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Deep Learning Assignment
PCB Board Classification Task Using Convolutional Neural Networks

1 Augumented Dataset PCB Board

1.1 Data Preprocessing

1. Total number of data : 5040 images (300X300X3)
2. 2520 images of both Defective and Non-Defective class
3. We have split the data into train and test datsets (70-30) splitting.
4. Data standardization as each pixel value was from (0-255).
5. One Hot encoding of class label (0 or 1).

1.2 Model 1: LeNet(1998)

- As dataSet if small and different than commonly seen datasets, LeNet seems to be a perfect fit, so we started off with LeNet as a Base Model.
- We got an accuracy of 88 % with f1 score of 0.90 and 0.88 for class 0 and 1.

1.3 Model 2: Modification to LeNet

- One more convolutional layer is added in LeNet architecture with 16 kernels of (5X5) followed by a max pool layer(2X2).
- Here we have used ADAM optimizer due to which model has converged a bit early (43/50) epochs. Test accuracy increased to 95 %.

1.4 Model 3: Custom Model with 4 Conv2D and Max pooling layers

- Here total 4 Conv2D and Max pool layers are created with (16-32-32-32) filters first of 3X3 and rest 5X5. Max pooling layers are same as LeNet.
- Since one more layer is added and number of filters are also increased, With Adam optimizer, accuracy was increased to 97.94 % with f1 score of 0.98 for both classes.

1.5 Summary

Model	Optimizer	Val loss	Test Loss	Val Accuracy	test accuracy	F1(class 0)	F1(class 1)
LeNet	SGD	0.56	0.37	0.87	0.88	0.90	0.87
Modified LeNet	Adam	0.59	0.53	0.9603	0.9589	0.96	0.96
4 Conv + Max pool	Adam	0.23	0.13	0.9745	0.9794	0.98	0.98

2 Balanced Dataset PCB Board

2.1 Data Preprocessing

1. Total number of data : 298 images (300X300X3)
2. 149 images of both Defective and Non-Defective class
3. We have split the data into train and test datsets splitting.(80-20 since we have very less amount of data)
4. Data standardization as each pixel value was from (0-255).
5. One Hot encoding of class label (0 or 1).

2.2 Summary / Observations of all the experiments performed on balanced dataset:

- First we trained all the 3 models which was used for Augmented dataset, out of which the best model we found out was Model number 3. (4 Conv layers described in last section).
- As we increse the number of layers, difference between train loss and test loss was increasing after certain amount of epochs.Also due to less number of points and a relatively deep network, model was found to be overfitting. So we added dropout in 3rd model and accuracy was increased from 69% to 76%
- Since the best model was Model -3; we also tried out image Augmentation on the same to see if the accuracy is increasing or not. We were not able to see an increase in accuracy or performance.

2.3 Transfer Learning with VGG-16:

- Since the dataset is small, we did not have much data to train on. So we tried transfer learning with VGG-16 model. We kept all the weights of VGG 16 as it is (trained with ImageNet data) and added last dense layers as per our classification.(Original model was trained on 1000 class classification problem, so we modified the last two layers so that it will be trained for binary classification.)
- To take care of overfitting, we added dropout in final 2 dense layers and we got a better accuracy of 81% than rest of the models.

2.4 Results

Model	Optimizer	Dropout	Val Loss	Val Accuracy	test accuracy	F1(class 0)	F1(class 1)
LeNet	SGD	No	0.287	0.963	0.75	0.78	0.72
Modified LeNet	ADAM	No	0.363	0.895	0.733	0.75	0.71
4 Conv + Max pool	ADAM	Yes	0.796	0.85	0.76	0.78	0.75
4 Model3 + Augmentation	ADAM	Yes	0.65	0.70	0.69	0.79	0.50
4 VGG-16 + Dense Layers	ADAM	Yes	0.45	0.8542	0.8166	0.83	0.80

2.5 Conclusion

Below are the best Models from all the above experiments.

Data	Model	Val Accuracy	test accuracy	F1(class 0)	F1(class 1)
Augmented PCB	4 ConV + MaxPool Model	0.9745	0.9794	0.98	0.98
Balanced PCB	VGG-16 + Dense Layers	0.8542	0.8166	0.83	0.80