

Me: \*uses machine learning\*

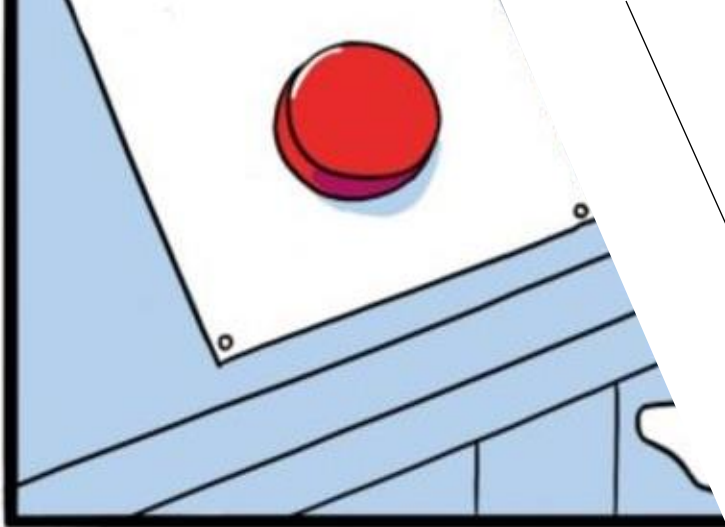
Machine: \*learns\*

Me:



# MEMEMATCH: YOUR AI MEME RECOMMENDATION ASSISTANT

Tri An Le



JAKE-CLARK.TUMBLR

## I. PROBLEMS

- Multimodal Meme and Meme Template Retrieval and Recommendation.
- Text-to-Image Relevance Evaluation.
- Information Retrieval Metrics and Analysis.

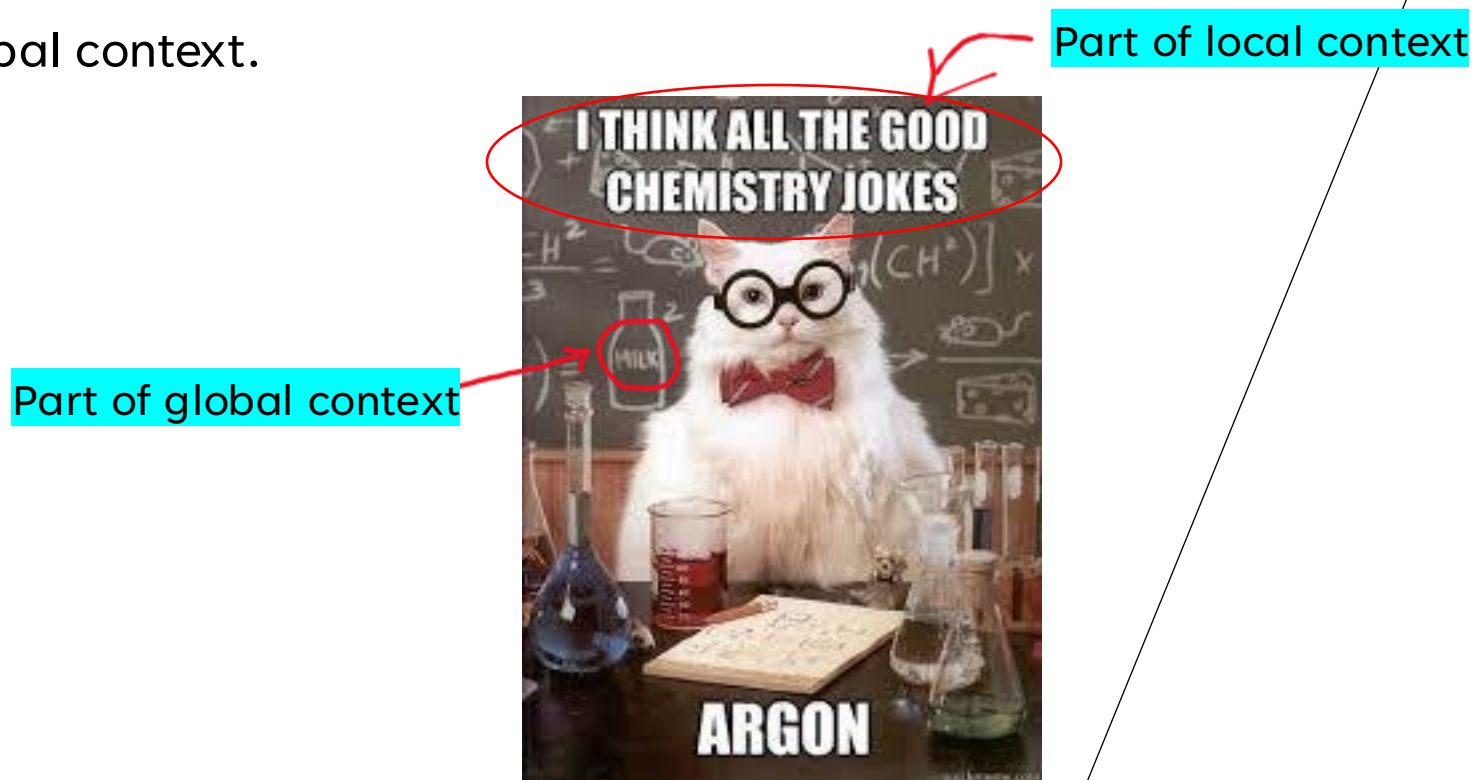
## II. DATA



# BACKGROUND

## Dataset:

- ~301K image-with-text memes from Reddit and ImageFlip.
- ~2100 meme templates from ImageFlip.
- Metadata includes: upvotes, titles, urls, created time.
- 2 parts: local context and global context.



### III. DATA PREPROCESSING, METHODOLOGY & RESULTS

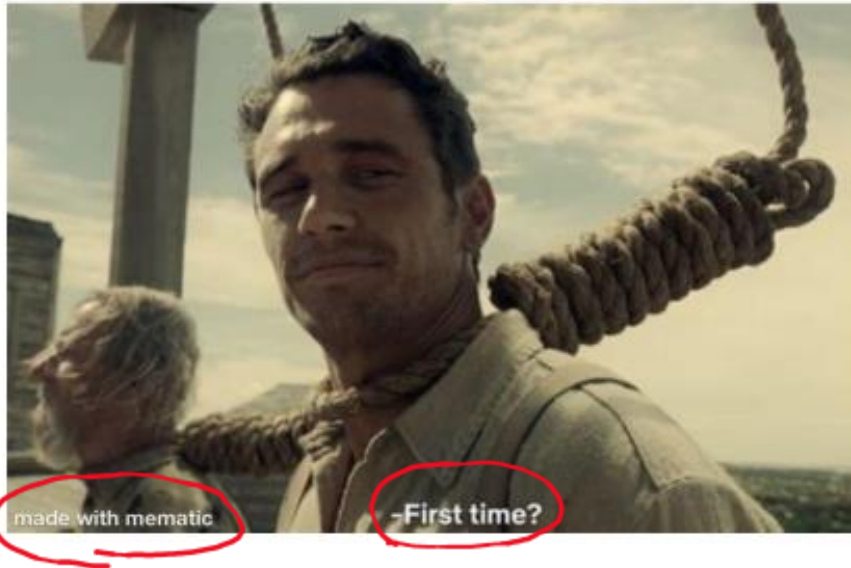




## 1. Text Extraction

3DS owners: OH NO! We'll have to pirate games now!

