Data Lakehouse with Snowflake

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1. Introduction

YouTube (the world-famous video sharing website) maintains a list of the top trending videos on the platform. According to Variety magazine, "To determine the year's top-trending videos, YouTube uses a combination of factors including measuring users' interactions (e.g., number of views, shares, comments and likes).

1.1. Role

In this assignment, Snowflake was used to analyze the dataset (consisting of CSV and JSON files). Data was uploaded to a cloud storage (Azure), ingested into the Data Lakehouse (Snowflake), transformed, and finally analysed.
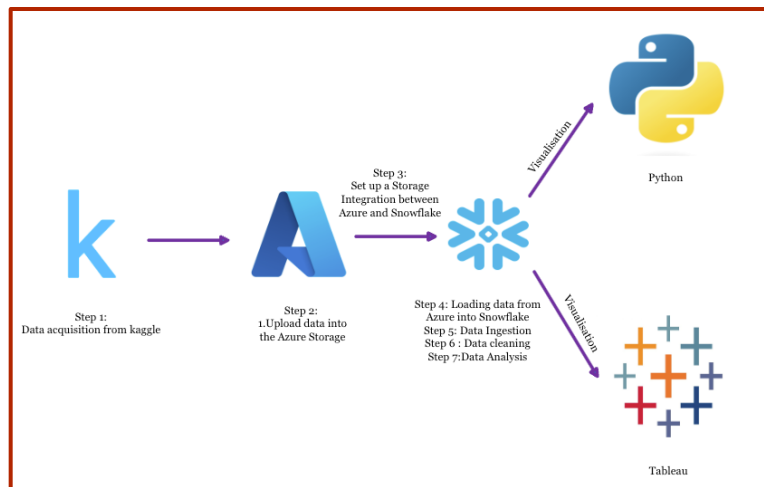
2. Setup

Figure 1-workflow

2.1 Upload data into Azure Storage

First, Jsons and CSVs files were downloaded from Kaggle. Next, an Azure account was created, and the data was uploaded to a container called "youtube" on a storage account called "bdemohammadiyasaman".

2.2 Setting up a Storage Integration between Azure and Snowflake:

In the Snowflake environment, a new database called "bde1" was created and then switched to.

```
-- Create a new database called bde1
CREATE DATABASE bde1;


--switch to database bde1
USE DATABASE bde1;
```

With the following code, a storage integration called "azure_bde1" was created:

```
--Create a storage integration called bde1
CREATE STORAGE INTEGRATION azure_bde1
  TYPE = EXTERNAL_STAGE
  STORAGE_PROVIDER = AZURE
  ENABLED = TRUE
  AZURE_TENANT_ID = 'e8911c26-cf9f-4a9c-878e-527807be8791'
  STORAGE_ALLOWED_LOCATIONS = ('azure://bdemohammadiyasaman.blob.core.windows.net/youtube');
```

We used below command to retrieve the AZURE_CONSENT_URL

```
-- Use the DESC STORAGE INTEGRATION command to retrieve the AZURE_CONSENT_URL
DESC STORAGE INTEGRATION azure_bde1;
```

	property	property_type	property_value	...	property_default
1	ENABLED	Boolean	true		false
2	STORAGE_PROVIDER	String	AZURE		
3	STORAGE_ALLOWED_LOCATIONS	List	azure://bdemohammadiyasaman.blob.core.windows.net/youtube		[]
4	STORAGE_BLOCKED_LOCATIONS	List			[]
5	AZURE_TENANT_ID	String	e8911c26-cf9f-4a9c-878e-527807be8791		
6	AZURE_CONSENT_URL	String	https://login.microsoftonline.com/e8911c26-cf9f-4a9c-878e-527807be8791/oauth2/authori		
7	AZURE_MULTI_TENANT_APP_NAME	String	ajde9isnowflakepacint_1692322898335		
8	COMMENT	String			

Above url was copied and pasted and permission request was accepted.

