```
In [1]: import boto3
        import pandas as pd
        import numpy as np
        import os
        from datetime import datetime
        import requests
        import zipfile
        import io
        import re
        import time
        import urllib.parse
```

```
In [2]: s3 = boto3.resource(
            service_name = 's3',
            region_name = 'ap-south-1',
            aws_access_key_id='AKIAQ---------HT5W5',
            aws_secret_access_key = 'upWVXX6-----ucuZu72IH-----78CeMwb---jxka'
        )
```

```
In [3]: for bucket in s3.buckets.all():
            print(bucket.name)
```

```
portfolio-return-data
portfolio-return-raw-bucket
```

1. Data Ingestion :

```
a. Download raw data from source.
b. Extract
c. Parse the files into structured format
```

```
In [4]: def get_zip_links():
            years = range(2017, 2026)
            base = "https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives"

            links = []
            for y in years:
                folder = f"08 {y} Update"
                for ext in ["TXT"]:
```

```
            url = f"{base}/{folder}/ftp/6_Portfolios_2x3_{ext}.zip"
            links.append(url)

    return links

zip_links = get_zip_links()
zip_links
```

Out[4]:

```
['https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2017 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2018 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2019 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2020 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2021 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2022 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2023 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2024 Update/ftp/6_Port
folios_2x3_TXT.zip',
 'https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2025 Update/ftp/6_Port
folios_2x3_TXT.zip']
```

In [5]:

```
output_dir = r"C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv"
os.makedirs(output_dir, exist_ok=True)

markers = [
    "Average Value Weighted Returns -- Monthly",
    "Average Equal Weighted Returns -- Monthly",
    "Average Value Weighted Returns -- Annual"
]

def parse_fama_french_text(text):
    lines = text.splitlines()
    positions = {}

    for i, line in enumerate(lines):
        for m in markers:
            if m in line:
                positions[m] = i

    tables = {}
    marker_list = sorted(positions.items(), key=lambda x: x[1])

    for idx in range(len(marker_list)-1):
        name, start = marker_list[idx]
        _, end = marker_list[idx + 1]

        block = lines[start + 2:end]
        rows = []

        for line in block:
            parts = line.strip().split()
            if parts and parts[0].isdigit():
                rows.append(parts)

        if rows:
            df = pd.DataFrame(rows, columns=[
                "Date",
                "Small_Low", "Small_2", "Small_High",
                "Big_Low", "Big_2", "Big_High"
            ])

            for col in df.columns[1:]:
                df[col] = pd.to_numeric(df[col], errors="coerce")

            df["Date"] = pd.to_datetime(df["Date"], format="%Y%m", errors="coerce")
            tables[name] = df

    return tables

# MAIN LOOP
for url in zip_links:
    print(f"Processing: {url}")

    response = requests.get(url, verify=False)
    zip_bytes = io.BytesIO(response.content)

    with zipfile.ZipFile(zip_bytes) as z:
        txt_files = [f for f in z.namelist() if f.endswith(".txt")]
        if not txt_files:
            print("No txt file found inside ZIP:", url)
            continue

        txt_filename = txt_files[0]
        text_data = z.read(txt_filename).decode("latin-1")

    # Parse tables
    tables = parse_fama_french_text(text_data)

    year_match = re.search(r"/.*?(\d{4}).*?/", url)
    if year_match:
        year = year_match.group(1)
    else:
        print("Could not extract year → skipping:", url)
        continue

    year_folder = os.path.join(output_dir, year)
    os.makedirs(year_folder, exist_ok=True)


    # Save CSV files inside YEAR folder
    for name, df in tables.items():
        clean_name = name.replace(" ", "_").replace("-", "")
        csv_path = os.path.join(year_folder, f"{clean_name}.csv")

        df.to_csv(csv_path, index=False)
        print(f"Saved → {csv_path}")

print("\nAll files processed successfully")
```

```
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2017 Update/f
tp/6_Portfolios_2x3_TXT.zip
C:\Users\nshinga\without_conda\Lib\site-packages\urllib3\connectionpool.py:1099: InsecureRequestWarning: Unverified H
TTPS request is being made to host 'mba.tuck.dartmouth.edu'. Adding certificate verification is strongly advised. Se
e: https://urllib3.readthedocs.io/en/latest/advanced-usage.html#tls-warnings
  warnings.warn(
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2018 Update/f
tp/6_Portfolios_2x3_TXT.zip
```

```
C:\Users\nshinga\without_conda\Lib\site-packages\urllib3\connectionpool.py:1099: InsecureRequestWarning: Unverified H
TTPS request is being made to host 'mba.tuck.dartmouth.edu'. Adding certificate verification is strongly advised. Se
e: https://urllib3.readthedocs.io/en/latest/advanced-usage.html#tls-warnings
  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2018\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2018\Average_Equal_Wei
ghted_Returns__Monthly.csv
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2019 Update/f
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  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2019\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2019\Average_Equal_Wei
ghted_Returns__Monthly.csv
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2020 Update/f
tp/6_Portfolios_2x3_TXT.zip
C:\Users\nshinga\without_conda\Lib\site-packages\urllib3\connectionpool.py:1099: InsecureRequestWarning: Unverified H
TTPS request is being made to host 'mba.tuck.dartmouth.edu'. Adding certificate verification is strongly advised. Se
e: https://urllib3.readthedocs.io/en/latest/advanced-usage.html#tls-warnings
  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2020\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2020\Average_Equal_Wei
ghted_Returns__Monthly.csv
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2021 Update/f
tp/6_Portfolios_2x3_TXT.zip
C:\Users\nshinga\without_conda\Lib\site-packages\urllib3\connectionpool.py:1099: InsecureRequestWarning: Unverified H
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  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2021\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2021\Average_Equal_Wei
ghted_Returns__Monthly.csv
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2022 Update/f
tp/6_Portfolios_2x3_TXT.zip
```

```
C:\Users\nshinga\without_conda\Lib\site-packages\urllib3\connectionpool.py:1099: InsecureRequestWarning: Unverified H
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  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2022\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2022\Average_Equal_Wei
ghted_Returns__Monthly.csv
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2023 Update/f
tp/6_Portfolios_2x3_TXT.zip
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  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2023\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2023\Average_Equal_Wei
ghted_Returns__Monthly.csv
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2024 Update/f
tp/6_Portfolios_2x3_TXT.zip
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  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2024\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2024\Average_Equal_Wei
ghted_Returns__Monthly.csv
Processing: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/Historical_Archives/08 2025 Update/f
tp/6_Portfolios_2x3_TXT.zip
C:\Users\nshinga\without_conda\Lib\site-packages\urllib3\connectionpool.py:1099: InsecureRequestWarning: Unverified H
TTPS request is being made to host 'mba.tuck.dartmouth.edu'. Adding certificate verification is strongly advised. Se
e: https://urllib3.readthedocs.io/en/latest/advanced-usage.html#tls-warnings
  warnings.warn(
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2025\Average_Value_Wei
ghted_Returns__Monthly.csv
Saved → C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2025\Average_Equal_Wei
ghted_Returns__Monthly.csv

All files processed successfully
```

