Supplementary Material: Toward Robustness against Label Noise in Training Deep Discriminative Neural Networks

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1 Visualization

As shown in the E step in Sec. 3.3, the variational distribution q infers latent clean labels by combining information from both the image-based CRF-CNN model $p_{\boldsymbol{\theta}}(\hat{\boldsymbol{y}}, \boldsymbol{h}|\boldsymbol{y}, \boldsymbol{x})$ and the label-based auxiliary distribution $p^{\alpha}_{aux}(\hat{\boldsymbol{y}}, \boldsymbol{h}|\boldsymbol{y})$. In our experiments, we observe that in general q proposes clean labels more accurately than the auxiliary distribution. Fig. 1 compares q against p_{aux} in terms of its ability to infer clean labels for a few instances in the noisy training set (D_N) for the COCO experiment with actual Flickr tags. In Fig. 2, examples of the recovered clean labels are visualized for the CIFAR-10 experiment.

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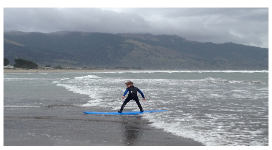
Flickr	∅
p_{aux}	person
q	skateboard, person
clean	skateboard, person

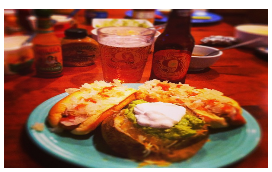
Flickr	∅
p_{aux}	person
q	person, baseball glove, baseball bat
clean	person, baseball glove, baseball bat, sports ball, chair, bench

Flickr	2009, miami
p_{aux}	person
q	person, tennis racket
clean	person, tennis racket



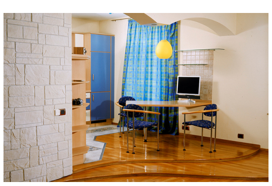
Flickr	uploaded:by=flickr_mobile, flickriosapp:filter=NoFilter
p_{aux}	person
q	person, surfboard
clean	person, surfboard

Flickr	computer
p_{aux}	∅
q	laptop, mouse, tv, keyboard
clean	laptop, mouse, tv, keyboard



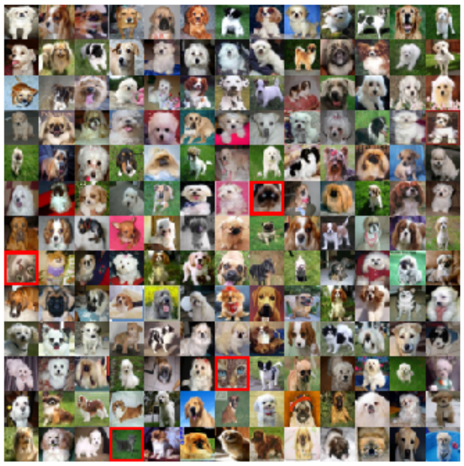
Flickr	square, iphoneography, square format, instagram app, uploaded:by=instagram
p_{aux}	∅
q	cup, dining table, bottle, bowl
clean	cup, dining table, bottle, bowl, spoon, hot dog

Flickr	food, square, square format, nikon, white, orange, fruit, color, India, photography, table, project365, bowl, colour, wood, 50mm, nikkor, bokeh
p_{aux}	orange, apple, banana
q	orange, bowl, dining table
clean	orange, bowl

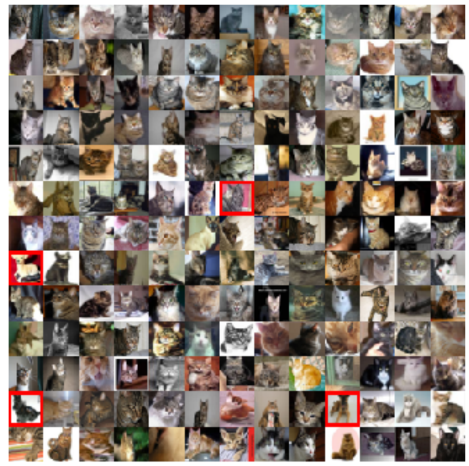


Flickr	home, light, photo, art, chair, room, table, architecture, apartment, interior, couch, decor, beauty, design, live, lamp, indoor, furniture, relaxed, sofa, flooring, modern
p_{aux}	chair, couch, vase, book, dining table, sink, clock, bed, potted plant
q	chair, couch, vase, book
clean	chair, dining table, tv

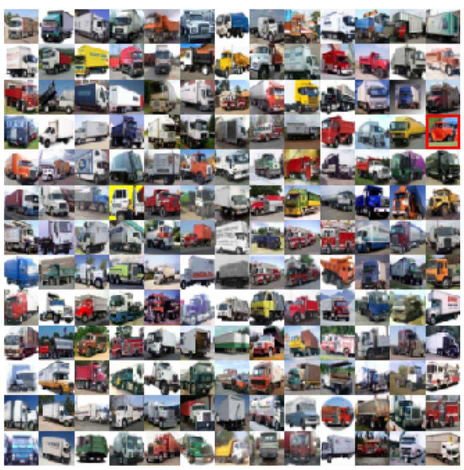
Figure 1: Visualization of inferred labels for a few instances in the noisy training set (D_N) of the COCO dataset. Flickr labels represent the noisy labels extracted from Flickr tags, whereas clean labels are the true labels ignored during training. p_{aux} and q correspond to the labels that are extracted using these distribution by thresholding at 0.5. The auxiliary distribution p_{aux} tends to assign the label "person" to the images with no tag while q adds more clean labels. In the last two images, q removes a few unrelated labels.



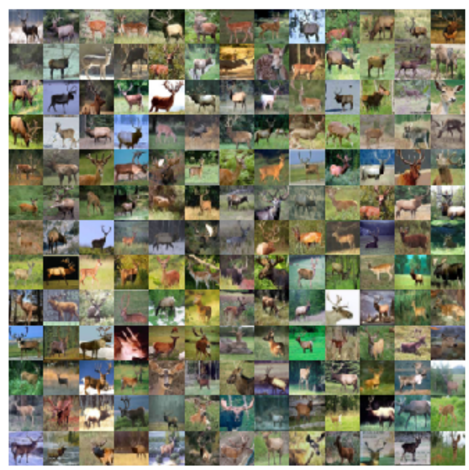
(a) cat → dog



(b) dog → cat



(c) automobile → truck



(d) horse → deer

Figure 2: Our proposed model can recover clean labels in the noisy training dataset. Here, corrupted instances are visualized for different categories in the CIFAR-10 training dataset. Sub-figures (a) through (d), captioned with *annotated label* → *inferred label*, represents the instances that are labeled with the annotated label but have been assigned to the inferred label by our proposed variational distribution q. In this visualization, images are sorted based on the confidence of q for the inferred label from left to right and top to bottom, and the mistaken instances are marked with the red frame. The probability that q assigns for the inferred label is typically very high (> 0.9) for these images, which indicates that q is confident in changing the noisy labels.