Learning with Collaborative Neural Network Group by Reflection

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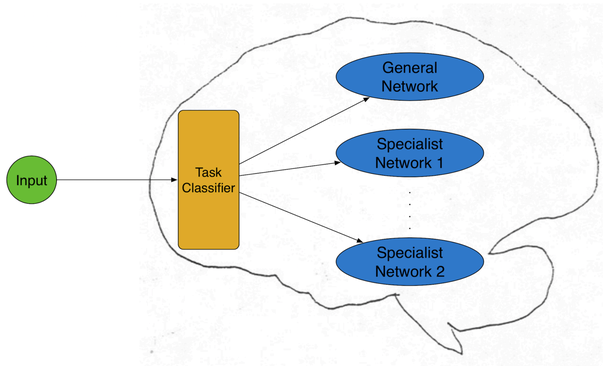
Introduction

For the current architecture of neural networks, it usually requires a high training cost in time and computation. From our perspective, the current methods in deep learning might not be optimal in architecture and it fails to have an efficient learning strategy. To solve these problems, in this paper, we would like to introduce the Collaborative Neural Network Group (CNNG). CNNG is a series of neural networks that work collaboratively to handle different tasks separately in the same learning system. It is evolved from a single neural network by Reflection.

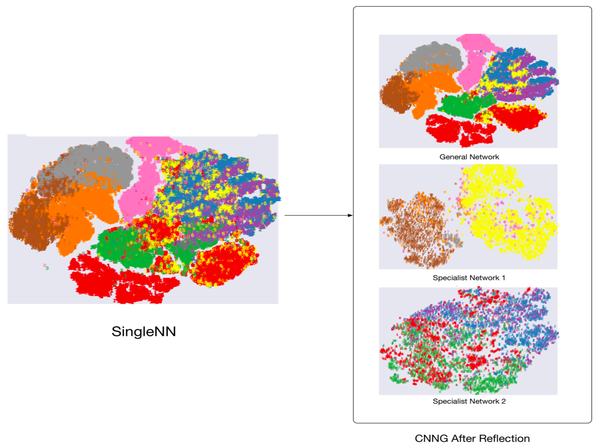


CNNG Model description

CNNG is a group of neural networks that will be used to process the input data. It is evolved from a single neural network by the reflection algorithm. The benefit of CNNG is the collaboration of several small networks which are specified on different special tasks individually can help to largely improve the accuracy. It requires a much lower training cost at the same time. The architecture of the CNNG is combined with task classifier, general neural network and specialist neural networks.

Algorithm 1 CNNG reflection algorithm

```
function REFLECT(X, Y, ErrSet)
    SpecialistNetworkSet = []
    TaskClassifierDataDict = {}
    SpecialistsTrainingSet = Kmeans(ErrSet, SpecialistNum)
    for all trainingData ∈ SpecialistsTrainingSet do
        network = TrainNetwork(trainingData)
        TaskClassifierDataDict.add(trainingData.getX())
        SpecialistNetworkSet.append(network)
    end for
    TaskClassifier = DecisionTree.train(TaskClassifierDataDict)
    return SpecialistNetworkSet, TaskClassifier
end function
```



CNNG After Reflection

Task classifier

The task classifier is used for the CNNG to decide which is the best network to use when predicting the label of the input data. In our approach, the task classifier is a decision tree. The task classifier allows the neural networks to collaboratively work together as a group.

Specialist neural network

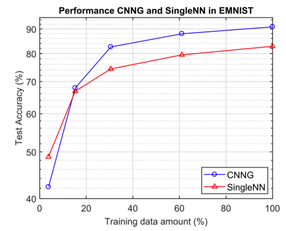
The specialist neural network is the neural network that will focus on different subtasks. It will be trained from the error that produced by the general network. It is viewed as the specialist in the system that will process the corner cases for general network.

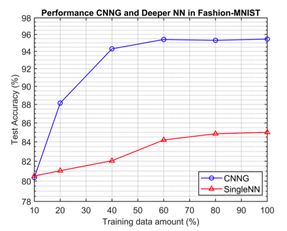
General neural network

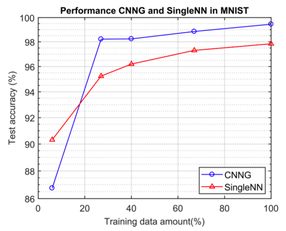
The general neural network is the network that is initially trained by all the training data. This will serve as a general situation when handling the input data. A reflection will be performed based on the general network. The error cases will be used to train the specialist neural networks.

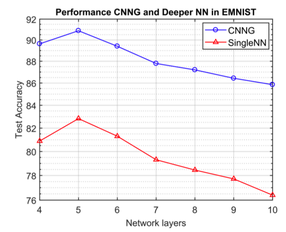
Experiments and Resultes

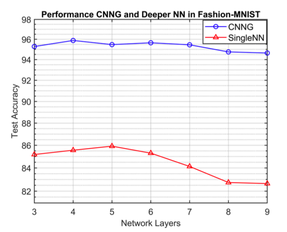
We conducted detailed experiments on the performance of CNNG with reflection compared to SingleNN with different amount of training data, deeper neural networks. The evaluation of task classifier and the networks in CNNG individually can provide an insight to show where does the increase in performance come from. The SingleNN that we use in the experiments is a simple feedforward network. For the MNIST, the initial network contains three layers. For the Fashion-MNIST, the initial network contains four layers. For the EMNIST, the initial network contains four layers.

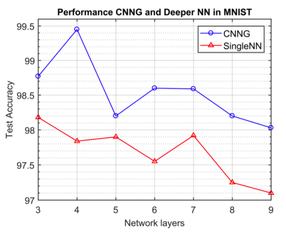












Preformance of CNNG and SingleNN					
Task	CNNG Accuracy (*)	SingleNN Accuracy	CNN accuracy	Adaboost Accuracy	CNNE Accuracy
MNIST	**99.65%**	97.84%	96.35%	79%	98.6%
EMNIST	**90.88%**	82.32%	83.5%	65%	89.3%
Fashion-MNIST	**98.81%**	85.56%	91.9%	93.6%	92.22%

Performance of different classifiers type on different tasks				
Task Datasets	Decision Tree (*)	KNN	MLP	Naive Bayes
MNIST	99.65%	96.32%	94.41%	36.78%
EMNIST	90.88%	83.80%	84.30%	20.70%
Fashion-MNIST	98.81%	96.12%	92.43%	32.47%

Preformance of networks in CNNG for Fashion-MNIST			
Network	Percentage using by CNNG	Overall Accuracy	Accuracy on specified task
GeneralNet	72.5%	84.32%	99.43%
SpecNet1	12.4%	15.32%	96.96%
SpecNet2	14.9%	10.20%	93.33%