Fitting Cognify to VLM applications

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Content

1 What is the problem, and why is it important?

2 New Workflows

3 New Cogs

4 New Search Option

5 Evaluation

6 Issues?

7 Q&A

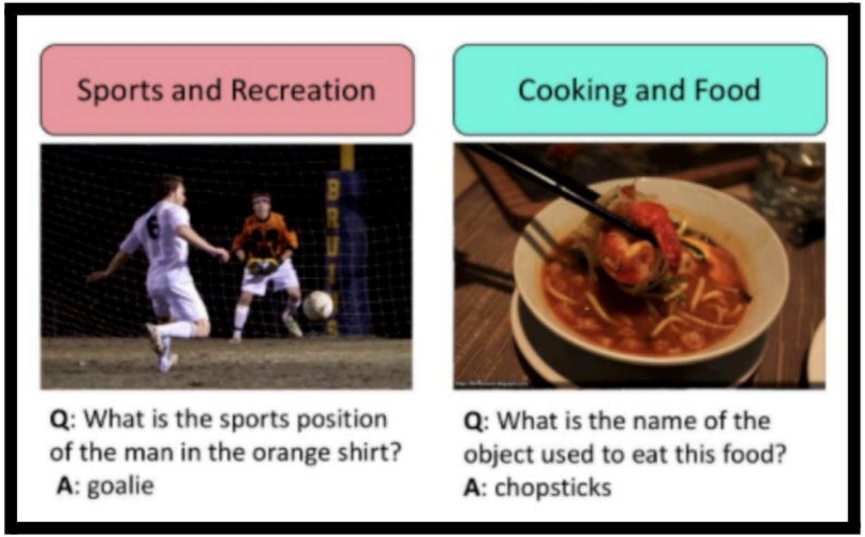
Cognify

Cognify = GenAI Workflow Optimization

https://github.com/GenseeAI/cognify

GenseeAI

Current Cognify Performance on Vision Tasks



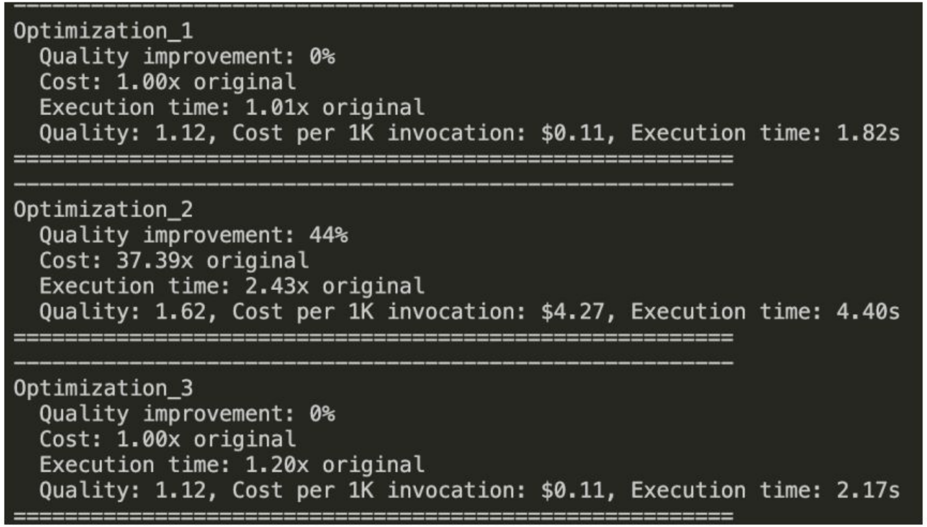
Sports and Recreation

Q: What is the sports position of the man in the orange shirt?
A: goalie

Cooking and Food

Q: What is the name of the object used to eat this food?
A: chopsticks

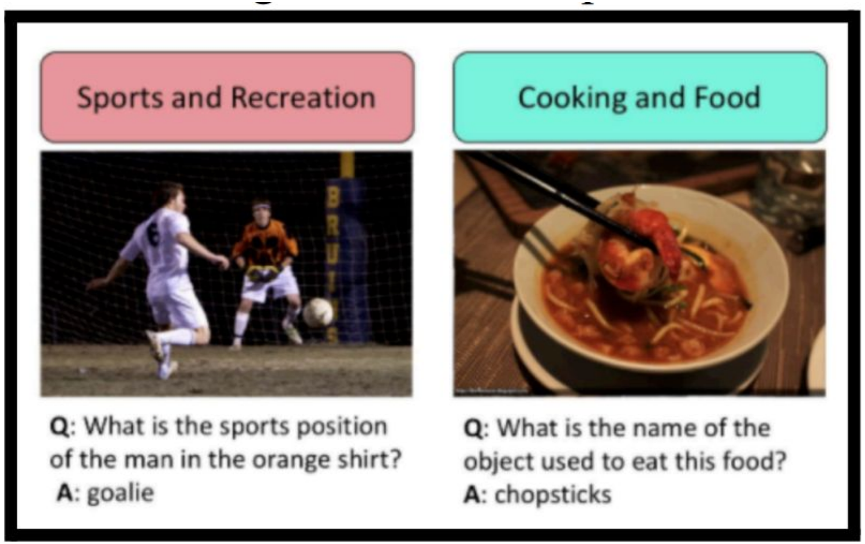
Figure 1 - VQA Dataset Example



```
-----------------------------------------------------------------
Optimization_1
  Quality improvement: 0%
  Cost: 1.00x original
  Execution time: 1.01x original
  Quality: 1.12, Cost per 1K invocation: $0.11, Execution time: 1.82s
=================================================================
-----------------------------------------------------------------
Optimization_2
  Quality improvement: 44%
  Cost: 37.39x original
  Execution time: 2.43x original
  Quality: 1.62, Cost per 1K invocation: $4.27, Execution time: 4.40s
=================================================================
-----------------------------------------------------------------
Optimization_3
  Quality improvement: 0%
  Cost: 1.00x original
  Execution time: 1.20x original
  Quality: 1.12, Cost per 1K invocation: $0.11, Execution time: 2.17s
=================================================================
```

