Institute for Infocomm Research

I²R

END OF STUDIES INTERNSHIP DEFENSE

Visual tasks representation for remote perception and guidance using a wearable device

Gouneau Joceran, supervised by Ng Lai Xing

7th of September 2023

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Introduction

Institute for Infocomm Research

I²R

"To create digital world innovations for a thriving and resilient Singapore harnessing AI, Connectivity and Cybersecurity."

Human-in-the-loop systems; Augmented reality

Task Assistant using a wearable device

CREATING GROWTH, ENHANCING LIVES

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Problem

source: https://ego4d-data.org/

- Episodic Memory
- Hand-Object Interactions
- Audio-Visual Diarization
- Social Interactions
- Forecasting

CREATING GROWTH, ENHANCING LIVES

Problem

Given a video V and a timestamp t, the model should be able, given V up to t, to predict the next active objects :

$$\{(\hat{b}_i, \hat{n}_i, \hat{v}_i, \hat{\delta}_i, \hat{s}_i)\}_{i=1}^{N}$$

Where :

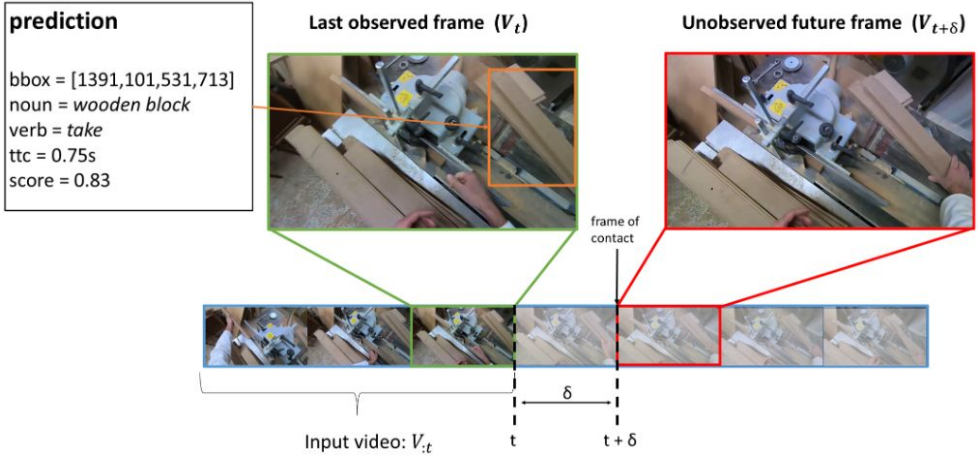
$\hat{b}_i$ is the bounding box at t.

$\hat{n}_i$ is a *name*.

$\hat{v}_i$ is a *verb*.

$\hat{\delta}_i$ is the *time to contact* from t.

$\hat{s}_i$ is a confidence score.



F. Ragusa et al. *Stillfast: An end-to-end approach for short-term object interaction anticipation*, 2023.

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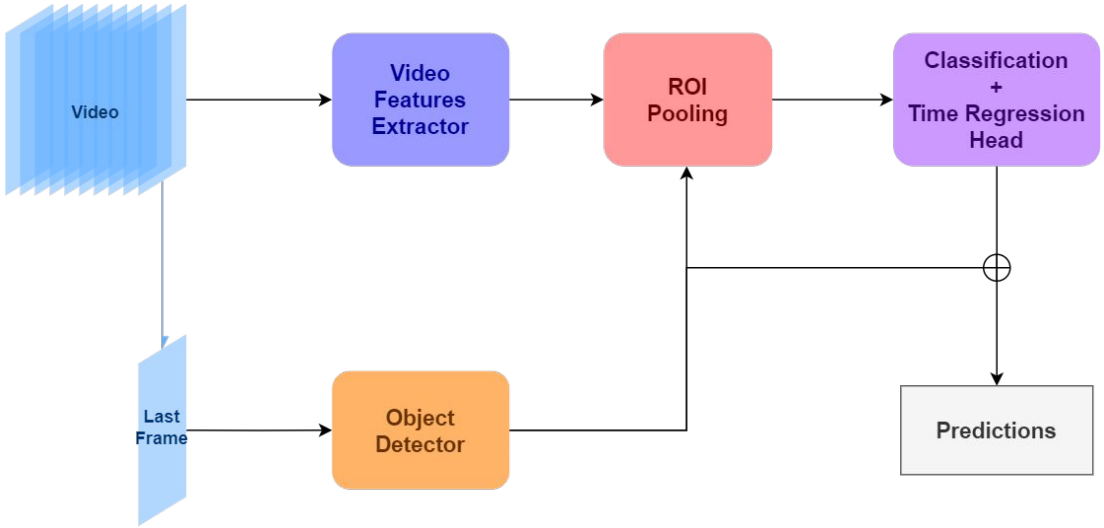
Current Solutions

Model Name	Object Detector	Video Backbone	Dataset Version	$\mathbf{mAP}_{\text{Overall}}$
Baseline V1	Faster RCNN	SlowFast	V1	2.45
InternVideo	DINO DETR	VideoMAE	V1	3.40
Baseline V2	Faster RCNN	SlowFast	V2	3.61



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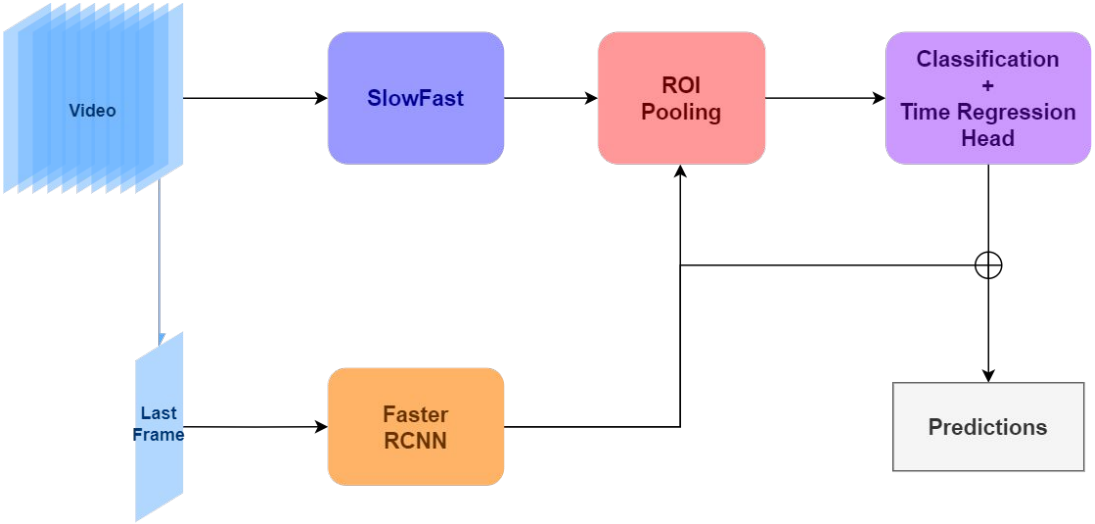
Baseline



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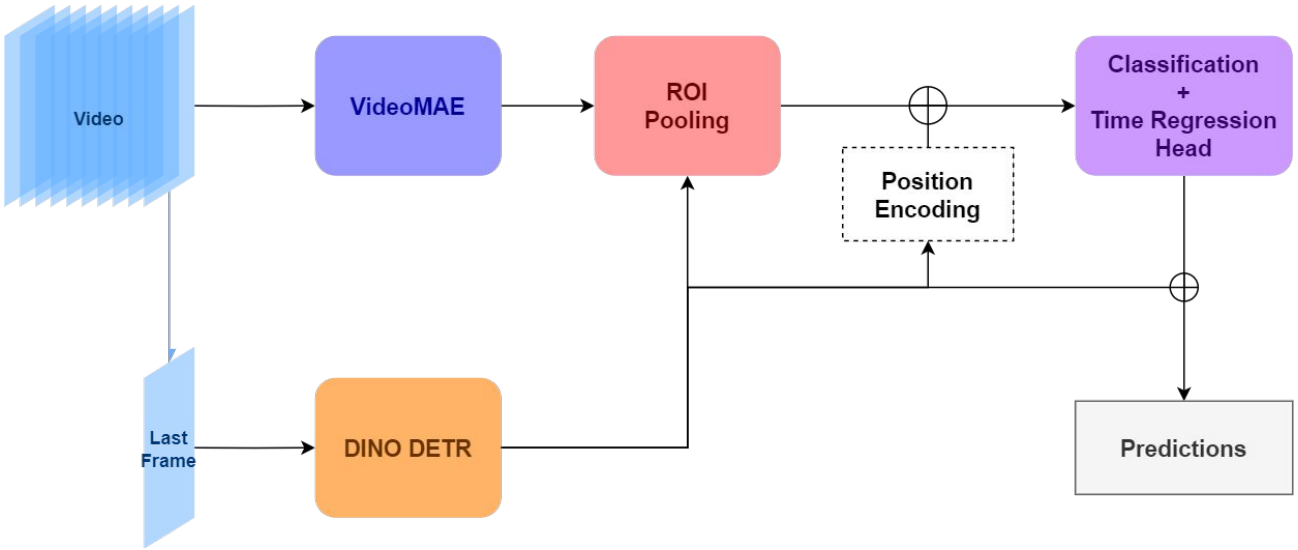
InternVideo



