Experiments on WHOI

---a class imbalanced database

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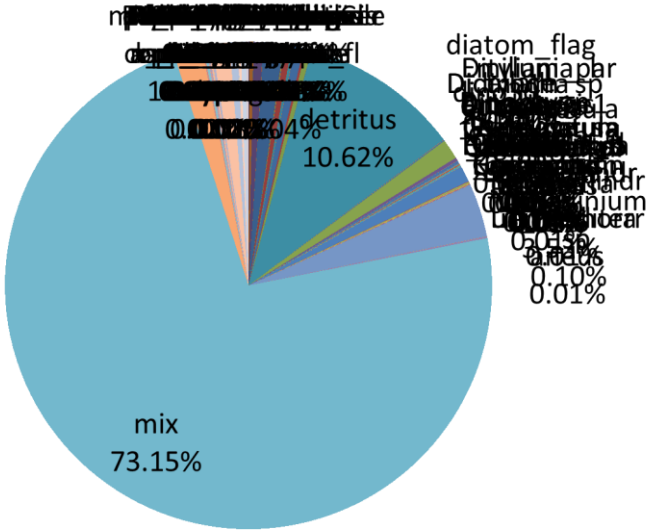
Overview

- Baseline
- Transfer from data
- Transferred model based approach
- Q&A

Baseline

Introduction

- Database distribution



Classes	Total	Training	Testing
Mix	73.2%	72.4%	80.1%
Detritus	10.6%	10.6%	11.0%
Leptocylindrus	3.5%	3.8%	1.3%
Mix_elongated	1.9%	2.0%	1.1%
Dino30	1.3%	1.4%	1.2%
Sum	90.5%	90.2%	94.7%

- Challenge: class is very imbalance.

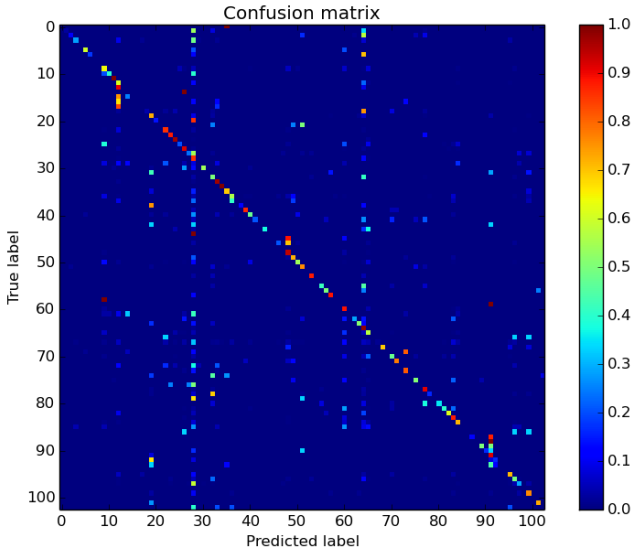
What is a better solution on this problem

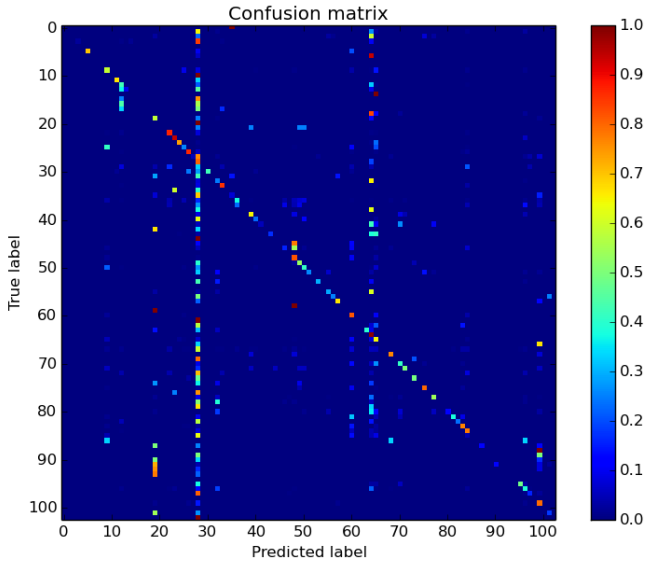
- Average accuracy
- Precision and recall
- F1 score
- Confusion matrix