Figure 2 - Optimization Results

Current Cognify Performance on Vision Tasks



Q: What is the sports position of the man in the orange shirt?
A: goalie

Q: What is the name of the object used to eat this food?
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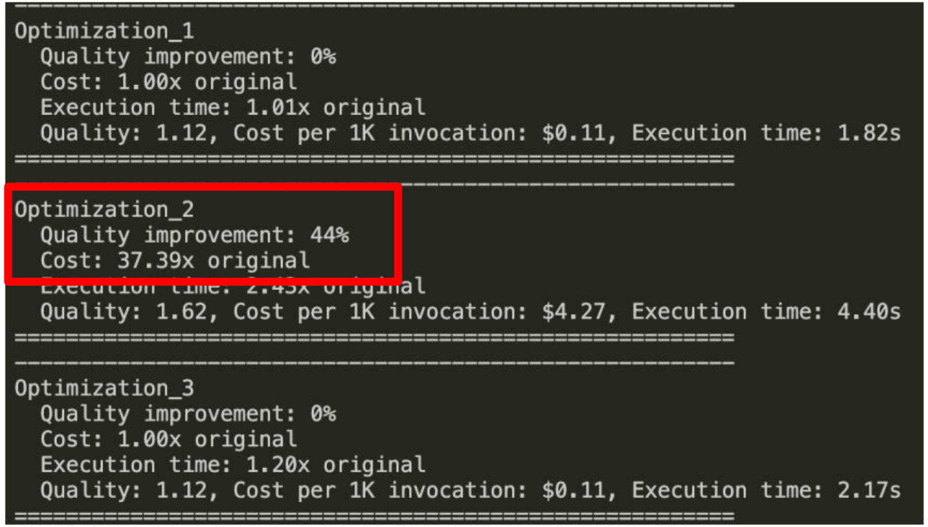
Figure 1 - VQA Dataset Example



```
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```
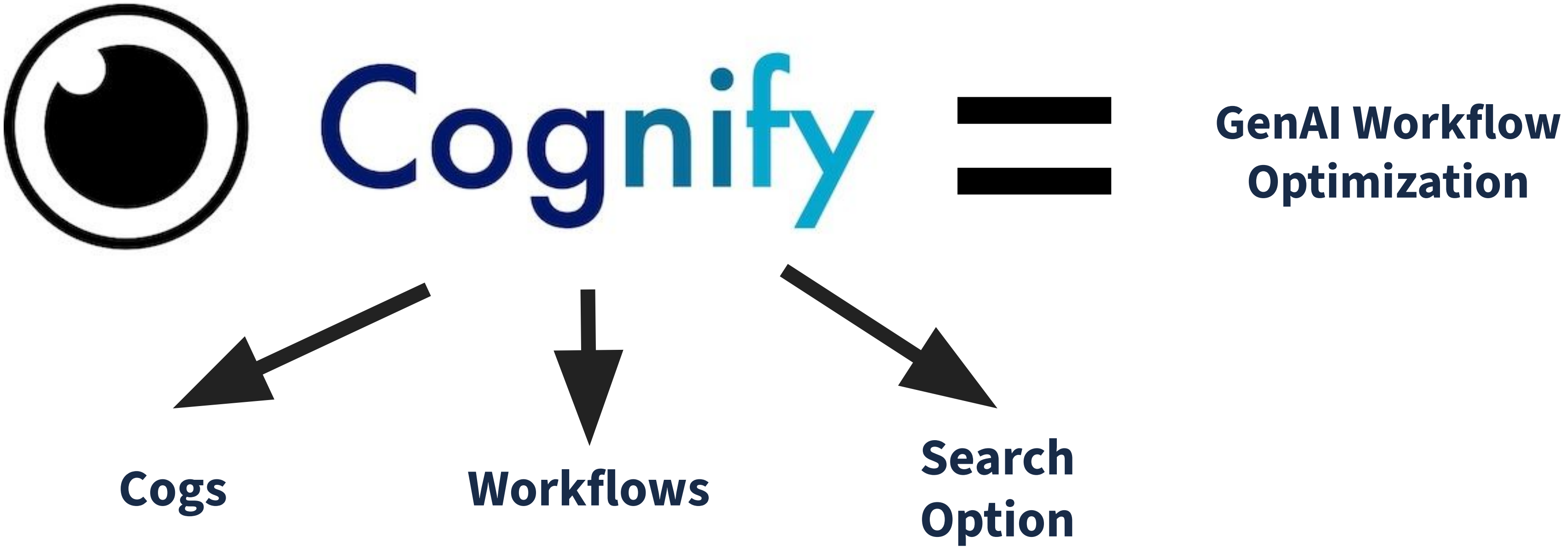

Figure 2 - Optimization Results

Can we do better?

Cognify = GenAI Workflow Optimization

Can we do better?



Cognify = GenAI Workflow Optimization

Cogs

Workflows

Search Option

New VLM Workflows! (to evaluate on)

Image Classification

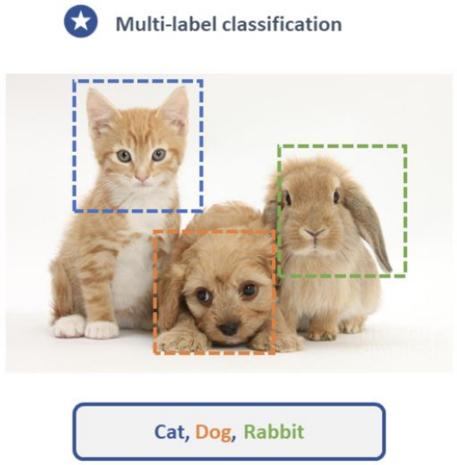
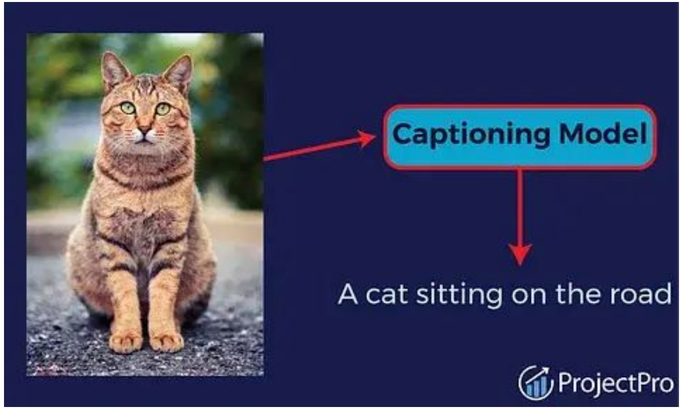


Image Captioning (Description)

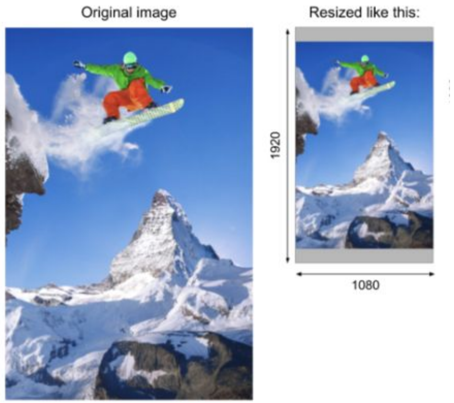


Visual Question Answering

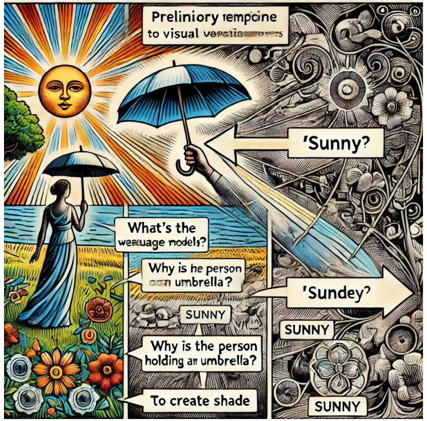
How many slices of pizza are there?