Wii owners:



"3DS owners: OH NO! We'll have to pirate games now! Wii owners: made with mematic First time?"



"Corporate needs you to find the differences between this picture and this picture: made with mematic They're the same picture. Fat free milk water"

OCR result

-> Cannot be used because of improper format (watermark, global context, delimiter issue, etc.)

## 1. Text Extraction

Local Context

3DS owners: OH NO! We'll have to pirate games now!

Wii owners:



"3DS owners: OH NO! We'll have to pirate games now! Wii owners:"

OCR result after data cleaning

-> Good to use!



"Fat free milk water"

2. Metadata

3DS owners: OH NO! We'll have to pirate games now!

Wii owners:



		id	score	title	body	url	image_url	post_link	created_utc
...		755700	meme_submissions_1287583	24	Darkness	https://i.redd.it/zb9g8eu3kwi81.jpg	https://preview.redd.it/zb9g8eu3kwi81.jpg?auto...	/r/meme/comments/swqxzy/darkness/	2022-02-20 02:52:39
...		738792	meme_submissions_1249423	27	No difference whatsoever	https://i.redd.it/wytrjxdyn2581.jpg	https://preview.redd.it/wytrjxdyn2581.jpg?auto...	/r/meme/comments/reknze/no_difference_whatsoever/	2021-12-12 08:27:02

→ Final local context: “Fat free milk water No difference whatsoever”



### 3. Image Captioning



“a man with a rope around his neck”

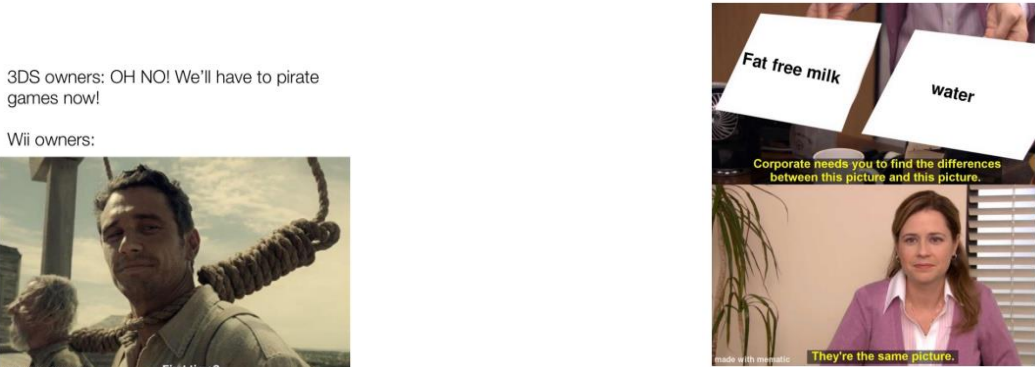


“a woman in a purple jacket is holding a piece of paper”

- PaddleOCR for white masking
- "Salesforce/blip-image-captioning-base" for Image Captioning

# 4. Sentiment Analysis

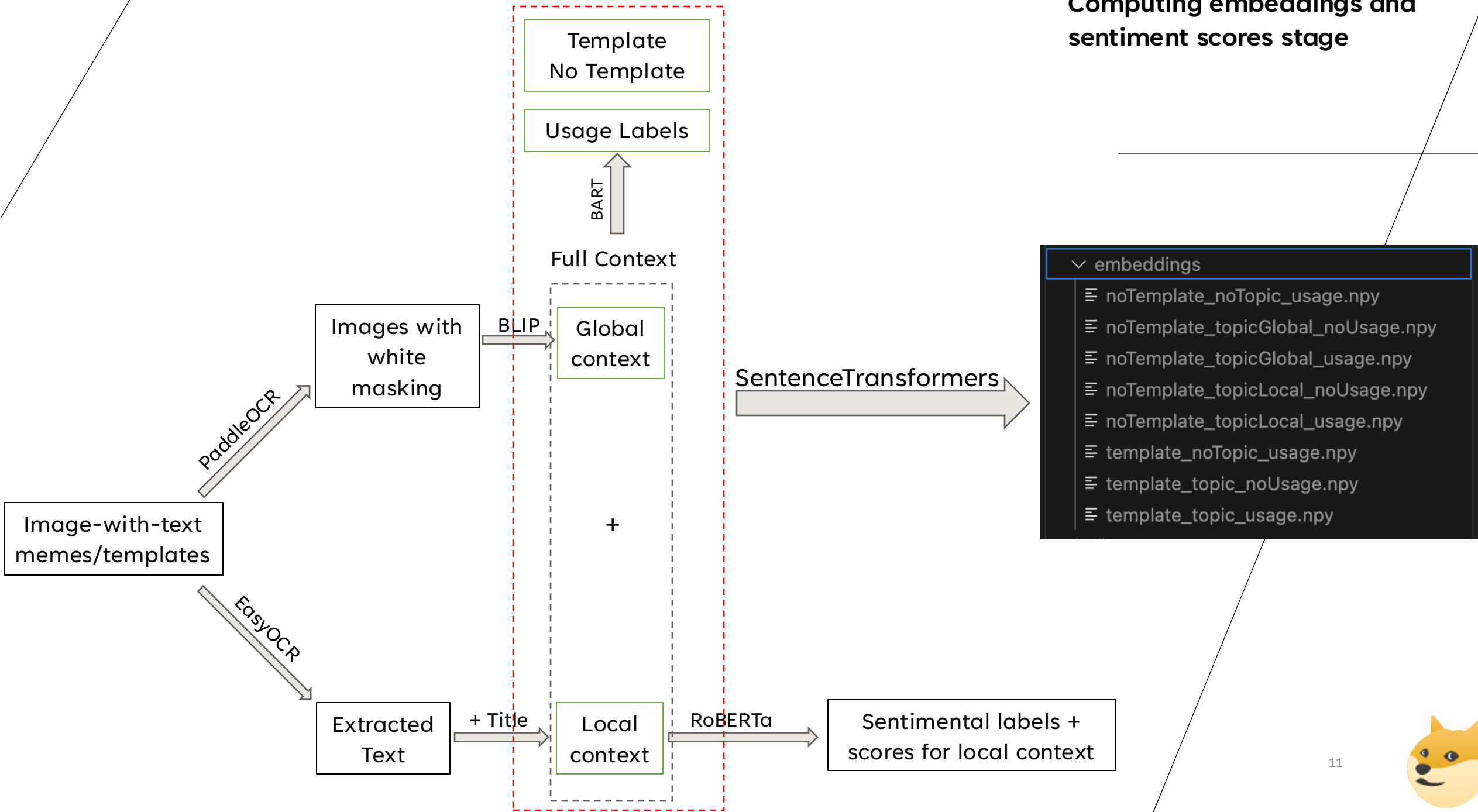
2 RoBERTa models → 14 sentiments and their corresponding scores



