Decoupling Features in Hierarchical Propagation for Video Object Segmentation

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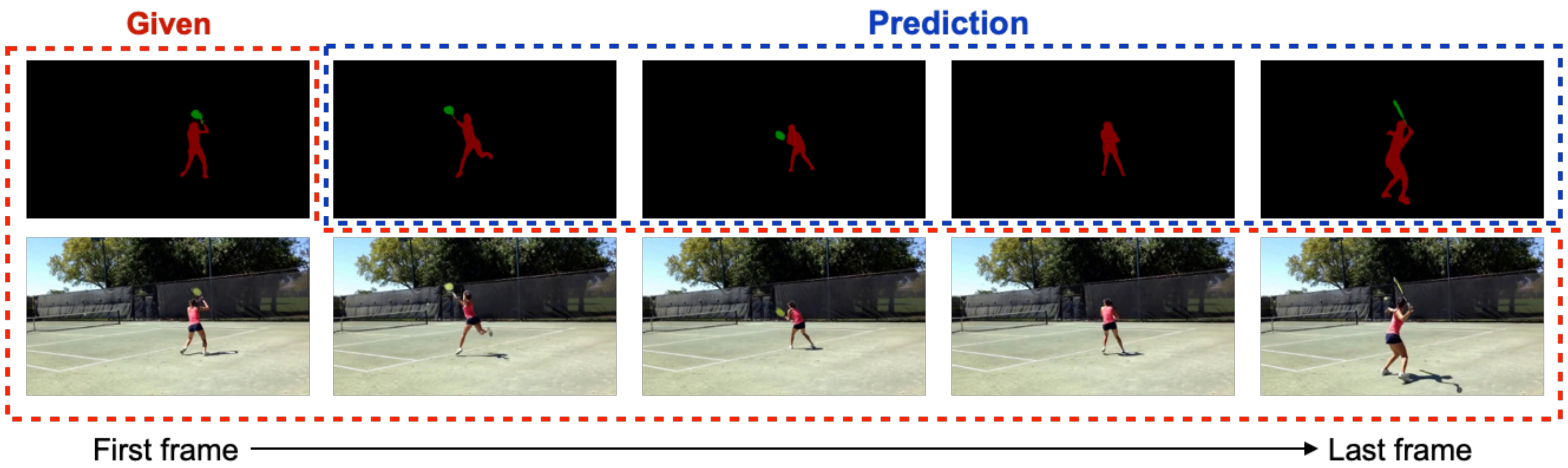
Task

Semi-supervised Video Object Segmentation (VOS)



Single-object results

Multi-object (panoptic) results

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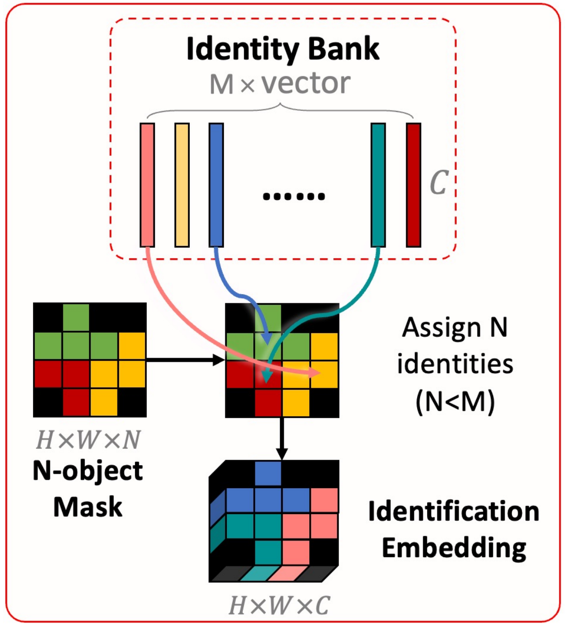
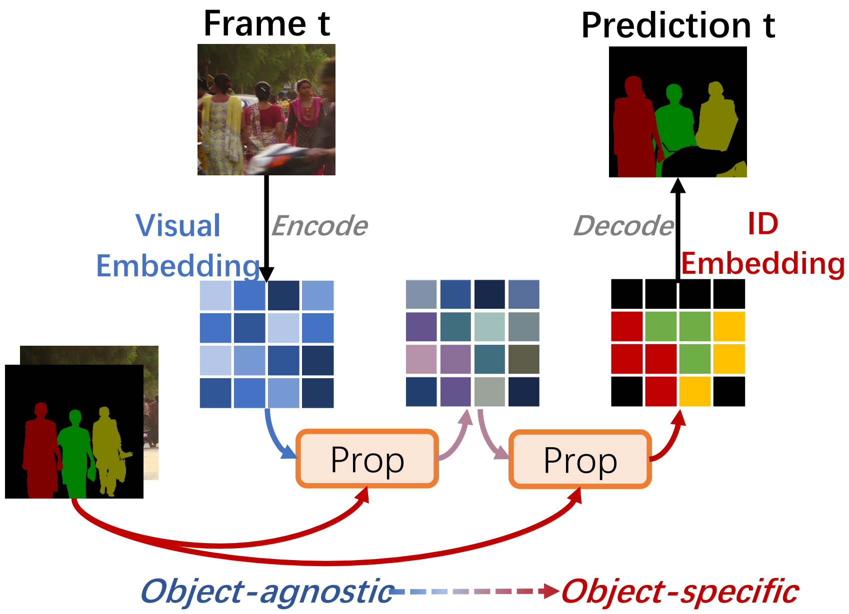
Revisit Hierarchical Propagation for VOS