Is this a vegetarian pizza?

New VLM-Specific Cogs!

Image Compression



Vision Planning


Preliniory rempcine to visual veretionwers
'Sunny?
What's the wenuage nodels?
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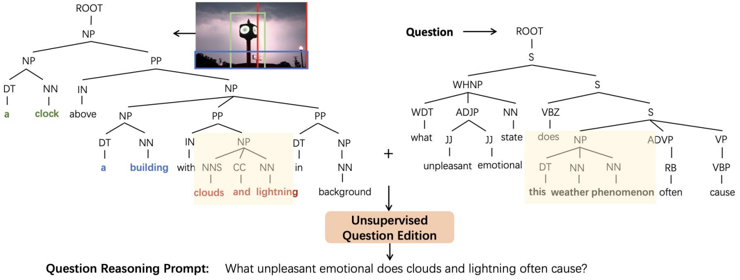
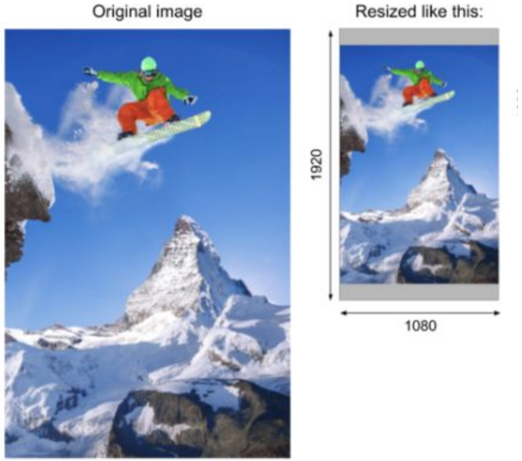
Query Disambiguation



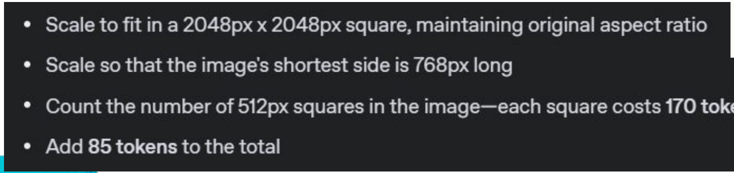
Question Reasoning Prompt: What unpleasant emotional does clouds and lightning often cause?

New VLM Cog - Image Compression

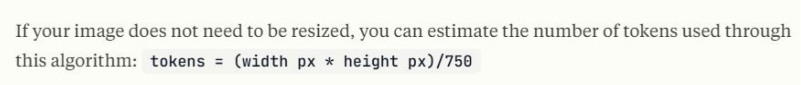


Issue:
Images get tokenized when input into VLM. Tokens cost money.

Solution:
Test few different image sizes to find a relatively cheap one which will not reduce the quality of workflow output.



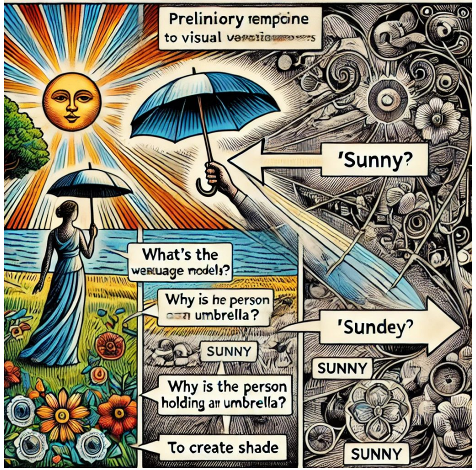
- Scale to fit in a 2048px x 2048px square, maintaining original aspect ratio
- Scale so that the image's shortest side is 768px long
- Count the number of 512px squares in the image—each square costs **170 tokens**