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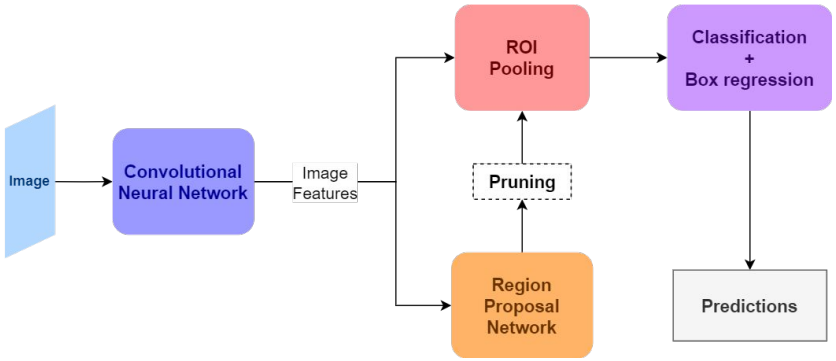
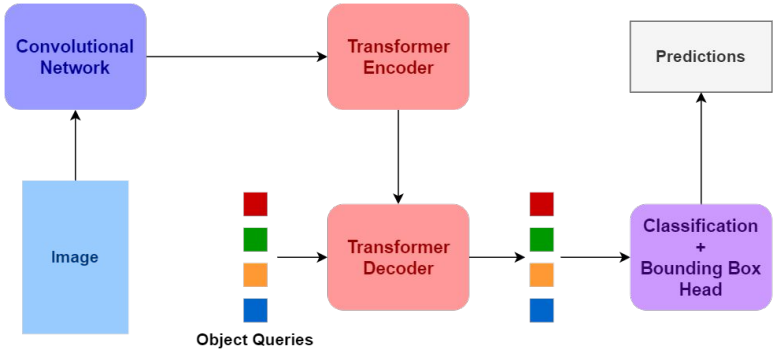
Transformers for Detection



Faster RCNN



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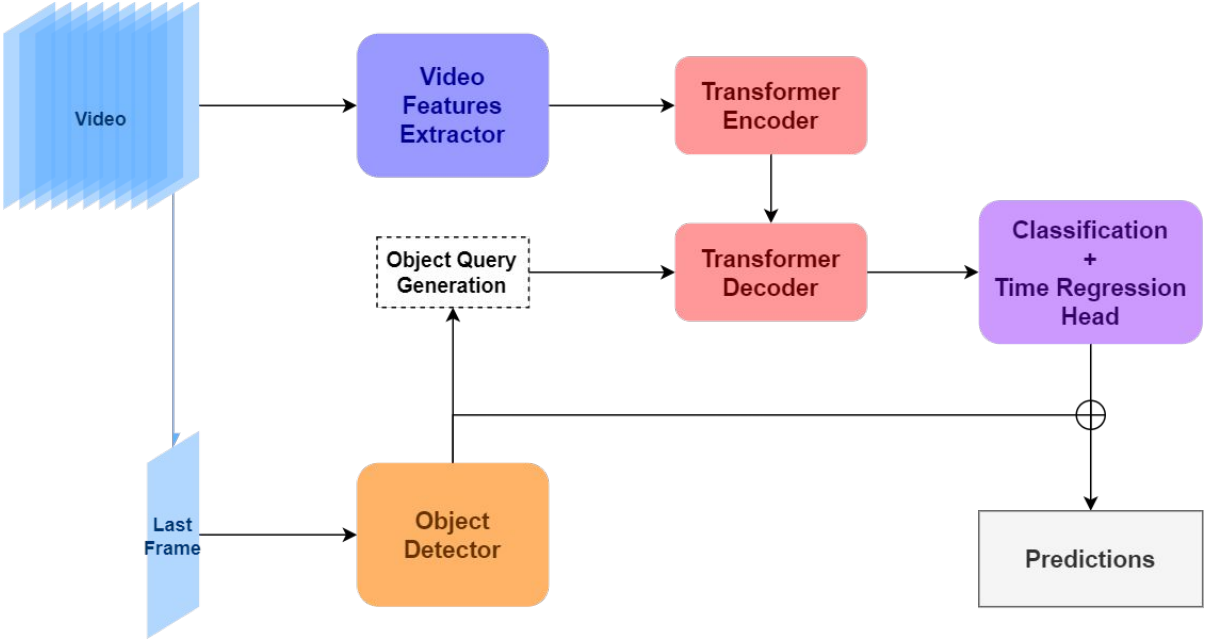

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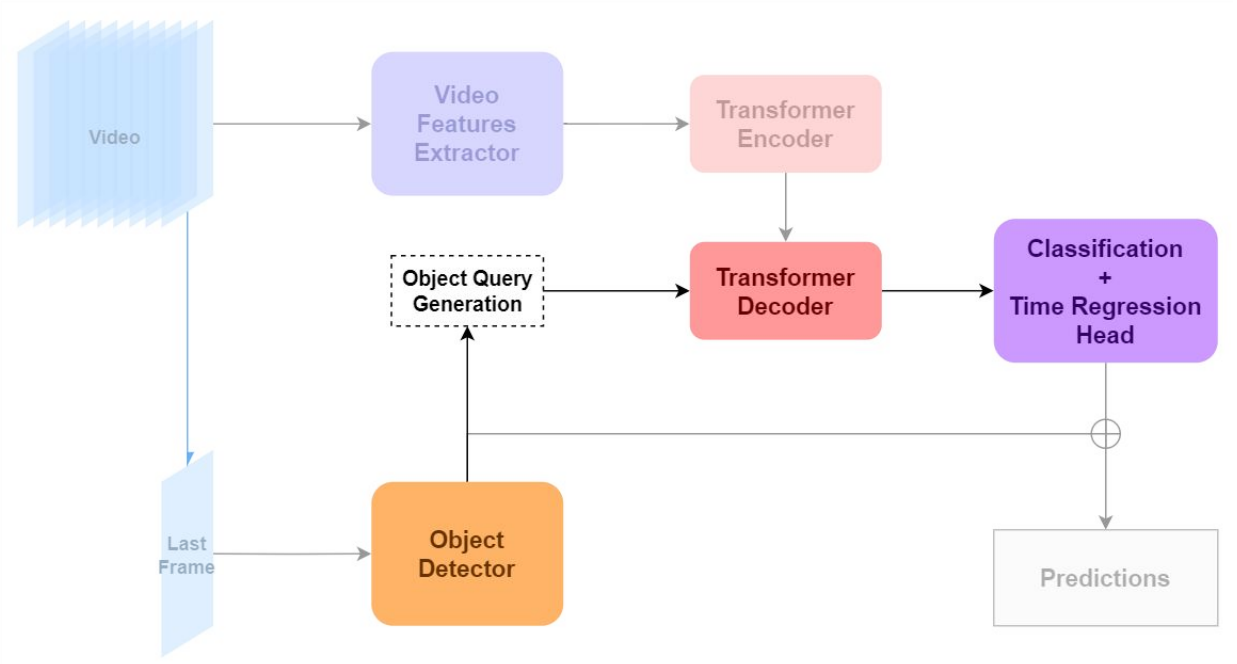