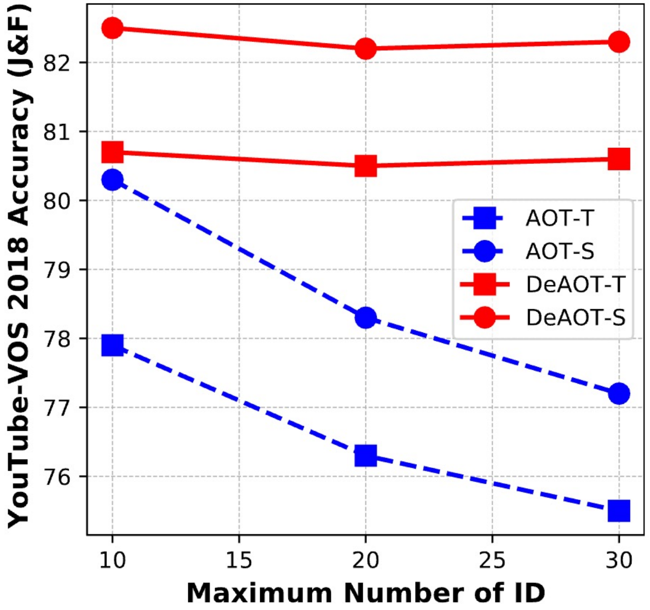
Absorbing the ID information leads to the oblivion of visual information



IDentification (ID) embedding



AOT[1]-like propagation



In AOT, more ID information, worse accuracy

[1] Yang, Zongxin, Yunchao Wei, and Yi Yang. "Associating objects with transformers for video object segmentation." NeurIPS 2021

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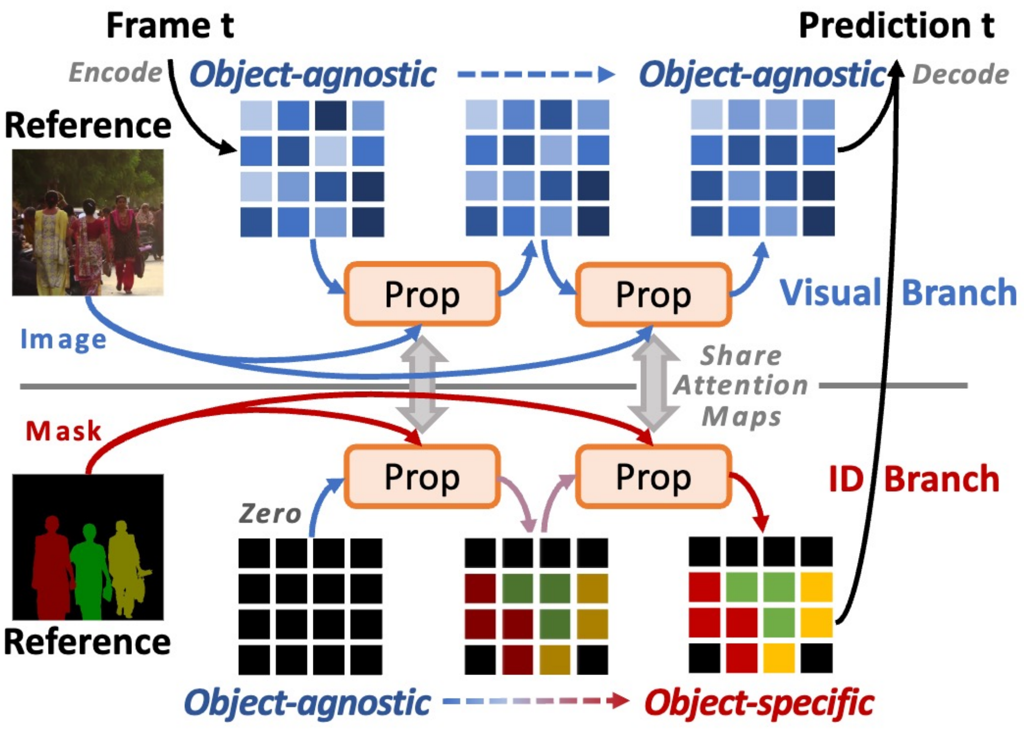
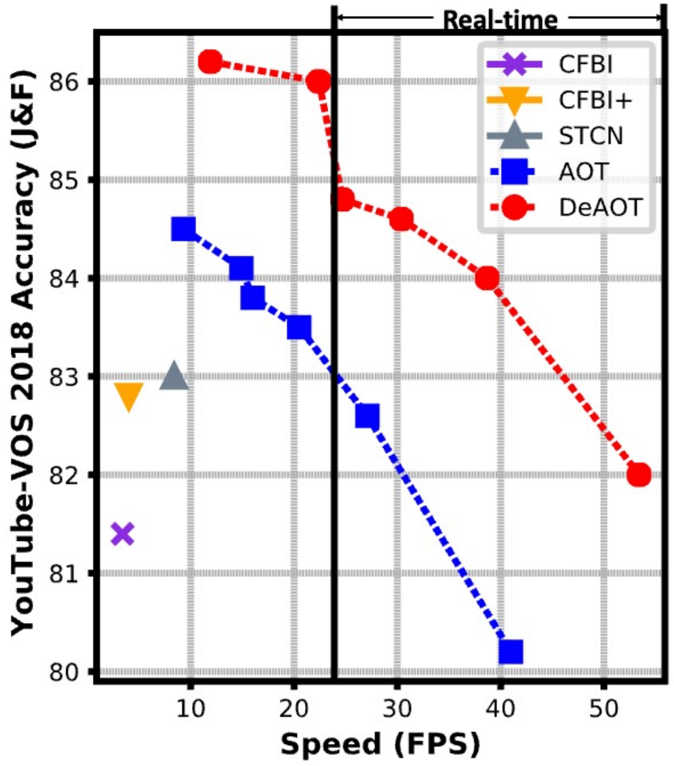
Our Solution: Decoupling Features