upload data to s3

In [6]:
```
local_base_dir = r"C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv"
bucket_name = "portfolio-return-data"
s3_prefix = "ff_6_portfolios/output_csv"

for root, dirs, files in os.walk(local_base_dir):
    for file in files:
        if file.endswith(".csv"):
            local_path = os.path.join(root, file)

            rel_path = os.path.relpath(local_path, local_base_dir)
            s3_key = os.path.join(s3_prefix, rel_path).replace("\\", "/")

            print(f"Uploading {local_path} → s3://{bucket_name}/{s3_key}")
            s3.Bucket('portfolio-return-data').upload_file(local_path, s3_key)

print("Upload complete")
```

```
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2018\Average_Equal_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2018/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2018\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2018/Average_Value_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2019\Average_Equal_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2019/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2019\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2019/Average_Value_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2020\Average_Equal_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2020/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2020\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2020/Average_Value_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2021\Average_Equal_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2021/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2021\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2021/Average_Value_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2022\Average_Equal_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2022/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2022\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2022/Average_Value_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2023\Average_Equal_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2023/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2023\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2023/Average_Value_Weighted_Retu
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eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2024/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2024\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2024/Average_Value_Weighted_Retu
rns__Monthly.csv
```

```
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2025\Average_Equal_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2025/Average_Equal_Weighted_Retu
rns__Monthly.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2025\Average_Value_W
eighted_Returns__Monthly.csv → s3://portfolio-return-data/ff_6_portfolios/output_csv/2025/Average_Value_Weighted_Retu
rns__Monthly.csv
Upload complete
```

2. Transform to Long Format

In [7]:

```python
main_path = r"C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv"

raw_data_list = []
ingestion_map_list = []

for root, dirs, files in os.walk(main_path):
    for file in files:
        if file.endswith('.csv'):
            file_path = os.path.join(root, file)
            df = pd.read_csv(file_path)

            # Convert to long format
            df = df.melt(id_vars=df.columns[0], var_name='PORTFOLIO', value_name='RETURN')

            # Convert date column to datetime
            df[df.columns[0]] = pd.to_datetime(df[df.columns[0]], format='%Y-%m-%d', errors='coerce')
            df.rename(columns={df.columns[0]: 'DATE'}, inplace=True)

            # Add metadata
            df['SOURCE'] = file_path
            df['INGESTION_TIME'] = datetime.now()
            df['INGESTED_BY'] = 'Neha Shingare'
            df['INGESTED_SYSTEM'] = 'Python_Local'

            raw_data_list.append(df)

            # Record ingestion map
            ingestion_map_list.append({
                'FILE_NAME': file,
                'YEAR_FOLDER': os.path.basename(root),
                'INGESTION_TIME': datetime.now(),
                'RECORDS_INGESTED': len(df)
            })
```

