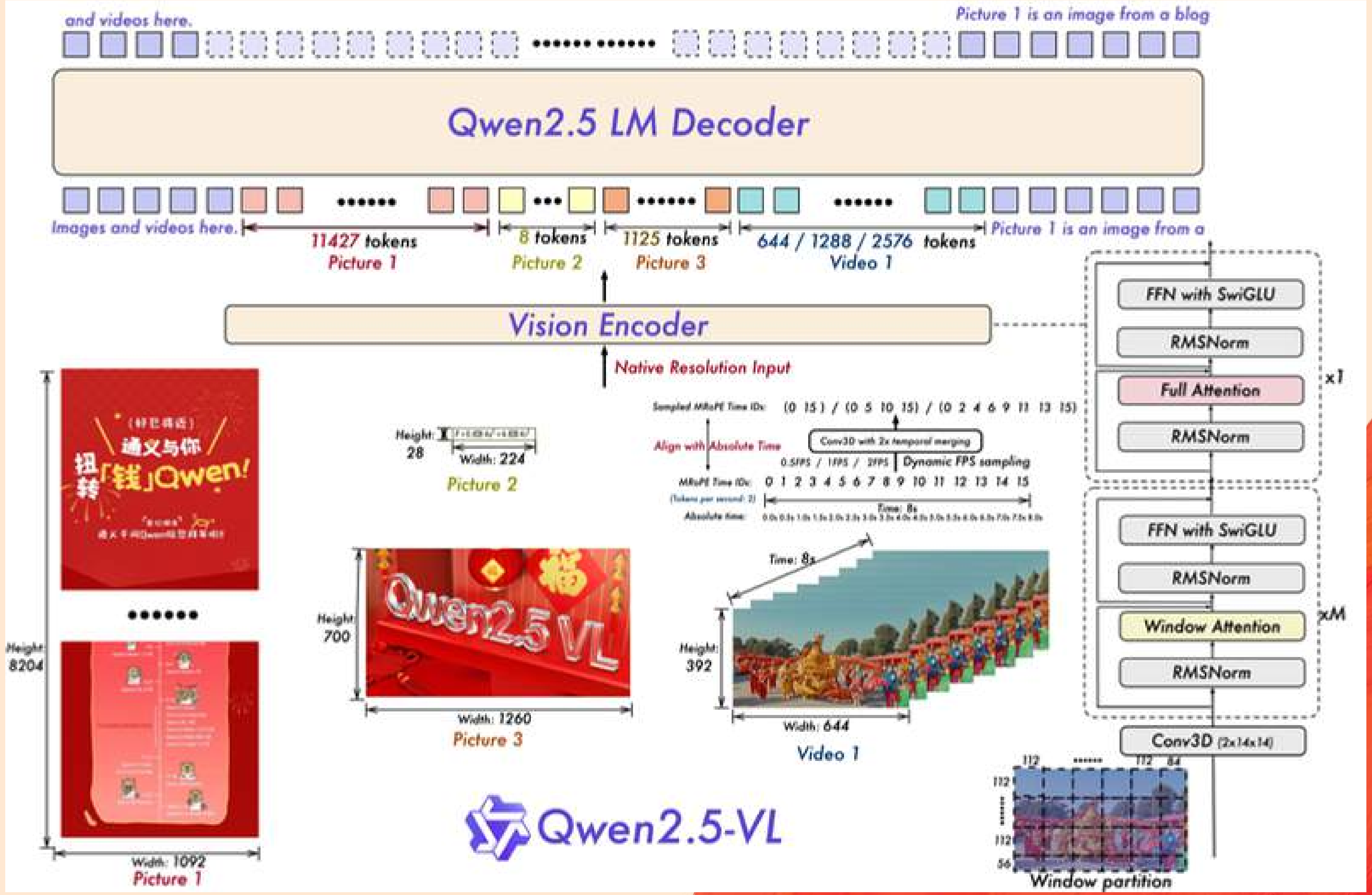
Qwen2.5 -VL

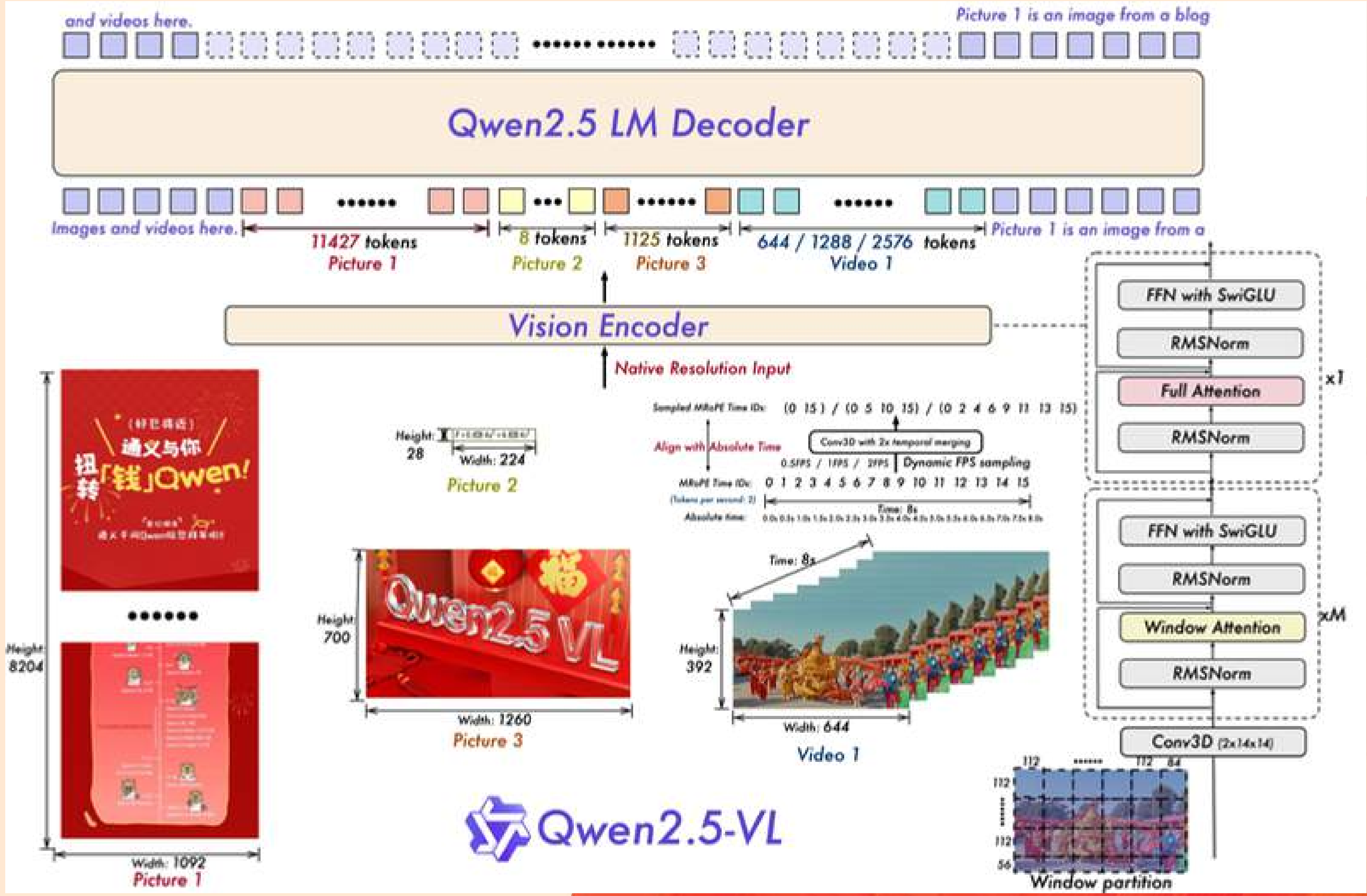
Technical Report

What is it being done?

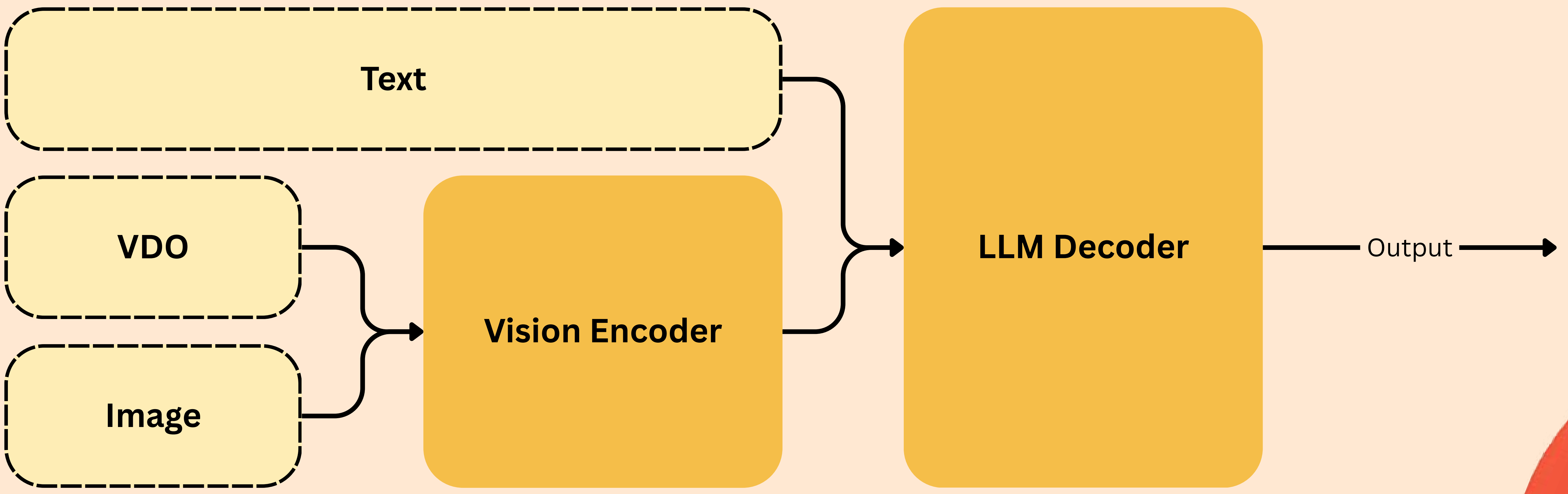
Qwen2.5-VL is a new Large vision-language models (LVLMs) that significantly advances visual understanding and interaction capabilities.

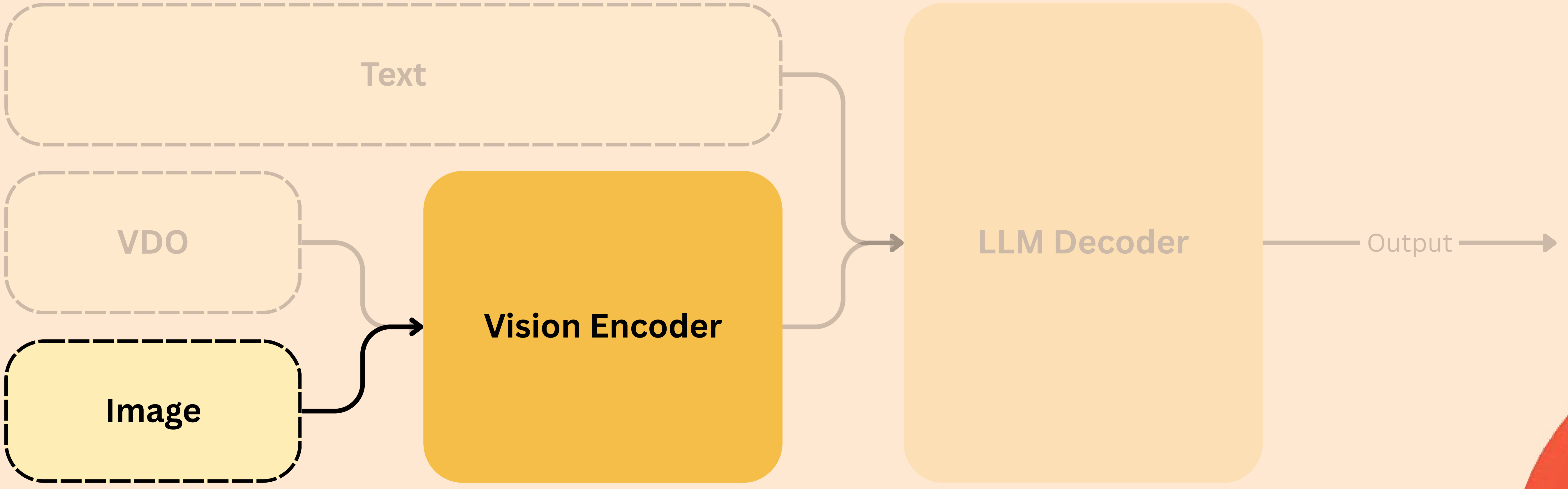


- Major advancements include enhanced visual recognition, precise object localization, robust document parsing, and long-video comprehension.
- Native dynamic-resolution processing and absolute time encoding for improved spatial and temporal understanding.



