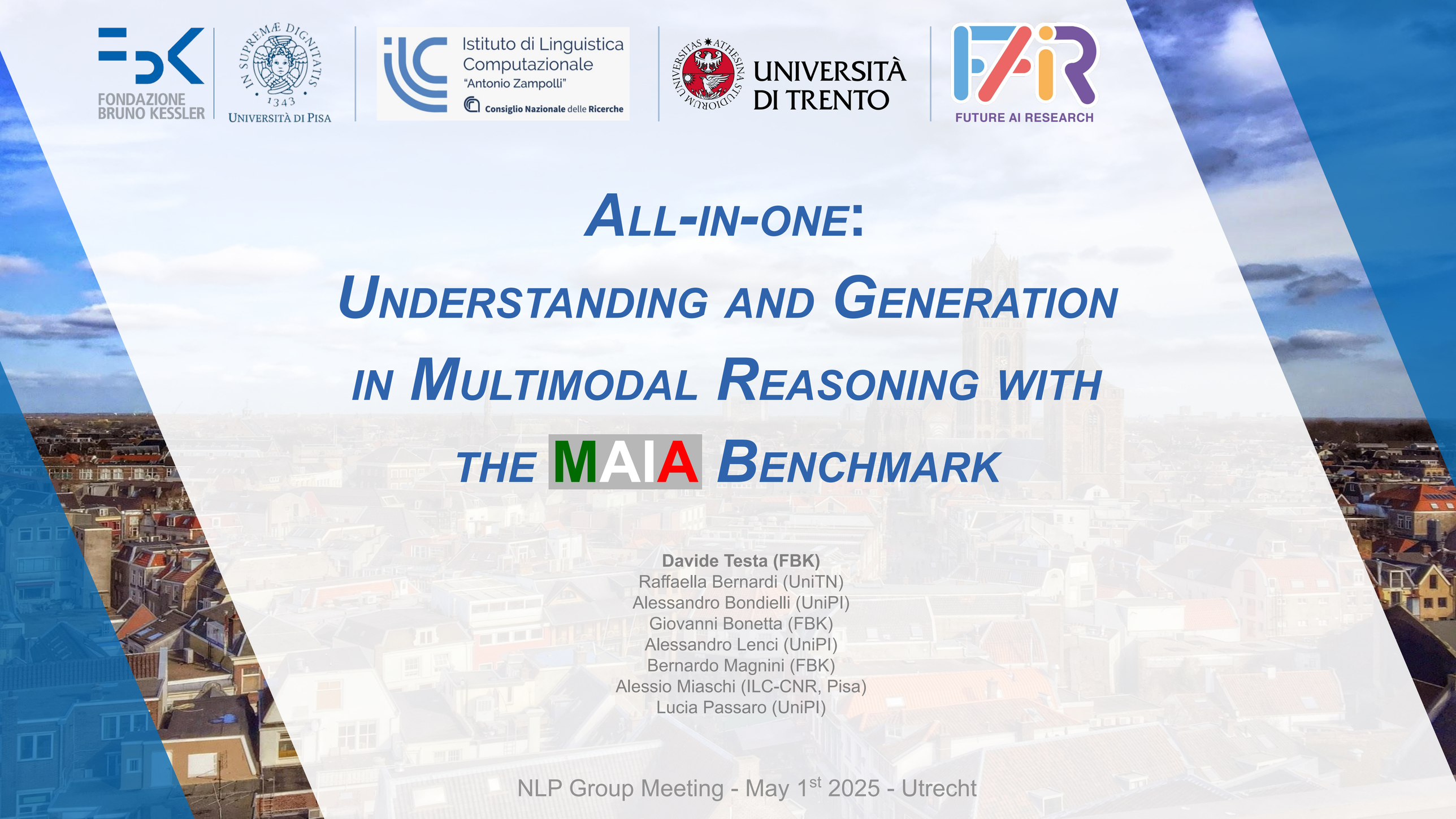

ALL-IN-ONE: UNDERSTANDING AND GENERATION IN MULTIMODAL REASONING WITH THE MAIA BENCHMARK

Davide Testa (FBK)
Raffaella Bernardi (UniTN)
Alessandro Bondielli (UniPI)
Giovanni Bonetta (FBK)
Alessandro Lenci (UniPI)
Bernardo Magnini (FBK)
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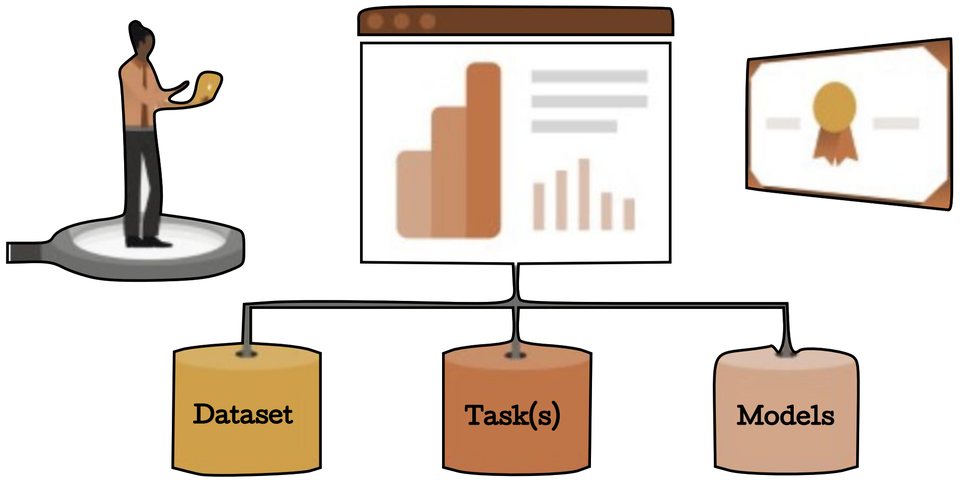
Lucia Passaro (UniPI)

NLP Group Meeting - May 1st 2025 - Utrecht

CAN AI “REASON” (AND SEE) √ THE WORLD?

1. **How** to evaluate *reasoning* in VLMs?
    - Test the understanding of a benchmark



CAN AI “REASON” (AND SEE) √ THE WORLD?

1. **How** to evaluate *reasoning* in VLMs?
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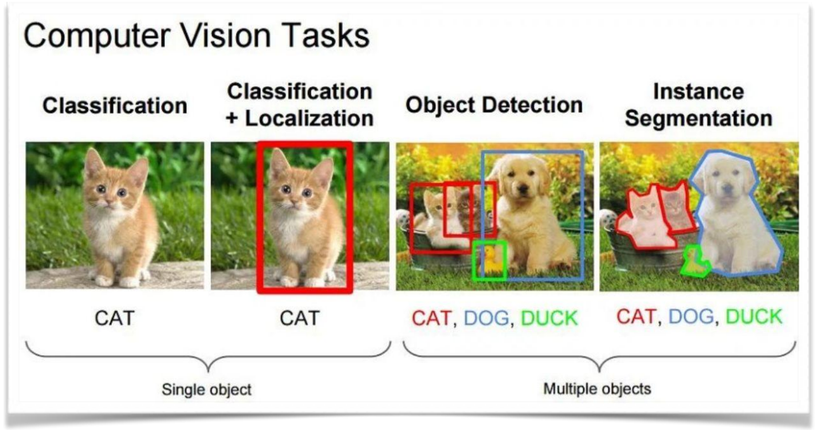
    - Task



CAN AI “REASON” (AND SEE) √ THE WORLD?

