Residual Networks & Densly Connected Convolutional Networks

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Outline

ResNet (published 2015)

- Architecture

- Properties

DenseNet (published 2018)

- Architecture

- Properties

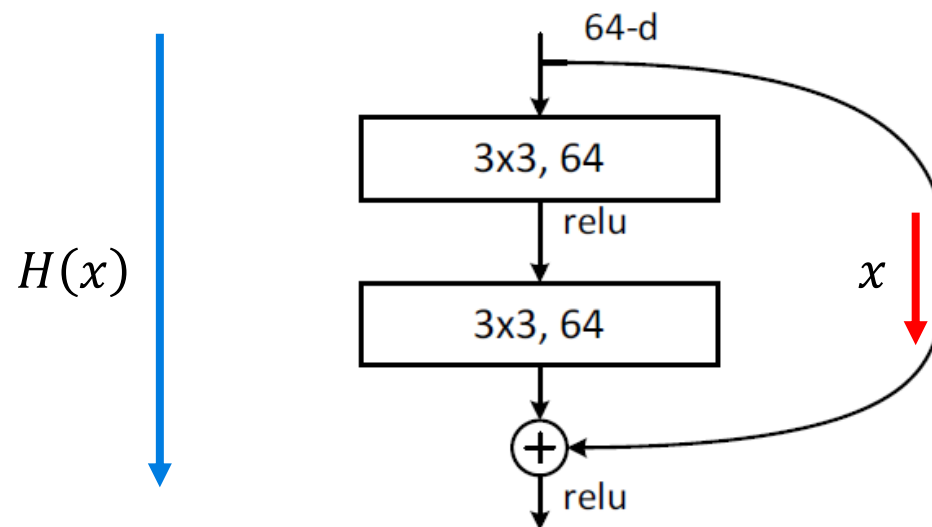## Experiments

ResNet
Residual Unit
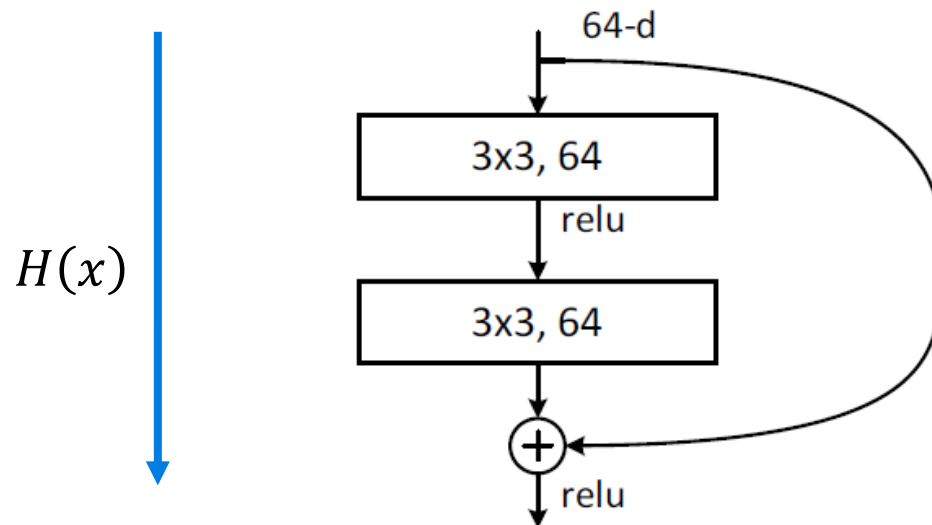
- $H(x)$ old mapping

