Exploiting Distilled Learning for Deep Siamese Tracking

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Background and Aims

Background:

Existing deep Siamese trackers demand for

- huge power consumption
- high memory usage

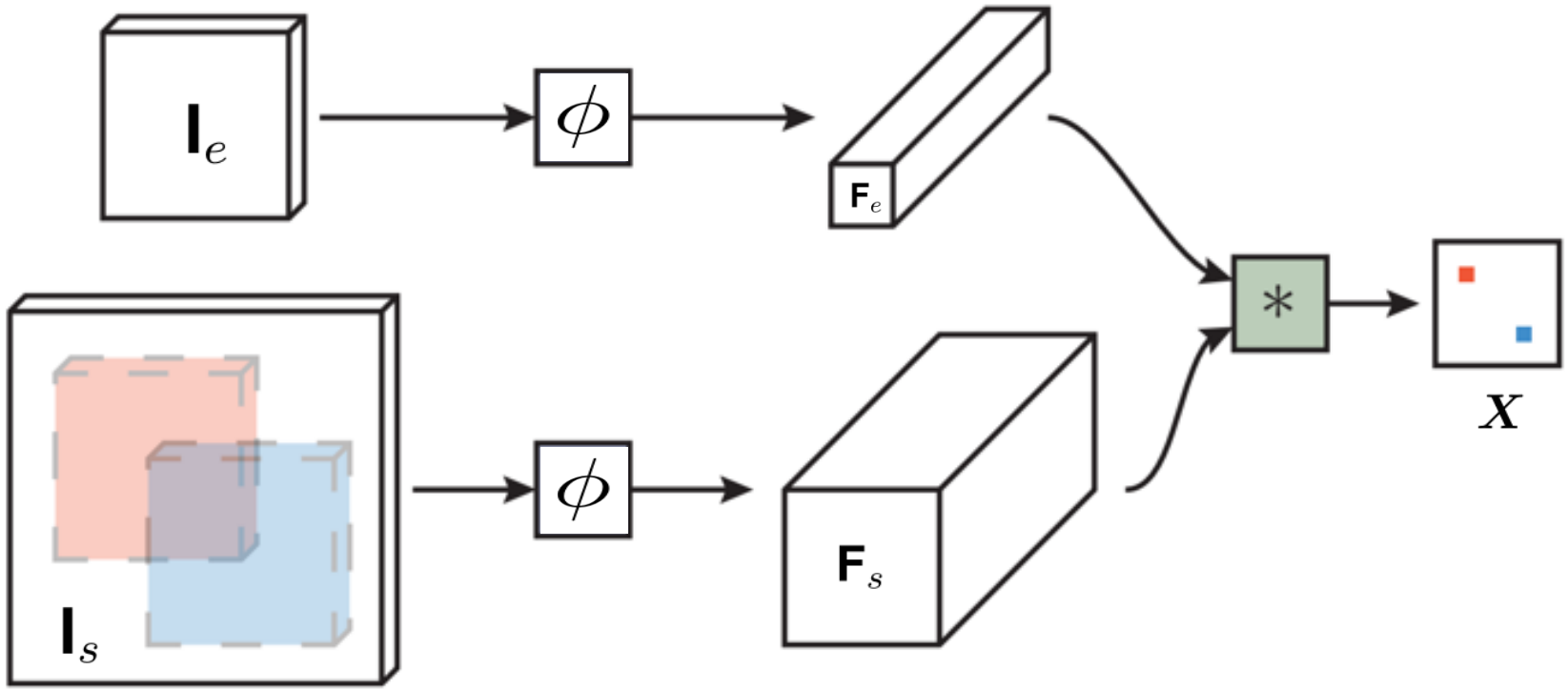
Our aims:

- Learning tracking model with efficiency and high accuracy

How to learn ?

- Teacher-Student learning paradigm
- Exploiting distilled learning for transferring knowledge