1. **How** to evaluate *reasoning* in VLMs?
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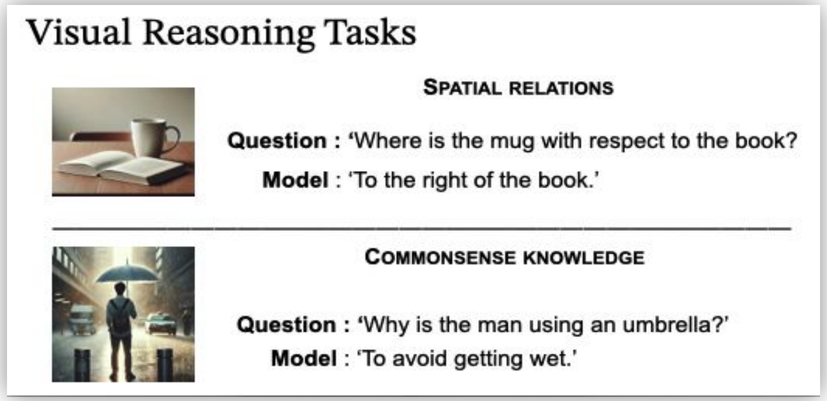
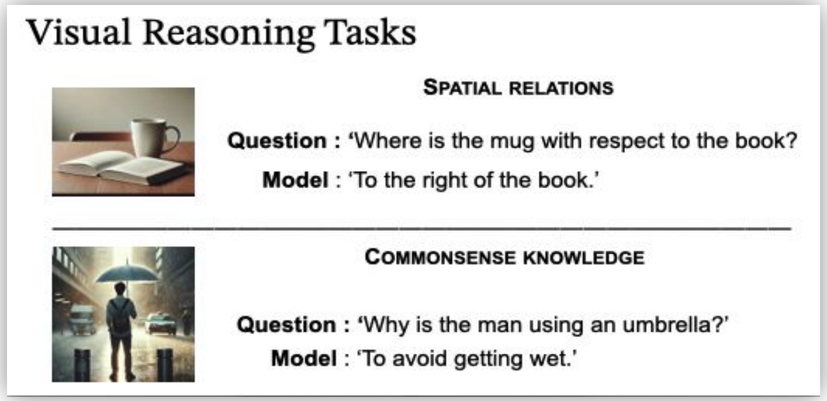
2. **What** to evaluate?
   - Task
   - Competence



CAN AI “REASON” (AND SEE) √ THE WORLD?

1. **How** to evaluate *reasoning* in VLMs?
   - Test the understanding of a benchmark
2. **What** to evaluate?
   - Task
   - Competence
   - What model does ≠ What model knows [1,2,3]

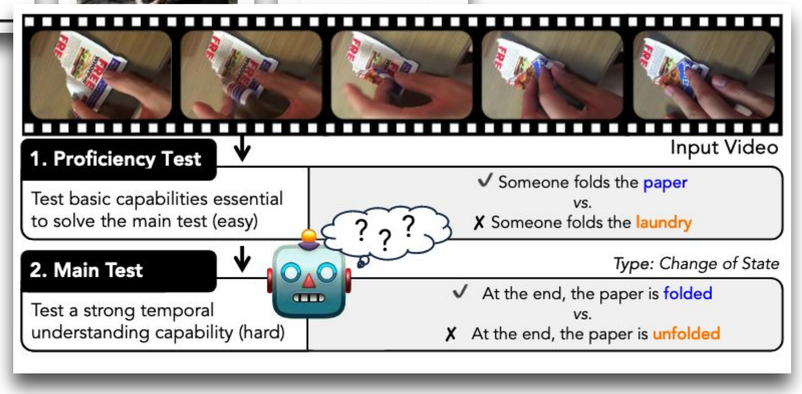


RELATED WORKS

- Several task-oriented datasets and/or benchmarks:
  - MSCOCO (*Lin et al., 2015*)
  - VQAv2 (*Goyal et al., 2017*)
  - LAION (*Schuhmann et al., 2021*)
  - LVLM-eHub (*Xu et al., 2023*)
  - MM-Bench (*Liu et al., 2023*)
  - Video-Bench (*Ning et al., 2023*)
  - …

- **Competence-oriented benchmarks are still rare!**
  - VALSE (*Parcalabescu et al., 2022*)
  - ViLMA (*Kelsen et al., 2023*)
  - BLA (*Chen et al., 2023*)
  - MMMU (*Yue et al., 2024*)
  - MMT-Bench (*Ying et al., 2024*)

VALSE

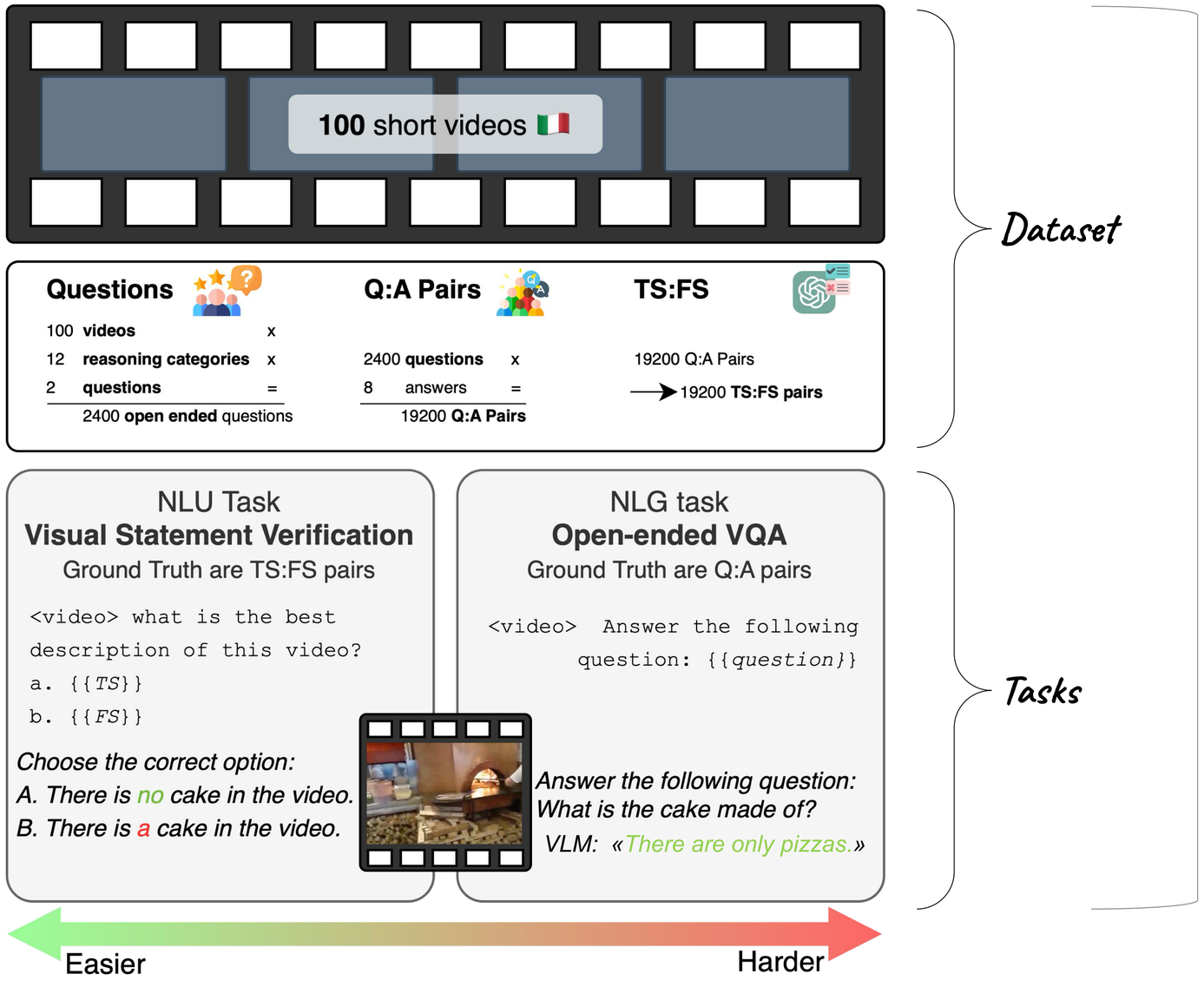


ViLMA (Temporal reasoning)

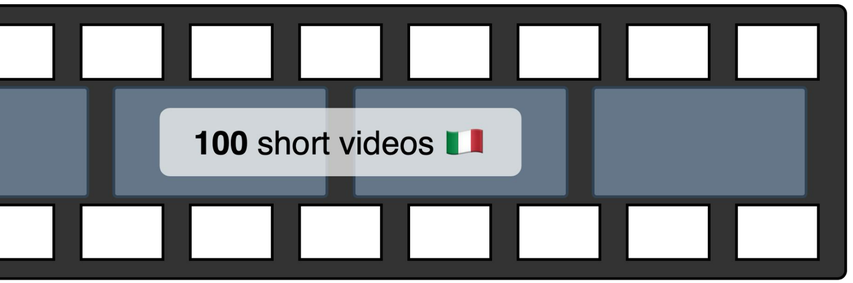
- No existing benchmarks covering a comprehensive set of semantic categories for visual linguistic reasoning
  - Especially for low-resources languages!

