Beyond Customer Reviews :

Analyzing iPhone Issues Through Topic Modeling and LLM-Enhanced Interpretation

NLP Final Project

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Impact of Issues Identification on Company

- Issues identification and interpretation play a vital role in today's business success. Companies must spot and understand problems quickly to stay competitive and keep customers happy.

- When **companies fail to identify emerging problems or misinterpret customer feedback**, they risk facing significant consequences including **damaged brand reputation**, **lost market share**, and **decreased customer loyalty**. This is particularly critical in the smartphone industry, where **user experience directly impacts brand perception and market success**.

- In this project, we address this challenge by focusing on **iPhone issues identification**, implementing an advanced analytics pipeline to better understand and interpret user complaints and feedback.

- We built an analysis pipeline that works in three steps:
    - We use **sentiment classification** to understand how users feel about iPhone products
    - **BERTopic** helps us group and identify common issues from user negative discussions
    - **MistralAI** then interprets these findings to explain what the problems mean for users

Dataset

iPhone Community Data Collection and Preprocessing

Scrape Reddit Data: Collect data from subreddits like **r/iPhone16, r/iPhone16Pro, r/ iPhone** and related forums. Aim to capture titles, body text.

iphone-discussions-reddit.csv

Dataset

iPhone Community Data Collection and Preprocessing

PULLPUSH-IO
THE REDDIT ARCHIVE

https://api.pullpush.io/reddit/search/submission/?subreddit=iphone16

Raw | Parsed

```
{
  "data": [
    {
      "approved_at_utc": null,
      "subreddit": "iPhone16",
      "selftext": "so I updated to the latest os. I cant use some apps while on 5g. it says they cant
find network. but like safari, texting etc all work fine. I can use some apps like amazon and
Facebook while on 5g. but like reddit/discord/starbucks I cant.\n\n  \nie. I cant placed an
order in the star bucks app. but in safari if I go to the website I can\n\nits so odd\n\n
\nwhen I am on home on wifi my phone works like n normal.",
      "author_fullname": "t2_77l4jnf9",
      "saved": false,
      "mod_reason_title": null,
      "gilded": 0,
      "clicked": false,
      "title": "any one else have have problems with apps on 5g after the latests update?",
      "link_flair_richtext": [],
      "subreddit_name_prefixed": "r/iPhone16",
```

```python
subreddits = ["iPhone16", "iPhone16Pro", "iPhone"]
start_date = datetime(2024, 1, 1)
end_date = datetime.now()
```

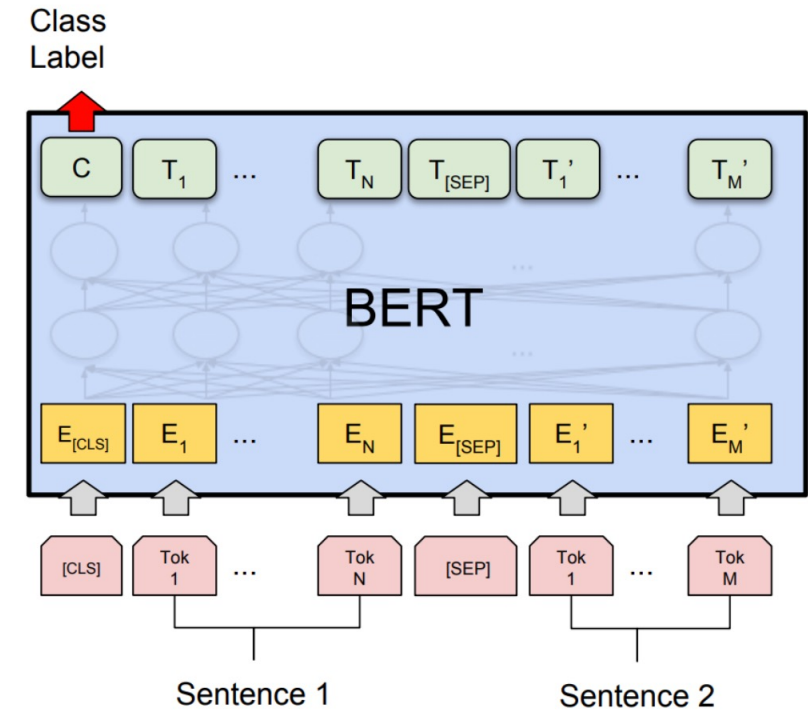|	title	selftext	subreddit
0	Should i upgrade from 12 mini to 16 pro max?	I know, the size difference is going to be ins...	iPhone16
1	new photographic styles - full featured on reg...	For now I haven't cleared out whether the new ...	iPhone16
2	iPhone 15 Pro or iPhone 16?	I'm upgrading this month and I'm genuinely not...	iPhone16
3	Everything Apple Announced at the Glowtime Eve...		iPhone16
4	A17 pro or A18 which is more powerful chip?		iPhone16

Total Data: 3204

Clean Text Data:

Preprocess the text by **removing URLs, missing value, special characters**, **stopwords**, and **performing sentiment classification.**

Sentiment Analysis

- To identify product issues, we first focus on detecting negative sentiments within the text corpus, as problems typically manifest **through negative user feedback**.