Decouple object-agnostic and object-specific informations



Decoupling Features in Hierarchical Propagation (DeAOT)



DeAOT variants achieve superior accuracy and efficiency

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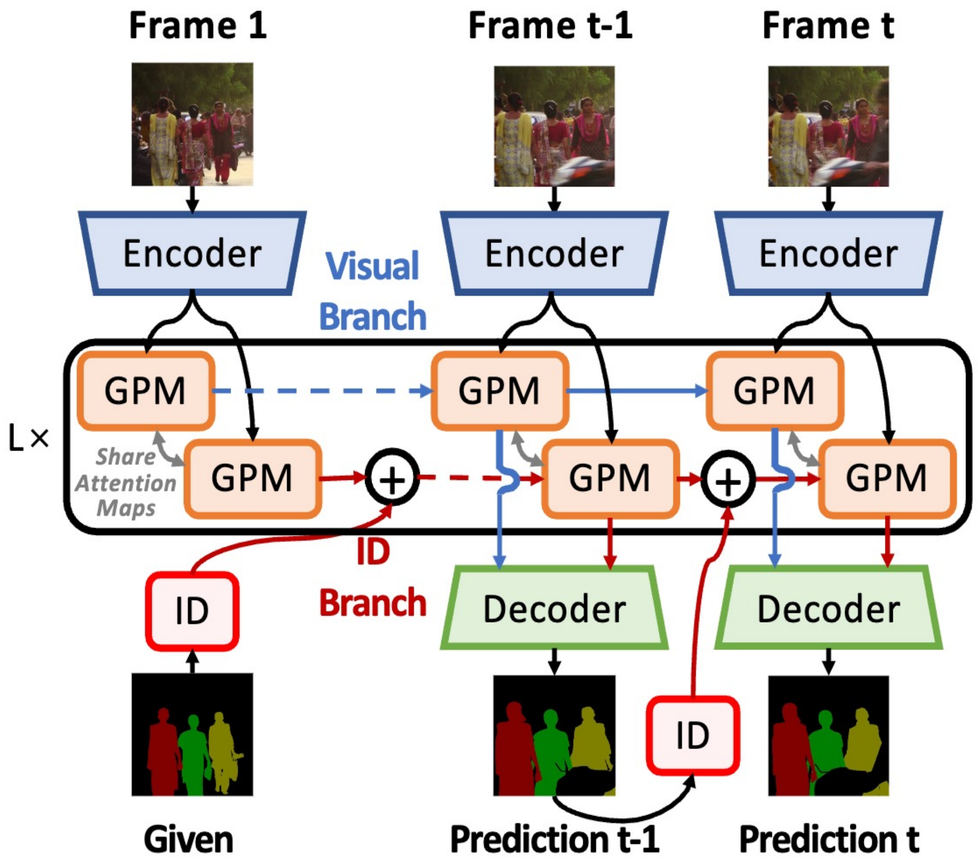
Decoupling Features in Hierarchical Propagation