How is it being done?


Text
VDO
Image
Vision Encoder
LLM Decoder
Output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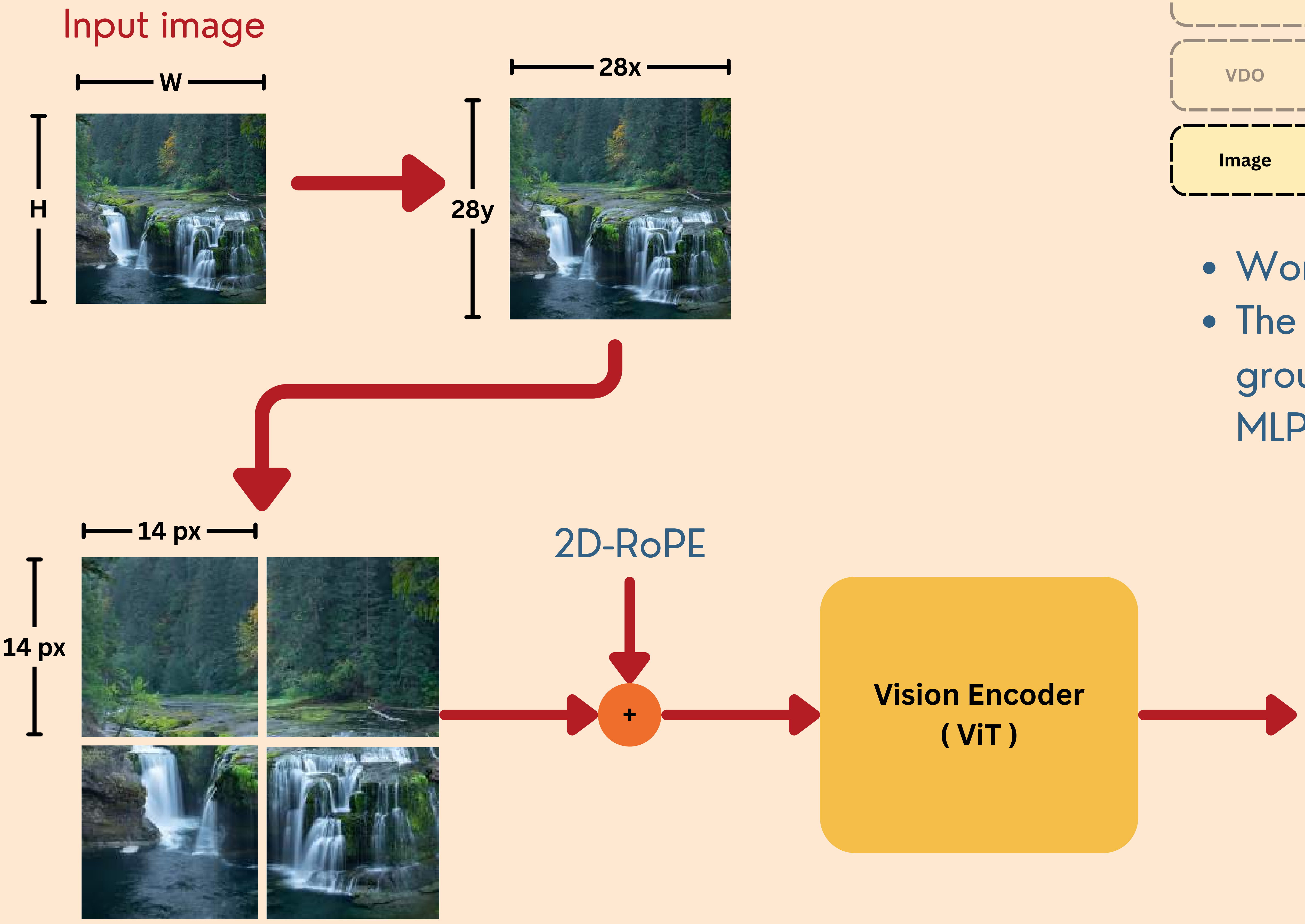
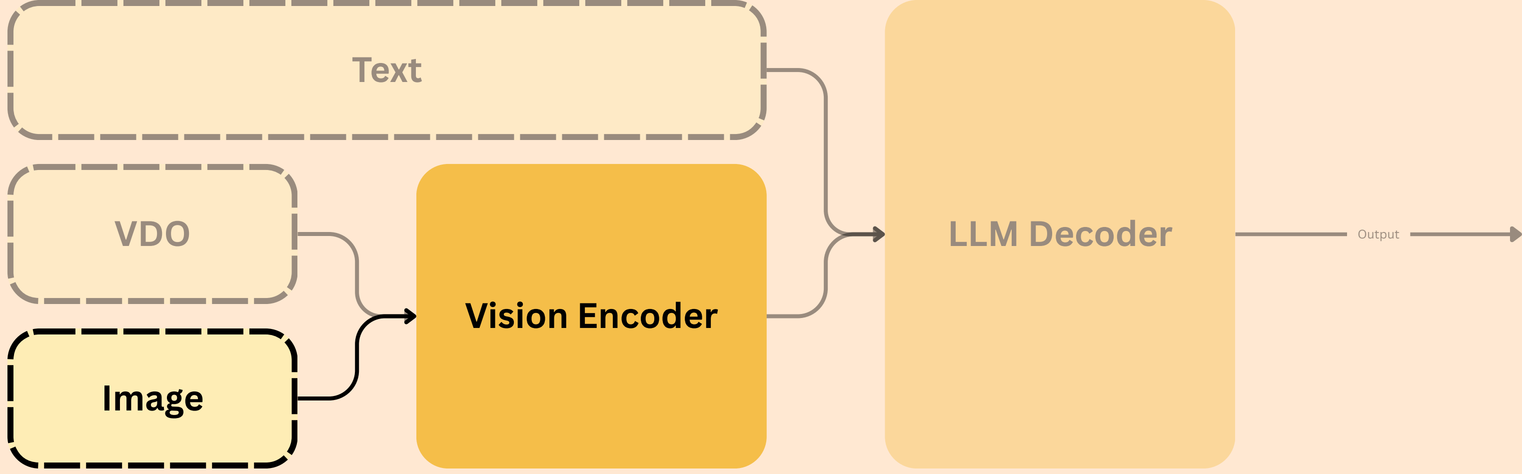
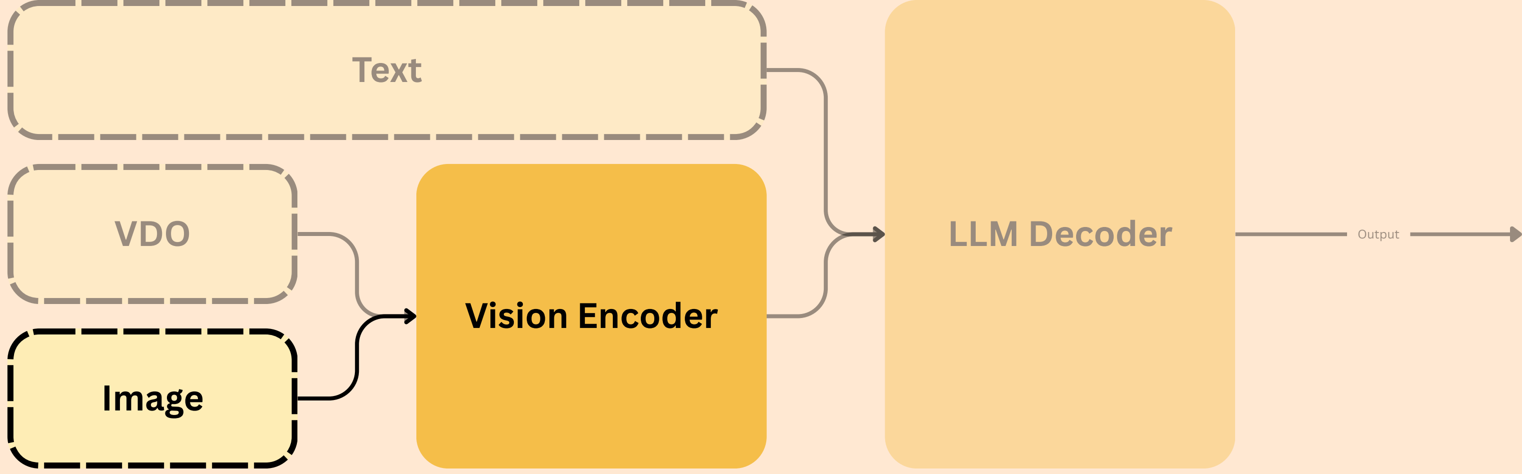




- Work with native resolution.
- The features of 4 adjacent patches grouped together then projects with MLP.