3. Access method and Source Map Table

In [8]:
```
%%time
RAW_DATA = pd.concat(raw_data_list, ignore_index=True)
DATA_INGESTION_MAP = pd.DataFrame(ingestion_map_list)

# Cleaning data
RAW_DATA['DATE'] = pd.to_datetime(RAW_DATA['DATE'])
RAW_DATA['RETURN'] = pd.to_numeric(RAW_DATA['RETURN'], errors='coerce')

# handling nulls & duplicates
RAW_DATA.dropna(subset=['DATE', 'PORTFOLIO', 'RETURN'], inplace=True)
RAW_DATA.drop_duplicates(inplace=True)


pit_data_list = []
for year in range(2017, 2026):
    pit_df = RAW_DATA[RAW_DATA['DATE'] <= pd.Timestamp(year=year, month=7, day=31)].copy()
    pit_df['PIT_YEAR'] = year
    pit_data_list.append(pit_df)
PIT_DATA = pd.concat(pit_data_list, ignore_index=True)

# CURRENT_DATA = RAW_DATA.copy()
CURRENT_DATA = RAW_DATA.loc[RAW_DATA.groupby('PORTFOLIO')['DATE'].idxmax()].reset_index(drop=True)

output_path = r"C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\processed_output"
os.makedirs(output_path, exist_ok=True)

RAW_DATA.to_csv(os.path.join(output_path, 'RAW_DATA.csv'), index=False)
PIT_DATA.to_csv(os.path.join(output_path, 'PIT_DATA.csv'), index=False)
CURRENT_DATA.to_csv(os.path.join(output_path, 'CURRENT_DATA.csv'), index=False)
DATA_INGESTION_MAP.to_csv(os.path.join(output_path, 'DATA_INGESTION_MAP.csv'), index=False)

print("Data processing complete")
```

```
Data processing complete
CPU times: total: 10.1 s
Wall time: 27.6 s
```

In [9]:
```
RAW_DATA.shape, PIT_DATA.shape, CURRENT_DATA.shape
```
Out[9]:
```
((110112, 7), (973728, 8), (6, 7))
```

4. Upload data to S3

In [10]:
```
%%time
local_dir = r"C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\processed_output"
bucket_name = "portfolio-return-data"
s3_prefix = "ff_6_portfolios/processed_output/"


for file in os.listdir(local_dir):
    if file.endswith(".csv"):
        local_path = os.path.join(local_dir, file)
        s3_key = os.path.join(s3_prefix, file).replace("\\", "/")

        print(f"Uploading {local_path} → s3://{bucket_name}/{s3_key}")
        s3.Bucket('portfolio-return-data').upload_file(local_path, s3_key)

print("Upload complete")
```
```
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\processed_output\CURRENT_DATA.c
sv → s3://portfolio-return-data/ff_6_portfolios/processed_output/CURRENT_DATA.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\processed_output\DATA_INGESTION
_MAP.csv → s3://portfolio-return-data/ff_6_portfolios/processed_output/DATA_INGESTION_MAP.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\processed_output\PIT_DATA.csv →
s3://portfolio-return-data/ff_6_portfolios/processed_output/PIT_DATA.csv
Uploading C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\processed_output\RAW_DATA.csv →
s3://portfolio-return-data/ff_6_portfolios/processed_output/RAW_DATA.csv
Upload complete
CPU times: total: 12.8 s
Wall time: 28.2 s
```