Overview

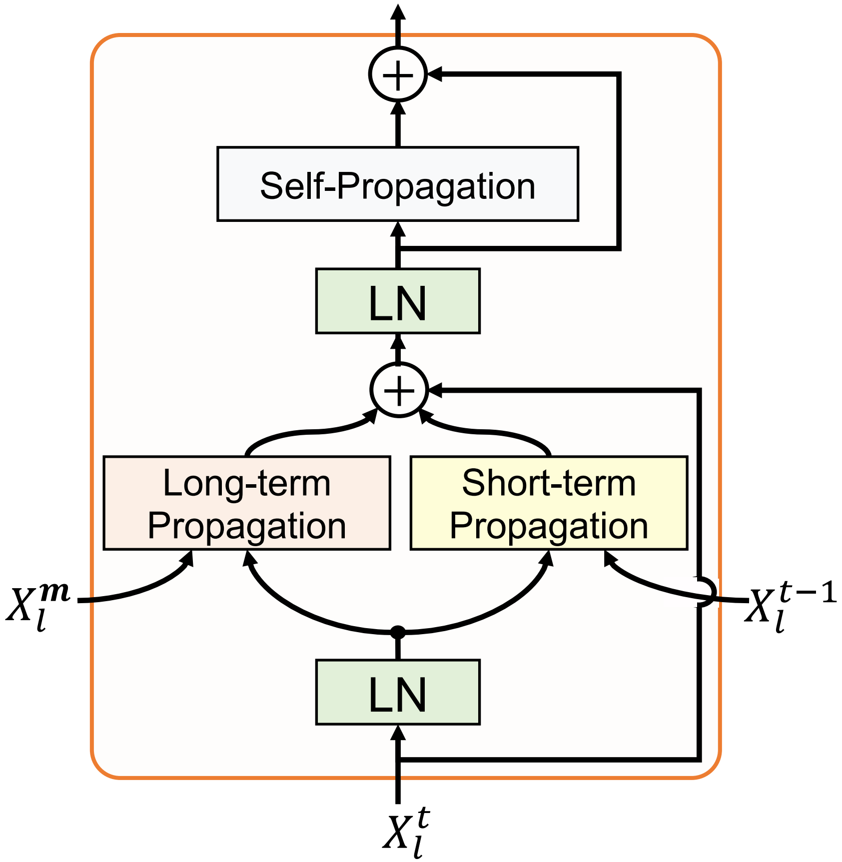
Our DeAOT decouples the propagation of visual embedding and ID embedding in two branches, i.e., **Visual Branch** and **ID Branch**.

The efficient propagation module, Gated Propagation Module (**GPM**) , shares attention maps between two branches.

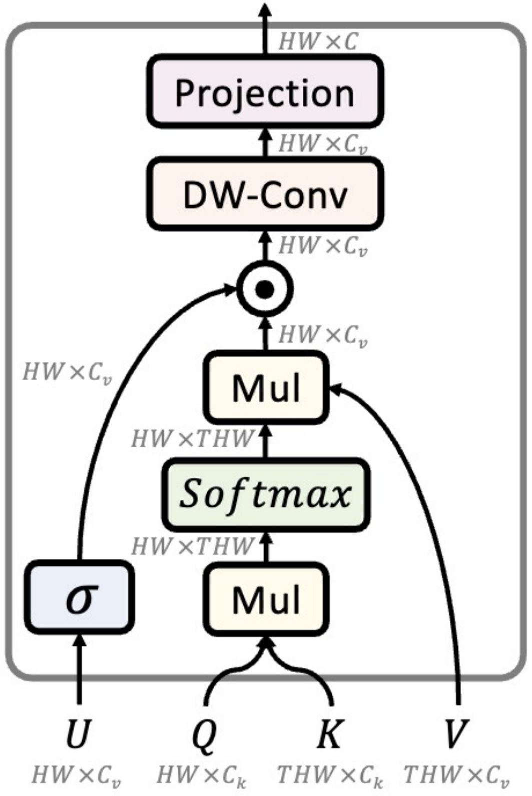


Gated Propagation Module

For efficient hierarchical propagation



Gated Propagation Module



Gated Propagation Function

	Robustness	Computation
Multi-head attention	Good	Heavy
Single-head attention	Limited	Light
Gated propagation	Good	Light

Gated propagation improves single-head attention by light-weight gated process and depth-wise convolution (DW-Conv)

