



Improving Generalization via Scalable Neighborhood Component Analysis



Zhirong Wu, Alexei A. Efros, Stella X. Yu
UC Berkeley / ICSI, Microsoft Research Asia

github.com/Microsoft/snca.pytorch

Motivations

Learning Classifiers

Vs.

Learning Embeddings

Parametric Softmax

Nearest Neighbors

Recognition as Naming

Recognition as Association

Fixed Set of Categories

Generalize to New Categories



Object Classification
Object Detection



Face Recognition
Person Re-identification

A Simple Neighborhood Model (NCA)

Pairwise similarity:

$$s_{ij} = \cos(\theta) = \frac{v_i v_j}{\|v_i\| \|v_j\|}$$

Probability that i selects j as a neighbor:

$$p_{ij} = \frac{\exp(s_{ij}/\sigma)}{\sum_{k \neq i} \exp(s_{ik}/\sigma)}, \quad p_{ii} = 0$$

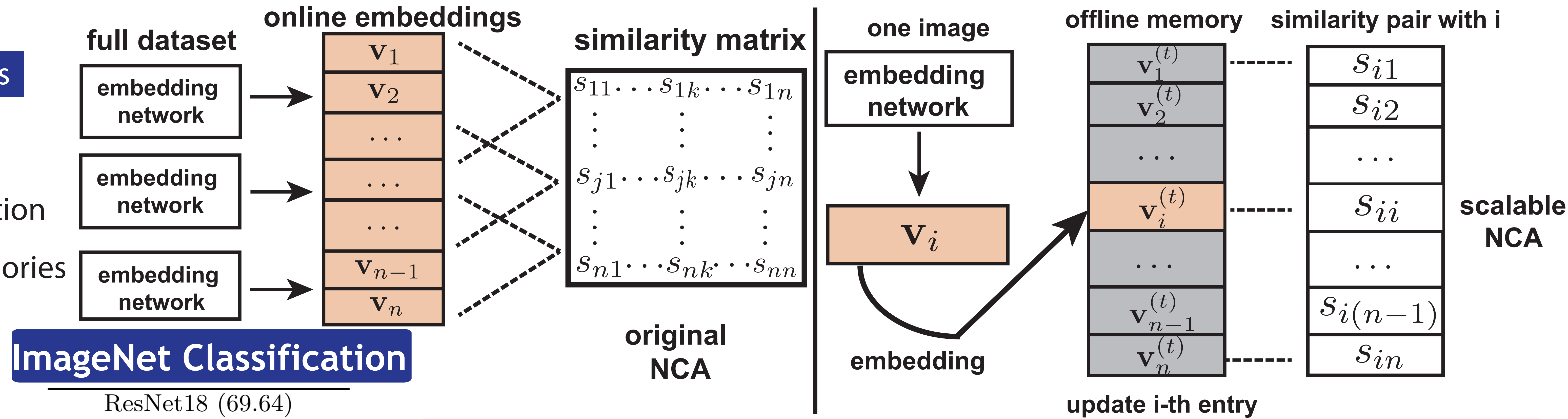
Probability that example i is recognized:

$$p_i = \sum_{j \in \Omega_i} p_{ij}$$

Log probability over the dataset:

$$J = \frac{1}{n} \sum_i J_i = -\frac{1}{n} \sum_i \log(p_i)$$

Scalable Neighborhood Component Analysis



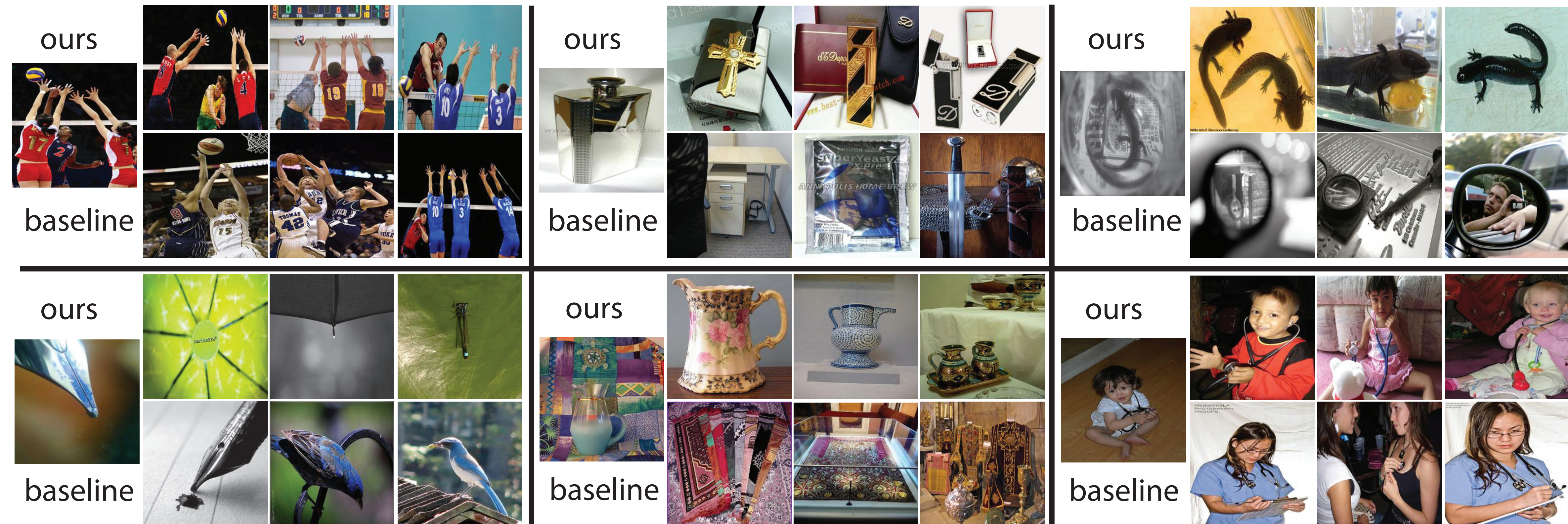
ImageNet Classification

ResNet18 (69.64)				
Feature	d	k=1	k=30	
Baseline	512	62.91	68.41	
+PCA	128	60.43	66.26	
Ours	128	67.39	70.58	

ResNet34 (73.27)				
Feature	d	k=1	k=30	
Baseline	512	67.73	72.32	
+PCA	128	65.58	70.67	
Ours	128	71.81	74.43	

ResNet50 (76.01)				
Feature	d	k=1	k=30	
Baseline	2048	71.35	75.09	
+PCA	128	69.72	73.69	
Ours	128	74.34	76.67	

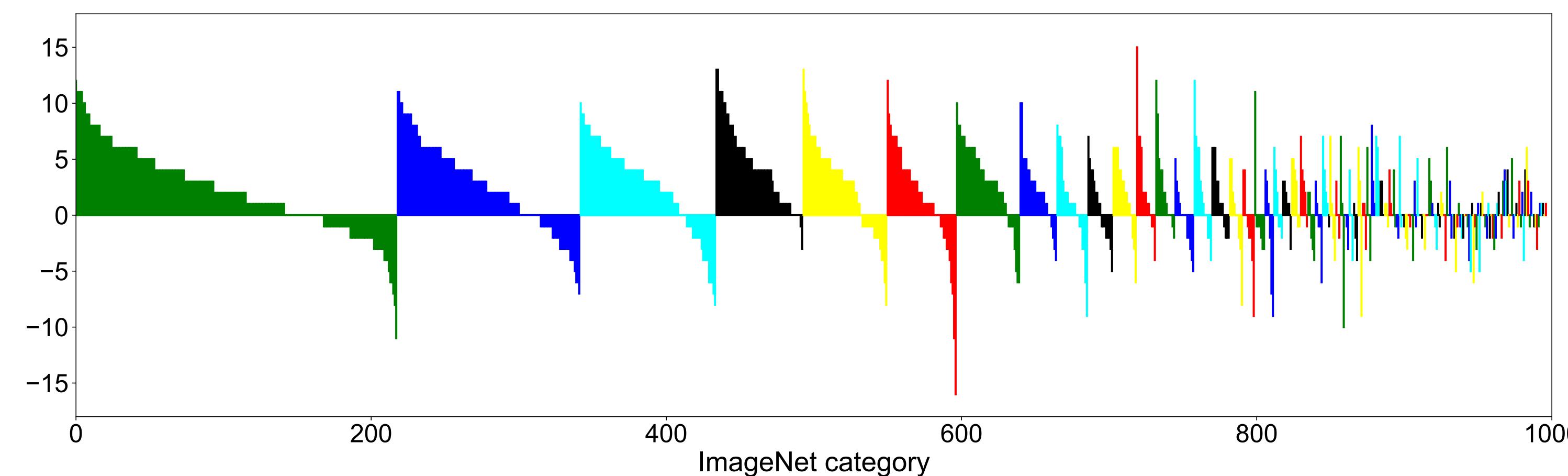
Nearest Neighbors



Sub-category Discovery

Transfer from coarse to fine-grained categories

CIFAR			ImageNet		
Task	20 classes	100 classes	Task	127 classes	1000 classes
Baseline	81.53	54.17	Baseline	81.48	48.07
Ours	81.42	62.32	Ours	81.62	52.75



Few-shot Recognition

Transfer to open-set new categories on Mini-ImageNet

Method	Network	FineTune	5-way Setting		20-way Setting	
			1-shot	5-shot	1-shot	5-shot
NN Baseline [44]	Small	No	41.1±0.7	51.0±0.7	-	-
Meta-LSTM [29]	Small	No	43.4±0.8	60.1±0.7	16.7±0.2	26.1±0.3
MAML [6]	Small	Yes	48.7±0.7	63.2±0.9	16.5±0.6	19.3±0.3
Meta-SGD [21]	Small	No	50.5±1.9	64.0±0.9	17.6±0.6	28.9±0.4
Matching Net [44]	Small	Yes	46.6±0.8	60.0±0.7	-	-
Prototypical [38]	Small	No	49.4±0.8	68.2±0.7	-	-
RelationNet [41]	Small	No	51.4±0.8	61.1±0.7	-	-
Ours	Small	No	50.3±0.7	64.1±0.8	23.7±0.4	36.0±0.5
SNAIL [27]	Large	No	55.7±1.0	68.9±0.9	-	-
RelationNet [41]	Large	No	57.0±0.9	71.1±0.7	-	-
Ours	Large	No	57.8±0.8	72.8±0.7	30.5±0.5	44.8±0.5