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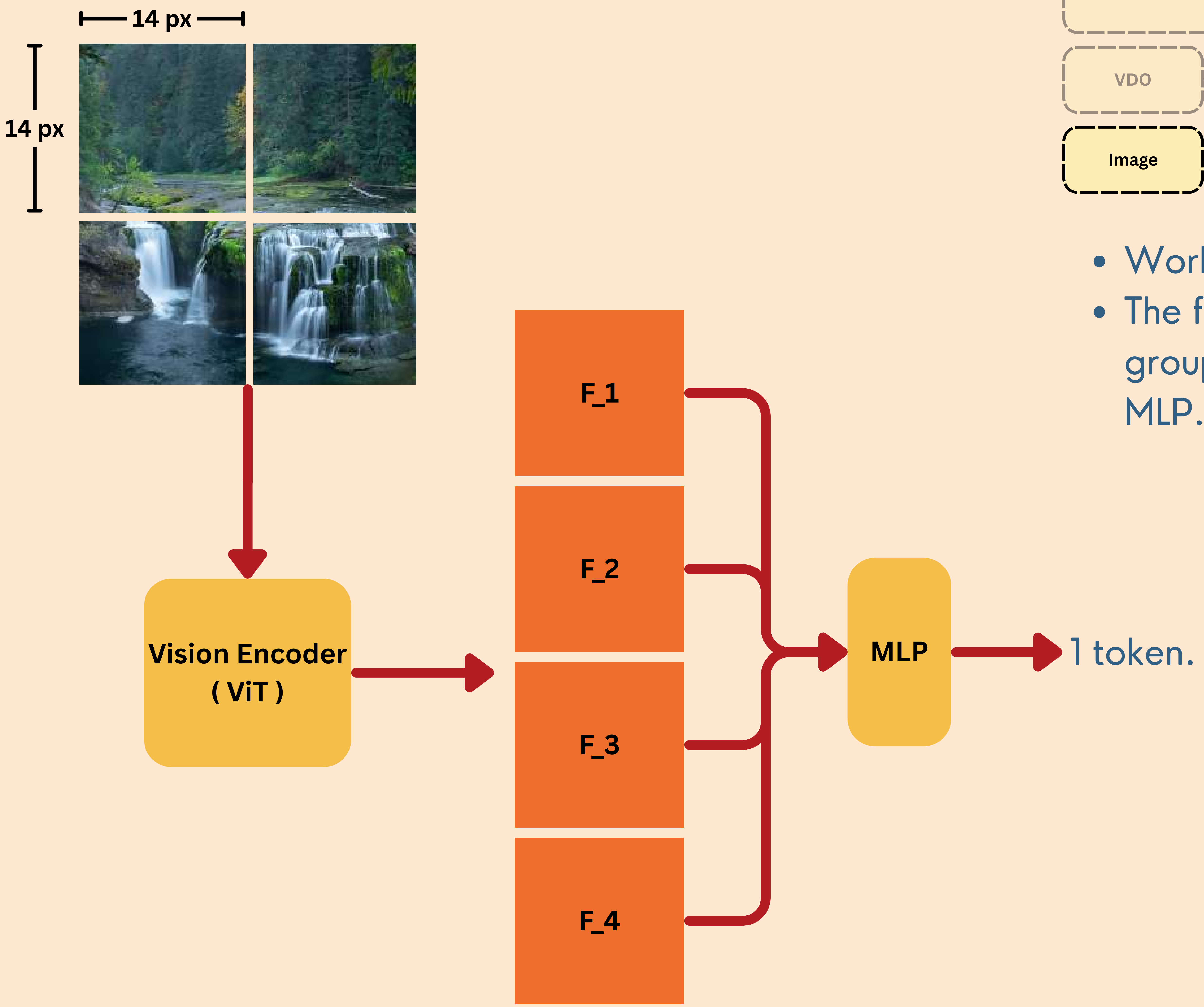

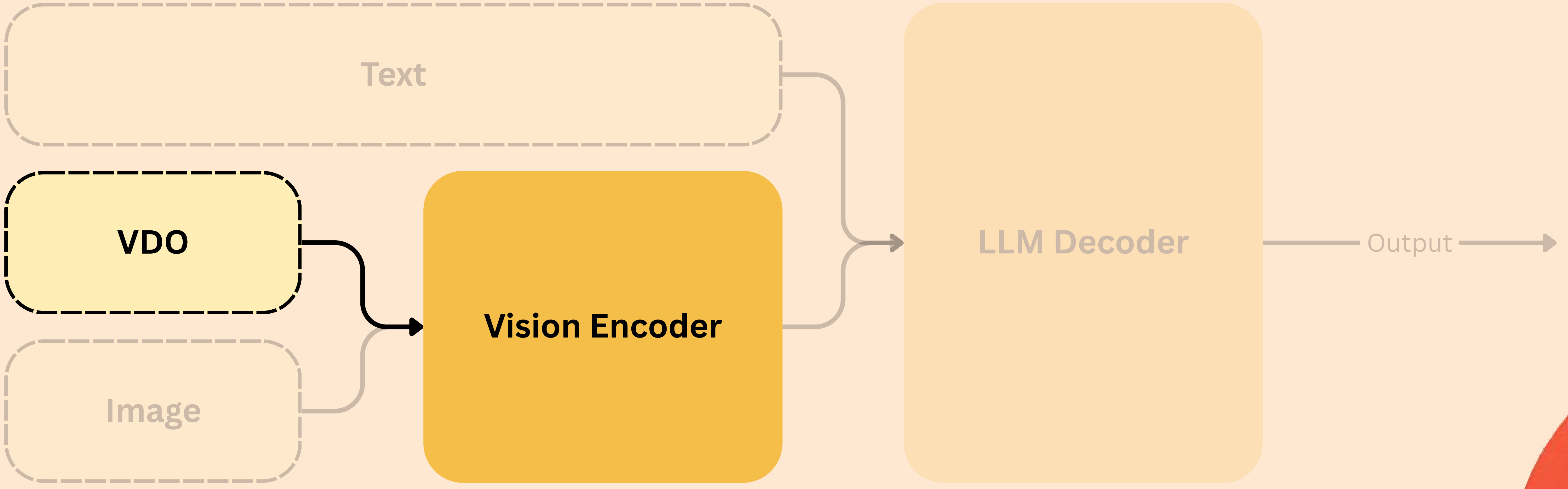
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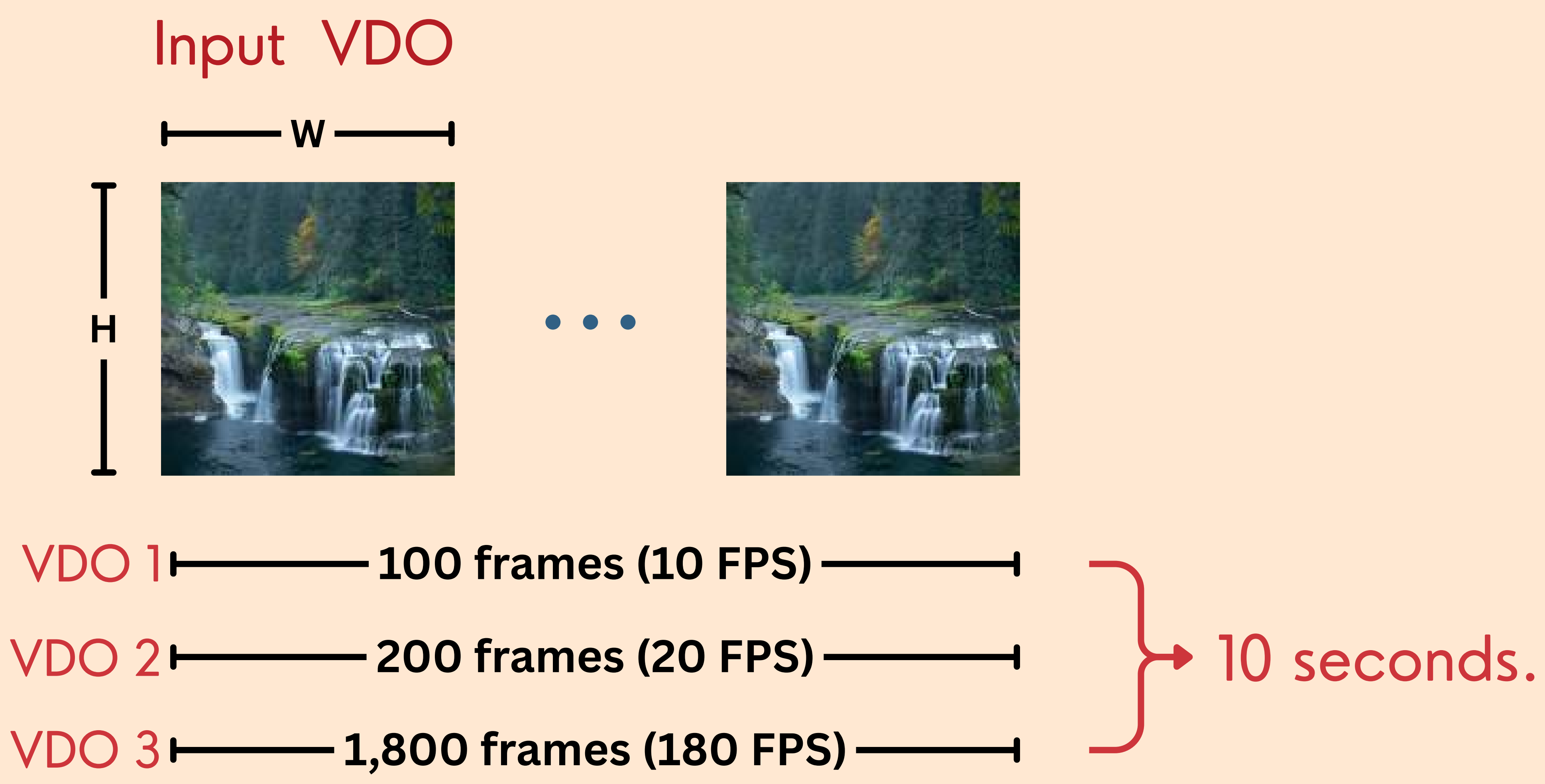
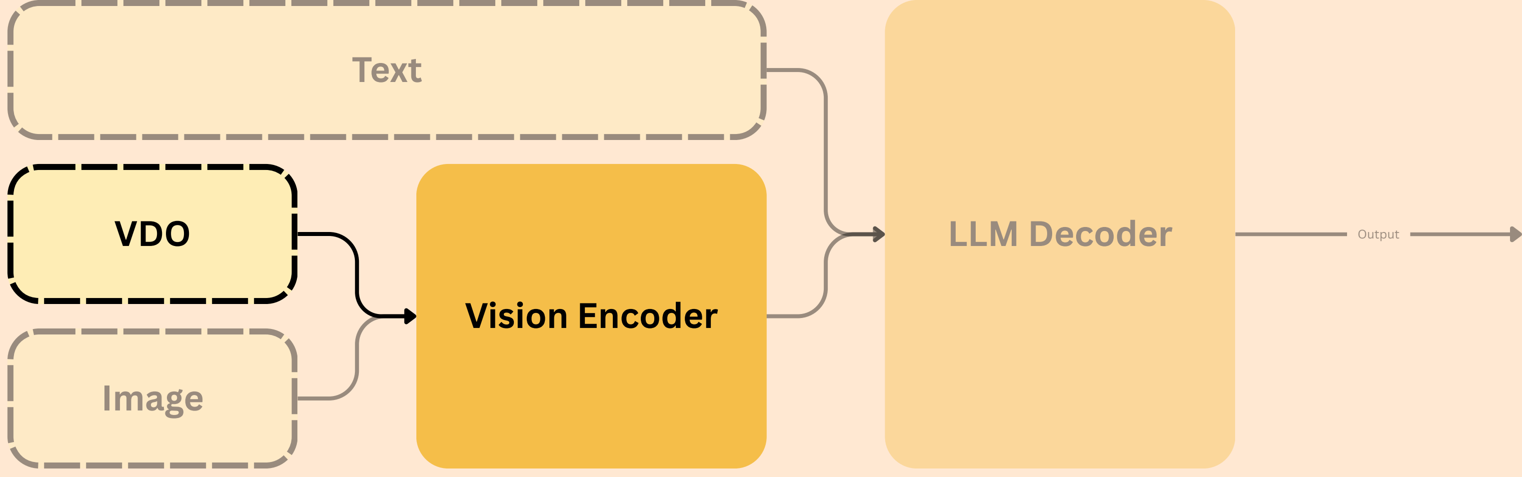
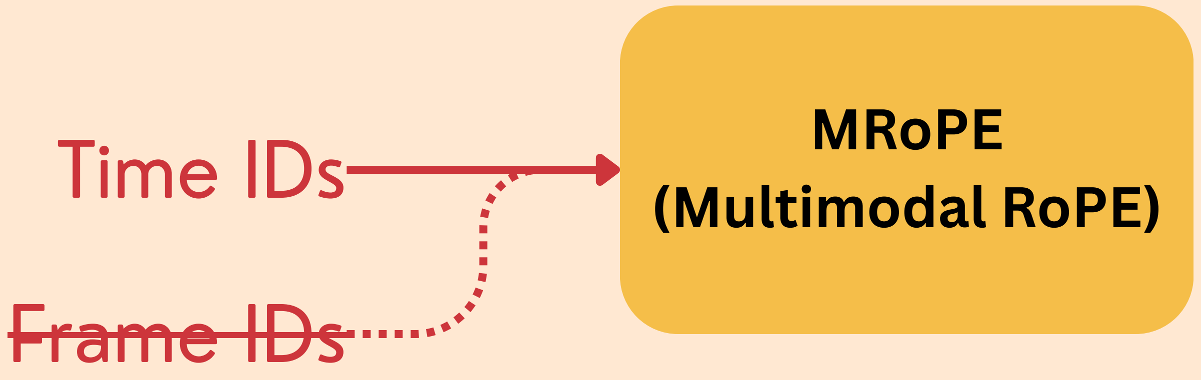




- Work with native resolution.
- Support dynamic FPS sampling.
- Positional Encoding with absolute time.
- The features of 2 consecutive frames are group together.

