Analysis of the effect of regularization techniques on Class Activation Map

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Jinhwan Seo, Group 5

Motivation

- Why regularization?

  Neural network tend to overfit due to the complexity of model.

  Overfitting degrades performance on test data

  It helps to the model to generalize better for unseen data.

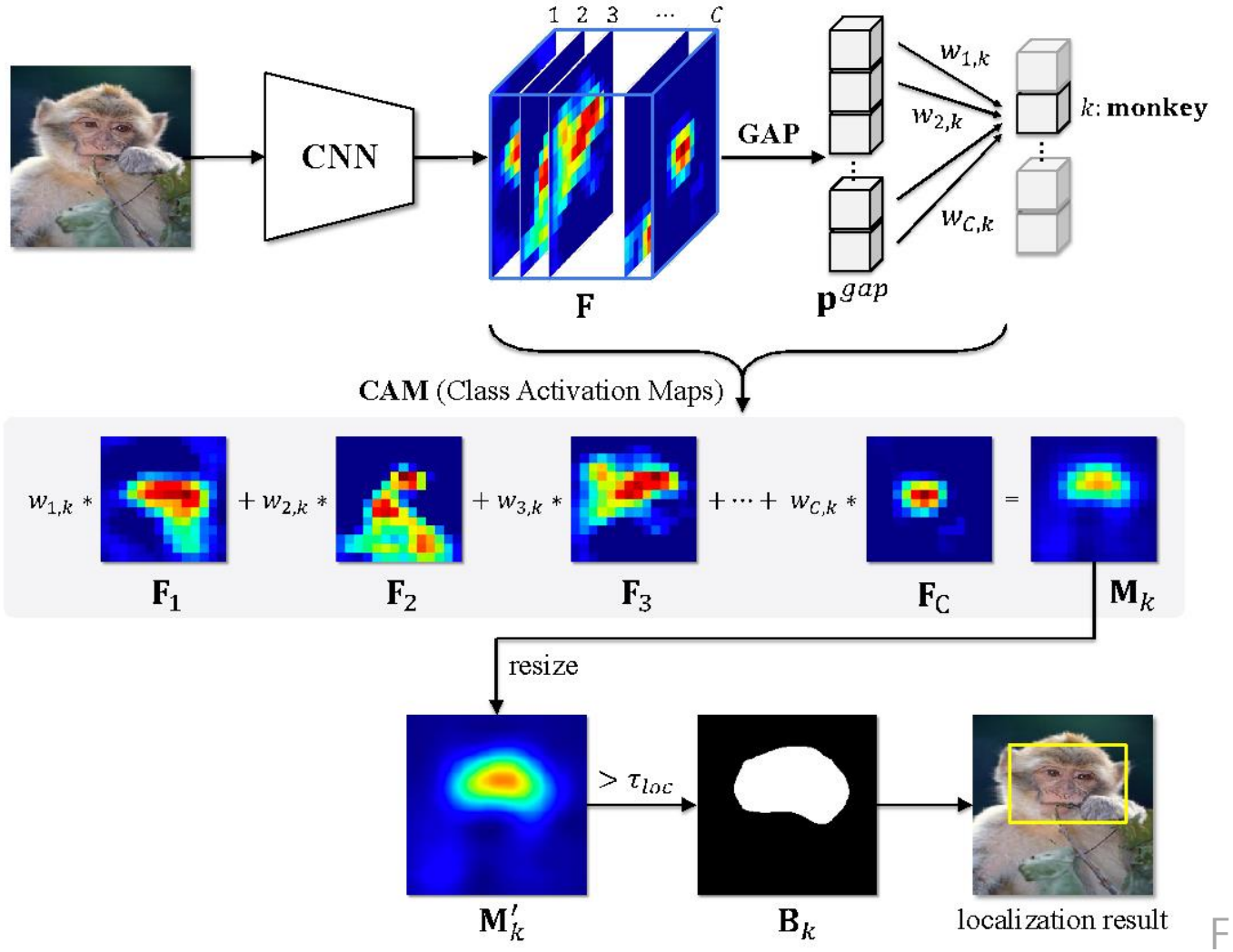
Motivation

- $L(\theta) = \frac{1}{n}\sum_{i=1}^{n} l(x_i, y_i; \theta)$

Different regularization techniques.

- $\min_{\theta} L_R(\theta) = L(\theta) + \lambda||\theta||_1$ (L1 regularization)
  - Feature selection and sparse solution
- $\min_{\theta} L_R(\theta) = L(\theta) + \frac{\lambda}{2}||\theta||_2^2$ (L2 regularization)
  - Forcing weights to be small, but not making to be zero

Background



$$p_c^{gap} = \frac{1}{H \times W} \sum_{(h,w)} F_c(h,w)$$

where $F \in \mathbb{R}^{H \times W \times C}$.