- We fine-tuned a **BERT-base-uncased** model using **Stanford Sentiment Treebank** dataset to accurately classify these negative expressions in the user discussions.
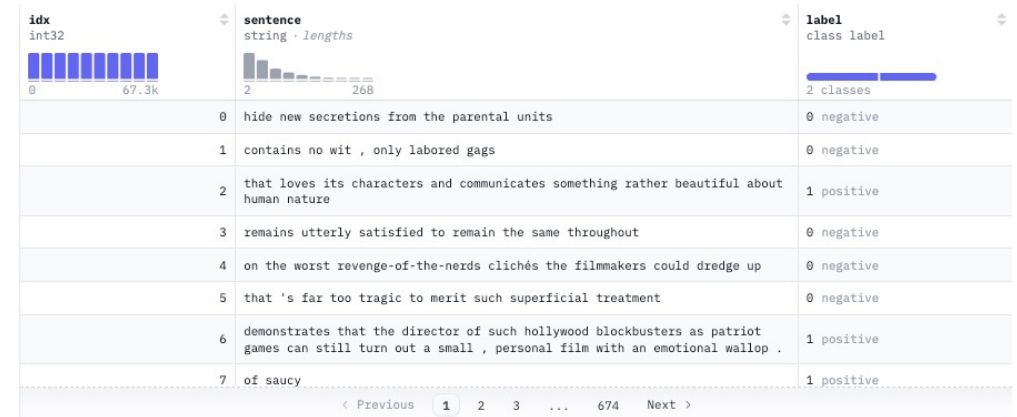
Methodology

Sentiment Analysis

- The Stanford Sentiment Treebank is a corpus with fully labeled parse trees that allows for a complete analysis of the compositional effects of sentiment in language.

- The corpus is based on the dataset introduced by Pang and Lee (2005) and consists of 11,855 single sentences extracted from movie reviews.

- It was parsed with the Stanford parser and includes a total of 215,154 unique phrases from those parse trees, each annotated by 3 human judges.

- Binary classification experiments on full sentences (negative or somewhat negative vs somewhat positive or positive with neutral sentences discarded) refer to the dataset as SST-2 or SST binary.

idx int32	sentence string · lengths	label class label
0	hide new secretions from the parental units	0 negative
1	contains no wit , only labored gags	0 negative
2	that loves its characters and communicates something rather beautiful about human nature	1 positive
3	remains utterly satisfied to remain the same throughout	0 negative
4	on the worst revenge-of-the-nerds clichés the filmmakers could dredge up	0 negative
5	that 's far too tragic to merit such superficial treatment	0 negative
6	demonstrates that the director of such hollywood blockbusters as patriot games can still turn out a small , personal film with an emotional wallop .	1 positive
7	of saucy	1 positive

‹ Previous **1** 2 3 ... 674 Next ›

Methodology

Sentiment Analysis

- We utilize **bert-base-uncased** fine-tuned on the **stanfordnlp/sst2** dataset for a binary classification task.

```python
# Load SST-2 dataset
ds = load_dataset("stanfordnlp/sst2")
```

```python
# Initialize tokenizer and model
model_name = "bert-base-uncased"
tokenizer = AutoTokenizer.from_pretrained(model_name)
```

```python
# The SST-2 dataset uses binary labels (0: negative, 1: positive)
id2label = {0: "negative", 1: "positive"}
label2id = {"negative": 0, "positive": 1}

model = AutoModelForSequenceClassification.from_pretrained(
    model_name,
    num_labels=2,  # Binary classification
    id2label=id2label,
    label2id=label2id,
    problem_type="single_label_classification"
)
```

```python
# Tokenize datasets
def tokenize_function(examples):
    return tokenizer(
        examples['sentence'],
        padding='max_length',
        truncation=True
    )
```

```python
tokenized_datasets = ds.map(
    tokenize_function,
    batched=True,
    remove_columns=['sentence', 'idx']
)
```

```python
# Define training arguments
training_args = TrainingArguments(
    output_dir="./results_sst2",
    learning_rate=2e-5,
    per_device_train_batch_size=32,
    per_device_eval_batch_size=32,
    num_train_epochs=3,
    weight_decay=0.01,
    evaluation_strategy="epoch",
    save_strategy="epoch",
    load_best_model_at_end=True,
    push_to_hub=True,
    hub_model_id="mavinsao/bert-sst2-sentiment",
    logging_dir='./logs',
    logging_steps=100,
)
```

```python
# Initialize Trainer
trainer = Trainer(
    model=model,
    args=training_args,
    train_dataset=tokenized_datasets['train'],
    eval_dataset=tokenized_datasets['validation'],
    compute_metrics=compute_metrics,
    callbacks=[EarlyStoppingCallback(early_stopping_patience=2)]
)
```

```python
# Train the model
trainer.train()
```

Train & Validation Result

Epoch	Training Loss	Validation Loss	Accuracy	F1	Precision	Recall
1	0.165400	0.215688	0.924312	0.924270	0.924706	0.924312
2	0.099000	0.253313	0.919725	0.919725	0.919725	0.919725
3	0.077900	0.276418	0.919725	0.919680	0.920111	0.919725

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    weight_decay=0.01,
    evaluation_strategy="epoch",
    save_strategy="epoch",
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3	0.077900	0.276418	0.919725	0.919680	0.920111	0.919725

Sentiment Analysis

Test Result

```
Accuracy: 0.9243

Classification Report:
               precision    recall   f1-score    support

    Negative       0.94       0.91      0.92        428
    Positive       0.91       0.94      0.93        444

    accuracy                            0.92        872
   macro avg       0.92       0.92      0.92        872
weighted avg       0.92       0.92      0.92        872
```