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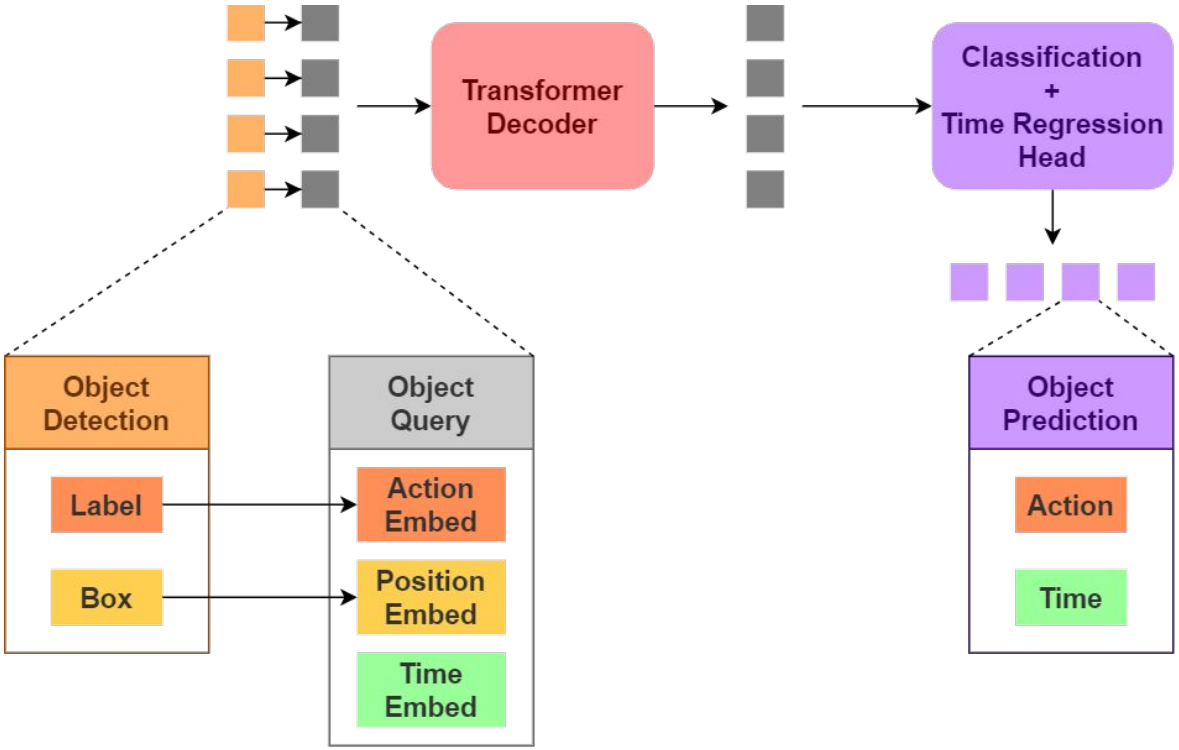

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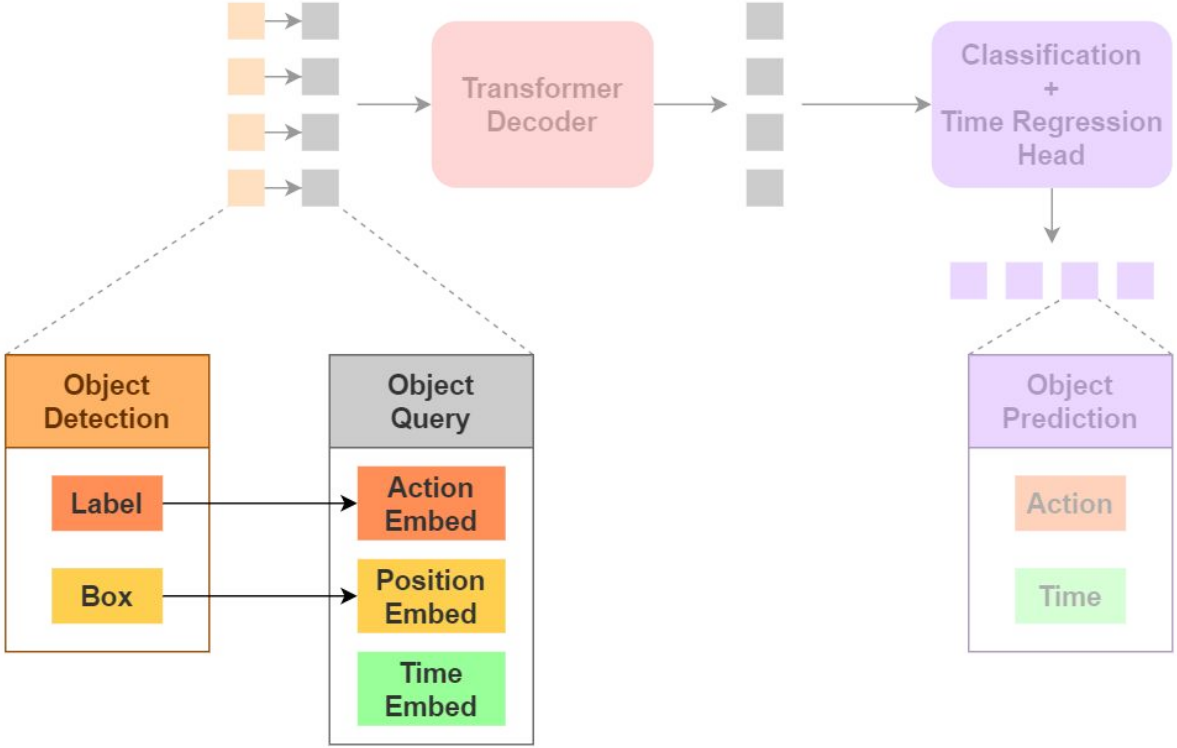

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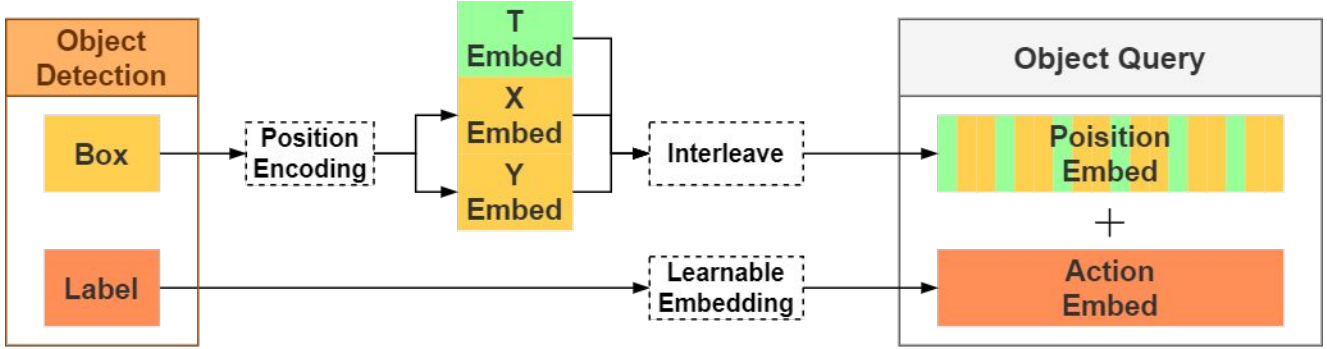
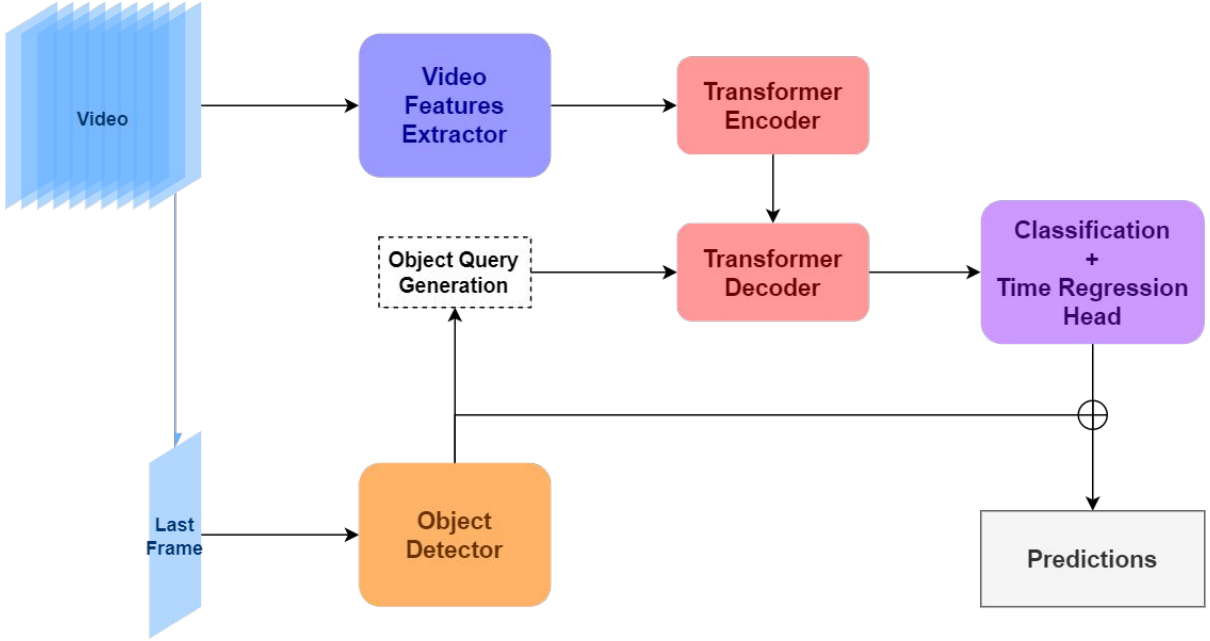