Data quality check

In [21]:
```
def robustness_checks(df_raw):
    print("1. NULL CHECKS")
    null_counts = df_raw.isnull().sum()
    print(null_counts)
    print("\n")

    print("2. DUPLICATE CHECKS")
    dup_count = df_raw.duplicated().sum()
    print(f"Total duplicated rows: {dup_count}")
    if dup_count > 0:
        print("Removing duplicates...")
        df_raw.drop_duplicates(inplace=True)
    print("\n")

    print("3. SCHEMA & DTYPE VALIDATION")
    expected_columns = ['DATE', 'PORTFOLIO', 'RETURN', 'SOURCE', 'INGESTION_TIME', 'INGESTED_BY', 'INGESTED_SYSTEM']

    missing_cols = [col for col in expected_columns if col not in df_raw.columns]
    if missing_cols:
        print(f"Missing required columns: {missing_cols}")
    else:
        print("All required columns present")

    # enforce types
    try:
        df_raw['DATE'] = pd.to_datetime(df_raw['DATE'])
        print("DATE converted to datetime")
    except:
        print("Failed to convert DATE to datetime")

    try:
        df_raw['RETURN'] = pd.to_numeric(df_raw['RETURN'], errors='coerce')
        print("RETURN converted to numeric")
    except:
        print("Failed to convert RETURN to numeric")

    print("\n")

    print("4. DATE RANGE VALIDATION")
    min_date = df_raw['DATE'].min()
    max_date = df_raw['DATE'].max()
    print(f"Earliest DATE: {min_date}")
    print(f"Latest DATE:   {max_date}")

    # Business rule: Data must be >= July 2017
    cutoff_date = pd.Timestamp("2017-07-01")
```

```
if min_date < cutoff_date:
    print(f"Some dates earlier than July 2017 found: {min_date}")
else:
    print("No dates before July 2017")

# No future dates allowed
today = pd.Timestamp.today()
if max_date > today:
    print(f"Future dates detected: {max_date}")
else:
    print("No future dates detected")
print("\n")

print("5. MONTHLY CONTINUITY CHECK")
expected_months = pd.date_range(start=min_date, end=max_date, freq='MS')
actual_months = df_raw['DATE'].dt.to_period('M').unique()

missing_months = set(expected_months.to_period('M')) - set(actual_months)

if missing_months:
    print(f"Missing months: {sorted(missing_months)}")
else:
    print("No missing months in the dataset")
print("\n")


print("6. PORTFOLIO VALIDATION")
allowed_prefixes = ['SL', 'SM', 'SH', 'BL', 'BM', 'BH', 'Bi','Sm']  # Example for 6 FF portfolios

invalid_portfolios = df_raw[~df_raw['PORTFOLIO'].str[:2].isin([x[:2] for x in allowed_prefixes])]['PORTFOLIO'].ur

if len(invalid_portfolios) > 0:
    print(f"Unexpected portfolio labels found: {invalid_portfolios}")
else:
    print("Portfolio labels follow expected pattern")
print("\n")


print("7. RETURN VALUE VALIDATION")
if df_raw['RETURN'].isnull().sum() > 0:
    print(f"⚠ RETURN contains {df_raw['RETURN'].isnull().sum()} null values")
```

```
if not df_raw['RETURN'].between(-100, 100).all():
    print("Some RETURN values fall outside typical % return bounds (-100 to 100)")
else:
    print("RETURN values within reasonable range")
print("\n")


print("8. PIT (Point-In-Time) INTEGRITY CHECK")
# Example: ensure PIT cutoff logic holds:
# PIT for year X should only contain dates <= July of year X
try:
    PIT_DATA  # check if exists
    for year in range(2017, 2026):
        pit_violations = df_raw[df_raw['DATE'] > pd.Timestamp(year=year, month=7, day=31)]

    if len(pit_violations) > 0:
        print("PIT dataset contains rows beyond PIT cutoff.")
    else:
        print("PIT dataset passes integrity checks")
except:
    print("PIT dataset not loaded in this environment")
print("\n")


print("9. S3 UPLOAD CHECK (Optional)")
s3 = boto3.client(
    service_name = 's3',
    region_name = 'ap-south-1',
    aws_access_key_id='AKIAQ----------HT5W5',
    aws_secret_access_key = 'upWVXX6-----ucuZu72IH-----78CeMwb---jxka'
)

bucket_name = 'portfolio-return-data'
s3_path_prefix = 'ff_6_portfolios/processed_output/'

response = s3.list_objects_v2(Bucket=bucket_name, Prefix=s3_path_prefix)

if 'Contents' in response:
    print(f"Files in '{s3_path_prefix}':")
    for obj in response['Contents']:
        print(obj['Key'])
else:
    print(f"No files found in '{s3_path_prefix}' in bucket '{bucket_name}'.")


return df_raw
```

In [22]:
```
df_raw_checked = robustness_checks(CURRENT_DATA)
```

```
1. NULL CHECKS
DATE               0
PORTFOLIO          0
RETURN             0
SOURCE             0
INGESTION_TIME     0
INGESTED_BY        0
INGESTED_SYSTEM    0
dtype: int64


2. DUPLICATE CHECKS
Total duplicated rows: 0


3. SCHEMA & DTYPE VALIDATION
All required columns present
DATE converted to datetime
RETURN converted to numeric


4. DATE RANGE VALIDATION
Earliest DATE: 2025-07-01 00:00:00
Latest DATE:   2025-07-01 00:00:00
No dates before July 2017
No future dates detected


5. MONTHLY CONTINUITY CHECK
No missing months in the dataset


6. PORTFOLIO VALIDATION
Portfolio labels follow expected pattern


7. RETURN VALUE VALIDATION
RETURN values within reasonable range


8. PIT (Point-In-Time) INTEGRITY CHECK
PIT dataset passes integrity checks
```

```
9. S3 UPLOAD CHECK (Optional)
Files in 'ff_6_portfolios/processed_output/':
ff_6_portfolios/processed_output/CURRENT_DATA.csv
ff_6_portfolios/processed_output/DATA_INGESTION_MAP.csv
ff_6_portfolios/processed_output/PIT_DATA.csv
ff_6_portfolios/processed_output/RAW_DATA.csv
```