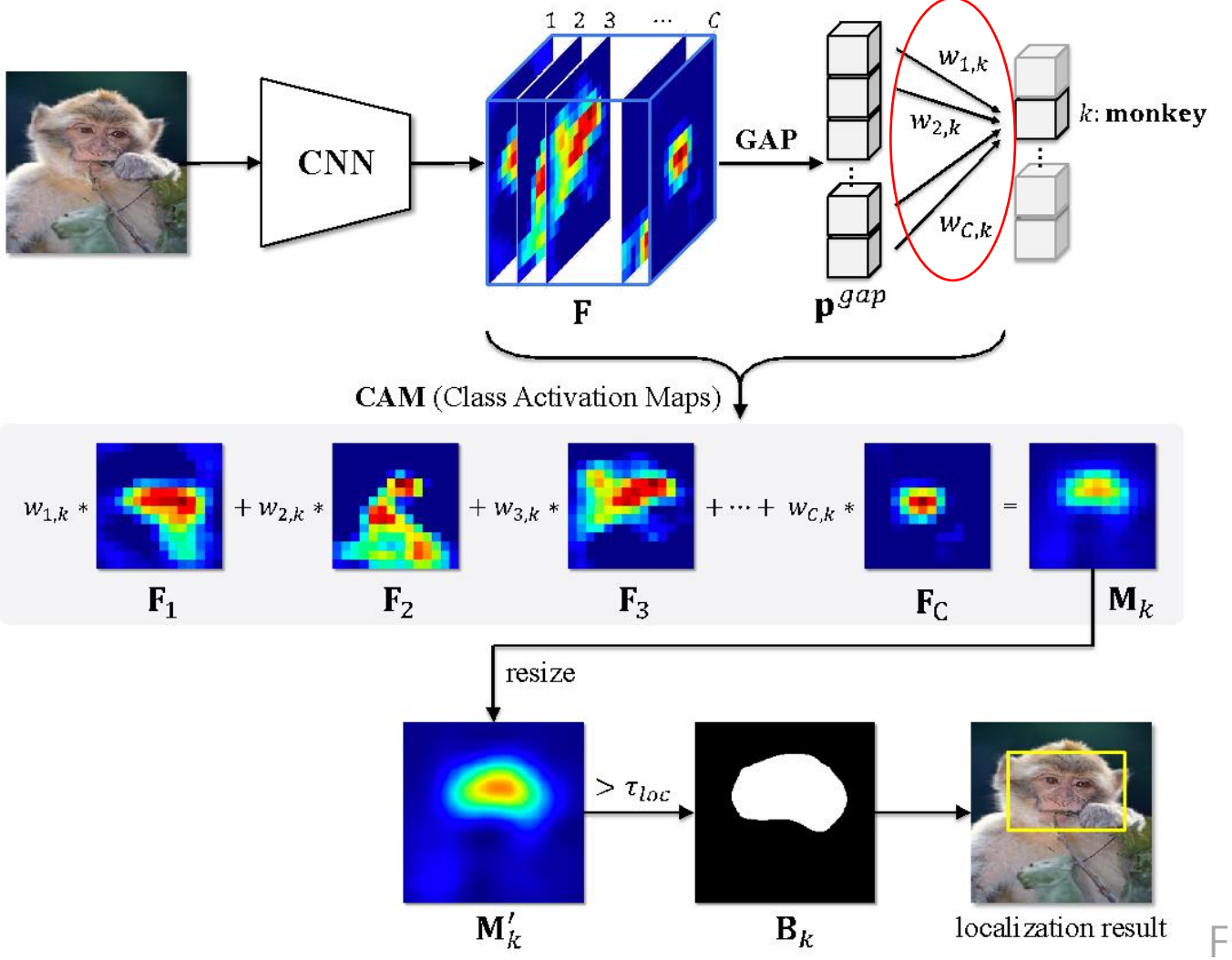
$$M_k = \sum_{c=1}^{C} w_{c,k} \cdot F_c$$

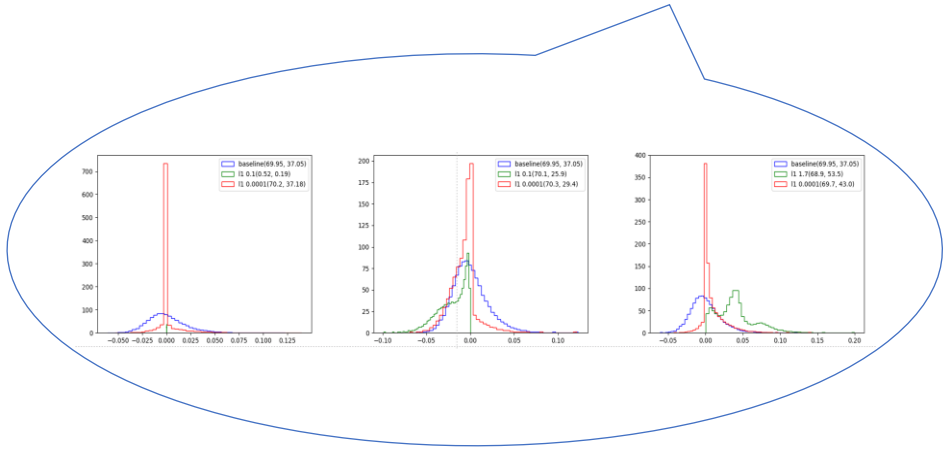
where $M_k \in \mathbb{R}^{H \times W}$ and $W \in \mathbb{R}^{C \times K}$

$$\tau_{loc} = \theta_{loc} \cdot max\acute{M}_k$$

Figure credit: Bae et. al

Background





$$\min_{\theta,W} L(\theta, W) + \lambda||W||_1$$

$$\min_{\theta,W} L(\theta, W) + \lambda||W||_2^2$$

Regularize the weight of last layer which determines the importance at inference time.