- Don’t be fooled by the weighted accuracy

Benchmark

database	model	iteration	accuracy	F1 score
full	cifar10 CNN model	120k	0.9297	0.1975
full	alexnet	20k	0.9395	0.3837
full	vgg16	70k	0.9335	0.2902





The Challenge:
class is extremely imbalance

Two ways to solve the problem

- Common goal: shrink the imbalance

- Approach 1: Sampling based approach
  - Data Augmentation(Oversampling)
  - Undersampling
  - Mix
- Approach 2: Loss function based
  - Punish the large class

Transfer from data

Method

- Set the dataset:
  - full: the whole data
  - sample data: the number of images exceed 5,000
- Method
  - Training a single model on sample data
  - Fine tune the pre-trained model on the full data

R. A. Fisher (1936). "The use of multiple measurements in taxonomic problems". Annals of Eugenics.

Experiments result

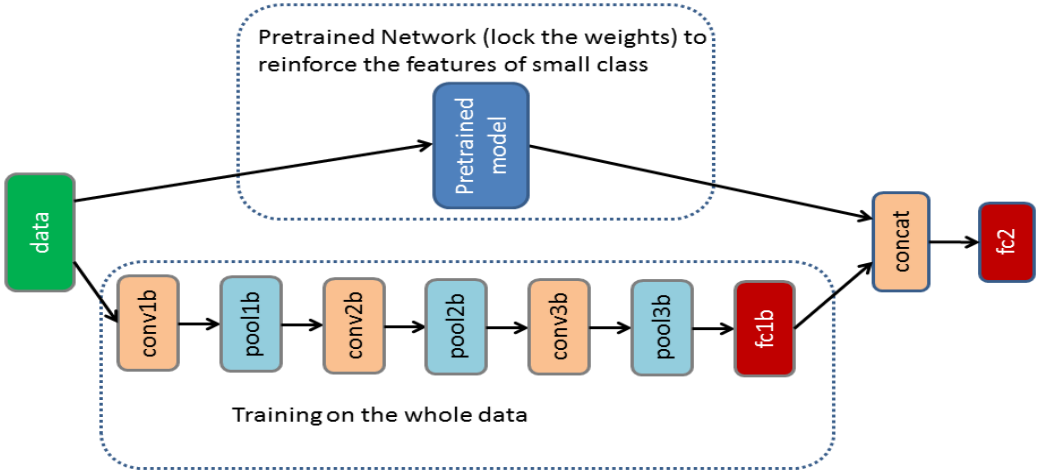
database	model	iteration	accuracy	F1 score
sample	cifar10 CNN	108k	0.8271	0.3086
full + sample	cifar10 CNN	40k	0.9350	0.3339
sample	vgg16	140k	0.8972	0.4919
full + sample	vgg16	10k	0.9416	0.4482

Insights

- insight 1: their method with vgg16 not work well
- insight 2: CNN features mater
- insight 3: the database itself lack of small class's samples, means that lack the features