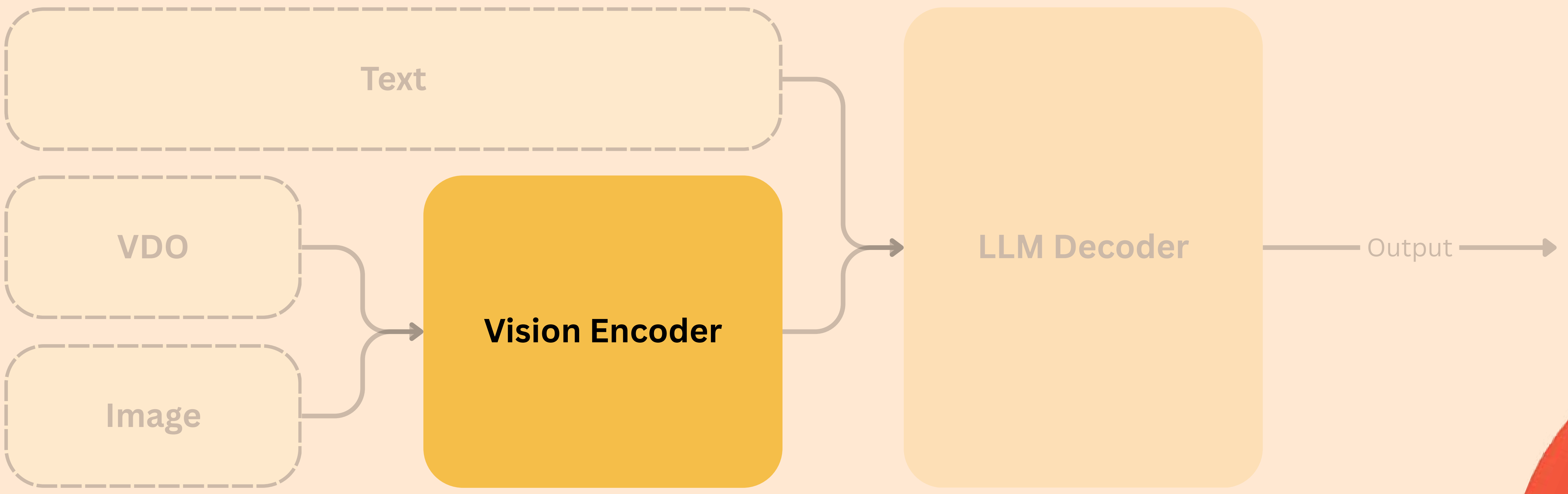
!!! So, we use **Time IDs** instead of **Frame IDs** !!!



Explaination

MRoPE (Multimodal RoPE)

	Width	Height	Temporal
Text	Position IDs	Position IDs	Position IDs
Image	Image width	Image height	Constants
Video	Video width	Video height	Time IDs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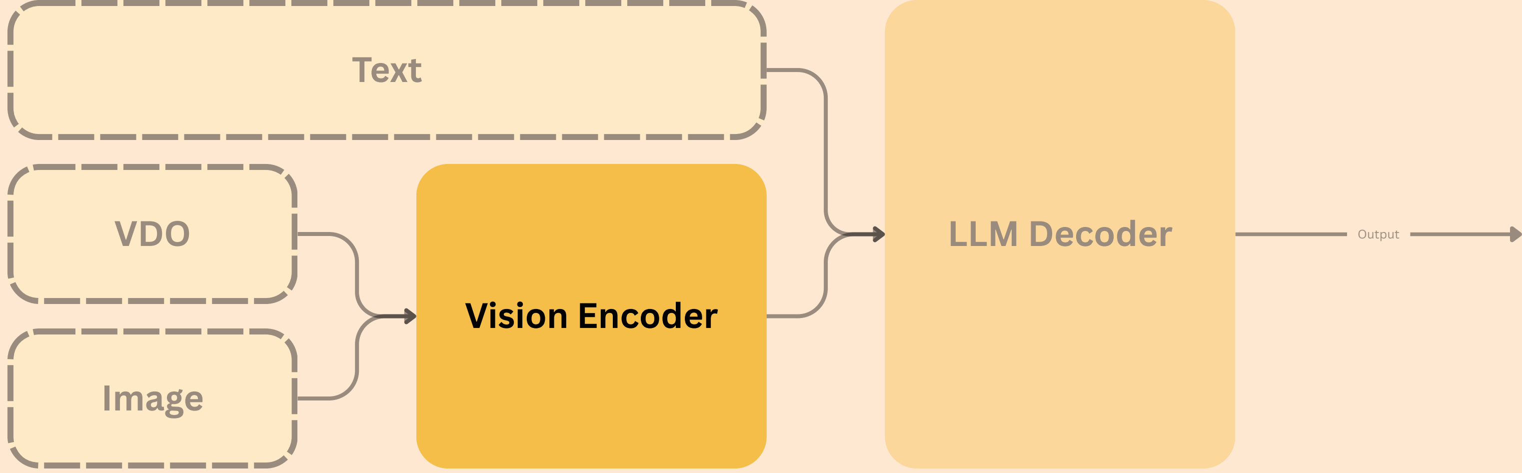


- Apply LLM design into the Vision Transformer
  - Activation function → **SwiGLU**
  - Normalization → **RMSNorm (Root Mean Square Normalization)**

- window-based attention to reduce computational efforts
  - window size = 112x112 (**8x8 patches**), no padding if smaller

HOW IS IT DIFFERENT FROM PREVIOUS WORK

หัวข้อ	**Transformer ปกติ**	**Qwen2.5-VL**
Input	Text หรือ Image (fixed)	Text + Image + Video (dynamic)
Position Encoding	1D RoPE	3D MRoPE (temporal + spatial)
Attention	Full Attention	Windowed Attention + Selective full attention (4X)
ViT	Standard ViT	Custom ViT + RMSNorm + SwiGLU
Multi-modal Fusion	Concatenation/linear	MLP Merger (compressed patches)
Video Support	จำกัด ความยาววิดีโอ	รองรับ long video, absolute time encoding
Image Resolution	Resize required	รองรับ native resolution

Dataset

PRE-TRAINING DATA

Stages	Visual Pre-Training	Multimodal Pre-Training	Long-Context Pre-Training
Data	Image Caption Knowledge OCR	+ Pure text Interleaved Data VQA, Video Grounding, Agent	+ Long Video Long Agent Long Document
Tokens	1.5T	2T	0.6T
Sequence length	8192	8192	32768
Training	ViT	ViT & LLM	ViT & LLM

- Approximately 4 trillion tokens.
- It includes cleaned web data, synthetic data, and multimodal sources such as image captions, interleaved image-text pairs, OCR data, visual knowledge datasets, multimodal academic questions, localization and grounding datasets, document parsing data, video descriptions, and agent interaction data.

INTERLEAVED IMAGE-TEXT DATA

Purpose:

- Enables multimodal learning by offering both visual and textual cues simultaneously.
- Ensures that the model maintains robust text-only capabilities when images are absent.
- Provides a wide range of general information, even though raw interleaved data can be noisy.

Example not real dataset.

INTERLEAVED IMAGE-TEXT DATA

Preprocessing

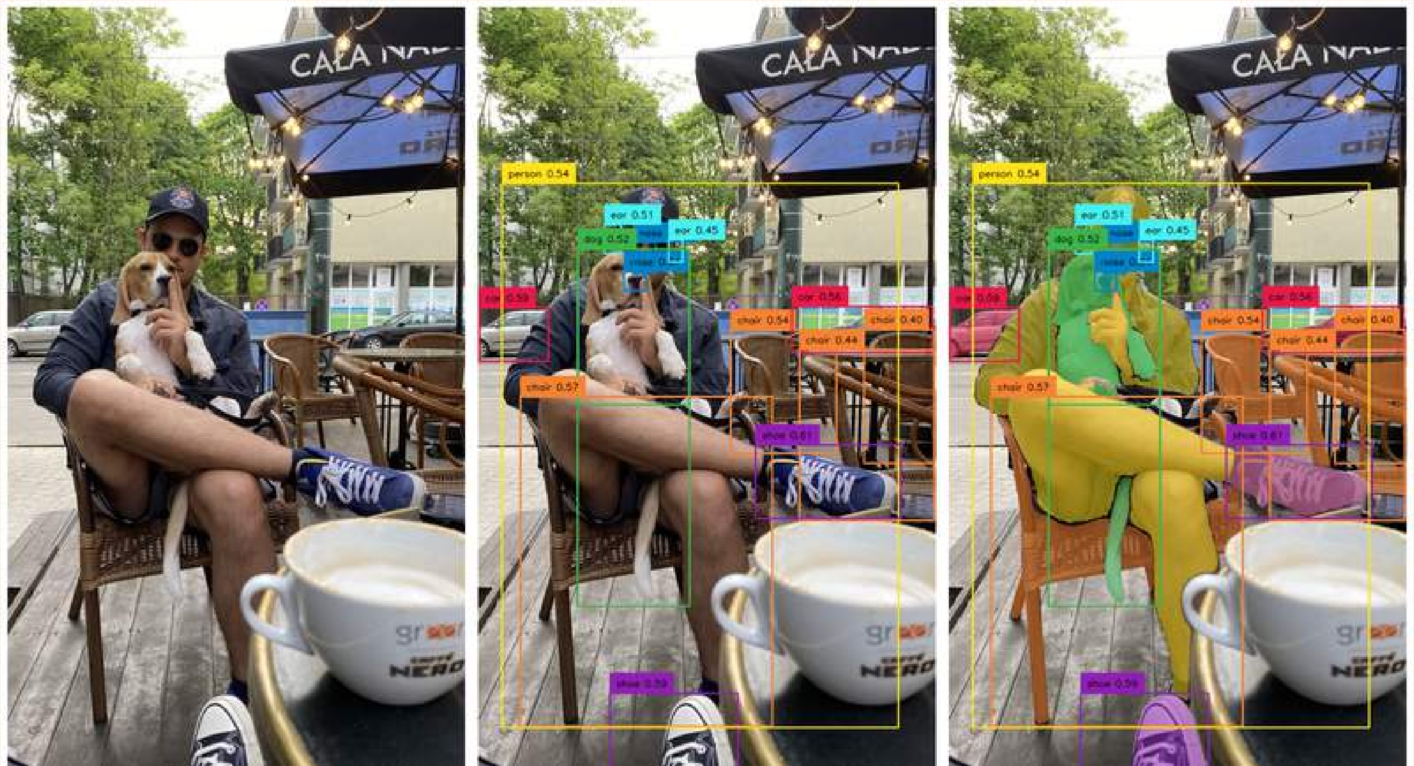
- Scoring System:
  - A four-stage evaluation using an internal model based on:
    1. Text-Only Quality
    2. Image-Text Relevance – Ensuring that the image adds meaningful context.
    3. Information Complementarity – Both modalities provide unique, complementary information.
    4. Information Density Balance – Balancing the amount of information from both the image and the text.
- This scoring helps in filtering and selecting only high-quality, useful image-text pairs.

GROUNDING DATA WITH ABSOLUTE POSITION COORDINATES

Purpose:

- To accurately capture the size and location of objects within images.
- Supports tasks such as object detection and localization by preserving the real-world scale.