MAIA

(Multimodal AI Assessment)

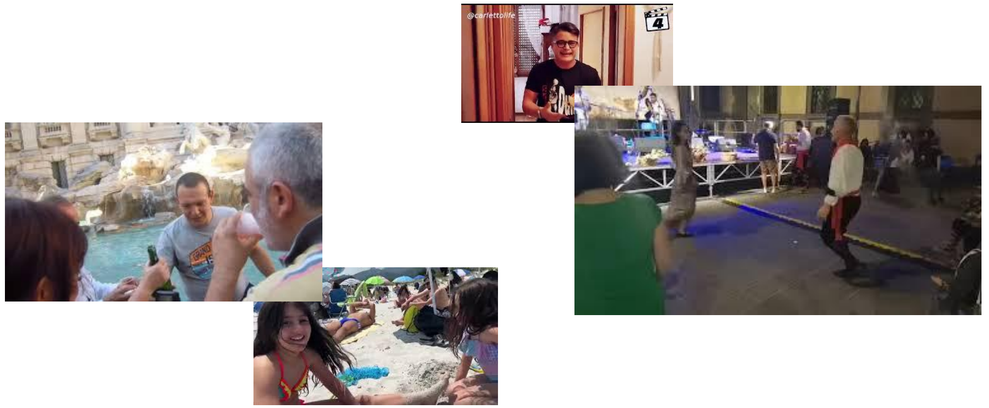


- **Competence-oriented** benchmark
- Italian Video-based Tool
- Objective:
  - Challenge VLMs on **Reasoning**
  - Assess VLMs **Robustness**
- Novelties:
  - Fine-grained **Semantic Categories**
  - **Open-ended VQA**
  - Two **aligned tasks**
  - Several **experimental settings**



MAIA Dataset

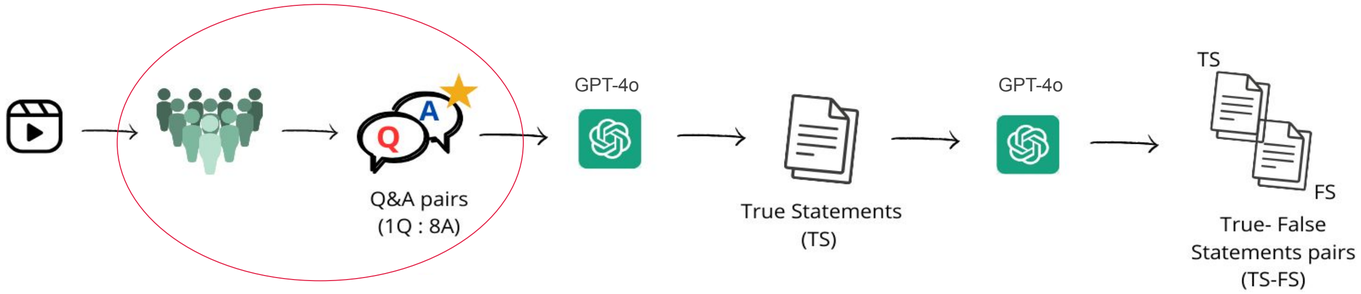
- 100 Italian videos
- Italian culture related contents
- Origin: Youtube-it [*Creative Common License*]
- Duration: ~ 30 secs
- Topics covered:
  - Locations (indoor / outdoor)
  - Food
  - Sport
  - People at work
  - Italian landscapes
  - Art
  - Italian typical events / situations



12 (LINGUISTIC) REASONING CATEGORIES

1. **COUNTERFACTUAL**: What would happen if the pizza fell?
2. **OUT-OF-SCOPE**: Where is the cat?
3. **UNCERTAINTY**: How many pizzas does the pizza maker make each day?
4. **IMPLICIT REASONING**: Which kind of pizza is the pizza maker making? x2
5. **SENTIMENT**: What is the pizza maker's attitude as he takes the pizza out of the oven?
6. **PLANNING**: What should the pizzaiolo do to revitalize the fire?
7. **SPATIAL**: Where is the pizza placed after it comes out of the oven? x2
8. **TEMPORAL**: How long does the pizza take to cook? x2
9. **CAUSAL**: Why did the mozzarella cheese on the pizza melt at the end of the video?

MAIA Dataset



Questions

100 **videos** x
12 **reasoning categories** x
2 **questions** =
2400 **open ended** questions

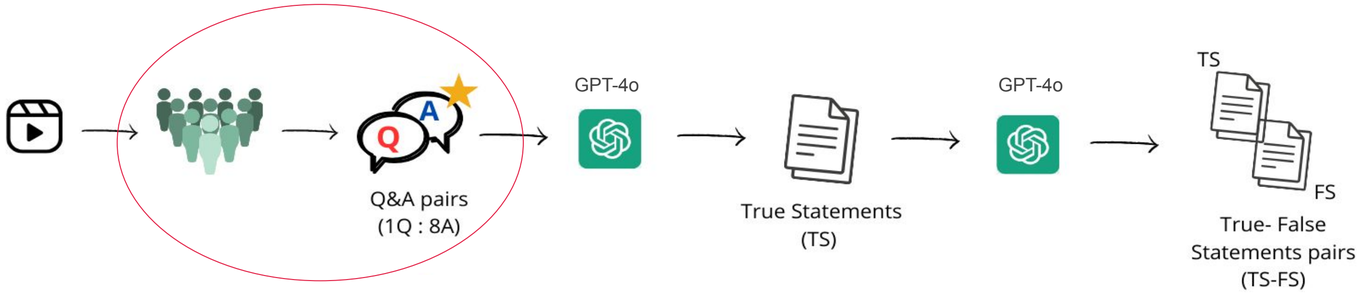
Q:A Pairs

2400 **questions** x
8 answers =
19200 **Q:A Pairs**

TS:FS

19200 Q:A Pairs
→ 19200 **TS:FS pairs**

MAIA Dataset



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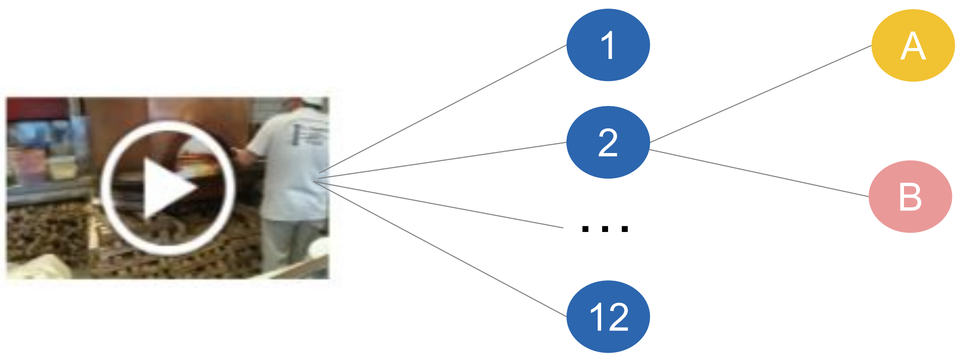
CATEGORY **QUESTION**

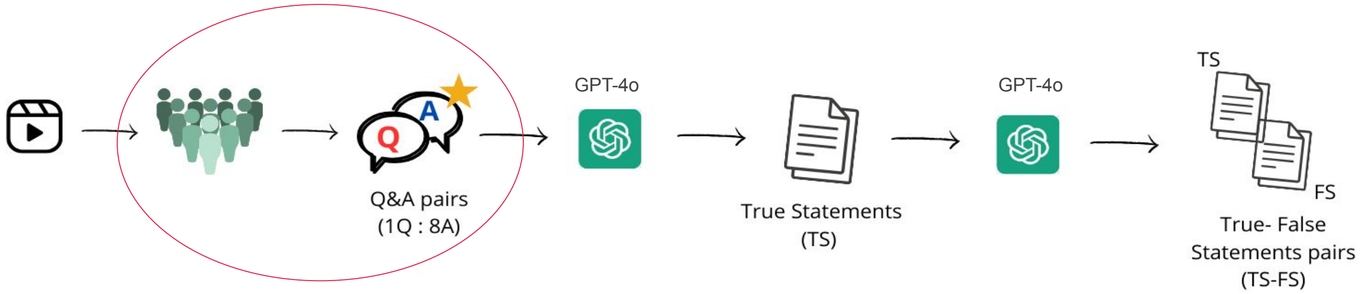


Example

CATEGORY: Spatial

Q_A : Where is the pizza maker?