My approach

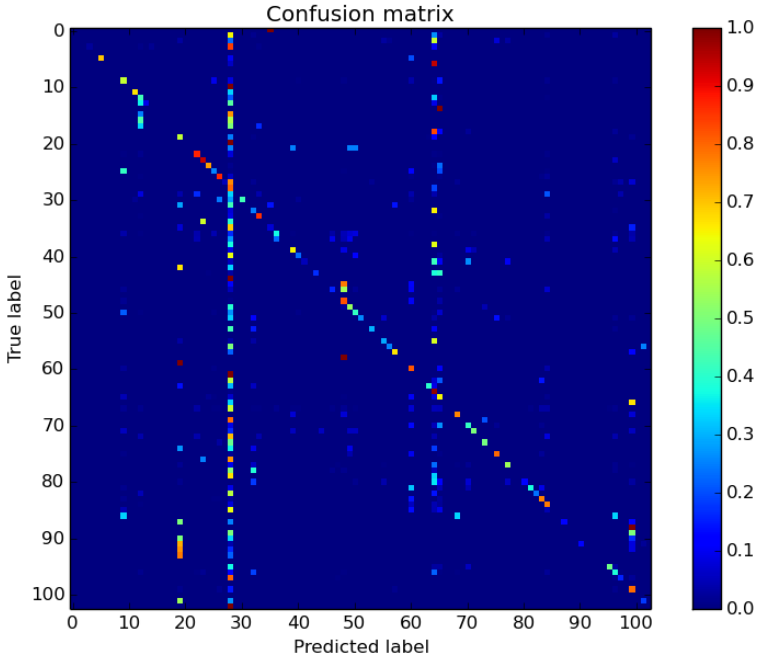
- Architecture:



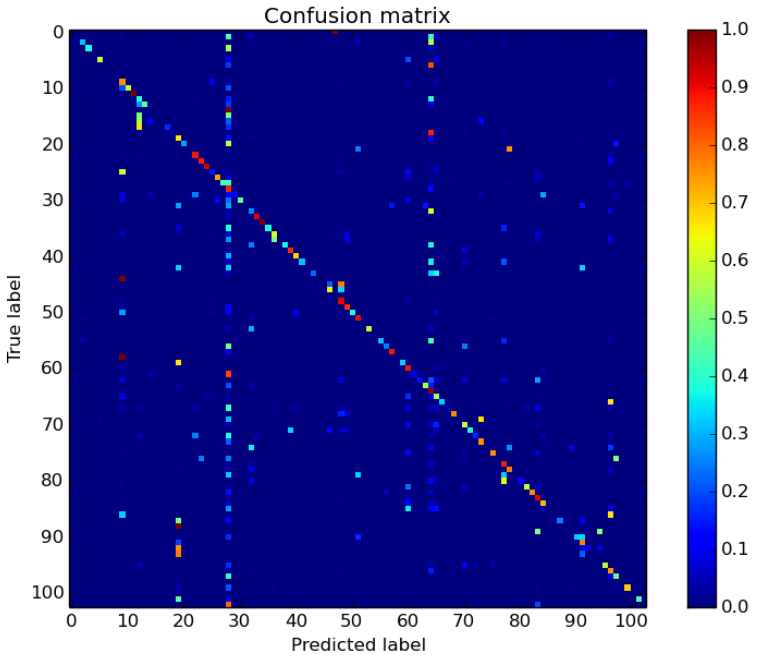
- Training pipeline:
  - Select the small class image number under 5,000
  - Training on the data of small class
  - Store and combine the model(eg. variant of vgg)
  - Training on the full data and fixed model a to enhance the small class's deep features