Figure credit: Bae et. al

Problem

1. The activation maps of each channel corresponding to the weight are often over / underestimated by $w_{c,k}$.
   - Add penalty on $w_{c,k}$

2. The large portion of negative weights indicate foreground so that it negatively affect on localization.
   - Split $w_{c,k}$ depend on the sign of weight

Experiment settings

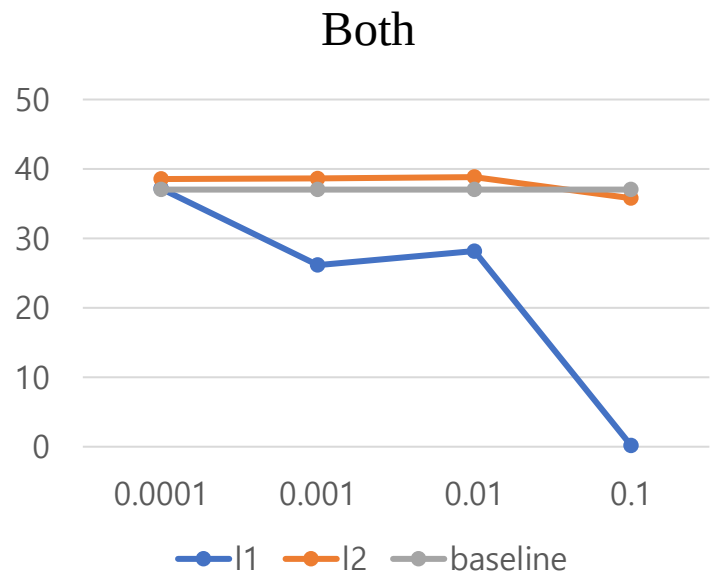
- Dataset: CUB-200-2011
- Backbone: VGG16
- Batch size: 32
- Learning rate: 0.003
- Epochs: 200
- Optimizer: SGD

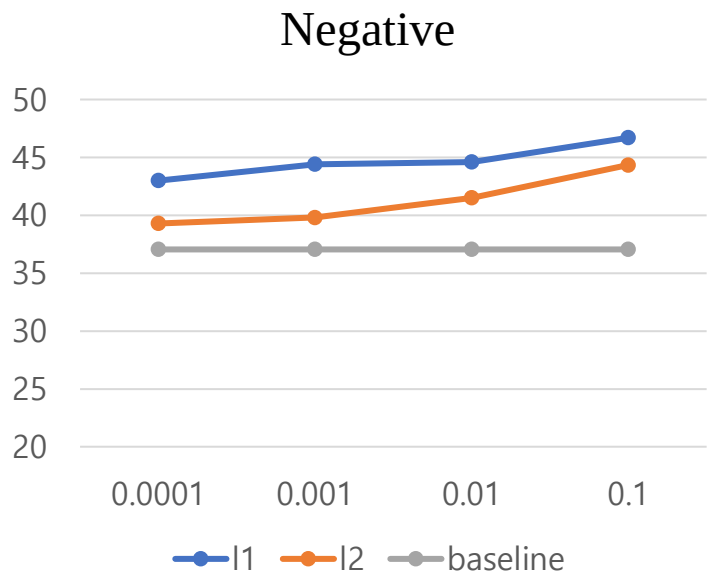
- Dataset: ImageNet-1K
- Backbone: VGG16
- Batch size: 40
- Learning rate: 0.02
- Epochs: 200
- Optimizer: SGD