	property	property_type	property_value	...	property_default
1	ENABLED	Boolean	true		false
2	STORAGE_PROVIDER	String	AZURE		
3	STORAGE_ALLOWED_LOCATIONS	List	azure://bdemohammadiyasaman.blob.core.windows.net/youtube		[]
4	STORAGE_BLOCKED_LOCATIONS	List			[]
5	AZURE_TENANT_ID	String	e8911c26-cf9f-4a9c-878e-527807be8791		
6	AZURE_CONSENT_URL	String	https://login.microsoftonline.com/e8911c26-cf9f-4a9c-878e-527807be8791/oauth2/authori		
7	AZURE_MULTI_TENANT_APP_NAME	String	ajde9isnowflakepacint_1692322898335		
8	COMMENT	String			

"ajde9isnowflakepacint" was added on the snowflake as a storage blob data owner.

3. Overall Architecture

This section outlines the overarching architecture that forms the foundation for analysing YouTube's top-trending videos. The architecture is designed to efficiently handle data ingestion, transformation, analysis, and deployment processes.
The architecture consists of the following key components:

3.1 Cloud Infrastructure

We leverage Microsoft Azure as our cloud platform of choice for this project. Azure provides a robust and scalable environment to host and manage our data processing and storage needs.

3.2 Data Ingestion

The journey begins with data ingestion, where YouTube's top-trending video data is collected from the source. This data, stored in CSV and JSON formats, is uploaded to Azure cloud storage. The storage acts as a landing zone for the raw data before transforming.

3.3 Data Transformation

Snowflake, a modern cloud-based data warehousing platform, serves as the heart of our data transformation process. Data from Azure cloud storage is ingested into Snowflake's Data Lakehouse, which undergoes a series of transformations to prepare it for analysis. Snowflake's flexibility and performance ensure efficient data processing and handling of complex queries.

3.4 Analysis and Insights

We delve into the analysis phase once the data is transformed within Snowflake. In each part of the project, we generated valuable insights and answered questions using Snowflake's powerful querying capabilities.

4. Analysing Data on Snowflake

4.1 Data Ingestion

4.1.1 trending data

We established an external table named "ex_youtube_trending" to house all the trending data in CSV format. The following code was used to create an external table from all the CSV files in the "bde1" storage:

```
--Create an external table called ex_youtube_trending
CREATE OR REPLACE EXTERNAL TABLE ex_youtube_trending
WITH LOCATION = @stage_bde1
FILE_FORMAT = file_format_csv
PATTERN = '.*[.]csv';
```

After correcting data type issues in each column, we saved the table as "table_youtube_trending."

title	publishedAt	channelId	channelTitle	categoryId	trending_date
LEVEI UM FORA? FINGI ESTA	2020-08-11T22:21:49Z	UCGfBwrCoi9ZJjKiUK8MmJN	Pietro Guedes	22	2020-08-12T00:00:00Z
ITZY "Not Shy" M/V TEASER	2020-08-11T15:00:13Z	UCaO6TYtlC8U5ttz62hTrZg	JYP Entertainment	10	2020-08-12T00:00:00Z
Oh Juliana PARÓDIA - MC Nia	2020-08-10T14:59:00Z	UCoXZmVma073v5G1cW82	As Irmãs Mota	22	2020-08-12T00:00:00Z
Contos de Runeterra: Targon	2020-08-11T15:00:09Z	UC6Xqz2pm50gDCORYztqh	League of Legends BR	20	2020-08-12T00:00:00Z
Entrevista com Thammy Mira	2020-08-11T20:04:02Z	UCEWOoncsrmirqnFqxer9lm	The Noite com Danilo Gentili	23	2020-08-12T00:00:00Z
DICAS DA RODADA 2 │ CART	2020-08-11T17:14:20Z	UCJVbvkrBLp7L2pnaqc5Cm	Cartoleiros Gazeta do Povo	17	2020-08-12T00:00:00Z
LIVE PLAYLIST DA TAY.	2020-08-12T03:31:08Z	UCg9nWuUISG69Hv2VaCrE7	Tayara Andreza	10	2020-08-12T00:00:00Z
PEDI ELA EM NAMORO? FIZ	2020-08-11T00:02:35Z	UCOPS25AxMB9te9_-AHt3J	PEIXE	24	2020-08-12T00:00:00Z

