JUNE 18-22, 2023
CVPR
VANCOUVER, CANADA

Code, Model Zoo, and Demos

Bootstrapping Objectness from Videos by Relaxed Common Fate and Visual Grouping

Long Lian

UC Berkeley

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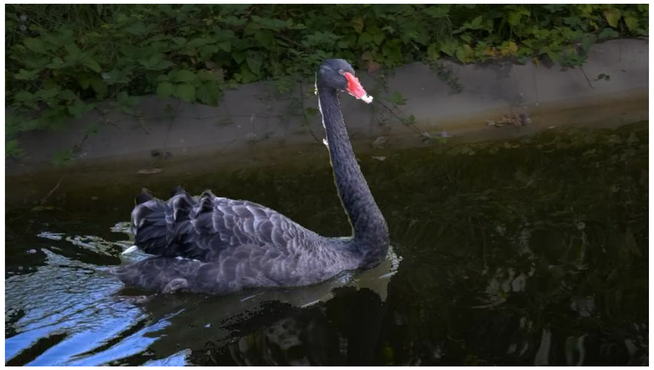
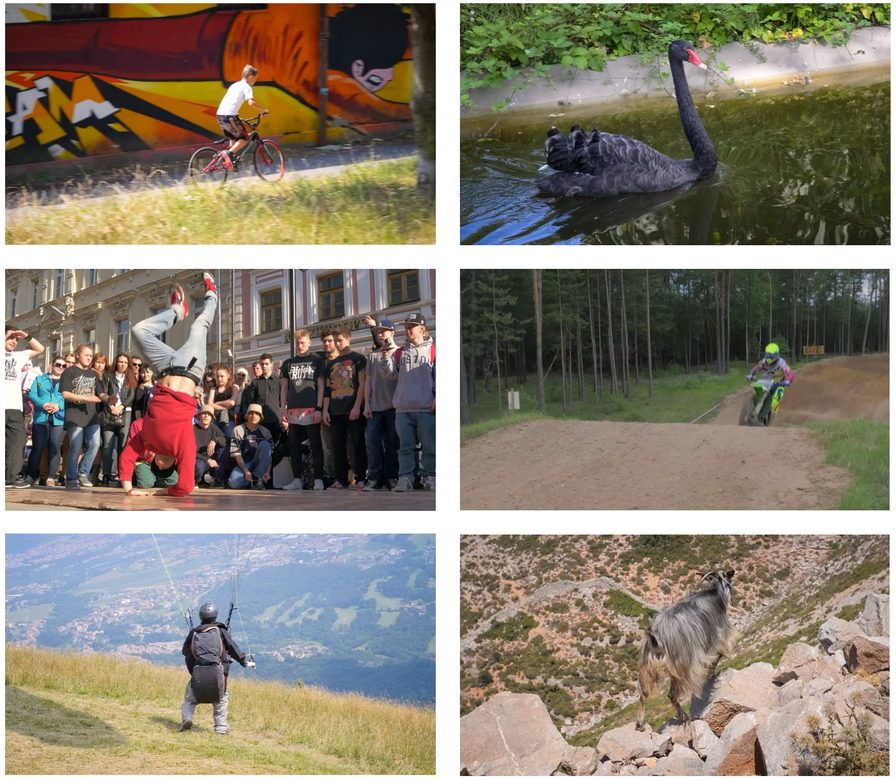
Input: Unlabeled Videos

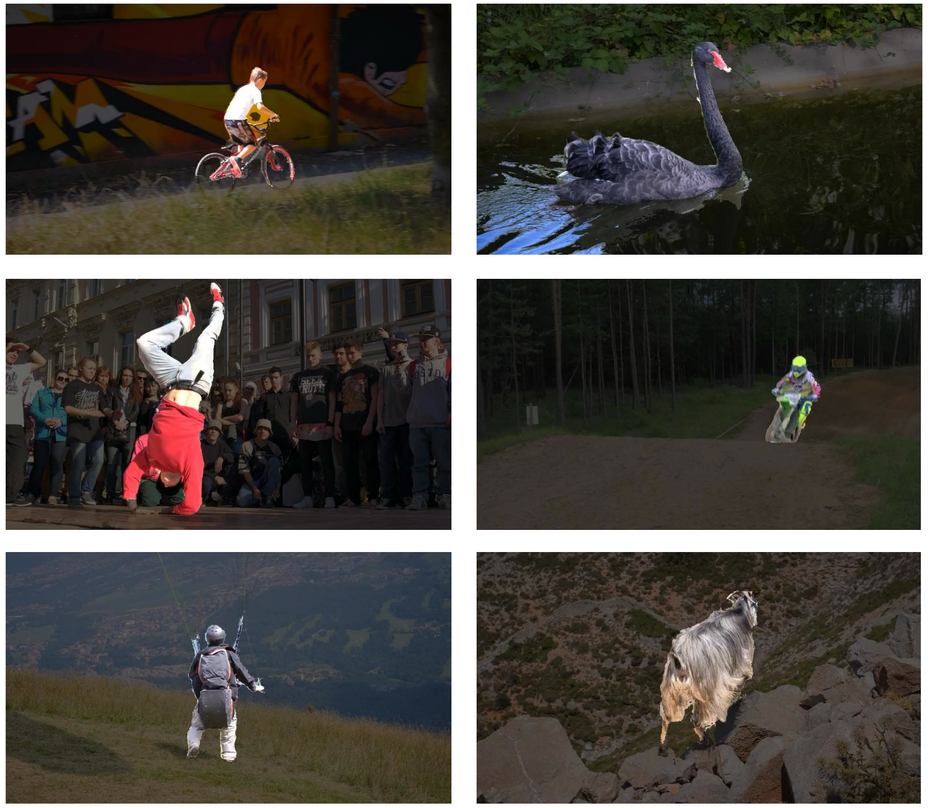
Output: Objectness Segmentation



Our Task: Unlabeled Videos ⇨ Object Segmentation



Given optical flow detector



(Our RCF Segmentation)