- Add **85 tokens** to the total



If your image does not need to be resized, you can estimate the number of tokens used through this algorithm: `tokens = (width px * height px)/750`

Bigger images = Bigger cost

New VLM Cog - Vision Planning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gpt made this, please don't read the text

Issue:

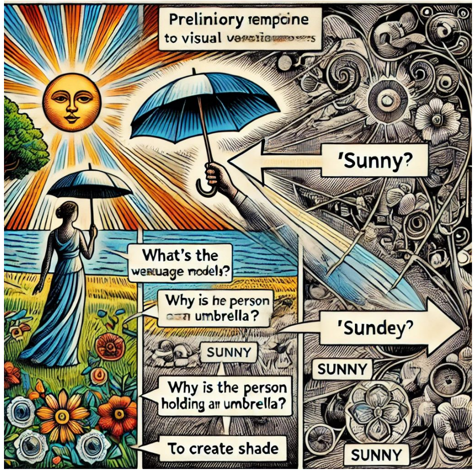
VLM responses will sometimes be more influenced by the query, ignoring the content of the image[1]

Solution:

Inject more information about the image as extra context.

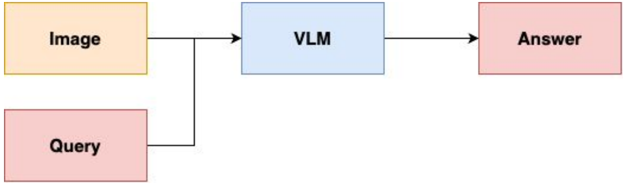
[1] Wang, Z., Chen, C., Li, P., & Liu, Y. (2023). Filling the image information gap for vqa: Prompting large language models to proactively ask questions. arXiv preprint arXiv:2311.11598.

New VLM Cog - Vision Planning



gpt made this, please don't read the text

Vanilla VLM Workflow:



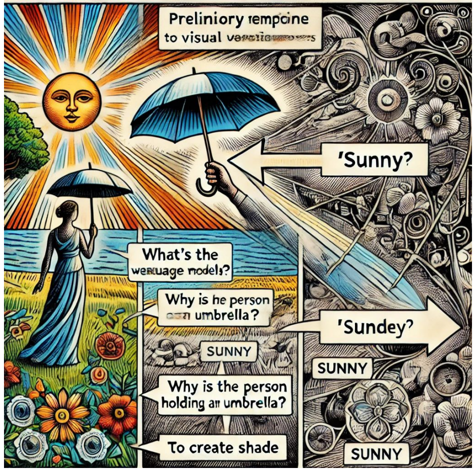
Image