It is necessary to correct the datatypes in "publishedAt" and "trending_data" using one of the following codes:

```
CREATE OR REPLACE TABLE table_youtube_trending as
SELECT
value:c1::varchar as VIDEO_ID,
value:c2::varchar as TITLE,
REPLACE(REPLACE(value:c3::varchar, 'T', ' '), 'Z', ' ') as PUBLISHEDAT,
value:c4::varchar as channelId,
value:c5::varchar as channeltitle,
value:c6::int as categoryId,
REPLACE(REPLACE(value:c7::varchar, 'T', ' '), 'Z', ' ') as trending_date,
value:c8::varchar as tags,
value:c9::int as view_count,
value:c10::int as likes,
value:c11::int as dislikes,
value:c12::int as comment_count,
value:c13::varchar as thumbnail_link,
value:c14::BOOLEAN as comments_disabled,
value:c16::varchar as description,
split_part(metadata$filename, '_', 1)::varchar as country -- extracting country name from each csv file name
FROM ex_youtube_trending;
```

```
CREATE OR REPLACE TABLE table_youtube_trending as
SELECT
value:c1::varchar as VIDEO_ID,
value:c2::varchar as TITLE,
value:c3::datetime as publishedat,
value:c4::varchar as channelId,
value:c5::varchar as channeltitle,
value:c6::int as categoryId,
value:c7::date as trending_date,
value:c8::int as view_count,
value:c9::int as likes,
value:c10::int as dislikes,
value:c11::int as comment_count,
value:c12::BOOLEAN as comments_disabled,
split_part(metadata$filename, '_', 1)::varchar as country -- extracting country name from each csv file name
FROM ex_youtube_trending;
```

We used the second code to have the correct data type in following parts.

⚠ **issues:** *Initially, we tried to create an external table from each country CSV file separately and then concatenate all the external tables, adding a column titled "country" to the concatenated table. Each approach, however, has resulted in an incorrect result or a country column consisting of null values. To avoid this, we extracted country names from the file names by defining a pattern for reading all the CSV files in the storage file and then created the external table "ex_youtube_trending" from them all.*

4.1.2 category data

We established an external table named " ex_table_youtube_category" to house all the trending data in Jasons format.
The following code was used to create an external table from all the Jsons files in the "bde1" storage:

```
---Create an external table called table_youtube_category
CREATE OR REPLACE EXTERNAL TABLE ex_table_youtube_category
WITH LOCATION = @stage_bde1
FILE_FORMAT = (TYPE=JSON)
PATTERN = '.*[.]json';
```

The Lateral Flatten function is applied to the column that contains the JSON file. Once the array has been flattened, each object within the Name and Value Pair will be moved as an independent row:

```
--Create a new table called'table_youtube_category'containing the correct data format
CREATE OR REPLACE TABLE table_youtube_category as
SELECT
split_part(metadata$filename, '_', 1)::varchar as country,
l.value:id::int as categoryid,
l.value:snippet:title::varchar as category_title
FROM ex_table_youtube_category,
LATERAL FLATTEN(value:items) l    --retrieving the columns from 'ex_table_youtube_category' by using Lateral Flatten function
```

4.1.3 Final table

The final step of this part involves creating one final table ("table_youtube_final") by combining "table_youtube_trending" and "table_youtube_category", while adding a new field called "id" by using the "UUID_STRING()" function.
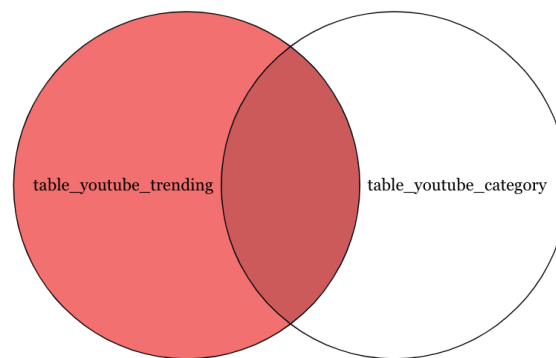

Figure 2-Left outer join

For this part, the **LEFT OUTER JOIN** was used to return all records from the left table ("table_youtube_trending") and the matching records from the right table("table_youtube_category"). The columns "country" and "categoryid" must match to join these two tables.

