NIPS2019 CellSignal Challenge
2nd place solution

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Task and Challenge

Task：

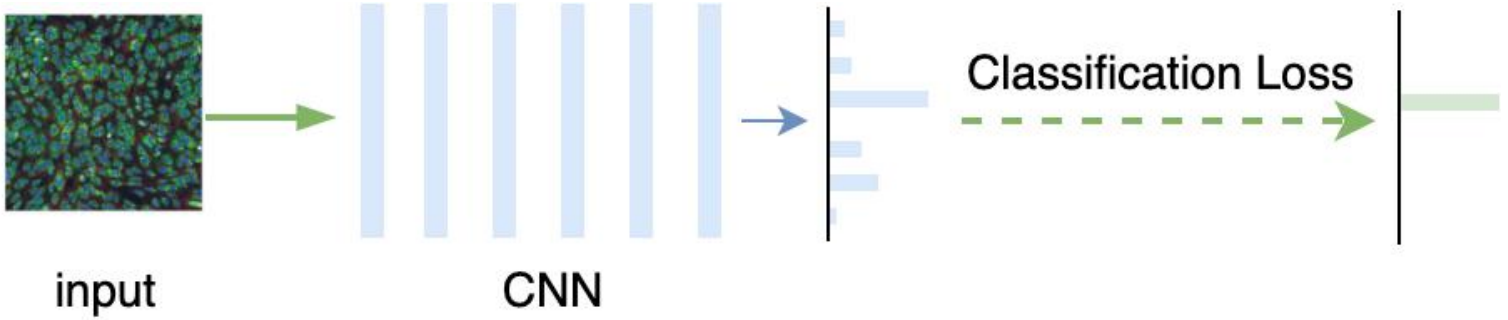
- **1108 image classification；**

Challenge：

- **Multi-domain learning;**
- **Few shot learning;**
- **Semi-supervised learning;**

Solution: Baseline

- Baseline from the organizer[1]



Split	All	HUVEC	RPE	HepG2	U2OS
Batch	44.1% ± 5.7	56.7% ± 8.4	31.2% ± 2.7	30.8% ± 4.0	2.4% ± 1.0
Random	52.8% ± 0.0	68.9% ± 0.3	40.0% ± 0.9	39.7% ± 0.2	22.0% ± 0.4

[1] RxRx1 - An image set for cellular morphological variation across many experimental batches.

Solution: Multi domain learning

What is "domain" in this dataset?

- domain == cell
- domain == batch
- domain == plate

Solution: Multi domain learning

Devils in BatchNorm: AdaBN[1]

Baseline: random batch sampling, val top1 acc 40+%

Two options:

1. Training with domain sampling, Test with domain AdaBN :
   - sample batches in the same cell type, val top1 acc 50+%
   - sample batches in the same experiment, val top1 acc 60+%
   - sample batches in the same plate, val top1 acc 70+%

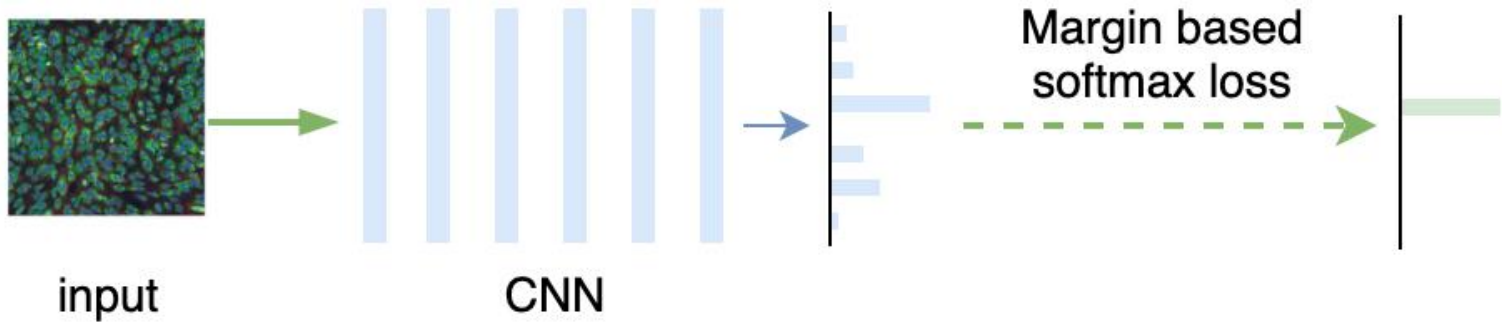
2. DataNorm by domain: (data- mean) / std
   - data norm by cell type, val top1 acc 50+%
   - data norm by batch val top1 acc 60+%
   - data norm by plate, val top1 acc 70+%

[1] Li Y , Wang N , Shi J , et al. Adaptive Batch Normalization for practical domain adaptation[J]. Pattern Recognition, 2016, 80.