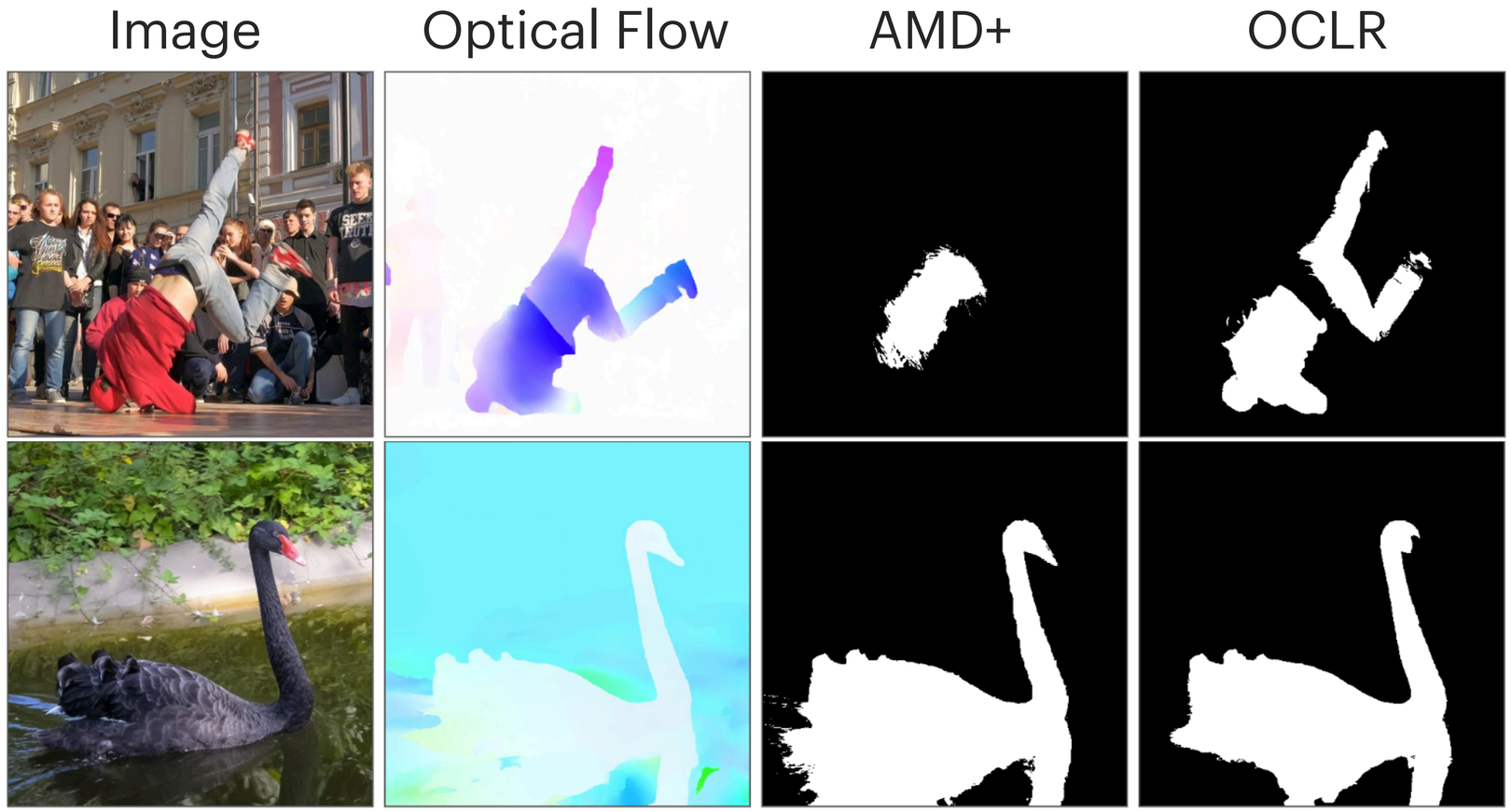
Existing Methods Rely on Common Fate

Motion Grouping. ICCV. 2021.
OCLR. NeurIPS 2022.
GWM. BMVC 2022.
AMD. NeurIPS 2021.