ID	VIDEO_ID	TITLE	PUBLISHEDAT	CHANNELID	CHANNELTITLE	CATEGORYID	CATEGORY_TITLE	TRENDING_DATE.	VIEW_COUNT	LIKES	DISLIKES	COMMENT_COUNT	COMMENTS_DISABLED	COUNTRY
3c375779-f...	KJI2qg5F-9E	Bonez MC - ...	2020-08-11 ...	UCGh8tmH9...	CrhymeTV	10	Music	2020-08-12	573902	69319	970	3311	FALSE	DE
17ff6bf3-64...	K0vYnOn7wZI	Nik hat hefti...	2020-08-11 ...	UCnrvUg5M...	Köln 50667	24	Entertainment	2020-08-12	381375	13637	435	866	FALSE	DE
ce86d878-c...	2bbn9b79LRc	Camper Tou...	2020-08-11 ...	UCBt8RY61t...	AnaJohnson	24	Entertainment	2020-08-12	142296	9480	144	364	FALSE	DE
ca9679ab-4...	Zv-3qNnAM...	Ich TESTE S...	2020-08-12 ...	UCccDoH6Q...	Einfach Marci	24	Entertainment	2020-08-12	55640	3420	124	229	FALSE	DE
d76615f4-6...	7cIgQLneouU	STATEMENT...	2020-08-11 ...	UC8E8eD7m...	Domo	24	Entertainment	2020-08-12	233899	25251	375	1051	FALSE	DE
ddc9b581-8...	g7vdQgRsTKc	Bayer unterli...	2020-08-10 ...	UCNxq-0KJ...	DAZN UEFA Eu...	17	Sports	2020-08-12	623938	12770	357	1514	FALSE	DE
43cff37c-62...	86gzh8jftSE	GEBRAUCH...	2020-08-11 ...	UCzH549YI...	AlexiBexi	24	Entertainment	2020-08-12	249531	17199	304	812	FALSE	DE
d2906951-8...	YECPzRfksI4	Erkennst DU...	2020-08-11 ...	UCL5-tPmf_...	World Wide Wo...	24	Entertainment	2020-08-12	470201	43045	369	1719	FALSE	DE

This final table is called "table_youtube_final" and it contains 1,175,478 records.

4.2 Data Cleaning

1. If we do not include the category ID in the table_youtube_category, the "category_title" for "Comedy" has duplicates.
2. In "table_youtube_category", "Nonprofits & Activism" as a "category_title" only appears in one country (US).
3. In "table_youtube_final", categoryid of the missing category_title ("Nonprofits & Activism") is 29.

4. Since we have missing values in "Nonprofits & Activism" As "category_title", we updated our table using the below code:

```
UPDATE table_youtube_final
SET category_title = 'Nonprofits & Activism'
WHERE category_title is NULL;
```

5. Video named "Thomas | Rohith V S | Juvis Productions | Adventure Company" does not have a "channeltitle".
6. We removed 14,619 records with "video_id" as #NAME? to clean the dataset.
7. Duplicates were removed from the final table; by removing them, the number of records equals 1,123,017.

4.3 Data Analysis

4.3.1 The three most viewed videos for each country in the "Sports" category for the trending date of "2021-10-17" (Ordering the result by country and the rank):

Figure 3-Bar chart of most viewed videos for each country in the sport category for the trending date of 2021-10-17

Following the execution of the necessary code in Snowflake, a CSV file for solving this problem was created, and a bar chart was created in Tableau based on this file.