- Anger 🤔🔥
- Anticipation ⌚😞
- Disgust 🤢🤮
- Fear 😱😨
- Joy 😄🎉
- Love ❤️😍
- Optimism 😊☀️
- Pessimism 😞☁️
- Sadness 😭💔
- Surprise 😲😮
- Trust 🤝👌
- Negative 🚫👎
- Neutral 😐🙄
- Positive ✅👍

0.479241	0.593545
0.19945	0.054121,
0.647908	0.673541
0.066868	0.010768
0.032594	0.033441
0.002387	0.003806
0.016223	0.021999
0.075464	0.022189
0.217513	0.673541
0.060239	0.022189
0.00559	0.00443
0.768447	0.079837
0.215292	0.720003
0.016261	0.20016

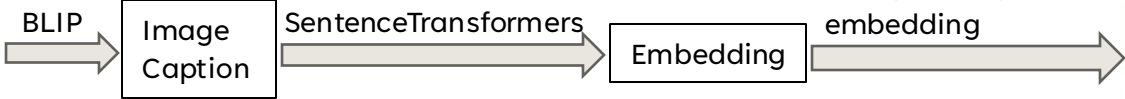
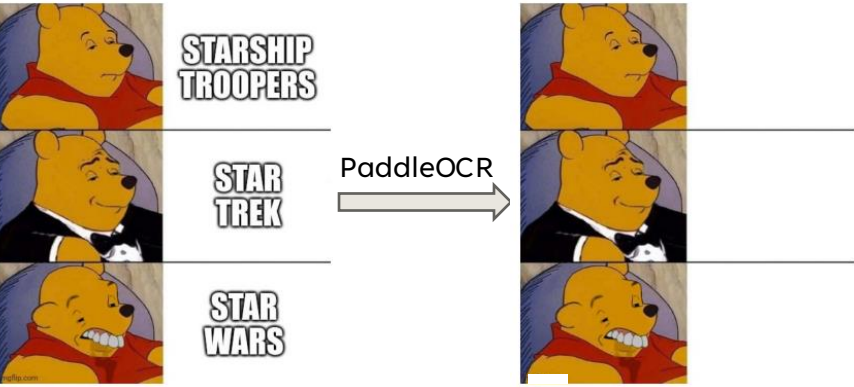
## Computing embeddings and sentiment scores stage



Feature 1: Find similar memes based on Global Context (Image-based)



Uploaded Meme:



Output: Top n similar memes based on image

	oc meme creators
	memers who use this: 
	AND AT THIS POINT I'M TOO AFRAID TO ASK
	at this point im afraid to ask upvoters
	made with beeing slightly annoyed

```
embeddings
├─ noTemplate_noTopic_usage.npy
├─ noTemplate_topicGlobal_noUsage.npy
├─ noTemplate_topicGlobal_usage.npy
├─ noTemplate_topicLocal_noUsage.npy
├─ noTemplate_topicLocal_usage.npy
├─ template_noTopic_usage.npy
├─ template_topic_noUsage.npy
├─ template_topic_usage.npy
```

\* Embeddings are generated by SentenceTransformer("all-mpnet-base-v2")

	America	No
	UK	No
	Australia	NAUR

	PEOPLE WHO SAY "NICE WORK IF YOU CAN GET IT" WAS THE ANDREWS SISTERS FIRST RECORD.
	PEOPLE WHO SAY "JAMMIN" WAS THE FIRST ANDREWS SISTERS RECORD.
	PEOPLE WHO SAY "BEER BARREL POLKA" WAS THE ANDREWS SISTERS RECORD.

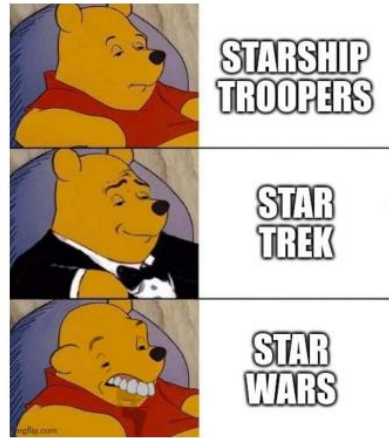
	2021 2nd best military in the world
	2022 2nd best military in Ukraine
	2023 2nd best military in Russia



## Feature 2: Find similar memes based on Local Context (Text-based)

**Output:** Top n similar memes based on text

**Uploaded Meme:**



EasyOCR

Extracted  
Text

SentenceTransformers

Embedding

Cosine  
Similarity  
with  
precomputed  
embedding

Star Wars



Star Trek



Battlestar  
Galactica



embeddings

- noTemplate\_noTopic\_usage.npy
- noTemplate\_topicGlobal\_noUsage.npy
- noTemplate\_topicGlobal\_usage.npy
- noTemplate\_topicLocal\_noUsage.npy**
- noTemplate\_topicLocal\_usage.npy
- template\_noTopic\_usage.npy
- template\_topic\_noUsage.npy
- template\_topic\_usage.npy



## Introduction of Meme Usages

3DS owners: OH NO! We'll have to pirate games now!

