

# Railway Track Fault Detection

## Mathematical Modeling Practice

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# Dataset introduction and Problem Statement

## Example images



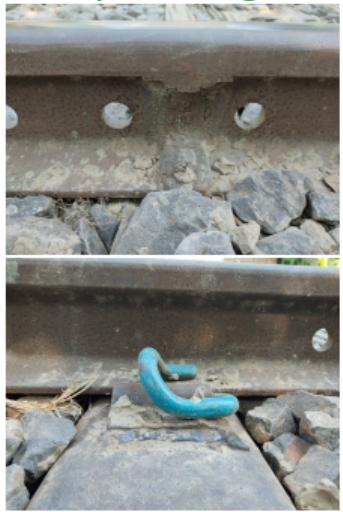
Non defective



Defective

# Dataset introduction and Problem Statement

## Example images



Non defective



Defective

Dataset type	Number of images
Training	2x150
Validation	2x31
Test	2x11

# Dataset introduction and Problem Statement

## Example images



Non defective



Defective

Dataset type	Number of images
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- Q1 What kind of defects are represented in the images?
- Q2 Can these defects detected by applying image manipulation and machine learning approach?
- Q3 What accuracy rate can be achieved with the algorithm?

# Defect types



Cracked rail



Disjoint rails



StockFreelImages.com

ID: 6415000

Surface pitting



Missing spring



Missing fastener

# Convolutional Neural Networks

## Timeline

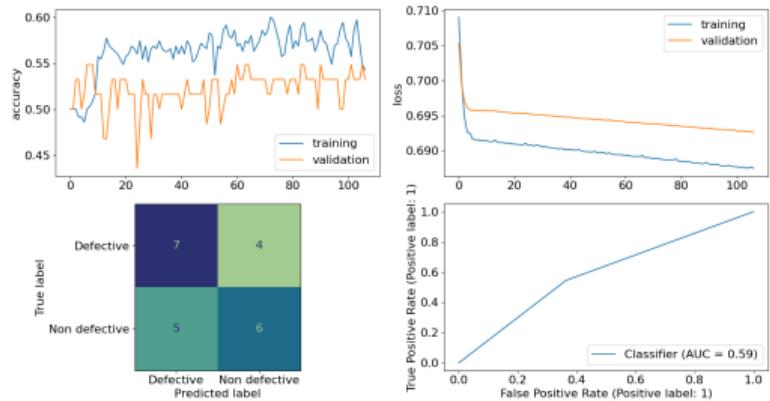
- 1989 ConvNet
- 1998 LeNet
- 2012 AlexNet
- GoogleNet
- Inception
- VGG
- ResNet
- DenseNet
- ResNeXt
- Channel Boosted CNN
- EfficientNet

## Settings

- |                   |                         |
|-------------------|-------------------------|
| Optimizer         | Adam                    |
| Loss function     | Binary crossentropy     |
| Learning rate     | Manually tuned          |
| Callbacks         | ModelCheckPoint         |
|                   | EarlyStopping           |
|                   | ReduceLROnPlateau       |
| Data augmentation | Separated from pipeline |
|                   | 2x25 images             |
|                   | Rotation, Zoom          |