4.3.2 *The total number of videos with a title that contains the word "BTS" for each country:*

When executing SQL code, it is necessary to use wildcards to locate videos that contain the word "BTS" in their title. In SQL, wildcards are used to search for specified patterns in character strings using the LIKE operator.

```sql
SELECT
country,
COUNT(DISTINCT video_id) AS CT
FROM
table_youtube_final
WHERE
title LIKE '%BTS%'
GROUP BY country
ORDER BY CT DESC;
```

To gain a better understanding of the produced table in Snowflake, a pie chart was plotted using Python.
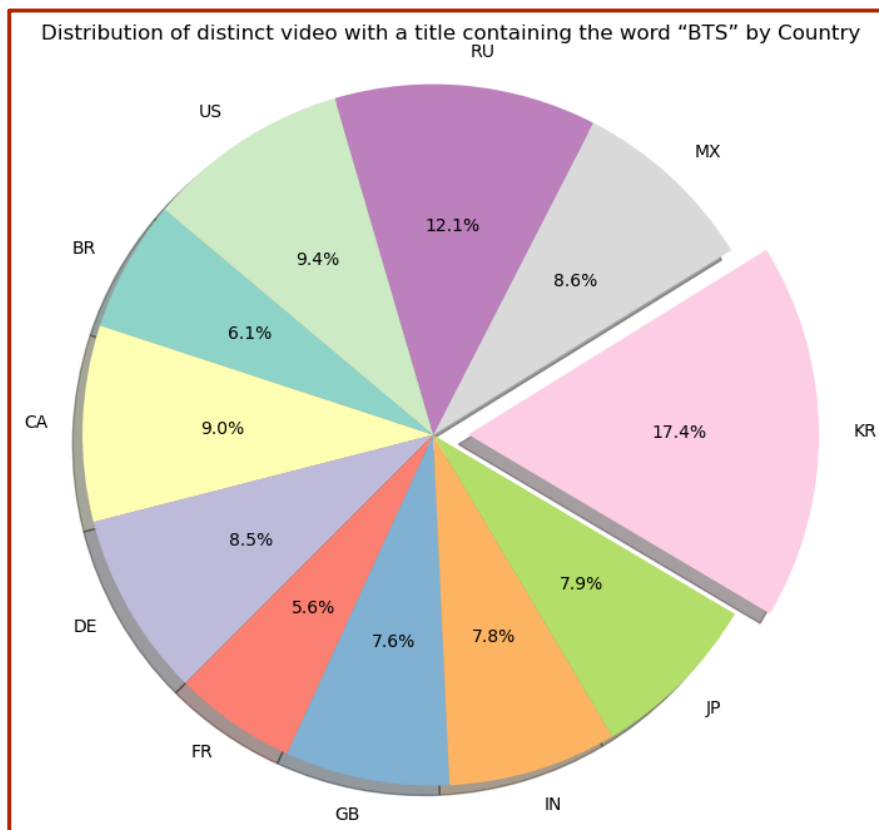

Figure 4-Pie chart of Distribution of distinct video with a title containing the word "BTS" by country

South Korea has more videos related to "BTS" than other countries. Since BTS is a South Korean boy band, this makes sense.

4.3.3 By executing SQL code, we identified the most-viewed videos for each country, year, and month as well as their like ratio (defined as the percentage of likes against the number of views):

	COUNTRY ···	YEAR_MONTH	TITLE	CHANNELTITLE	CATEGORY_TITLE	VIEW_COUNT	LIKES_RATIO
1	BR	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	244,507,902	6.52
2	CA	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	232,649,205	6.76
3	DE	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	219,110,491	7.06
4	FR	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	232,649,205	6.76
5	GB	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	208,581,468	7.31
6	IN	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	253,995,993	6.34
7	JP	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	262,319,276	6.20
8	KR	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	262,319,276	6.20
9	MX	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	253,995,993	6.34
10	RU	2020-08-01	BTS (방탄소년단) 'Dynamite' Official MV	Big Hit Labels	Music	183,532,509	8.00

Table 1-the most-viewed videos for each country, year and month as well as their like ratio.