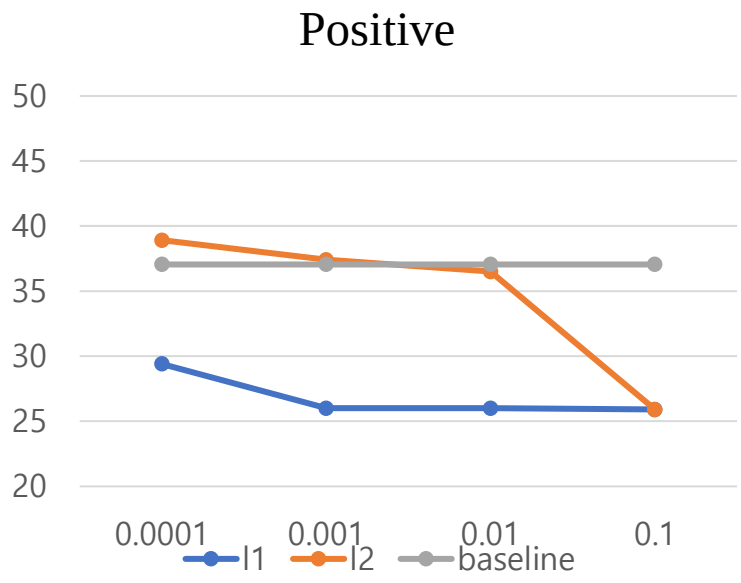
Experimental results on CUB-200-2011

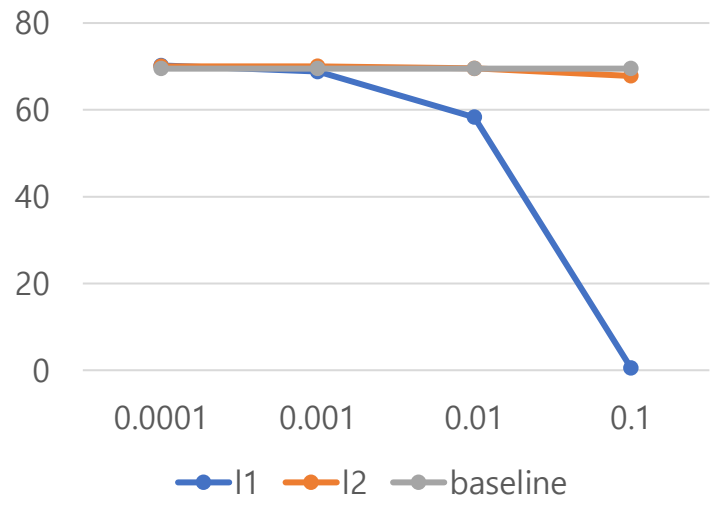
Top1-Loc

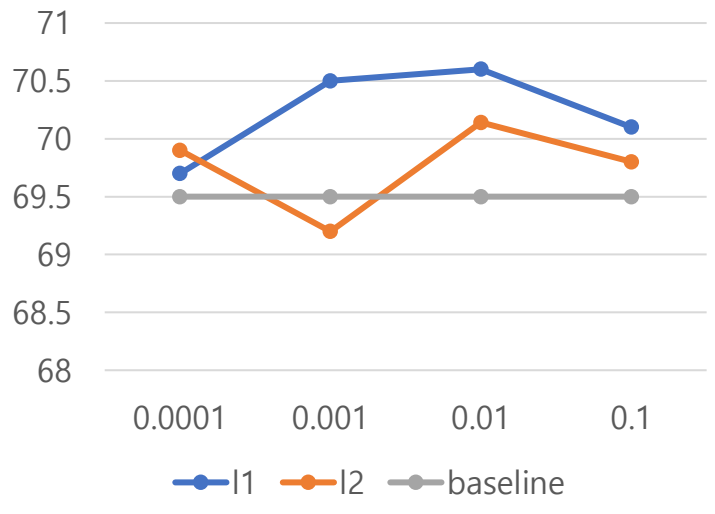
Top1-Cls

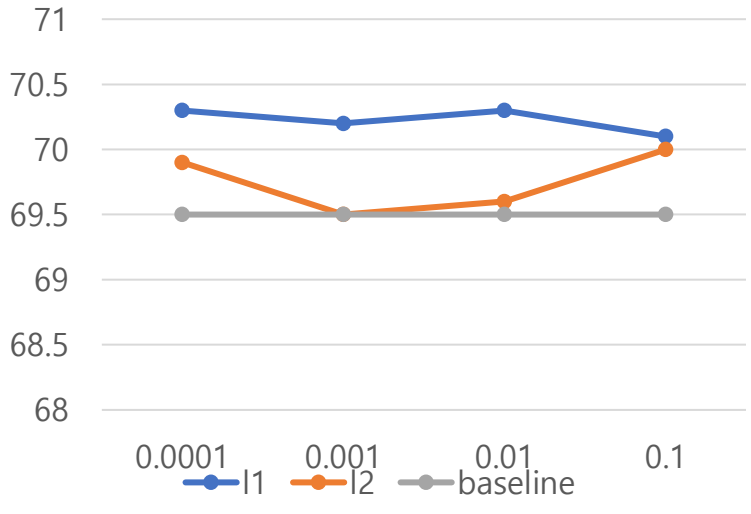