In [23]:
```
df_raw_checked = robustness_checks(RAW_DATA)
```

```
1. NULL CHECKS
DATE                0
PORTFOLIO           0
RETURN              0
SOURCE              0
INGESTION_TIME      0
INGESTED_BY         0
INGESTED_SYSTEM     0
dtype: int64


2. DUPLICATE CHECKS
Total duplicated rows: 0


3. SCHEMA & DTYPE VALIDATION
All required columns present
DATE converted to datetime
RETURN converted to numeric


4. DATE RANGE VALIDATION
Earliest DATE: 1926-07-01 00:00:00
Latest DATE:   2025-07-01 00:00:00
Some dates earlier than July 2017 found: 1926-07-01 00:00:00
No future dates detected


5. MONTHLY CONTINUITY CHECK
No missing months in the dataset


6. PORTFOLIO VALIDATION
Portfolio labels follow expected pattern


7. RETURN VALUE VALIDATION
RETURN values within reasonable range


8. PIT (Point-In-Time) INTEGRITY CHECK
PIT dataset passes integrity checks
```

```
9. S3 UPLOAD CHECK (Optional)
Files in 'ff_6_portfolios/processed_output/':
ff_6_portfolios/processed_output/CURRENT_DATA.csv
ff_6_portfolios/processed_output/DATA_INGESTION_MAP.csv
ff_6_portfolios/processed_output/PIT_DATA.csv
ff_6_portfolios/processed_output/RAW_DATA.csv
```

In [24]:
```
df_raw_checked = robustness_checks(PIT_DATA)
```

```
1. NULL CHECKS
DATE               0
PORTFOLIO          0
RETURN             0
SOURCE             0
INGESTION_TIME     0
INGESTED_BY        0
INGESTED_SYSTEM    0
PIT_YEAR           0
dtype: int64


2. DUPLICATE CHECKS
Total duplicated rows: 0


3. SCHEMA & DTYPE VALIDATION
All required columns present
DATE converted to datetime
RETURN converted to numeric


4. DATE RANGE VALIDATION
Earliest DATE: 1926-07-01 00:00:00
Latest DATE:   2025-07-01 00:00:00
Some dates earlier than July 2017 found: 1926-07-01 00:00:00
No future dates detected


5. MONTHLY CONTINUITY CHECK
No missing months in the dataset


6. PORTFOLIO VALIDATION
Portfolio labels follow expected pattern


7. RETURN VALUE VALIDATION
RETURN values within reasonable range


8. PIT (Point-In-Time) INTEGRITY CHECK
```

```
PIT dataset passes integrity checks


9. S3 UPLOAD CHECK (Optional)
Files in 'ff_6_portfolios/processed_output/':
ff_6_portfolios/processed_output/CURRENT_DATA.csv
ff_6_portfolios/processed_output/DATA_INGESTION_MAP.csv
ff_6_portfolios/processed_output/PIT_DATA.csv
ff_6_portfolios/processed_output/RAW_DATA.csv
```

In [25]:

```python
database_name = "ff_6_portfolios"
s3_data_location = "s3://portfolio-return-data/ff_6_portfolios/processed_output/"
s3_output = "s3://portfolio-return-data/athena-query-results/"  # Athena query results

athena_client = boto3.client(
    service_name = 'athena',
    region_name = 'ap-south-1',
    aws_access_key_id='AKIAQ----------HT5W5',
    aws_secret_access_key = 'upWVXX6-----ucuZu72IH-----78CeMwb---jxka'
)

s3_client = boto3.client(
    service_name = 's3',
    region_name = 'ap-south-1',
    aws_access_key_id='AKIAQ----------HT5W5',
    aws_secret_access_key = 'upWVXX6-----ucuZu72IH-----78CeMwb---jxka'
)

def wait_for_query(query_execution_id):
    while True:
        response = athena_client.get_query_execution(QueryExecutionId=query_execution_id)
        status = response['QueryExecution']['Status']['State']
        if status in ["SUCCEEDED", "FAILED", "CANCELLED"]:
            break
        time.sleep(2)
    return status


# Create database
query = f"""
CREATE DATABASE IF NOT EXISTS {database_name}
LOCATION '{s3_data_location}'
```

```
"""
response = athena_client.start_query_execution(
    QueryString=query,
    ResultConfiguration={"OutputLocation": s3_output}
)
wait_for_query(response["QueryExecutionId"])
print(f"Database '{database_name}' ensured.")


# List CSV files in S3 folder
parsed_url = urllib.parse.urlparse(s3_data_location)
bucket = parsed_url.netloc
prefix = parsed_url.path.lstrip("/")

csv_objects = s3_client.list_objects_v2(Bucket=bucket, Prefix=prefix)
csv_files = [obj['Key'] for obj in csv_objects.get('Contents', []) if obj['Key'].endswith('.csv')]

if not csv_files:
    print("No CSV files found in the specified S3 folder.")
    exit()

# Create tables from CSVs
for csv_file in csv_files:
    table_name = csv_file.split("/")[-1].replace(".csv", "").replace("-", "_")

    obj = s3_client.get_object(Bucket=bucket, Key=csv_file)
    df = pd.read_csv(io.BytesIO(obj['Body'].read()), nrows=5)

    columns = ",\n    ".join([f"{col.replace(' ', '_')} string" for col in df.columns])

    # Location = parent folder, not the file itself
    s3_file_folder = s3_data_location  # points to folder, not individual file

    create_table_query = f"""
    CREATE EXTERNAL TABLE IF NOT EXISTS {database_name}.{table_name} (
        {columns}
    )
    ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe'
    WITH SERDEPROPERTIES (
        'serialization.format' = ',',
        'field.delim' = ','
    )
    STORED AS TEXTFILE
    LOCATION '{s3_file_folder}'
    TBLPROPERTIES ('has_encrypted_data'='false');
    """

    response = athena_client.start_query_execution(
        QueryString=create_table_query,
        ResultConfiguration={"OutputLocation": s3_output}
    )

    status = wait_for_query(response["QueryExecutionId"])
    if status == "SUCCEEDED":
        print(f"Table '{table_name}' created successfully.")
    else:
        print(f"Failed to create table '{table_name}'. Status: {status}")
```

```
Database 'ff_6_portfolios' ensured.
Table 'CURRENT_DATA' created successfully.
Table 'DATA_INGESTION_MAP' created successfully.
Table 'PIT_DATA' created successfully.
Table 'RAW_DATA' created successfully.
```