YouTube operates as a business entity aiming to maximize its revenue streams. Central to this goal is the aspiration to engage users on the platform for prolonged periods, increasing the potential for higher profits. Additionally, YouTube endeavors to ensure that its most exceptional content receives widespread exposure, aiming to enhance the overall user experience to the utmost degree. This strategy of delivering top-quality content serves a dual purpose: it enables YouTube to thrive economically while concurrently furnishing its users with an outstanding service.

The dislike button on YouTube does not pose a significant detriment. Firstly, it is worth acknowledging the universal truth that a fraction, specifically 5%, of individuals habitually express dissatisfaction regardless of the circumstances or content presented. This phenomenon is a well-documented aspect of human nature. Whether within business, social interactions, or daily life, a certain segment of individuals invariably tends towards discontent and complaint. Consequently, every video published on YouTube inevitably becomes a potential target for dislikes, mainly due to this intrinsic tendency among a subset of users.

Therefore, instead of solely focusing on the number of dislikes, YouTube's algorithm emphasises **the ratio between likes and dislikes** when determining the visibility and success of videos on the platform. This approach prioritizes video engagement and ensures that quality content can thrive despite a minority of dissatisfied viewers, ultimately enriching the overall user experience on YouTube.

4.3.4 In each country, a category title with the largest number of distinct videos and the percentage (2 decimals) of those videos out of the total number of distinct videos within that country was computed by SQL and a table was built as follows:

	COUNTRY	CATEGORY_TITLE	TOTAL_CATEGORY_VIDEO	TOTAL_COUNTRY_VIDEO	PERCENTAGE
1	BR	Entertainment	4,294	16,372	26.23
2	CA	Entertainment	4,314	20,808	20.73
3	DE	Entertainment	6,680	25,300	26.40
4	FR	Entertainment	5,298	22,097	23.98
5	GB	Entertainment	4,512	20,473	22.04
6	IN	Entertainment	12,840	29,432	43.63
7	JP	Entertainment	4,946	14,817	33.38
8	KR	Entertainment	4,626	13,458	34.37
9	MX	Entertainment	3,629	15,348	23.64
10	RU	People & Blogs	10,401	63,878	16.28
11	US	Entertainment	3,813	19,131	19.93

Table 2- In each country, a category title with the largest number of distinct videos in each country

The above table show that the category title with the largest number of distinct videos is "Entertainment" in all countries except Russia.

4.3.5 A channel title entitled "Colors TV" has produced the most distinct videos. This channel has produced 806 distinct videos in total.
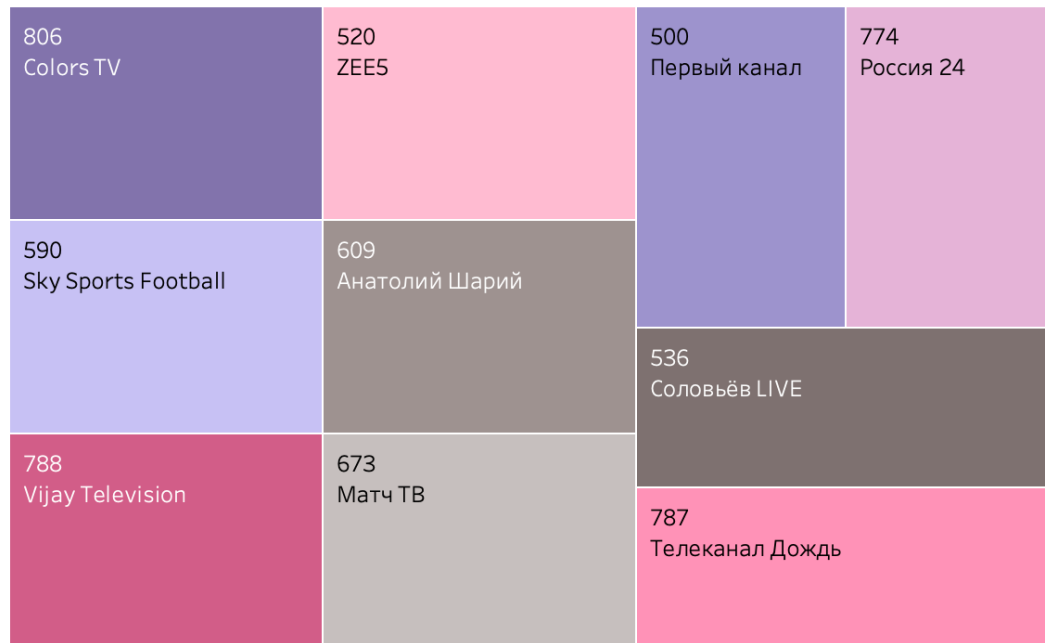