-Includes over 10,000 object categories.
-Synthesizes non-existent object categories and constructs images with multiple instances per object for robustness.



Example not real dataset.

DOCUMENT OMNI-PARSING DATA

Purpose:

- To enable the model to parse and understand complex document layouts and elements, including text, tables, charts, formulas, images, and more.

- Uniformly formatted in HTML.

QwenVL HTML Format

```
<html><body>
# paragraph
<p data-bbox="x1 y1 x2 y2"> content </p>
# table
<style>table{id} style</style><table data-bbox="x1 y1 x2 y2" class="table{id}"> table content
</table>
# chart
<div class="chart" data-bbox="x1 y1 x2 y2"> <img data-bbox="x1 y1 x2 y2" /><table> chart content
</table></div>
# formula
<div class="formula" data-bbox="x1 y1 x2 y2"> <img data-bbox="x1 y1 x2 y2" /> <div> formula
content </div></div>
# image caption
<div class="image caption" data-bbox="x1 y1 x2 y2"> <img data-bbox="x1 y1 x2 y2" /><p> image
caption </p></div>
# image ocr
<div class="image ocr" data-bbox="x1 y1 x2 y2"> <img data-bbox="x1 y1 x2 y2" /><p> image ocr
</p></div>
# music sheet
<div class="music sheet" format="abc notation" data-bbox="x1 y1 x2 y2"> <img data-bbox="x1 y1
x2 y2" /> <div> music sheet content </div></div>
# chemical formula content
<div class="chemical formula" format="smile" data-bbox="x1 y1 x2 y2"> <img data-bbox="x1 y1
x2 y2" /> <div> chemical formula content </div></div>
</html></body>
```

OCR DATA

Purpose:

- To improve the model's ability to recognize and process textual content in images.
- Supports multilingual OCR capabilities.

-Includes languages such as French, German, Italian, Spanish, Portuguese, Arabic, Russian, Japanese, Korean, and Vietnamese.
-1 million samples are synthesized, 6 million real-world samples

Example not real dataset.

VIDEO DATA

Purpose:

- To ensure the model can robustly understand video content across varying frame rates (FPS) and long-duration videos.

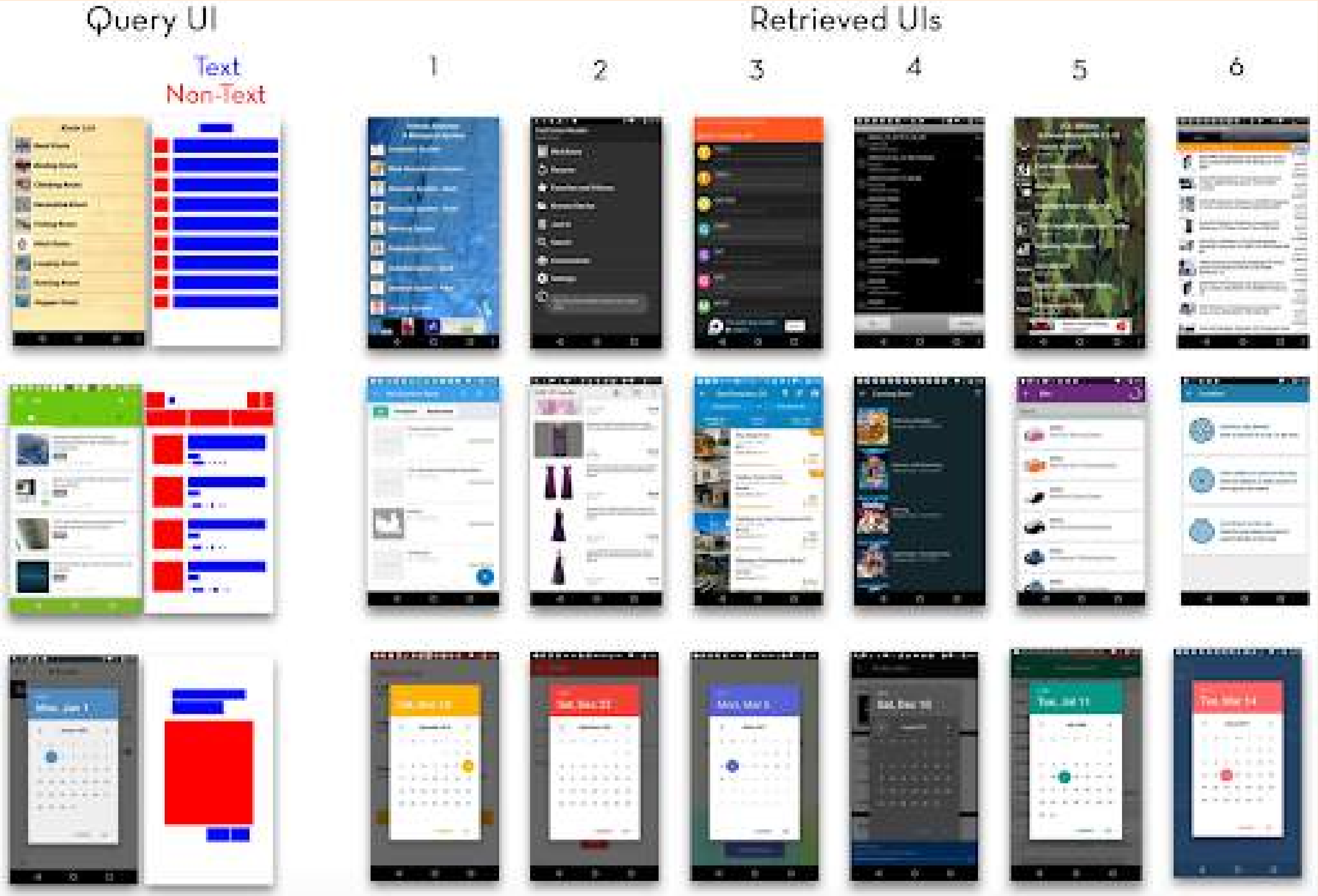
Example not real dataset.

AGENT DATA

Purpose:

- Enhances the model's perception and decision-making abilities in user interface (UI) contexts across various platforms (mobile, web, desktop).

-Screenshots from different platforms.



Example not real dataset.

INSTRUCTION DATA

- Used in the Supervised Fine-Tuning (SFT) phase.
- Approximately 2 million entries.
- Pure text data (50%) and multimodal data (50%).
- Primary Languages is Chinese and English and has additional multilingual entries.
- Data is structured to support a wide range of queries, ensuring broad coverage.

INSTRUCTION DATA

Dialogue Complexity:

- Single-Turn Interactions: Simpler, one-shot inputs where the query is addressed in a single interaction.
- Multi-Turn Interactions: More complex, where context is maintained over several conversational turns.
- Visual Dynamics: The data simulates realistic scenarios ranging from single-image inputs to sequences of multiple images, adding layers of context and complexity.

-

INSTRUCTION DATA

include:

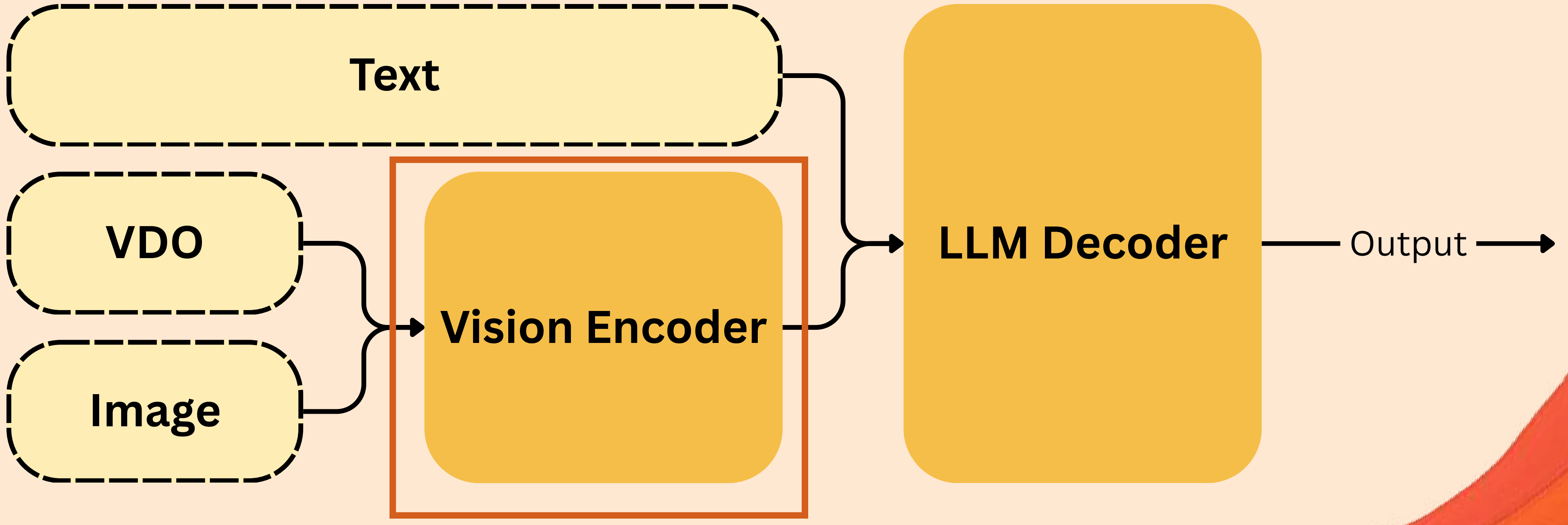
- General Visual Question Answering (VQA) and Image Captioning
- Mathematical Problem-Solving and Coding Tasks
- Security-Related Queries
- Document and OCR Tasks
- Grounding and Video Analysis
- Agent Interactions (focused on UI and operational decision-making)

-

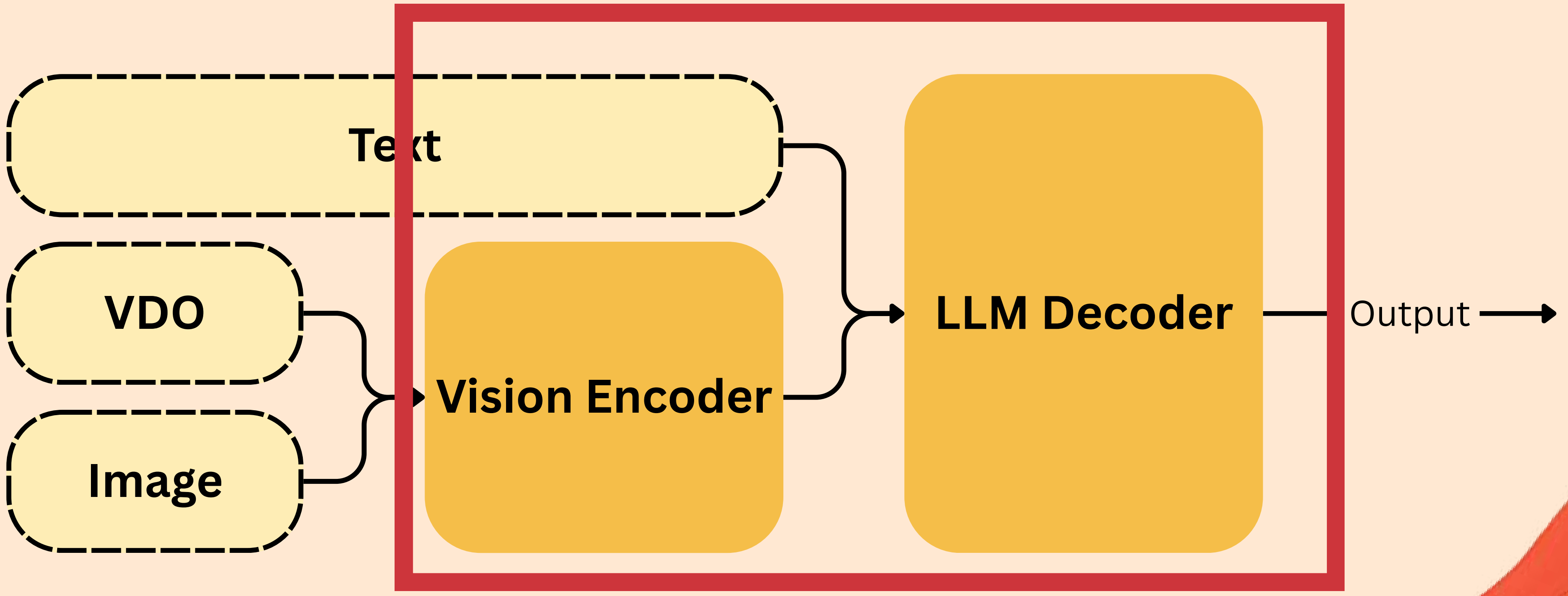
Training and fine-tuning

PHASE 1: VISION ENCODER TRAINING

- Only Vision Encoder training is trained in this phase
- Datasets such as image captions, visual knowledge, and OCR data are used to train in this phase



