Railway Track Fault Detection

Mathemathical Modeling Practice

Tamás DEMUS (XP4B9D)

Fall Semester 2022

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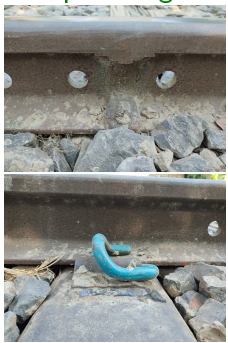
Dataset introduction and Problem Statement

Example images



Non defective

Defective

Dataset introduction and Problem Statement

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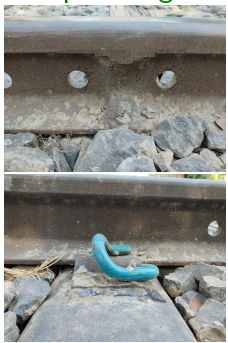

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Training	2x150
Validation	2x31
Test	2x11

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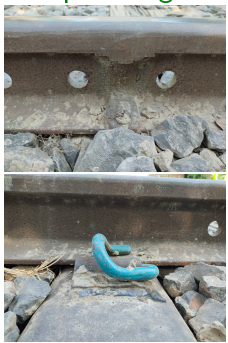

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Q1 What kind of defects are represented in the images?

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

Surface pitting

Missing spring

Missing fastener

Convolutional Neural Networks

Timeline

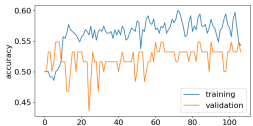
- 1989 ConvNet
- 1998 LeNet
- 2012 AlexNet
- GoogleNet
- 2014 Inception
- VGG
- 2015 ResNet
- 2016 DenseNet
- 2017 ResNeXt
- 2018 Channel Boosted CNN
- 2019 EfficientNet

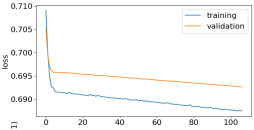
Settings

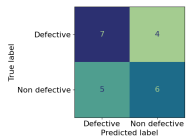
Optimizer	Adam
Loss function	Binary crossentropy
Learning rate	Manually tuned
Callbacks	ModelCheckPoint
	EarlyStopping
	ReduceLROnPlateau
Data augmentation	Separated from pipeline
	2x25 images
	Rotation, Zoom

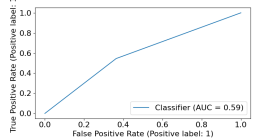
Results

LeNet-5









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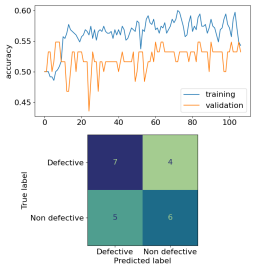
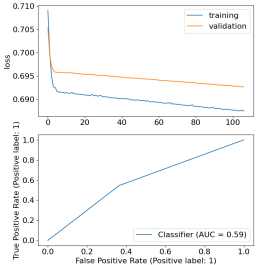
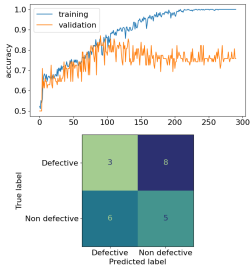
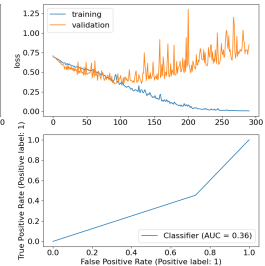




AlexNet





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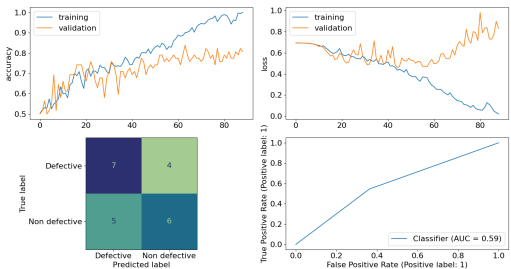
VGG16