In [ ]:

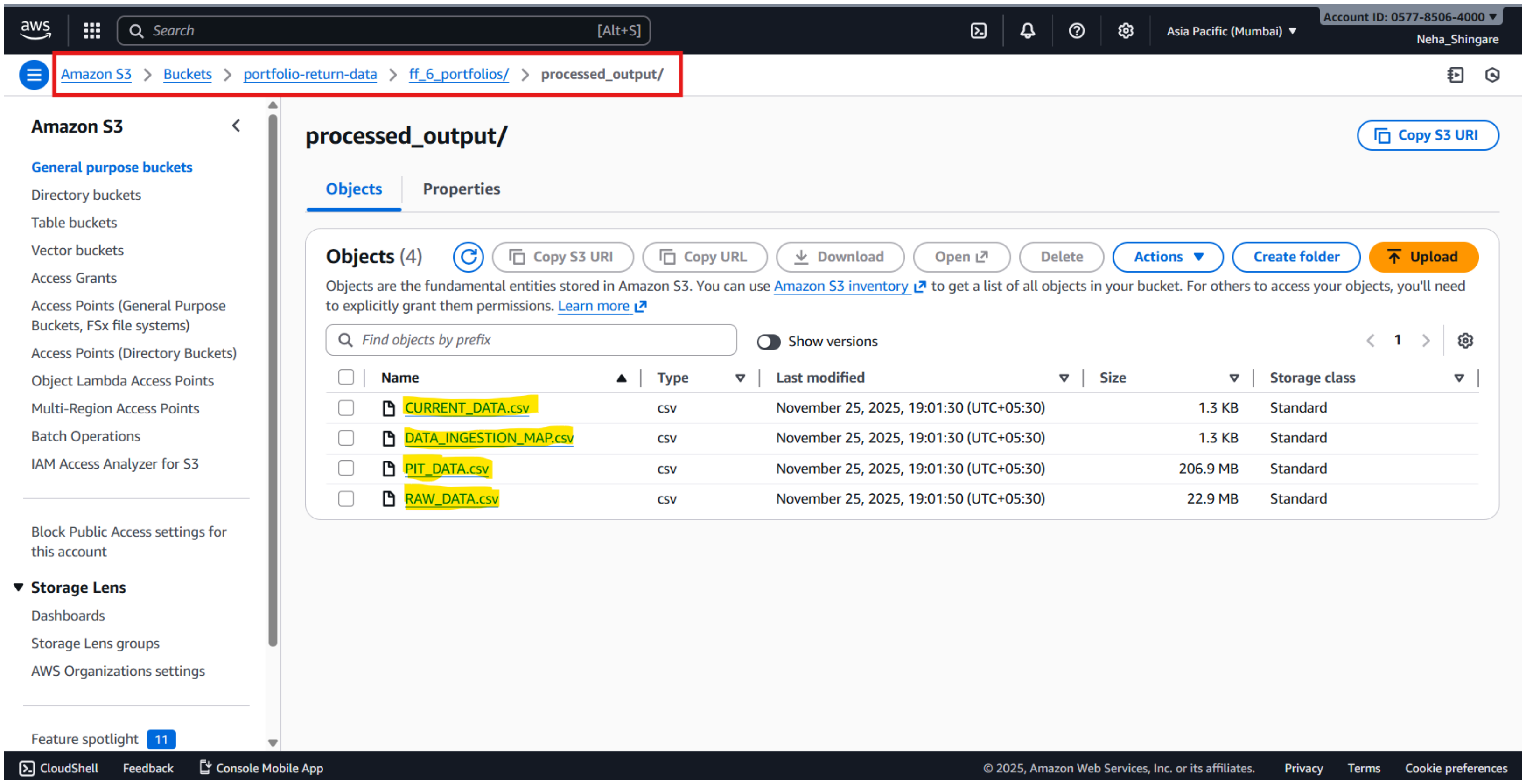
In [ ]:

AWS Services Used:

1. Amazon S3 — Data Lake Storage

Amazon S3 is used as the central storage layer for:

- **Raw data** (RAW_DATA)
- **Point-in-Time snapshots** (PIT_DATA)
- **Latest curated data** (CURRENT_DATA)
- **Ingestion metadata** (DATA_INGESTION_MAP)



Amazon S3 > Buckets > portfolio-return-data > ff_6_portfolios/ > processed_output/

processed_output/

Objects (4)

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

Name	Type	Last modified	Size	Storage class
CURRENT_DATA.csv	csv	November 25, 2025, 19:01:30 (UTC+05:30)	1.3 KB	Standard
DATA_INGESTION_MAP.csv	csv	November 25, 2025, 19:01:30 (UTC+05:30)	1.3 KB	Standard
PIT_DATA.csv	csv	November 25, 2025, 19:01:30 (UTC+05:30)	206.9 MB	Standard
RAW_DATA.csv	csv	November 25, 2025, 19:01:50 (UTC+05:30)	22.9 MB	Standard

Reasons for choosing S3:

- Highly durable.
- Low cost for storing historical datasets.
- Serverless and fully managed.
- Integrates directly with Athena, Redshift Spectrum, Glue, and other AWS analytics services.
- Ideal for a *data lake* pattern where files are append-only and immutable.

Assumptions / Constraints:

- Dataset size is small (few MBs).
- Monthly ingestion frequency.
- Low query concurrency.

2. AWS Glue Data Catalog — Metadata Layer

Athena uses the Glue Data Catalog to store table definitions for:

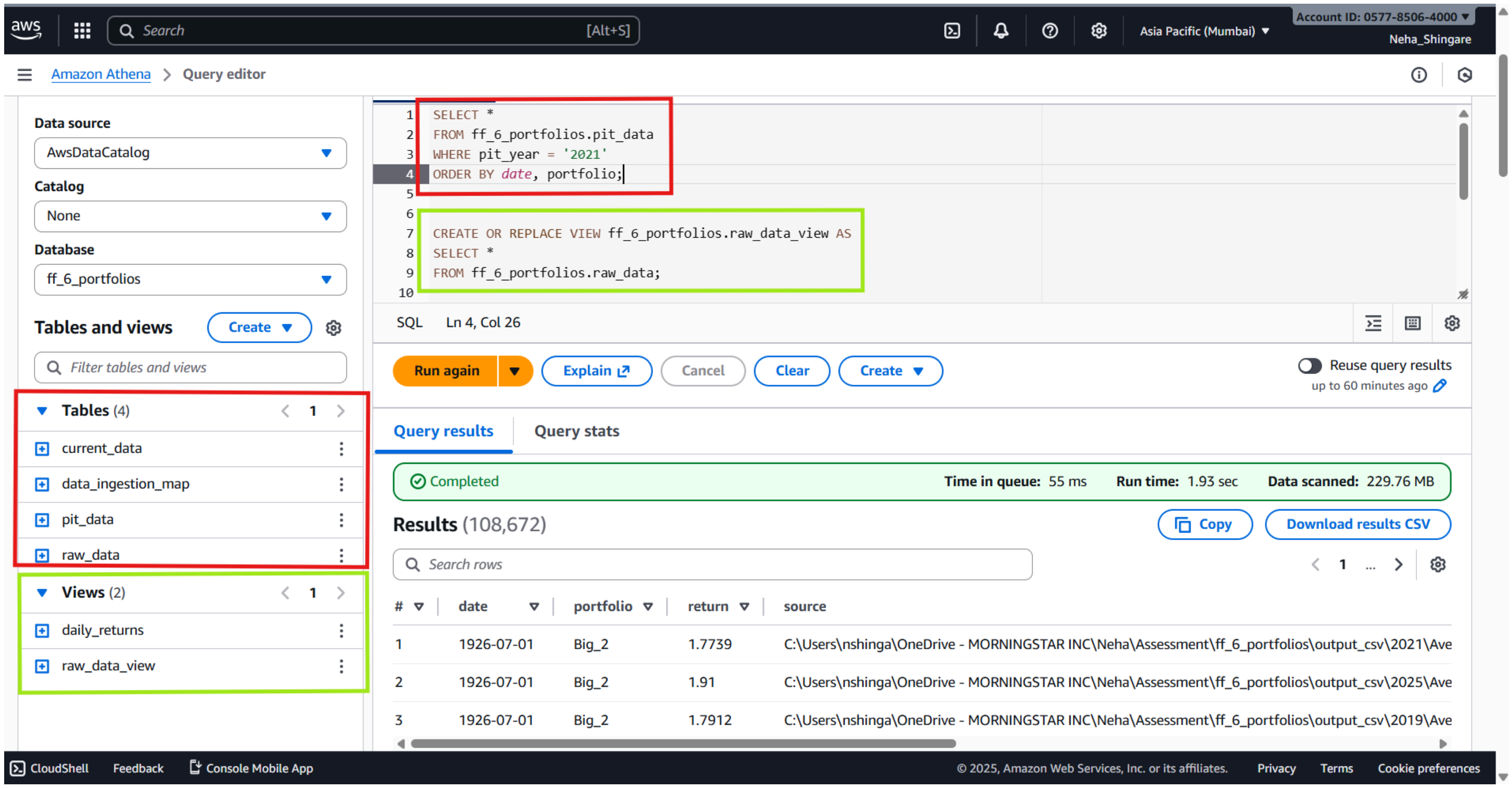
- RAW_DATA
- PIT_DATA
- CURRENT_DATA
- DATA_INGESTION_MAP

This provides schema-on-read capability over files stored in S3.