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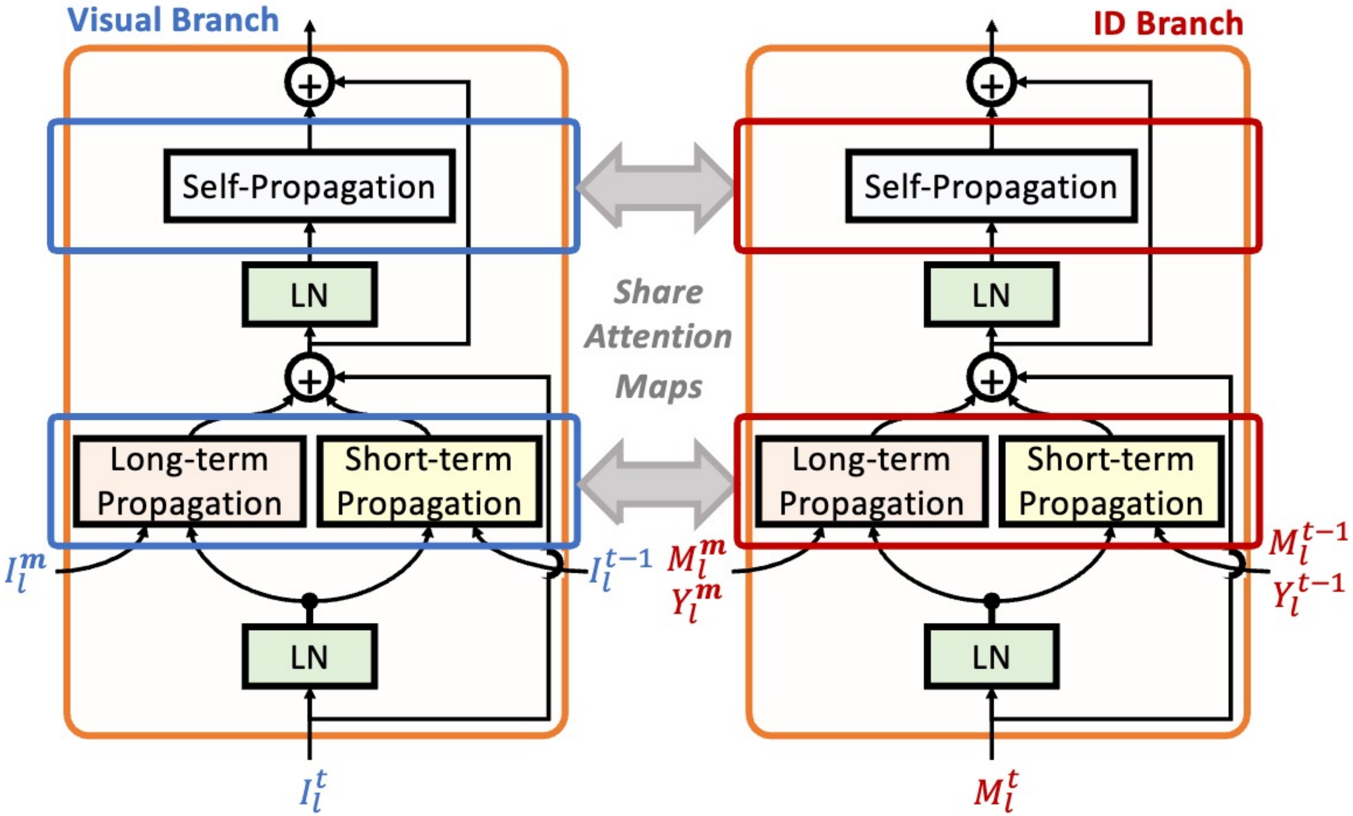
Dual-branch Propagation

For decoupling visual and identification embeddings



- **Visual Branch**: calculate attention maps, propagate visual embedding
- **ID Branch**: reuse the attention maps from Visual Branch, propagate ID embedding

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Results: Multi-object benchmarks

Compare DeAOT variants with SOTA methods

YouTube-VOS (large-scale) DAVIS 2017 (small-scale)