806 Colors TV	520 ZEE5	500 Первый канал	774 Россия 24
590 Sky Sports Football	609 Анатолий Шарий	536 Соловьёв LIVE	
788 Vijay Television	673 Матч ТВ	787 Телеканал Дождь	

Table 3- Treemap of channel titles which produced the most distinct videos

4.4 Business Question

Strategic Video Category Choice for Trending Success on YouTube

Creating a video likely to become one of the top trending videos on YouTube requires understanding how YouTube's algorithm operates.

Initially, SQL code was executed to count the total number of views for each category title in each country. In most countries, the "Gaming" category appears to have a high view count, excluding the "Music" and "Entertainment" categories. However, some countries have different preferences, such as Germany, India, Japan, and South Korea, where "People and Blogs" is the top trend category after music and entertainment.

country	category_title	view_counts
DE	People & Blogs	20,650,573,356
	Gaming	17,952,772,987
IN	People & Blogs	31,625,313,834
	Gaming	10,365,725,958
JP	People & Blogs	10,345,965,105
	Gaming	9,874,624,769
KR	People & Blogs	14,035,951,277
	Gaming	4,895,971,897

Table 4-The two Top Trend categories in countries that the trend category is "People & Blogs"

COUNTRY	CATEGORY_TITLE	TOTAL_VIEW_COUNT	LIKES_RATIO	LIKES_VS_DISLIKES_RATIO	MEAN_TIME_TO_TREND_IN_DAYS
BR	Gaming	13949500197	6.37	61.73	4.227899
BR	People & Blogs	13908130145	9.24	56.14	4.569348
CA	Gaming	39898738624	5.54	60.19	3.676442
CA	People & Blogs	29435945146	5.19	36.86	4.484064
DE	People & Blogs	20650573356	4.96	32.29	3.519344
DE	Gaming	17952772987	5.96	56.24	2.995262
FR	Gaming	8389408837	5.58	55.98	3.236499
FR	Sports	8306082743	2.53	38.67	2.915700
GB	Gaming	34058581411	5.71	60.43	3.731401
GB	People & Blogs	24360452830	5.03	36.22	4.087670
IN	People & Blogs	31625313834	5.60	41.69	2.653569
IN	Comedy	21656090378	7.40	44.21	3.047376
JP	People & Blogs	10345965105	3.55	53.79	4.810368
JP	Gaming	9874624769	3.05	55.08	4.893401
KR	People & Blogs	14035951277	3.73	49.16	5.326519
KR	Sports	8405030103	1.39	32.99	4.963816
MX	Gaming	24213782349	7.57	62.15	4.670165
MX	People & Blogs	20765682252	8.30	57.41	4.781611
RU	People & Blogs	8351666094	7.64	32.17	1.326010
RU	Comedy	5744485021	5.87	31.12	1.395544
US	Gaming	41451172152	5.50	59.42	3.855438
US	Sports	23477241374	2.50	37.07	3.768643