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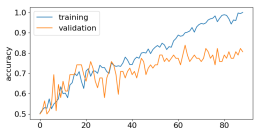
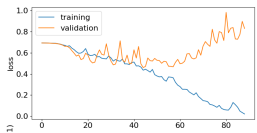
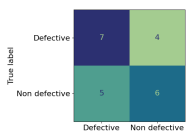
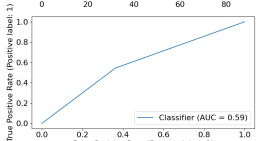
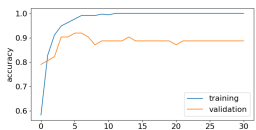


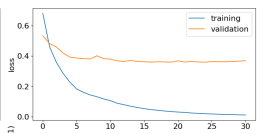


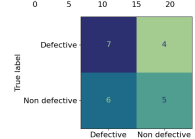


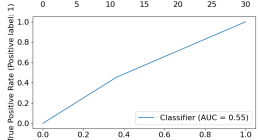


Pretrained VGG16



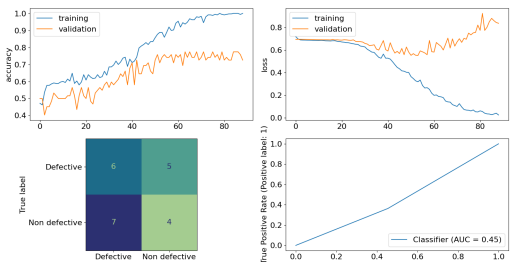






Results

Pretrained ResNet50



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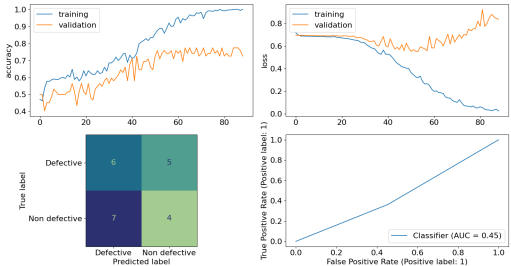
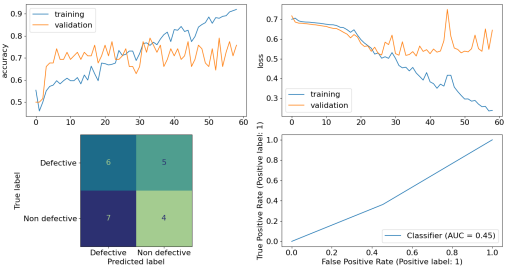


Fine-tuned ResNet50



Hypertuning

Find best fit on validation dataset

RandomSearch on Learning Rate

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Find best fit on validation dataset

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Bootstrapping

Mitigate test dataset representativity

10 iterations with best LR

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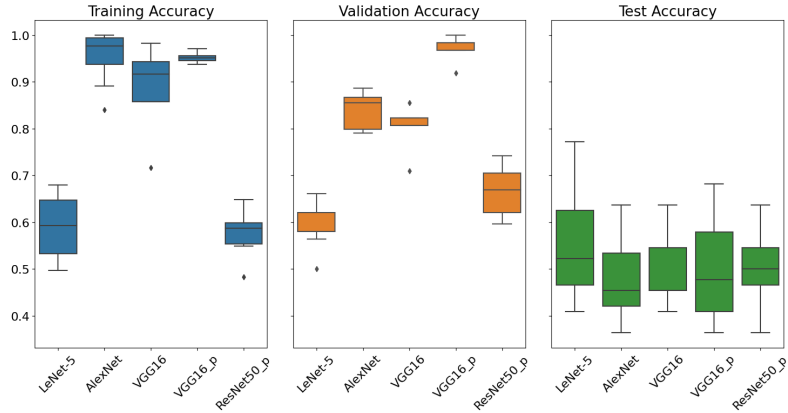

Conclusion

- 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!