Query

VLM

Answer

New VLM Cog - Vision Planning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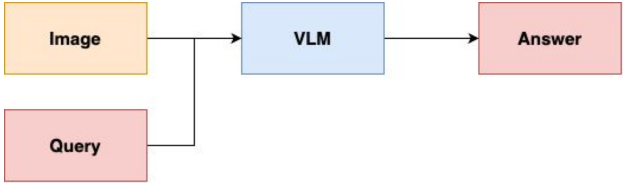
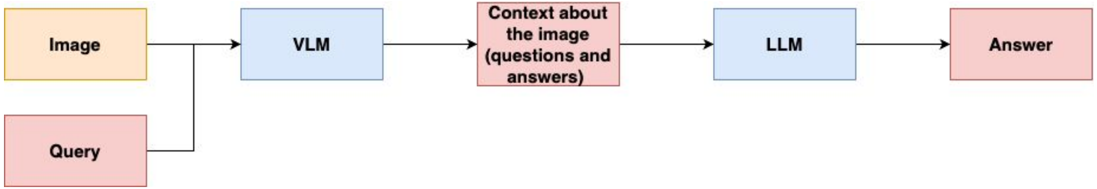
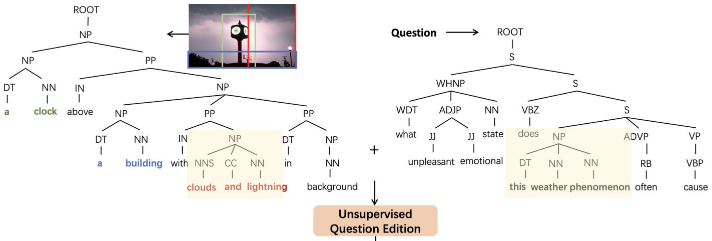
Vanilla VLM Workflow:



VLM Workflow with Vision Planning Cog:



New VLM Cog - Query Disambiguation



Question Reasoning Prompt: What unpleasant emotional does clouds and lightning often cause?

Issue:

The queries in VLM often reference objects in the image, which makes answering them harder

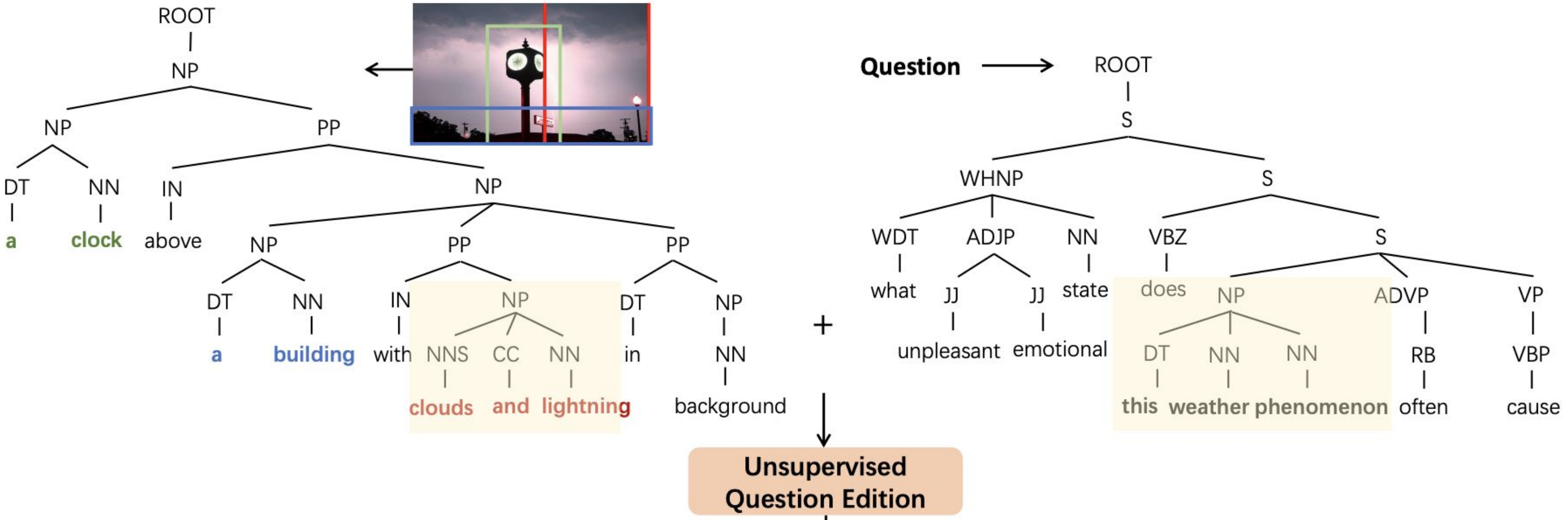
Solution:

Disambiguate query.

Example:

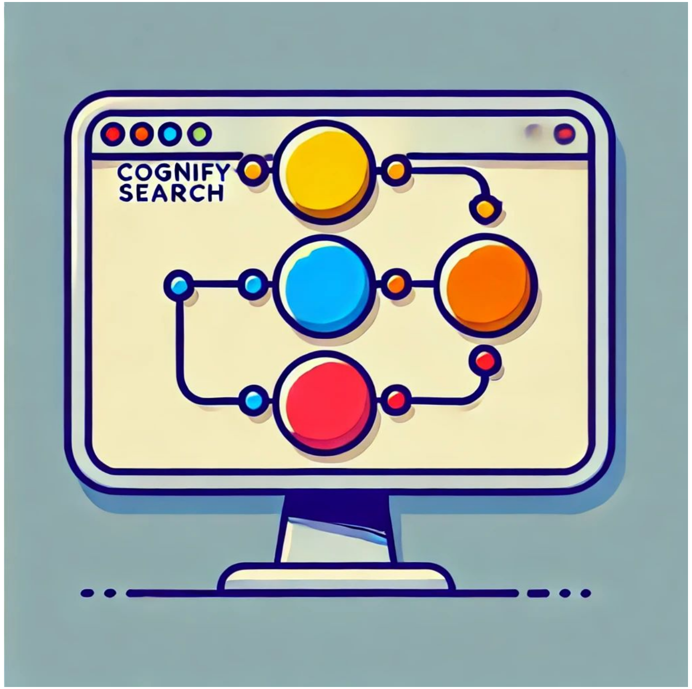
Query: “What did person in the image invent?”
Image Caption: “Einstein standing on a stand”
Disambiguated query: “What did Einstein invent?”

New VLM Cog – Query Disambiguation



Question Reasoning Prompt: What unpleasant emotional does clouds and lightning often cause?

New Search Option!



Issue:
All of our Cogs are applicable to only VLM-related task

Solution:
Create a new separate search **option** that can be applied to VLM tasks

Details:
One Layer Search.
Search created based on our (somewhat short) experience.
Search combines our newly created Cogs, together with Few Shot learning and Model Selection Cogs

Evaluation per Cog - Summary

Applications

Cogs

	Image Classification	Image Captioning (Description)	Visual Question Answering
Image Compression	Decreases cost	Decreases cost	Decreases cost
Vision Planning	?	?	?
Query Disambiguation	?	?	?

Evaluation

- ● Vanilla Cognify
- ● FewShot + ModelSelect + Image Comp.+ Vision Plan
- ● Image Comp. + Vision Plan
- ● Image Comp. + FewShot + ModelSelect
- ● Image Compression Only

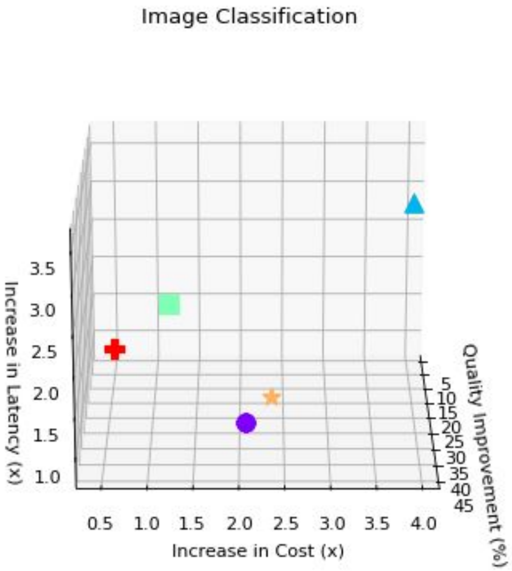


Image Classification

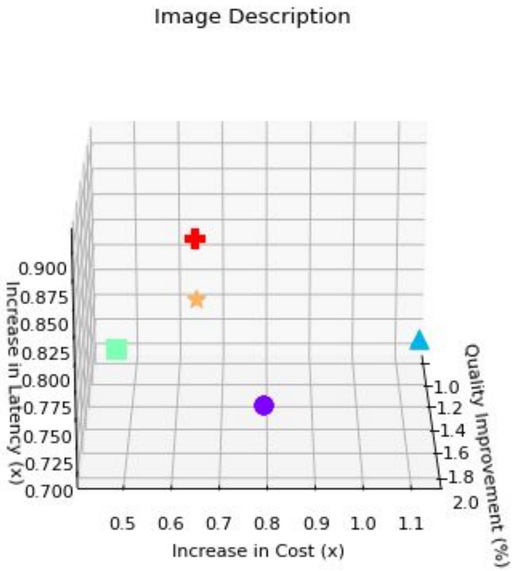
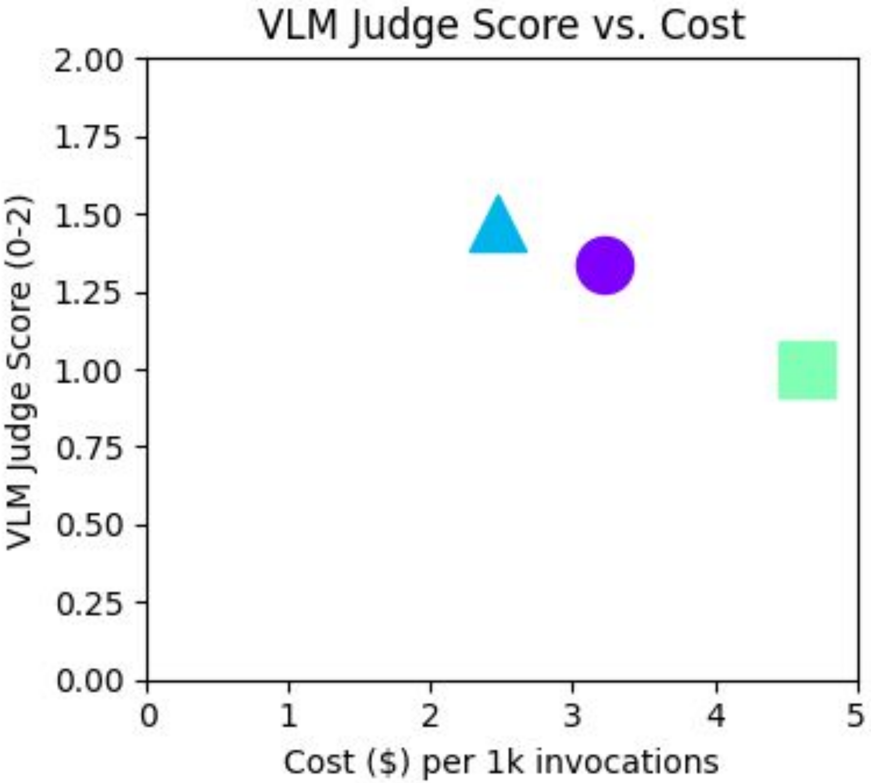


Image Description

Evaluated on Google Open Images Dataset V6

Evaluation - VQA

