IMAGE CLASSIFICATION USING SELF-TAUGHT LEARNING FOR FEATURE DISCOVERY

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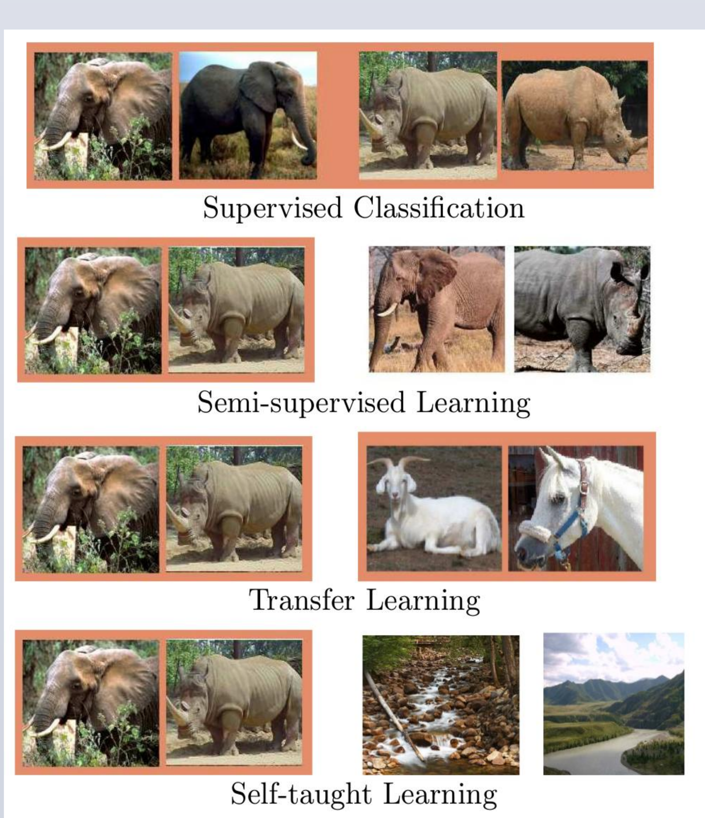
ABSTRACT

Deep Learning has produced results which match the benchmark results in many object classification tasks. Deep Belief Networks are a class of deep neural-networks, composed of numerous hidden layers with connections across layers and no connections between neurons in the same layer. Convolutional deep belief networks[1] with probabilistic max pooling provide a translational invariant hierarchical generative model supporting both top-down and bottom-up inference. The advantages of CDBN are used for image classification using a new semi-supervised technique called Self-Taught Learning[2]. In our project, we experiment with CDBNs for classification of Caltech 101dataset.

INTRODUCTION

- **Convolutional Neural Networks** are known for their ability to exploit the 2-D nature of images in contrast to neural networks and **Deep Belief Networks** make use of Pre-training phase to improve results while classification.
- Convolutional deep belief networks combine the positives of both the state of the art models to get even better performance. Probabilistic max pooling provides a translational invariant hierarchical generative model supporting both top-down and bottom-up inference.
- Raina et al. proposed the concept of Self-Taught Learning in 2007.
  - Labeled data – generally, difficult to obtain
  - Unlabeled data – abundant and cheap
- Self Taught learning makes use of unlabeled data to learn a generic representation of images using Sparse coding which can be later used to learn features from the labeled images.

CLASSIFICATION TECHNIQUES



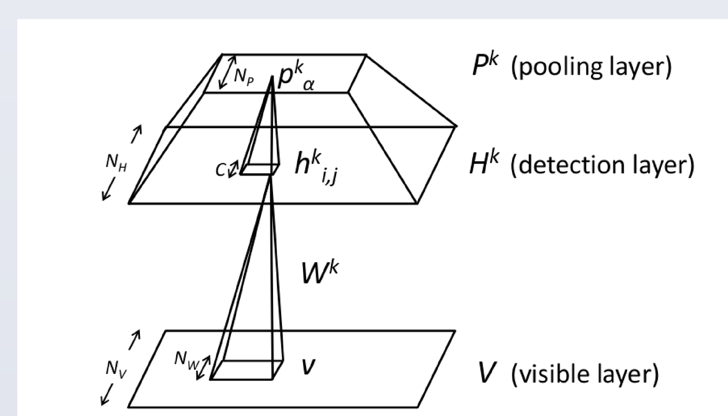
Raina R., Battle A., Lee H., Packer B., & Ng

PREVIOUS WORK

In 2007, Raina et al.[2] used it to match many state of the art results in different domains like image classification, music genre classification and UseNet article classification. Lee et al.[1] used CDBNs to match the best results on Caltech 101 dataset using a model which was very generic in nature and used limited training examples. The state of the art results for Caltech 101 is 67% overall, averaged on all classes.