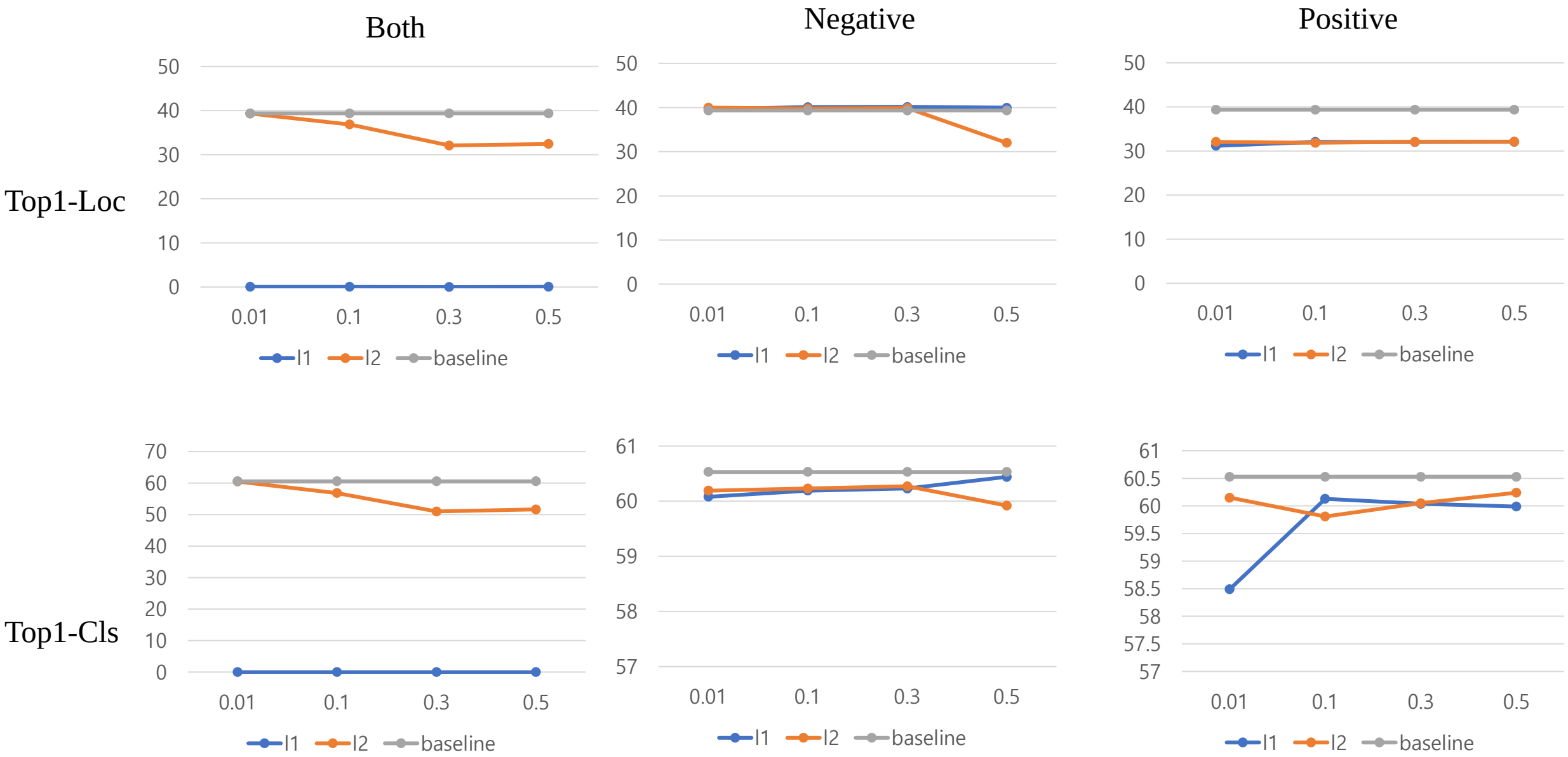








Experimental results on ImageNet-1K



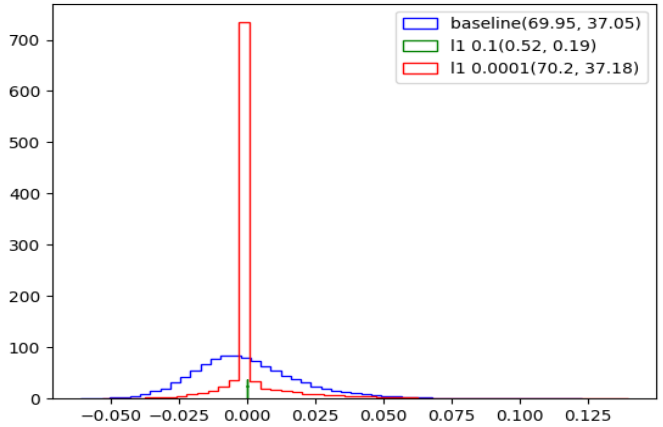
Histogram of weights on CUB-200-2011

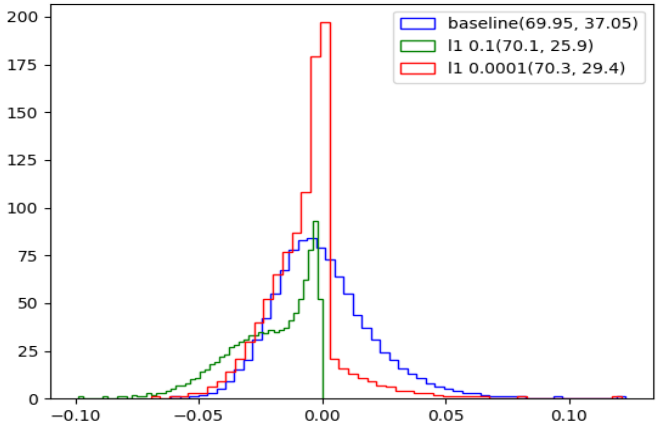
Both

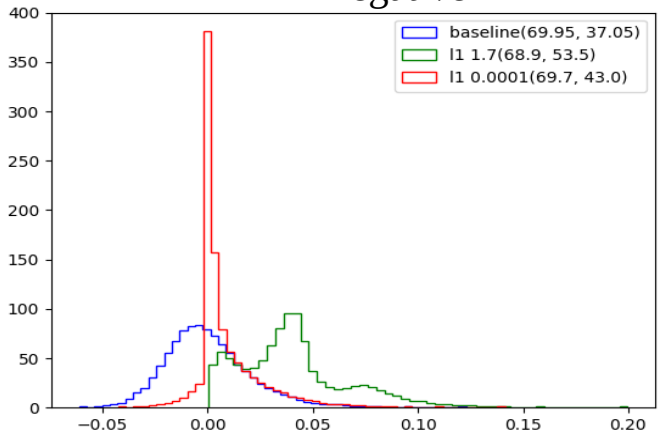