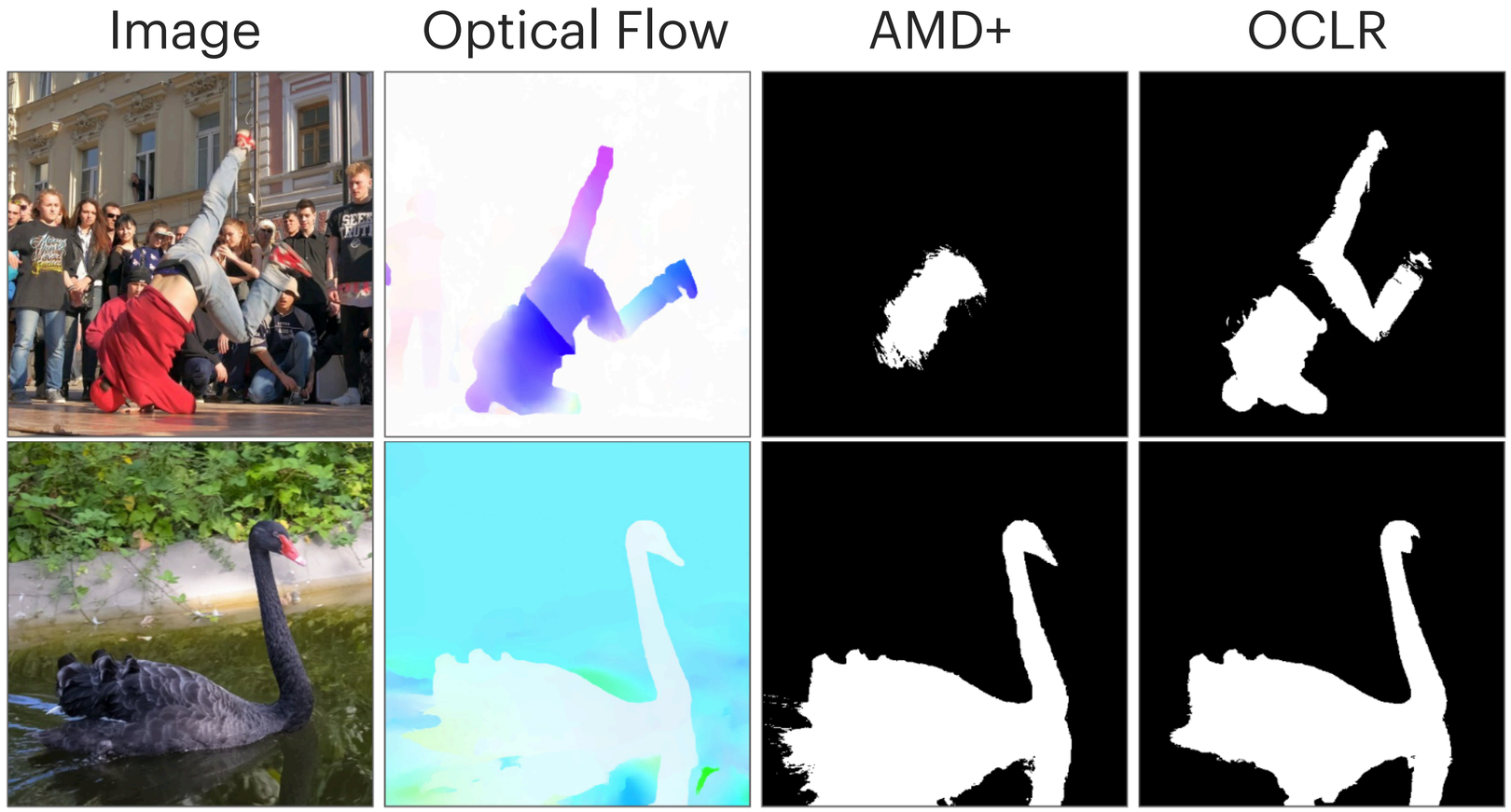
Objectness = What Move Together Belong Together

Motion Grouping. ICCV. 2021.
OCLR. NeurIPS 2022.
GWM. BMVC 2022.
AMD. NeurIPS 2021.

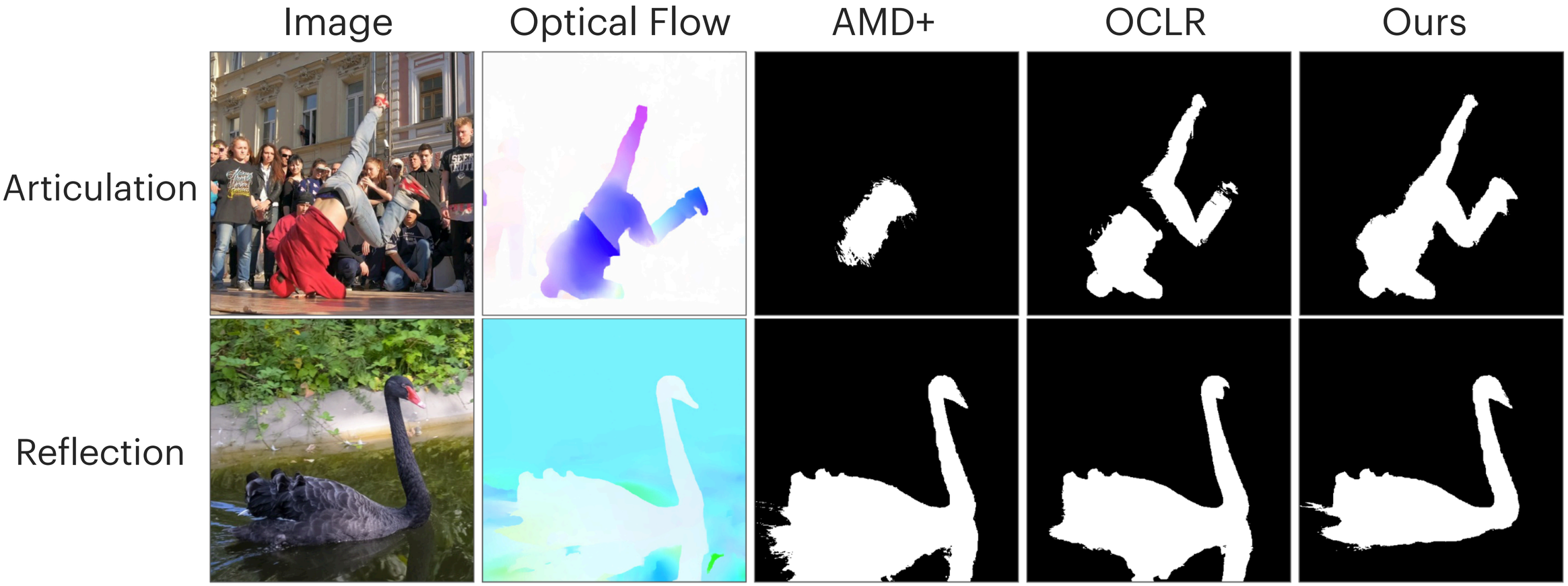
Two Failure Modes From Gestalt Law of Common Fate