	YouTube-VOS 2018 Val					YouTube-VOS 2019 Val						DAVIS-17 Val			DAVIS-17 Test			
Method	Avg	$\mathcal{J}_S$	$\mathcal{F}_S$	$\mathcal{J}_U$	$\mathcal{F}_U$	Avg	$\mathcal{J}_S$	$\mathcal{F}_S$	$\mathcal{J}_U$	$\mathcal{F}_U$	fps	Avg	$\mathcal{J}$	$\mathcal{F}$	Avg	$\mathcal{J}$	$\mathcal{F}$	fps
KMN[ECCV20] [43]	81.4	81.4	85.6	75.3	83.3	-	-	-	-	-	-	82.8	80.0	85.6	77.2	74.1	80.3	-
CFBI[ECCV20] [62]	81.4	81.1	85.8	75.3	83.4	81.0	80.6	85.1	75.2	83.0	3.4	81.9	79.3	84.5	76.6	73.0	80.1	2.9
SST[CVPR21] [17]	81.7	81.2	-	76.0	-	81.8	80.9	-	76.6	-	-	82.5	79.9	85.1	-	-	-	-
HMMN[ICCV21] [44]	82.6	82.1	87.0	76.8	84.6	82.5	81.7	86.1	77.3	85.0	-	84.7	81.9	87.5	78.6	74.7	82.5	$3.4^{\ddagger}$
CFBI+[TPAMI21] [64]	82.8	81.8	86.6	77.1	85.6	82.6	81.7	86.2	77.1	85.2	4.0	82.9	80.1	85.7	78.0	74.4	81.6	3.4
STCN[NeurIPS21] [11]	83.0	81.9	86.5	77.9	85.7	82.7	81.1	85.4	78.2	85.9	$8.4^{\star}$	85.4	82.2	88.6	76.1	72.7	79.6	$19.5^{\star}$
RPCM[AAAI22] [58]	84.0	83.1	87.7	78.5	86.7	83.9	82.6	86.9	79.1	87.1	-	83.7	81.3	86.0	79.2	75.8	82.6	-
AOT-T [63]	80.2	80.1	84.5	74.0	82.2	79.7	79.6	83.8	73.7	81.8	41.0	79.9	77.4	82.3	72.0	68.3	75.7	51.4
DeAOT-T	**82.0**	**81.6**	**86.3**	**75.8**	**84.2**	**82.0**	**81.2**	**85.6**	**76.4**	**84.7**	**53.4**	**80.5**	**77.7**	**83.3**	**73.7**	**70.0**	**77.3**	**63.5**
AOT-S [63]	82.6	82.0	86.7	76.6	85.0	82.2	81.3	85.9	76.6	84.9	27.1	**81.3**	**78.7**	**83.9**	73.9	70.3	77.5	40.0
DeAOT-S	**84.0**	**83.3**	**88.3**	**77.9**	**86.6**	**83.8**	**82.8**	**87.5**	**78.1**	**86.8**	**38.7**	80.8	77.8	83.8	**75.4**	**71.9**	**79.0**	**49.2**
AOT-B [63]	83.5	82.6	87.5	77.7	86.0	83.3	82.4	87.1	77.8	86.0	20.5	**82.5**	**79.7**	**85.2**	75.5	71.6	79.3	29.6
DeAOT-B	**84.6**	**83.9**	**88.9**	**78.5**	**87.0**	**84.6**	**83.5**	**88.3**	**79.1**	**87.5**	**30.4**	82.2	79.2	85.1	**76.2**	**72.5**	**79.9**	**40.9**
AOT-L [63]	83.8	82.9	87.9	77.7	86.5	83.7	82.8	87.5	78.0	**86.7**	16.0	83.8	**81.1**	86.4	**78.3**	**74.3**	**82.3**	18.7
DeAOT-L	**84.8**	**84.2**	**89.4**	**78.6**	**87.0**	**84.7**	**83.8**	**88.8**	**79.0**	**87.2**	**24.7**	**84.1**	81.0	**87.1**	77.9	74.1	81.7	**28.5**
R50-AOT-L [63]	84.1	83.7	88.5	78.1	86.1	84.1	83.5	88.1	**78.4**	86.3	14.9	84.9	**82.3**	87.5	79.6	75.9	83.3	18.0
R50-DeAOT-L	**86.0**	**84.9**	**89.9**	**80.4**	**88.7**	**85.9**	**84.6**	**89.4**	**80.8**	**88.9**	**22.4**	**85.2**	82.2	**88.2**	**80.7**	**76.9**	**84.5**	**27.0**
SwinB-AOT-L [63]	84.5	84.3	89.3	77.9	86.4	84.5	84.0	88.8	78.4	86.7	9.3	85.4	82.4	88.4	81.2	77.3	85.1	12.1
SwinB-DeAOT-L	**86.2**	**85.6**	**90.6**	**80.0**	**88.4**	**86.1**	**85.3**	**90.2**	**80.4**	**88.6**	**11.9**	**86.2**	**83.1**	**89.2**	**82.8**	**78.9**	**86.7**	**15.4**

more

GPM Number

less

DeAOT-L: state-of-the-art

DeAOT-T: real-time

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Results: Single-object benchmarks