$$H(x)$$

64-d

3x3, 64

relu

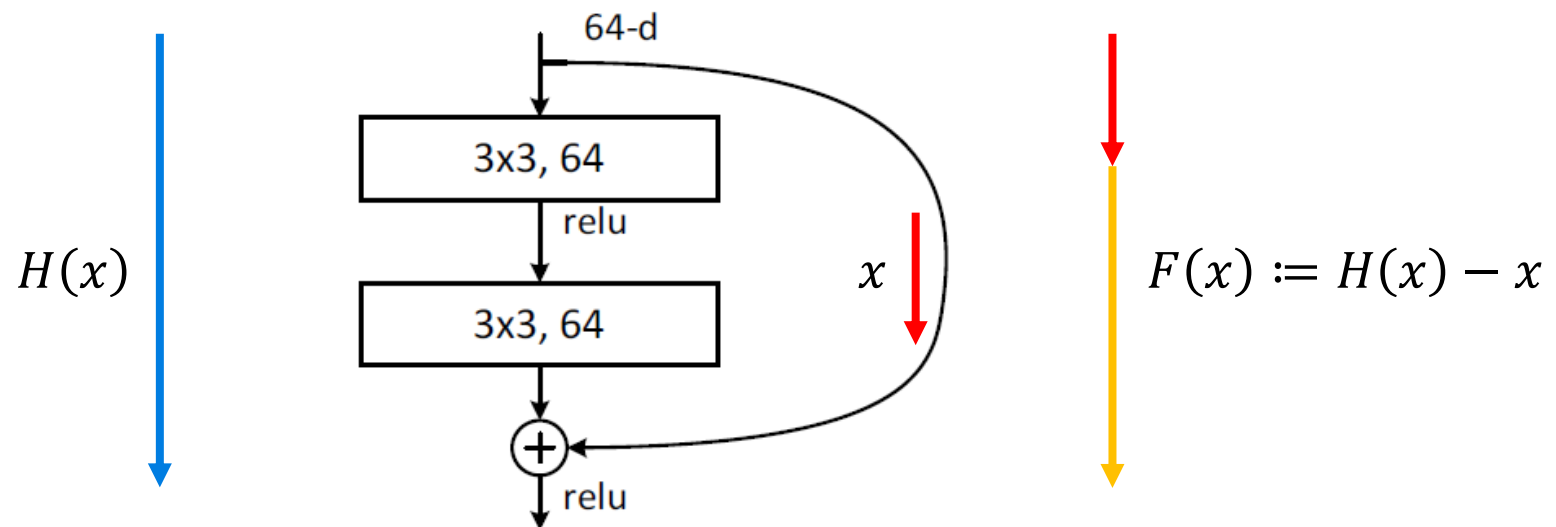3x3, 64

$\oplus$

relu

Source: (modified) Paper „Deep Residual Learning for Image Recognition"

ResNet
Residual Unit

- $H(x)$ old mapping

- x skip connection / identity

Source: (modified) Paper „Deep Residual Learning for Image Recognition"
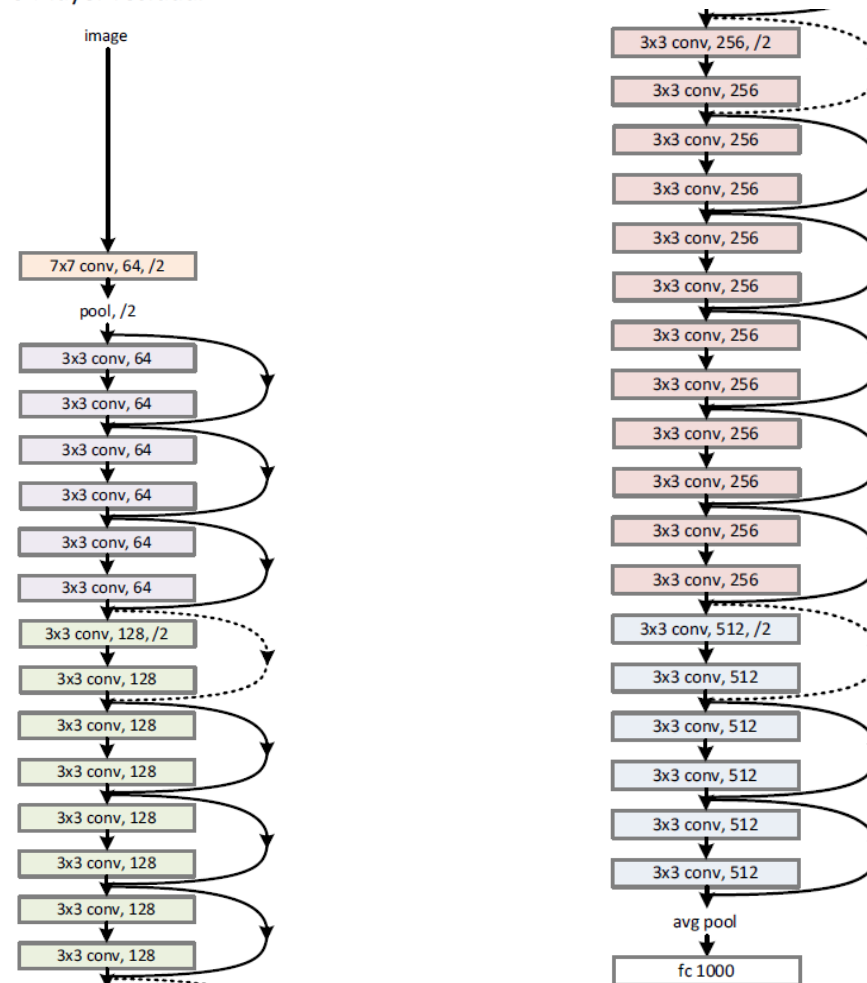
ResNet
Residual Unit