Confusion Matrix
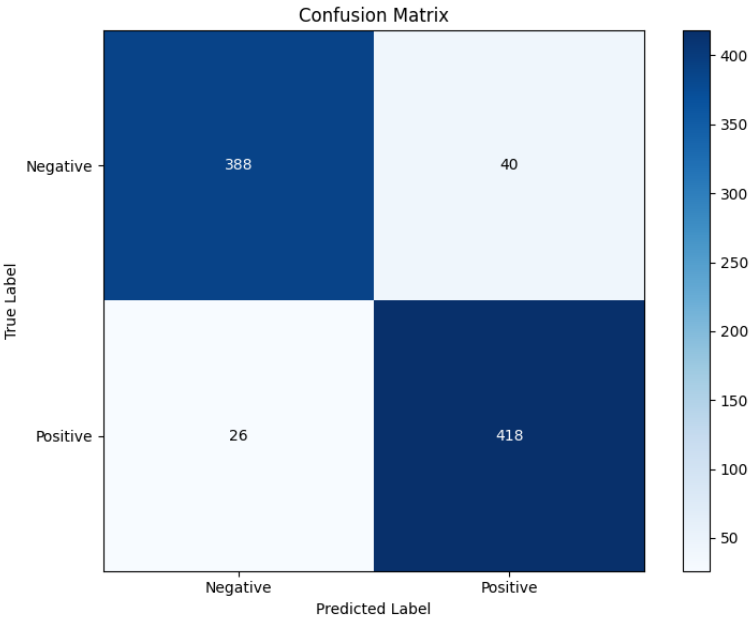
Sentiment Analysis

Then we use our fine-tuned model to **identify negative posts from our collected dataset**.

Sentiment Analysis Functions

```
In [6]:
from transformers import pipeline
import torch

def setup_sentiment_analyzer(model_name="mavinsao/bert-sst2-sentiment"):
    """Initialize the sentiment analysis pipeline."""

    device = 0 if torch.cuda.is_available() else -1  # 0 for first GPU, -1 for CPU

    return pipeline(
        "text-classification",
        model=model_name,
        max_length=512,
        device = device,
        truncation=True
    )

def analyze_sentiments_batch(texts, classifier, batch_size=16):
    """Analyze sentiments in batches."""
    labels, scores = [], []

    for i in range(0, len(texts), batch_size):
        batch = texts[i:i + batch_size]
        results = classifier(batch)

        for result in results:
            labels.append(result['label'])
            scores.append(result['score'])

    return labels, scores
```
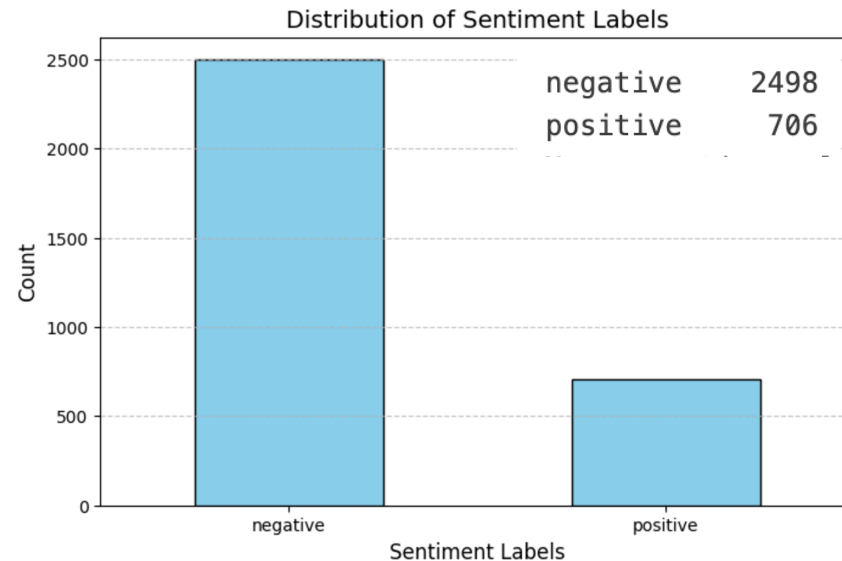
Run sentiment analysis

```
In [7]:
# Run sentiment analysis
sentiment_classifier = setup_sentiment_analyzer()
labels, scores = analyze_sentiments_batch(df['text'].tolist(), sentiment_classifier)

# Add results to dataframe
df['sentiment_label'] = labels
df['sentiment_score'] = scores
```
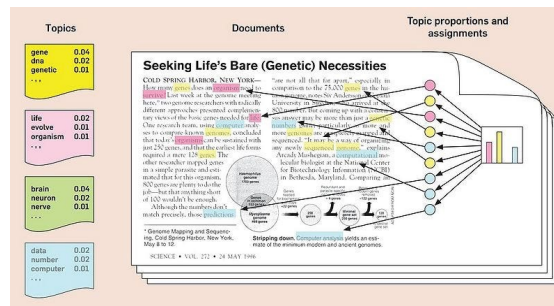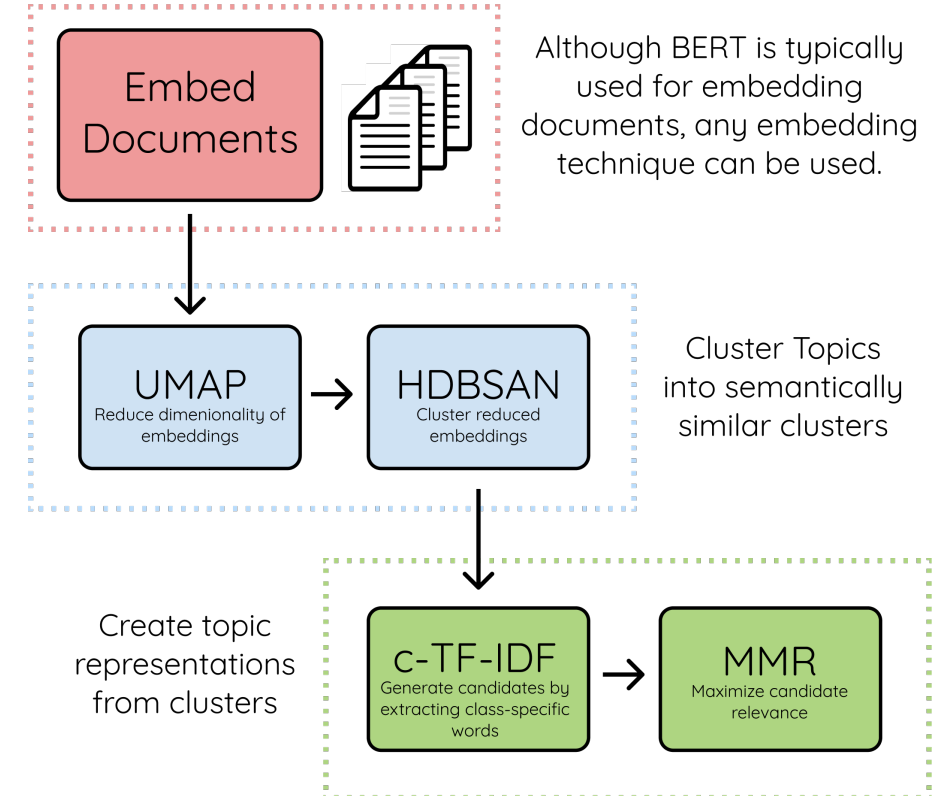