Experiment result

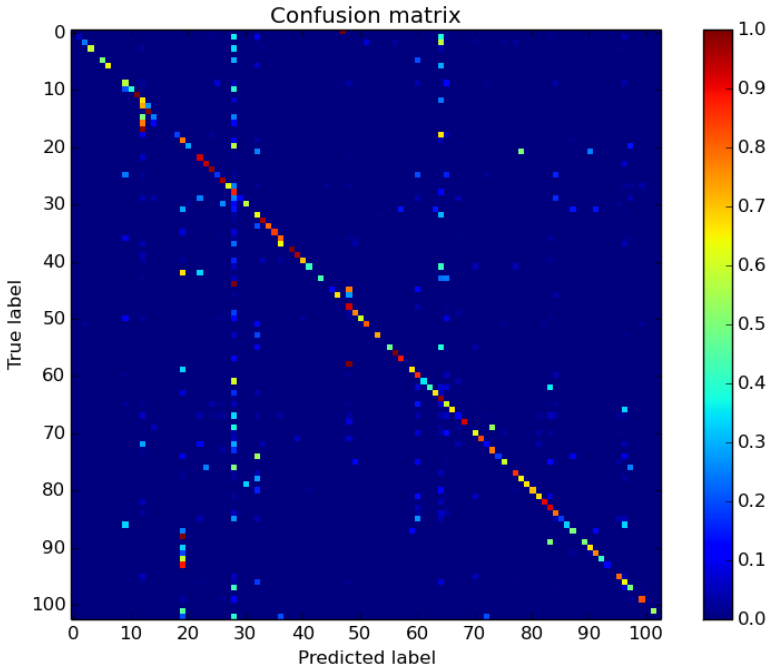
database	model	iteration	accuracy	F1 score
full	cifar10 CNN	120k	0.9297	0.1975
full	vgg16	70k	0.9339	0.2902
full + sample	cifar10 CNN	40k	0.9350	0.3339
full + sample	vgg16	10k	0.9416	0.4482
full + small	cifar10 reinforce	136k	**0.9370**	**0.3752**
full + small	vgg16 reinforce	150k	**0.9498**	**0.5444**