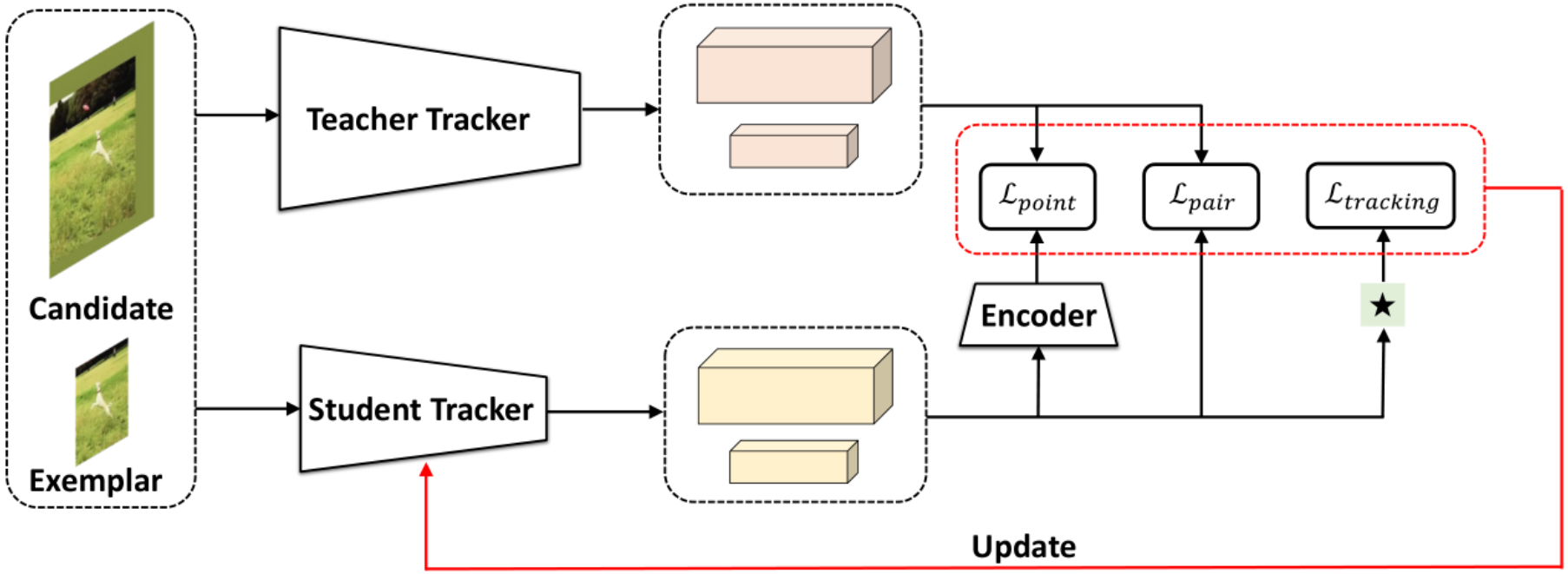
Preliminary



$$\boldsymbol{X} = \mathbf{F}_e \star \mathbf{F}_s + b \cdot \mathbb{1}$$

$$\mathcal{L}_{tracking} = \arg\min_{\Theta} \mathop{\mathbb{E}}_{(\mathbf{I}_e, \mathbf{I}_s, \boldsymbol{Y})} \mathcal{L}(\boldsymbol{Y}, \boldsymbol{X})$$

Method



An overview of our proposed Distilled Learning Framework (DLF)

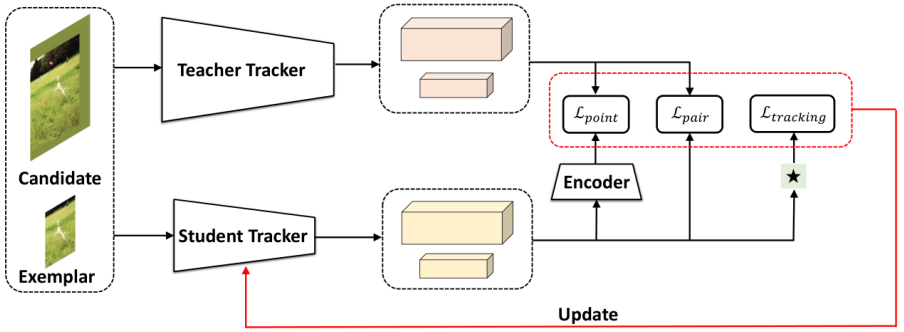
During training, student tracker is optimized under the guidance of teacher tracker.

Method

- Point-Wise Distillation

$$\mathcal{L}_{point} = \|\mathbf{F}_T - E(\mathbf{F}_S)\|_2$$

where $\mathbf{F}_T$ and $\mathbf{F}_S$ are teacher and student features



- Pair-Wise Distillation

$$\boldsymbol{S}_{\mathbf{F}}^{ij} = \frac{1}{h \times w} \cdot \frac{\mathbf{F}_i}{\|\mathbf{F}_i\|_2} \cdot \frac{\mathbf{F}_j}{\|\mathbf{F}_j\|_2} \qquad \mathcal{L}_{pair} = \sum_i \sum_j \left\| \boldsymbol{S}_{\mathbf{F}_S}^{ij} - \boldsymbol{S}_{\mathbf{F}_T}^{ij} \right\|^2$$

where $\boldsymbol{S} \in \mathbb{R}^{hw \times hw}$ is the pair-wise similarity matrix

- Optimization

$$\mathcal{L} = \mathcal{L}_{tracking} + \lambda_0 \mathcal{L}_{point} + \lambda_1 \mathcal{L}_{pair}$$