Wii owners:



Sarcasm or Irony|  
Confusion or Disbelief|  
Reaction or Reply Meme|  
Parody or Spoof|  
Popular Meme Format|  
Self-Deprecation|  
Absurd or Random Humor|  
Comparison or Contrast|  
Emotional Frustration|  
Product or Brand Promotion|  
Media or Brand Critique|  
Hyperbole or Exaggeration|  
Sadness or Disappointment|  
Punchline or Joke



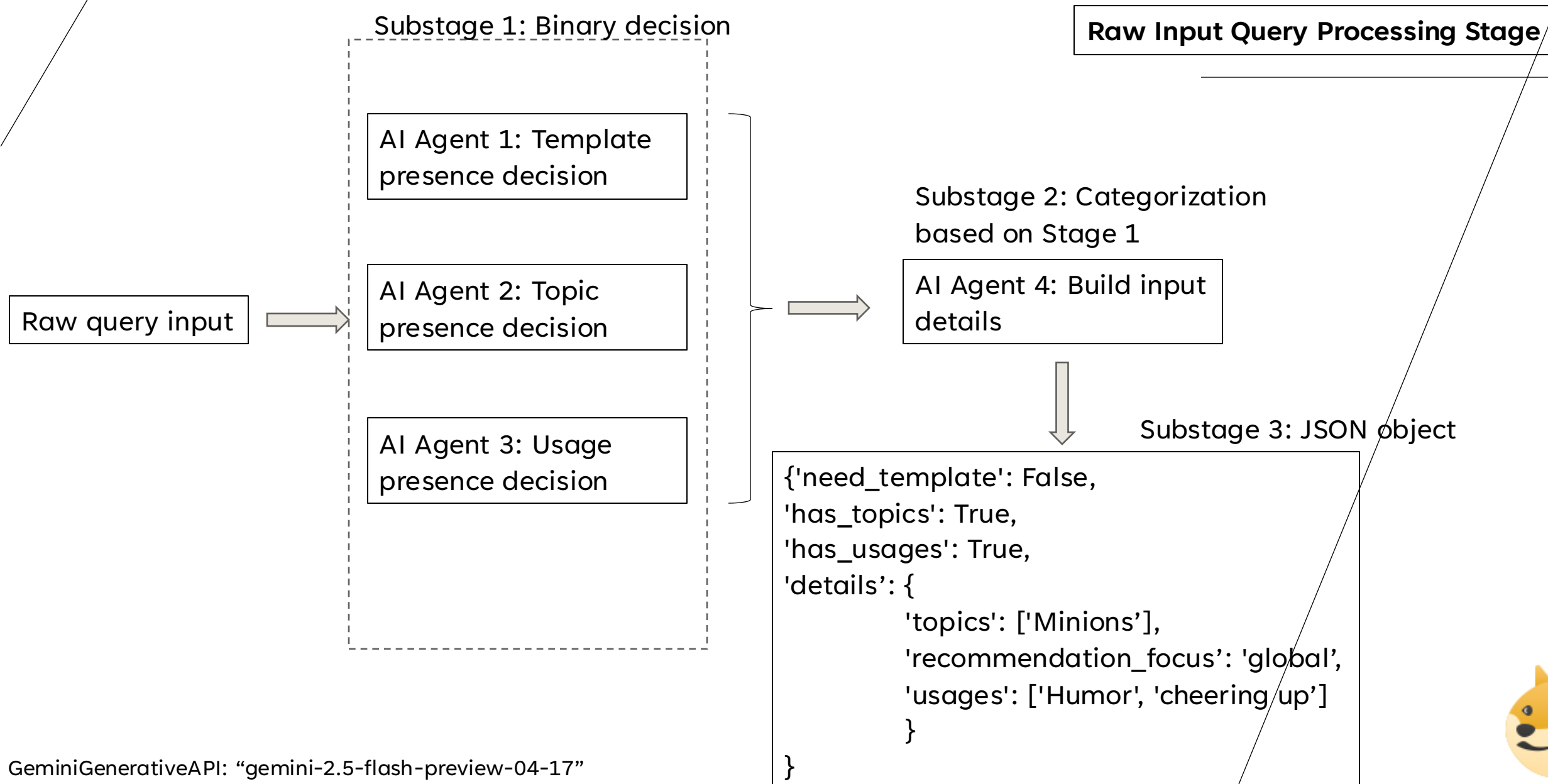
Parody or Spoof|  
Absurd or Random Humor

-> Methodology: Zero-shot classification with Hugging Face Transformers (BART-Large-MNLI) and using custom usage labels.



### Feature 3: Natural Language Query

Query: My day has been really bad, I want a meme that can cheer me up. I really like the movie Despicable Me, give me some Minions memes.



### Feature 3: Natural Language Query

Query: My day has been really bad, I want a meme that can cheer me up. I really like the movie Despicable Me, give me some Minions memes.

#### Semantic Searching & Ranking Stage

```
{'need_template': False,
'has_topics': True,
'has_usages': True,
'details': {
  'topics': ['Minions'],
  'recommendation_focus': 'global',
  'usages': ['Humor', 'cheering up']
}}
```

SentenceTransformers

User input  
embedding

Cosine Similarity  
with precomputed  
case-based  
embedding

Top n  
Recommendations

#### embeddings

- noTemplate\_noTopic\_usage.npy
- noTemplate\_topicGlobal\_noUsage.npy
- noTemplate\_topicGlobal\_usage.npy
- noTemplate\_topicLocal\_noUsage.npy
- noTemplate\_topicLocal\_usage.npy
- template\_noTopic\_usage.npy
- template\_topic\_noUsage.npy
- template\_topic\_usage.npy





### Feature 3: Natural Language Query

Query: I just want to see some memes.

Fallback Condition

...

→

```
{'need_template': False,  
'has_topics': False,  
'has_usages': False,  
'details': {  
    'sentiment_preference': 'neutral'  
  }  
}
```