Distribution of Sentiment Labels

negative   2498
positive   706

BERTopic: Negative Topic Extraction

- Topic modeling is a technique that automatically **discovers hidden themes or topics within a collection of documents.**

- **BERTopic** is a modern topic modeling technique that leverages BERT embeddings to create more meaningful topics from text data.

- Unlike traditional methods like LDA, BERTopic **first transforms documents into embeddings**, clusters these embeddings using **UMAP and HDBSCAN**, and then uses **c-TF-IDF** to extract and interpret the topics, resulting in more coherent and contextually relevant topic representations.

BERTopic

Embed Documents

Although BERT is typically used for embedding documents, any embedding technique can be used.

UMAP
Reduce dimenionality of embeddings

HDBSAN
Cluster reduced embeddings

Cluster Topics into semantically similar clusters

Create topic representations from clusters

c-TF-IDF
Generate candidates by extracting class-specific words

MMR
Maximize candidate relevance

BERTopic: Negative Topic Extraction

```python
# create model
model = BERTopic(verbose=True,embedding_model='paraphrase-MiniLM-L3-v2', min_topic_size= 10)

ne_df = df[df['sentiment_label'] == 'negative']

topics, probabilities = model.fit_transform(ne_df['text'].tolist())

topic_results = model.get_topic_info()
print("Number of topics: {}".format( len(topic_results)))
topic_results.head(11)
```
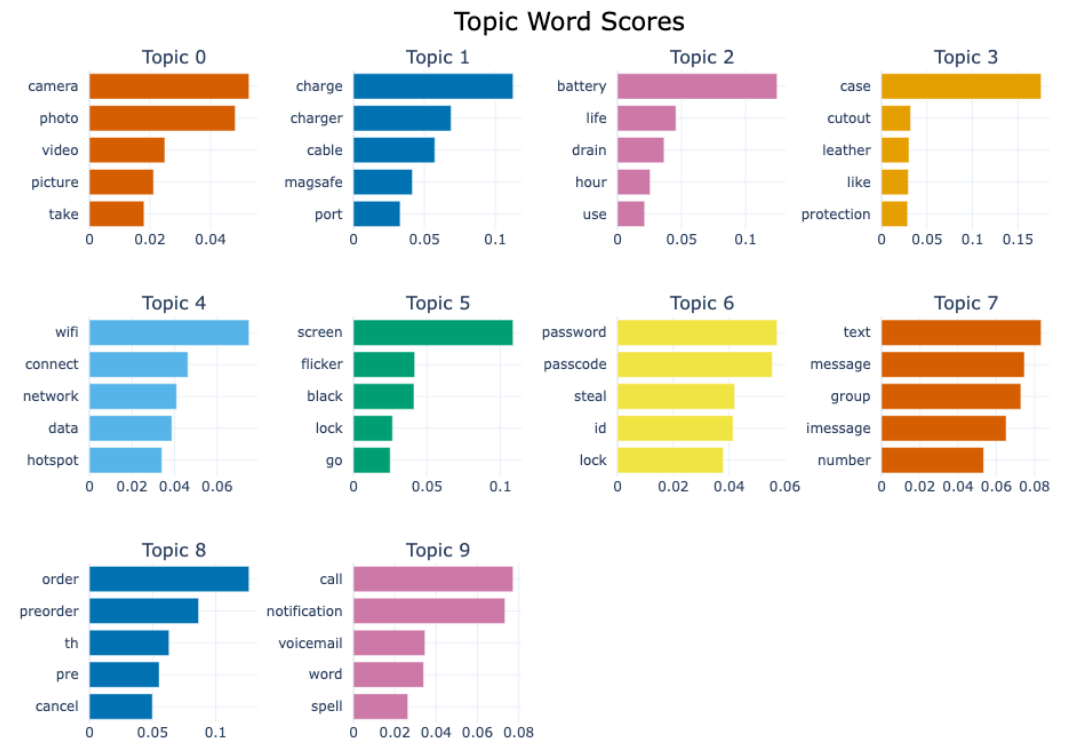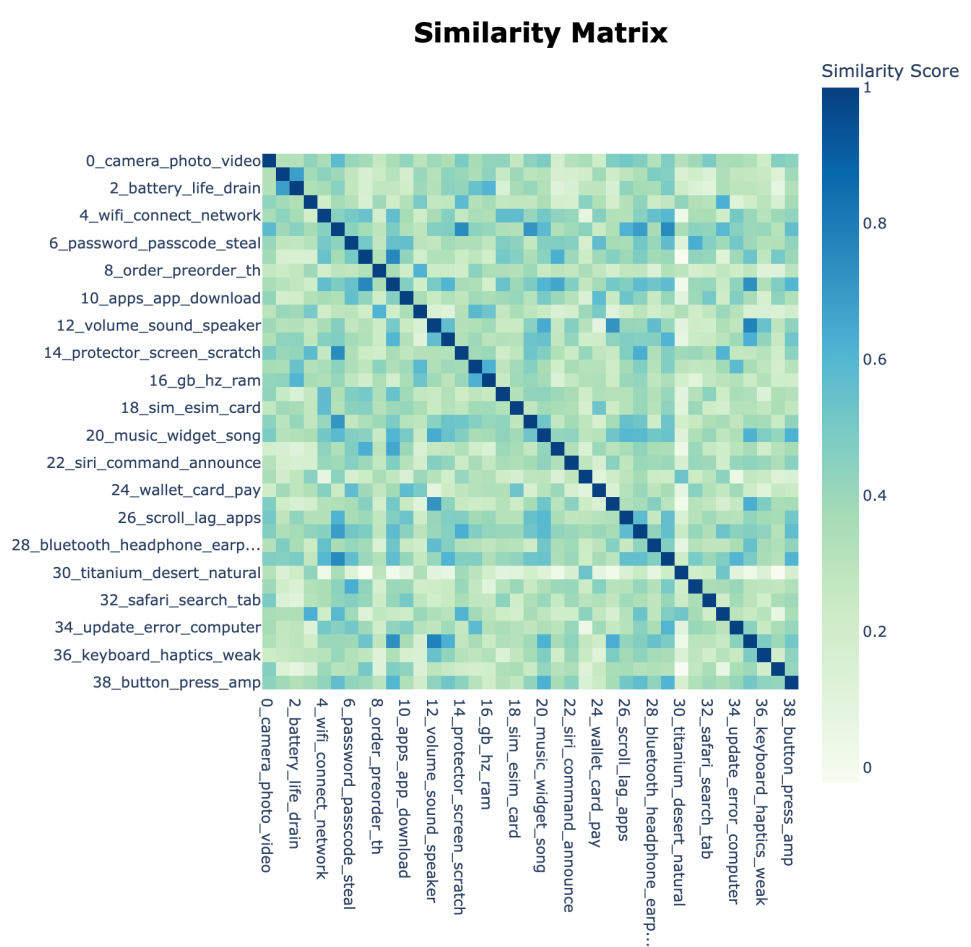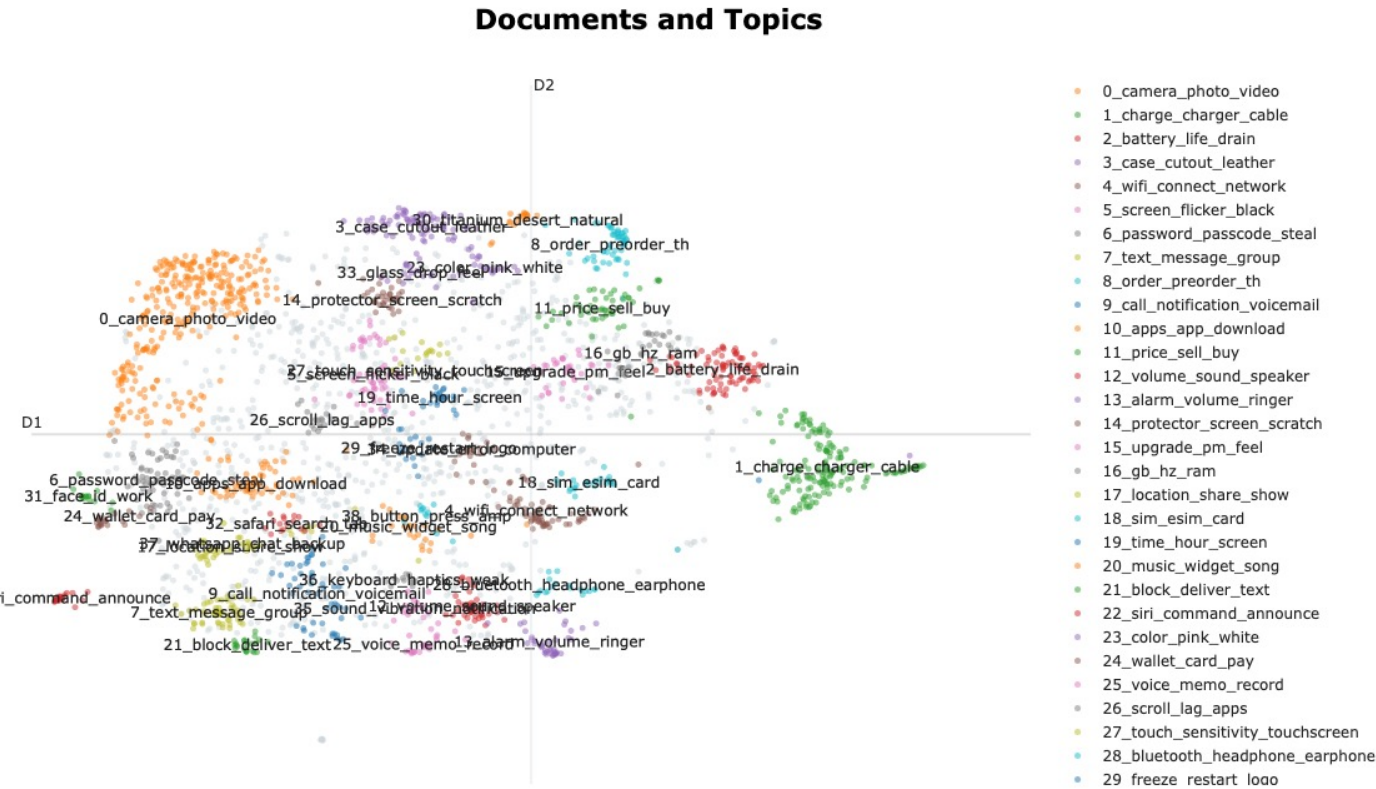
Number of topics: 40