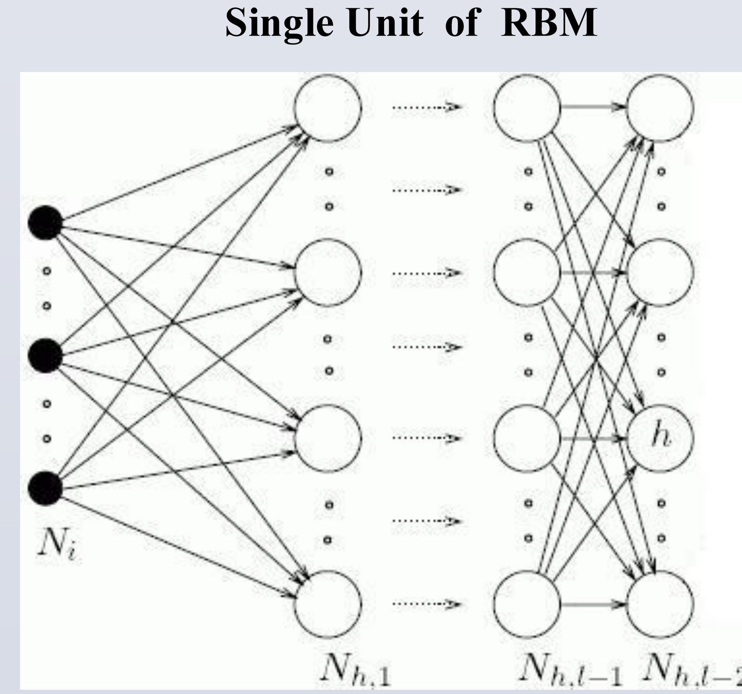
CONVOLUTIONAL DEEP BELIEF NETWORK

Multiple layers of CRBMs



H. Lee,R. Grosse, R. Ranganath and A. Ng

Single Unit of RBM



http://www.codeproject.com/Articles/19323/Image-Recognition-with-Neural-Networks

$$E(\mathbf{v},\mathbf{h}) = -\sum_k \sum_{i,j} \left(h^k_{i,j} (\tilde{W}^k * v)_{i,j} + b_k h^k_{i,j} \right) - c \sum_{i,j} v_{i,j}$$

$$\text{subj. to} \quad \sum_{(i,j)\in B_\alpha} h^k_{i,j} \le 1, \quad \forall k, \alpha.$$

DATASET

ImageNet[7] Natural Objects Dataset as source of unlabeled data

- Cropped to Uniform Size 150 X 200

Caltech 101[8] dataset for labeled images - 5 objects

- Elephant
- Leopard
- Car
- Motorbike
- Airplane

30 images were used as labeled images of each class

- 20 were used for training
- 10 were used for testing

ALGORITHM

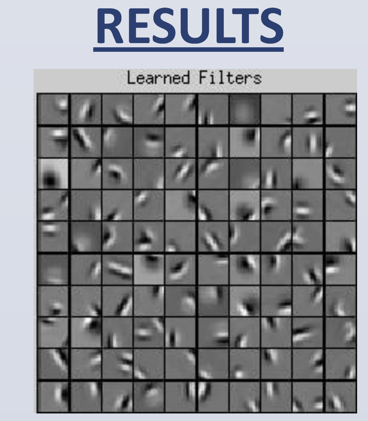
Using only labeled data

1. Train CDBN on labeled dataset
2. Use learnt weights to extract features
3. Classify using SVM (linear kernel).

Self-taught learning

1. Train CDBN on unlabeled dataset of natural images
2. Use learnt weights to extract features from labeled dataset
3. Classify using SVM

RESULTS



	Car	Airplane	Elephant	Leopard	Bike
Car	5	1	1	0	3
Airplane	1	6	0	1	2
Elephant	1	1	7	0	1
Leopard	1	2	2	4	1
Bike	2	0	1	0	7

ACCURACY

CDBN with Self Taught Learning	CDBN
58 %	52 %

CONCLUSIONS

- Self Taught Learning is a very effective technique when the size of labeled datasets is very small.
- Convolutional Deep Belief Networks are known for learning very good hierarchical representations of inputs at different levels.
- The complexity of implementing CDBNs is high, and generally different implementations end up producing different results.
- There are a lot of hyper parameters which need to be initialized and can play an influencing role in the results.

REFERENCES

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