Sentiment score ranking

→

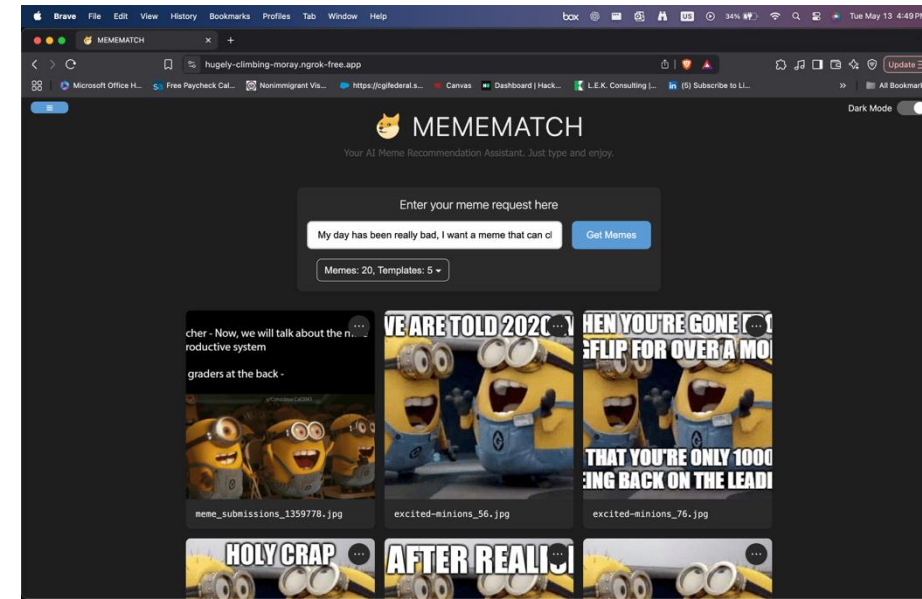
Top n  
Recommendations





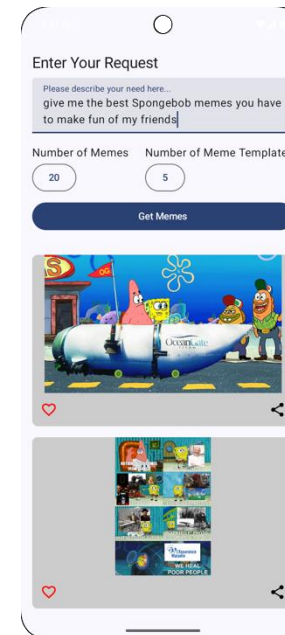
## Web Interface

- **Frontend:** Built with HTML, CSS, and JavaScript for the user interface.
- **Backend:** Powered by FastAPI to handle HTTP requests and responses via RESTful endpoints.
- **Tunneling:** Ngrok is used to expose the local FastAPI server to the internet through a secure tunnel.



## Android App

- **UI Layer.**
- **ViewModel Layer.**
- **Backend Communication:** Retrofit is used to interact with a Python-based backend API.
- **Firestore Integration:** Firebase Authentication, Firestore Database.
- **Extra features:** Favorites, sharing to social media platforms.



Demo!



### III. PERFORMANCE EVALUATION & ANALYSIS

when the teacher asks  
you to do a self assessment



**PROGRAMMER  
IN RICH  
COUNTRIES**



**PROGRAMMER  
IN POOR  
COUNTRIES**

## 1. Semi-automated Test Label Generation

How relevant are the meme/meme template retrieval results and the query?

- Randomly generate **~200 meme queries** and **~200 meme template queries** that are diverse in lengths, topics, and expressions.
- **20 results** per meme query.
- **10 results** per meme template query.



Output from meme/meme template retrieval model (A pair of query and image)

GeminiGenAPI

Relevance Labels

2 (highly relevant) / 1 (relevant) / 0 (not relevant)

```
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/socially-awesome-awkward-penguin_12.png
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/Victoria_David_Beckham_Be_Honest_1.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/meme_submissions_1330569.png
memes mocking the idea of networking on LinkedIn with strangers,0,test_images/Expectation_vs_Reality_5.png
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/meme_submissions_1362907.png
memes mocking the idea of networking on LinkedIn with strangers,0,test_images/meme_submissions_1217150.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/pepe-silvia_8.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/meme_submissions_1393434.png
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/Peter_Parker_Reading_Book__Crying_9.png
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/meme_submissions_1226418.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/meme_submissions_1249349.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/meme_submissions_1478706.png
memes mocking the idea of networking on LinkedIn with strangers,0,test_images/squidward-pointing_9.png
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/meme_submissions_1386498.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/meme_submissions_1458924.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/neo-dodging-a-bullet-matrix_10.png
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/meme_submissions_1293717.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/meme_submissions_1345435.png
memes mocking the idea of networking on LinkedIn with strangers,1,test_images/meme_submissions_1266685.png
memes mocking the idea of networking on LinkedIn with strangers,2,test_images/math-ladyconfused-lady-135.png
```



## 2. Evaluation Result

- Threshold = 1, **relevant**

Evaluation results for meme retrieval	Evaluation results for meme template retrieval
nDCG@5: 0.6383 Precision@5: 0.8465 Recall@5: 0.2590 nDCG@10: 0.6837 Precision@10: 0.8446 Recall@10: 0.5151 nDCG@20: 0.8411 Precision@20: 0.8255 Recall@20: 1.0000 MAP: 0.8635 MRR: 0.9163	nDCG@5: 0.5008 Precision@5: 0.4960 Recall@5: 0.5233 nDCG@10: 0.7029 Precision@10: 0.4697 Recall@10: 1.0000 MAP: 0.5982 MRR: 0.6558

- The meme retriever is very strong. It's precise, retrieves all relevant memes, and ranks them well.
- The **meme template retriever finds all relevant results** (great recall).
- Compared to meme retrieval, **template performance is weaker**, especially in **early precision** and **ranking sharpness** (due to the nature of meme template and the size of template dataset).



## 2. Evaluation Result

- Threshold = 2, **highly relevant**

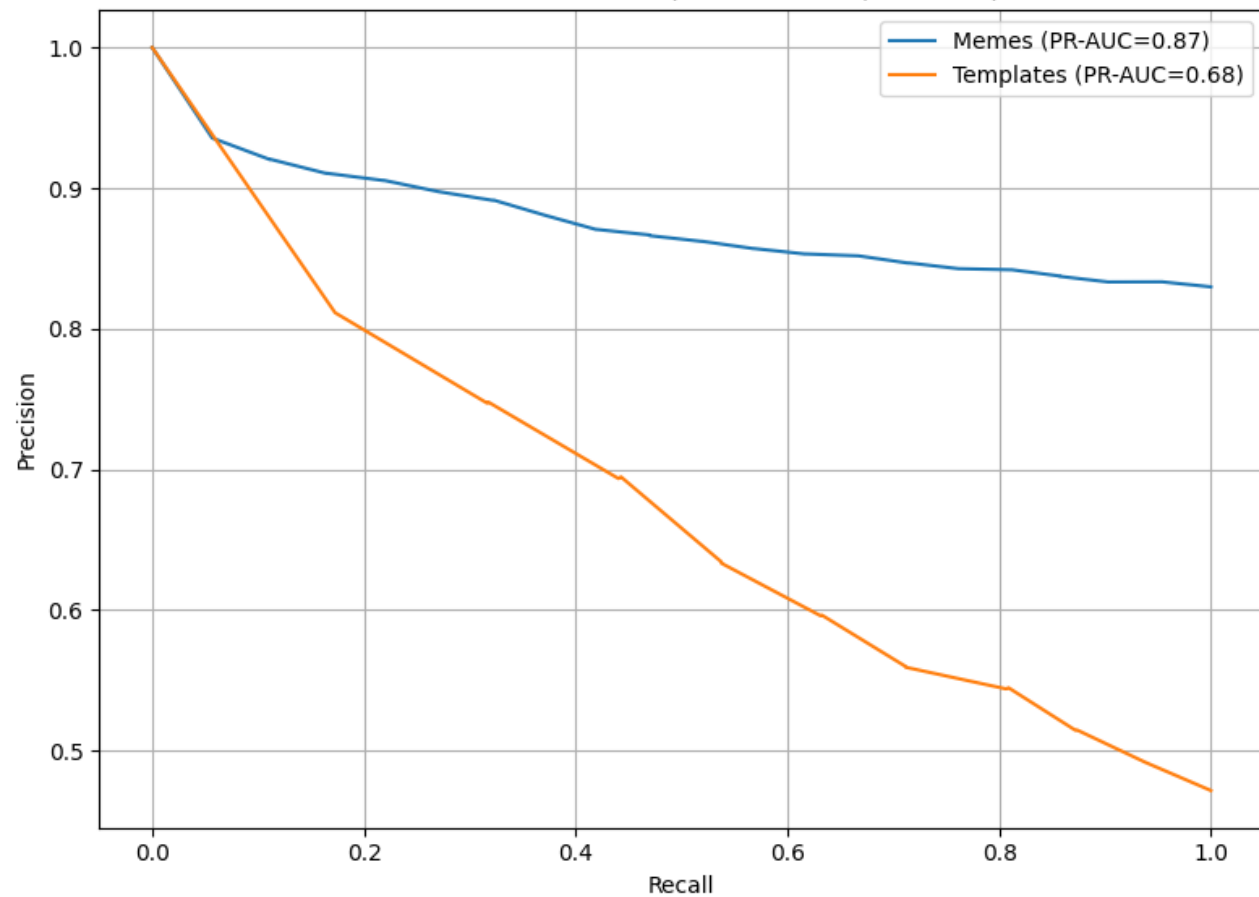
Evaluation results for meme retrieval	Evaluation results for meme template retrieval
nDCG@5: 0.6383 Precision@5: 0.4901 Recall@5: 0.2503 nDCG@10: 0.6837 Precision@10: 0.4871 Recall@10: 0.4893 nDCG@20: 0.8411 Precision@20: 0.4869 Recall@20: 0.9802 MAP: 0.5623 MRR: 0.6578	nDCG@5: 0.5008 Precision@5: 0.3714 Recall@5: 0.5021 nDCG@10: 0.7029 Precision@10: 0.3417 Recall@10: 0.9657 MAP: 0.4944 MRR: 0.5509