Object Detection
Box
Label
Position Encoding
T Embed
X Embed
Y Embed
Interleave
Learnable Embedding
Object Query
Poisition Embed
+
Action Embed

Method



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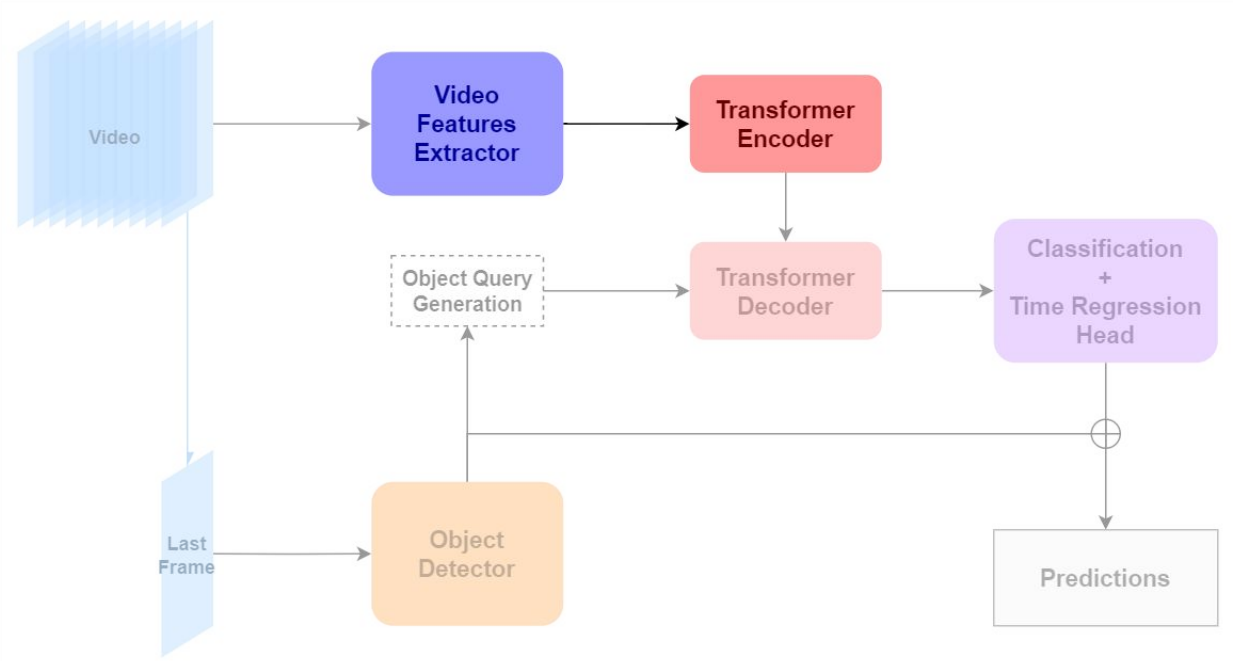

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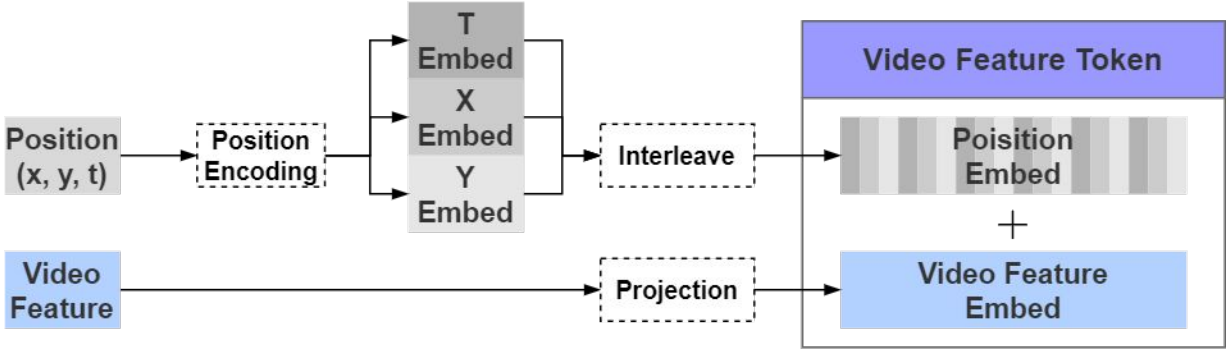

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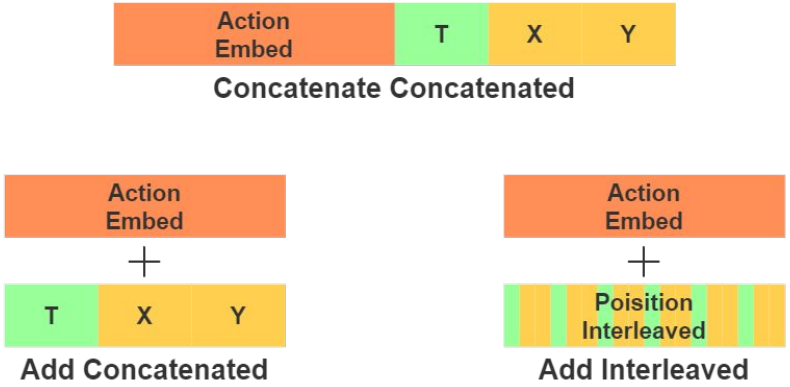
Jupyter Notebook Quickstart

- pre-extracted video features by Omnivore:
  - frozen
  - time only dependent



Model Name	$\mathbf{mAP}_{\text{Box, Noun}}$	$\mathbf{mAP}_{\text{Box, Noun, Verb}}$	$\mathbf{mAP}_{\text{Box, Noun, TTC}}$	$\mathbf{mAP}_{\text{Overall}}$
Notebook Baseline	29.11	10.08	**7.16**	2.61
Concat Concatenate		10.00	6.57	2.38
Add Concatenate		9.81	5.92	2.21
Add Interleaved		**10.38**	6.68	**2.69**

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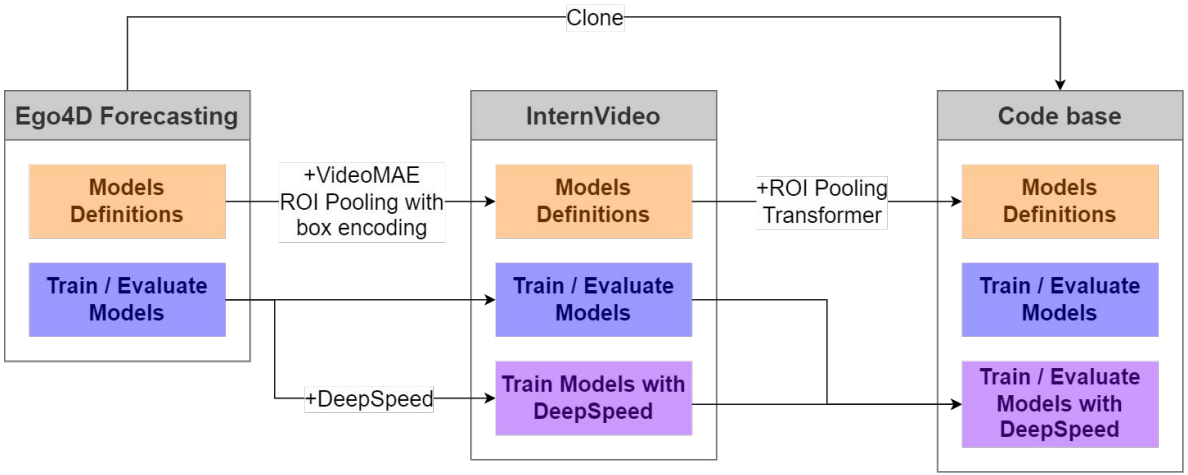
Building the Codebase

- Ego4D Forecasting:
  - Official Training / Evaluation scripts;
  - SlowFast definition (pre-trained on Kinetics-400);
  - Baseline definition;
- InternVideo:
  - Modified Training Pipeline using DeepSpeed;
  - VideoMAE definition (pre-trained on Ego4D V1);