Two Failure Modes From Gestalt Law of Common Fate



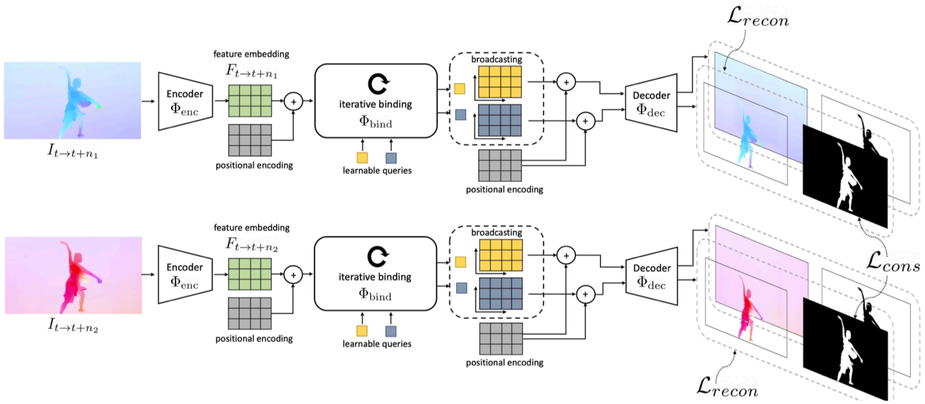
Our Approach Addresses Both Caveats



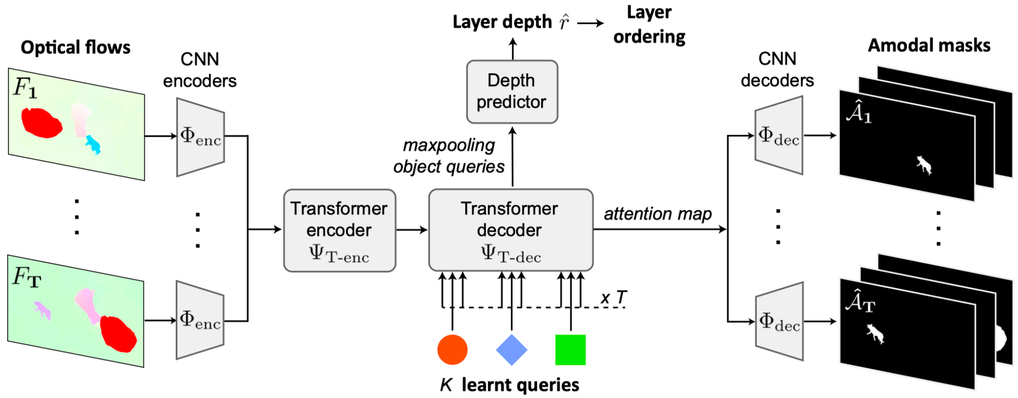
Existing Methods: Three Camps

1. Motion Segmentation

Motion Grouping



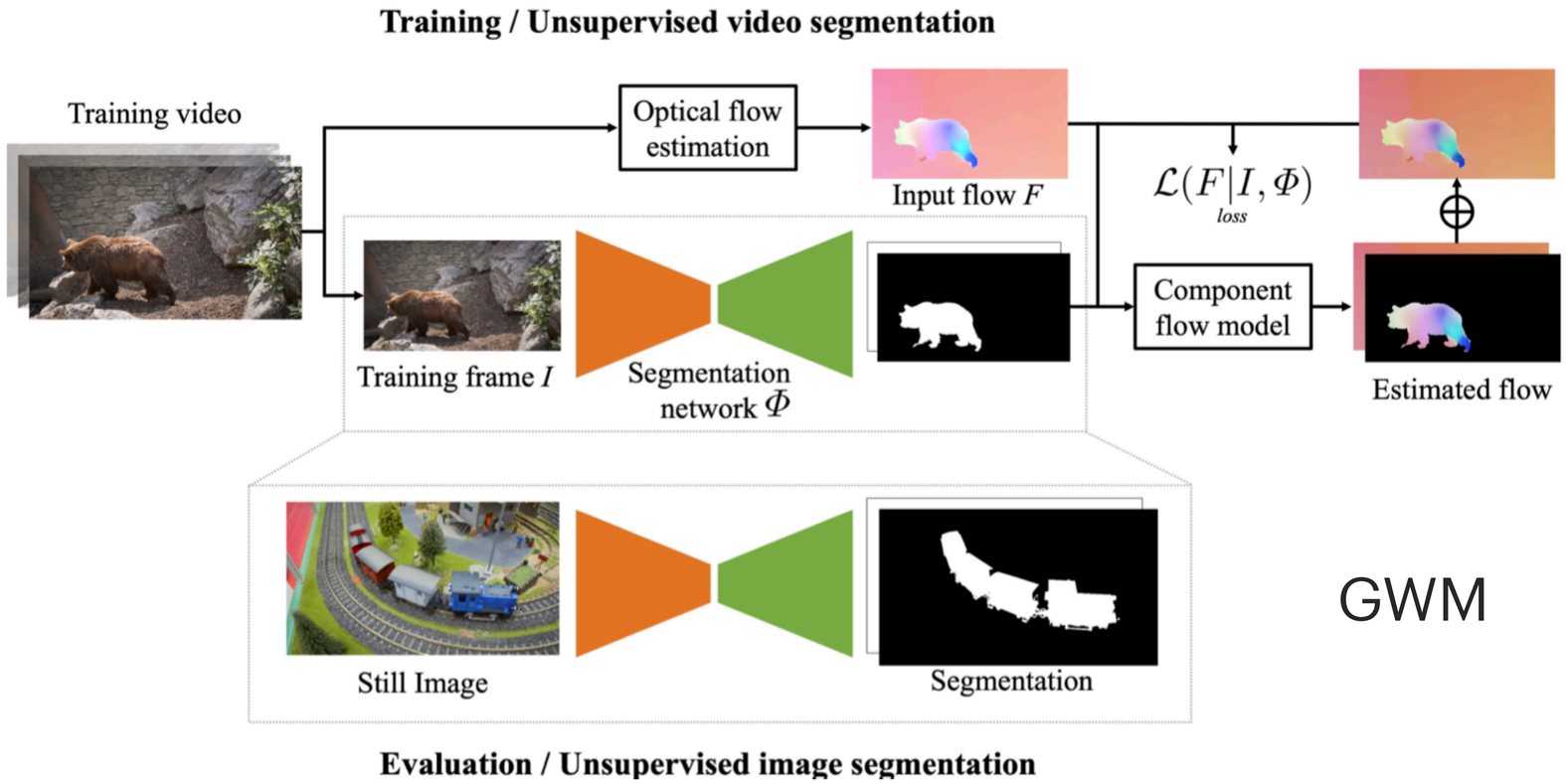
OCLR



Motion Grouping." ICCV. 2021.