- ● Vanilla Cognify
- ● Image Compression + Vision Planning+ Vanilla Cognify
- ● Image Compression + Vision Planning Only

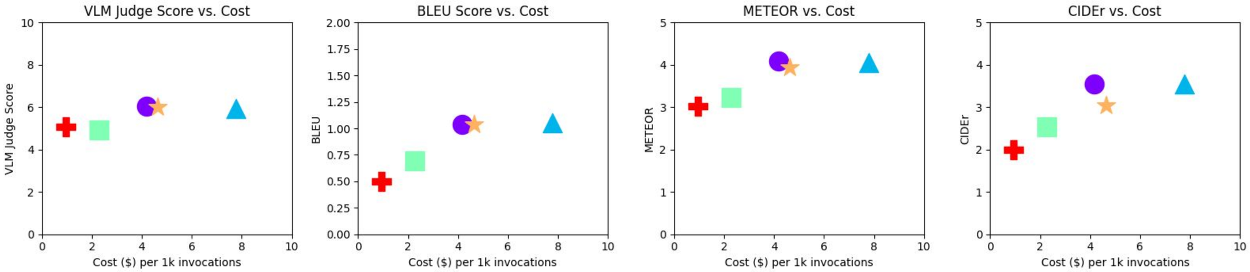


Evaluated on OK-VQA

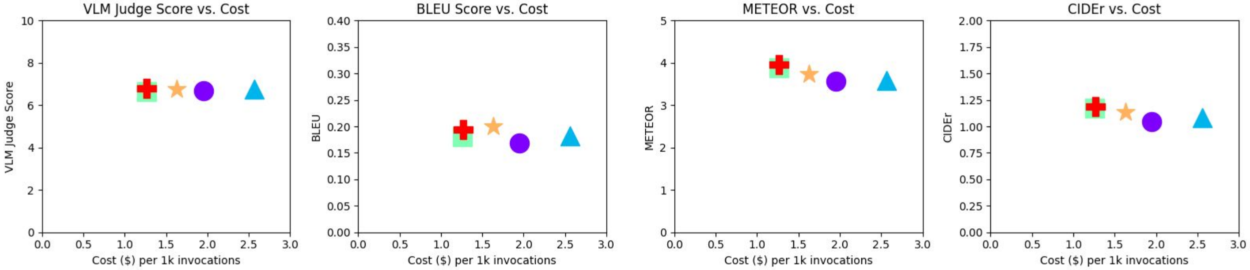
Evaluation - Other applications

- 🟣 Vanilla Cognify
- 🔵 Image Comp.+ Vision Plan + Vanilla Cognify
- 🟢 Image Comp. + Vision Plan Only
- 🟠 Image Comp. + Vanilla Cognify
- 🔴 Image Compression Only

Classification



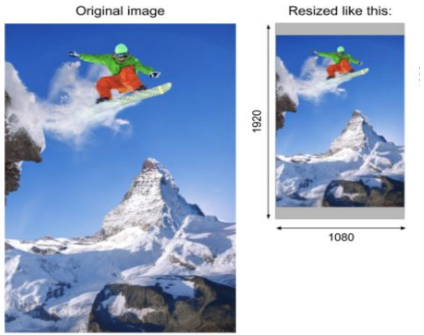
Description



Evaluated on Google Open Images Dataset V6

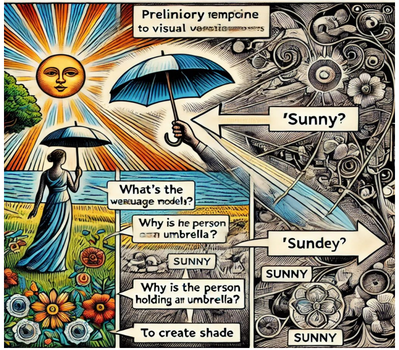
Evaluation per Cog - Summary

Image Compression



Cost & Latency

Vision Planning



Preliniory rempoine to visual ve[illegible]
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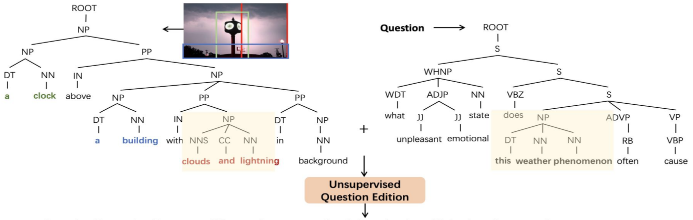
Mixed results for Quality

(slightly positive)

Query Disambiguation



Question Reasoning Prompt: What unpleasant emotional does clouds and lightning often cause?

Quality

(Still experimenting)

Challenges

- There was a **sharp learning curve** for the code-base since the documentation is user-based and not contribution focused

- **GPT API calls are costly**, and have a token rate limit per minute - intervening with our evaluation efforts. **Using our own OpenAI API credits limited depth of testing.**

- **Coming up with Cog ideas isn't straightforward**. We've read through 10s of VLM-related research papers. All of our Cogs are grounded in singular or multiple research papers - cited here: Image Compression Cog, Vision Planning Cog, Query Disambiguation Cog.

- **Not every idea works**, we have to implement and more importantly experiment, especially do ablation studies.

Next Steps

- Finish cog integration with previous cogs
  - Some cogs may be closely integrated with each other
  - Verify with other existing example workflows

- Open a PR to contribute to open source project

Q&A