MAIA Dataset



Questions		Q:A Pairs		TS:FS
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12 **reasoning categories**	x	2400 **questions**	x	19200 Q:A Pairs
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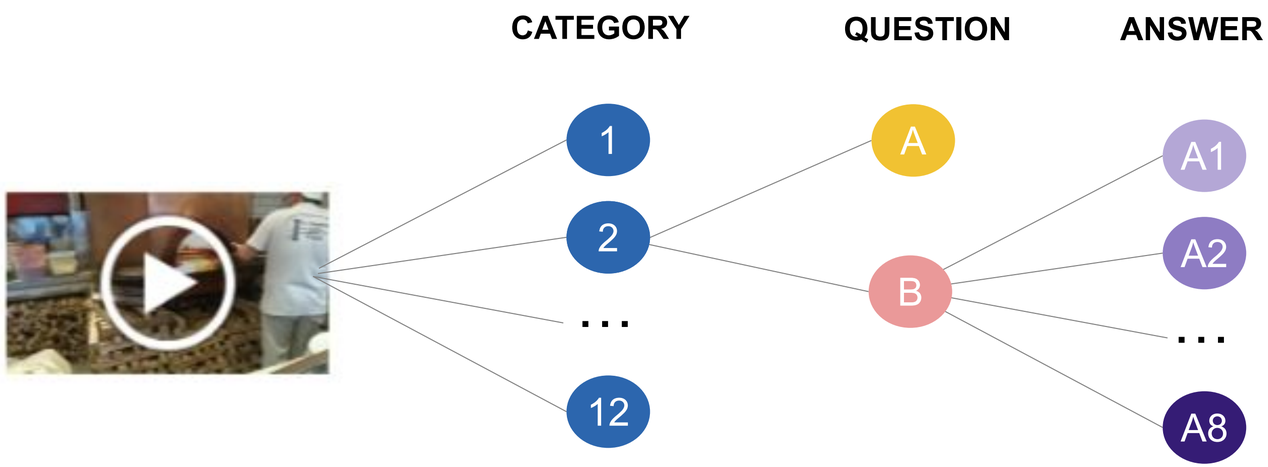


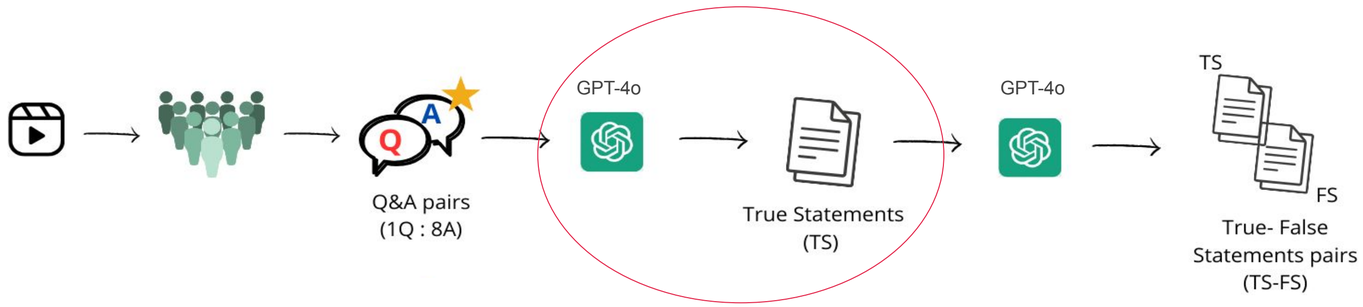
Example

CATEGORY: Spatial

Q_A : Where is the pizza maker?

A1: In front of the oven

MAIA Dataset



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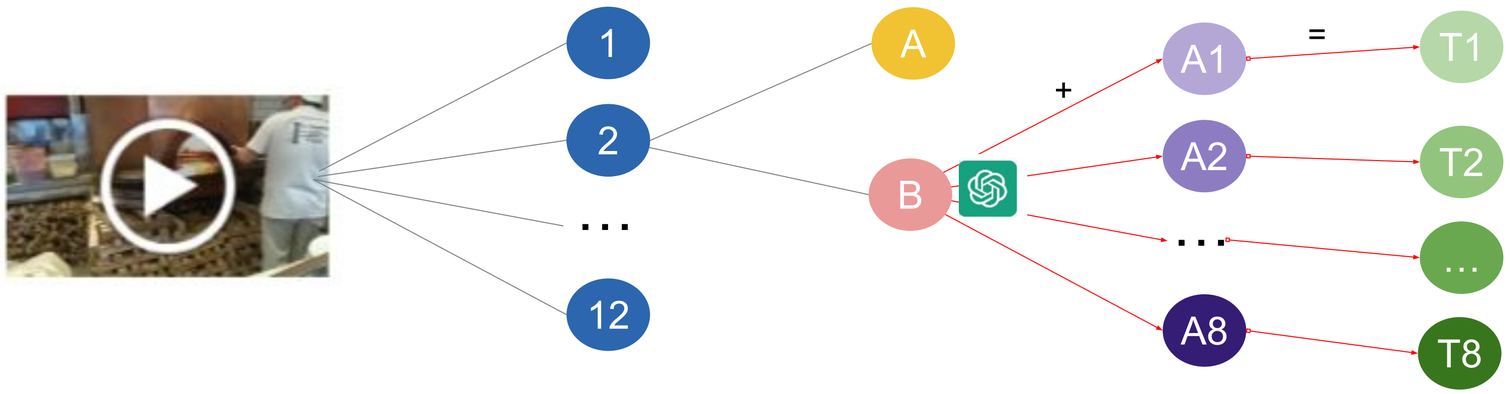


Example

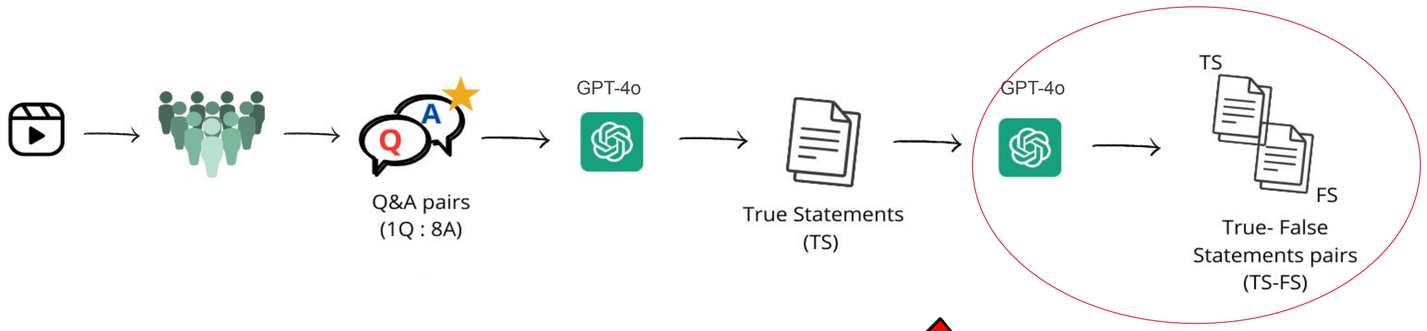
CATEGORY: Spatial

Q_A : Where is the pizza maker?