	Topic	Count	Name	Representation	Representative_Docs
0	-1	869	-1_get_use_im_screen	[get, use, im, screen, issue, go, like, dont, ...	[need thought issue hey guy need help one im g...
1	0	307	0_camera_photo_video_picture	[camera, photo, video, picture, take, transfer...	[photo wont delete k photo video ive copy exte...
2	1	158	1_charge_charger_cable_magsafe	[charge, charger, cable, magsafe, port, use, w...	[magsafe charger fail new old charger someone ...
3	2	84	2_battery_life_drain_hour	[battery, life, drain, hour, use, get, last, u...	[question battery health get new today notice ...
4	3	76	3_case_cutout_leather_like	[case, cutout, leather, like, protection, spig...	[case question anyone know case sell cover cam...
5	4	59	4_wifi_connect_network_data	[wifi, connect, network, data, hotspot, work, ...	[cellular data post community mom cellular dat...
6	5	57	5_screen_flicker_black_lock	[screen, flicker, black, lock, go, know, rando...	[cant use screen hi recently get brand new com...
7	6	56	6_password_passcode_steal_id	[password, passcode, steal, id, lock, account,...	[would work im lock recovery email id here sit...
8	7	55	7_text_message_group_imessage	[text, message, group, imessage, number, send,...	[android text message hello everyone come acro...
9	8	54	8_order_preorder_th_pre	[order, preorder, th, pre, cancel, store, wait...	[order drama wonder else trouble get unlocked ...
10	9	51	9_call_notification_voicemail_word	[call, notification, voicemail, word, spell, f...	[notification hi get notification fine come no...

Topic Word Scores

BERTopic: Negative Topic Extraction

Documents and Topics

- 0_camera_photo_video
- 1_charge_charger_cable
- 2_battery_life_drain
- 3_case_cutout_leather
- 4_wifi_connect_network
- 5_screen_flicker_black
- 6_password_passcode_steal
- 7_text_message_group
- 8_order_preorder_th
- 9_call_notification_voicemail
- 10_apps_app_download
- 11_price_sell_buy
- 12_volume_sound_speaker
- 13_alarm_volume_ringer
- 14_protector_screen_scratch
- 15_upgrade_pm_feel
- 16_gb_hz_ram
- 17_location_share_show
- 18_sim_esim_card
- 19_time_hour_screen
- 20_music_widget_song
- 21_block_deliver_text
- 22_siri_command_announce
- 23_color_pink_white
- 24_wallet_card_pay
- 25_voice_memo_record
- 26_scroll_lag_apps
- 27_touch_sensitivity_touchscreen
- 28_bluetooth_headphone_earphone
- 29_freeze_restart_logo

Similarity Matrix

BERTopic: Negative Topic Extraction

Topics over Time

Global Topic Representation
- 0_camera_photo_video_picture
- 1_charge_cable_charger_port
- 2_sound_volume_speaker_audio
- 3_battery_life_drain_upgrade
- 4_case_cutout_leather_protection
- 5_order_preorder_th_pre
- 6_wifi_connect_network_hotspot
- 7_screen_black_flicker_know
- 8_apps_app_download_store
- 9_password_passcode_steal_id
- 10_price_buy_sell_buying
- 11_alarm_volume_ringer_set
- 12_protector_screen_scratch_case

Methodology

Topic Interpretation with Mistral AI

Mistral AI is a **French AI company** that specializes in developing **open-weight large language models (LLMs)**. Founded in 2023, Mistral focuses on creating high-performance models that are accessible and adaptable for a variety of use cases.

Topic Interpretation with LLM

```python
from langchain_mistralai.chat_models import ChatMistralAI
from langchain.prompts import import PromptTemplate
from langchain.chains import LLMChain
import os
```

```python
if 'MISTRAL_API_KEY' not in os.environ:
        from getpass import getpass
        os.environ['MISTRAL_API_KEY'] = getpass("Enter your Mistral API key: ")
```

Your API keys

Manage your personal API Keys for workspace Mavin Sao's workspace.

Create new key

You can create up to 10 API keys, and delete them when you don't need them anymore.

Active Expired

Name	Key	Expiration date	
topic	****************************oAVG	Never	🗑
pdf_rag	****************************fHQn	Never	🗑

Mistral-small-lastest

```python
def setup_llm_interpreter():
    """Set up the LLM for topic interpretation."""
    chat_model = ChatMistralAI(model="mistral-small-latest")

    # Define prompts
    rename_prompt = PromptTemplate(
        input_variables=["keywords", "representative_docs"],
        template=(
            "The topic is represented by these keywords: {keywords}, and the following "
            "documents provide additional context: {representative_docs}. "
            "Suggest one concise and meaningful name for this topic, specifically focusing "
            "on the issue it might represent. Provide only one word or a short phrase."
        )
    )

    description_prompt = PromptTemplate(
        input_variables=["keywords", "name", "representative_docs"],
        template=(
            "The topic is named '{name}', represented by these keywords: {keywords}, and "
            "the following documents provide additional context: {representative_docs}. "
            "Interpret the topic as an issue and provide a concise description for it, "
            "focusing on what the issue may involve. Keep the description strictly between "
            "100 to 300 characters."
        )
    )

    return {
        'rename_chain': LLMChain(llm=chat_model, prompt=rename_prompt),
        'description_chain': LLMChain(llm=chat_model, prompt=description_prompt)
    }
```
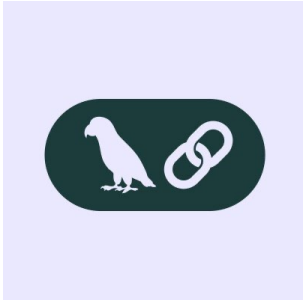
Methodology

