Pneumonia detection from Chest-X-Ray images using Transfer Learning

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Abstract

According to the World Health Organization (WHO), pneumonia kills about 2 million children under 5 years old every year and is consistently estimated as the single leading cause of childhood mortality. In this work, we will be using a deep learning based approach to solve the problem. Particularly, ResNet based architecture is used with Transfer learning on the chest X-Ray dataset from Kaggle. In Experiments, I have experimented with Pretrained weights and without pretrained weights. Using different learning rate schedules, model with pretrained weights results in 85.8 best test accuracy. Code has been made public at GitHub

1. Technical Approach

- The dataset contains 1341, 3875, 8, 8, 234, 390 normal, pneumonia images in train, val, test respectively.
- A ResNet based architecture namely resnet18 is chosen to use Transfer learning on the dataset.
- Network architecture uses every layer from resnet-18 except the last fully-connect layer in the network. We use a FC layer with 3 layers (512-128-1) to predict the class, with ReLu activation, dropout layer and sigmoid at last layer.
- Data Augmentations were extensively used. Horizontal Flip, Brightness Increase, Random Rotation, Normalization were used.
- Experiments use batch Size 32 unless mentioned with learning rate starting at 0.01 with reduction by 0.1/0.7 with patience 0 and trained for 30 epochs and Adam optimizer is being used.
- Our best model ResNet2 has 95 perc on train set, 87.5 on val set and 85.8 accuracy on Test set.
- Best model uses Resnet pretrained weights with 0.7 LR reduction every time and initial learning rate 0.01.

Figure 1: Accuracy and Losses of Best Model Resnet2. Train - Blue, Val - Red

Model	Pretrained weights	Init LR	lrReduction	Test Acc
ResNet1	True	0.1	0.1	0.84
ResNet2	**True**	**0.1**	**0.7**	**0.86**
ResNet3	False	0.1	0.7	0.76
ResNet4	False	0.1	0.1	0.73

Table 1: Results of various models on test set

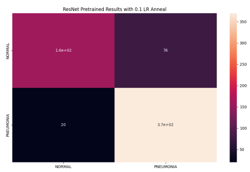
2. Experiments

We have 4 models with variation LR rate reduction of 0.1 or 0.7 and trained with pretrained weights or from scratch as showin the table 1.

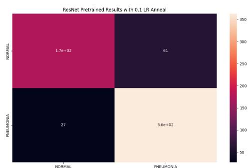
- Models with Pretrained weights performed better than trained from scratch.

Model	Train Acc	Val Acc	Test Acc
ResNet1	94.07	87.50	84.03
ResNet2	**94.36**	**87.50**	**86.50**
ResNet3	87.5	82.45	0.76
ResNet4	81.25	79.17	73.13

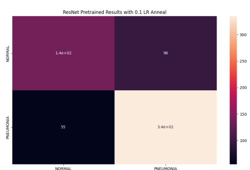
Table 2: Results of various models on train/val/test set



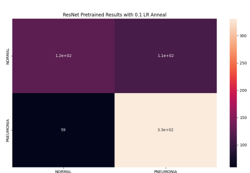
(a) ResNet1



(b) ResNet2



(c) ResNet3

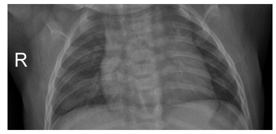


(d) ResNet4

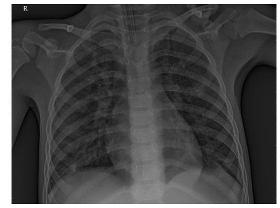
Figure 2: Three simple graphs

- Using a initial learning rate of 0.1, learning rate will be reduced by specified lrReduction value with minimum of 1e-5. Most of the pretrained models converged to this minimum rate within 30 epochs.

- A comparision of confusion matrix for all the models are showing in figure2 and accuracy for each class can be observed. Model 2 has 93.05 Accuracy on Pneumonia class and 73.8 Accuracy on Normal Class.



(a) PREDICTED : PNEUMONIA



(b) PREDICTED : NORMAL

Figure 3: Misclassified Examples

3. Failure Cases

In this section we will be seeing few images where the model was unable to generalize well

We'll do an example with three images along side each other with separate captions and labels. Here's some example images:

Figure 3(a), 3(b) are misclassified Examples with respective predicted tag.

4. Conclusion and Future Work

In this work, I have tried out different model architecture and learning schedules over the dataset. It has been observed that resnet18 with pretrained weights with 0.7 lr annealing gave better results than others on the test set. For future work, models other than ResNet18 can be tried out.The model is unable to converge on the val set.
Furthermore, further work includes deploying the model on AWS cloud platform and generating the publicly accessible link and also gradient CAM's for visualization of the predicted results.