Ablation Study

Teacher: SiamDW *Student*: SiamDW-L & SiamDW-S

Network Parameters

Model	SiamDW	SiamDW-L	SiamDW-S
Parameters	1.445M	0.354M	0.136M
compression ratio	-	4.08	10.62

Speed Comparison

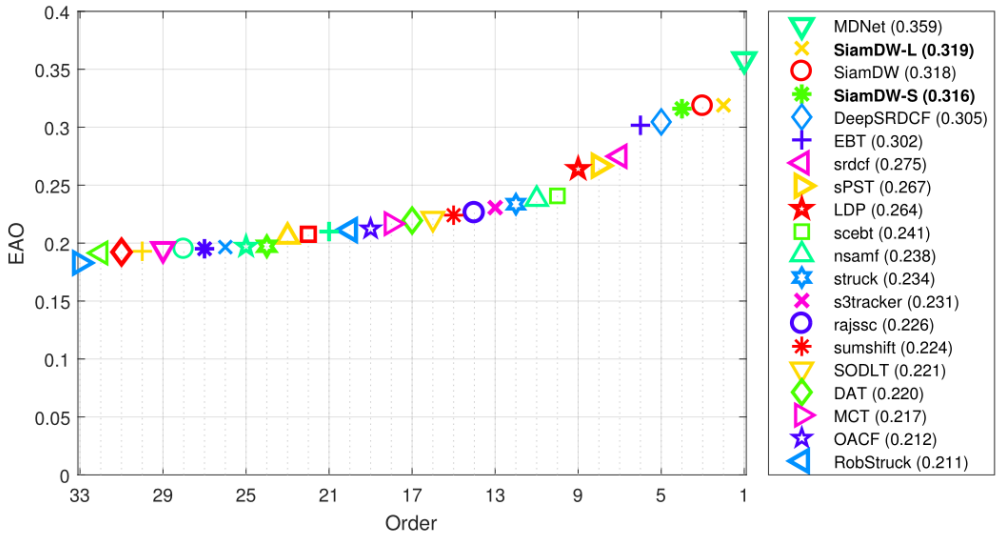
Model	SiamDW	SiamDW-L	SiamDW-S
FPS	53	73	80

Ablation Study

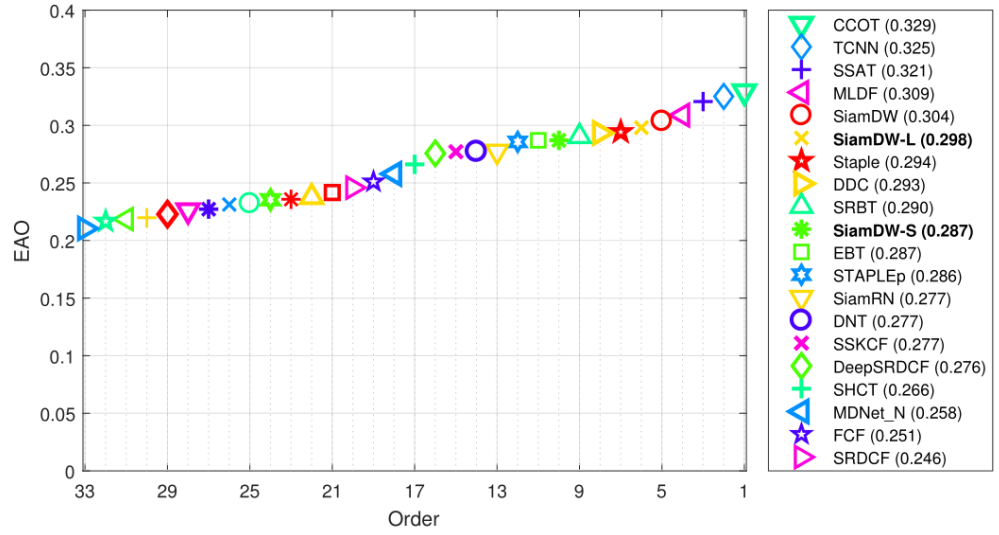
Model	PoD	PaD	Logistic	AUC
SiamDW-L			✓	0.560
	✓		✓	0.612
		✓	✓	0.622
	✓	✓	✓	0.636
SiamDW-S			✓	0.538
	✓		✓	0.587
		✓	✓	0.599
	✓	✓	✓	0.618

Experiments

VOT2015



VOT2016



Visualization

(a) CarScale

(b) BlurOwl

(c) Girl2

SiamDW SiamDW-L SiamDW-S

Summary

- A novel Distilled Learning Framework(DLF) for deep Siamese tracking
- Two simple yet effective knowledge distillation strategies

Thank you !