Tune It or Don't Use It:
Benchmarking Data-Efficient Image Classification

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Context

Data-efficient image classification (DEIC):

- Train classifiers from limited data - Few tens of samples per class
- Do not employ pre-trained networks - NO Transfer Learning from large datasets
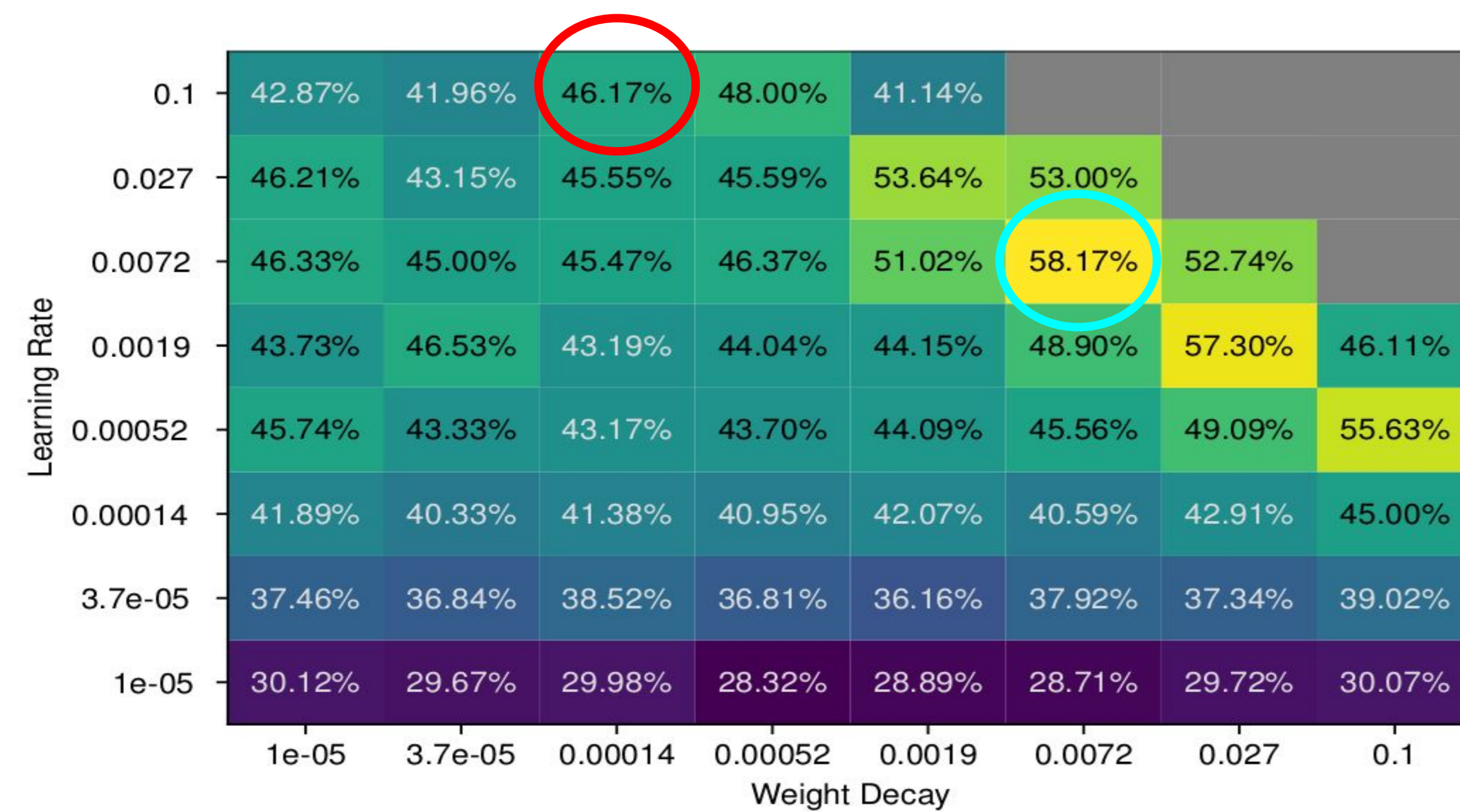
Motivation

Lack of a common benchmark

- Subsampled datasets without canonical splits
- Overfitting on natural images (e.g., CIFAR10) which generally do not have data-deficiency issues