Positive

Negative

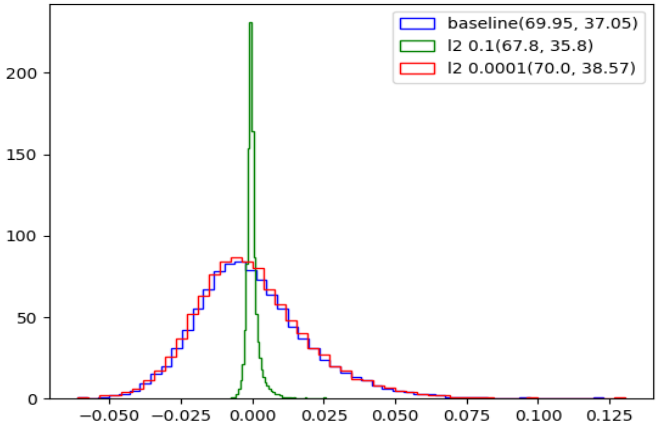
L1

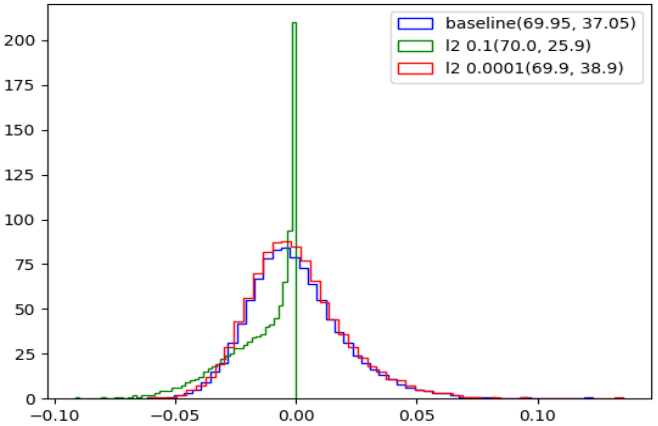


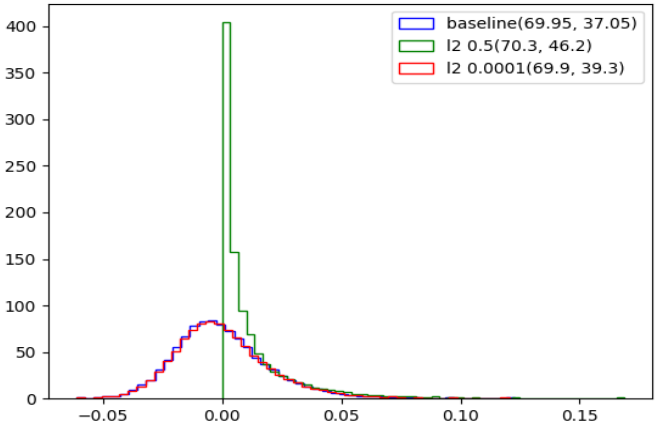




L2







Histogram of weights on ImageNet-1K

Both