A1: In front of the oven

TS1: The pizza maker is in front of the oven

MAIA Dataset



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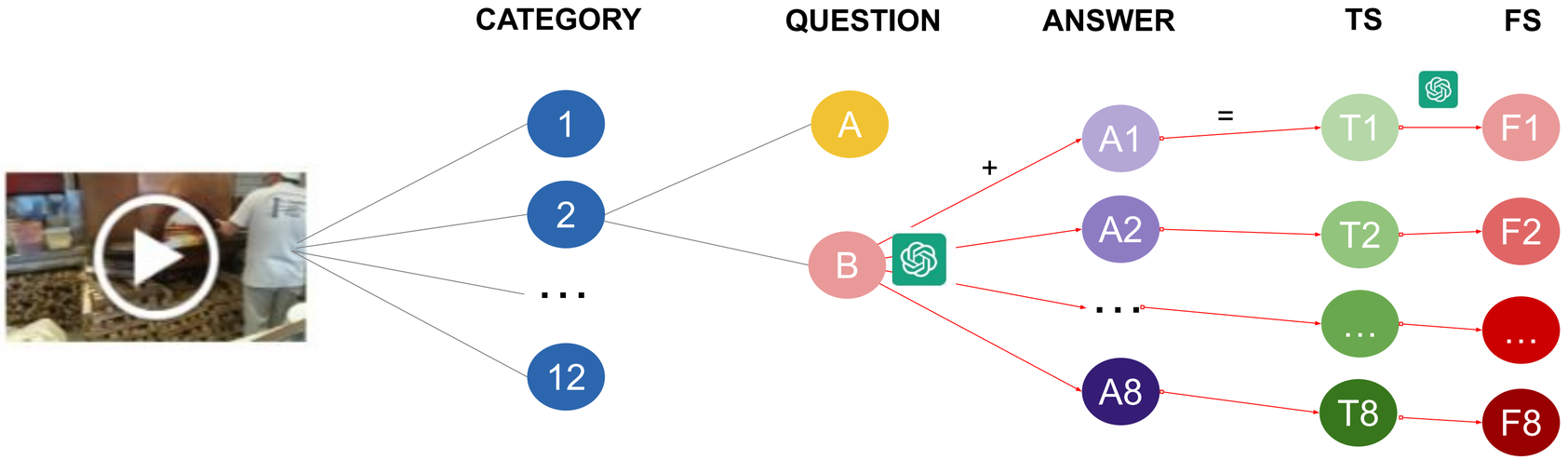


Example

CATEGORY: Spatial

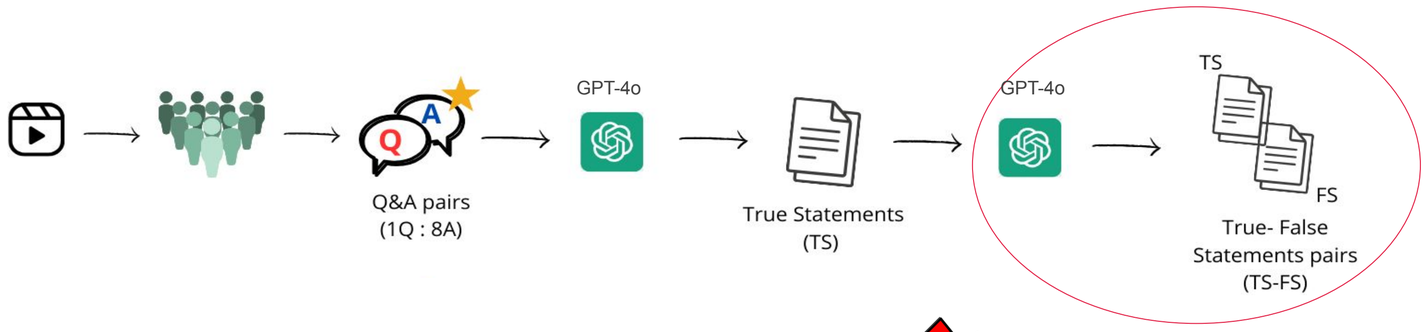
Q_A : Where is the pizza maker?

A1: In front of the oven

TS1: The pizza maker is in front of the oven

FS1: The pizza maker is behind the oven

MAIA Dataset



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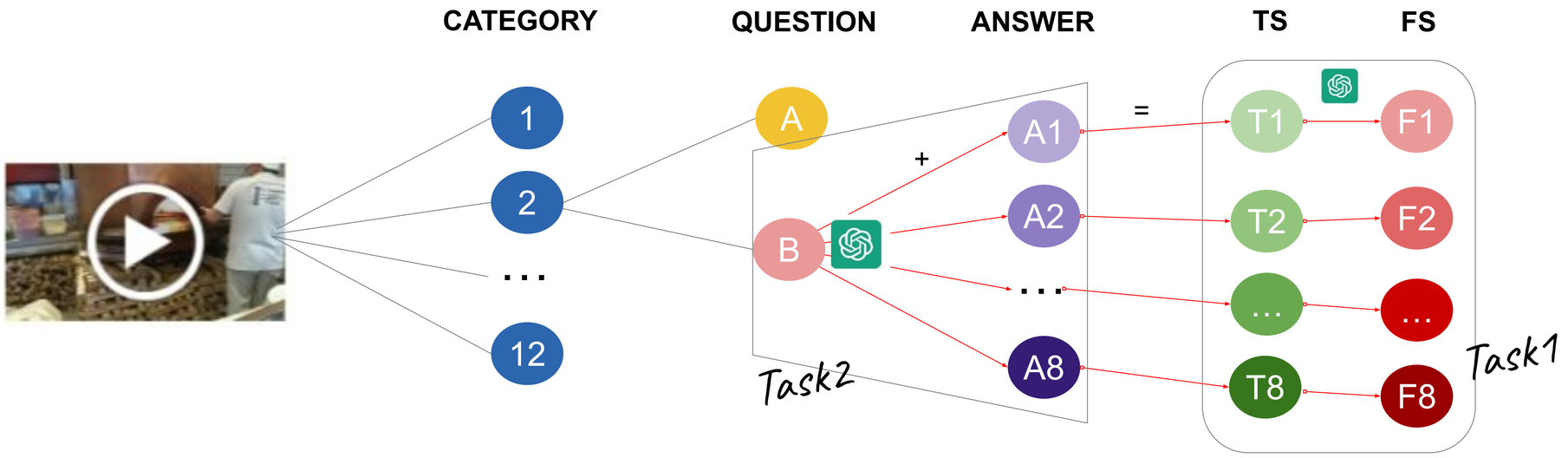


Example

CATEGORY: Spatial

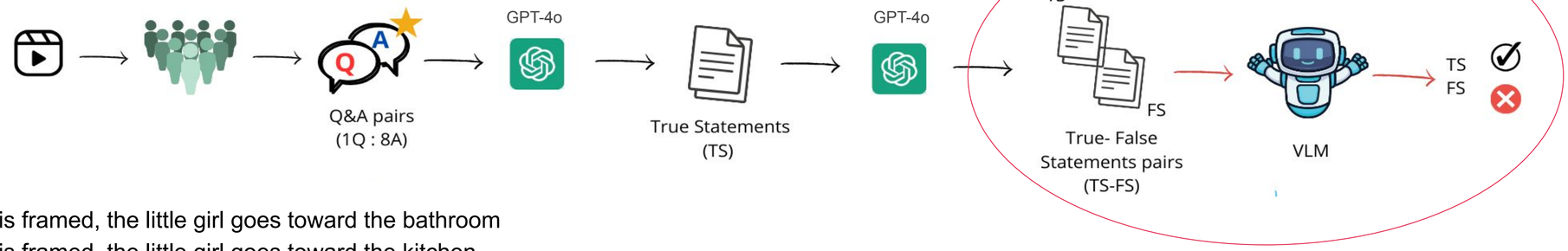
Q_A : Where is the pizza maker?

A1: In front of the oven

TS1: The pizza maker is **in front of** the oven

FS1: The pizza maker is **behind** the oven

MAIA Task1



Pool

TS: After the piano is framed, the little girl goes toward the bathroom
FS: After the piano is framed, the little girl goes toward the kitchen

TS: Following the shot of the piano, the girl goes toward the toilet
FS: Following the shot of the piano, the girl goes toward the kitchen

TS: After the piano has been framed, the little girl heads to the bathroom to get a handkerchief
FS: After the piano has been framed, the little girl heads to the living room to get a handkerchief

TS: After the piano has been shot, the little girl moves toward the bathroom to retrieve a piece of paper
FS: After the piano has been shot, the little girl moves toward the kitchen to retrieve a piece of paper

TS: The small child goes to the bathroom after the piano was framed
FS: The small child goes outside the house after the piano was framed

TS: The young girl heads to the bathroom, after the piano is framed
FS: The young girl heads to the kitchen after the piano is framed

TS: After the piano is framed, the child heads to another room
FS: After the piano is framed, the child heads to the garden

TS: After the piano is shown, the little girl moves toward the bathroom
FS: After the piano is shown, the little girl moves toward the garden

NLU Task
Visual Statement Verification
Ground Truth are TS:FS pairs

```
<video> what is the best
description of this video?
a. {{TS}}
b. {{FS}}
```

Choose the correct option:
A. There is no cake in the video.
B. There is a cake in the video.