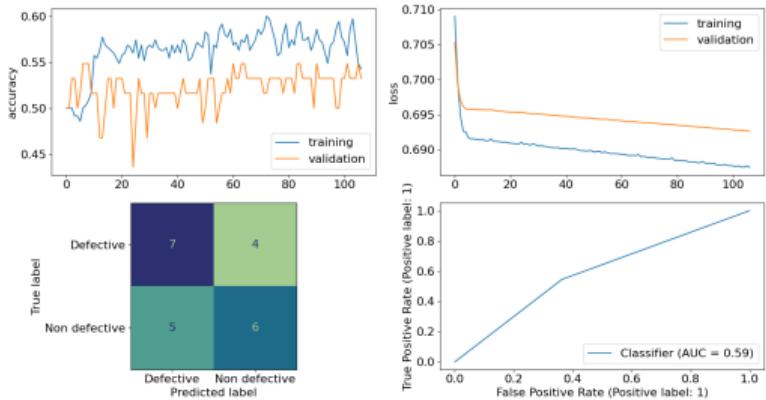
# Results

## LeNet-5

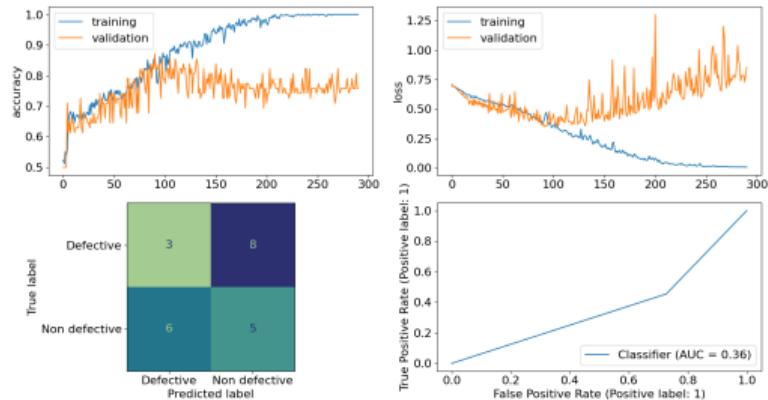


# Results

## LeNet-5

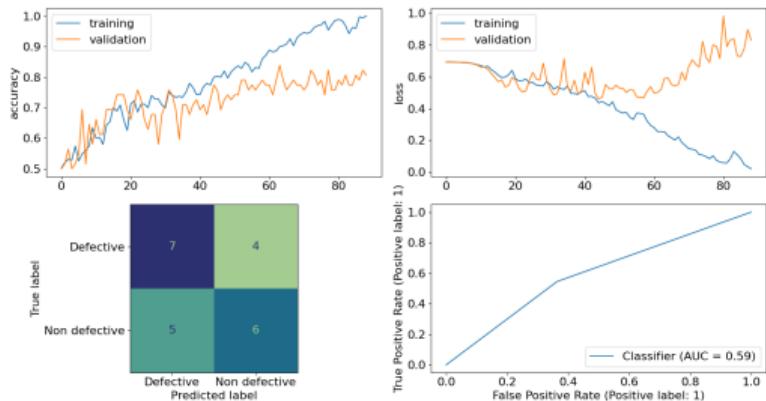


## AlexNet



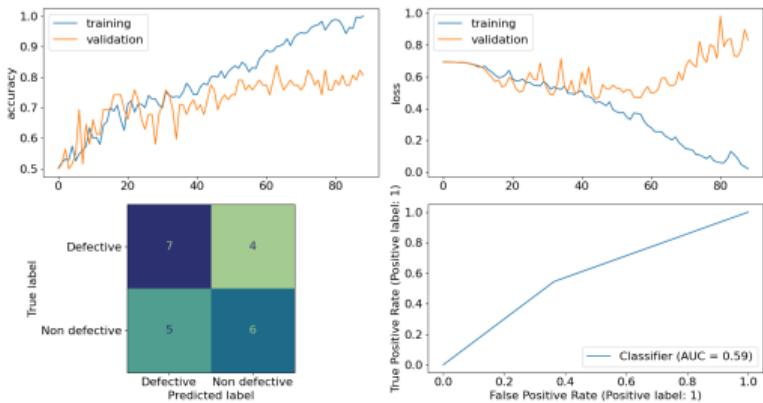
# Results

## VGG16

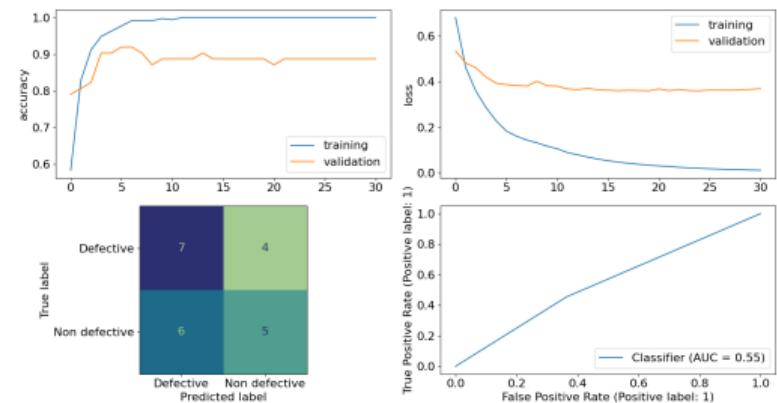


# Results

## VGG16

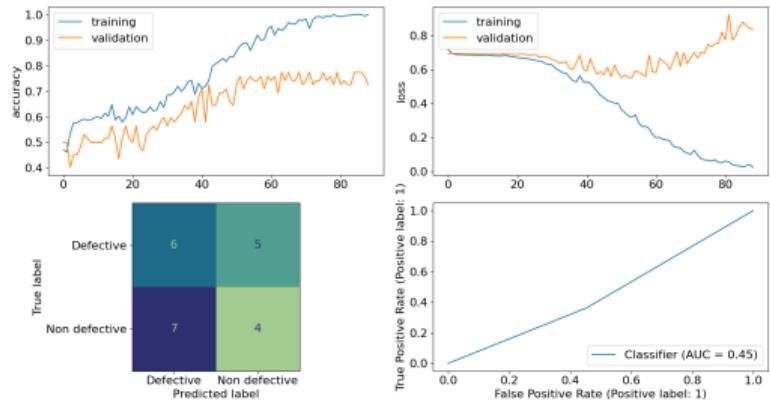


## Pretrained VGG16



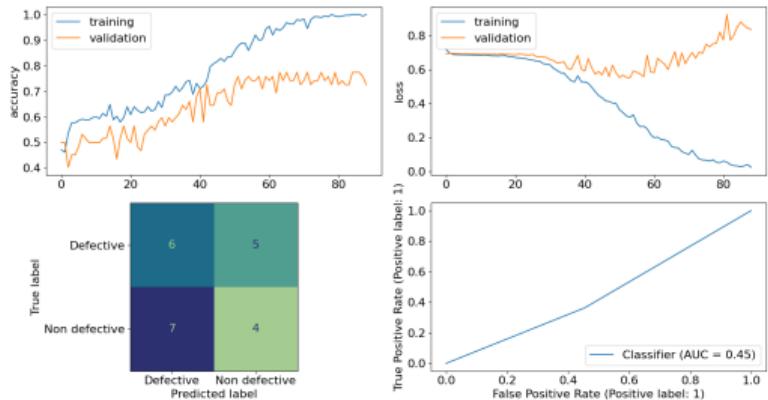
# Results

## Pretrained ResNet50

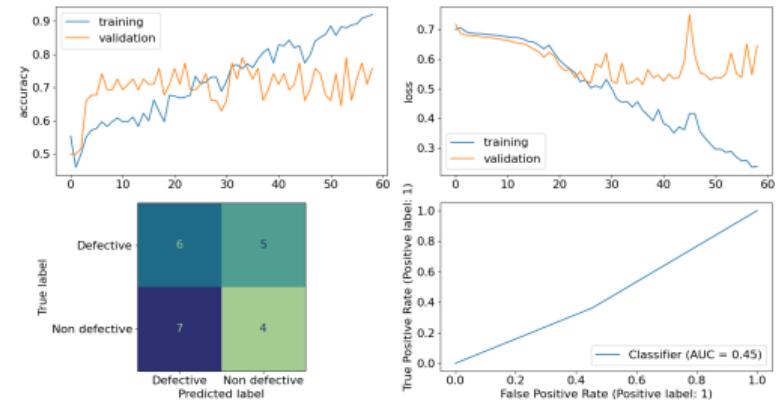


# Results

## Pretrained ResNet50



## Fine-tuned ResNet50



## Hypertuning

Find best fit on validation dataset

RandomSearch on Learning Rate

## Hypertuning

Find best fit on validation dataset  
RandomSearch on Learning Rate