Solution: Few shot learning

Distance-based classification :

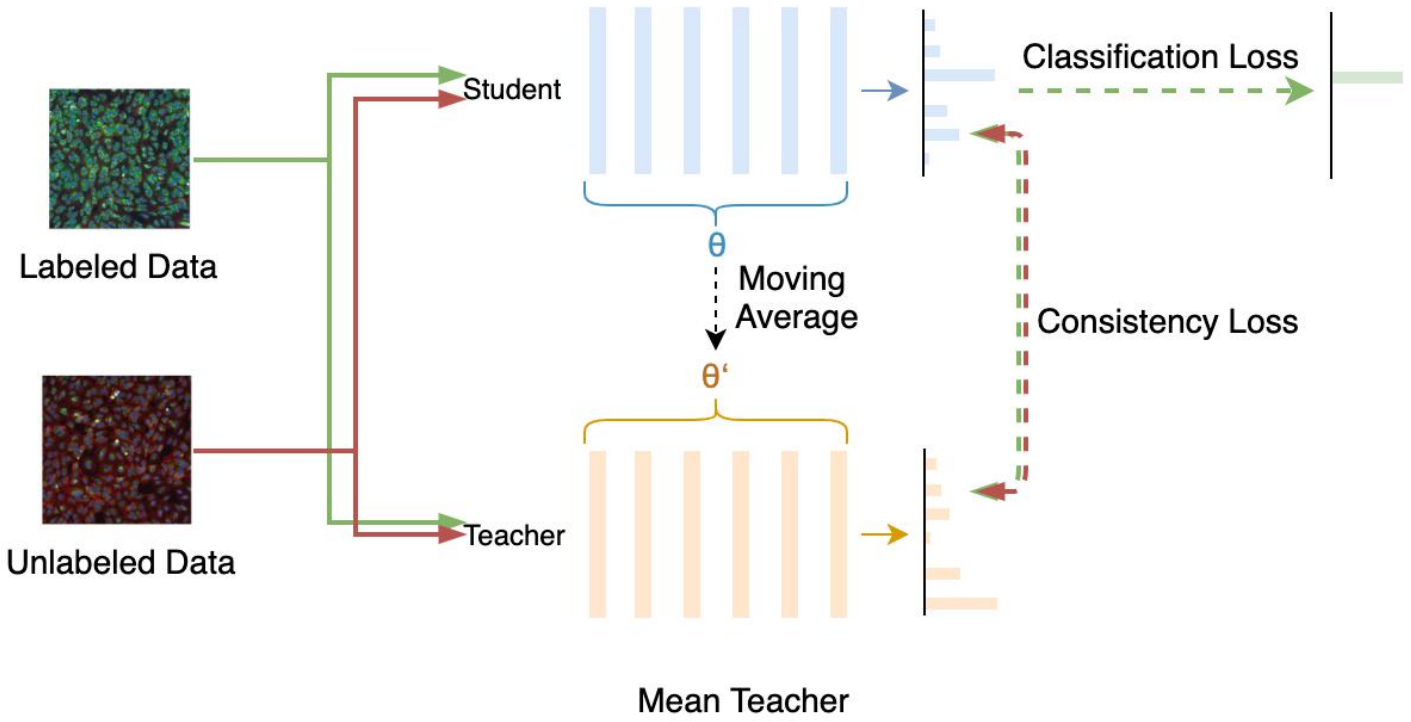
- Training the model with this distance-based classifier explicitly **reduce intra-class variations**[1].
- Margin-based softmax (arcface loss): top 1 acc 70% -> 85%