- $H(x)$ old mapping

- x skip connection / identity

- $F(x)$ new mapping with skip connection

Source: (modified) Paper „Deep Residual Learning for Image Recognition"

ResNet
Architecture

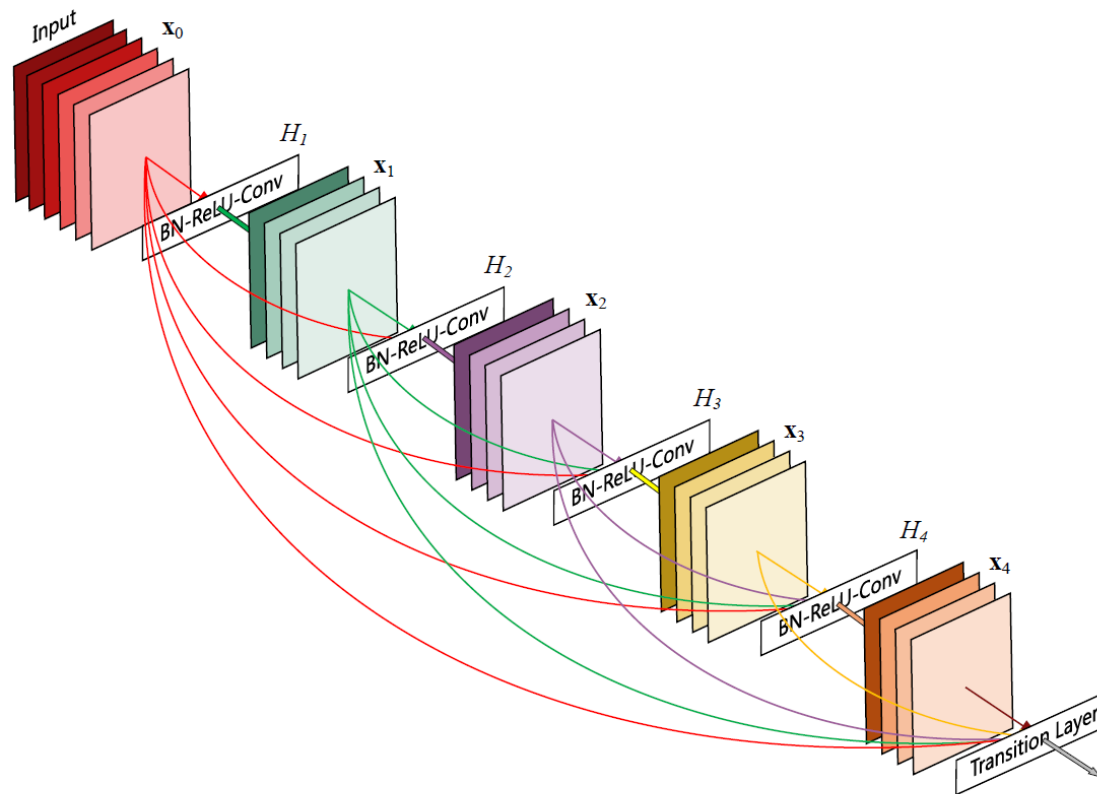Source: „Deep Residual Learning for Image Recognition"

