MMWorld: Towards Multi-discipline Multi-faceted World Model Evaluation in Videos

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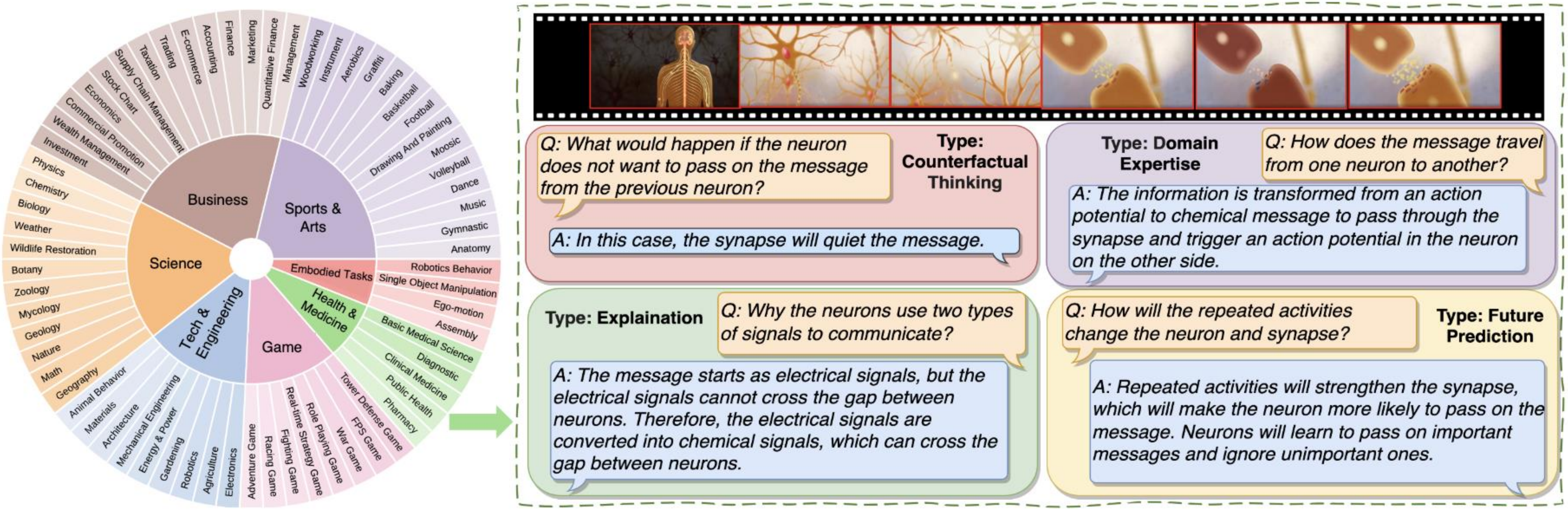
Motivation

Multimodal Language Language Models (MLLMs) demonstrate the emerging abilities of "world models"---interpreting and reasoning about complex real-world dynamics. To assess these abilities, we posit videos are the ideal medium, as they encapsulate rich representations of real-world dynamics and causalities.

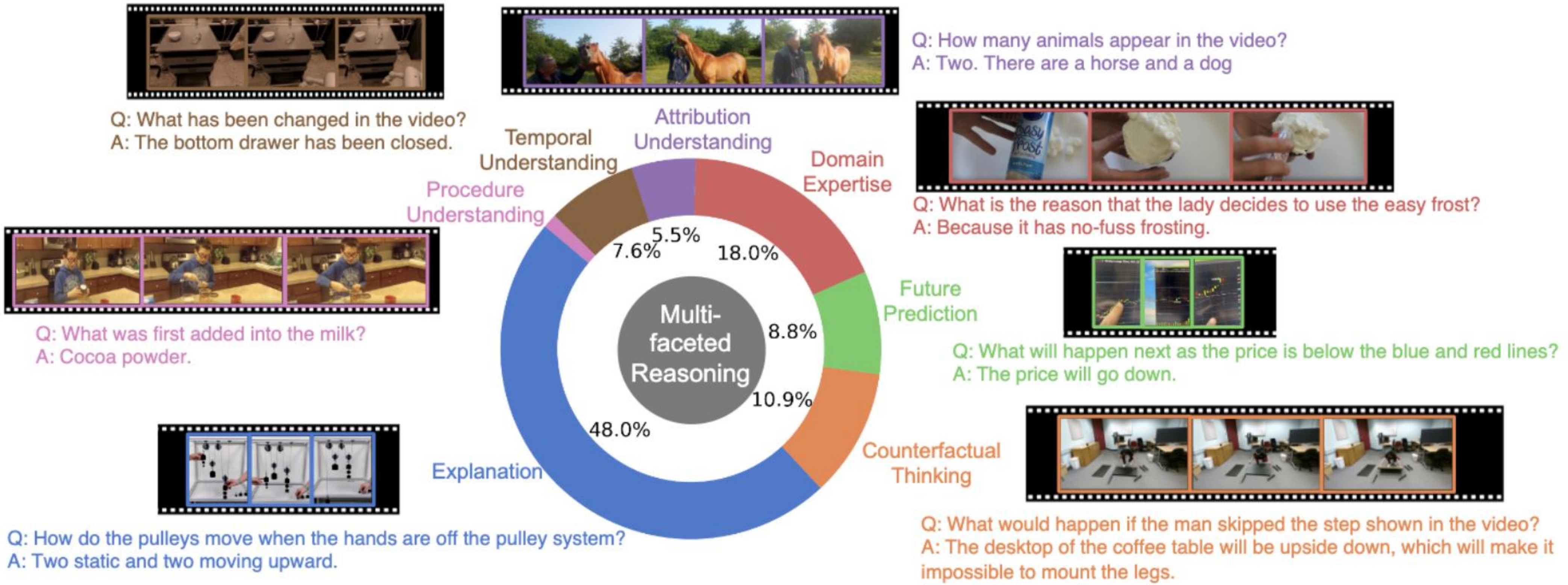
Multi-discipline Multi-faceted Video Understanding Benchmark