PHASE 2,3: ENTIRE MODEL TRAINING



- All model parameters are unfreeze.
- Datasets such as interleaved data, multi-task learning, visual question answering, multimodal mathematics, agent-based task, video understanding and pure text are introduce to train in the 2nd phase.
- The 3rd phase introduce data that has longer token lengths compared to 2nd phase. (8192 tokens compares to 32768)

FINE-TUNING

- Instruction-response based data are used to fine tune the model.
- Both single-turn and multi-turn interactions are introduced.
- Domain-specific categorization, Domain tailored filtering, Rule-Based filtering, and Model-Based filtering are applied to ensure dataset quality before the fine-tuning process


```
{"instruction": "What is Agentic AI?", "response": "Agentic AI is a type of artificial intelligence ch
{"instruction":"What is the core characteristic of Agentic AI that sets it apart from other types of A
{"instruction":"How does Agentic AI gather information about its environment?","context":"","response"
{"instruction":"What is the purpose of the reasoning stage in Agentic AI?","context":"","response":"To
{"instruction":"Can you describe a scenario where Agentic AI would be useful?","context":"","response"
{"instruction":"How does Agentic AI improve over time?","context":"","response":"Through the learning
{"instruction":"What are the four key stages of Agentic AI, and how do they relate to each other?","co
{"instruction":"How does Agentic AI differ from traditional AI systems that require constant human inp
{"instruction":"Can Agentic AI learn from its mistakes?","context":"","response":"Yes, through the lea
{"instruction":"What are some potential applications of Agentic AI in industries such as healthcare or
{"instruction": "How does Agentic AI maintain balance between autonomous decision-making and safety co
{"instruction": "How do the four stages interact with each other?", "context": "Agentic AI Operational
{"instruction": "What distinguishes Agentic AI's autonomy from traditional AI systems?", "context": "A
{"instruction": "Which stage is most critical for overall system performance?", "context": "Agentic AI
{"instruction": "How does autonomous learning contribute to improved decision-making?", "context": "Ag
{"instruction": "How does the perception stage filter relevant information?", "context": "Agentic AI O
{"instruction": "What role does initial programming play in autonomous behavior?", "context": "Agentic
{"instruction": "What role does reasoning play in decision optimization?", "context": "Agentic AI Oper
{"instruction": "How is autonomy measured or quantified in Agentic AI systems?", "context": "Agentic A
{"instruction": "How does the action stage implement decisions?", "context": "Agentic AI Operational S
{"instruction": "What are the ethical implications of AI autonomy?", "context": "Agentic AI Autonomy",
{"instruction": "What feedback mechanisms exist between stages?", "context": "Agentic AI Operational S
```

Evaluation

Overview

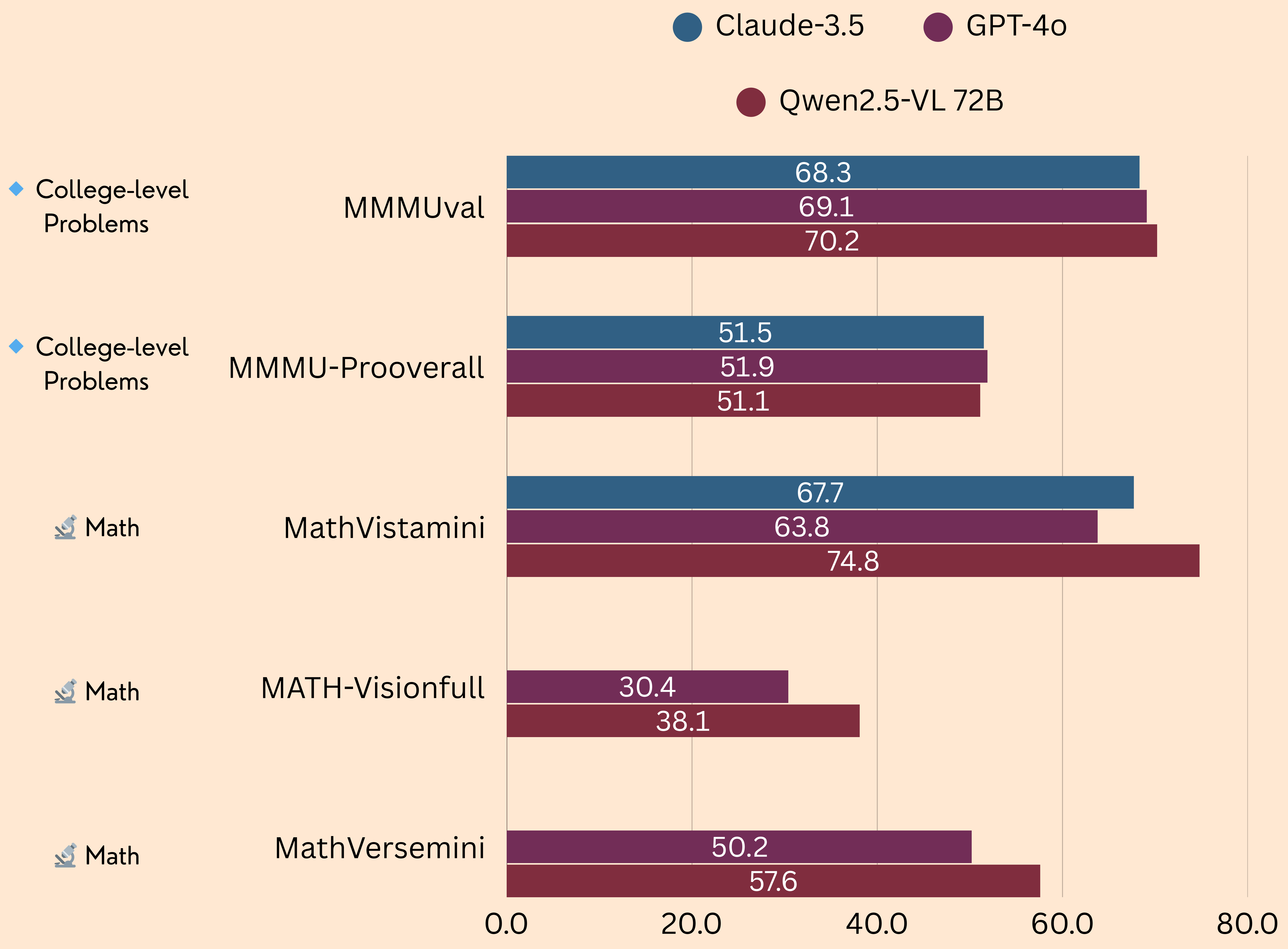
On Evaluation Task

1. General Language Understanding
2. Multimodal Tasks

Qwen2.5-VL-72B

VS

LLaMA 3.1 405B
GPT-4
Claude 3.5
Gemini 1.5
และ SOTA อื่น ๆ



General Language Understanding

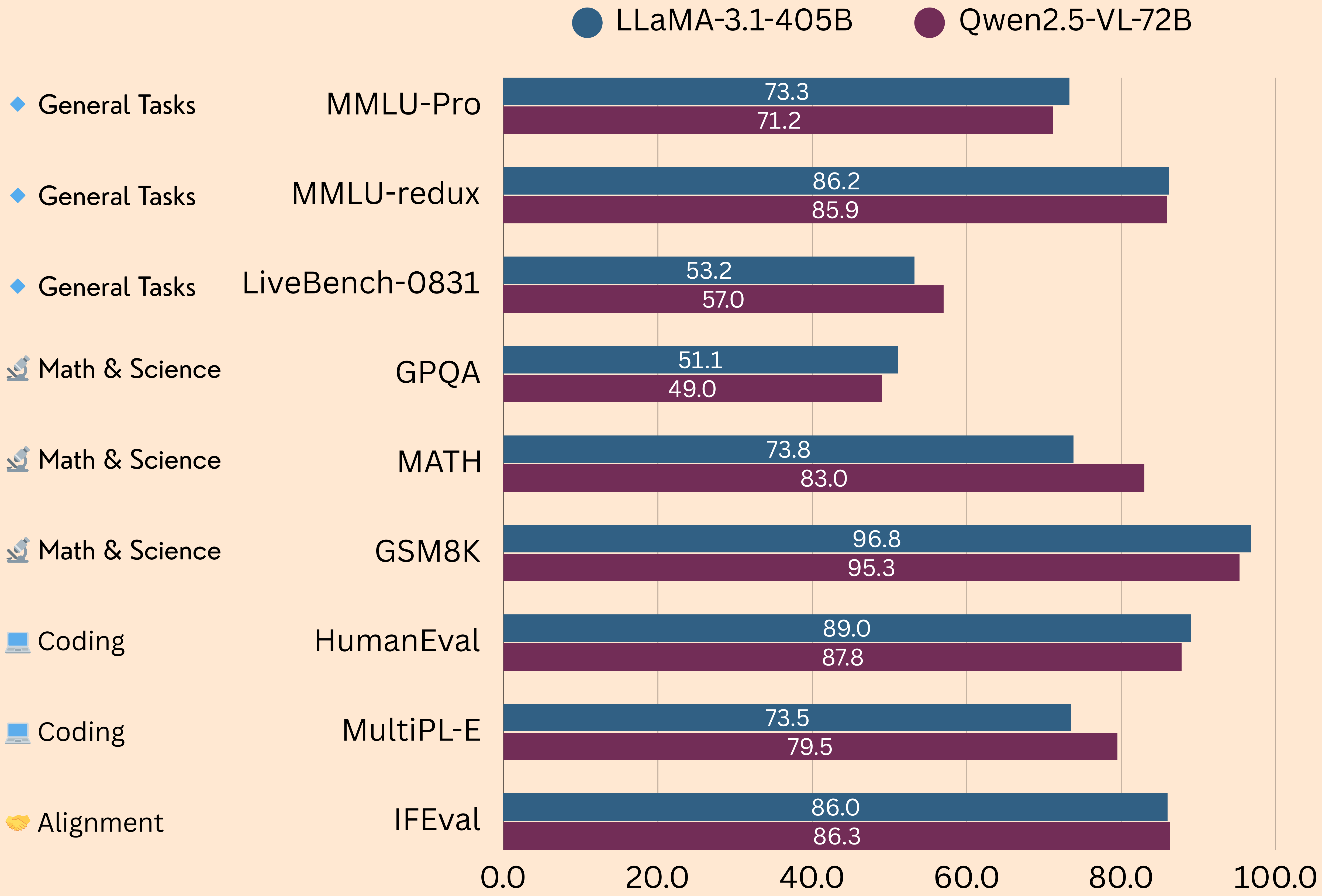
GPO-4o

- Evenly matched with GPO-4o in College-level Problems
- Qwen outperform in Math Problem

