



南京航空航天大学

Nanjing University of Aeronautics and Astronautics



模式分析与机器智能
工业和信息化部重点实验室

MIIT Key Laboratory of
Pattern Analysis & Machine Intelligence

Switching Temporary Teachers for Semi-Supervised Semantic Segmentation

NIPS 2024

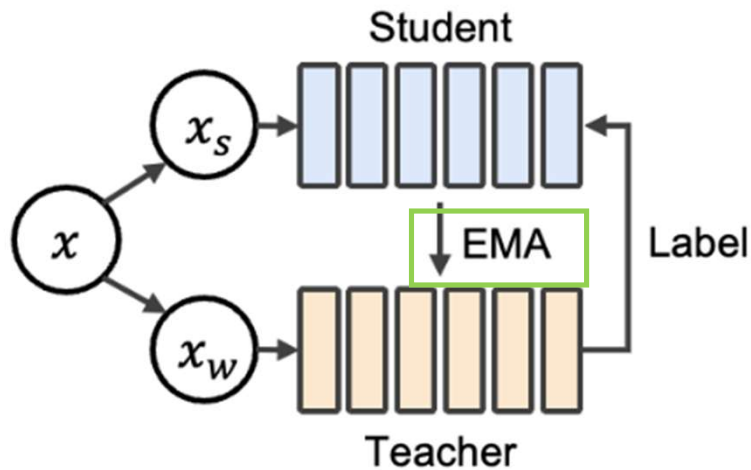
Field : Semi-supervised Semantic Segmantation



Problem to be solved : coupling problem

Causing potential performance bottleneck

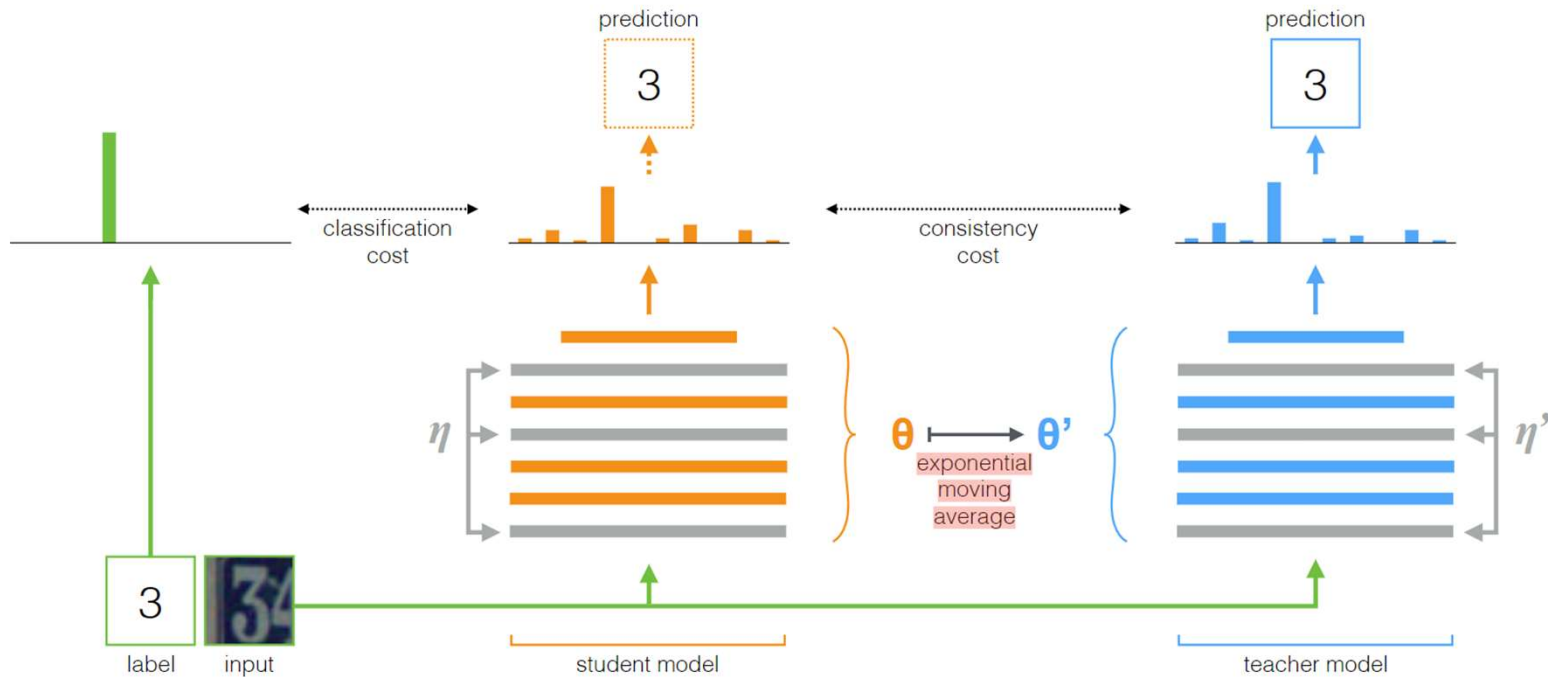
(1) When the teacher is too close to the student because of EMA updating