OCLR. NeurIPS 2022.
GWM. arXiv:2205.07844 (2022).
AMD. NeurIPS 2021.

Existing Methods: Three Camps

1. Motion Segmentation
2. Motion Guided Segmentation

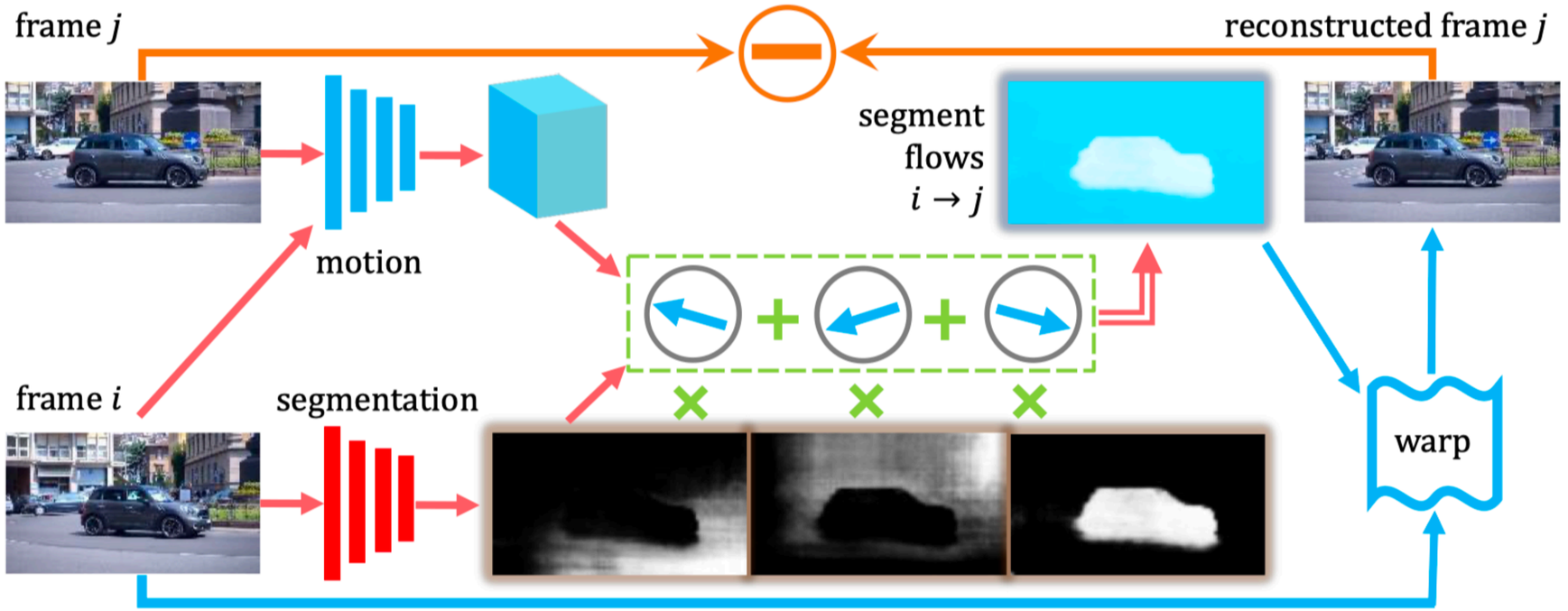


GWM

Motion Grouping." ICCV. 2021.
OCLR. NeurIPS 2022.
GWM. arXiv:2205.07844 (2022).
AMD. NeurIPS 2021.