vgg16_baseline

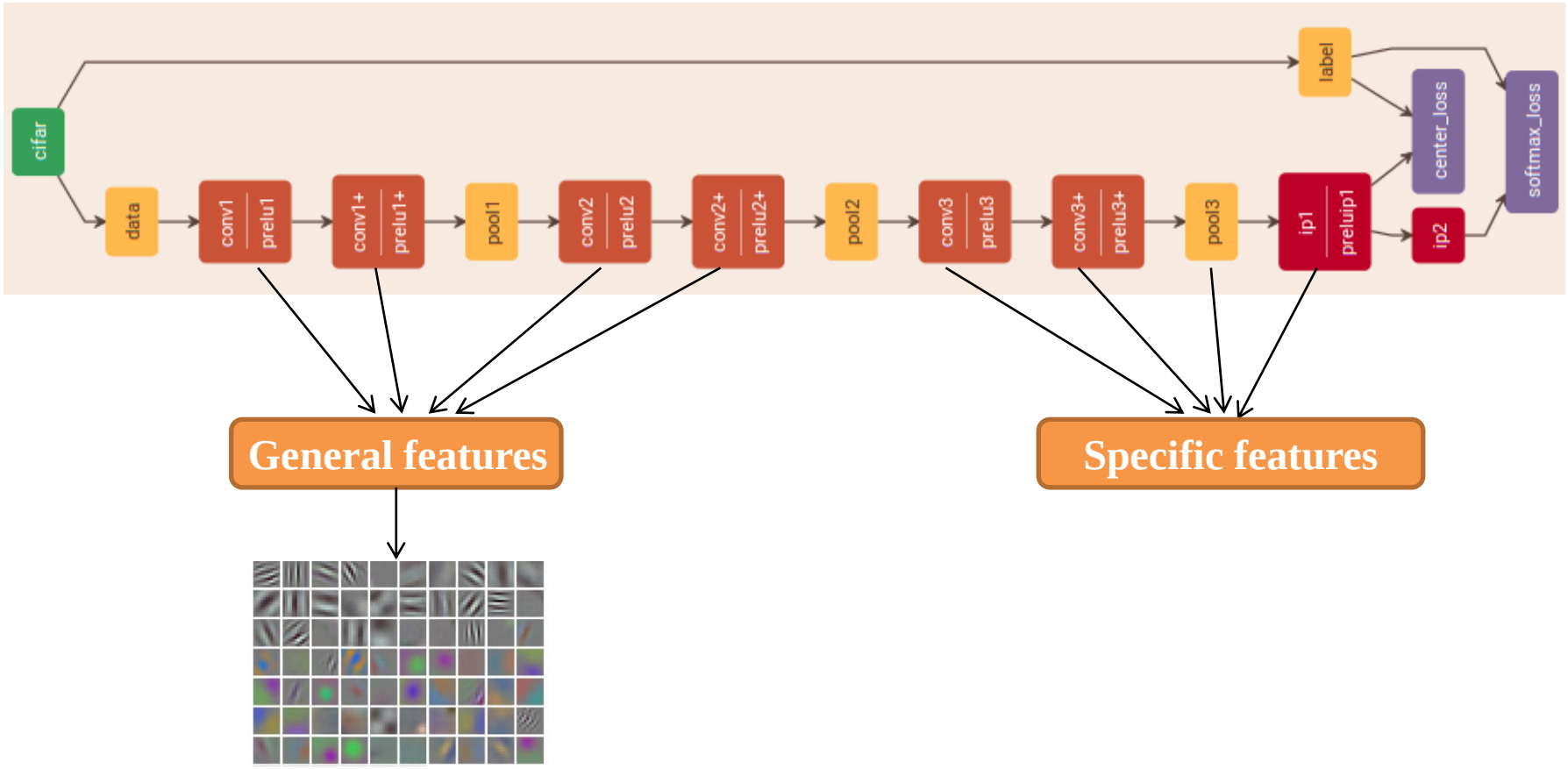


vgg16_transfer_from data: ICIP2016

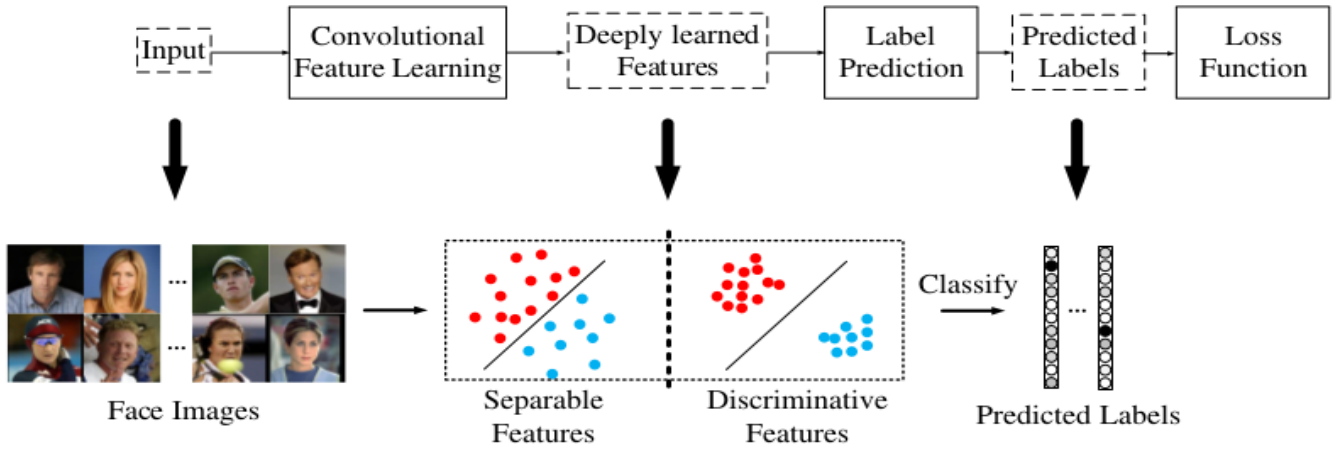


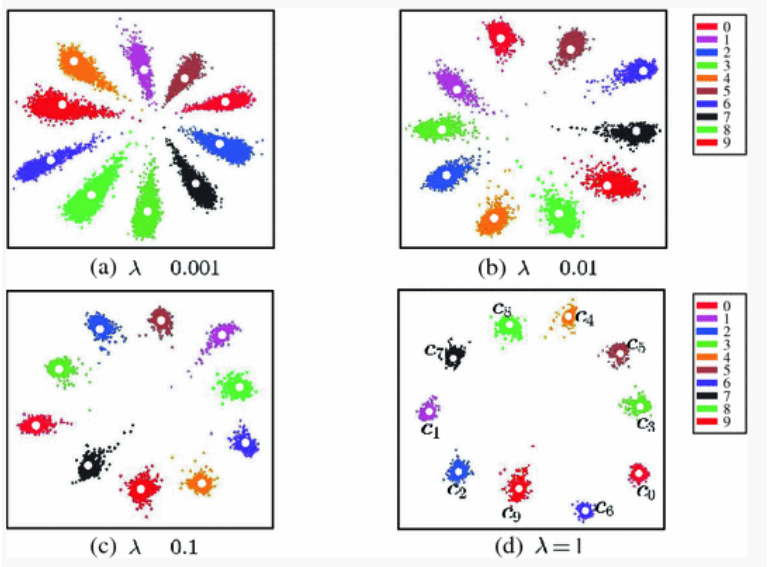
My model(variant of vgg16)

Deep feature visualization and analysis



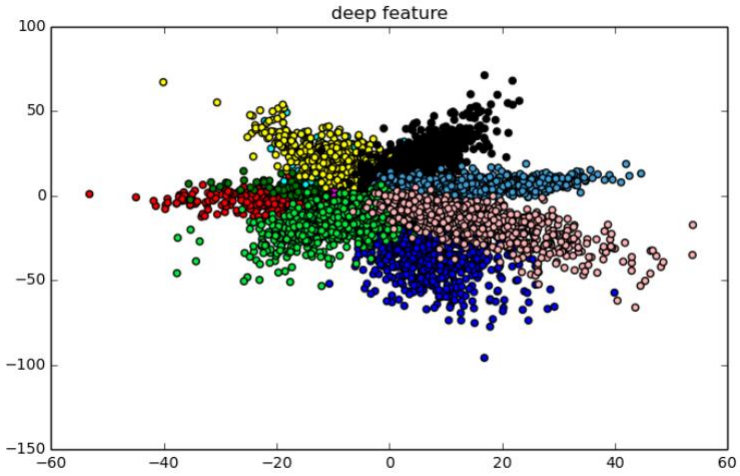