(a) Teacher-Student

(2) Training with complex labels like segmentation masks but limited annotated data.

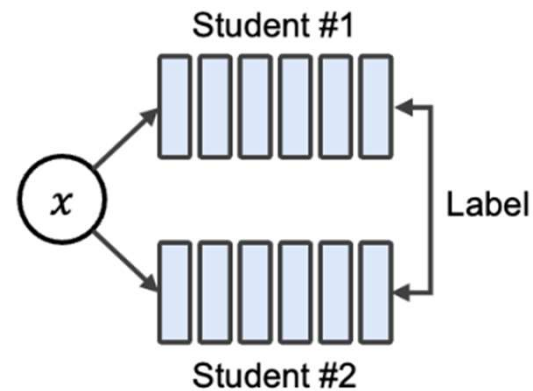
Preliminary : Teacher-Student framework



From 'Mean teachers are better role models: Weight-averaged consistency targets improve semi-supervised deep learning results'

Innovation 1 : Dual Temporary Teacher

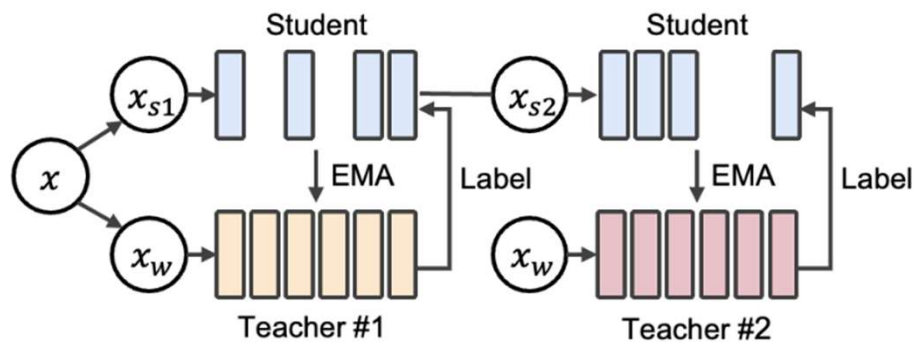
To alleviate the coupled problem by single EMA.



(b) Dual Student

Focusing on the diversity of student models creates a virtuous cycle of enhancing teacher models to prevent teacher and student models from becoming too similar as training progresses.

Innovation 1 : Dual Temporary Teacher



(c) Dual Teacher (ours)

```
if epoch % 2 == 0:  
    ema_model = model_teacher  
    do_cut_mix = True  
    do_class_mix = False  
else:  
    ema_model = model_teacher2  
    do_cut_mix = False  
    do_class_mix = True
```

Within each epoch, take turns being the teacher.



Innovation 1 : Dual Temporary Teacher

Strong augmentation pool

```
if do_class_mix:
    loss = compute_classmix(b, h, w, criterion, cm_loss_fn, model, ema_model, image, label,
image_u, image_u_strong, threshold=0.95)
if do_cut_mix:
    loss = compute_cutmix(h, w, image, label, criterion, model, ema_model, image_u,
threshold=0.95)
```