Compare DeAOT variants with SOTA methods

DAVIS 2016:
Video Object Segmentation

VOT 2020:
Visual Object Tracking

	DAVIS 2016				VOT 2020	
Method	Avg	$\mathcal{J}$	$\mathcal{F}$	fps	EAO	EAO^{RT}
CFBI+ [64]	89.9	88.7	91.1	5.9	-	-
RPCM [58]	90.6	87.1	94.0	5.8	-	-
HMMN [44]	90.8	89.6	92.0	10.0	-	-
STCN [11]	91.6	90.8	92.5	27.2*	-	-
AlphaRef [59]	-	-	-	-	0.482	0.486
RPT [33]	-	-	-	-	0.530	0.290
MixFormer-L [14]	-	-	-	-	0.555	-
AOT-T [63]	86.8	86.1	87.4	51.4	0.435	0.433
DeAOT-T	**88.9**	**87.8**	**89.9**	**63.5**	**0.472**	**0.463**
AOT-S [63]	**89.4**	**88.6**	90.2	40.0	0.512	0.499
DeAOT-S	89.3	87.6	**90.9**	**49.2**	**0.593**	**0.559**
AOT-B [63]	89.9	88.7	91.1	29.6	0.541	0.533
DeAOT-B	**91.0**	**89.4**	**92.5**	**40.9**	**0.571**	**0.542**
AOT-L [63]	90.4	89.6	91.1	18.7	0.574	0.560
DeAOT-L	**92.0**	**90.3**	**93.7**	**28.5**	**0.591**	**0.554**
R50-AOT-L [63]	91.1	90.1	92.1	18.0	0.569	0.540
R50-DeAOT-L	**92.3**	**90.5**	**94.0**	**27.0**	**0.613**	**0.571**
SwinB-AOT-L [63]	92.0	90.7	93.3	12.1	0.586	0.523
SwinB-DeAOT-L	**92.9**	**91.1**	**94.7**	**15.4**	**0.622**	**0.559**

more

GPM
Number

less

DeAOT-L:
state-of-the-art

DeAOT-T:
real-time

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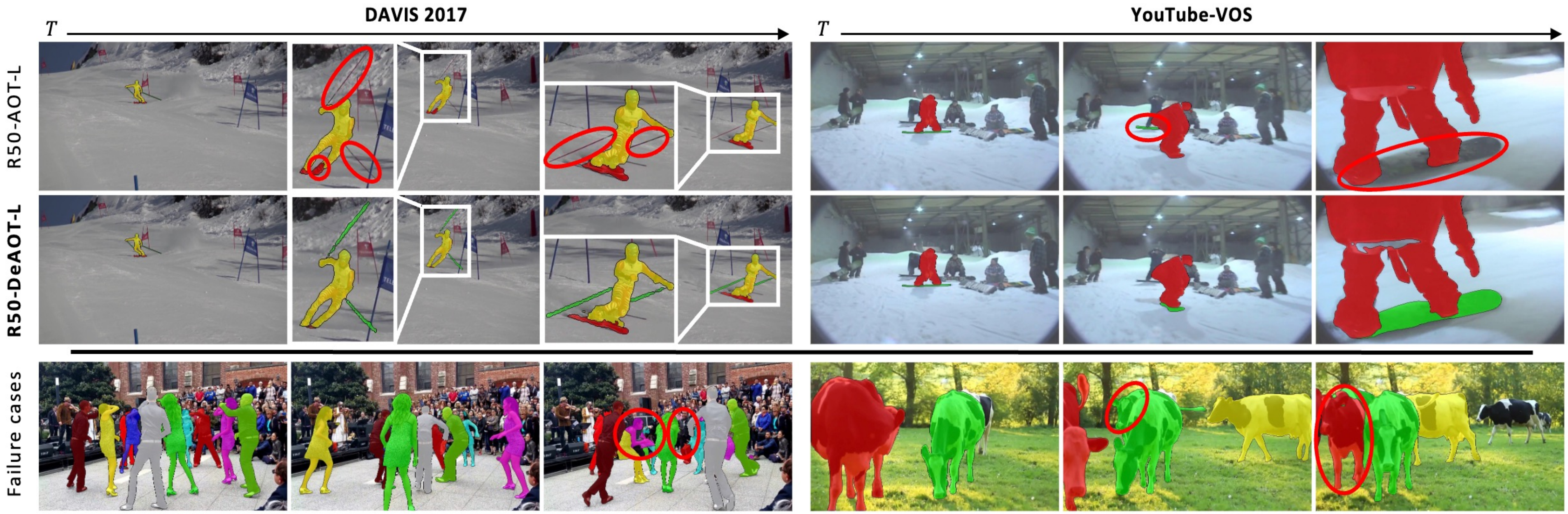
Results: Qualitative Results