MAIA Task2

Question : “Why are the young people dancing?”

VLM Answer : “ .... ”

Reference Answers :

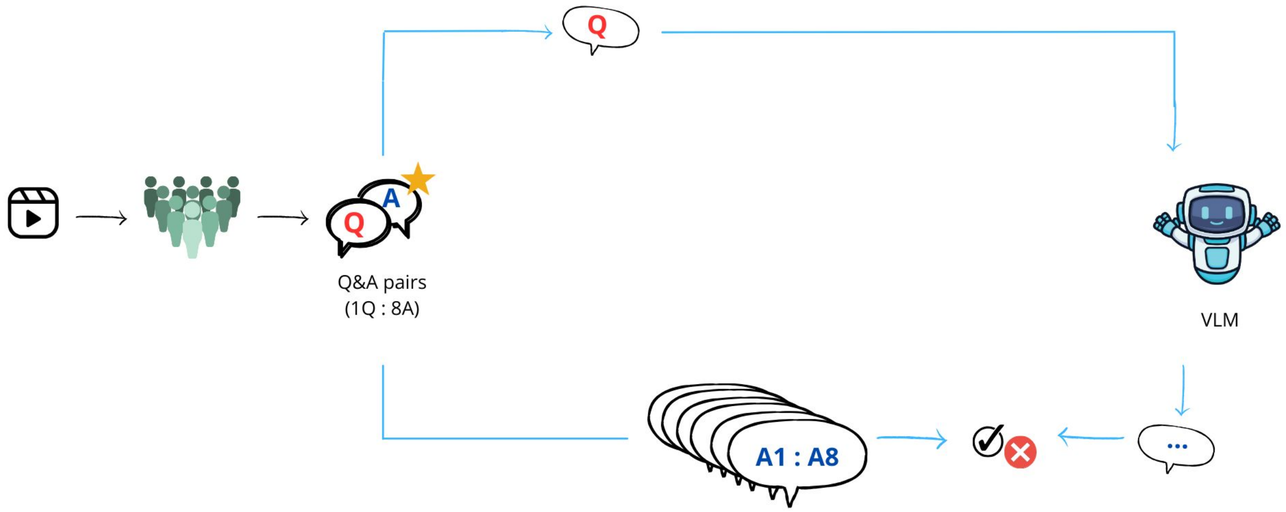
- A1→ Because of the DJ set.
- A2 → Because the DJ is playing music that people like.
- A3 → Because they are on a terrace where a DJ set is taking place.
- A4 → Because they enjoy the music.
- A5 → The kids are dancing to have fun.
- A6 → Because there is some music.
- A7 → The kids are dancing because they are at a party.
- A8 → Because there is dance music.

NLG task
Open-ended VQA
Ground Truth are Q:A pairs

```
<video>  Answer the following
question: {{question}}
```

Answer the following question: What is the cake made of?

VLM: «There are only pizzas.»



MAIA Task2

Question : “Why are the young people dancing?”

VLM Answer : “....”

Reference Answers :

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- A6 → Because there is some music.
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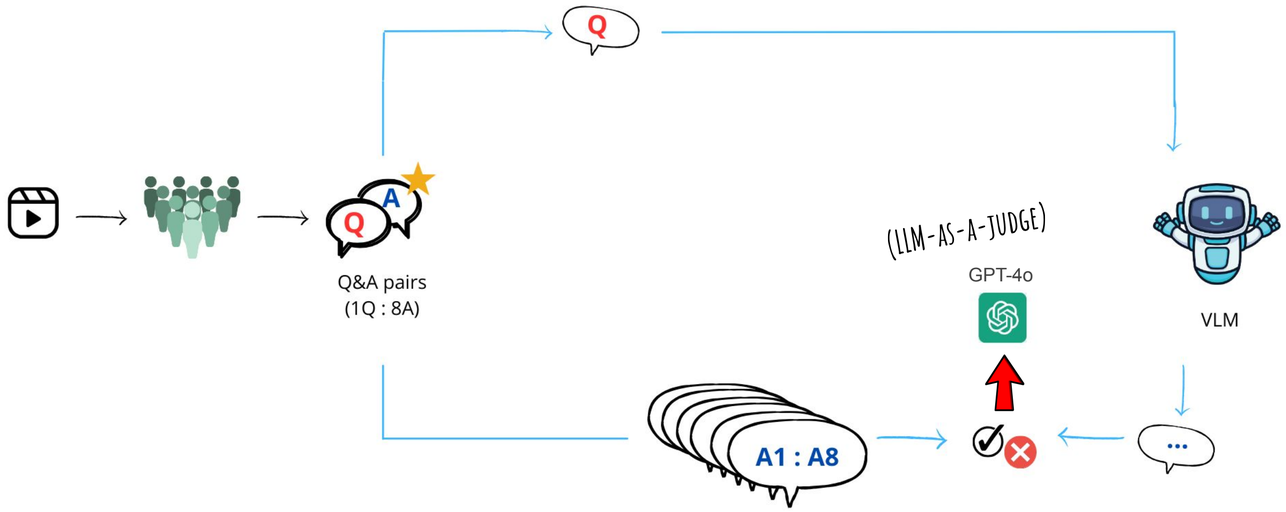
NLG task
Open-ended VQA
Ground Truth are Q:A pairs

```
<video>  Answer the following
question: {{question}}
```

Answer the following question: What is the cake made of?

VLM: «There are only pizzas.»



Task1

Single-pair accuracy

Baselines

	Models	Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
Most Probable		0.56	0.45	0.73	0.55	0.68	0.53	0.79	0.50	0.51	0.48	0.51	0.53	0.48
Black video	*InternVL2*	0.68	0.64	**0.88**	0.89	0.69	0.61	0.96	0.52	0.59	0.54	0.55	0.67	0.60
	Llava-Next-Video	0.50	0.49	0.52	0.48	0.51	0.52	0.45	0.50	0.51	0.51	0.49	0.51	0.48
	Llava-oneVision	0.59	0.55	0.48	**0.92**	0.61	0.38	0.97	0.52	0.53	0.50	0.52	0.60	0.51
	Qwen-2.5-VL	**0.73**	**0.68**	0.86	0.87	**0.75**	**0.72**	**0.98**	**0.56**	**0.62**	**0.61**	**0.65**	**0.73**	**0.70**
1-Frame	*InternVL2*	0.75	0.80	**0.87**	0.69	0.71	0.77	0.89	0.65	0.80	0.65	0.82	0.67	0.69
	Llava-Next-Video	0.61	0.68	0.76	0.49	0.63	0.75	0.40	0.59	0.65	0.59	0.70	0.56	0.53
	Llava-oneVision	0.76	0.79	0.78	0.89	0.74	0.76	0.91	0.68	0.81	0.64	0.81	**0.70**	0.67
	Qwen-2.5-VL	**0.79**	**0.81**	0.81	**0.91**	**0.75**	**0.82**	**0.70**	**0.82**	**0.96**	**0.67**	**0.82**	0.69	**0.73**
32-Frames	*InternVL2*	0.79	0.83	**0.85**	0.77	0.75	0.84	0.84	0.75	0.83	0.69	0.86	0.66	0.76
	Llava-Next-Video	0.52	0.56	0.57	0.42	0.57	0.61	0.32	0.52	0.59	0.52	0.56	0.51	0.48
	Llava-oneVision	0.81	0.87	0.78	0.88	0.76	**0.88**	0.85	0.80	0.85	0.71	0.87	0.65	0.80
	Qwen-2.5-VL	**0.84**	**0.89**	0.80	**0.89**	**0.78**	0.86	**0.92**	**0.82**	**0.88**	**0.83**	**0.90**	**0.75**	**0.81**