- Model does **very well in finding** highly relevant memes. There's **room to improve early ranking** (P@5/10).
- The template retriever **finds the right items**, but doesn't **rank them aggressively enough at the top**.
- The performance of the **meme template retriever** is **decent but weaker than meme retriever**, especially on **early precision**.

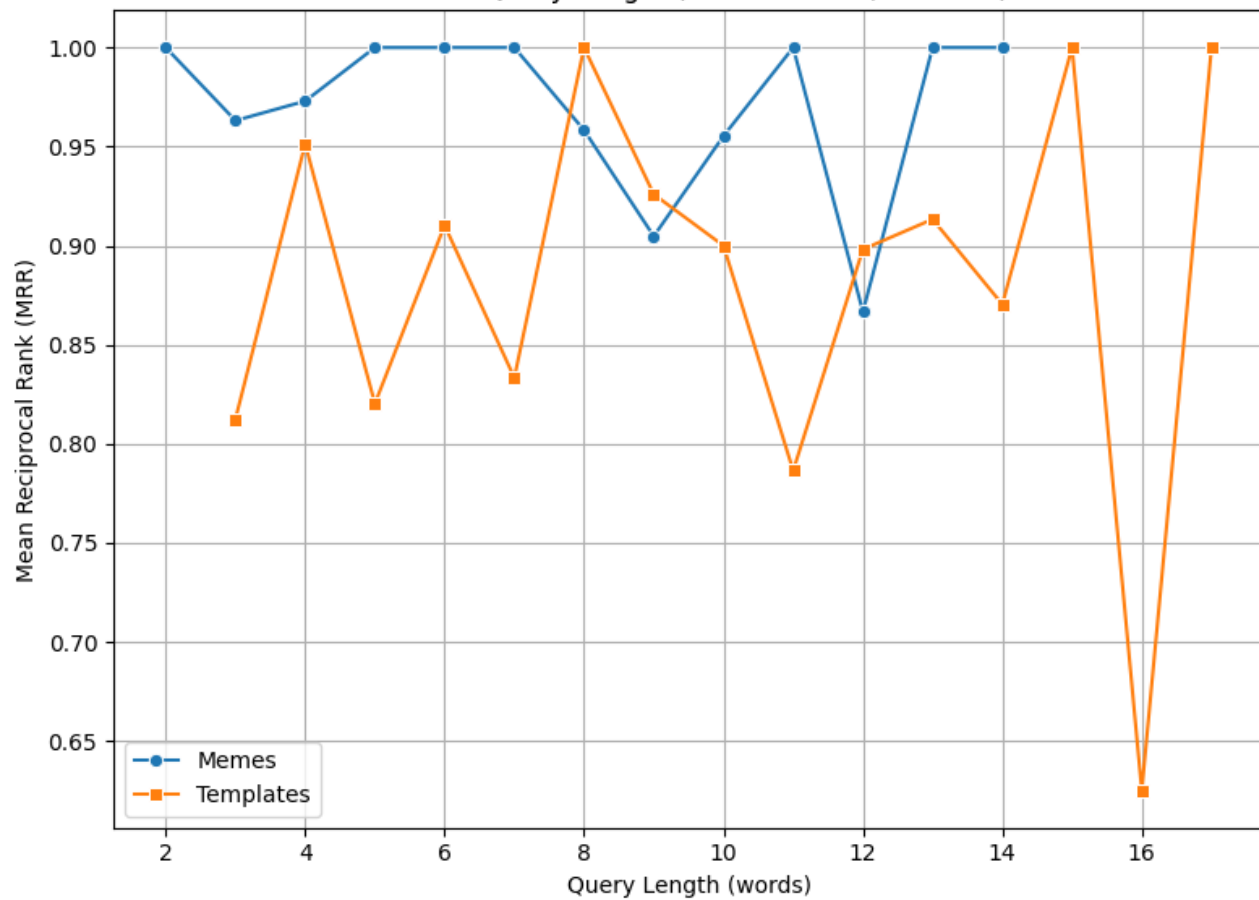


## 2. Evaluation Result

Precision-Recall Curve (threshold = 1, relevant)