Existing Methods: Three Camps

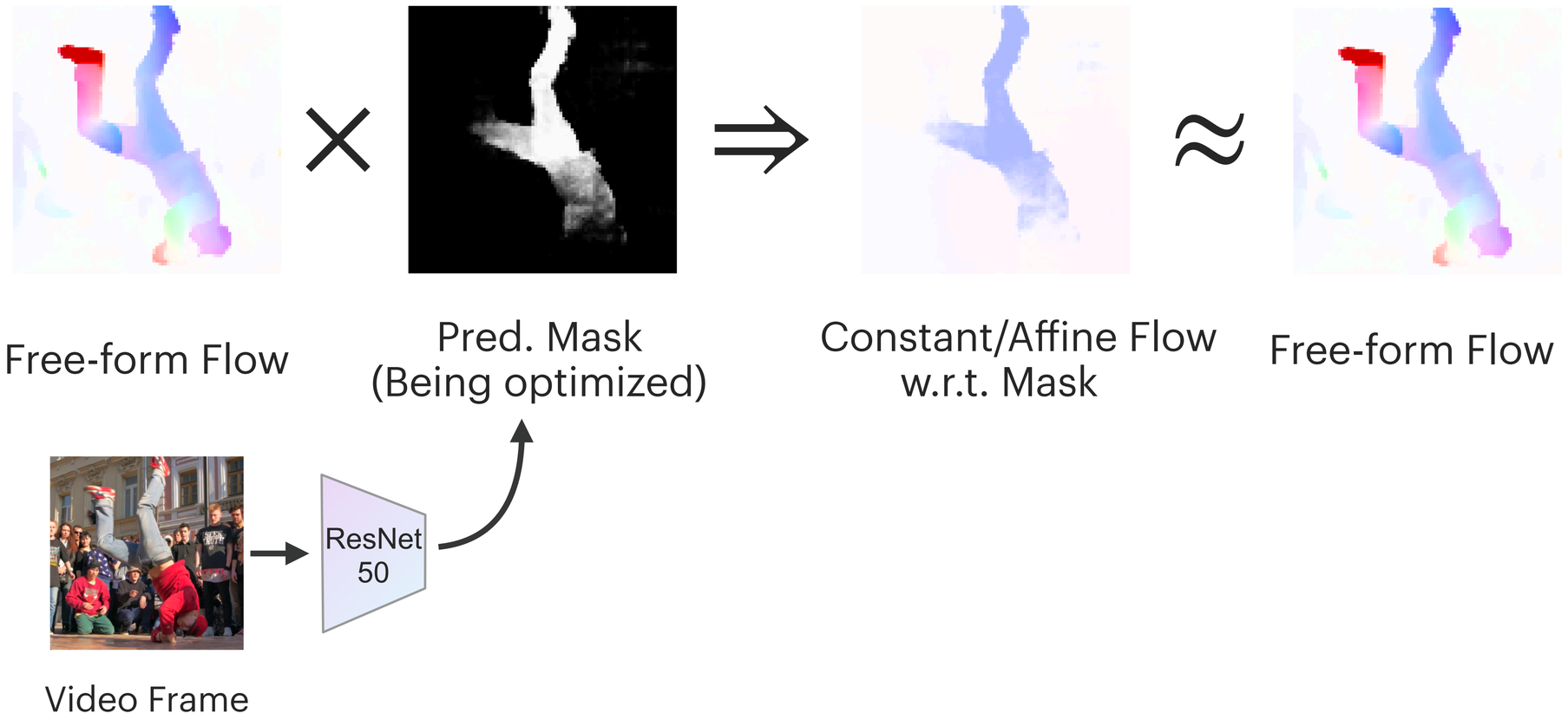
1. Motion Segmentation
2. Motion Guided Segmentation
3. Motion and Segmentation Jointly Learned



AMD

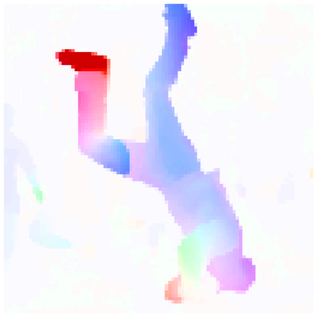
Motion Grouping." ICCV. 2021.
OCLR. NeurIPS 2022.
GWM. arXiv:2205.07844 (2022).
AMD. NeurIPS 2021.