Claude-3.5

- Qwen outperform Claude-3.5 in all dataset

General Language Understanding



Qwen2.5-VL-72B vs LLaMA-3.1-405B

- Most of the dataset, The performance is Evenly matched
- Better performance in MATH dataset

Multimodel Task

OCR-related Document Understading

- Best performace in 6 out of 12 dataset

Table 5: **Performance of Qwen2.5-VL and other models on OCR, chart, and document understanding benchmarks.**

Datasets	Claude-3.5 Sonnet	Gemini 1.5 Pro	GPT 4o	InternVL2.5 78B	Qwen2.5-VL 72B	Qwen2.5-VL 7B	Qwen2.5-VL 3B
OCR-related Parsing Tasks							
CC-OCR	62.5	73.0	66.9	64.7	**79.8**	77.8	74.5
$\text{OmniDocBench}_{\text{edit en/zh}}\downarrow$	0.330/0.381	0.230/**0.281**	0.265/0.435	0.275/0.324	**0.226**/0.324	0.308/0.398	0.409/0.543
OCR-related Understanding Tasks							
$\text{AI2D}_{\text{w. M.}}$	81.2	88.4	84.6	**89.1**	88.7	83.9	81.6
$\text{TextVQA}_{\text{val}}$	76.5	78.8	77.4	83.4	83.5	**84.9**	79.3
$\text{DocVQA}_{\text{test}}$	95.2	93.1	91.1	95.1	**96.4**	95.7	93.9
$\text{InfoVQA}_{\text{test}}$	74.3	81.0	80.7	84.1	**87.3**	82.6	77.1
$\text{ChartQA}_{\text{test Avg.}}$	**90.8**	87.2	86.7	88.3	89.5	87.3	84.0
$\text{CharXiv}_{\text{RQ/DQ}}$	**60.2**/84.3	43.3/72.0	47.1/84.5	42.4/82.3	49.7/**87.4**	42.5/73.9	31.3/58.6
SEED-Bench-2-Plus	71.7	70.8	72.0	71.3	**73.0**	70.4	67.6
OCRBench	788	754	736	854	**885**	864	797
$\text{VCR}_{\text{En-Hard-EM}}$	41.7	28.1	73.2	-	79.8	**80.5**	37.5
OCR-related Comprehensive Tasks							
$\text{OCRBench\_v2}_{\text{en/zh}}$	45.2/39.6	51.9/43.1	46.5/32.2	49.8/52.1	**61.5/63.7**	56.3/57.2	54.3/52.1

12 Datasets

+

“What is the total cost of this bill”

→ **“400 Bath”**

Multimodel Task

Counting Task

- Better than Gemini 1.5 Pro, Claude, GPT, the best performance

Table 7: **Performance of Qwen2.5-VL and other models on counting.**

Datasets	Gemini 1.5-Pro	GPT-4o	Claude-3.5 Sonnet	Molmo-72b	InternVL2.5-78B	Qwen2.5-VL-72B
CountBench	85.5	87.9	89.7	91.2	72.1	93.6

1 Dataset

“How many cows in the picture”

“4 Cows”

Multimodel Task

Grounding Task

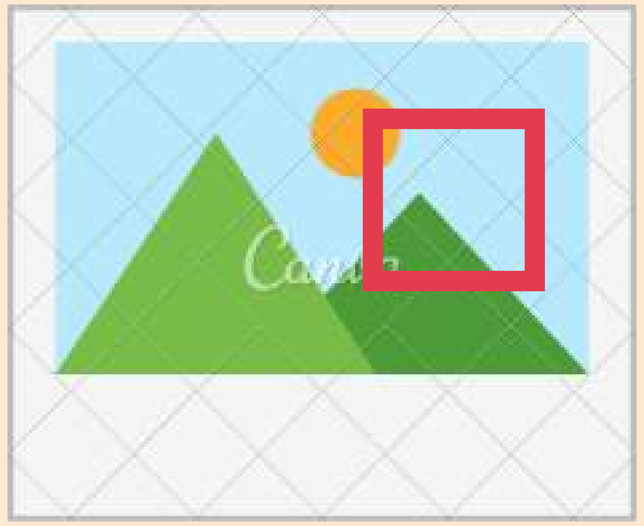
- Better than Gemini 1.5 Pro in all dataset
- But lower performance than InternVL

Table 6: **Performance of Qwen2.5-VL and other models on grounding.**

Datasets	Gemini 1.5 Pro	Grounding DINO	Molmo 72B	InternVL2.5 78B	Qwen2.5-VL 72B	Qwen2.5-VL 7B	Qwen2.5-VL 3B
Refcoco$_{val}$	73.2	90.6	-	93.7	92.7	90.0	89.1
Refcoco$_{testA}$	72.9	93.2	-	95.6	94.6	92.5	91.7
Refcoco$_{testB}$	74.6	88.2	-	92.5	89.7	85.4	84.0
Refcoco+$_{val}$	62.5	88.2	-	90.4	88.9	84.2	82.4
Refcoco+$_{testA}$	63.9	89.0	-	94.7	92.2	89.1	88.0
Refcoco+$_{testB}$	65.0	75.9	-	86.9	83.7	76.9	74.1
Refcocog$_{val}$	75.2	86.1	-	92.7	89.9	87.2	85.2
Refcocog$_{test}$	76.2	87.0	-	92.2	90.3	87.2	85.7
ODinW	36.7	55.0	-	31.7	43.1	37.3	37.5
PointGrounding	-	-	69.2	-	67.5	67.3	58.3

10 Datasets

"Where is the red car"



Multimodel Task

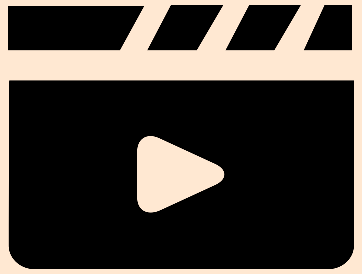
Video Task

- Better than Gemini 1.5 Pro, GPT-4o in most dataset
- Best performance in 8 out of 13 datasets

Table 8: **Performance of Qwen2.5-VL and other models on video benchmarks.**

Datasets	Gemini 1.5-Pro	GPT-4o	Qwen2.5-VL-72B	Qwen2.5-VL-7B	Qwen2.5-VL-3B
Video Understanding Tasks					
Video-MME$_{w/o\ sub.}$	**75.0**	71.9	73.3	65.1	61.5
Video-MME$_{w\ sub.}$	**81.3**	77.2	79.1	71.6	67.6
Video-MMMU	53.9	**61.2**	60.2	47.4	-
MMVU$_{val}$	65.4	**67.4**	62.9	50.1	-
MVBench	60.5	64.6	**70.4**	69.6	67.0
MMBench-Video	1.30	1.63	**2.02**	1.79	1.63
LongVideoBench$_{val}$	64.0	**66.7**	60.7	56.0	54.2
LVBench	33.1	30.8	**47.3**	45.3	43.3
EgoSchema$_{test}$	71.2	72.2	**76.2**	65.0	64.8
PerceptionTest$_{test}$	-	-	**73.2**	70.5	66.9
MLVU$_{M\text{-}Avg}$	-	64.6	**74.6**	70.2	68.2
TempCompass$_{Avg}$	67.1	73.8	**74.8**	71.7	64.4
Video Grounding Tasks					
Charades-STA$_{mIoU}$	-	35.7	**50.9**	43.6	38.8

13 Dataset



"What happen at 1:30?"

"Red car pass by"

Multimodel Task

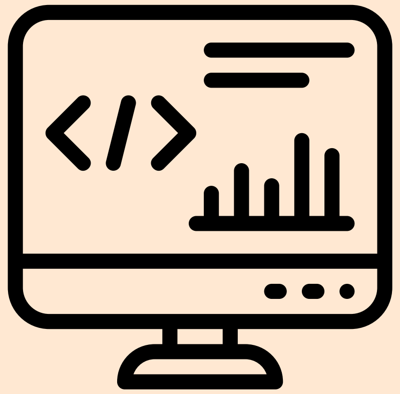
GUI Task

- Better than Gemini 2.0, GPT-4o, Claude in most dataset
- Best performance in 5 out of 7 dataset

Table 9: **Performance of Qwen2.5-VL and other models on GUI Agent benchmarks.**

Benchmarks	GPT-4o	Gemini 2.0	Claude	Aguvis-72B	Qwen2-VL-72B	Qwen2.5-VL-72B
ScreenSpot	18.1	84.0	83.0	**89.2**	-	87.1
ScreenSpot Pro	-	-	17.1	23.6	1.6	**43.6**
Android Control High$_{EM}$	20.8	28.5	12.5	66.4	59.1	**67.36**
Android Control Low$_{EM}$	19.4	60.2	19.4	84.4	59.2	**93.7**
AndroidWorld$_{SR}$	34.5% (SoM)	26% (SoM)	27.9%	26.1%	6% (SoM)	**35%**
MobileMiniWob++$_{SR}$	61%	42% (SoM)	61% (SoM)	66%	50% (SoM)	**68%**
OSWorld	5.03	4.70	**14.90**	10.26	2.42	8.83

7 Dataset



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"Click Setting Button"

Click Setting Button

Conclusion

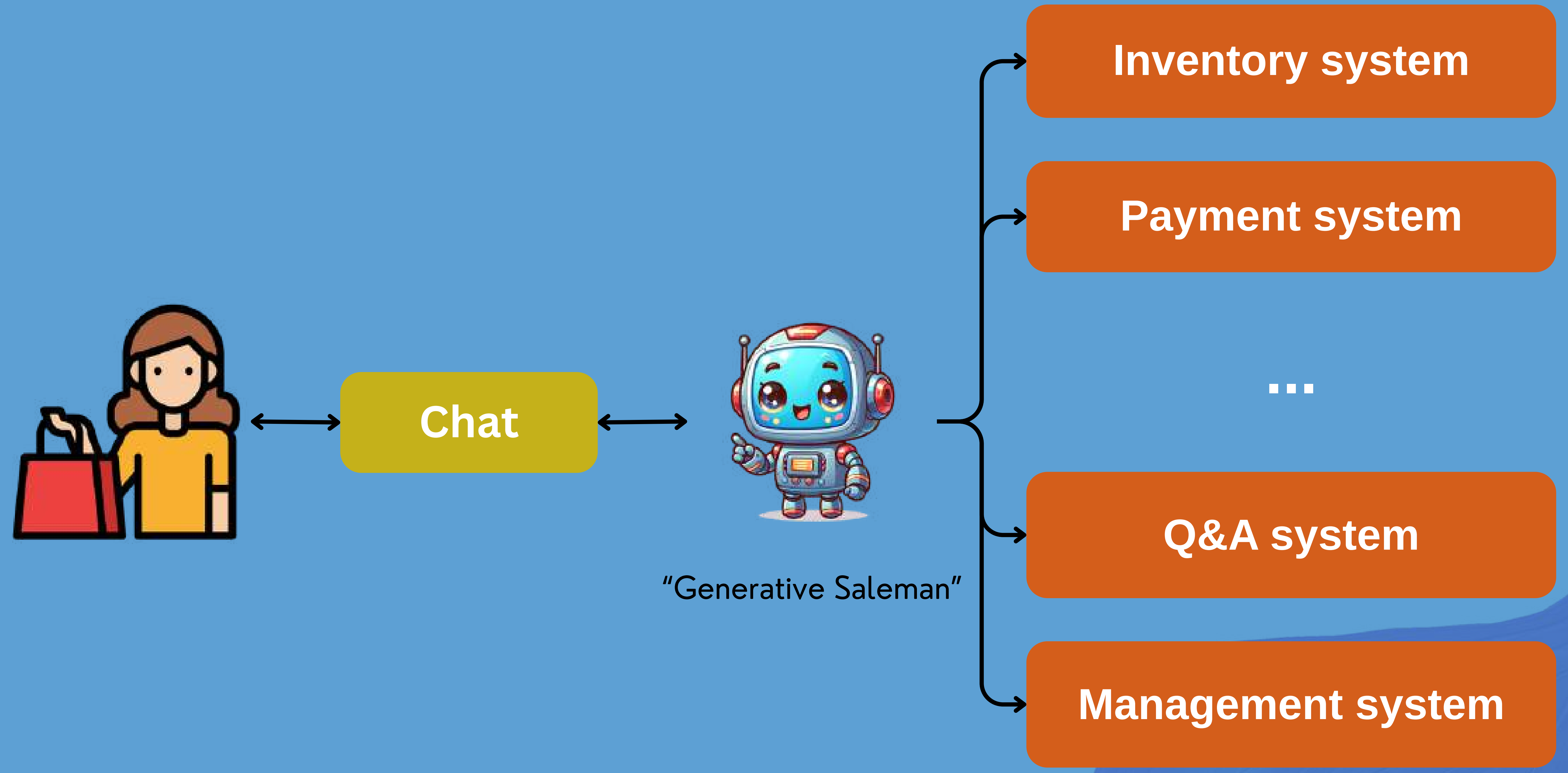
Qwen2.5-VL-72B

VS

LLaMA 3.1 405B
GPT-4
Claude 3.5
Gemini 1.5
และ SOTA อื่น ๆ

- Qwen2.5-VL-72B is clearly better than other model in Multimodel Task
- Qwen2.5-VL-72B is better perfomace in Math problem
- And have similar performance in General Language Understanding