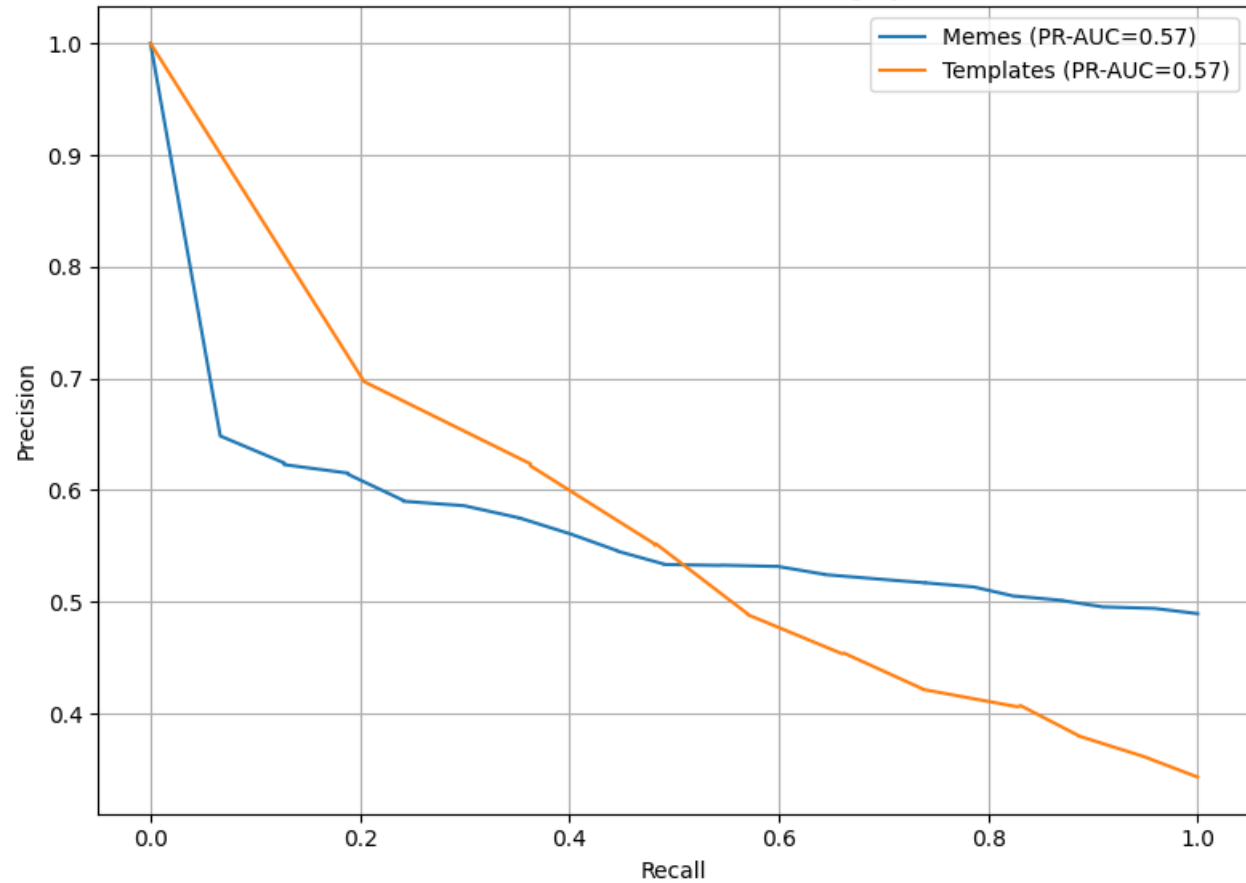


MRR vs. Query Length (threshold = 1, relevant)

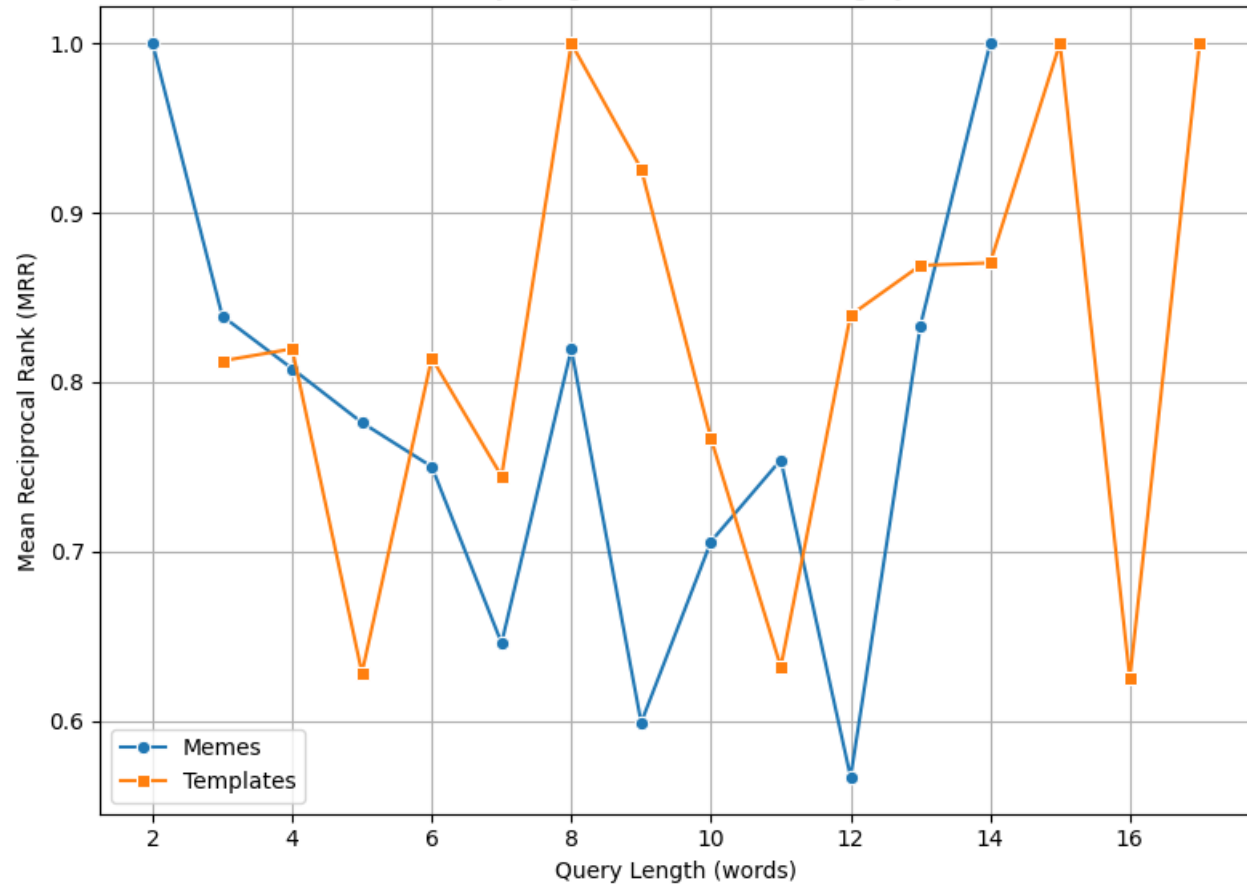


## 2. Evaluation Result

Precision-Recall Curve (threshold = 2, highly relevant)