Insight 1: Dealing with Articulation



Insight 1: Dealing with Articulation

Common Fate

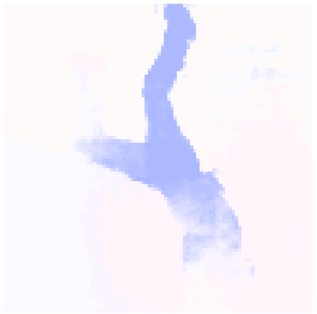


Free-form Flow

×

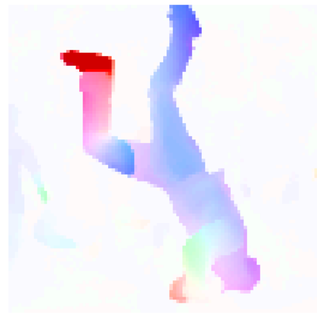
Pred. Mask
(Being optimized)

⇒



Constant/Affine Flow
w.r.t. Mask

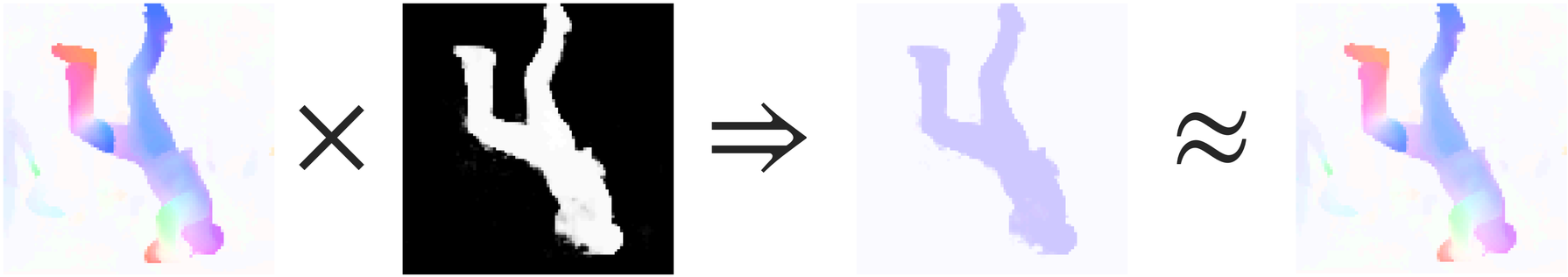
≈



Free-form Flow

Insight 1: Dealing with Articulation

Common Fate



Free-form Flow

Pred. Mask
(Being optimized)

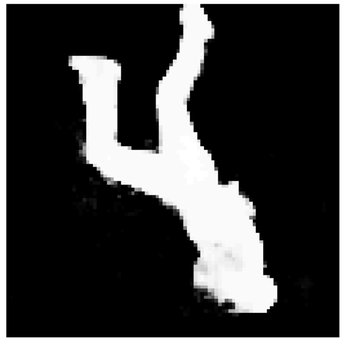
Constant/Affine Flow
w.r.t. Mask

Free-form Flow

Insight 1: Fitting Flow with *Relaxed* Common Fate

Free-form Flow

×



Pred. Mask
(Being optimized)

⇒

Relaxed
Common Fate

Constant/Affine Flow
w.r.t. Mask

+

Residual Flow
(Intra-mask motion)

≈

Free-form Flow

Video Frame

→

ResNet
50

Insight 2: Dealing with Artifacts from Motion

Let motion and appearance complement each other for supervision.

Motion Supervision Only

Insight 2: Visual Grouping within the Image

Let motion and appearance complement each other for supervision.

Motion Supervision Only

Bootstrapping from CRF

Motion + Appearance

Insight 2: Dealing with Reflection

Let motion and appearance complement each other for supervision.

Motion Supervision Only

Insight 2: Visual Grouping Based on Semantics across Images

Let motion and appearance complement each other for supervision.