A discriminative feature learning approach



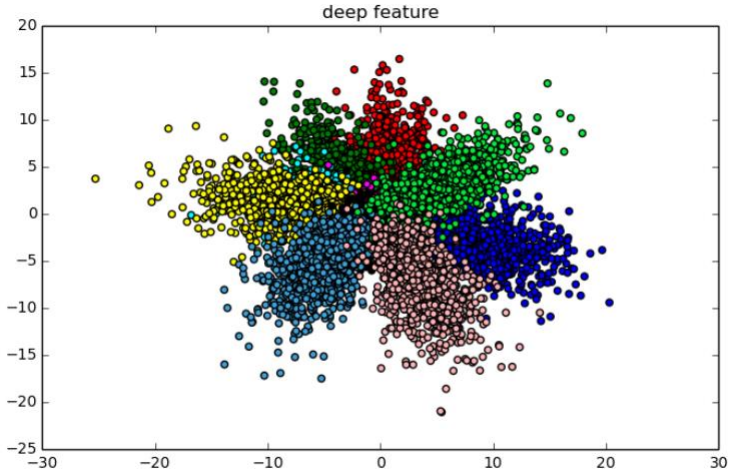


A discriminative feature learning approach

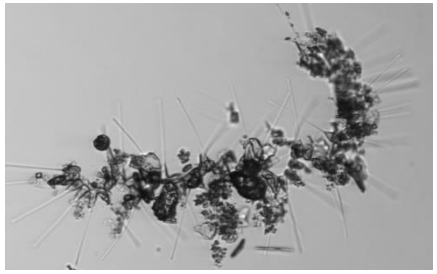
- softmax loss + center loss
- $L = L_s + \lambda L_c = L_s + \frac{\lambda}{2}\sum_{i=1}^{m} ||x_i - c_{y_i}||^2$