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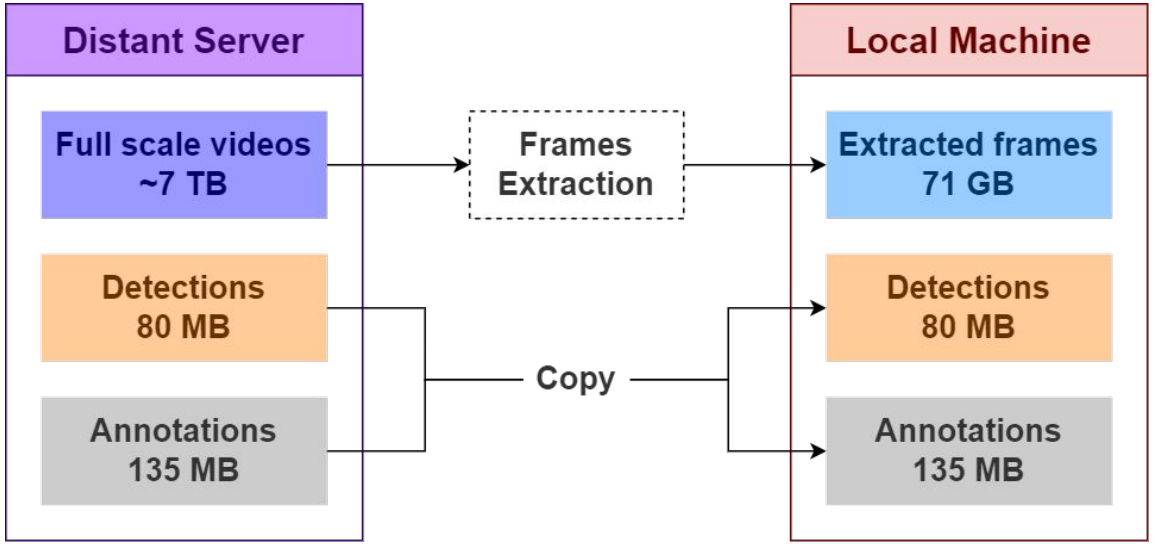
Accessing and Preprocessing the Data



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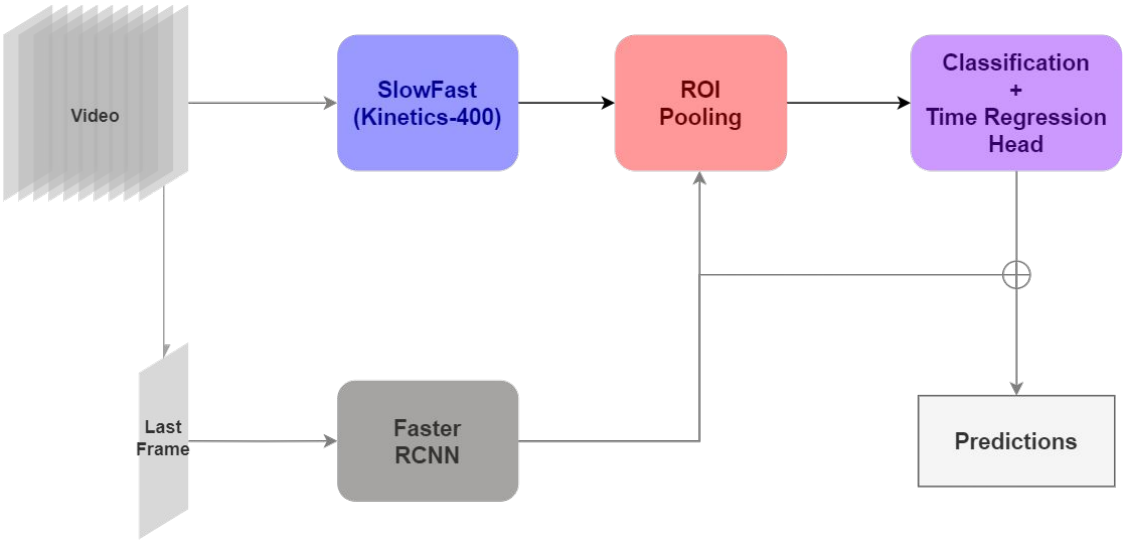
Establishing Our Baseline



Subset	$\mathbf{mAP}_{\text{Box, Noun}}$	$\mathbf{mAP}_{\text{Box, Noun, Verb}}$	$\mathbf{mAP}_{\text{Box, Noun, TTC}}$	$\mathbf{mAP}_{\text{Overall}}$
validation	24.79	8.86	7.58	2.66
test	26.15	9.48	8.11	3.36

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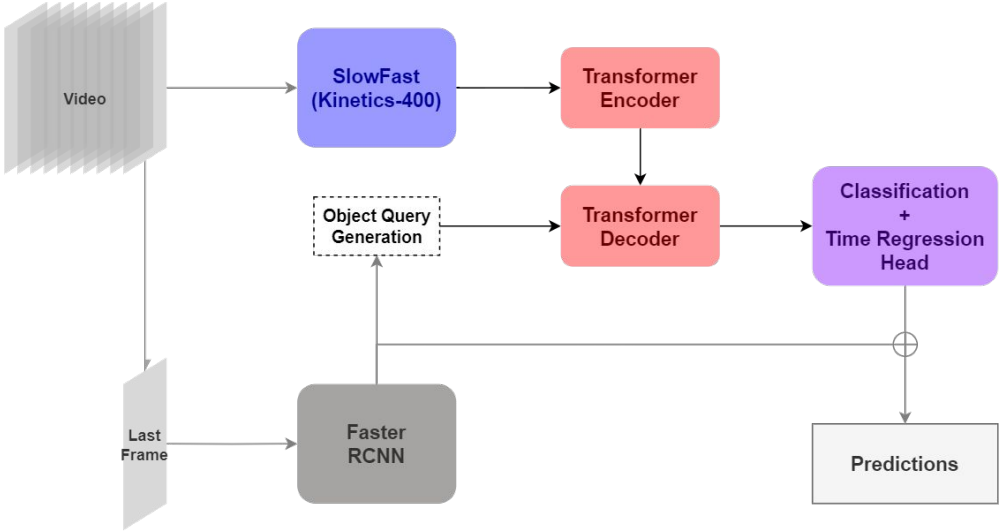
Using SlowFast as a Backbone



Subset	$\mathbf{mAP}_{\text{Box, Noun}}$	$\mathbf{mAP}_{\text{Box, Noun, Verb}}$	$\mathbf{mAP}_{\text{Box, Noun, TTC}}$	$\mathbf{mAP}_{\text{Overall}}$
validation	24.79	8.83	7.21	3.24
test	26.15	9.90	7.62	3.28

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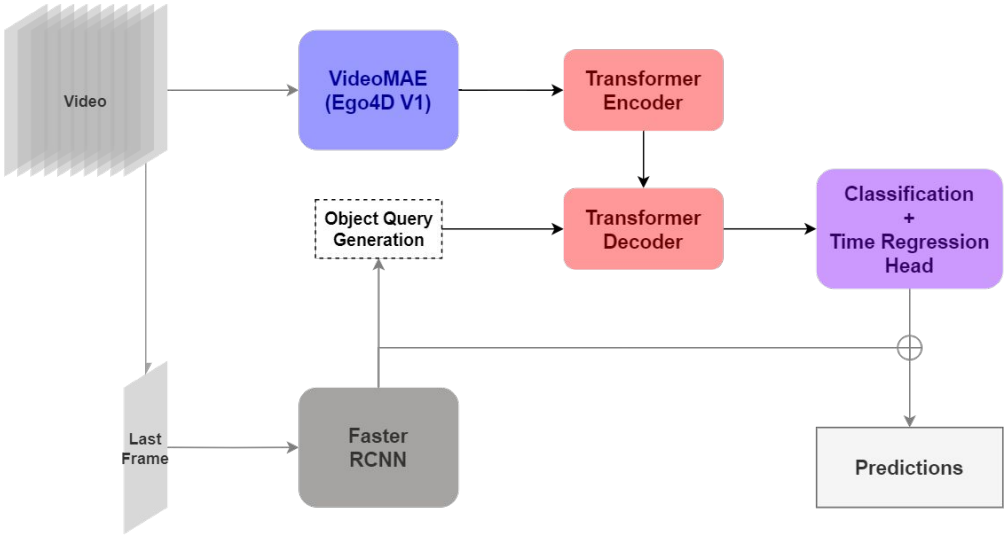
Using VideoMAE as a Backbone



Subset	$\mathbf{mAP}_{\text{Box, Noun}}$	$\mathbf{mAP}_{\text{Box, Noun, Verb}}$	$\mathbf{mAP}_{\text{Box, Noun, TTC}}$	$\mathbf{mAP}_{\text{Overall}}$
validation	24.79	10.48	8.70	3.92
test	26.15	11.25	9.22	4.75