Task1

Single-pair accuracy

Baselines

Models		Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
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Black video	*InternVL2*	0.68	0.64	**0.88**	0.89	0.69	0.61	0.96	0.52	0.59	0.54	0.55	0.67	0.60
	Llava-Next-Video	0.50	0.49	0.52	0.48	0.51	0.52	0.45	0.50	0.51	0.51	0.49	0.51	0.48
	Llava-oneVision	0.59	0.55	0.48	**0.92**	0.61	0.38	0.97	0.52	0.53	0.50	0.52	0.60	0.51
	Qwen-2.5-VL	**0.73**	**0.68**	0.86	0.87	**0.75**	**0.72**	**0.98**	**0.56**	**0.62**	**0.61**	**0.65**	**0.73**	**0.70**
1-Frame	*InternVL2*	0.75	0.80	**0.87**	0.69	0.71	0.77	0.89	0.65	0.80	0.65	0.82	0.67	0.69
	Llava-Next-Video	0.61	0.68	0.76	0.49	0.63	0.75	0.40	0.59	0.65	0.59	0.70	0.56	0.53
	Llava-oneVision	0.76	0.79	0.78	0.89	0.74	0.76	0.91	0.68	0.81	0.64	0.81	**0.70**	0.67
	Qwen-2.5-VL	**0.79**	**0.81**	0.81	**0.91**	**0.75**	**0.82**	**0.70**	**0.82**	**0.96**	**0.67**	**0.82**	0.69	**0.73**
32-Frames	*InternVL2*	0.79	0.83	**0.85**	0.77	0.75	0.84	0.84	0.75	0.83	0.69	0.86	0.66	0.76
	Llava-Next-Video	0.52	0.56	0.57	0.42	0.57	0.61	0.32	0.52	0.59	0.52	0.56	0.51	0.48
	Llava-oneVision	0.81	0.87	0.78	0.88	0.76	**0.88**	0.85	0.80	0.85	0.71	0.87	0.65	0.80
	Qwen-2.5-VL	**0.84**	**0.89**	0.80	**0.89**	**0.78**	0.86	**0.92**	**0.82**	**0.88**	**0.83**	**0.90**	**0.75**	**0.81**

Task1

aggregate pool accuracy

Baselines

Models		Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
Most Probable		0.05	0.01	0.12	0.04	0.04	0.02	0.17	0.04	0.04	0.01	0.01	0.03	0.04
Black video	*InternVL2*	0.18	0.07	**0.40**	**0.43**	0.08	0.06	0.73	0.03	0.03	0.03	0.02	**0.20**	0.05
	Llava-Next-Video	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01
	Llava-oneVision	0.14	0.01	0.04	0.59	0.04	0.00	0.83	0.04	0.04	0.01	0.01	0.06	0.01
	Qwen-2.5-VL	**0.22**	**0.11**	0.36	0.41	**0.17**	**0.16**	**0.87**	**0.04**	**0.06**	**0.09**	**0.07**	0.15	**0.16**
1-Frame	*InternVL2*	0.28	0.32	**0.41**	0.32	0.11	0.33	0.47	0.17	0.33	0.15	**0.39**	0.11	0.21
	Llava-Next-Video	0.08	0.12	0.23	0.01	0.03	0.21	0.01	0.06	0.11	0.03	0.14	0.01	0.03
	Llava-oneVision	0.32	0.35	0.29	0.64	0.14	0.32	0.65	0.21	0.35	0.12	0.36	0.15	0.20
	Qwen-2.5-VL	**0.36**	**0.36**	0.28	**0.64**	**0.16**	**0.44**	**0.81**	**0.25**	0.39	**0.14**	**0.39**	**0.21**	**0.24**
32-Frames	*InternVL2*	0.31	0.41	**0.35**	0.38	0.12	0.42	0.39	0.28	0.38	0.18	0.43	0.11	0.30
	Llava-Next-Video	0.03	0.04	0.04	0.01	0.03	0.09	0.00	0.01	0.06	0.01	0.04	0.01	0.01
	Llava-oneVision	0.38	0.51	0.21	0.61	0.19	**0.51**	0.45	0.39	0.47	0.26	0.48	0.11	**0.33**
	Qwen-2.5-VL	**0.44**	**0.53**	0.29	**0.63**	**0.23**	0.50	**0.67**	**0.43**	**0.56**	**0.28**	**0.55**	**0.28**	0.32

Task1

Single-pair accuracy

Baselines

	Models	Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
Most Probable		0.56	0.45	0.73	0.55	0.68	0.53	0.79	0.50	0.51	0.48	0.51	0.53	0.48
Black video	*InternVL2*	0.68	0.64	**0.88**	0.89	0.69	0.61	0.96	0.52	0.59	0.54	0.55	0.67	0.60
	Llava-Next-Video	0.50	0.49	0.52	0.48	0.51	0.52	0.45	0.50	0.51	0.51	0.49	0.51	0.48
	Llava-oneVision	0.59	0.55	0.48	**0.92**	0.61	0.38	0.97	0.52	0.53	0.50	0.52	0.60	0.51
	Qwen-2.5-VL	**0.73**	**0.68**	0.86	0.87	**0.75**	**0.72**	**0.98**	**0.56**	**0.62**	**0.61**	**0.65**	**0.73**	**0.70**
1-Frame	*InternVL2*	0.75	0.80	**0.87**	0.69	0.71	0.77	0.89	0.65	0.80	0.65	0.82	0.67	0.69
	Llava-Next-Video	0.61	0.68	0.76	0.49	0.63	0.75	0.40	0.59	0.65	0.59	0.70	0.56	0.53
	Llava-oneVision	0.76	0.79	0.78	0.89	0.74	0.76	0.91	0.68	0.81	0.64	0.81	**0.70**	0.67
	Qwen-2.5-VL	**0.79**	**0.81**	0.81	**0.91**	**0.75**	**0.82**	**0.70**	**0.82**	**0.96**	**0.67**	**0.82**	0.69	**0.73**
32-Frames	*InternVL2*	0.79	0.83	**0.85**	0.77	0.75	0.84	0.84	0.75	0.83	0.69	0.86	0.66	0.76
	Llava-Next-Video	0.52	0.56	0.57	0.42	0.57	0.61	0.32	0.52	0.59	0.52	0.56	0.51	0.48
	Llava-oneVision	0.81	0.87	0.78	0.88	0.76	**0.88**	0.85	0.80	0.85	0.71	0.87	0.65	0.80
	Qwen-2.5-VL	**0.84**	**0.89**	0.80	**0.89**	**0.78**	0.86	**0.92**	**0.82**	**0.88**	**0.83**	**0.90**	**0.75**	**0.81**

Task2

LLM-as-a-judge

Baselines

	Models	Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
Black video	*InternVL2*	0.37	0.42	0.60	0.30	**0.68**	0.43	0.08	0.21	0.23	**0.36**	**0.25**	**0.55**	**0.25**
	Llava-Next-Video	0.27	0.43	0.47	**0.30**	0.40	0.33	**0.51**	0.21	0.12	0.16	0.04	0.12	0.16
	Llava-oneVision	**0.40**	**0.66**	0.68	0.29	0.60	0.60	0.28	**0.26**	**0.24**	**0.36**	0.18	0.37	0.23
	Qwen-2.5-VL	0.35	0.36	**0.69**	0.08	0.54	**0.74**	0.23	0.24	0.19	0.30	0.19	0.41	0.20
1-Frame	*InternVL2*	0.44	0.57	0.65	0.21	0.65	0.60	0.10	0.33	0.38	0.39	0.47	0.53	0.35
	Llava-Next-Video	0.32	0.30	0.56	0.20	0.46	0.60	0.29	0.18	0.32	0.24	0.27	0.20	0.19
	Llava-oneVision	0.50	**0.59**	**0.78**	0.15	**0.66**	0.74	0.37	**0.39**	**0.54**	**0.39**	0.51	0.54	0.33
	Qwen-2.5-VL	**0.51**	0.56	0.76	**0.32**	0.60	**0.79**	**0.40**	0.35	0.50	0.38	**0.53**	**0.55**	**0.38**
32-Frames	*InternVL2*	0.49	0.54	0.68	0.28	0.64	0.62	0.11	0.45	0.48	0.47	0.51	**0.57**	0.46
	Llava-Next-Video	0.33	0.37	0.38	0.16	0.42	0.48	0.27	0.24	0.37	0.29	0.39	0.32	0.29
	Llava-oneVision	0.53	0.67	0.79	0.11	**0.65**	0.79	0.23	**0.55**	0.56	**0.51**	0.62	0.40	0.46
	Qwen-2.5-VL	**0.61**	**0.71**	**0.80**	**0.43**	0.60	**0.85**	**0.55**	**0.55**	**0.60**	0.50	**0.70**	0.54	**0.53**