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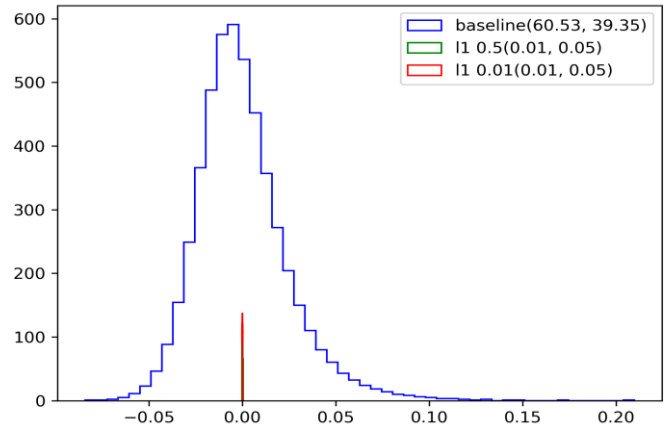
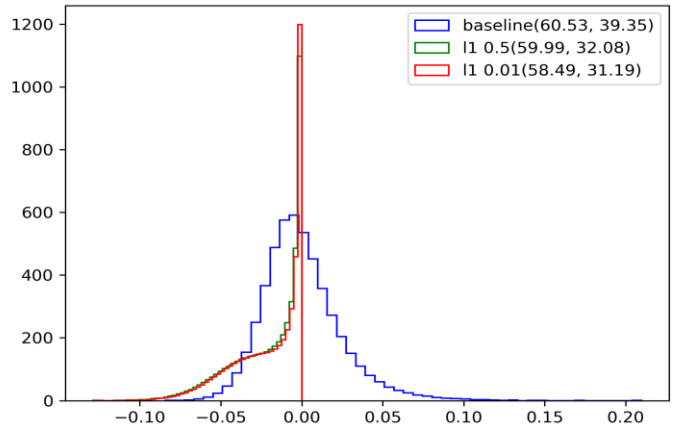
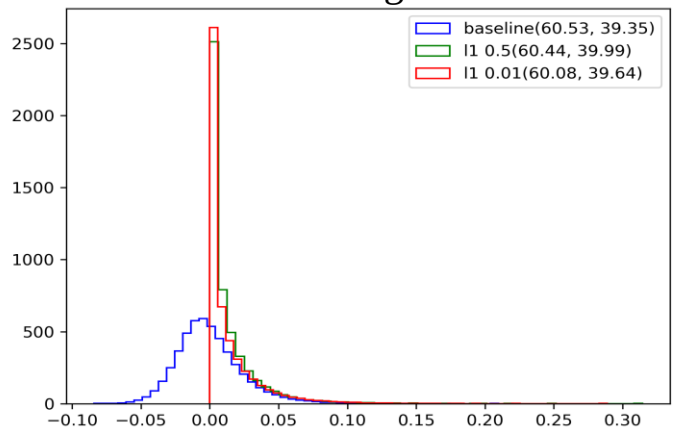
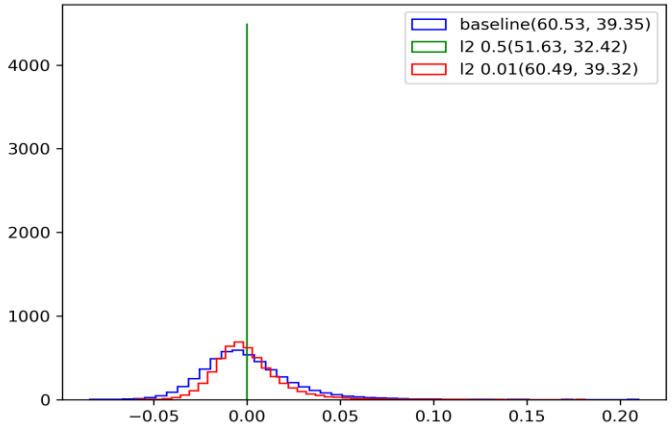
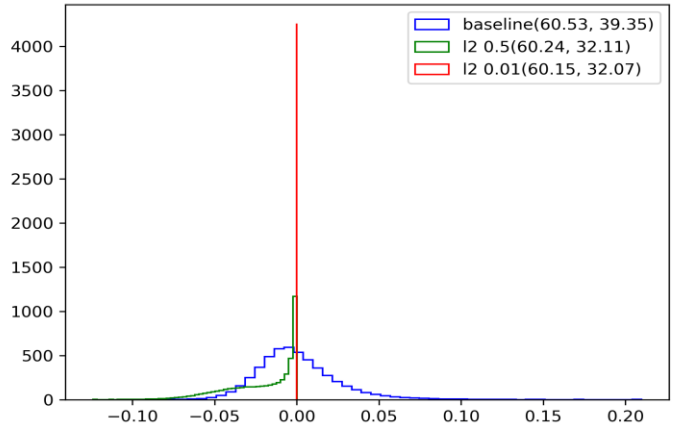