[1] Wei-Yu Yen-Cheng L, Zsolt K, et al. A Closer Look at Few-shot Classification

Solution: Semi-supervised learning

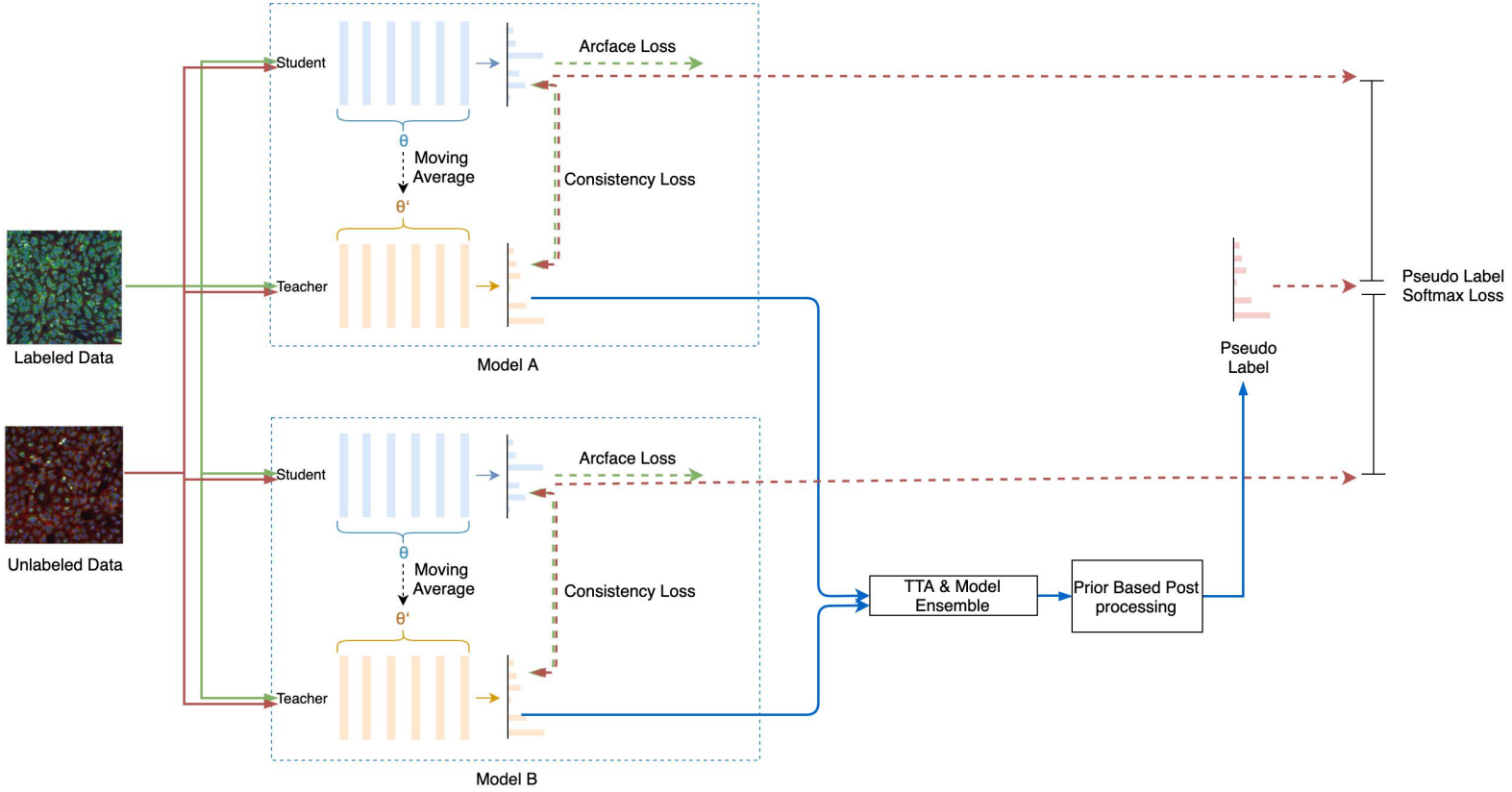
- Mean teachers[1]
- top 1 acc 85% -> 90%



[1] Tarvainen A , Valpola H . Mean teachers are better role models: Weight-averaged consistency targets improve semi-supervised deep learning results[J]. 2017.

Final solution-Dual Xception

- End-to-end semi-supervised learning pipeline
- top 1 acc 90% -> 95+%, 5fold + post processing -> 99.6%



- 1108 classification; Use Xception as the backbone;Model_A(xception),Model_B(xception_large);
- 5 fold cross validation; Finetuned on 4 cell types;
- Mean teachers with online prior pseudo-labeling; The pseudo labels updates using the highest validation score teacher models during training;

Other details:

Input and preprocessing:

- 6 channel input, image size 512*512
- per image standardization: normalization of 6 channels in images per plate,with small randomization
- augmentation: random flip, random rotation multiple of 90 degrees.