Topic Interpretation with Mistral AI

LangChain is a framework that **helps developers build applications using language models (like GPT) more easily.**

It provides tools to connect AI models with other data sources and break complex tasks into manageable steps, making it simpler to create applications like chatbots, Q&A systems, and document analyzers.

```python
def run_llm_chain(chain, **kwargs):
    """Run LLM chain with retry logic and rate limiting."""
    time.sleep(2)  # Add delay between requests
    return chain.run(**kwargs)
```

Topic Name Chain :

```python
# Get topic name with retry logic
name = run_llm_chain(
    interpreter_chains['rename_chain'],
    keywords=keywords,
    representative_docs=docs
).strip()


print(f"Topic Name: {name}")
```

Topic Decription Chain :

```python
description = run_llm_chain(
    interpreter_chains['description_chain'],
    keywords=keywords,
    name=name,
    representative_docs=docs
).strip()


print(f"Topic Decription: {description}")
```
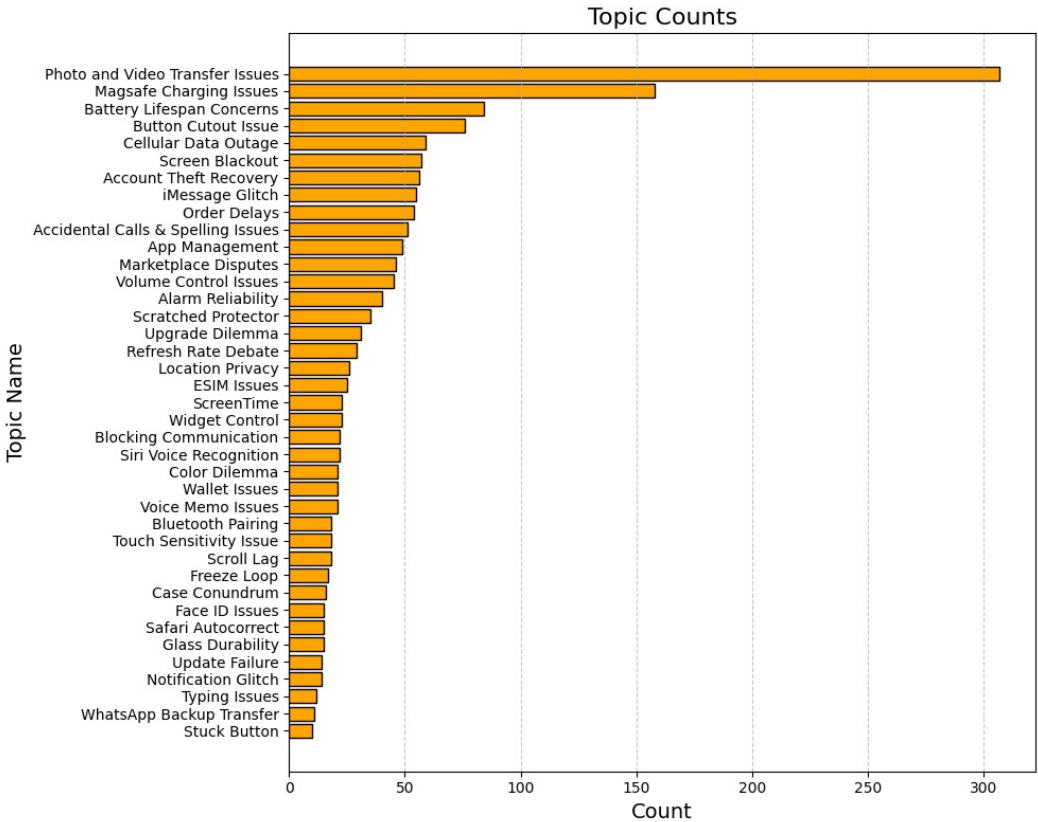
MISTRAL AI_

Topic Interpretation with Mistral AI

	Topic	Count	Name	Representation	Representative_Docs	Description	representative_docs
0	0	307	"Photo and Video Transfer Issues"	['camera', 'photo', 'video', 'picture', 'take'...	['photo wont delete k photo video ive copy ext...	Users are experiencing difficulties transferri...	Photos won't delete!! : I have 10k photos + vi...
1	1	158	"Magsafe Charging Issues"	['charge', 'charger', 'cable', 'magsafe', 'por...	['magsafe charger fail new old charger someone...	The topic "Magsafe Charging Issues" involves u...	Is my MagSafe charger failing? New phone, old ...
2	2	84	"Battery Lifespan Concerns"	['battery', 'life', 'drain', 'hour', 'use', 'g...	['question battery health get new today notice...	"Battery Lifespan Concerns": Users are worried...	Question about battery health : So i got the n...
3	3	76	"Button Cutout Issue"	['case', 'cutout', 'leather', 'like', 'protect...	['case question anyone know case sell cover ca...	The issue involves the design of smartphone ca...	Apple Cases for iPhone 16 Question : Does anyo...
4	4	59	Cellular Data Outage	['wifi', 'connect', 'network', 'data', 'hotspo...	['cellular data post community mom cellular da...	The issue involves a persistent cellular data ...	No cellular data and no : Posted this in the ...

Topic Name (By LLM): Photo and Video Transfer Issues

Representation: ['camera', 'photo', 'video', 'picture', 'take', 'transfer', 'use', 'icloud', 'delete', 'backup']

Topic Decription (By LLM):

Users are experiencing difficulties transferring photos and videos from iPhones to PCs using iCloud or external hard drives.
Issues include: incomplete transfers, error messages, and edited videos not transferring correctly. Some users also report difficulties deleting photos from iCloud and questions about video editing compatibility.