Table 5-Two top trends categories (excluding Music and entertainment) in each country
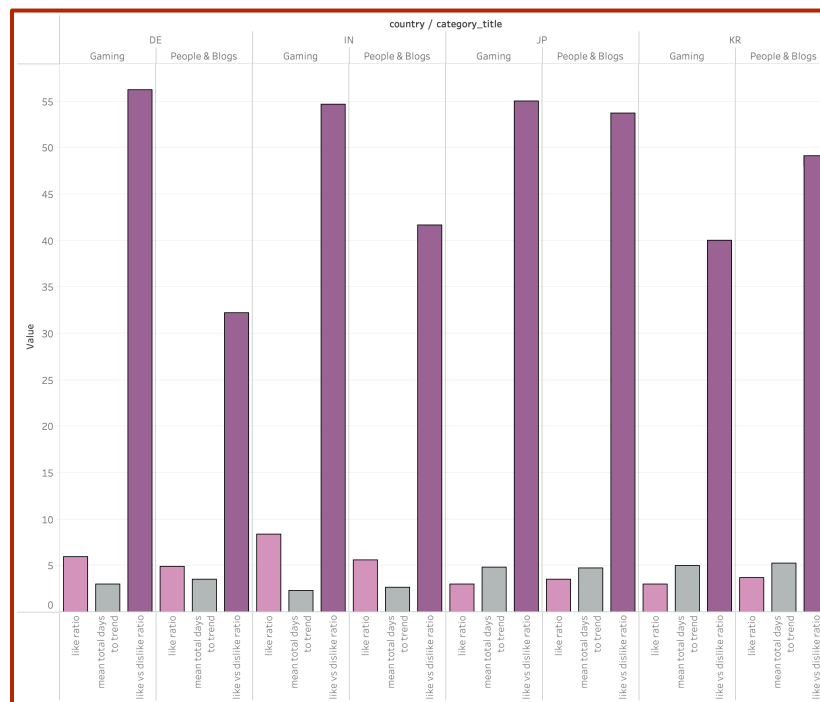

Table 6-Bar chart of "Gaming" and "People & Blogs" categories

(Like ratio/mean days to trend/like-to-dislike ratio)

In addition to considering the number of views in these countries, it is worthwhile to consider other parameters, such as the like-to-dislike ratio and the average number of days it takes for a video to trend on YouTube.

Germany (DE):

- There are no significant differences in the view count and the average number of days for a video to trend between the "Gaming" and "People and blogs" categories.
- In the "Gaming" category, the like-to-dislike ratio is much higher, indicating more engagement, and for a video to trend on YouTube, the algorithm also considers engagement.

India (IN):

- The "People and Blogs" category has almost three times more views than "Gaming" in this region, so this category might be a better choice in this region.

Japan (JP):

- The view count and the like-to-dislike ratio in the "People and blogs" category is slightly higher than in the "Gaming" category.
- The average number of days for a video to trend is similar in both categories.
- In the "Gaming" category, the like-to-dislike ratio is slightly higher, which indicates more engagement. For a video to trend on YouTube, the algorithm also considers engagement.

South Korea (KR):

- The view count of the "People and blogs" category is over three times greater than "Gaming" category, so this category might be a better choice in this region.

Russia (RU):

- The "people and blogs" category has more views than the next category ("Comedy"), and there is no significant difference in the mean days to trend and like-to-dislike ratio between the two categories.

5.Conclusion

In this report, we embarked on a comprehensive journey to analyse YouTube's top-trending videos using a combination of data ingestion, transformation, and analysis techniques. Leveraging the power of Snowflake as our data warehousing platform and Microsoft Azure as our cloud infrastructure, we successfully processed and examined a vast dataset containing valuable insights into YouTube's trending content.

To enhance our understanding of YouTube's trending videos, we harnessed the visual power of Tableau and Python. These tools allowed us to create compelling visualizations that brought our data to life.

In our study of YouTube's trending videos, we looked at what makes videos popular. YouTube's secret formula includes getting many views quickly, people interacting with the video (likes, comments, shares), how long people watch, and more. These factors vary in importance and change over time. However, the key takeaway is that making great content people like and engaging with the audience is crucial. Our findings also showed that YouTube's rules differ in different parts of the world, so knowing the audience is essential. This report highlights how using modern data tools and the cloud can help us understand what is popular on YouTube and gives content creators and marketers tips on how to succeed in the ever-changing world of online videos.

6.Refrences:

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7.Appendix: