DISCRIMINATIVE FEATURES FOR INCREMENTAL LEARNING CLASSIFIER

Tin Lay Nwe [1] , Balaji Nataraj [2] , Xie Shudong [1] , Li Yiqun [1] , Lin Dongyun [1] , Dong Sheng [1]

[1]Institute for Infocomm Research (I2R), Singapore, [2]National University of Singapore (NUS), Singapore

INTRODUCTION

- Propose an approach to enhance the discriminative property of features for incremental classifier learning
- Build a network for the universal feature space in which a group of image classes have intra-class compactness and inter-class separability
- Model each incremental class to have a maximum margin from the rest of the models in universal space
- Experiments on CIFAR-100 dataset and IMage Database for Context Aware Advertisement (IMDB-CAA) demonstrate the superiority of our approach.

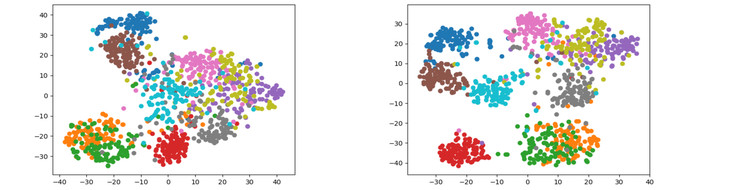
DISCRIMINATIVE FEATURES IN UFS

- ResNet-152 model trained using large Imagenet dataset as network for Universal Feature Space (UFS).
- Project classes of CIFAR-100 images into UFS.
- Include extra classes to the existing feature space of ResNet-152 for intra-class compactness and inter-class separability.
- ResNet-152 pre-trained model having 200 classes in Softmax layer to train a network for universal feature space.
- Extend the numbers of classes in Softmax layer to 500, 1000 and 1365 classes.

CLASSIFIER LEARNING IN UMS

- Create universal dataset and train binary SVM models for each class belonging to a subspace within a Universal Model Space (UMS)
- Optimize the margin between the region belonging to individual class and the rest in UMS

FEATURE AND MODEL DISTRIBUTIONS



(a) 200 Classes in Softmax (b) 500 Classes in Softmax

(c) 1000 Classes in Softmax (d) 1365 Classes in Softmax

Fig 1: Feature Distributions

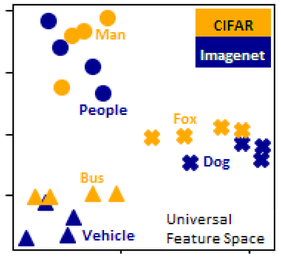


Fig 2: Feature mapping

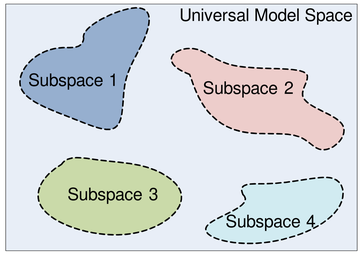


Fig 3: Models in UMS

DATASETS

- CIFAR-100 contains 100 image classes. Each class has 500 training images and 100 testing images.
- IMDB-CAA (IMage Database for Context Aware Advertisement) has about 12,000 color or gray-scale images with all images are manually labeled.
- Each category has 500 training images and 100 testing images.

EXPERIMENTS

- Experiments on standard incremental learning and few-shot learning setup
- For each new class, obtain the discriminative features from the bottleneck layer of the UFS network.
- System learns each new class sequentially and we throw away all the samples after training binary SVM models.

Table 1: Standard Incremental Classifier Accuracies

Dataset	Numbers of classes in softmax layer			
	200	500	1000	1365
CIFAR-100	52	56	57	58.5
IMDB-CAA	53.9	61.2	71.7	72.9

Table 2: Few-shot Incremental Classifier Accuracies

Dataset	1000 Classes		1365 Classes	
	20-shots	15-shots	20-shots	15-shots
CIFAR-100	41.1	37.3	43.3	42
IMDB-CAA	65.2	64.4	72.6	65.9

CONCLUSION

- Proposed Incremental learning system has no re-training process and no storage requirement of old samples.
- System can accommodate incremental steps size as small as one to learning new classes.