ResNet
Properties

- **Improved gradient flow**

  – Less prone to vanishing gradients

  – Deeper networks are trainable

- **Feauture propagation**

- **Skip connections are computationally cheap**

- **Very flexible**

  – Classification

  – Localization
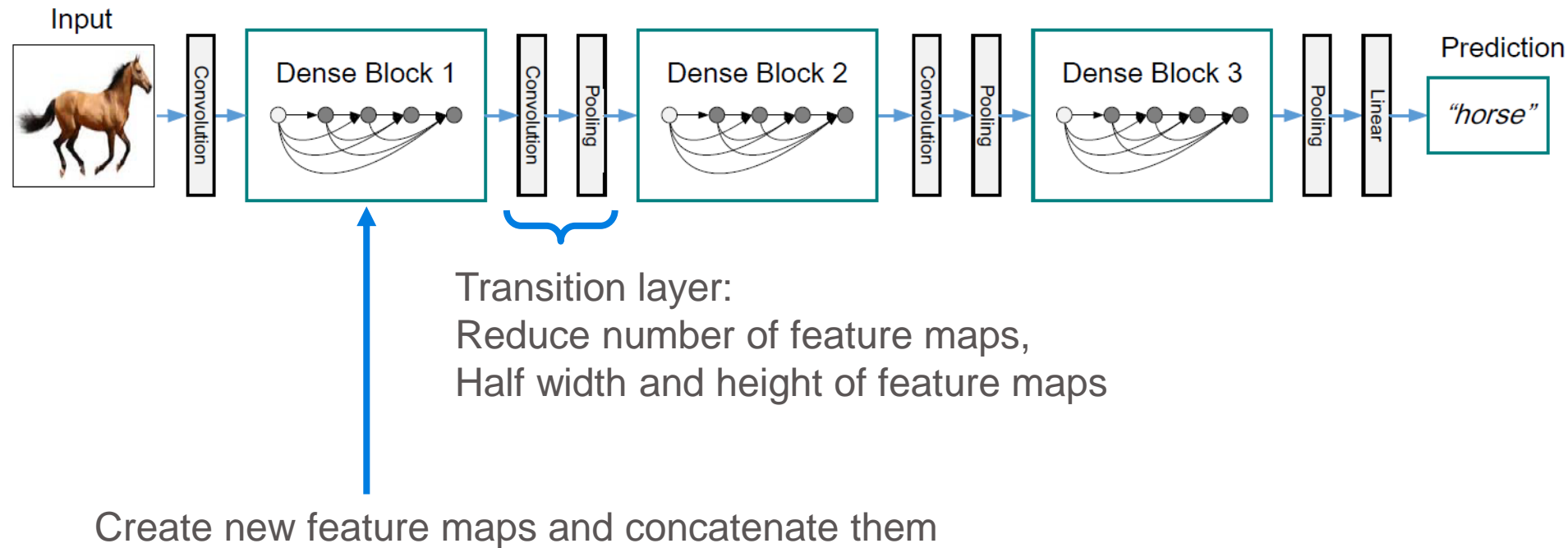
  – Detection

  – Segmentation

DenseNet
Architecture

Source: Paper „Densely Connected Convolutional Networks"

DenseNet
Architecture II

Transition layer:
Reduce number of feature maps,
Half width and height of feature maps

Create new feature maps and concatenate them

Source: Paper „Densely Connected Convolutional Networks"

DenseNet
Properties

Similarities compared to ResNet:

- Less prone to vanishing gradients

- Deeper networks are trainable

Differences compared to ResNet:

- Combine feature maps by concatenation

  - Improved information flow
    (no information loss through summation)

  - Enables feature reuse

- Summarize feature maps by transition layers

Experiments

Dataset

- Data from HS Offenburg Sweaty team

- Small dataset excerpt:
  - 8 Classes
  - 4917 Training images
  - 1230 Test images

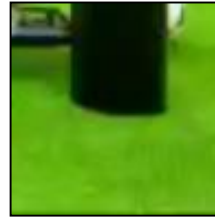Source: https://sweaty.hs-offenburg.de/projekt/
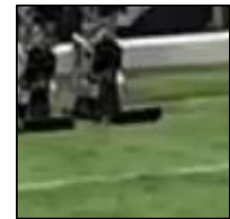
Dataset