Innovation 1 : Dual Temporary Teacher

Updating student and teachers

$$\theta_s \leftarrow \theta_s + \eta \frac{\partial(\mathcal{L}_{sup} + \lambda_u \mathcal{L}_{unsup})}{\partial \theta_s},$$

$$\mathcal{L}_{unsup} = \frac{1}{\mathcal{B}_u} \sum_{i=1}^{\mathcal{B}_u} \frac{1}{\mathcal{H} \cdot \mathcal{W}} \sum_{j=1}^{\mathcal{H} \cdot \mathcal{W}} \mathcal{L}_{ce}(p_{ij}^u, \hat{y}_{ij}^u),$$



Innovation 2 : Implicit Consistency Learning

construct the sub-models within the student model via **versatile stochastic depth**, applicable from CNN models to transformer-based models.

$$\mathcal{L}_{cons} = \frac{1}{\mathcal{B}} \sum_{i=1}^{\mathcal{B}} \frac{1}{\mathcal{H} \cdot \mathcal{W}} \sum_{j=1}^{\mathcal{H} \cdot \mathcal{W}} \mathcal{L}_{ce}(p_{ij}(\tilde{\theta}_s), \hat{y}_{ij}(\theta_t)),$$

parameter of sub-model

only apply weak augmentations to inputs for both teacher and student models

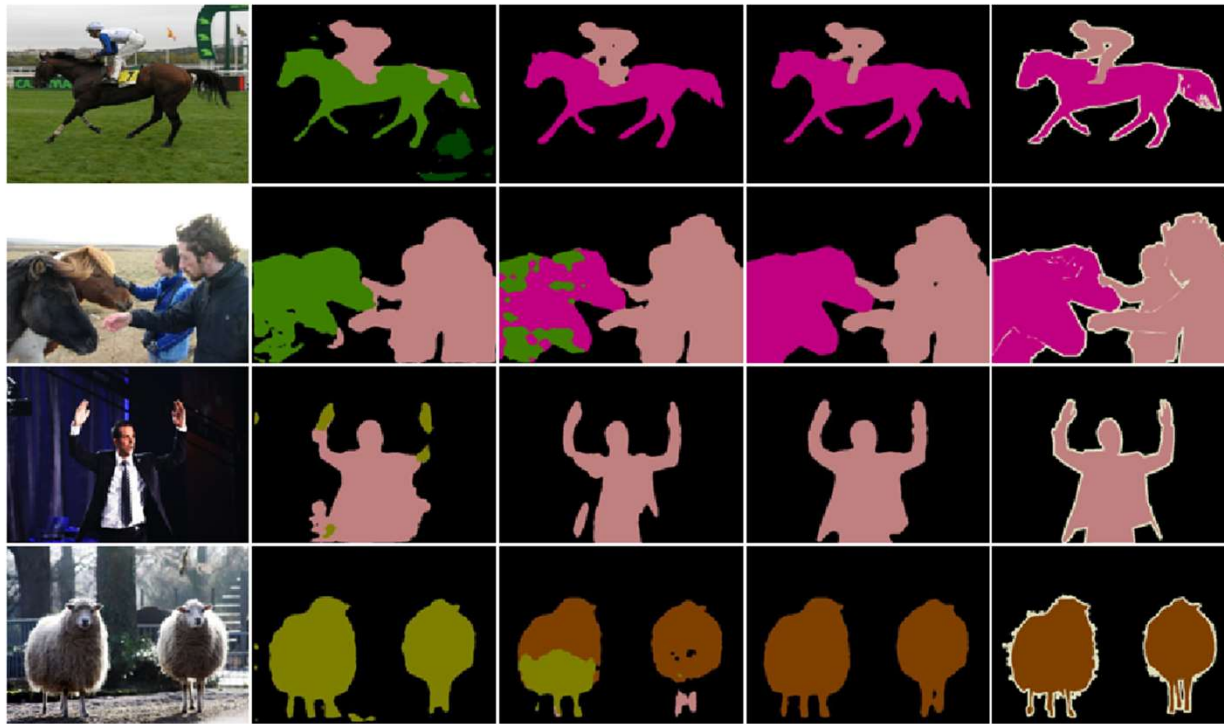
Experiment



Table 1: Comparison of mIoU (%) with state-of-the-art methods on **PASCAL VOC 2012** under different partitions. Labeled images are sampled from the *original high-quality* training set. All methods are based on DeepLabv3+ with ResNet-50 backbone. We also report the total amount of trainable parameters in each method.