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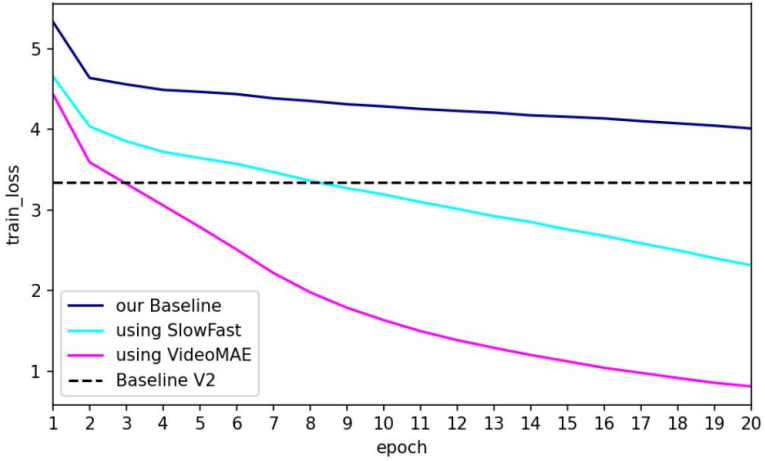
Comparison

Model	$\mathbf{mAP}_{\text{B, N}}$	$\mathbf{mAP}_{\text{B, N, V}}$	$\mathbf{mAP}_{\text{B, N, TTC}}$	$\mathbf{mAP}_{\text{Overall}}$
Baseline V1	20.45	6.78	6.17	2.45
InternVideo	24.60	9.19	7.64	3.40
Using SlowFast	**26.15**	9.90	7.62	3.28
Our Baseline		9.48	8.11	3.36
Baseline V2		9.45	8.69	3.61
Using VideoMAE		11.25	**9.22**	4.75
StillFast	25.06	13.29	9.14	5.12
GANO	25.67	**13.60**	9.02	**5.16**



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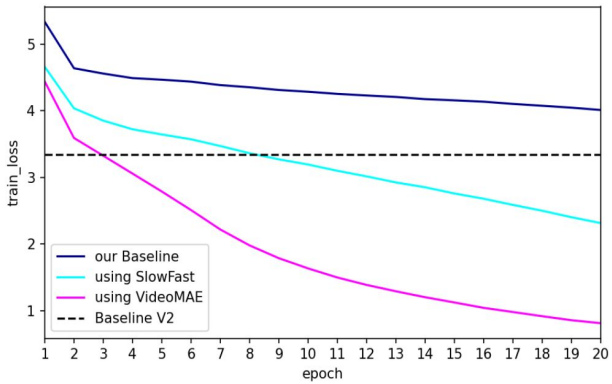
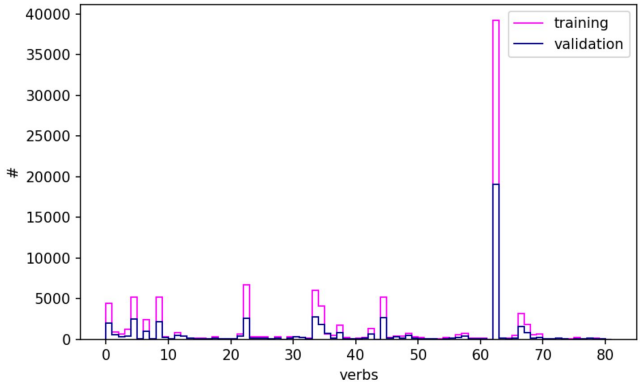
Areas of Improvement



Epoch	Subset	$\mathbf{Loss}_{\text{Total}}$	$\mathbf{Loss}_{\text{Verb}}$	$\mathbf{Loss}_{\text{TTC}}$	$\mathbf{mAP}_{\text{Overall}}$
20	train	0.82	0.27	0.05	
	validation	5.61	3.61	0.20	3.92
2	train	3.59	1.82	0.17	
	validation	4.02	2.13	0.19	2.70



Subset	Training		Validation	
Detections	GT	Pred	GT	Pred
$\mathbf{mAP}_{\text{Box, Noun}}$	100	46.01	100	24.79
$\mathbf{mAP}_{\text{Box, Noun, Verb}}/\mathbf{mAP}_{\text{Box, Noun}}$	84.15	77.14	42.41	42.28
$\mathbf{mAP}_{\text{Box, Noun, TTC}}/\mathbf{mAP}_{\text{Box, Noun}}$	45.31	41.80	38.30	35.09
$\mathbf{mAP}_{\text{Overall}}/\mathbf{mAP}_{\text{Box, Noun}}$	39.02	33.71	18.52	15.81

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Conclusion

Thank you !

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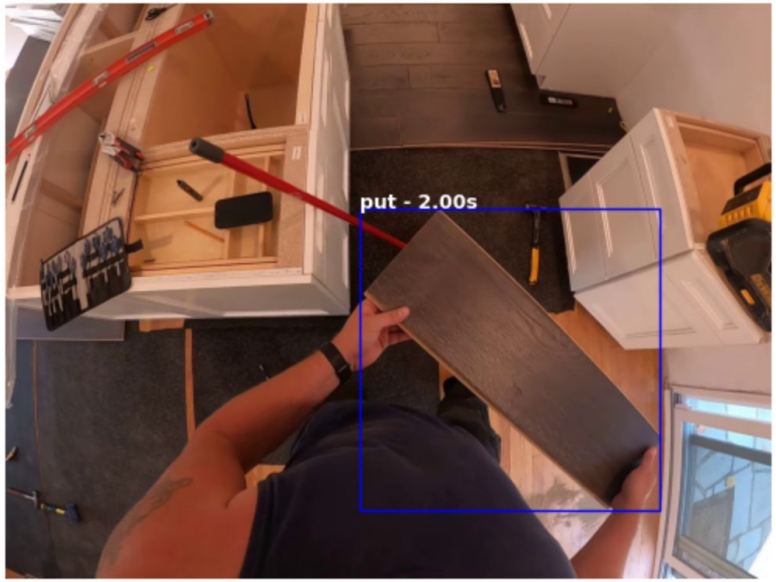
I²R

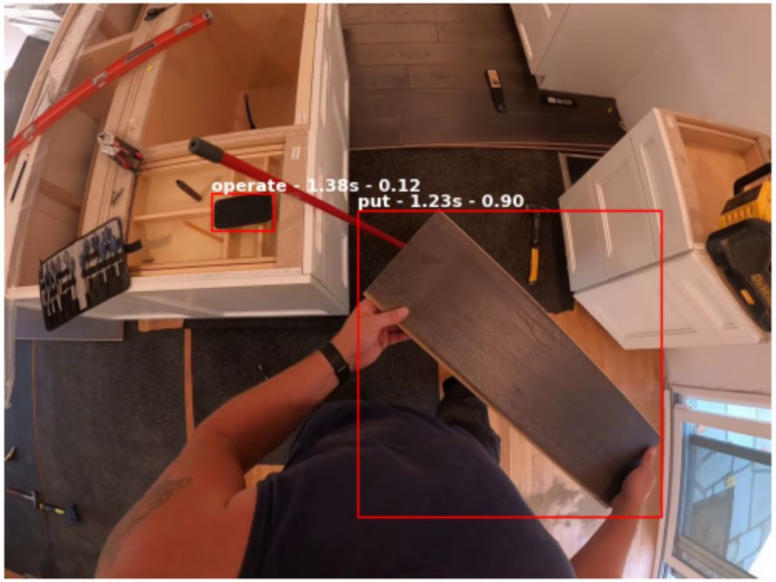
END OF STUDIES INTERNSHIP DEFENSE

Visual tasks representation for remote perception and guidance using a wearable device

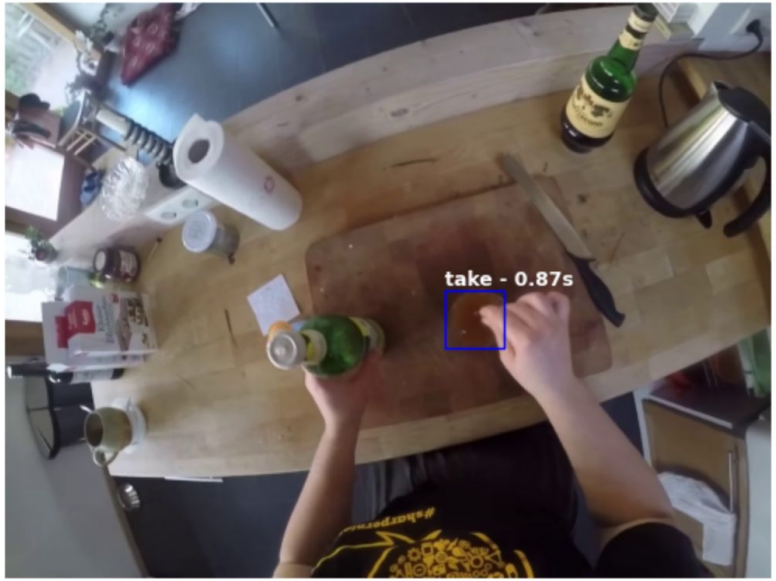
Gouneau Joceran, supervised by Ng Lai Xing