Training

- 1139 classification, 5 fold cross validation;
- Pretrain on all cell types, finetune on each cell type with semi-supervised learning(mean teacher + online pseudo labeling);
- LR schedule: Step LR for pretraining and cyclic LR for finetuning (5cycles/fold).

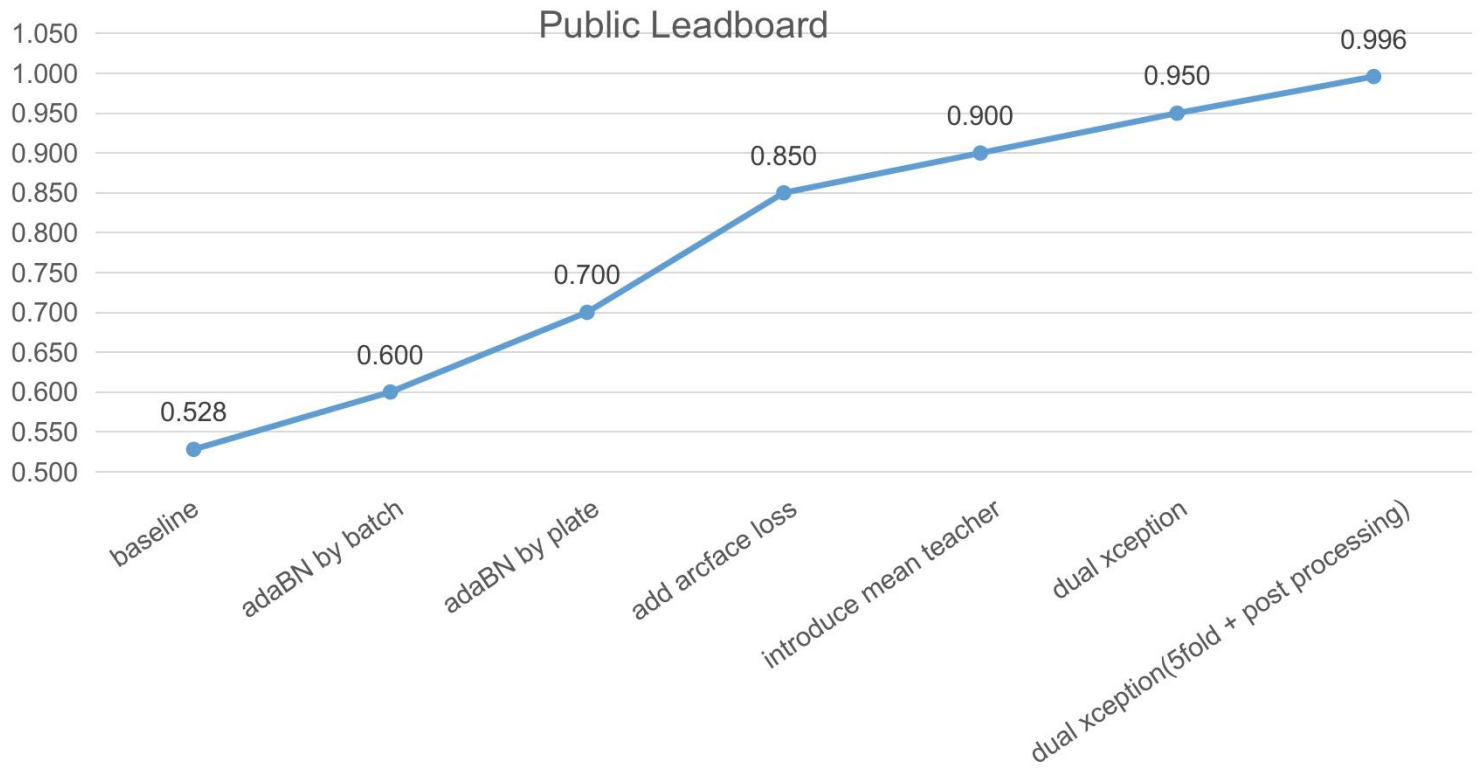
Post Processing

- Predictions from different site images and different test-time augmentations are combined by taking mean of logits;
- Predictions for control classes are ignored;
- Linear Sum Assignment (LSA) is applied;

Where the Improvements come from:

- Multi-domain learning; --> AdapBN / Data Plate Norm
- Few shot learning; --> Margin based softmax(ArcFace Loss)
- Semi-supervised learning; --> Mean teachers / Pseudo Labels

Score Growth Chart



Thank you