Lack of reliable comparisons

- Neglecting the existing state of the art
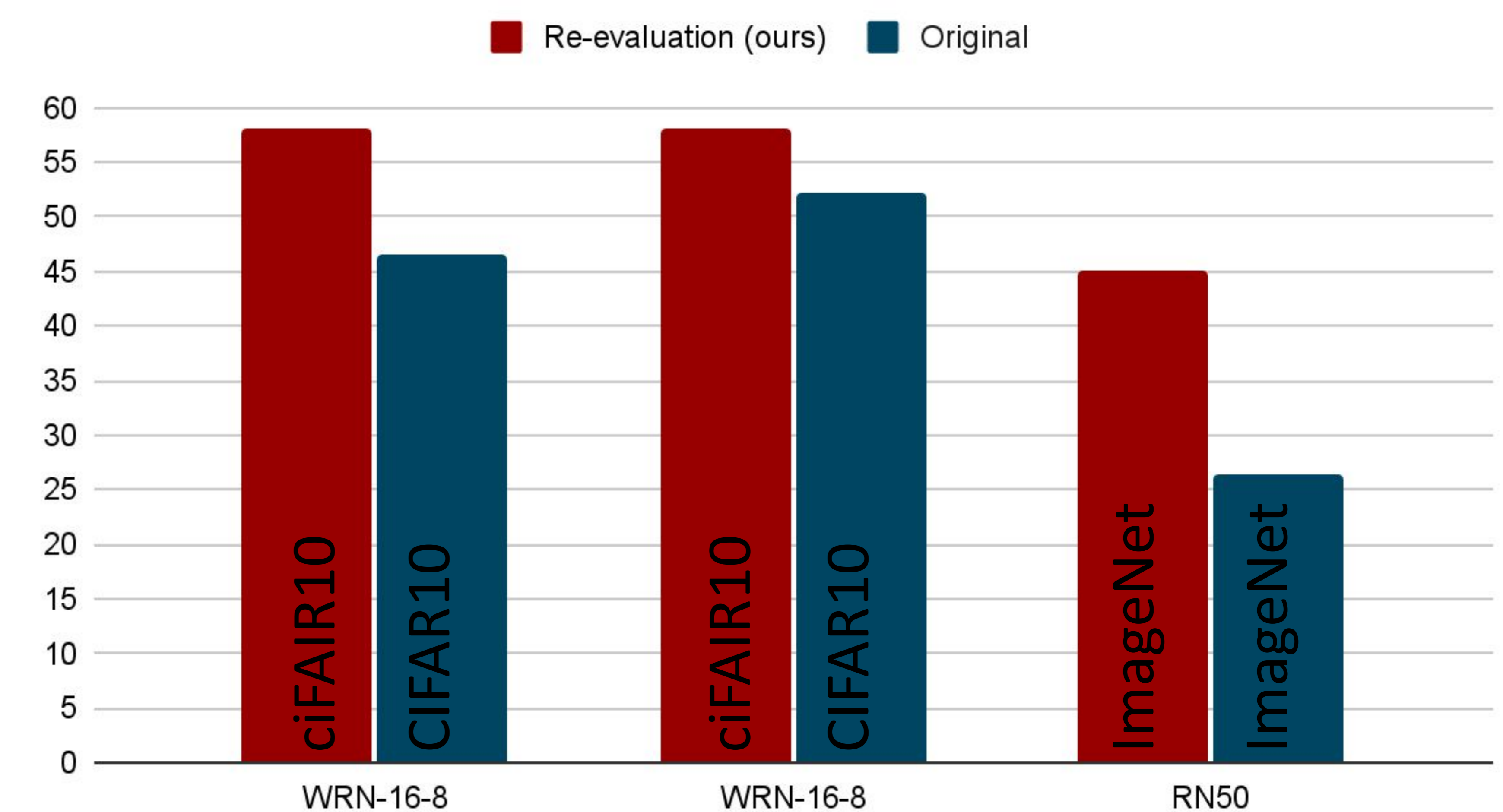- Using untuned baselines (default params may lead to suboptimal performance)

Contribution

1st Benchmark for DEIC (https://github.com/cvjena/deic):

- 6 different datasets covering different data types and domains (ciFAIR10, ImageNet, CUB200, EuroSAT, ISIC2018, ClaMM)
- Strict and realistic evaluation pipeline (HPO on small validation set, common base architecture and optimizer)
- Re-evaluation 8 state-of-the-art methods along with the baseline

Method	ImageNet	ciFAIR-10	CUB	EuroSAT	ISIC 2018	CLaMM	Average
Cross-Entropy Baseline	44.97	**58.22**	71.44	90.27	67.19	**75.34**	67.90
Deep Hybrid Networks [21, 22]	38.69	54.21	52.54	91.15	59.64	65.74	60.33
OLÉ [16]	43.05	54.92	63.32	89.29	62.89	71.42	64.15
Grad-ℓ_2 Penalty [3]	25.21	51.03	51.94	79.33	60.21	65.10	55.47
Cosine Loss [1]	37.22	52.39	66.94	88.53	62.42	68.89	62.73
Cosine Loss + Cross-Entropy [1]	44.39	51.74	70.80	88.77	64.52	69.29	64.92
Harmonic Networks [31, 32]	**46.36**	56.50	**72.26**	**92.09**	**70.42**	*74.59*	**68.70**
Full Convolution [13]	36.58	55.00	64.90	90.82	61.70	63.33	62.06
Dual Selective Kernel Networks [27]	45.21	54.06	71.02	91.25	64.78	61.51	64.64
T-vMF Similarity [14]	42.79	*57.50*	67.43	88.53	65.37	66.40	64.67

Findings

- Well-tuned cross-entropy is a strong baseline (ranks second only behind Harmonic Networks [Ulicny et al. 2019])
- Published baselines are underperforming
- Strong baseline: small bs (e.g., 16), $10^{-4} < wd < 10^{-2}$, $10^{-4} < lr < 10^{-3}$

Cross-Entropy Baseline