Ball

Goal post

Obstacle
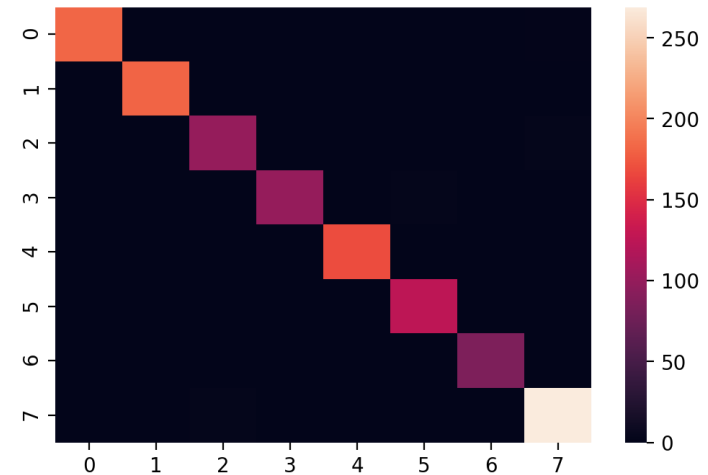
L-Line

X-Line

T-Line

Penalty spot

Robot foot

ResNet-50 Performance
Overview

2,5 h	Training time
1230	Test images
17	False predictions
1,38%	Error rate

Categorical Crossentropy Loss

Categorical Accuracy
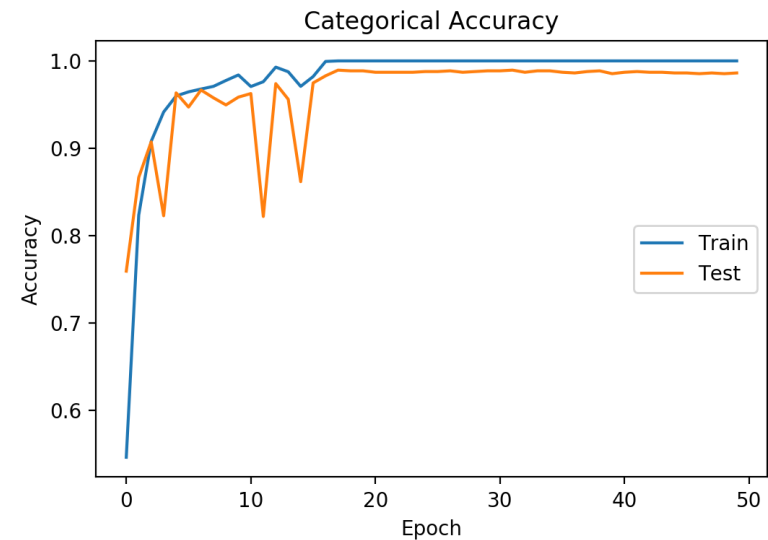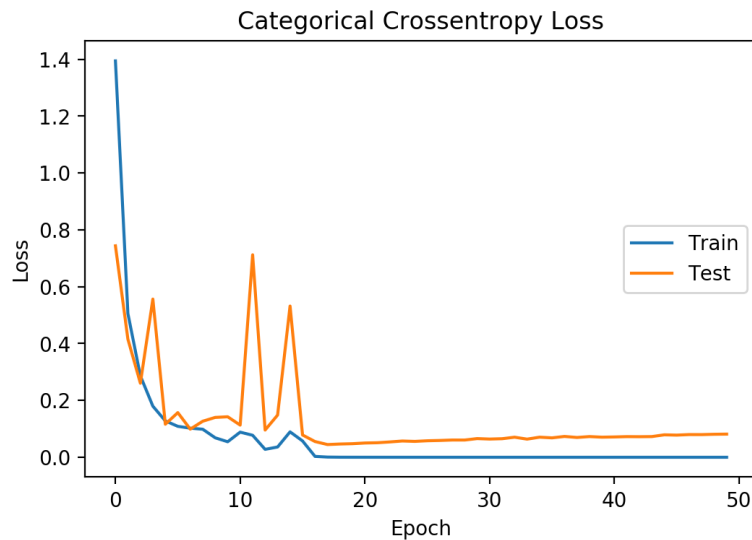
ResNet-50 Performance
False Predictions
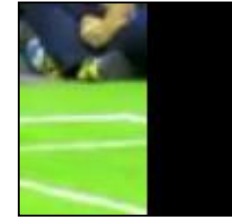

Robot foot
(Ball)