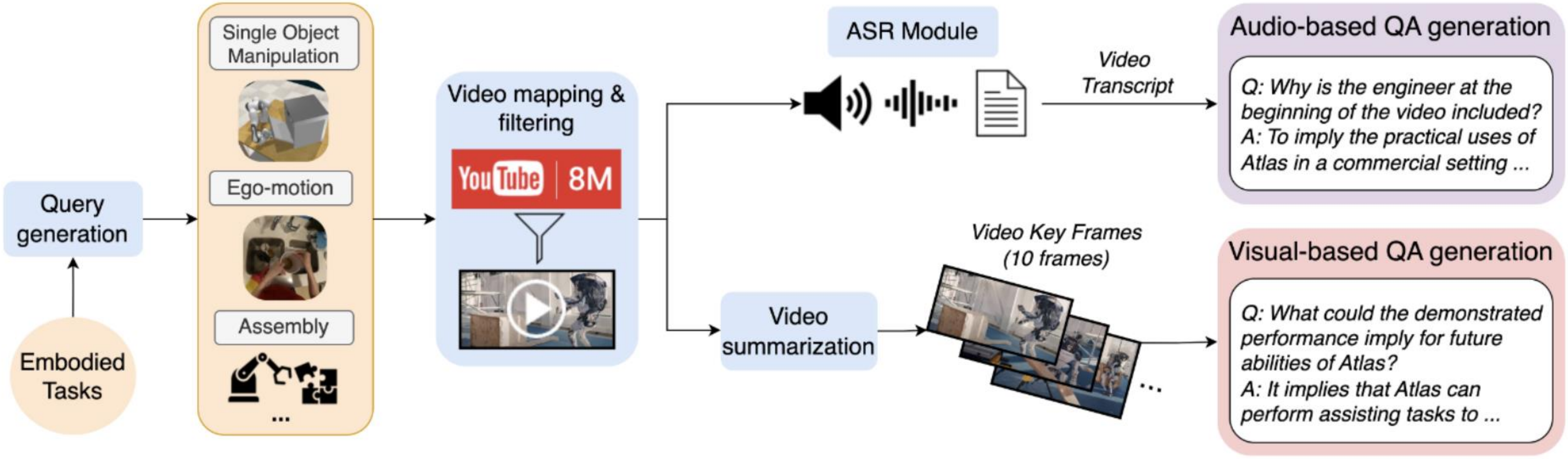
Dataset Characteristics

Benchmarks	Multi-Discipline	Multi-Task	Multi-Faceted Reasoning				First-Party Annotation
			Explain.	Counter.	Future.	Domain.	
MovieQA [57], TVQA [29]			✓				✓
ActivityNet-QA [71]							✓
MSVD-QA [66], MSRVTT-QA [67]							✓
Sports-QA [31]				✓		✓	✓
VaTeX [61]		✓					✓
VALUE [35]		✓					
Video-Bench [48]		✓			✓	✓	
MVBench [34]		✓		✓	✓		
Perception Test [53]		✓	✓	✓	✓		
MMWorld (Ours)	✓	✓	✓	✓	✓	✓	✓