Compare DeAOT variants with SOTA methods



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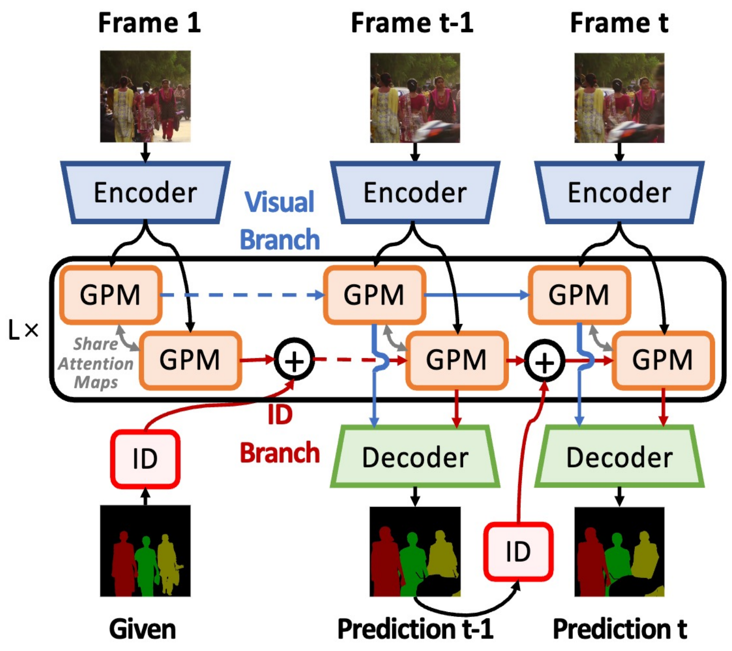
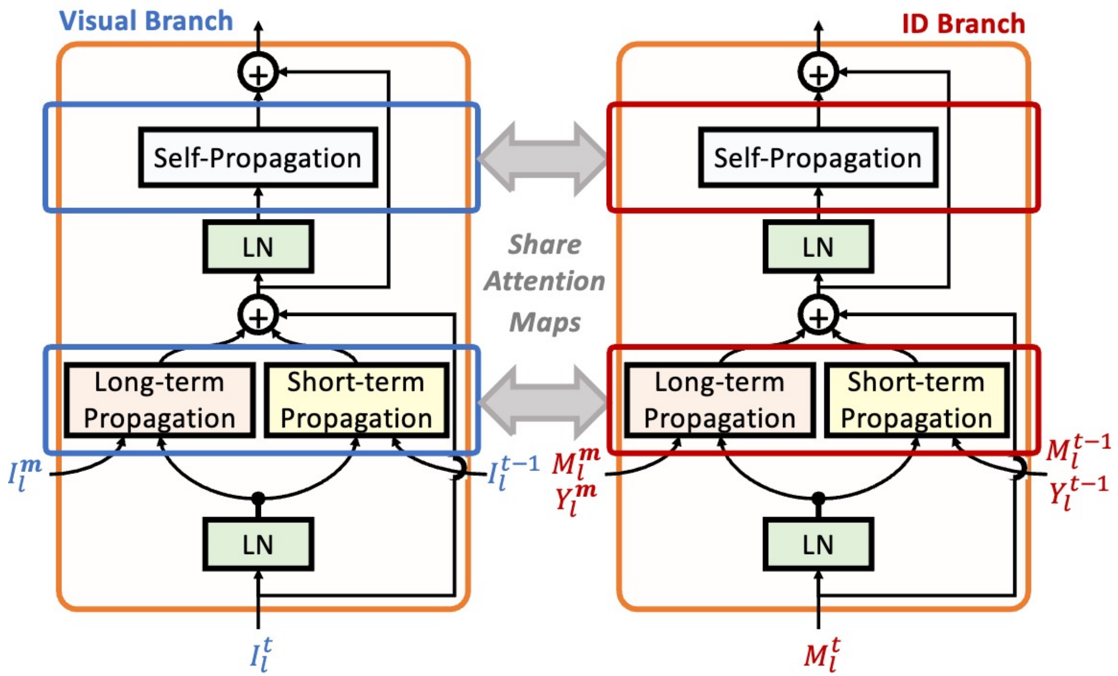
Decoupling Features in Hierarchical Propagation

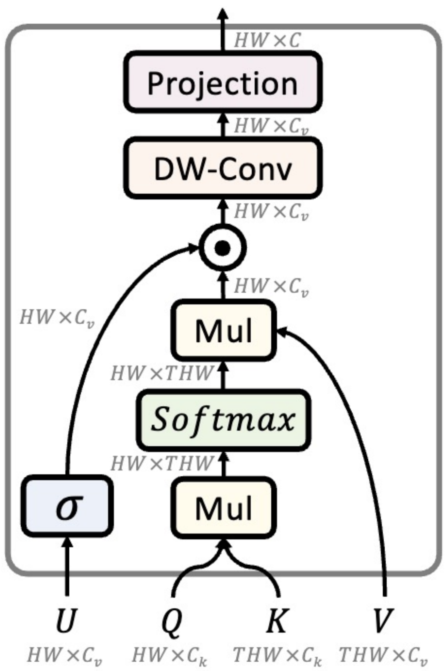
Overview



Dual-branch Propagation



Gated Propagation



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