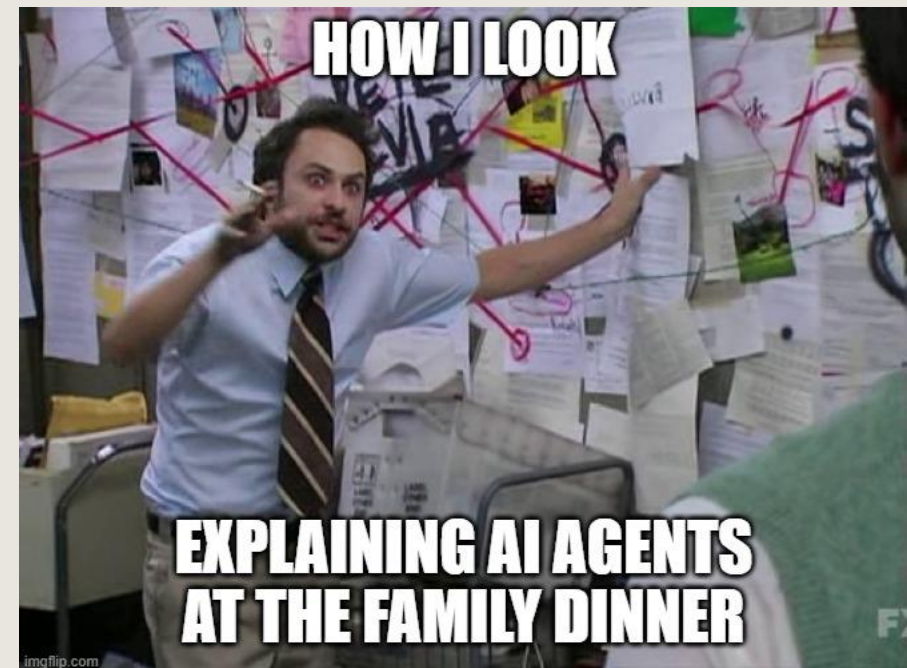
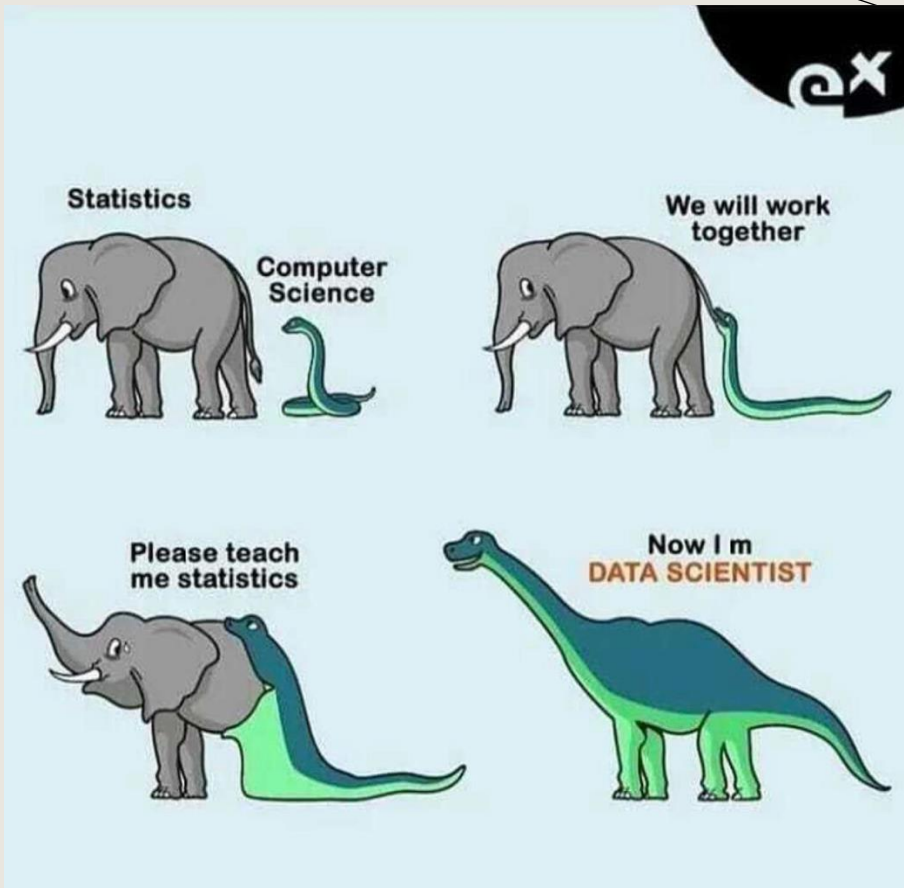


MRR vs. Query Length (threshold = 2, highly relevant)





## IV. FUTURE WORK

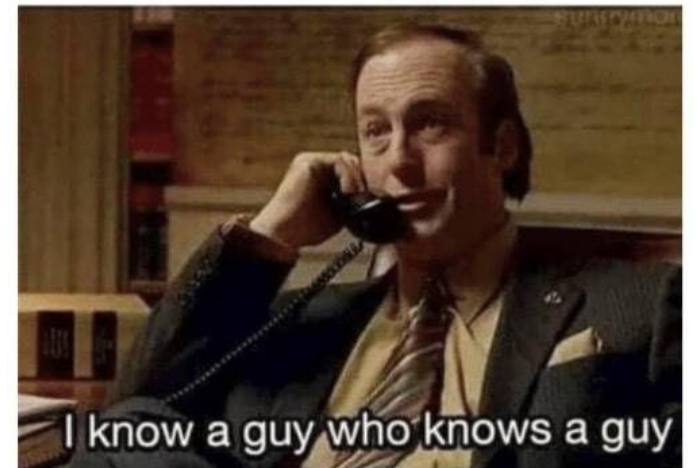


### III. Future Work

- Update and increase the meme dataset.
- Extend the scope of the project to GIFs dataset.
- Improve the performance of the existing text-to-image model.
- Manually checking the text-to-image model performance on small batch.
- IOS deployment.



**How Neural Networks work?**  
**Neurons:**



The image features three thin, dark grey lines that intersect to form a large, stylized 'X' shape across the entire frame. One line runs diagonally from the top-left towards the bottom-right, another runs diagonally from the top-right towards the bottom-left, and a third line runs horizontally across the upper portion of the image.

**MemeMatch finds the perfect meme for every moment.**



# THANK YOU

Tri An Le

Emails: [triandole@gmail.com](mailto:triandole@gmail.com)

Contact: +36 20 492 3602