Task1

Single-pair accuracy

Baselines

	Models	Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
Most Probable		0.56	0.45	0.73	0.55	0.68	0.53	0.79	0.50	0.51	0.48	0.51	0.53	0.48
Black video	*InternVL2*	0.68	0.64	**0.88**	0.89	0.69	0.61	0.96	0.52	0.59	0.54	0.55	0.67	0.60
	Llava-Next-Video	0.50	0.49	0.52	0.48	0.51	0.52	0.45	0.50	0.51	0.51	0.49	0.51	0.48
	Llava-oneVision	0.59	0.55	0.48	**0.92**	0.61	0.38	0.97	0.52	0.53	0.50	0.52	0.60	0.51
	Qwen-2.5-VL	**0.73**	**0.68**	0.86	0.87	**0.75**	**0.72**	**0.98**	**0.56**	**0.62**	**0.61**	**0.65**	**0.73**	**0.70**
1-Frame	*InternVL2*	0.75	0.80	**0.87**	0.69	0.71	0.77	0.89	0.65	0.80	0.65	0.82	0.67	0.69
	Llava-Next-Video	0.61	0.68	0.76	0.49	0.63	0.75	0.40	0.59	0.65	0.59	0.70	0.56	0.53
	Llava-oneVision	0.76	0.79	0.78	0.89	0.74	0.76	0.91	0.68	0.81	0.64	0.81	**0.70**	0.67
	Qwen-2.5-VL	**0.79**	**0.81**	0.81	**0.91**	**0.75**	**0.82**	**0.70**	**0.82**	**0.96**	**0.67**	**0.82**	0.69	**0.73**
32-Frames	*InternVL2*	0.79	0.83	**0.85**	0.77	0.75	0.84	0.84	0.75	0.83	0.69	0.86	0.66	0.76
	Llava-Next-Video	0.52	0.56	0.57	0.42	0.57	0.61	0.32	0.52	0.59	0.52	0.56	0.51	0.48
	Llava-oneVision	0.81	0.87	0.78	0.88	0.76	**0.88**	0.85	0.80	0.85	0.71	0.87	0.65	0.80
	Qwen-2.5-VL	**0.84**	**0.89**	0.80	**0.89**	**0.78**	0.86	**0.92**	**0.82**	**0.88**	**0.83**	**0.90**	**0.75**	**0.81**

Task2

LLM-as-a-judge

Baselines

	Models	Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
Black video	*InternVL2*	0.37	0.42	0.60	0.30	**0.68**	0.43	0.08	0.21	0.23	**0.36**	**0.25**	**0.55**	**0.25**
	Llava-Next-Video	0.27	0.43	0.47	**0.30**	0.40	0.33	**0.51**	0.21	0.12	0.16	0.04	0.12	0.16
	Llava-oneVision	**0.40**	**0.66**	0.68	0.29	0.60	0.60	0.28	**0.26**	**0.24**	**0.36**	0.18	0.37	0.23
	Qwen-2.5-VL	0.35	0.36	**0.69**	0.08	0.54	**0.74**	0.23	0.24	0.19	0.30	0.19	0.41	0.20
1-Frame	*InternVL2*	0.44	0.57	0.65	0.21	0.65	0.60	0.10	0.33	0.38	0.39	0.47	0.53	0.35
	Llava-Next-Video	0.32	0.30	0.56	0.20	0.46	0.60	0.29	0.18	0.32	0.24	0.27	0.20	0.19
	Llava-oneVision	0.50	**0.59**	**0.78**	0.15	**0.66**	0.74	0.37	**0.39**	**0.54**	**0.39**	0.51	0.54	0.33
	Qwen-2.5-VL	**0.51**	0.56	0.76	**0.32**	0.60	**0.79**	**0.40**	0.35	0.50	0.38	**0.53**	**0.55**	**0.38**
32-Frames	*InternVL2*	0.49	0.54	0.68	0.28	0.64	0.62	0.11	0.45	0.48	0.47	0.51	**0.57**	0.46
	Llava-Next-Video	0.33	0.37	0.38	0.16	0.42	0.48	0.27	0.24	0.37	0.29	0.39	0.32	0.29
	Llava-oneVision	0.53	0.67	0.79	0.11	**0.65**	0.79	0.23	**0.55**	0.56	**0.51**	0.62	0.40	0.46
	Qwen-2.5-VL	**0.61**	**0.71**	**0.80**	**0.43**	0.60	**0.85**	**0.55**	**0.55**	**0.60**	0.50	**0.70**	0.54	**0.53**

All-in-one

$$Agg\text{-}Acc(M,q) = \begin{cases} 1 & \text{if } \forall (TS, FS) \in S_q, \\ & a_M(TS, FS) = TS \\ & \text{and } a_M(q) \text{ is correct} \\ 0 & \text{otherwise} \end{cases}$$

	Model	Avg.	Causal	Counterfactual	Out-of-Scope	Planning	Sentiment	Uncertainty	Implicit		Spatial		Temporal	
									Partial	*Total*	*Partial*	*Total*	*Duration*	*Partial*
Black video	*Qwen-2.5-VL*	0.09	0.05	**0.29**	0.05	0.09	0.14	0.02	0.02	0.20	0.01	0.03	0.10	0.04
1-Frame	*Qwen-2.5-VL*	0.22	0.25	0.23	0.25	0.11	0.40	0.33	0.16	0.28	0.06	0.28	0.17	0.14
32-Frames	*Qwen-2.5-VL*	**0.31**	**0.41**	0.26	**0.31**	**0.16**	**0.48**	**0.41**	**0.31**	**0.38**	**0.19**	**0.44**	**0.22**	**0.19**

MAIA

CASE-STUDY: Multimodal Hallucinations

Category: Out-of-scope

Task1 : 8/8 Correct → Pool consistency

TS: In the scene there is no dog at the door
FS: In the scene there is a dog at the door

TS: In the movie there are no animals at the door
FS: In the movie there are animals at the door

TS: In the movie there is no doggie at the doorway
FS: In the movie there is a doggie at the doorway

TS: No pets are seen in front of the door
FS: Some Pets are seen in front of the door

TS: There are no dogs at the door in the video
FS: There are dogs at the door in the video

TS: No dog appears in the entrance area
FS: A dog appears in the entrance area

TS: No pets are visible in the video near the front door of the house
FS: A pet is visible in the video near the front door of the house

TS: In the video clip there is no dog at the door
FS: In the video clip there is a dog at the door

Task2 : Wrong Answer

Question : "What color is the dog at the door?"

VLM Answer : "**The dog at the door is black**."

Reference Answers:

- ★ A1 → There is no dog
- ★ A2 → There are no animals at the door
- ★ A3 → There is no doggie in the film
- ★ A4 → There is no dog in the scene
- ★ A5 → No pets are seen in front of the door
- ★ A6 → There is no dog in the video
- ★ A7 → No dog appears in the entrance area.
- ★ A8 → No pets are visible near the front door of the house

MAIA

Take-home messages

VLMs:

- Powerful:
  - effective cross-modal integration : outperform LLM baseline
  - *Unimodal collapse* phenomenon: less visible than in *Parcalabescu et al., 2022* , *Kelsen et al., 2023*

- Fragile:

  - Semantic Consistency + Robustness:

    → within tasks (Pool inconsistency in Task1)
    → between tasks (*Open-ended VQA* Vs. *Multiple Choice*)

  - Multimodal Hallucinations (*Qwen2.5VL*: 0.43 out-of-scope acc. in Task2-32F)

Thank you for the attention!