Motion Supervision Only

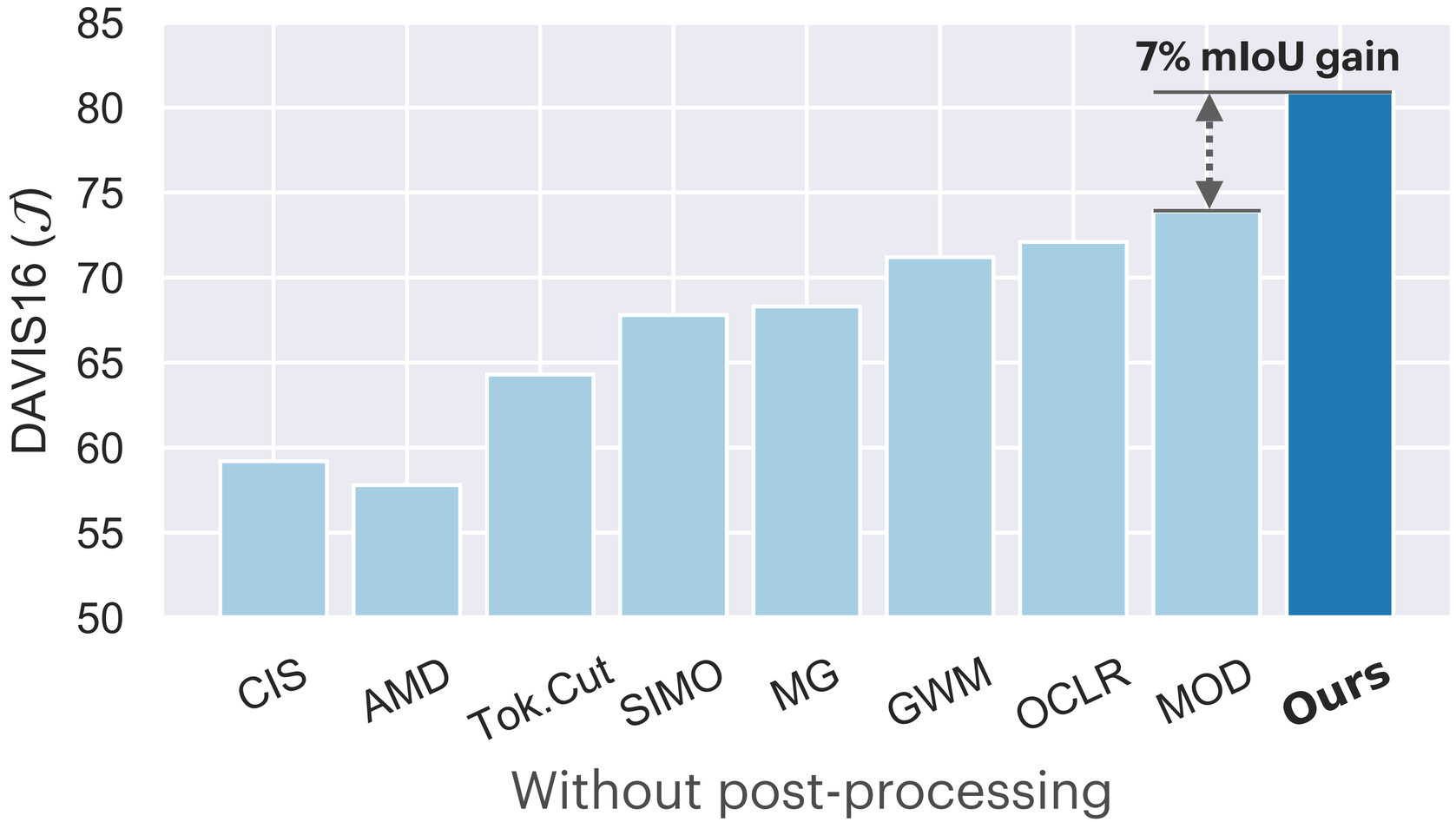
Iteratively minimize the normalized cut of DINO feature

Motion + Appearance

Advantages of Our RCF to Previous Methods

UVOS Method	Motion Grouping	Emergence of Objectness	Guess What Moves	**Our work (RCF)**
Sources of supervision	Motion	Motion (Frame Warping)	Motion	Motion + Appearance
Segment stationary objects	✗	✓	✓	✓
Handle articulated/ deformable objects	–	✗	✗	✓
Label-free hyperparameter	✗	✗	✗	✓

Our RCF: SOTA on Unsupervised Object Segmentation

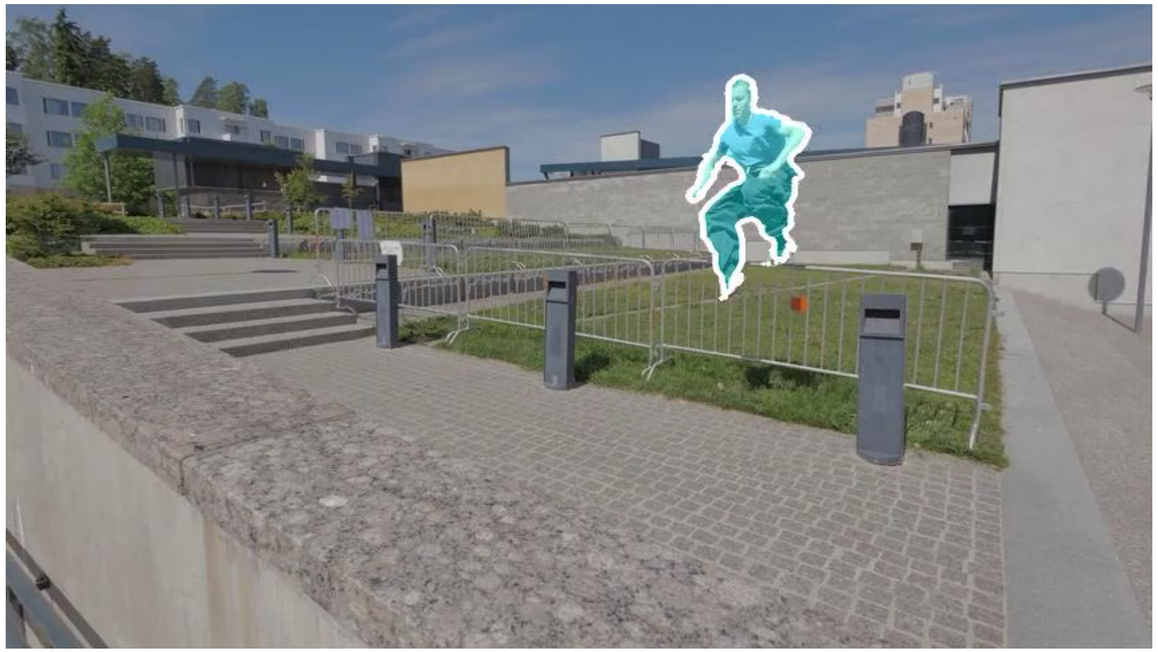


OCLR

RCF (***Ours***)

No post-processing applied: results can be further enhanced with post-processing

RCF (***Ours***)



No post-processing applied: results can be further enhanced with post-processing

Thank you!

Code, Model Zoo,
and Demos Available