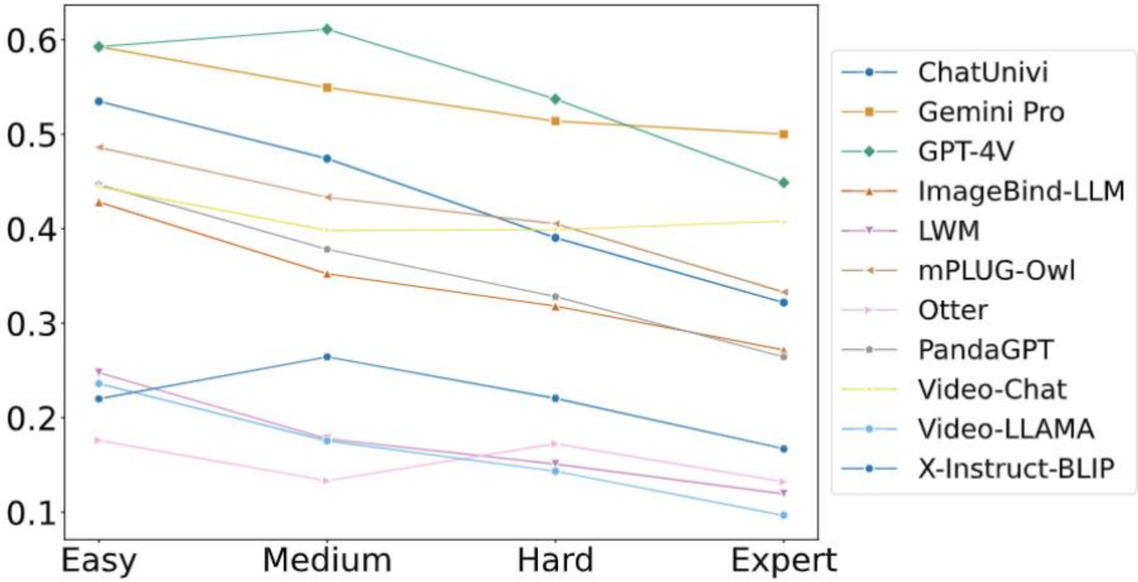
Question Types Distribution

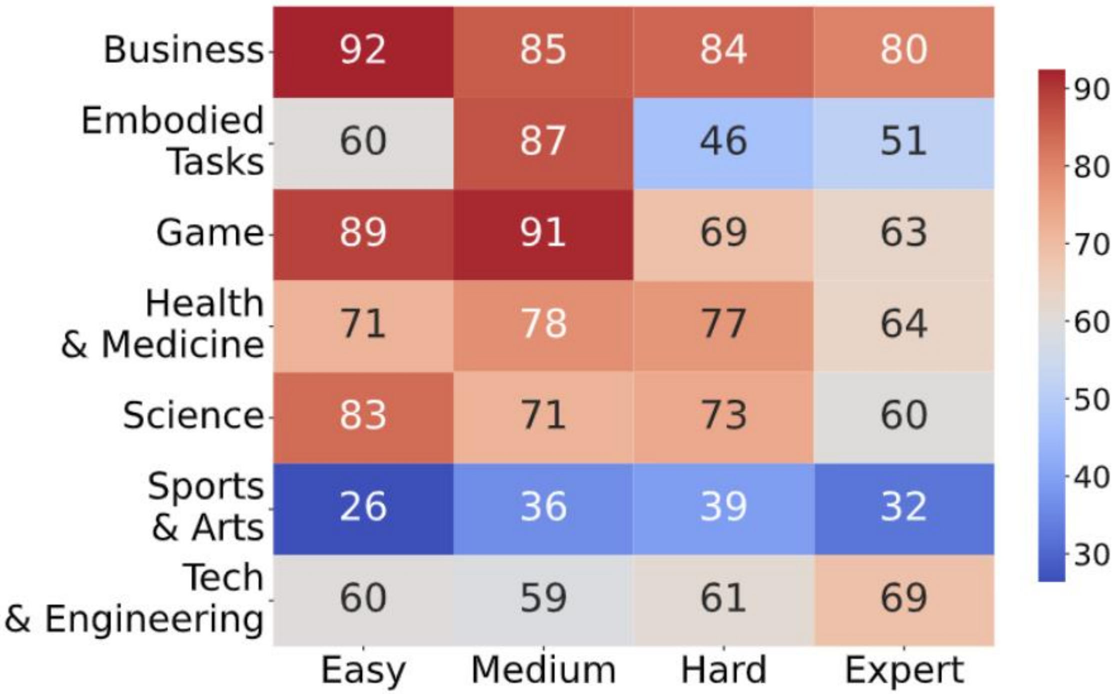


Synthetic Data Generation Pipeline



Study on MLLM Performance at Different Difficulty Levels for Average Humans





MLLM accuracy across diverse disciplines

Model	Art& Sports	Business	Science	Health& Medicine	Embodied Tasks	Tech& Engineering	Game	Average
Random Choice	25.03	25.09	26.44	25.00	26.48	30.92	25.23	26.31
Proprietary MLLMs								
GPT-4o (OpenAI, 2024)	47.87 ±1.47	**91.14** ±0.87	**73.78** ±2.88	**83.33** ±1.47	62.94 ±3.47	**75.53** ±2.61	**80.32** ±2.05	**62.54** ±0.79
Claude-3.5-Sonnet (Anthropic, 2024)	**54.58** ±0.45	63.87 ±0.40	59.85 ±1.28	54.51 ±1.28	30.99 ±0.40	58.87 ±0.61	59.44 ±0.68	54.54 ±0.29
GPT-4V (OpenAI, 2023b)	36.17 ±0.58	81.59 ±1.74	66.52 ±1.86	73.61 ±0.49	55.48 ±2.70	61.35 ±1.00	73.49 ±1.97	52.30 ±0.49
Gemini Pro (Team et al., 2023)	37.12 ±2.68	76.69 ±2.16	62.81 ±1.83	76.74 ±1.30	43.59 ±0.33	69.86 ±2.01	66.27 ±2.60	51.02 ±1.35
Open-source MLLMs								
Video-LLaVA-7B (Lin et al., 2023a)	35.91 ±0.96	51.28 ±0.87	56.30 ±0.76	32.64 ±0.49	**63.17** ±1.44	58.16 ±1.00	49.00 ±3.16	44.60 ±0.58
Video-Chat-7B (Li et al., 2023c)	39.53 ±0.06	51.05 ±0.00	30.81 ±0.21	46.18 ±0.49	40.56 ±0.57	39.36 ±0.00	44.98 ±0.57	40.11 ±0.06
ChatUnivi-7B (Jin et al., 2023)	24.47 ±0.49	60.84 ±1.51	52.00 ±0.73	61.11 ±1.96	46.15 ±2.06	56.74 ±1.33	52.61 ±2.84	39.47 ±0.42