Method	#Params	1/16 (92)	1/8 (183)	1/4 (366)	1/2 (732)	Full (1,464)
Supervised-only	43.6M	44.03	52.26	61.65	66.72	72.94
PseudoSeg [56] [ICLR'21]	43.6M	54.89	61.88	64.85	70.42	71.00
PC ² Seg [54] [ICCV'21]	43.6M	56.90	64.63	67.62	70.90	72.26
AugSeg [53] [CVPR'23]	43.6M	64.22	72.17	76.17	77.40	78.82
UniMatch [46] [CVPR'23]	43.6M	71.9	72.5	76.0	77.4	78.7
Ours	43.6M	70.76	74.53	76.43	77.68	78.15

Experiment



(a) Input (b) Supervised-only (c) Single Teacher (d) Dual Teacher (e) Ground Truth

Figure 4: **Visualization of semantic segmentation results on PASCAL VOC.** We qualitatively compare the segmentation results of our Dual Teacher with other methods. All methods are evaluated with DeepLabV3+ on top of ResNet-101 under $1/16$ label partitions.



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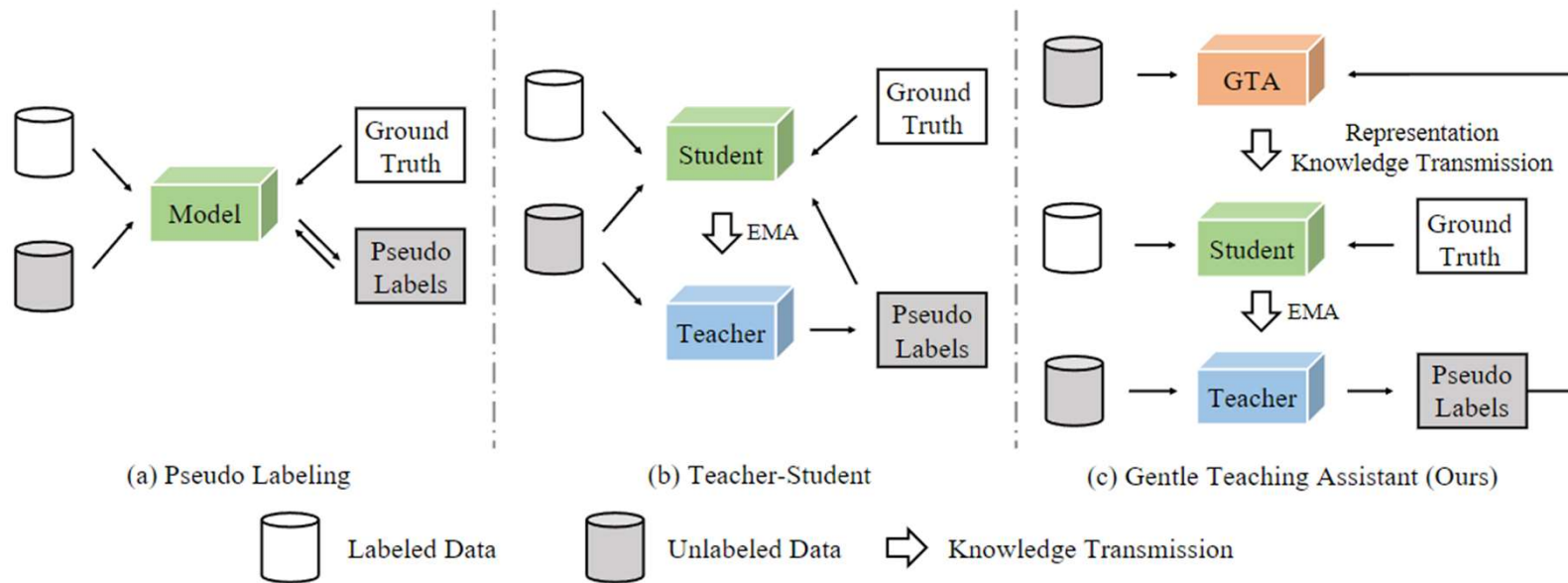


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Semi-Supervised Semantic Segmentation via Gentle Teaching Assistant

NIPS 2022

Gentle Teacher





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THANKS

Problem to be solved : coupling problem



- (a) full annotations
- (b) partial annotations
- (c) single positive label