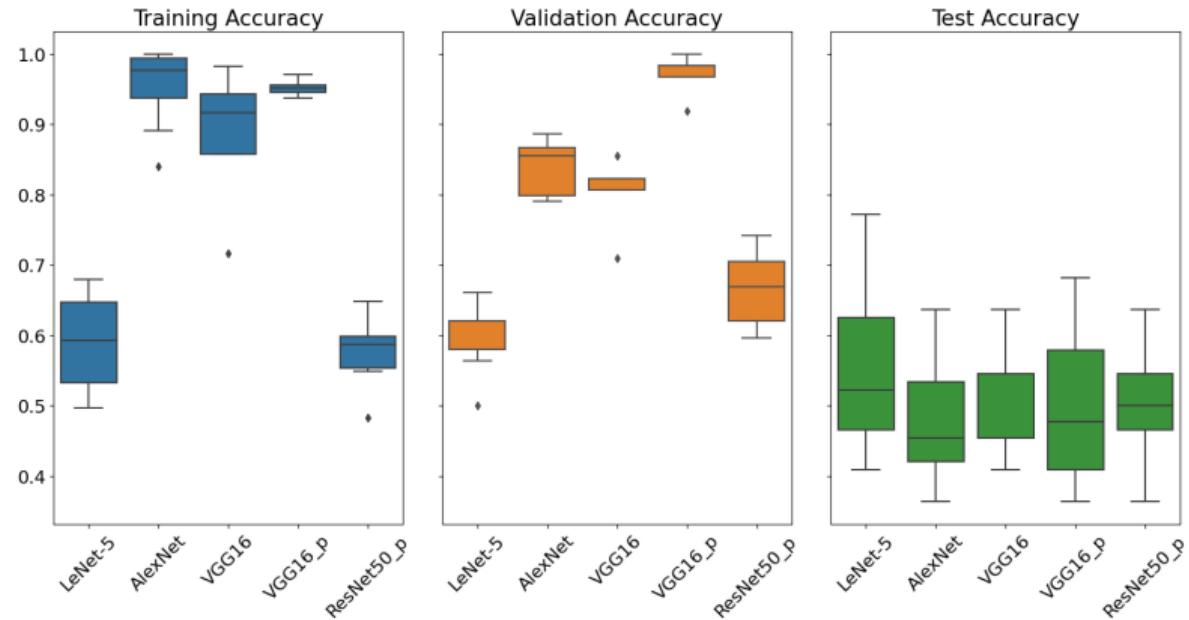
## Bootstrapping

Mitigate test dataset representativity  
10 iterations with best LR

## Hypertuning

Find best fit on validation dataset

RandomSearch on Learning Rate



## Bootstrapping

Mitigate test dataset representativity

10 iterations with best LR

## Conclusion

AlexNet and VGG learned the training and validation sets

No generalization of the model to the test dataset

Possible overfitting on training and validation data

Test dataset representativeness

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## Further steps

Hypertuning further parameters

Data augmentation in pipeline

Weight initialization

Additional models: VGG19, ResNet34

ResNet fine-tuning

Thank you very much for your kind attention!