Goal post
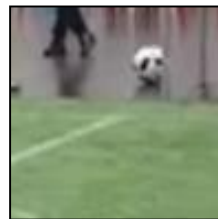
Goal post
(Obstacle)
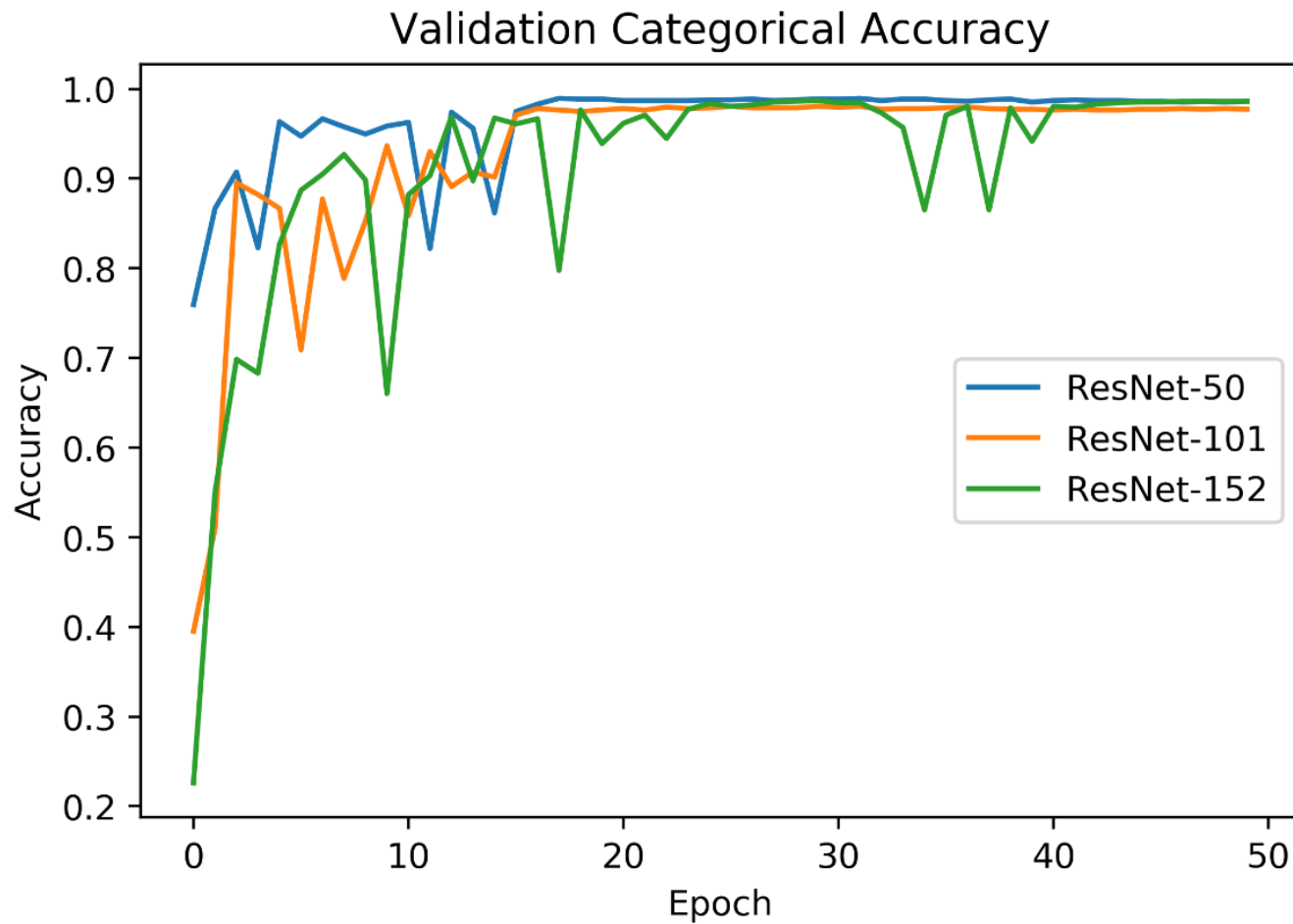
T-Line
(L-Line)

Robot foot
(X-Line)

Goal post
(T-Line)