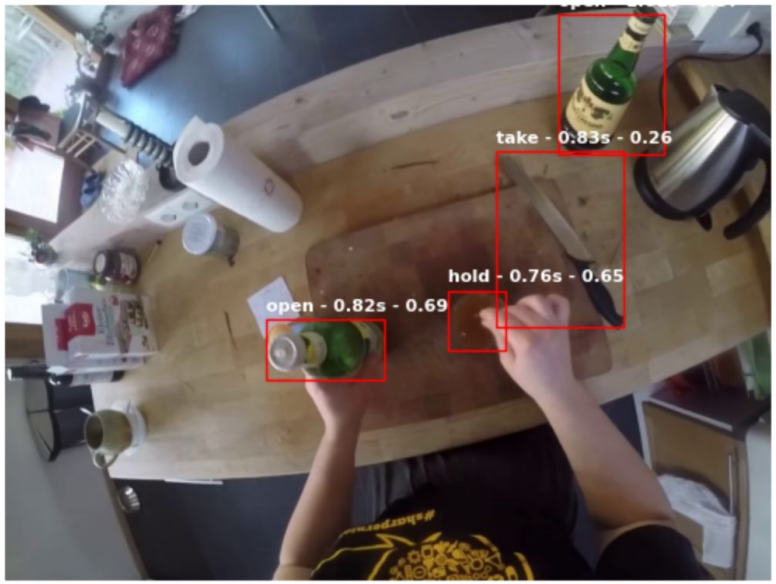
7th of September 2023



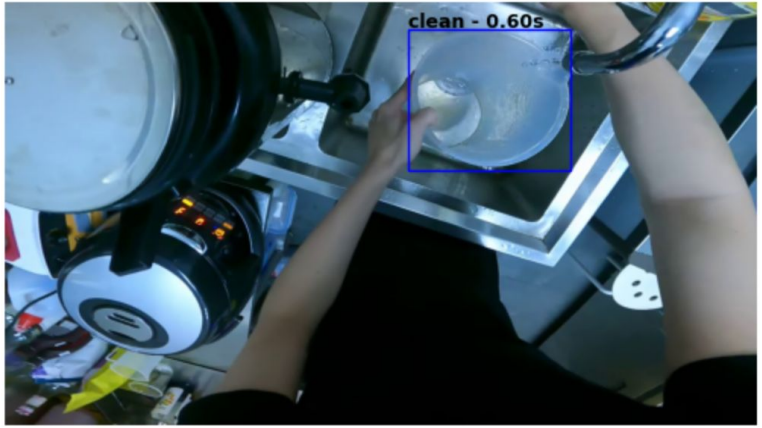


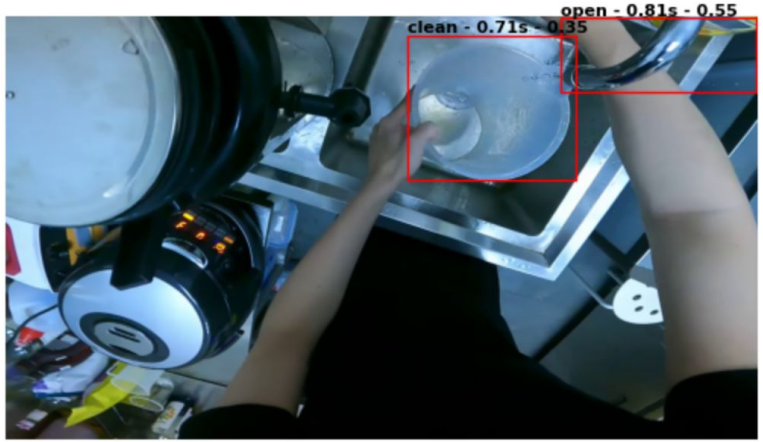
Training - Using VideoMae



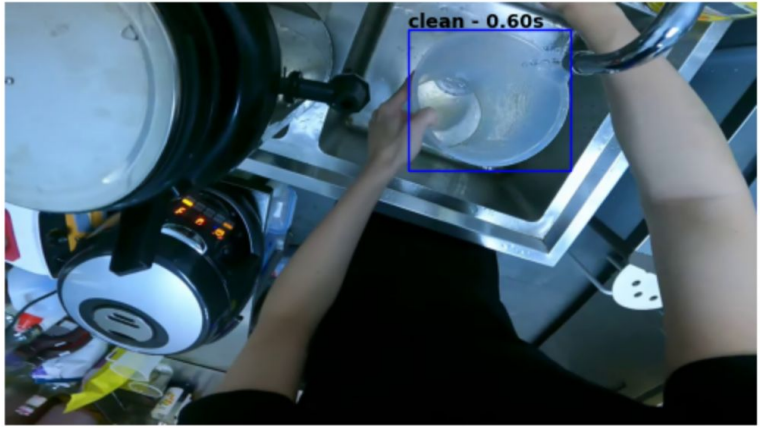


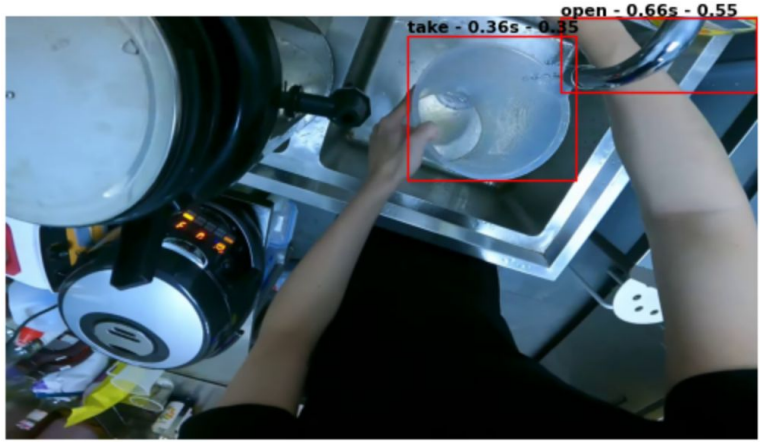
Training - Using VideoMae





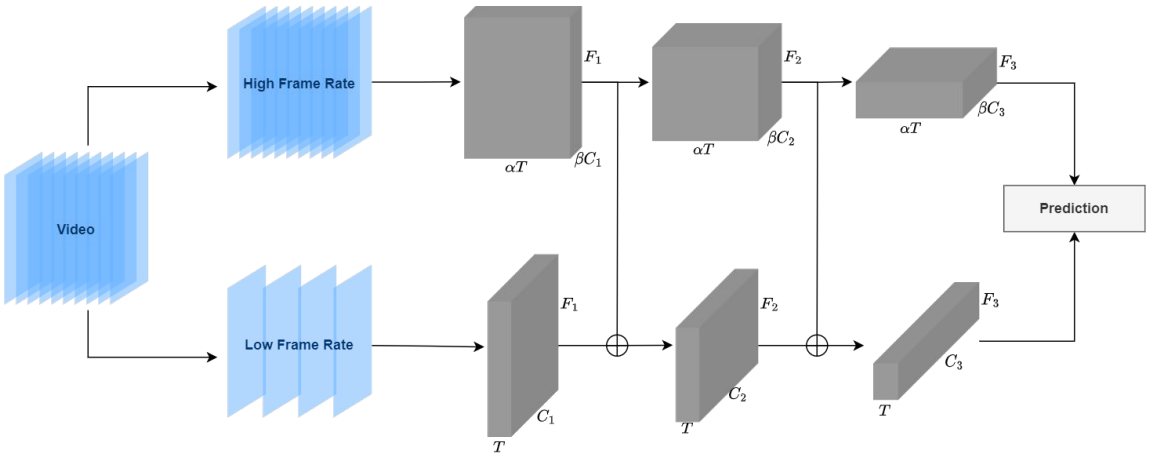
Validation - Using VideoMAE





Validation - Using SlowFast

SlowFast



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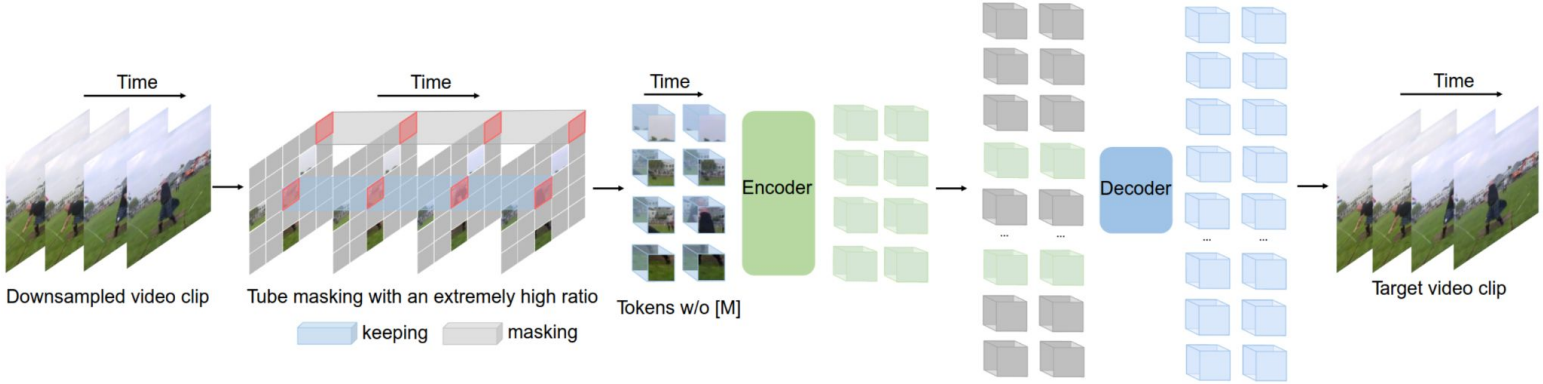