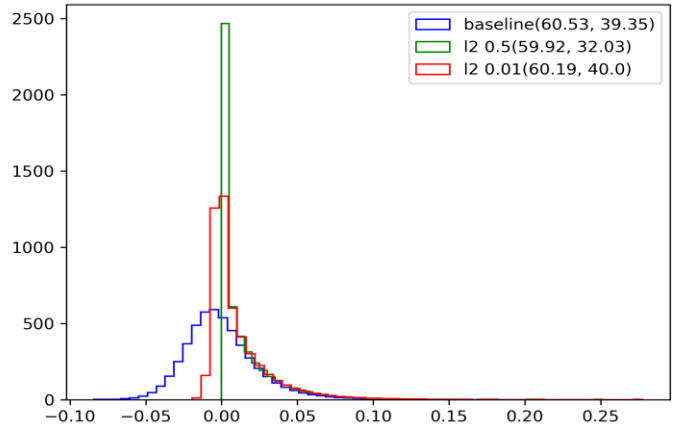


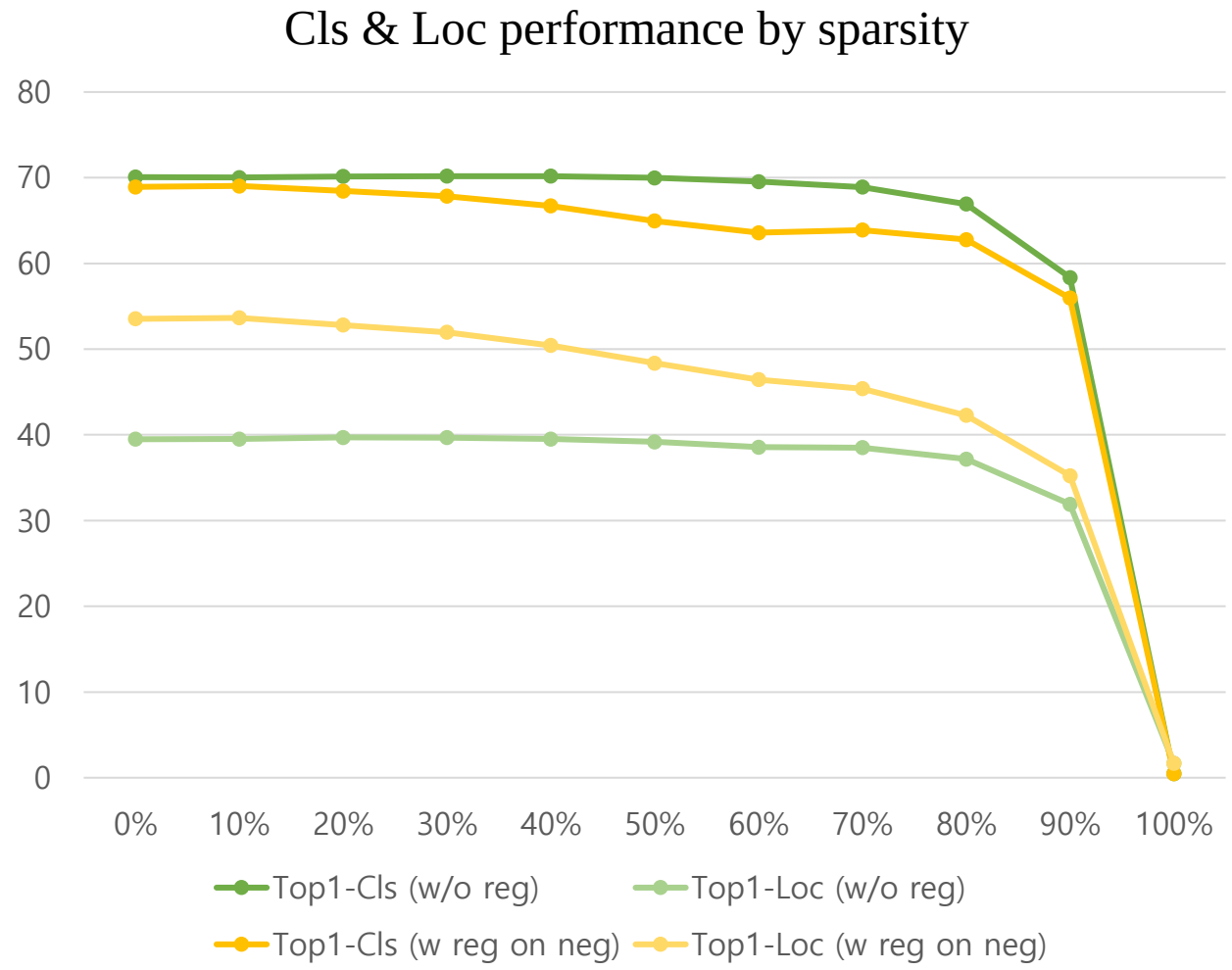


L2

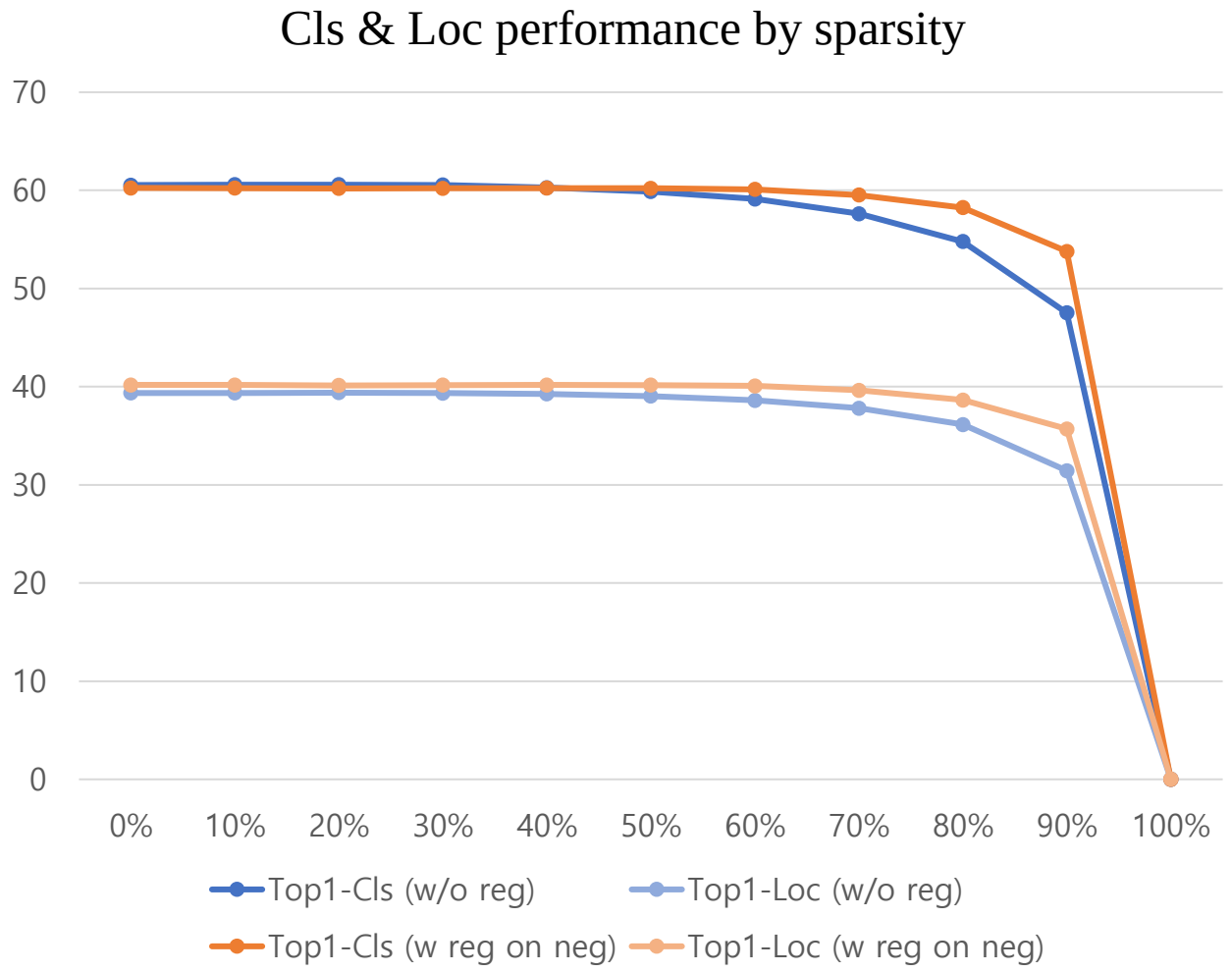








(a) CUB-200-2011



(b) ImageNet-1K

Summary

- We investigate the phenomena of CAM with / without regularization term on $w_{c,k}$.
- We show the distribution of weight with different penalty term.
- Negative weight affect negatively on localization.
- Similar pattern cannot be observed due to the difference of category on two dataset.