_df.count()
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()
dyf = DynamicFrame.fromDF(aggregate_df, glueContext, "dynamic_frame")
dyf.show()
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"
)


job.commit()
```

5 AWS Redshift

Here we see the result of our working Data Pipeline. All data are processed (transformed, aggregated) and then writen do AWS Redshift database for example further analytics.



```
select count(*) from regionalsales;
```

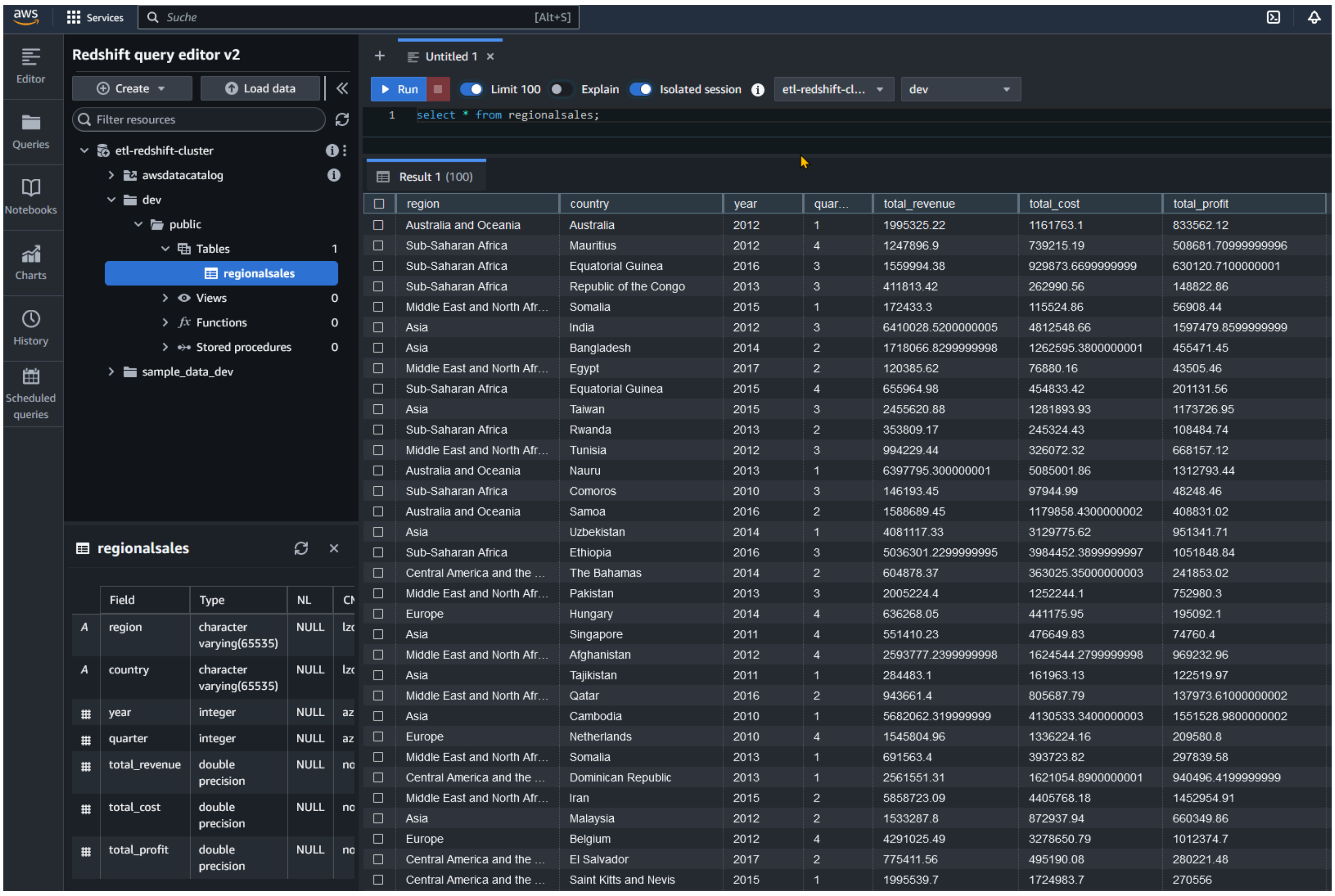
count
3317

regionalsales

	Field	Type	NL	CMP
A	region	character varying(65535)	NULL	lzo
A	country	character varying(65535)	NULL	lzo
#	year	integer	NULL	az64
#	quarter	integer	NULL	az64
#	total_revenue	double precision	NULL	none
#	total_cost	double precision	NULL	none
#	total_profit	double precision	NULL	none

```
only showing top 20 rows

3317
```

Amount ist he same as in interactive Jupyter Notebook



```
select * from regionalsales;
```

regionalsales

	Field	Type	NL	CI
A	region	character varying(65535)	NULL	lzo
A	country	character varying(65535)	NULL	lzo
▦	year	integer	NULL	az
▦	quarter	integer	NULL	az
▦	total_revenue	double precision	NULL	no
▦	total_cost	double precision	NULL	no
▦	total_profit	double precision	NULL	no

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