Topic Counts

Photo and Video Transfer Issues
Magsafe Charging Issues
Battery Lifespan Concerns
Button Cutout Issue
Cellular Data Outage
Screen Blackout
Account Theft Recovery
iMessage Glitch
Order Delays
Accidental Calls & Spelling Issues
App Management
Marketplace Disputes
Volume Control Issues
Alarm Reliability
Scratched Protector
Upgrade Dilemma
Refresh Rate Debate
Location Privacy
ESIM Issues
ScreenTime
Widget Control
Blocking Communication
Siri Voice Recognition
Color Dilemma
Wallet Issues
Voice Memo Issues
Bluetooth Pairing
Touch Sensitivity Issue
Scroll Lag
Freeze Loop
Case Conundrum
Face ID Issues
Safari Autocorrect
Glass Durability
Update Failure
Notification Glitch
Typing Issues
WhatsApp Backup Transfer
Stuck Button

Count

Topic Interpretation with Mistral AI

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Document 1: Photos won't delete!! : I have 10k photos + videos on my phone. I've copied them to an external hard drive. I have requested a deletion from iCloud — 30 day wait. Now **I can't even remove them from my phone?** Delete does nothing. Have tried restarting the phone, photos app, etc. I've tried to plug it into my PC And remove the photos, no luck. Help please!! :)

Document 2: Weird issue editing videos with Apple Photos app on iPhone : I do not see this as a "basic support question," so I figured I would ask this complicated discussion in this subreddit since there are a lot of knowledgeable people …. sometimes certain videos with the IMG_EXXX.MOV designation will refuse to transfer off the iPhone to PC....

Document 3: New iphone camera glitching : Hey everyone, i got a new iphone 14 like 3 days ago. First time the camera stopped working for me i just restarted the phone and it started working again. Yesterday **the camera just stopped working** and just shows a black screen. I tried everything, software update, hard reset, normal reset, even the **"Transfer or Reset iPhone"** option. The 0.5 camera works though but it took this picture... flashlight also doesnt work for some reason.... anyone know what i can do?

Topic Interpretation with Mistral AI

Topic Name (By LLM): Screen Blackout

Representation: ['screen', 'flicker', 'black', 'lock', 'go', 'know', 'randomly', 'since', 'turn', 'line']

Topic Decription (By LLM):

The "Screen Blackout" issue **involves a screen that randomly goes completely black or flickers like a Game Boy**, often occurring when touching the screen or during use. The problem persists despite reboots and updates, affecting the screen's usability and causing concern for device owners.

Document 1: can't use screen. : hi. i recently got a **brand new iphone 11**, from my phone company. was working fine. i haven't dropped it, always had a screen protector on it. randomly, **i could not use the screen, i couldn't swipe to turn it off, put my passcode in or anything.** but the screen was on and i could receive calls/messages and take screenshots. i rebooted it and it would work. i updated my phone and it's still doing it. it only mostly does it when i lock my screen. my last resort would be contacting apple support which i don't want to do. any ideas what is happening ??

Document 2: 15 Pro Screen Flicker : Has anyone here experienced a flicker on their screen like a GameBoy or a Television after you turn them off. **Like a small flash on the screen something like that**. I've been using my 15 pro for 4 months now and it occured just last month. Screen display is still good (i guess?) no ghost touch or anything. It just bothers me whenever I lock my phone and the screen will flash in an instant. But FYI it doesn't happen every time I use my phone. It's random 😅

Document 3: Screen problem? : I have a **phone 13 pro max**, and I'd say probably a week or 2 ago I noticed I put my hand over some of my screen. **It went completely black** until I removed my hand from over the screen and then it would go back to normal. It don't lock the phone when it goes black. And **this is not consistent it's happened a couple times I've noticed**. And I can make it go black a couple times and then it won't let me do it anymore. I would compare this too the setting in iPad. Where if you have a case with a screen cover on it when you put the cover on the screen it goes black and locks the iPad. Thank you in advance for any help.

Conclusion

- In conclusion, our sentiment analysis implementation, utilizing a **BERT model fine-tuned on the Stanford Sentiment Treebank**, effectively processed user posts and identified **2,498 negative** and **706 positive discussions** from the iPhone subreddit community.

- Through **BERTopic** analysis of these negative discussions, we successfully identified **39 distinct issues** from the iPhone subreddit community. The most frequently discussed concern was **Photo and Video Transfer Issues**, followed by **MagSafe Charging Problems** and **Battery Life Span Concerns**, respectively.

- We then employed **Mistral-small** to interpret and describe these issues using **carefully crafted prompts, providing clear descriptions for each identified topic**.

- The analysis resulted in a valuable deliverables for company use:

	Document_ID	Topic_ID	Topic_Name	Topic_Description	topic_score	is_primary_topic	title	selftext	subreddit
0	1	0	"Photo and Video Transfer Issues"	Users are experiencing difficulties transferri...	1.0	True	Some billionaire posted a picture allegedly ta...	Check at the bottom of the picture	iPhone16
1	1357	0	"Photo and Video Transfer Issues"	Users are experiencing difficulties transferri...	1.0	True	Transferring Large Amount of Photos from PC to...	I have a lot of photos I took on a camera on a...	iPhone
2	1305	13	"Alarm Reliability"	The issue involves alarm clocks or apps not fu...	1.0	True	Alarm still not showing, when's going to be fi...	Been over 10 days without alarm. No updates an...	iPhone
3	1317	31	"Face ID Issues"	Users are experiencing difficulties with Face ...	1.0	True	face id sensor	Okay so , i tried uploading the video here but...	iPhone
4	1320	0	"Photo and Video Transfer Issues"	Users are experiencing difficulties transferri...	1.0	True	how to transfer everything from my old phone t...	ik you can do old to new. but my dad just gave...	iPhone

Thank You

Q&A