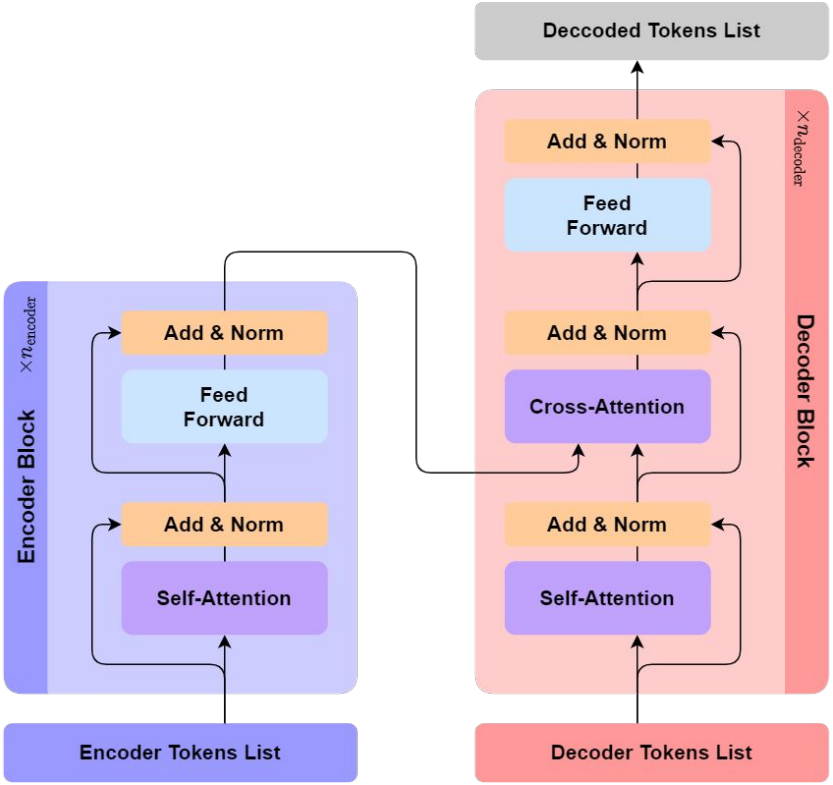
VideoMAE

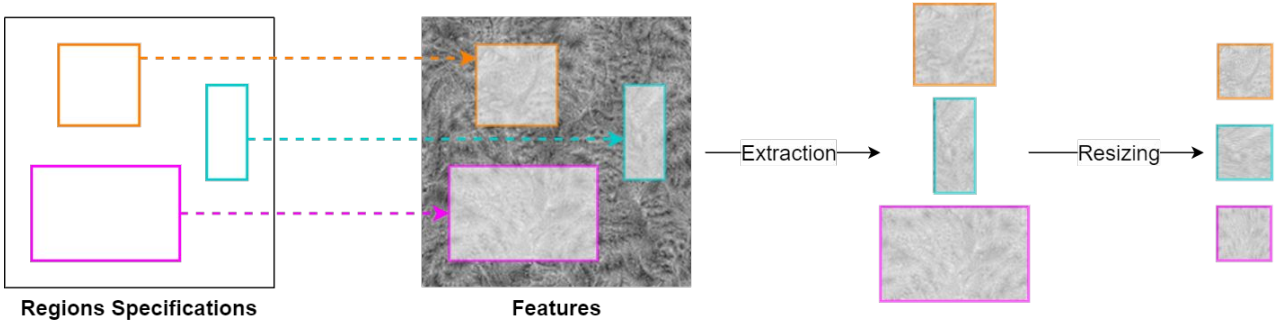


Z. Tong et al. *Videomae: Masked autoencoders are data-efficient learners for self-supervised video pre-training*, 2022

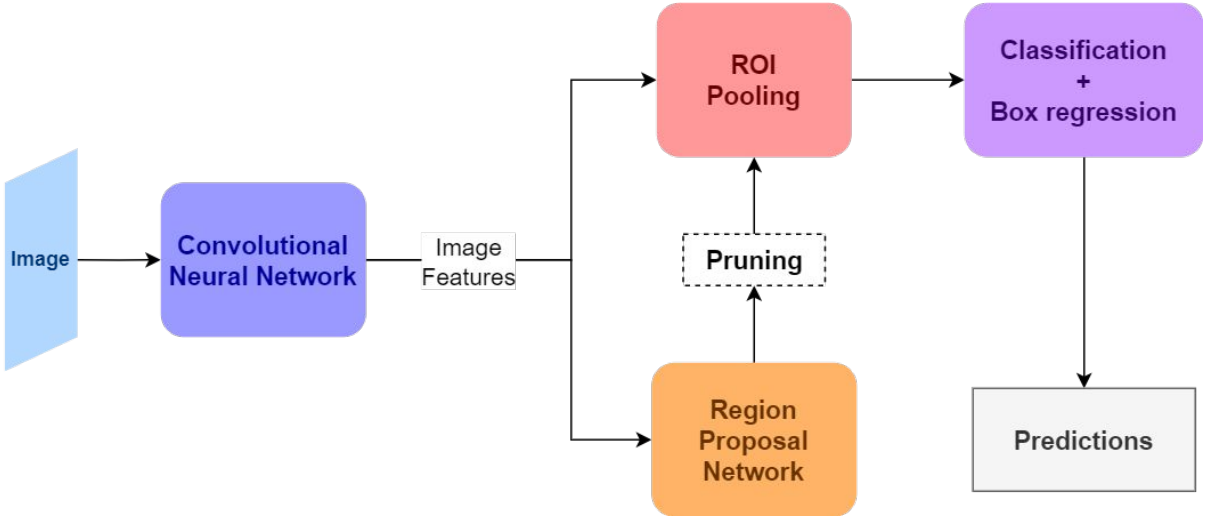
Transformer



ROI Pooling



Faster RCNN



Ground Truth Attribution

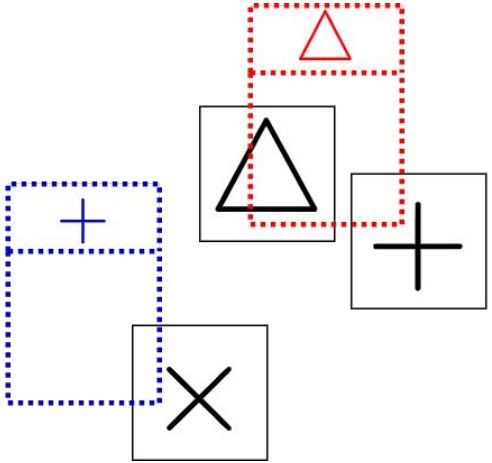


Table of Correspondence		
Detections		
Ground Truth		

Packing and Un-packing Data