mPLUG-Owl-7B (Ye et al., 2023)	29.16 ±1.62	64.10 ±1.84	47.41 ±3.29	60.07 ±1.30	23.78 ±3.47	41.84 ±5.09	62.25 ±3.16	38.94 ±1.52
Video-ChatGPT-7B (Maaz et al., 2024)	26.84 ±0.69	39.16 ±3.02	36.45 ±1.31	53.12 ±0.00	36.60 ±3.25	41.49 ±1.74	36.55 ±2.27	33.27 ±0.97
PandaGPT-7B (Su et al., 2023)	25.33 ±0.54	42.66 ±3.02	39.41 ±2.67	38.54 ±3.07	35.43 ±0.87	41.84 ±2.79	40.16 ±4.65	32.48 ±0.45
ImageBind-LLM-7B (Han et al., 2023)	24.82 ±0.16	42.66 ±0.99	32.15 ±1.11	30.21 ±1.47	46.85 ±1.14	41.49 ±1.50	41.37 ±0.57	31.75 ±0.14
X-Instruct-BLIP-7B (Panagopoulou et al., 2023)	21.08 ±0.27	15.85 ±0.87	22.52 ±1.11	28.47 ±0.49	18.41 ±1.44	22.34 ±0.87	26.10 ±0.57	21.36 ±0.18
LWM-1M-JAX (Liu et al., 2024b)	12.04 ±0.53	17.48 ±0.57	15.41 ±0.91	20.49 ±0.98	25.87 ±1.98	21.99 ±2.19	11.65 ±3.01	15.39 ±0.32
Otter-7B (Li et al., 2023a)	17.12 ±1.17	18.65 ±0.87	9.33 ±0.36	6.94 ±0.98	13.29 ±1.51	15.96 ±1.74	15.26 ±0.57	14.99 ±0.77
Video-LLaMA-2-13B (Zhang et al., 2023a)	6.15 ±0.44	21.21 ±0.66	22.22 ±1.45	31.25 ±1.70	15.38 ±1.14	19.15 ±1.74	24.90 ±5.93	14.03 ±0.29

Conclusions and Future Works

- Our MMWorld Benchmark represents a significant step forward in the quest for advanced multi-modal language models capable of understanding complex video content.
- By presenting a diverse array of videos across seven disciplines, accompanied by questions that challenge models to demonstrate explanation, counterfactual thinking, future prediction, and domain expertise, we have created a rigorous testing ground for the next generation of AI.