---

3. Amazon Athena — Query Engine

Athena is used to run SQL queries directly on S3-based datasets without provisioning any servers.



```sql
SELECT *
FROM ff_6_portfolios.pit_data
WHERE pit_year = '2021'
ORDER BY date, portfolio;


CREATE OR REPLACE VIEW ff_6_portfolios.raw_data_view AS
SELECT *
FROM ff_6_portfolios.raw_data;
```

Completed Time in queue: 55 ms Run time: 1.93 sec Data scanned: 229.76 MB

Results (108,672)

#	date	portfolio	return	source
1	1926-07-01	Big_2	1.7739	C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2021\Ave
2	1926-07-01	Big_2	1.91	C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2025\Ave
3	1926-07-01	Big_2	1.7912	C:\Users\nshinga\OneDrive - MORNINGSTAR INC\Neha\Assessment\ff_6_portfolios\output_csv\2019\Ave

--Tables and athena query in red box, view creation and views in green box

Reasons for choosing Athena:

- Serverless: no cluster to manage.
- Pay-per-query: cost-effective for low/medium volumes.
- Perfect for analytical workloads over partitioned, columnar S3 data.
- Automatically scales with the dataset.

Typical queries run:

- Validation of RAW_DATA
- Querying PIT and CURRENT datasets
- Quality checks and auditing from the ingestion map

Impact of Scaling Up (Task Takes 25 Minutes or Data Grows 100×)

If ingestion time grows significantly or dataset increases by two orders of magnitude:

1. Switch from CSV to Parquet

- 10–40× reduction in storage size
- Much faster Athena queries
- Lower S3 scan cost

2. Introduce S3 Partitioning

Partition RAW_DATA by: year= / month=

Athena scans only relevant partitions → major performance improvement.

3. Move ETL to AWS Glue or AWS Lambda

- Glue ETL Jobs for large Spark-style transformations
- Lambda for lightweight parallel ingestion tasks

4. Use Workflow Orchestration (AWS Step Functions)

To manage: Download → Transform → Validate → Upload → Update Metadata

5. Consider Redshift for Heavy / Frequent Queries

If analytics workloads become intensive, migration to Redshift or using Redshift Spectrum is appropriate.

Architecture Diagram:

```
               ┌───────────────────────────────┐
               │   Fama-French Data Source     │
               └──────────────┬────────────────┘
                              │ (HTTP Pull)
                              ▼
                 ┌──────────────────────────┐
                 │  Jupyter ETL Notebook    │
                 │  - Download data         │
                 │  - Validate & clean      │
                 │  - Create RAW/PIT/CURR   │
                 └──────────────┬───────────┘
                                │ (Upload to S3)
                                ▼
            ┌─────────────────────────────────────┐
            │              Amazon S3              │
            │  raw/       → RAW_DATA              │
            │  pit/       → PIT_DATA              │
            │  current/   → CURRENT_DATA          │
            │  logs/      → DATA_INGESTION_MAP    │
            └─────────────────┬───────────────────┘
                              │ (Schema)
                              ▼
                ┌────────────────────────────┐
                │  AWS Glue Data Catalog     │
                └─────────────┬──────────────┘
                              │
                              ▼
                  ┌───────────────────────────┐
                  │        Athena SQL         │
                  │ Query RAW/PIT/CURRENT     │
                  └───────────────────────────┘
```

```
Optional for scale:
                              ┌──────────────────────────────┐
                              │ Amazon Redshift               │
                              │ (via Redshift Spectrum)       │
                              └──────────────────────────────┘
```

Robustness Check:

```
1. Null check
2. Duplicate check
3. Schema and dtype validation
4. Date range validation
5. Monthly Continuity Check
6. Portfolio Validation
7. Return Value Validation
8. S3 upload check
```

Notes:

- ***Before running this notebook, please update the AWS configuration by inserting your own Access Key ID and Secret Access Key in the aws_access_key_id and aws_secret_access_key variables.***
- Naming conventions followed (`UPPER_CASE` for output tables, snake_case for internal variables)
- Long format for scalability and easier pivoting
- Metadata for traceability (`ingestion_time` , `source_url` , `ingested_by`)
- PIT vs Current for reproducibility vs latest reporting

This notebook structure covers:

- Data ingestion
- Transformation to long format
- PIT & current data
- Source map / metadata

- Error handling & robustness
- AWS services & architecture explanation
- Outputs clearly defined

In [ ]:

```
```