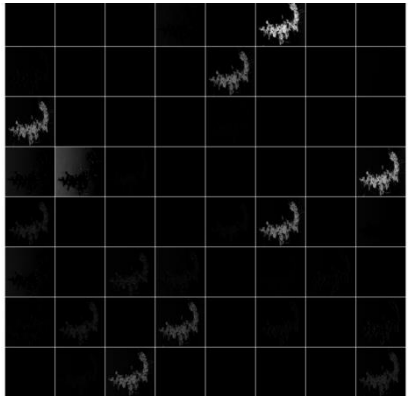


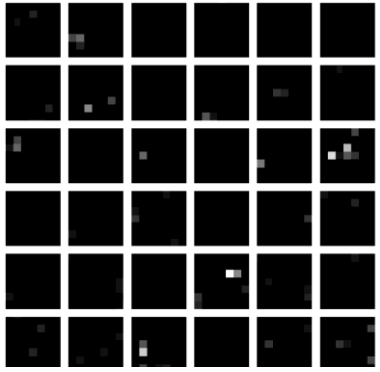
softmax loss

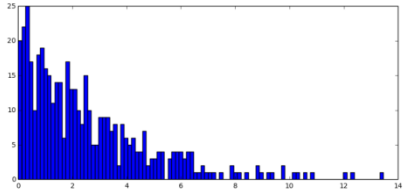


softmax loss + center loss





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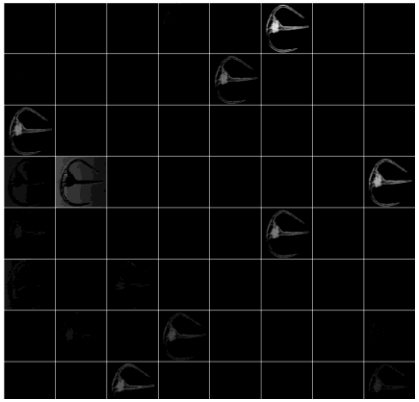

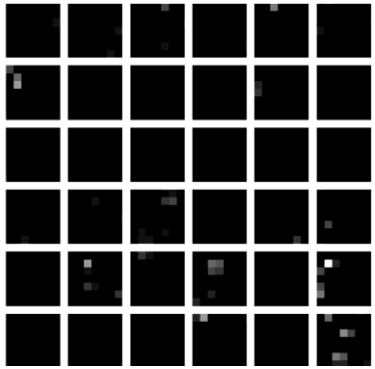

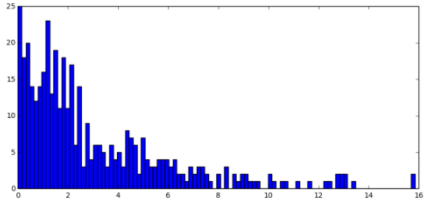
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All tools and method I use

- Sample from dataset
  - https://github.com/godisboy/TopCoder/tree/master/sample_dataset
- Conf_matrix pylayer
  - https://github.com/zhenglab/2016DL/blob/master/ChaoWang/caffe-Chao/examples/cifar10/python_confmat.py
- Conf_matrix visualization
  - https://github.com/zhenglab/2016DL/blob/master/ChaoWang/Conf_matrix.ipynb
- Net combine
  - https://github.com/zhenglab/2016DL/blob/master/ChaoWang/caffe-Chao/examples/combine_deep_net.ipynb
- Extract features
  - https://github.com/zhenglab/2016DL/blob/master/ChaoWang/caffe-Chao/tools/extract_features.cpp
- Center loss layer
  - https://github.com/zhenglab/2016DL/blob/master/ChaoWang/caffe-Chao/src/caffe/layers/center_loss_layer.cpp

Q & A