Abstract

In this project we go through the process of collecting, storing and Analysing youtube trending videos from 12th August 2020 till date. We demonstrate the construction of data ingestion pipeline to regularly call the youtube API for trending videos and storing the in- formation on a managed Microsoft Azure instance in a docker container. We further analyze the data to extract insights about the general viewing practice of people furing the COVID-19 Pandemic period. We draw insights about which category of youtube videos are generally seen on the youtube trending tab, we also analyze which channels are regularly seen on the trending tab. Finally, We also train a BERT(Bidirectional Encoder Representations from Transformers) powered model from title of collected youtube videos to estimate the category to which a video belongs to.

In [1]:
```
import urllib
from sqlalchemy import create_engine

import pandas as pd
import numpy as np

import matplotlib.pyplot as plt
plt.style.use('seaborn-pastel')
import matplotlib.dates as mdates

from scipy.signal import find_peaks

import torch
from torch import nn
from torch.optim import Adam

from transformers import BertTokenizer, BertModel

from tqdm import tqdm
```

In [2]:
```
username = 'root'
password = 'root'
host = '4.240.82.255'
db_name = 'youtube_db'
```

```
postgres_url = f'postgresql://{username}:{password}@{host}:5432/{db_name}'

engine = create_engine(postgres_url)
```

In [7]:
```
query = '''
SELECT *
FROM "trendingVideos"
LIMIT 20;
'''

df = pd.read_sql_query(query, con=engine)
df.columns
```

Out[7]:
```
Index(['id', 'rank', 'title', 'channel', 'channel_id', 'description',
       'thumbnail', 'category', 'view_count', 'like_count', 'comment_count',
       'publish_date', 'trending_date', 'country'],
      dtype='object')
```

In [8]:
```
categories = pd.read_sql("""SELECT * FROM "videoCategories";""", con = engine)

categories.head()
```

Out[8]:

	id	title
0	1	Film & Animation
1	2	Autos & Vehicles
2	10	Music
3	15	Pets & Animals
4	17	Sports

In [9]:
```
query = '''
SELECT AVG("view_count"), "trending_date", "country"
FROM "trendingVideos"
GROUP BY "trending_date", "country"
ORDER BY "trending_date";
'''
```

```
df = pd.read_sql_query(query, con=engine)
df.head()
```

Out[9]:

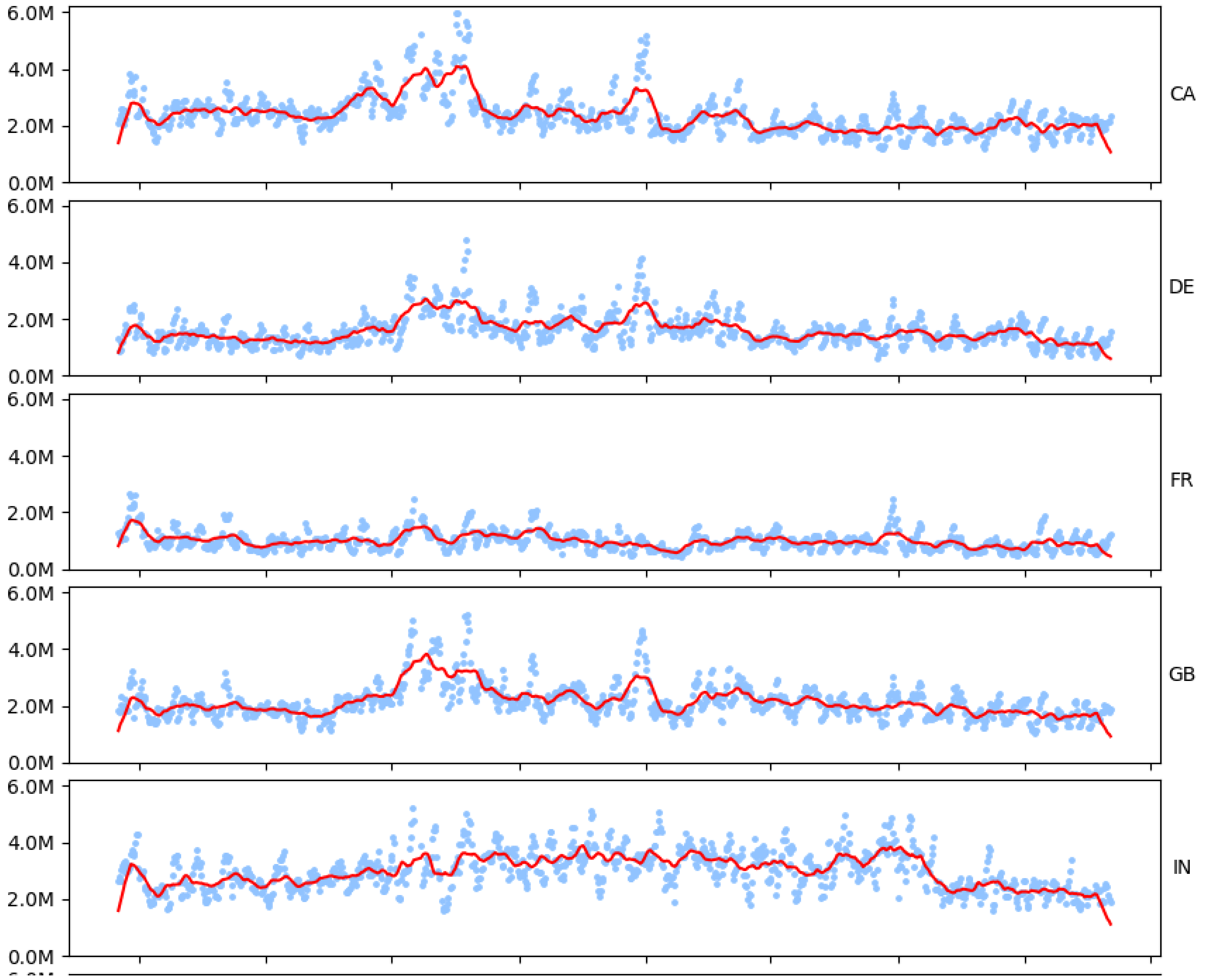
	avg	trending_date	country
0	2.105358e+06	2020-08-12	CA
1	1.297415e+06	2020-08-12	DE
2	1.280138e+06	2020-08-12	FR
3	1.836706e+06	2020-08-12	GB
4	2.621453e+06	2020-08-12	IN

In [10]:
```
df.country.unique()
```

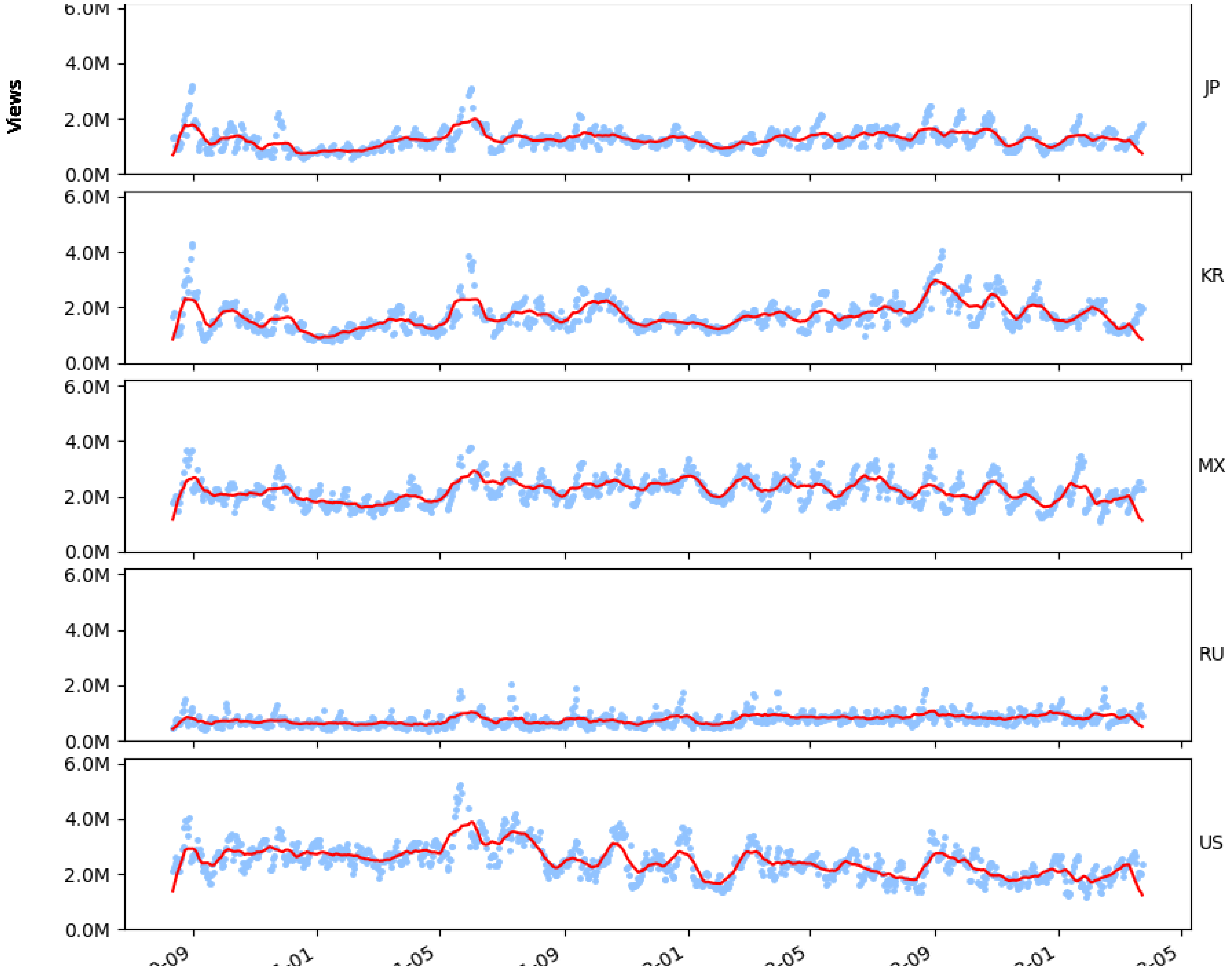
Out[10]:
```
array(['CA', 'DE', 'FR', 'GB', 'IN', 'JP', 'KR', 'MX', 'RU', 'US'],
      dtype=object)
```

In [13]:
```
def plot_country(df, ax):
    x = df['trending_date']
    y = df['avg']

    window_size = 25

    window = np.ones(int(window_size))/float(window_size)
    z = np.convolve(y, window, 'same')

    ax.scatter(x=x, y=y, s=6)
    ax.plot(x, z, 'r')


N = len(df.country.unique())

fig, axs = plt.subplots(N, 1, sharex=True, figsize=(10, 20))

fig.subplots_adjust(hspace=0.1)

for i, country in enumerate(df.country.unique()):
    ax = axs[i]
    plot_country(df.loc[df['country'] == country], ax)
    plt.gcf().autofmt_xdate()

    ax.text(1.02, 0.5, country,
        horizontalalignment='center',
        verticalalignment='center',
        transform=ax.transAxes)

    ax.set_ylim(0, 6200000)
    current_values = ax.get_yticks()

    ax.set_yticklabels([f'{x/1000000:.1f}M' for x in current_values])

    fig.text(0.04, 0.5, 'Views', va='center', rotation='vertical')

plt.show()
```

```
C:\Users\13mud\AppData\Local\Temp\ipykernel_28092\417348100.py:33: UserWarning: FixedFormatter should only be used together w
ith FixedLocator
  ax.set_yticklabels([f'{x/1000000:.1f}M' for x in current_values])
```



6.0M
4.0M
2.0M
0.0M
CA
DE
FR
GB
IN


Views
JP
KR
MX
RU
US
0.0M
2.0M
4.0M
6.0M
-09
-01
-05

In [13]:
```
query = """
SELECT "channel", COUNT("trending_date") as "trending_count", COUNT(DISTINCT "country") as "countries",
        AVG("view_count") as "avg_views", AVG("rank") as "avg_rank"
FROM "trendingVideos"
GROUP BY "channel"
ORDER BY COUNT("trending_date") DESC
LIMIT 50;
"""

df_popular_channels = pd.read_sql_query(query, con=engine)
df_popular_channels.head(10)
```

Out[13]:

	channel	trending_count	countries	avg_views	avg_rank
0	BANGTANTV	4312	10	1.096245e+07	106.921614
1	JYP Entertainment	3919	10	1.777034e+07	104.735647
2	SMTOWN	3868	10	1.800122e+07	101.823164
3	HYBE LABELS	3662	10	2.190246e+07	96.327417
4	FORMULA 1	3153	9	4.363194e+06	105.787187
5	NFL	2924	10	6.492250e+06	95.740766
6	東海オンエア	2717	1	1.836095e+06	75.396393
7	BLACKPINK	2701	10	3.475369e+07	94.876342
8	NBA	2578	9	2.223982e+06	101.742048
9	The United Stand	2437	4	3.471158e+05	96.193681

In [12]:
```
query = """
SELECT "videoCategories"."title", (CASE WHEN "a"."count" IS NULL THEN 0 ELSE "a"."count" END) as "count"
FROM "videoCategories"
LEFT JOIN (SELECT "category", COUNT("trending_date") as "count" FROM "trendingVideos" GROUP BY "category") as "a"
ON "a"."category" = "videoCategories"."id"
ORDER BY "count" DESC
"""
```

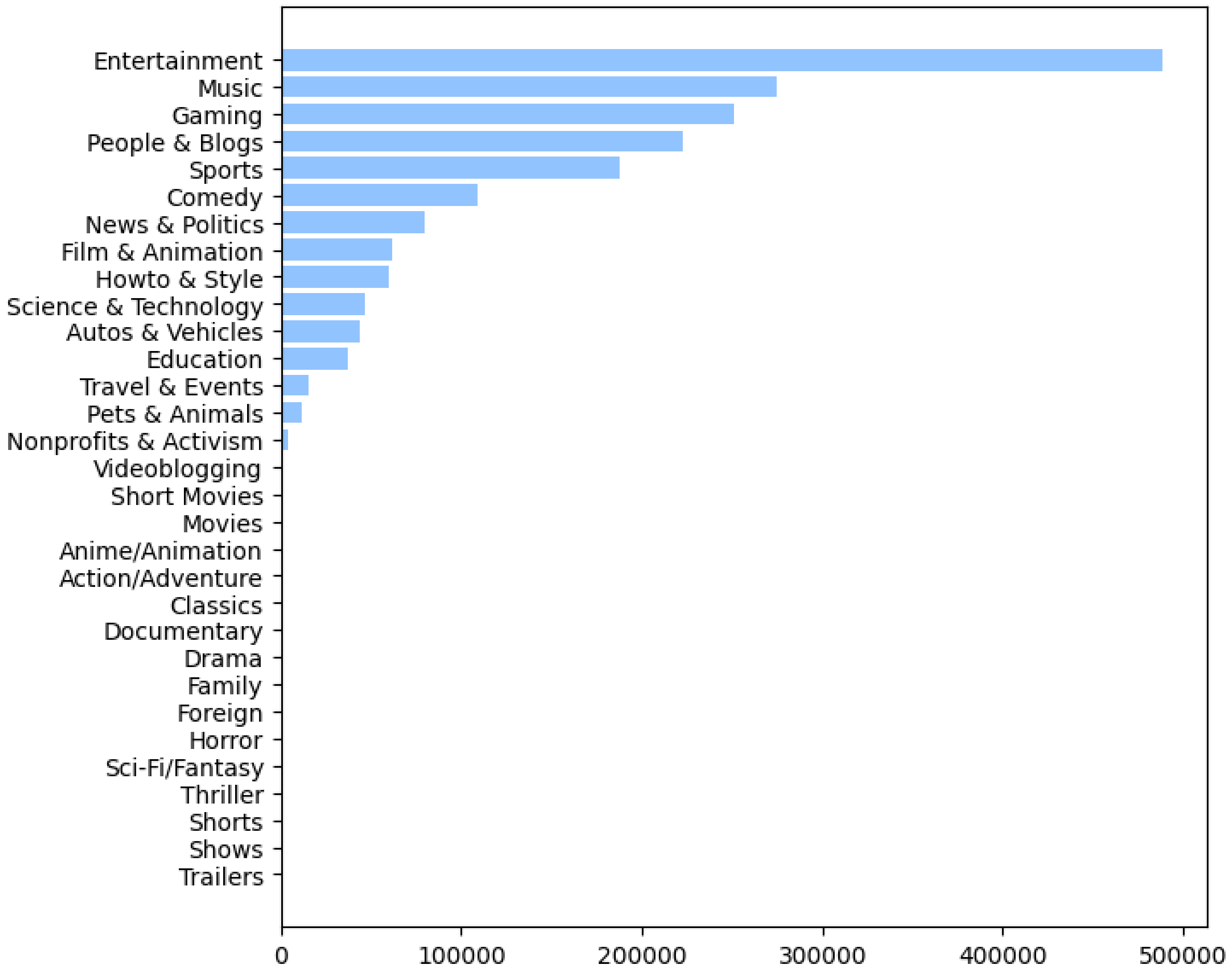
```
df_categories = pd.read_sql_query(query, con=engine)
df_categories.head()
```

Out[12]:

	title	count
0	Entertainment	488784
1	Music	274675
2	Gaming	250904
3	People & Blogs	223141
4	Sports	187759

In [14]:

```
fig, ax = plt.subplots(1, 1, figsize=(7, 7))

ax.barh(df_categories['title'], df_categories['count'], align="center")
ax.invert_yaxis()
plt.show()
```



In [16]:
```
query = '''
SELECT "id", "title", "channel", "description", "category", MIN("country") as "country", count(*)
FROM "trendingVideos"
WHERE "country" = 'US' OR "country" = 'IN' OR "country" = 'GB' OR "country" = 'CA'
GROUP BY "id", "title", "channel", "description", "category"
```

```
ORDER BY count(*) DESC;
'''

df = pd.read_sql_query(query, con=engine)
df
```

Out[16]:

	id	title	channel	description	category	country	count
0	aONT7atzqfw	Floyd Mayweather vs Logan Paul: Fight goes the...	CBS Sports HQ	Watch the highlight from the Mayweather-Paul b...	17	CA	62
1	E6E22XQPhhg	Anything You Can Fit In The Triangle I'll Pay For	MrBeast	Sorry for the long time no uploads! I had 4 di...	24	CA	58
2	wY6UyatwVTA	India claim stunning series win, end Australia...	cricket.com.au	Rishabh Pant was the hero as an injury-ravaged...	17	CA	57
3	myjEoDypUD8	Watch the uncensored moment Will Smith smacks ...	Guardian News	Best actor nominee Will Smith appeared to slap...	25	CA	56
4	Df_hrHHcQ_g	Fastest Soapbox Car Wins	Dude Perfect	Build a car and race down the track! Who will ...	17	CA	55
...	...	...	...	...	...	...	...
125855	Z7XiKx_rj2I	Wafa Na Raas Aayee Song Jubin Nautiyal Ft.Hima...	T-Series	Gulshan Kumar & T-Series presents Bhushan Kuma...	10	IN	1
125856	YVJZQHNzhsM	Virender Sehwag: Five matches, five first-ball...	ICC	Virender Sehwag announces the Indian innings o...	17	IN	1
125857	ystQh9VH4Po	Barrister Babu | बैरिस्टर बाबू | Episode 204 &...	Colors TV	Bondita is shocked when she overhears Anirudh ...	24	IN	1
125858	zbyjx-0U5nE	Paul Heyman never doubts Roman Reigns: WWE Net...	WWE	After the Universal Champion blows past the in...	17	IN	1
125859	Z7uwVb9IXbw	Village Series2 Climax Promo | MCA | Middle Cl...	Funmoji	#funmoji #MCA #middleclassabbayi #Infinitumm...	24	IN	1

125860 rows × 7 columns

In [14]:

```
tokenizer = BertTokenizer.from_pretrained('bert-base-multilingual-cased')
```

```python
def is_none(text):
    return text or ''

class Dataset(torch.utils.data.Dataset):

    def __init__(self, df):

        self.labels = [categories.loc[categories['id'] == category].index[0] for category in df['category']]
        self.texts = [tokenizer(title,
                               padding='max_length', max_length = 256, truncation=True,
                                return_tensors="pt") for title in df['title']]

    def classes(self):
        return self.labels

    def __len__(self):
        return len(self.labels)

    def get_batch_labels(self, idx):
        # Fetch a batch of labels
        return np.array(self.labels[idx])

    def get_batch_texts(self, idx):
        # Fetch a batch of inputs
        return self.texts[idx]

    def __getitem__(self, idx):

        batch_texts = self.get_batch_texts(idx)
        batch_y = self.get_batch_labels(idx)

        return batch_texts, batch_y
```

In [18]:
```python
np.random.seed(112)
temp_df = df.sample(frac = 1, random_state=42)
df_train, df_val, df_test = np.split(temp_df,
                                     [int(.8*len(temp_df)), int(.9*len(temp_df))])

print(len(df_train),len(df_val), len(df_test))
```

```
100688 12586 12586
```

In [19]:
```python
class BertClassifier(nn.Module):

    def __init__(self, dropout=0.5):

        super(BertClassifier, self).__init__()

        self.bert = BertModel.from_pretrained('bert-base-multilingual-cased')
        self.dropout = nn.Dropout(dropout)
        self.linear = nn.Linear(768, 32)
        self.relu = nn.ReLU()

    def forward(self, input_id, mask):

        _, pooled_output = self.bert(input_ids= input_id, attention_mask=mask,return_dict=False)
        dropout_output = self.dropout(pooled_output)
        linear_output = self.linear(dropout_output)
        final_layer = self.relu(linear_output)

        return final_layer
```

In [20]:
```python
def train(model, train_data, val_data, learning_rate, epochs):

    train, val = Dataset(train_data), Dataset(val_data)

    train_dataloader = torch.utils.data.DataLoader(train, batch_size=2, shuffle=True)
    val_dataloader = torch.utils.data.DataLoader(val, batch_size=2)

    use_cuda = torch.cuda.is_available()
    device = torch.device("cuda" if use_cuda else "cpu")

    criterion = nn.CrossEntropyLoss()
    optimizer = Adam(model.parameters(), lr= learning_rate)

    if use_cuda:

            model = model.cuda()
            criterion = criterion.cuda()
    for epoch_num in range(epochs):

            total_acc_train = 0
            total_loss_train = 0

            for train_input, train_label in tqdm(train_dataloader):

                train_label = train_label.to(device)
                mask = train_input['attention_mask'].to(device)
                input_id = train_input['input_ids'].squeeze(1).to(device)

                output = model(input_id, mask)

                batch_loss = criterion(output, train_label.long())
                total_loss_train += batch_loss.item()

                acc = (output.argmax(dim=1) == train_label).sum().item()
                total_acc_train += acc

                model.zero_grad()
                batch_loss.backward()
                optimizer.step()

            total_acc_val = 0
            total_loss_val = 0

            with torch.no_grad():

                for val_input, val_label in val_dataloader:

                    val_label = val_label.to(device)
                    mask = val_input['attention_mask'].to(device)
                    input_id = val_input['input_ids'].squeeze(1).to(device)

                    output = model(input_id, mask)

                    batch_loss = criterion(output, val_label.long())
                    total_loss_val += batch_loss.item()

                    acc = (output.argmax(dim=1) == val_label).sum().item()
                    total_acc_val += acc
            print(
                f'Epochs: {epoch_num + 1} | Train Loss: {total_loss_train / len(train_data): .3f} \
                | Train Accuracy: {total_acc_train / len(train_data): .3f} \
                | Val Loss: {total_loss_val / len(val_data): .3f} \
                | Val Accuracy: {total_acc_val / len(val_data): .3f}')

EPOCHS = 5
model = BertClassifier()
LR = 1e-6

train(model, df_train, df_val, LR, EPOCHS)
```

```
loading model model loaded 0.5506540507185614 Creating dataset Dataset created Using GPU

100%|██████████| 50344/50344 [1:57:35<00:00, 7.14it/s]

Epochs: 2 | Train Loss: 0.457 | Train Accuracy: 0.724 | Val Loss: 0.466 | Val Accuracy: 0.717

100%|██████████| 50344/50344 [1:57:35<00:00, 7.14it/s]

Epochs: 3 | Train Loss: 0.343 | Train Accuracy: 0.797 | Val Loss: 0.430 | Val Accuracy: 0.744

51%|█████     | 25632/50344 [59:56<58:20, 7.06it/s]
```

In [ ]:

```
def evaluate(model, test_data):

    test = Dataset(test_data)

    test_dataloader = torch.utils.data.DataLoader(test, batch_size=2)

    use_cuda = torch.cuda.is_available()
    device = torch.device("cuda" if use_cuda else "cpu")

    if use_cuda:

        model = model.cuda()

    total_acc_test = 0
    with torch.no_grad():

        for test_input, test_label in test_dataloader:

              test_label = test_label.to(device)
              mask = test_input['attention_mask'].to(device)
              input_id = test_input['input_ids'].squeeze(1).to(device)

              output = model(input_id, mask)

              acc = (output.argmax(dim=1) == test_label).sum().item()
              total_acc_test += acc

    print(f'Test Accuracy: {total_acc_test / len(test_data): .3f}')

evaluate(model, df_test)
```

```
Test Accuracy: 0.754
```