Our Project Update



Chat
"Generative Saleman"
Inventory system
Payment system
...
Q&A system
Management system

Scope and Goal

- Thai language only
- For use exclusively in Board Game trading context only
- Not yet connected to social media chat application, initially includes only a simple and user-friendly UI

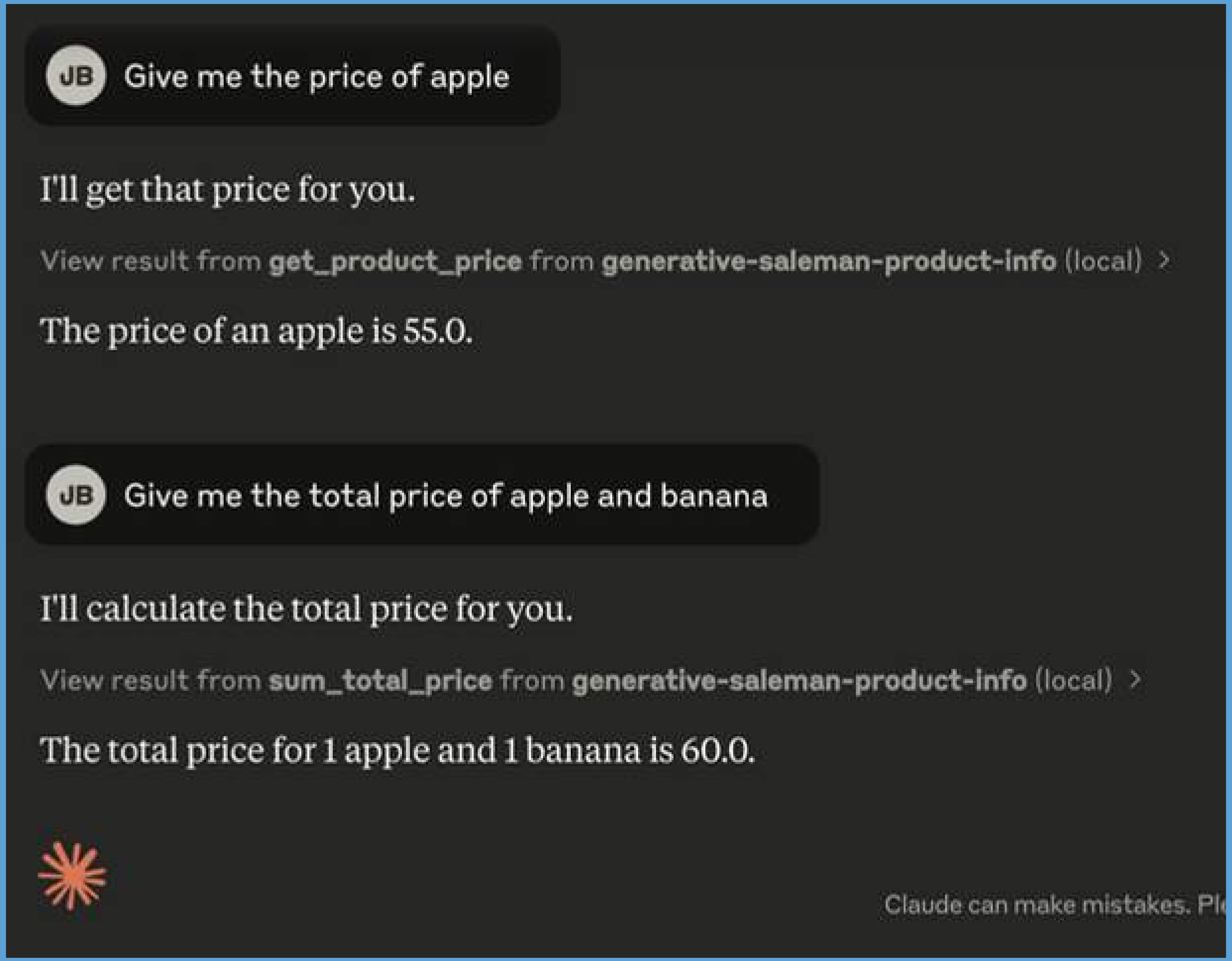
```python
# Add sum_total_price tool
@mcp.tool()
def sum_total_price(product_list: list[tuple[str, int]]) -> float:
    """
    Calculate the total price of a list of products.

    :param product_list: A list of product names which in form (product_name, quantity).
    :type product_list: list[tuple[str, int]]

    :return: The total price of the products.
    :rtype: float

    ## Example
    > sum_total_price([('apple', 1), ('banana', 1)])
    60.0
    > sum_total_price([('grape', 1), ('watermelon', 2)])
    95.0
    """
    total_price = 0
    for product, quantity in product_list:
        total_price += PRODUCT_NAME_TO_PRICE.get(product, 0) * quantity
    return total_price
```

Example code in MCP frameworks

Model Context Protocol

An open protocol that enables seamless integration between LLM applications and external data sources and tools. - Model Context Protocol

GitHub



Example usage in Claude Desktop

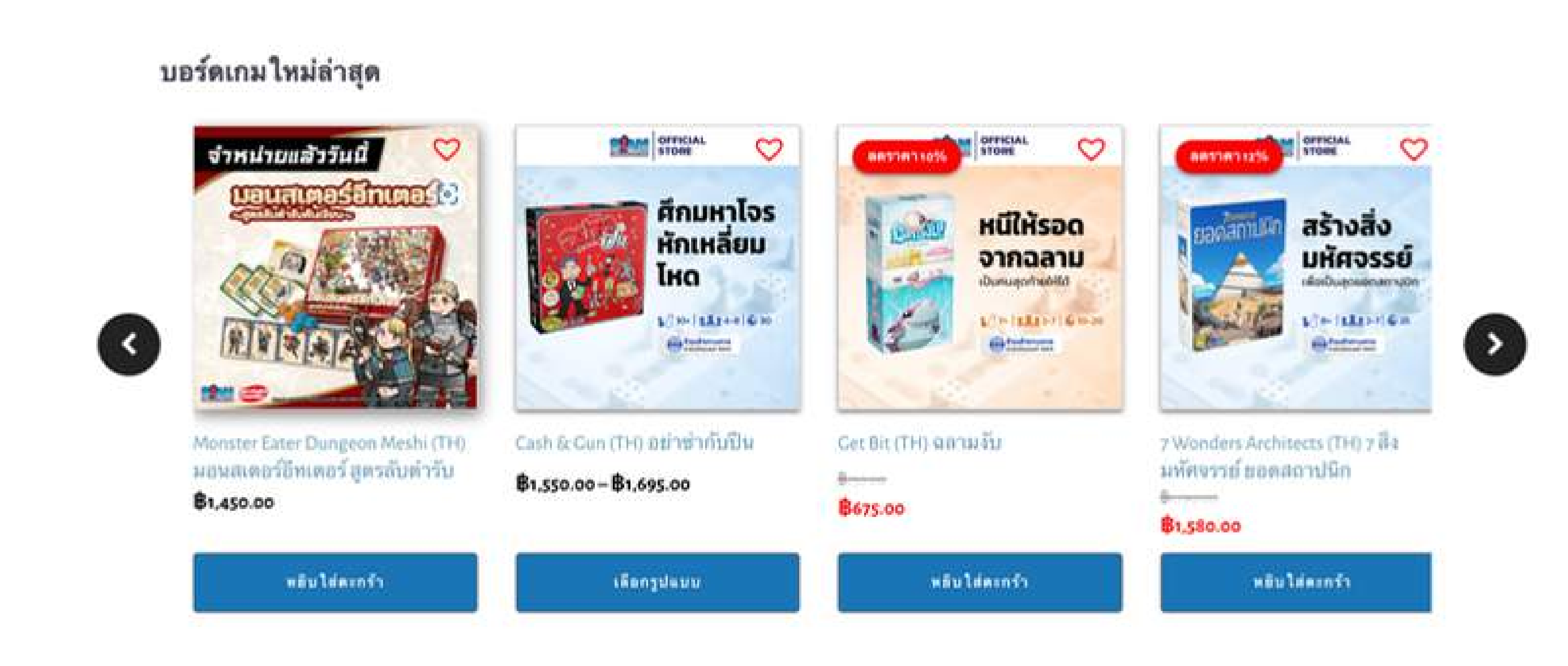
Payment Solutions

- Generate QR code from API https://promptpay.io/
- Using API from https://openslipverify.com/ to verify slip


```
{'success': True,
 'statusMessage': 'SUCCESS',
 'data': {'receivingBank': '004',
  'sendingBank': '004',
  'transRef': '0450855o5op7poh5wDDM',
  'transDate': '20250326',
  'transTime': '15:17',
  'sender': {'displayName': 'นาย ศุภฤกษ์ ค',
   'name': 'MR. SUPHAROEK K',
   'account': {'value': 'xxx-x-x8695-x'}},
  'billerID': '010753600031508',
  'billerName': 'MIXUE CU',
  'amount': 20,
  'compCode': '-',
  'ref1': 'KB000001896105',
  'ref2': 'KPS004KB000001896105',
  'ref3': '-'}}
```

Dataset

- Scaping Data from https://siamboardgames.com/
- Open Boardgame dataset https://www.kaggle.com/datasets/andrewmvd/board-games/data
- Huggingface https://huggingface.co/datasets/goendalf666/sales-conversations



ID BoardGamesGeek ID	Name Board game name	Year Published Year published	Min Players Min suggested players	Max Players Max suggested players	Play Average suggest creators
0 total values	20338 unique values	1948 total values	6875 total values	11135 total values	
174430	Gloomhaven	2017	1	4	120
161936	Pandemic Legacy: Season 1	2015	2	4	60
224517	Brass: Birmingham	2018	2	4	120
167791	Terraforming Mars	2016	1	5	120
233078	Twilight Imperium: Fourth Edition	2017	3	6	480
291457	Gloomhaven: Jaws of the Lion	2020	1	4	120
182028	Through the Ages: A New Story of Civilization	2015	2	4	120
220308	Gaia Project	2017	1	4	150
187645	Star Wars: Rebellion	2016	2	4	240