Penalty spot

Obstacle
(Robot foot)
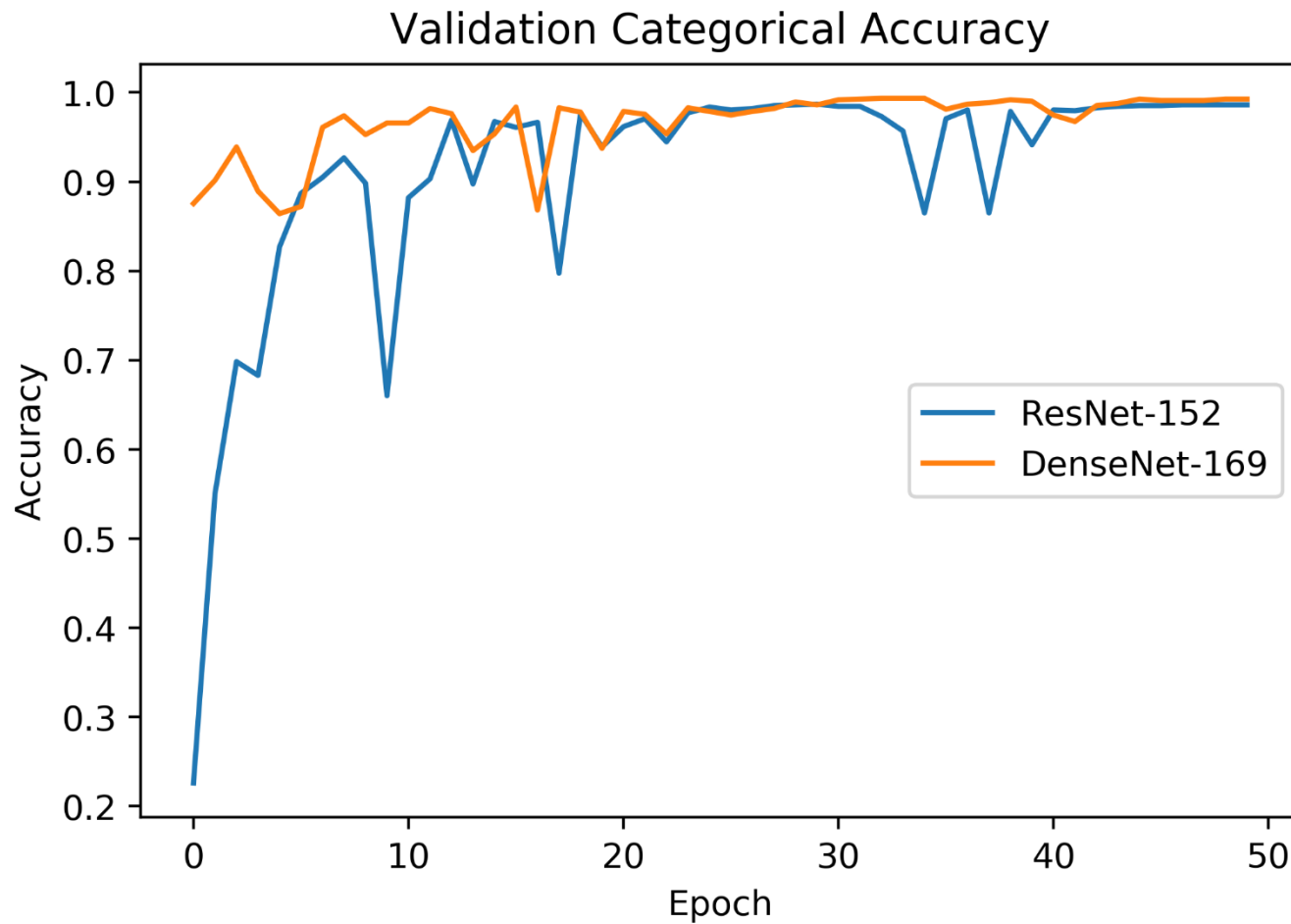
ResNet-50 -101 -152

Validation Categorical Accuracy

ResNet-152 & DenseNet-169

Validation Categorical Accuracy

Literature

- Colab Notebook:

  https://github.com/abieren/DL-Seminar-ResNet-DenseNet

- Source code and documentation:

  Keras ResNet Documentation
  https://keras.io/applications/#resnet

  "Tutorial Keras: Transfer Learning with ResNet50"
  https://www.kaggle.com/suniliitb96/tutorial-keras-transfer-learning-with-resnet50

  GitHub: „How to add and remove new layers in keras after loading weights?"
  https://stackoverflow.com/questions/41668813/how-to-add-and-remove-new-layers-in-keras-after-loading-weights

- ResNet Paper:
  „Deep Residual Learning for Image Recognition"
  https://arxiv.org/abs/1512.03385

- DenseNet Paper:
  „Densely Connected Convolutional Networks"
  https://arxiv.org/abs/1608.06993

- Sweaty HS Offenburg:

  https://sweaty.hs-offenburg.de/projekt/